

PHYSICS



EXAM QUESTION PACK

9 ELECTRICITY

SCORE

/

PERCENTAGE

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Chapter 11

Current of electricity

11.1 Electric current

1080. 9702_m20_qp_12 Q: 32

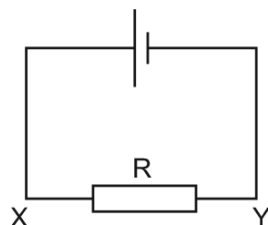
Electrons move in a vacuum from one metal plate to another metal plate. As a result of this, there is an electric current of $48\text{ }\mu\text{A}$ between the two plates.

How many electrons are emitted by the first plate in a time of 5.0 minutes?

- A** 1.4×10^4 **B** 1.5×10^{15} **C** 1.8×10^{16} **D** 9.0×10^{16}

1081. 9702_s20_qp_11 Q: 33

The current in the circuit shown is 3.2 mA .



What are the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow/ s^{-1}
A	X to Y	2.0×10^{16}
B	X to Y	5.1×10^{-22}
C	Y to X	2.0×10^{16}
D	Y to X	5.1×10^{-22}

1082. 9702_s20_qp_12 Q: 33

The number density of free electrons in copper is $8.0 \times 10^{28} \text{ m}^{-3}$.

A copper wire has diameter 0.42 mm.

What is the average drift speed of the free electrons in the wire when the current in the wire is 0.57 A?

- A $8.0 \times 10^{-11} \text{ ms}^{-1}$
- B $3.2 \times 10^{-10} \text{ ms}^{-1}$
- C $8.0 \times 10^{-5} \text{ ms}^{-1}$
- D $3.2 \times 10^{-4} \text{ ms}^{-1}$

1083. 9702_s20_qp_13 Q: 33

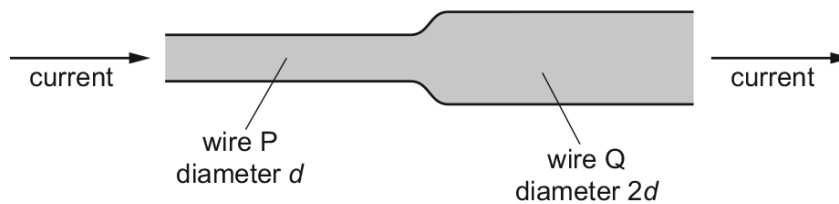
The unit of electric charge is the coulomb.

What is meant by 1 coulomb?

- A the charge passing a point in 1 second when a current produces 1 joule of work
- B the charge passing a point in 1 second when a current produces 1 watt of power
- C the charge passing a point in 1 second when there is a current of 1 ampere
- D the charge passing a point in 1 second when there is 1 ohm of resistance

1084. 9702_s20_qp_13 Q: 34

Two copper wires are joined together and carry a current, as shown.



Wire P has diameter d and wire Q has diameter $2d$.

What is the ratio $\frac{\text{average drift speed of the free electrons in wire P}}{\text{average drift speed of the free electrons in wire Q}}$?

- A $\frac{1}{4}$
- B $\frac{1}{2}$
- C 2
- D 4

1085. 9702_m19_qp_12 Q: 32

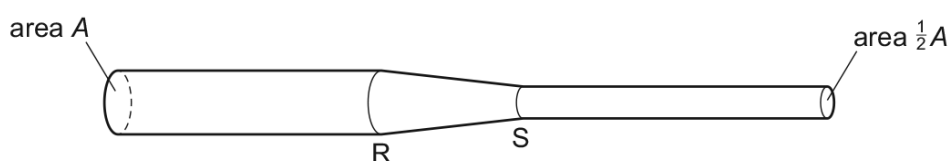
The electric current in a wire may be calculated using the equation $I = Anvq$.

Which statement is **not** correct?

- A n is the number of charge carriers per unit volume of the wire.
- B nA is the number of charge carriers per unit length of the wire.
- C q is the charge of each charge carrier.
- D v is the velocity of each charge carrier.

1086. 9702_s19_qp_12 Q: 33

A length of wire is connected into a circuit.



The area of the cross-section of the wire changes from A at R to $\frac{1}{2}A$ at S.

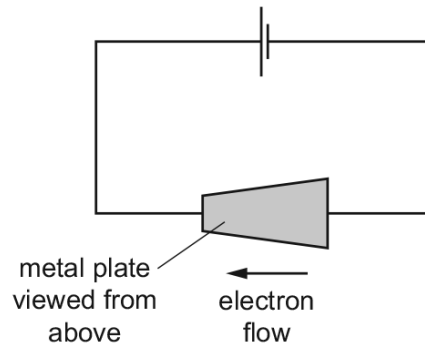
There is a constant current in the wire. Charge Q passes R in time t .

What is the charge passing point S in the same time t ?

- A $\frac{1}{2}Q$
- B Q
- C $Q\sqrt{2}$
- D $2Q$

1087. 9702_w19_qp_11 Q: 30

A metal plate of uniform thickness is connected to a cell as shown.



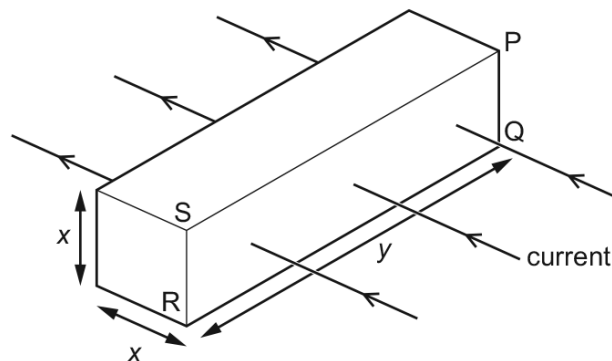
Electrons move clockwise around the circuit.

Which statement about the metal plate is correct?

- A** The average drift speed of the conduction electrons decreases as they move from right to left through the plate.
- B** The average drift speed of the conduction electrons increases as they move from right to left through the plate.
- C** The number density of the conduction electrons decreases from right to left through the plate.
- D** The number density of the conduction electrons increases from right to left through the plate.

1088. 9702_w19_qp_11 Q: 31

The diagram shows the direction of the current in a metal block. The charge carriers enter the block through the face PQRS and leave the block through the opposite face.



The number density of charge carriers is n . Each charge carrier has charge e . The average drift speed of the charge carriers is v .

Which expression gives the current in the block?

- A** $envx^2$
- B** $envxy$
- C** $envx^3y^2$
- D** $envx^4y$

1089. 9702_w19_qp_12 Q: 31

When the current in a wire is 5.0 A, the average drift speed of the conduction electrons in the wire is $7.4 \times 10^{-4} \text{ m s}^{-1}$.

Which row gives a possible cross-sectional area and number of conduction electrons per unit volume for this wire?

	cross-sectional area / m^2	number of conduction electrons per unit volume / m^{-3}
A	7.2×10^{-7}	1.2×10^{28}
B	7.2×10^{-7}	5.9×10^{28}
C	2.3×10^{-6}	7.3×10^{26}
D	2.3×10^{-6}	3.7×10^{27}

1090. 9702_w19_qp_13 Q: 33

A metal electrical conductor has a resistance of $5.6 \text{ k}\Omega$. A potential difference (p.d.) of 9.0 V is applied across its ends.

How many electrons pass a point in the conductor in one minute?

- A** 6.0×10^{20} **B** 1.0×10^{19} **C** 6.0×10^{17} **D** 1.0×10^{16}

1091. 9702_m18_qp_12 Q: 35

Charge carriers, each of charge q , move along a wire of fixed length. The number density of the charge carriers in the wire is n .

What is also required, for this wire, to determine the average drift velocity of the charge carriers in terms of n and q ?

- A** current per unit of cross-sectional area
B potential difference per unit of length
C resistance and cross-sectional area
D resistivity and length

1092. 9702_s18_qp_11 Q: 30

The current I in a metal wire is given by the expression shown.

$$I = Anvq$$

What does the symbol n represent?

- A the number of atoms per unit volume of the metal
- B the number of free electrons per atom in the metal
- C the number of free electrons per unit volume of the metal
- D the total number of electrons per unit volume of the metal

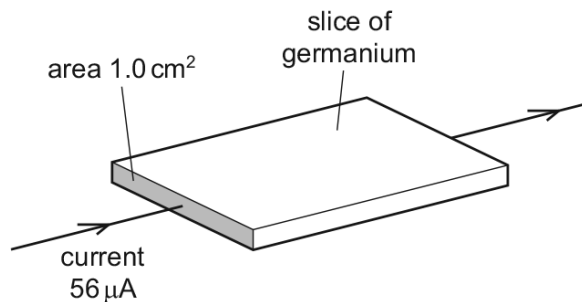
1093. 9702_s18_qp_13 Q: 29

What is a possible charge on a particle?

- A $6.40 \times 10^{-20} \text{ C}$
- B $4.00 \times 10^{-19} \text{ C}$
- C $1.12 \times 10^{-18} \text{ C}$
- D $9.11 \times 10^{-18} \text{ C}$

1094. 9702_s18_qp_13 Q: 30

A slice of germanium of cross-sectional area 1.0 cm^2 carries a current of $56 \mu\text{A}$. The number density of charge carriers in the germanium is $2.0 \times 10^{13} \text{ cm}^{-3}$. Each charge carrier has a charge equal to the charge on an electron.



What is the average drift velocity of the charge carriers in the germanium?

- A 0.18 ms^{-1}
- B 18 ms^{-1}
- C 180 ms^{-1}
- D 1800 ms^{-1}

1095. 9702_w18_qp_11 Q: 33

When there is a current of 5.0 A in a copper wire, the average drift velocity of the free electrons is $8.0 \times 10^{-4} \text{ ms}^{-1}$.

What is the average drift velocity in a different copper wire that has twice the diameter and a current of 10.0 A?

- A $4.0 \times 10^{-4} \text{ ms}^{-1}$
 - B $8.0 \times 10^{-4} \text{ ms}^{-1}$
 - C $1.6 \times 10^{-3} \text{ ms}^{-1}$
 - D $3.2 \times 10^{-3} \text{ ms}^{-1}$
-

1096. 9702_w18_qp_12 Q: 33

Which two units are used to define the coulomb?

- A ampere and second
 - B ampere and volt
 - C volt and ohm
 - D volt and second
-

1097. 9702_w18_qp_13 Q: 32

The current I in a copper wire can be calculated using the equation shown.

$$I = Anvq$$

What does the symbol v represent?

- A the average drift velocity of the charge carriers
 - B the instantaneous velocity of the charge carriers
 - C the voltage applied across the wire
 - D the volume of the wire
-

1098. 9702_m17_qp_12 Q: 32

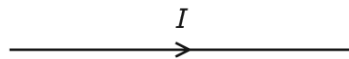
An electric current I is given in the list of formulae on page 3 as $I = Anvq$.

What do each of the symbols represent for an electric current in a metal wire?

	A	n	v	q
A	area of cross-section	number of free electrons	voltage	charge of each molecule
B	area of cross-section	number of free electrons per unit volume	average drift speed of electrons	charge of each electron
C	current	number of free electrons	average drift speed of electrons	charge of each molecule
D	current	number of free electrons per unit volume	voltage	charge of each electron

1099. 9702_s17_qp_11 Q: 32

The diagram shows the symbol for a wire carrying a current I .



What does this current represent?

- A** the charge flowing past a point in the wire per unit time
- B** the number of electrons flowing past a point in the wire per unit time
- C** the number of positive ions flowing past a point in the wire per unit time
- D** the number of protons flowing past a point in the wire per unit time

1100. 9702_s17_qp_12 Q: 32

The current in a circuit component is $2.00\mu\text{A}$.

How many electrons pass through the component each second?

- A** 1.25×10^{13}
- B** 1.25×10^{16}
- C** 1.25×10^{19}
- D** 1.25×10^{25}

1101. 9702_s17_qp_13 Q: 31

Two metal plates are a distance of 30 cm apart in a vacuum.

A current exists between the two plates consisting of electrons moving at a constant speed of $1.5 \times 10^6 \text{ ms}^{-1}$.

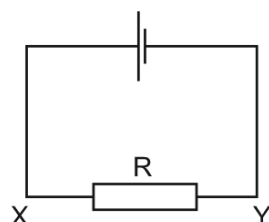
At any instant, there is always just one electron travelling between the plates.

What is the current between the plates?

- A** $3.2 \times 10^{-26} \text{ A}$
- B** $8.0 \times 10^{-13} \text{ A}$
- C** $1.6 \times 10^{-12} \text{ A}$
- D** $2.0 \times 10^{-7} \text{ A}$

1102. 9702_w17_qp_11 Q: 33

The current in the circuit shown is 3.2 mA.

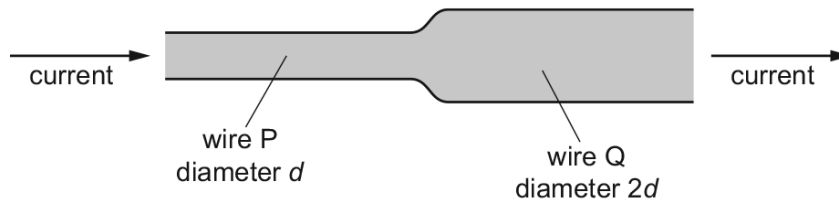


What are the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow / s^{-1}
A	X to Y	2.0×10^{16}
B	X to Y	5.1×10^{-22}
C	Y to X	2.0×10^{16}
D	Y to X	5.1×10^{-22}

1103. 9702_w17_qp_12 Q: 33

Two copper wires are joined together and carry a current, as shown.



Wire P has diameter d and wire Q has diameter $2d$.

What is the ratio $\frac{\text{average drift speed of the free electrons in wire P}}{\text{average drift speed of the free electrons in wire Q}}$?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

1104. 9702_w17_qp_13 Q: 33

The number density of conduction electrons in copper is $8.0 \times 10^{28} \text{ m}^{-3}$.

What is the average drift speed of electrons in a copper wire of diameter 0.42 mm when the current in the wire is 0.57 A?

- A** $8.0 \times 10^{-11} \text{ ms}^{-1}$
B $3.2 \times 10^{-10} \text{ ms}^{-1}$
C $8.0 \times 10^{-5} \text{ ms}^{-1}$
D $3.2 \times 10^{-4} \text{ ms}^{-1}$

1105. 9702_m16_qp_12 Q: 30

An electrical conductor has a resistance of $5.6 \text{ k}\Omega$. A potential difference (p.d.) of 9.0 V is applied across its ends.

How many electrons pass a point in the conductor in one minute?

- A** 6.0×10^{20} **B** 1.0×10^{19} **C** 6.0×10^{17} **D** 1.0×10^{16}

1106. 9702_s16_qp_13 Q: 31

In an electrolyte, the electric current is carried by charged particles (ions) in solution.

What is **not** a possible value for the charge on an ion in solution?

- A** $-4.8 \times 10^{-19} \text{ C}$
 - B** $+1.6 \times 10^{-19} \text{ C}$
 - C** $+3.2 \times 10^{-19} \text{ C}$
 - D** $+4.0 \times 10^{-19} \text{ C}$
-

1107. 9702_w16_qp_12 Q: 33

A wire carries a current of 2.0 A for 1.0 hour.

How many electrons pass a point in the wire in this time?

- A** 1.2×10^{-15}
 - B** 7.2×10^3
 - C** 1.3×10^{19}
 - D** 4.5×10^{22}
-

11.2 Potential difference and power

1108. 9702_s20_qp_12 Q: 34

An electric kettle is rated at 2.0 kW, which describes the power supplied to the heating coil in the kettle.

The coil has a resistance of 5.0 k Ω .

What is the current in the coil?

- A** 0.40 A
 - B** 0.63 A
 - C** 1.6 A
 - D** 2.5 A
-

1109. 9702_m19_qp_12 Q: 16

A crane is being used to lift containers off a ship. One container has a mass of 14 000 kg and is being lifted vertically with a speed of 3.2 m s⁻¹.

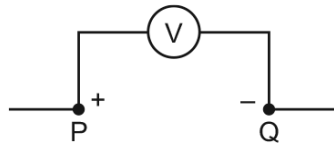
The electric motor being used to supply the power to lift the container is using a current of 240 A at a potential difference of 2200 V.

What is the efficiency of the system?

- A** 8.1%
 - B** 8.5%
 - C** 48%
 - D** 83%
-

1110. 9702_s19_qp_11 Q: 33

A voltmeter connected between two points P and Q in an electrical circuit shows a reading of 1 V.



Which statement is correct?

- A** The energy needed to move +1 C of charge from P to Q is 1 J.
- B** The energy needed to move +1 C of charge from Q to P is 1 J.
- C** The energy needed to move one electron from P to Q is 1 J.
- D** The energy needed to move one electron from Q to P is 1 J.

1111. 9702_s19_qp_13 Q: 32

Which two units are used to define the volt?

- A** ampere and ohm
- B** coulomb and joule
- C** coulomb and ohm
- D** coulomb and second

1112. 9702_s19_qp_13 Q: 35

A wire supplying a shower heater with a current of 35 A has a resistance of 25 m Ω .

What is the power dissipated in the wire?

- A** 31 W **B** 49 W **C** 31 kW **D** 49 kW

1113. 9702_w19_qp_11 Q: 32

What could **not** be used as a unit of potential difference?

- A** A Ω **B** N m⁻¹ C⁻¹ **C** W A⁻¹ **D** (Ω W) ^{$\frac{1}{2}$}

1114. 9702_w19_qp_12 Q: 32

A fixed resistor of resistance 12Ω is connected to a battery. There is a current of 0.20 A in the resistor. The current is now doubled.

What is the new power dissipated in the resistor?

- A** 0.48 W **B** 0.96 W **C** 1.9 W **D** 4.8 W
-

1115. 9702_w19_qp_12 Q: 33

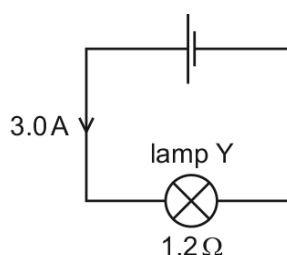
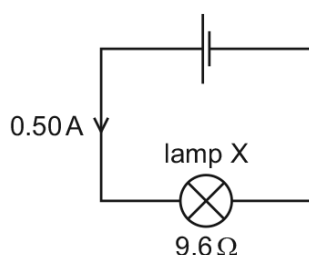
There is a current in a resistor for an unknown time.

Which two quantities can be used to calculate the energy dissipated by the resistor?

- A** the current in the resistor and the potential difference across the resistor
B the resistance of the resistor and the current in the resistor
C the total charge passing through the resistor and the potential difference across the resistor
D the total charge passing through the resistor and the resistance of the resistor
-

1116. 9702_s18_qp_11 Q: 31

The circuit diagrams show two lamps X and Y each connected to a cell. The current in lamp X is 0.50 A and its resistance is 9.6Ω . The current in lamp Y is 3.0 A and its resistance is 1.2Ω .



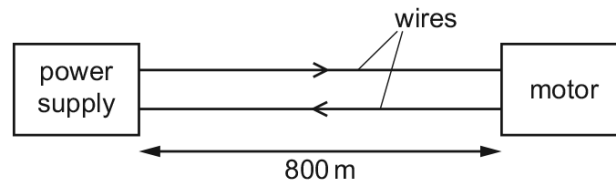
What is the ratio $\frac{\text{power in lamp X}}{\text{power in lamp Y}}$?

- A** 0.22 **B** 0.75 **C** 1.3 **D** 4.5
-

1117. 9702_s18_qp_11 Q: 37

A motor is required to operate at a distance of 800 m from its power supply. The motor requires a potential difference (p.d.) of 16.0 V and a current of 0.60 A to operate.

Two wires are used to supply power to the motor as shown.



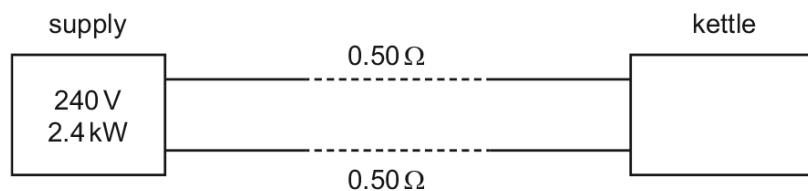
The resistance of each of these wires is 0.0050Ω per metre.

What is the minimum output p.d. of the power supply?

- A** 11.2 V **B** 16.0 V **C** 18.4 V **D** 20.8 V

1118. 9702_s18_qp_12 Q: 32

The power output of an electrical supply is 2.4 kW at a potential difference (p.d.) of 240 V. The two wires between the supply and a kettle each have a resistance of 0.50Ω , as shown.



What is the power supplied to the kettle and what is the p.d. across the kettle?

	power / kW	p.d. / V
A	2.3	230
B	2.3	235
C	2.4	230
D	2.4	235

1119. 9702_w18_qp_11 Q: 34

What is equivalent to one volt?

- A** one coulomb per second
B one joule per coulomb
C one joule per second
D one joule second per coulomb squared

1120. 9702_m17_qp_12 Q: 33

The potential difference across a resistor is 12V. The current in the resistor is 2.0A.

A charge of 4.0C passes through the resistor.

What is the energy transferred in the resistor and the time taken for the charge to pass through the resistor?

	energy / J	time / s
A	3.0	2.0
B	3.0	8.0
C	48	2.0
D	48	8.0

1121. 9702_s17_qp_11 Q: 33

Which values of current and resistance will produce a rate of energy transfer of 16 J s^{-1} ?

	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

1122. 9702_s17_qp_12 Q: 33

The filament of a 240V, 100W electric lamp heats up from room temperature to its operating temperature. As it heats up, its resistance increases by a factor of 16.

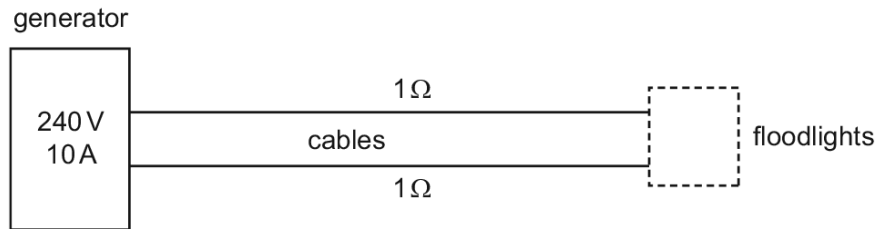
What is the resistance of the filament at room temperature?

A 36Ω **B** 580Ω **C** $1.5 \text{ k}\Omega$ **D** $9.2 \text{ k}\Omega$

1123. 9702_s17_qp_13 Q: 32

The diagram shows a portable generator connected by cables to floodlights. The generator produces a current of 10 A at a constant potential difference (p.d.) of 240 V.

The total resistance of the cables is $2\ \Omega$.



What is the p.d. V across, and the power P delivered to, the floodlights?

	V/V	P/W
A	220	2000
B	220	2200
C	230	2000
D	230	2300

1124. 9702_w17_qp_11 Q: 34

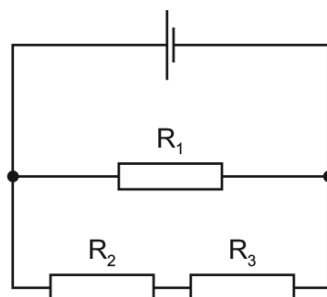
A filament lamp has a resistance of $180\ \Omega$ when the current in it is 500 mA.

What is the power dissipated in the lamp?

- A** 45 W **B** 90 W **C** 290 W **D** 360 W

1125. 9702_w17_qp_12 Q: 34

A cell of negligible internal resistance is connected to resistors R_1 , R_2 and R_3 , as shown. The cell provides power to the circuit and power is dissipated in the resistors.



Which word equation **must** be correct?

- A power loss in R_1 = power loss in R_2 + power loss in R_3
- B power loss in R_2 = power loss in R_3
- C power output of cell = power loss in R_1 + power loss in R_2 + power loss in R_3
- D power output of cell = power loss in R_1

1126. 9702_m16_qp_12 Q: 31

A fixed resistor of resistance 12Ω is connected to a battery. There is a current of 0.20A in the resistor. The current is now doubled.

What is the new power dissipated in the resistor?

- A 0.48W B 0.96W C 1.92W D 4.8W

1127. 9702_m16_qp_12 Q: 33

A 12V battery is charged for 20 minutes by connecting it to a source of electromotive force (e.m.f.). The battery is supplied with $7.2 \times 10^4\text{J}$ of energy in this time.

How much charge flows through the battery?

- A 5.0C B 60C C 100C D 6000C

1128. 9702_s16_qp_11 Q: 30

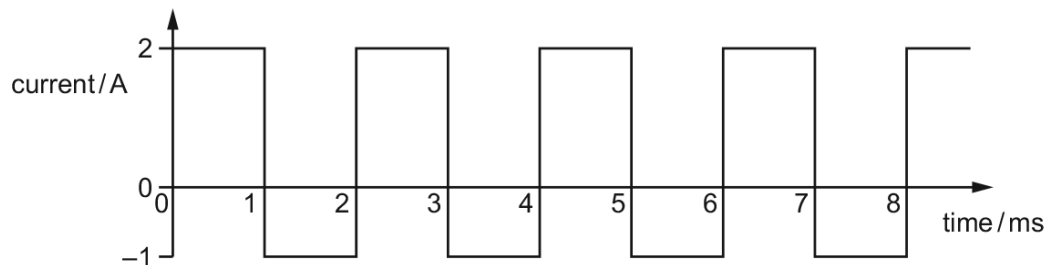
There is a current in a resistor for an unknown time.

Which two quantities can be used to calculate the energy dissipated by the resistor?

- A** the current in the resistor and the potential difference across the resistor
- B** the resistance of the resistor and the current in the resistor
- C** the total charge passing through the resistor and the potential difference across the resistor
- D** the total charge passing through the resistor and the resistance of the resistor

1129. 9702_s16_qp_11 Q: 32

A $100\ \Omega$ resistor conducts a current with changing direction and magnitude, as shown.



What is the mean power dissipated in the resistor?

- A** 100 W
- B** 150 W
- C** 250 W
- D** 400 W

1130. 9702_s16_qp_12 Q: 33

Two lamps are connected in series to a 250 V power supply. One lamp is rated 240 V, 60 W and the other is rated 10 V, 2.5 W.

Which statement most accurately describes what happens?

- A** Both lamps light at less than their normal brightness.
- B** Both lamps light at their normal brightness.
- C** Only the 240 V lamp lights.
- D** The 10 V lamp blows.

1131. 9702_s16_qp_13 Q: 33

What describes the electric potential difference between two points in a wire that carries a current?

- A** the force required to move a unit positive charge between the points
- B** the ratio of the energy dissipated between the points to the current
- C** the ratio of the power dissipated between the points to the current
- D** the ratio of the power dissipated between the points to the charge moved

1132. 9702_w16_qp_11 Q: 33

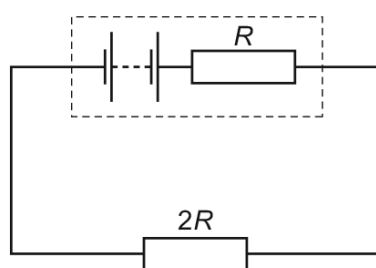
An electric kettle is marked 3.10 kW. It is used with an electrical supply of 240 V.

What is the electric current in the kettle and what is the kettle's electrical resistance when working?

	current / A	resistance / Ω
A	0.0129	18 600
B	0.0770	3100
C	12.9	18.6
D	12.9	3100

1133. 9702_w16_qp_12 Q: 34

The diagram shows an electric circuit in which the resistance of the external resistor is $2R$ and the internal resistance of the source is R .



What is the ratio $\frac{\text{power in internal resistance}}{\text{power in external resistor}}$?

- A** $\frac{1}{4}$
- B** $\frac{1}{2}$
- C** 2
- D** 4

1134. 9702_w16_qp_13 Q: 33

An electric kettle is marked 3.10 kW. It is used with an electrical supply of 240 V.

What is the electric current in the kettle and what is the kettle's electrical resistance when working?

	current / A	resistance / Ω
A	0.0129	18 600
B	0.0770	3100
C	12.9	18.6
D	12.9	3100

1135. 9702_s15_qp_11 Q: 35

The charge that an electric battery can deliver is specified in ampere-hours.

For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2 A for 200 hours.

What is the maximum energy that a fully charged 12 V, 40 ampere-hour battery could supply?

- A** 1.7 kJ **B** 29 kJ **C** 1.7 MJ **D** 29 MJ

1136. 9702_s15_qp_12 Q: 31

Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

- A** ampere
B joule
C ohm
D second

1137. 9702_s15_qp_13 Q: 32

A pedal bicycle is fitted with an electric motor. The rider switches on the motor for a time of 3.0 minutes. A constant current of 3.5 A in the electric motor is provided from a battery with a terminal voltage of 24 V.

What is the energy supplied by the battery?

- A** 84 J **B** 250 J **C** 630 J **D** 15 000 J

11.3 Resistance and resistivity

1138. 9702_m20_qp_12 Q: 34

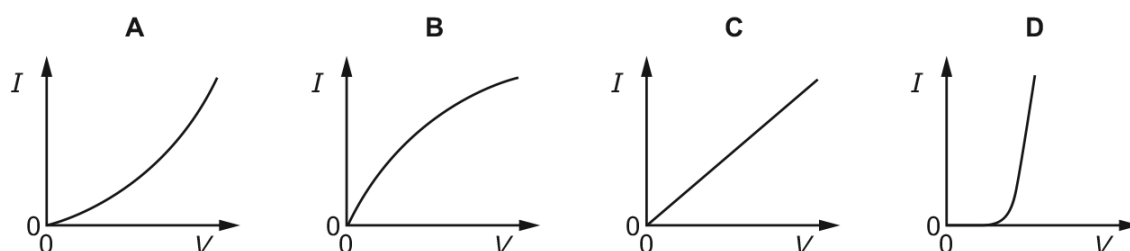
A manufacturer recommends that the longer the extension cord you use with an electric drill, the bigger the cross-sectional area of the cord should be.

What is a reason for this recommendation?

- A** Resistance is inversely proportional to both the length and the cross-sectional area.
- B** Resistance is inversely proportional to the length and directly proportional to the cross-sectional area.
- C** Resistance is proportional to both the length and the cross-sectional area.
- D** Resistance is proportional to the length and inversely proportional to the cross-sectional area.

1139. 9702_s20_qp_11 Q: 34

Which graph best represents the way the current I through a filament lamp varies with the potential difference V across it?



1140. 9702_s20_qp_11 Q: 35

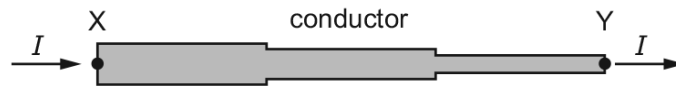
A cylindrical metal wire X has resistance R . The same volume of the same metal is made into a cylindrical wire Y of double the length.

What is the resistance of wire Y?

- A** R
 - B** $2R$
 - C** $4R$
 - D** $8R$
-

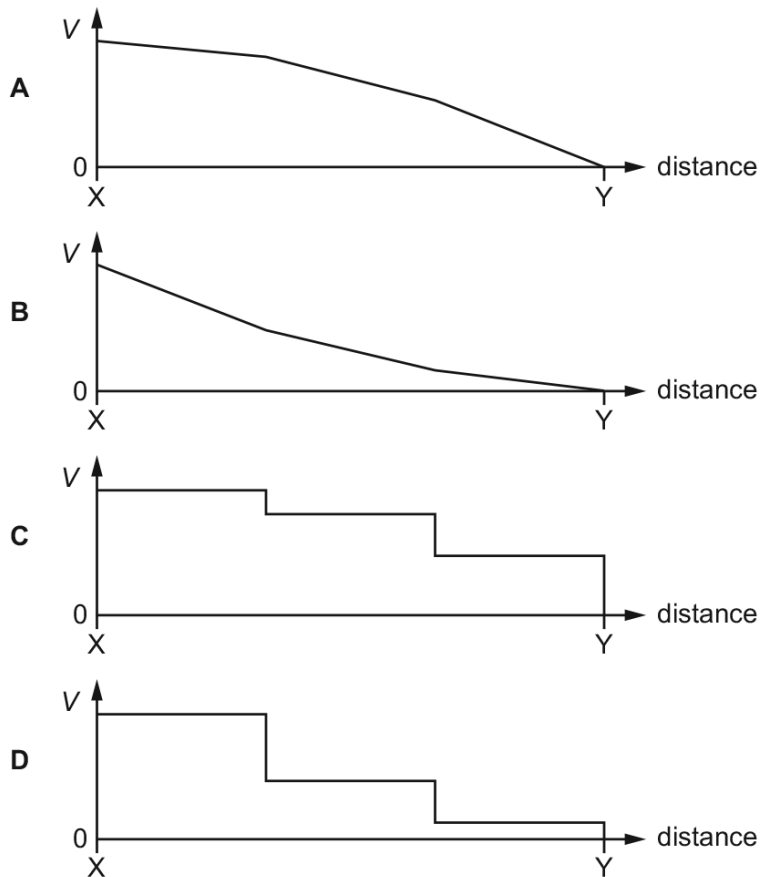
1141. 9702_s20_qp_12 Q: 35

A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current I in the conductor.



Point Y on the conductor is at zero potential.

Which graph best shows the variation of potential V with distance along the conductor?



1142. 9702_s20_qp_13 Q: 36

The wire of a heating element has resistance R . The wire breaks and is replaced by a different wire.

Data for the original wire and for the replacement wire are shown in the table.

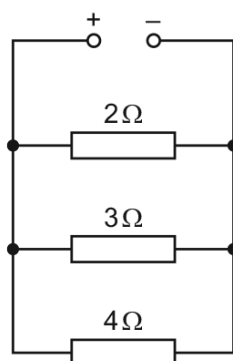
	length	diameter	resistivity of metal
original wire	l	d	ρ
replacement wire	l	$2d$	2ρ

What is the resistance of the replacement wire?

- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

1143. 9702_m19_qp_12 Q: 33

Three resistors are connected in parallel across a power supply, as shown.



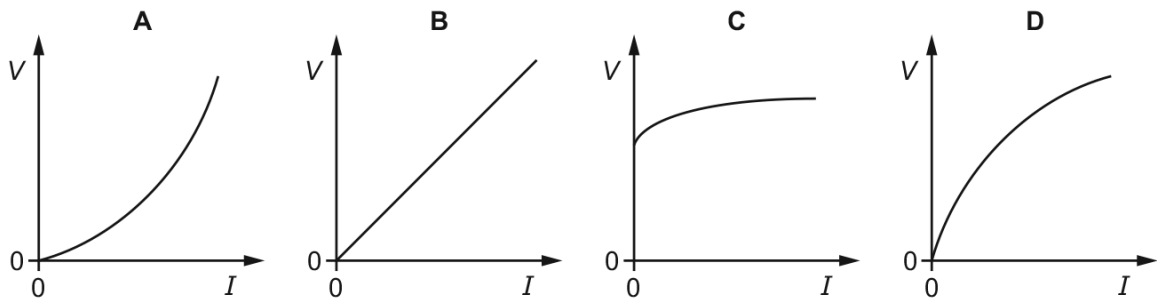
The power dissipated in each of the resistors of resistance 2Ω , 3Ω and 4Ω is P_2 , P_3 and P_4 respectively.

What is the ratio $P_2:P_3:P_4$?

- A** 2:3:4 **B** 4:3:2 **C** 6:4:3 **D** 36:16:9

1144. 9702_m19_qp_12 Q: 34

Which graph shows the variation with current I of the potential difference V of a filament lamp?



1145. 9702_m19_qp_12 Q: 35

A wire of cross-sectional area $5.0 \times 10^{-6} \text{ m}^2$ is made of a metal of resistivity $50 \times 10^{-8} \Omega \text{ m}$.

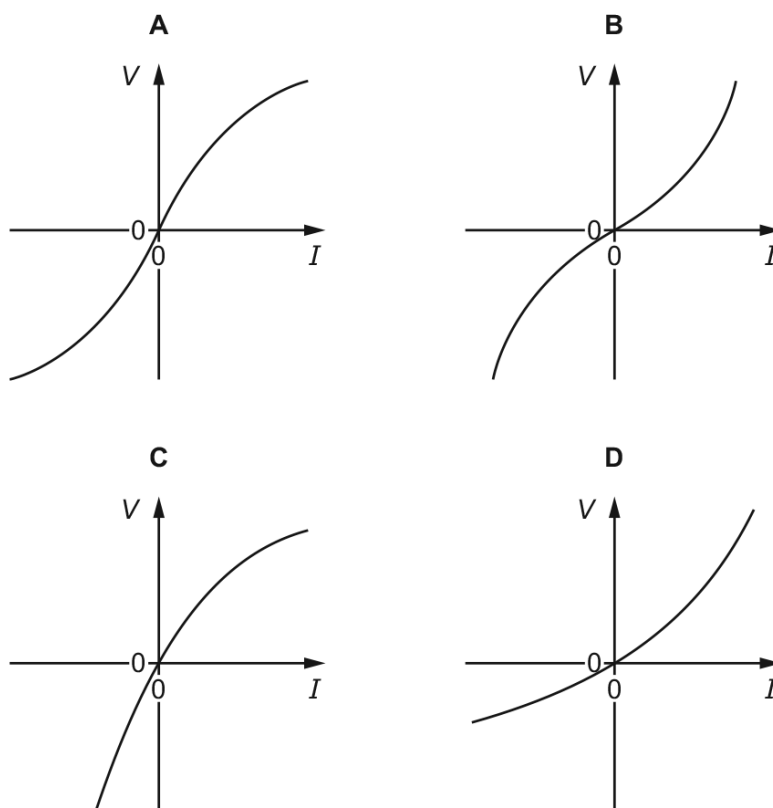
The potential difference across the wire is 6.0 V and the current is 3.0 A.

What is the length of the wire?

- A** 0.050 m **B** 0.20 m **C** 5.0 m **D** 20 m

1146. 9702_s19_qp_11 Q: 34

Which graph best represents the variation with current I of potential difference V for a filament lamp?



1147. 9702_s19_qp_12 Q: 34

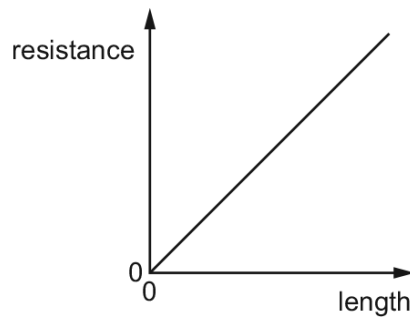
Four wires are made of the same metal. The cross-sectional areas, lengths and thermodynamic temperatures of the wires are shown.

Which wire has the largest resistance?

	cross-sectional area	length	temperature
A	A	$2L$	$2T$
B	A	L	T
C	$2A$	$2L$	$2T$
D	$2A$	L	T

1148. 9702_s19_qp_13 Q: 33

The graph shows the variation with length of the resistance of a uniform metal wire.



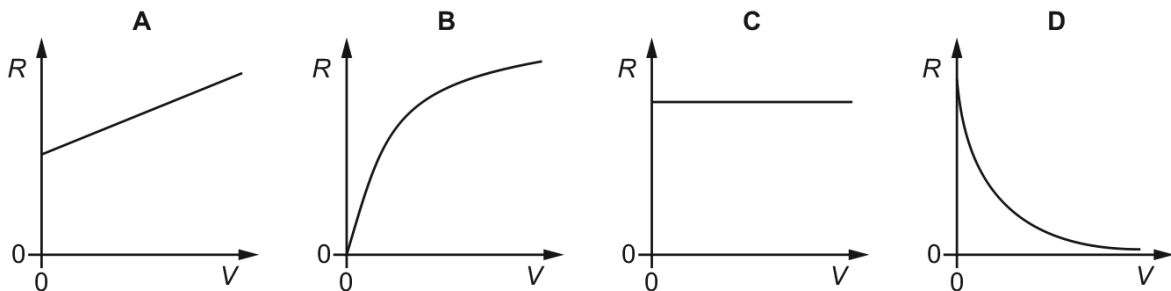
The gradient of the graph is G .
The wire has cross-sectional area A .

Which expression could be used to calculate the resistivity of the metal of the wire?

- A** $G \times A$ **B** $\frac{G}{A}$ **C** $\frac{A}{G}$ **D** $G \times A^2$

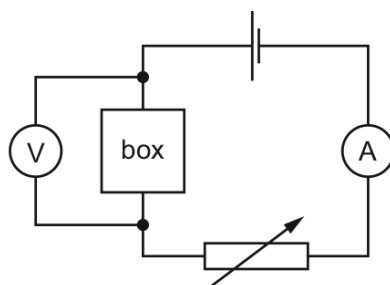
1149. 9702_w19_qp_11 Q: 33

Which graph could show how the resistance R of a filament lamp varies with the applied potential difference (p.d.) V , as V is increased to the normal operating p.d.?

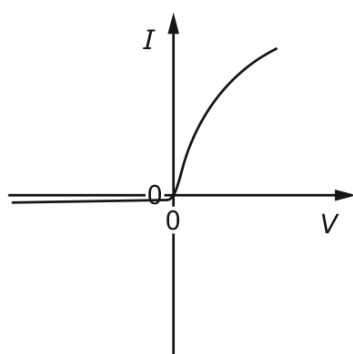


1150. 9702_w19_qp_13 Q: 35

A box containing two electrical components is connected into a circuit.



The variable resistor is adjusted and measurements are taken to determine the I – V characteristic for the box, as shown.



Which arrangement of two electrical components in the box would create the best fit to the measured I – V characteristic?

- A** a filament lamp and a fixed resistor in parallel
- B** a filament lamp and a fixed resistor in series
- C** a semiconductor diode and a filament lamp in parallel
- D** a semiconductor diode and a filament lamp in series

1151. 9702_m18_qp_12 Q: 33

A resistor has resistance R . When the potential difference across the resistor is V , the current in the resistor is I . The power dissipated in the resistor is P . Work W is done when charge Q flows through the resistor.

What is **not** a valid relationship between these variables?

- A** $I = \frac{P}{V}$
- B** $Q = \frac{W}{V}$
- C** $R = \frac{P}{I^2}$
- D** $R = \frac{V}{P}$

1152. 9702_m18_qp_12 Q: 34

A wire of resistance $9.55\ \Omega$ has a diameter of 0.280 mm .

It is made of metal of resistivity $4.90 \times 10^{-7}\ \Omega\text{ m}$.

What is the length of the wire?

- A** 1.20 m **B** 4.80 m **C** 19.0 m **D** 76.8 m
-

1153. 9702_s18_qp_11 Q: 32

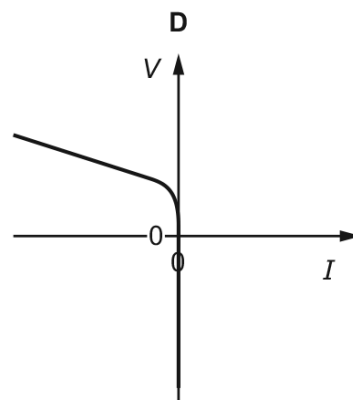
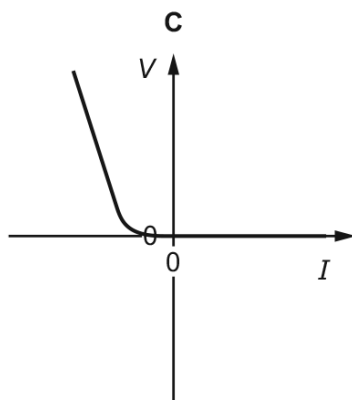
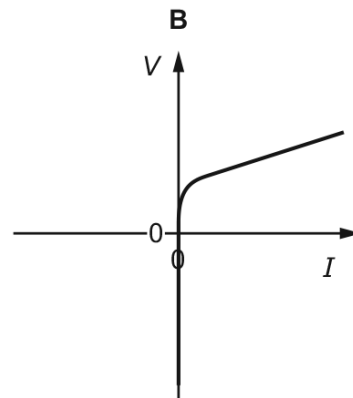
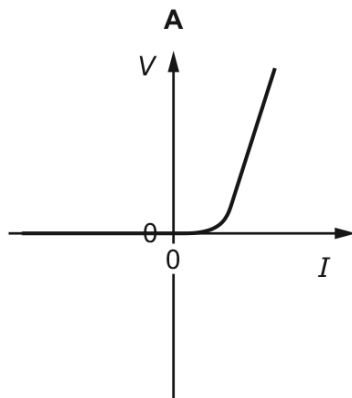
A cylindrical piece of a soft, electrically-conducting material has resistance R . It is rolled out so that its length is doubled but its volume stays constant.

What is its new resistance?

- A** $\frac{R}{2}$ **B** R **C** $2R$ **D** $4R$
-

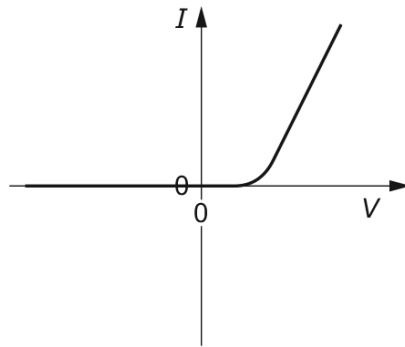
1154. 9702_s18_qp_12 Q: 33

Which graph shows the variation of voltage V with current I for a semiconductor diode?



1155. 9702_s18_qp_13 Q: 32

The graph shows the I - V characteristic of an electrical component.



What is the component?

- A** a filament lamp
- B** a metallic conductor at constant temperature
- C** a resistor
- D** a semiconductor diode

1156. 9702_s18_qp_13 Q: 33

A metal wire of length 1.4 m has a uniform cross-sectional area of $7.8 \times 10^{-7} \text{ m}^2$.

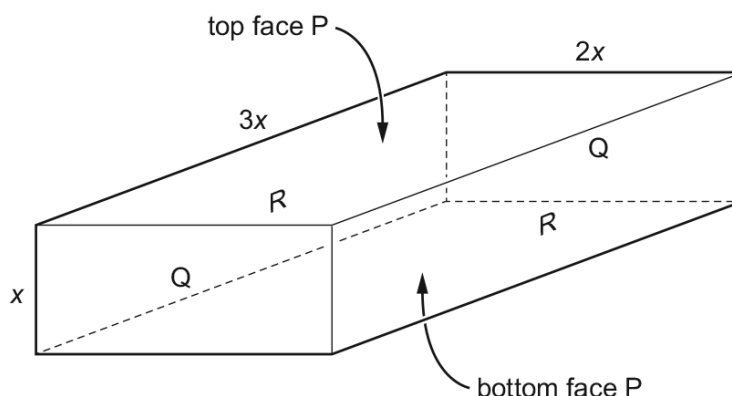
The resistivity of the metal is $1.7 \times 10^{-8} \Omega \text{ m}$.

What is the resistance of the wire?

- A** 0.016Ω
- B** 0.031Ω
- C** 33Ω
- D** 64Ω

1157. 9702_w18_qp_11 Q: 35

The diagram shows a rectangular block with dimensions x , $2x$ and $3x$.



Electrical contact can be made to the block between opposite pairs of faces (for example, between the faces labelled R).

Which statement describing the electrical resistance of the block is correct?

- A It is maximum between the faces labelled P.
- B It is maximum between the faces labelled Q.
- C It is maximum between the faces labelled R.
- D It is the same, whichever pair of faces is used.

1158. 9702_w18_qp_12 Q: 35

A wire of length L has resistance R . The cross-section of the wire is circular with radius r .

A second wire, also of circular cross-section, and of the same material, has resistance $\frac{1}{2} R$.

What could be the radius and the length of the second wire?

	radius	length
A	$\frac{r}{2}$	$\frac{L}{2}$
B	$\frac{r}{\sqrt{2}}$	$\frac{L}{2}$
C	$r\sqrt{2}$	$2L$
D	$2r$	$2L$

1159. 9702_w18_qp_13 Q: 34

Gold is sometimes used to make very small connecting wires in electronic circuits.

A particular gold wire has length $2.50 \times 10^{-3} \text{ m}$ and cross-sectional area $6.25 \times 10^{-8} \text{ m}^2$. Gold has resistivity $2.30 \times 10^{-8} \Omega \text{ m}$.

What is the resistance of the wire?

- A $3.6 \times 10^{-18} \Omega$
- B $5.8 \times 10^{-13} \Omega$
- C $9.2 \times 10^{-4} \Omega$
- D $6.8 \times 10^{-3} \Omega$

1160. 9702_m17_qp_12 Q: 34

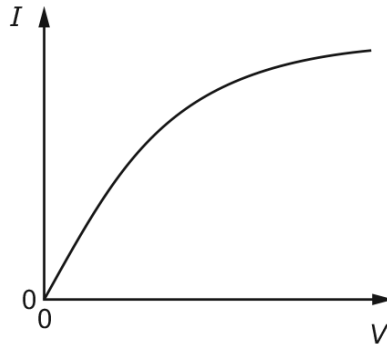
A coil contains N turns of insulated copper wire wound on to a cylindrical iron core of diameter D . The copper wire has a diameter d . The resistivity of copper is ρ . Diameter D is much greater than diameter d .

What is the total resistance between the two ends of the coil?

- A $\frac{4N\rho D}{d^2}$
- B $\frac{4N\rho d}{D^2}$
- C $\frac{8N\rho D}{d^2}$
- D $\frac{8N\rho d}{D^2}$

1161. 9702_s17_qp_11 Q: 34

Which component has the I - V graph shown?



- A filament lamp
- B metallic conductor at constant temperature
- C resistor of fixed resistance
- D semiconductor diode

1162. 9702_s17_qp_12 Q: 34

Two wires have the same length and the same resistance. Wire X is made of a metal of resistivity $1.7 \times 10^{-8} \Omega \text{ m}$ and wire Y is made of a metal of resistivity $5.6 \times 10^{-8} \Omega \text{ m}$.

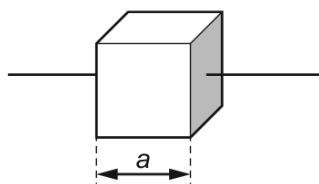
The diameter of wire X is 0.315 mm.

What is the diameter of wire Y?

- A** 0.17 mm **B** 0.33 mm **C** 0.57 mm **D** 1.0 mm

1163. 9702_s17_qp_13 Q: 33

A metal cube with sides of length a has electrical resistance R between opposite faces.

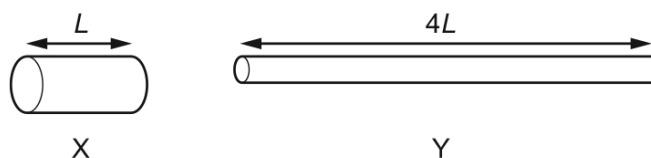


What is the resistance between the opposite faces of a cube of the same metal with sides of length $3a$?

- A** $9R$ **B** $3R$ **C** $\frac{R}{3}$ **D** $\frac{R}{9}$

1164. 9702_w17_qp_11 Q: 35

Two copper wires X and Y have the same volume. Wire Y is four times as long as wire X.

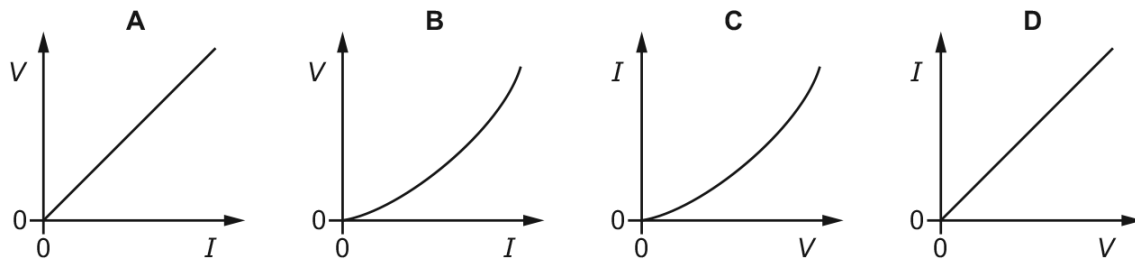


What is the ratio $\frac{\text{resistance of wire Y}}{\text{resistance of wire X}}$?

- A** 1 **B** 4 **C** 8 **D** 16

1165. 9702_w17_qp_12 Q: 35

Which graph represents a metallic conductor, where the resistance of the conductor is given by the gradient of the graph?



1166. 9702_m16_qp_12 Q: 32

Which **measurements** are taken in order to calculate the resistivity of the metal of a piece of wire?

- A** p.d., current, area, length
- B** p.d., current, diameter, length
- C** resistance, area, length
- D** resistance, length, radius

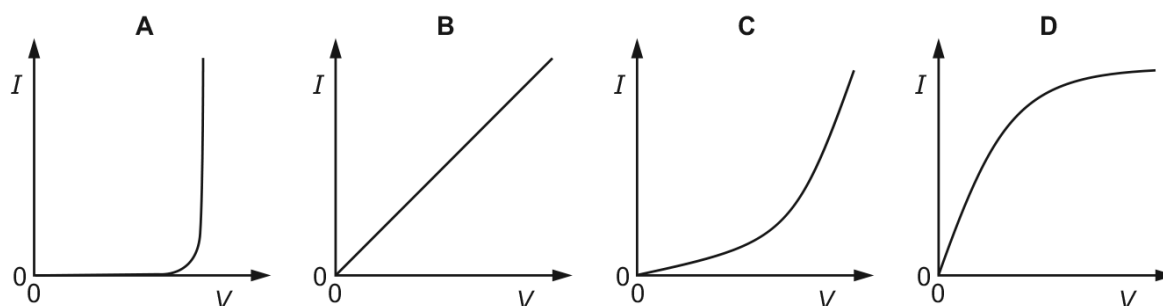
1167. 9702_s16_qp_11 Q: 31

Two copper wires of equal length are connected in parallel. A potential difference is applied across the ends of this parallel arrangement. Wire S has a diameter of 3.0 mm. Wire T has a diameter of 1.5 mm.

What is the value of the ratio $\frac{\text{current in S}}{\text{current in T}}$?

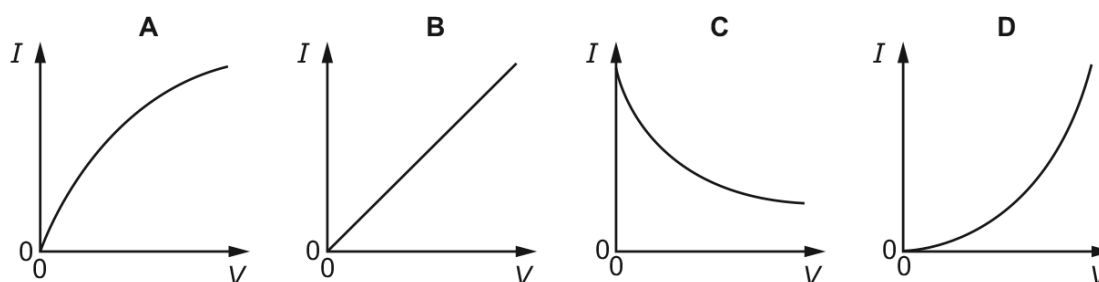
- A** $\frac{1}{4}$
- B** $\frac{1}{2}$
- C** 2
- D** 4

1168. 9702_s16_qp_11 Q: 33

Which graph shows the I - V characteristic of a filament lamp?

1169. 9702_s16_qp_12 Q: 32

The potential difference V across a filament lamp is slowly raised from zero to its normal operating value.

Which graph represents the variation with V of the current I in the lamp?

1170. 9702_s16_qp_12 Q: 34

Which equation is used to define resistance?

- A** energy = (current)² × resistance × time
- B** potential difference = current × resistance
- C** power = (current)² × resistance
- D** resistivity = resistance × area ÷ length

1171. 9702_s16_qp_12 Q: 35

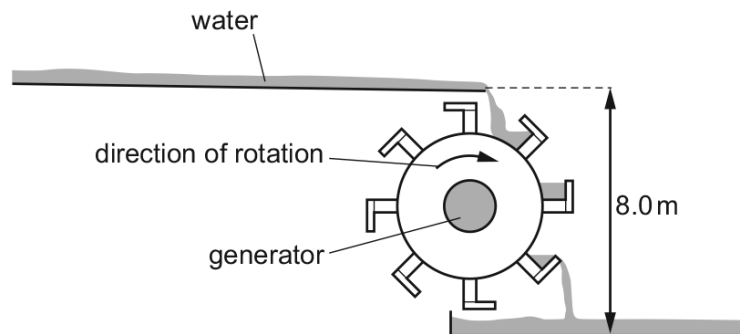
The charge that a fully charged 12 V car battery can supply is 100 kC. The starter motor of the car requires a current of 200 A for an average period of 2.0 s. The battery does not recharge because of a fault.

What is the maximum number of times the starter motor of the car can be used?

- A** 21 **B** 25 **C** 42 **D** 250

1172. 9702_s16_qp_13 Q: 19

The diagram shows the design of a water wheel which drives a generator to produce electrical power. The flow rate of the water is 200 kg s^{-1} . The generator supplies a current of 32 A at a voltage of 230 V.

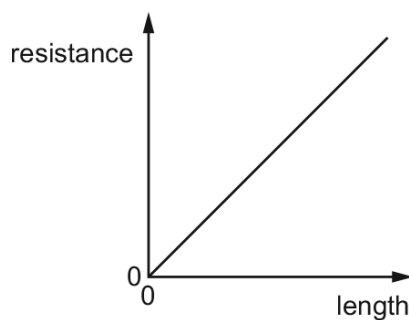


Ignoring any changes in kinetic energy of the water, what is the efficiency of the system?

- A** 14% **B** 16% **C** 22% **D** 47%

1173. 9702_s16_qp_13 Q: 32

The graph shows the variation with length of the resistance of a uniform metal wire.



The gradient of the graph is G .

The wire has cross-sectional area A .

Which expression could be used to calculate the resistivity of the metal of the wire?

A $G \times A$

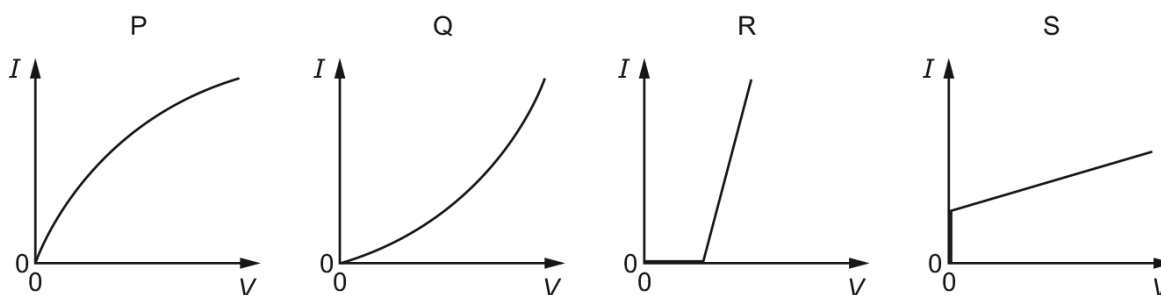
B $\frac{G}{A}$

C $\frac{A}{G}$

D $G \times A^2$

1174. 9702_s16_qp_13 Q: 34

The graphs show possible current-voltage (I - V) characteristics for a filament lamp and for a semiconductor diode.

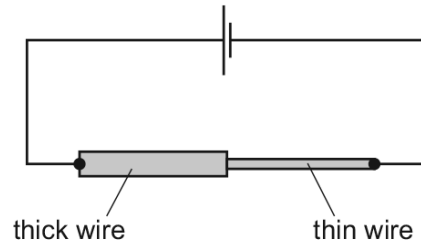


Which row in the table best specifies the correct I - V graphs for the lamp and for the diode?

	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

1175. 9702_w16_qp_11 Q: 34

A thick copper wire is connected to a thin copper wire in series with a cell, as shown.



What is significantly **less** in the thick wire than in the thin wire?

- A the charge passing a point per unit time
- B the drift speed of the electrons
- C the number density of the free electrons
- D the number of free electrons passing a point per unit time

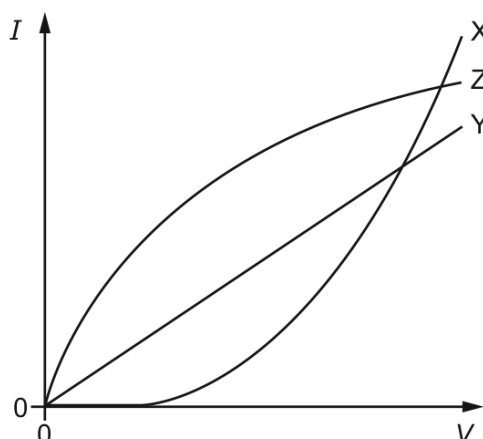
1176. 9702_w16_qp_11 Q: 35

What is a typical value for the order of magnitude of the resistivity of copper?

- A $10^{-13} \Omega \text{m}$ B $10^{-8} \Omega \text{m}$ C $10^{-3} \Omega \text{m}$ D $10^2 \Omega \text{m}$

1177. 9702_w16_qp_12 Q: 35

The graph shows the variation with potential difference V of the current I in components X, Y and Z.

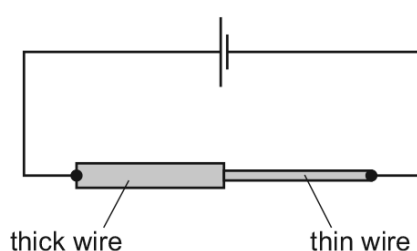


Which row correctly identifies the components?

	metallic conductor at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	Y	X

1178. 9702_w16_qp_13 Q: 34

A thick copper wire is connected to a thin copper wire in series with a cell, as shown.



What is significantly **less** in the thick wire than in the thin wire?

- A** the charge passing a point per unit time
- B** the drift speed of the electrons
- C** the number density of the free electrons
- D** the number of free electrons passing a point per unit time

1179. 9702_w16_qp_13 Q: 35

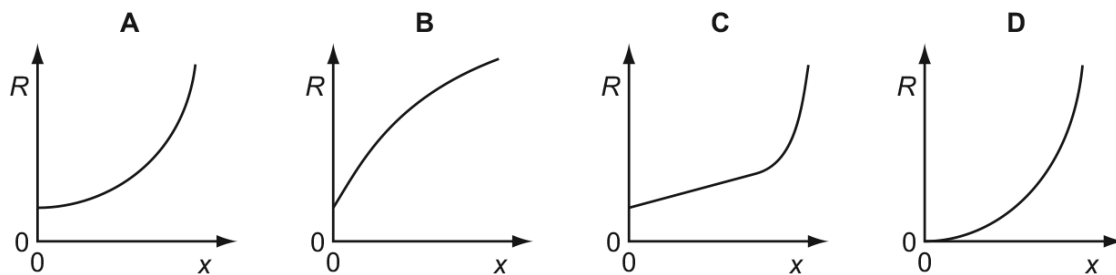
What is a typical value for the order of magnitude of the resistivity of copper?

- A** $10^{-13} \Omega \text{m}$ **B** $10^{-8} \Omega \text{m}$ **C** $10^{-3} \Omega \text{m}$ **D** $10^2 \Omega \text{m}$
-

1180. 9702_s15_qp_12 Q: 32

When a thin metal wire is stretched, it becomes longer and thinner. This causes a change in the resistance of the wire. The volume of the wire remains constant.

Which graph could represent the variation with extension x of the resistance R of the wire?



Paper 1 Multiple Choice Answers: Electricity

Question	Paper	Q. No.	Answer
1080	9702_m20_qp_12	32	D
1081	9702_s20_qp_11	33	C
1082	9702_s20_qp_12	33	D
1083	9702_s20_qp_13	33	C
1084	9702_s20_qp_13	34	D
1085	9702_m19_qp_12	32	D
1086	9702_s19_qp_12	33	B
1087	9702_w19_qp_11	30	B
1088	9702_w19_qp_11	31	B
1089	9702_w19_qp_12	31	B
1090	9702_w19_qp_13	33	C
1091	9702_m18_qp_12	35	A
1092	9702_s18_qp_11	30	C
1093	9702_s18_qp_13	29	C
1094	9702_s18_qp_13	30	A
1095	9702_w18_qp_11	33	A
1096	9702_w18_qp_12	33	A
1097	9702_w18_qp_13	32	A
1098	9702_m17_qp_12	32	B
1099	9702_s17_qp_11	32	A
1100	9702_s17_qp_12	32	A
1101	9702_s17_qp_13	31	B
1102	9702_w17_qp_11	33	C
1103	9702_w17_qp_12	33	D
1104	9702_w17_qp_13	33	D
1105	9702_m16_qp_12	30	C
1106	9702_s16_qp_13	31	D
1107	9702_w16_qp_12	33	D
1108	9702_s20_qp_12	34	B
1109	9702_m19_qp_12	16	D
1110	9702_s19_qp_11	33	B
1111	9702_s19_qp_13	32	B
1112	9702_s19_qp_13	35	A
1113	9702_w19_qp_11	32	B
1114	9702_w19_qp_12	32	C
1115	9702_w19_qp_12	33	C
1116	9702_s18_qp_11	31	A
1117	9702_s18_qp_11	37	D
1118	9702_s18_qp_12	32	A
1119	9702_w18_qp_11	34	B
1120	9702_m17_qp_12	33	C
1121	9702_s17_qp_11	33	C
1122	9702_s17_qp_12	33	A
1123	9702_s17_qp_13	32	B
1124	9702_w17_qp_11	34	A
1125	9702_w17_qp_12	34	C

Paper 1 Multiple Choice Answers: Electricity (continued)

Question	Paper	Q. No.	Answer
1126	9702_m16_qp_12	31	C
1127	9702_m16_qp_12	33	D
1128	9702_sl6_qp_11	30	C
1129	9702_sl6_qp_11	32	C
1130	9702_sl6_qp_12	33	B
1131	9702_sl6_qp_13	33	C
1132	9702_w16_qp_11	33	C
1133	9702_w16_qp_12	34	B
1134	9702_w16_qp_13	33	C
1135	9702_sl5_qp_11	35	C
1136	9702_sl5_qp_12	31	C
1137	9702_sl5_qp_13	32	D
1138	9702_m20_qp_12	34	D
1139	9702_s20_qp_11	34	B
1140	9702_s20_qp_11	35	C
1141	9702_s20_qp_12	35	A
1142	9702_s20_qp_13	36	B
1143	9702_m19_qp_12	33	C
1144	9702_m19_qp_12	34	A
1145	9702_m19_qp_12	35	D
1146	9702_sl9_qp_11	34	B
1147	9702_sl9_qp_12	34	A
1148	9702_sl9_qp_13	33	A
1149	9702_w19_qp_11	33	A
1150	9702_w19_qp_13	35	D
1151	9702_m18_qp_12	33	D
1152	9702_m18_qp_12	34	A
1153	9702_sl8_qp_11	32	D
1154	9702_sl8_qp_12	33	B
1155	9702_sl8_qp_13	32	D
1156	9702_sl8_qp_13	33	B
1157	9702_w18_qp_11	35	B
1158	9702_w18_qp_12	35	D
1159	9702_w18_qp_13	34	C
1160	9702_m17_qp_12	34	A
1161	9702_sl7_qp_11	34	A
1162	9702_sl7_qp_12	34	C
1163	9702_sl7_qp_13	33	C
1164	9702_w17_qp_11	35	D
1165	9702_w17_qp_12	35	A
1166	9702_m16_qp_12	32	B
1167	9702_sl6_qp_11	31	D
1168	9702_sl6_qp_11	33	D
1169	9702_sl6_qp_12	32	A
1170	9702_sl6_qp_12	34	B
1171	9702_sl6_qp_12	35	D

Paper 1 Multiple Choice Answers: Electricity (continued)

Question	Paper	Q. No.	Answer
1172	9702_s16_qp_13	19	D
1173	9702_s16_qp_13	32	A
1174	9702_s16_qp_13	34	A
1175	9702_w16_qp_11	34	B
1176	9702_w16_qp_11	35	B
1177	9702_w16_qp_12	35	B
1178	9702_w16_qp_13	34	B
1179	9702_w16_qp_13	35	B
1180	9702_s15_qp_12	32	A

Chapter 11

Current of electricity

11.1 Electric current

199. 9702_s20_qp_23 Q: 6

The current I in a metal wire is given by the expression

$$I = Anve$$

where v is the average drift speed of the free electrons in the wire and e is the elementary charge.

(a) State what is meant by the symbols A and n .

A :

n :

[2]

(b) Use the above expression to determine the SI base units of e .
Show your working.

base units [2]

(c) Two lamps P and Q are connected in series to a battery, as shown in Fig. 6.1.

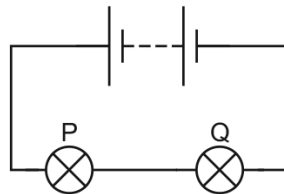


Fig. 6.1

The radius of the filament wire of lamp P is twice the radius of the filament wire of lamp Q.
The filament wires are made of metals with the same value of n .

Calculate the ratio

$$\frac{\text{average drift speed of free electrons in filament wire of P}}{\text{average drift speed of free electrons in filament wire of Q}}.$$

ratio = ... [2]

[Total: 6]

200. 9702_w18_qp_22 Q: 7

- (a) The current I in a metal wire is given by the expression

$$I = Anve.$$

State what is meant by the symbols A and n .

A :

n : [2]

- (b) The diameter of a wire XY varies linearly with distance along the wire as shown in Fig. 7.1.

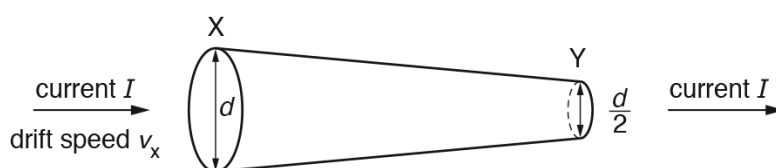


Fig. 7.1

There is a current I in the wire. At end X of the wire, the diameter is d and the average drift speed of the free electrons is v_x . At end Y of the wire, the diameter is $\frac{d}{2}$.

On Fig. 7.2, sketch a graph to show the variation of the average drift speed with position along the wire between X and Y.

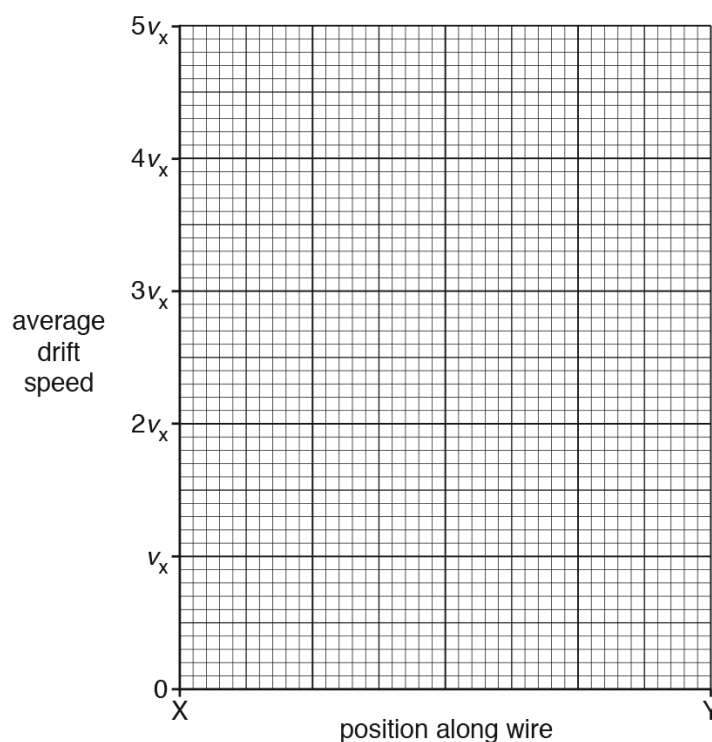


Fig. 7.2

[2]

[Total: 4]

201. 9702_w18_qp_23 Q: 6

(a) Define the *coulomb*.

.....
[1]

(b) An electric current is a flow of charge carriers.

In the following list, underline the possible charges for a charge carrier.

$8.0 \times 10^{-19} \text{ C}$ $4.0 \times 10^{-19} \text{ C}$ $1.6 \times 10^{-19} \text{ C}$ $1.6 \times 10^{-20} \text{ C}$ [1]

(c) The diameter of a wire ST varies linearly with distance along the wire as shown in Fig. 6.1.

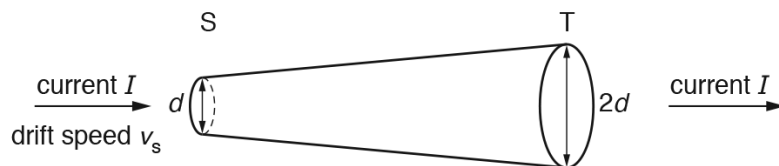


Fig. 6.1

There is a current I in the wire. At end S of the wire, the diameter is d and the average drift speed of the free electrons is v_s . At end T of the wire, the diameter is $2d$.

On Fig. 6.2, sketch a graph to show the variation of the average drift speed with position along the wire between S and T.

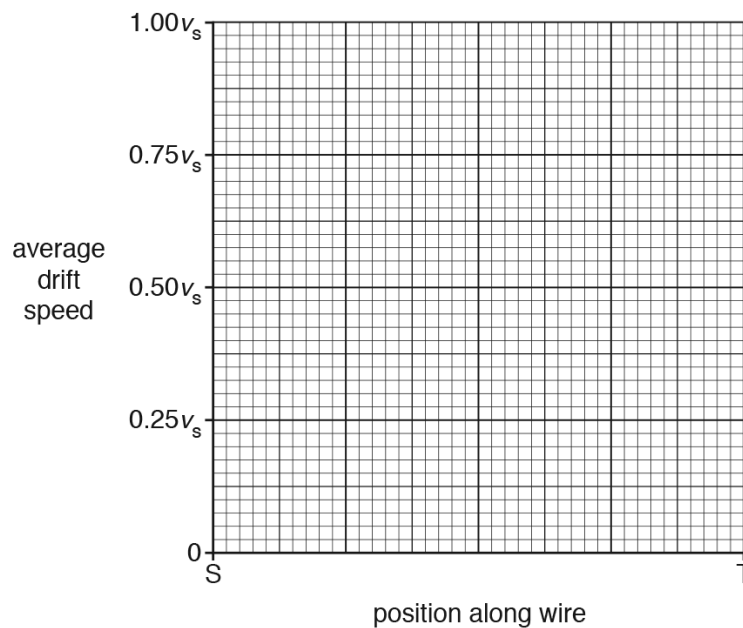


Fig. 6.2

[2]

[Total: 4]

202. 9702_w17_qp_22 Q: 5

- (a) Define the *coulomb*.

.....[1]

- (b) Two vertical metal plates in a vacuum have a separation of 4.0 cm. A potential difference of $2.0 \times 10^2 \text{ V}$ is applied between the plates. Fig. 5.1 shows a side view of this arrangement.

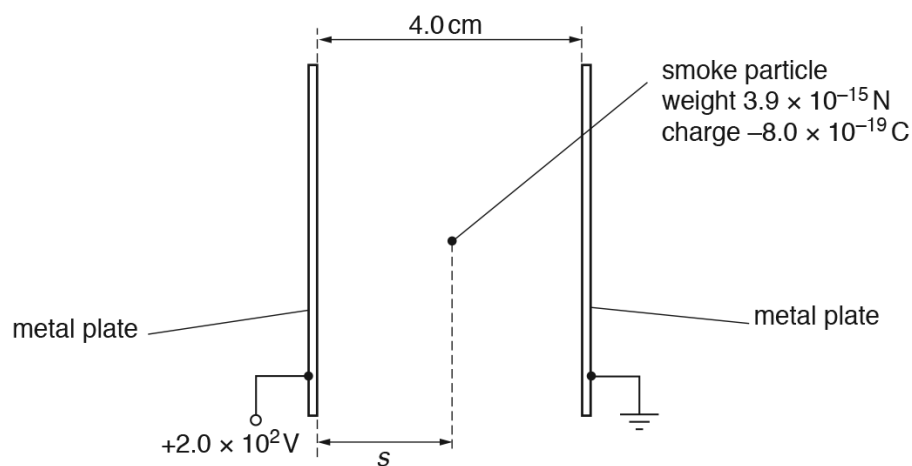


Fig. 5.1

A smoke particle is in the uniform electric field between the plates. The particle has weight $3.9 \times 10^{-15} \text{ N}$ and charge $-8.0 \times 10^{-19} \text{ C}$.

- (i) Show that the electric force acting on the particle is $4.0 \times 10^{-15} \text{ N}$.

[2]

- (ii) On Fig. 5.1, draw labelled arrows to show the directions of the two forces acting on the smoke particle. [1]

- (iii) The resultant force acting on the particle is F .

Determine

1. the magnitude of F ,

magnitude = ... N

2. the angle of F to the horizontal.

angle = ...°
[3]

- (c) The electric field in (b) is switched on at time $t = 0$ when the particle is at a horizontal displacement $s = 2.0\text{ cm}$ from the left-hand plate. At time $t = 0$ the horizontal velocity of the particle is zero. The particle is then moved by the electric field until it hits a plate at time $t = T$.

On Fig. 5.2, sketch the variation with time t of the horizontal displacement s of the particle from the left-hand plate.

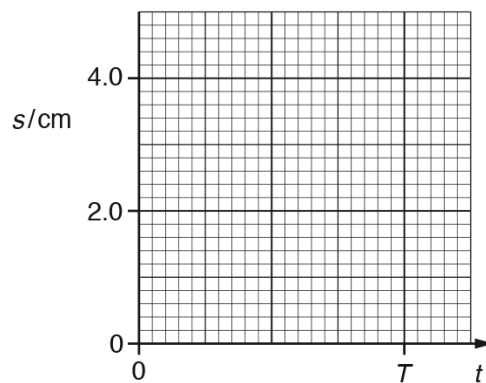


Fig. 5.2

[2]

[Total: 9]

11.2 Potential difference and power

203. 9702_s15_qp_22 Q: 1

- (a) Use the definition of work done to show that the SI base units of energy are $\text{kg m}^2\text{s}^{-2}$.

[2]

- (b) Define potential difference.

.....
..... [1]

- (c) Determine the SI base units of resistance. Show your working.

units [3]

11.3 Resistance and resistivity

204. 9702_s20_qp_22 Q: 5

One end of a wire is attached to a fixed point. A force F is applied to the wire to cause extension x . The variation with F of x is shown in Fig. 5.1.

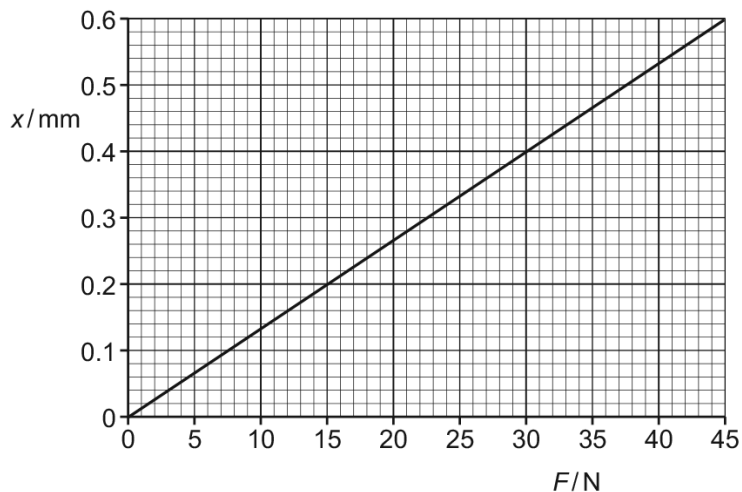


Fig. 5.1

The wire has a cross-sectional area of $4.1 \times 10^{-7} \text{ m}^2$ and is made of metal of Young modulus $1.7 \times 10^{11} \text{ Pa}$. Assume that the cross-sectional area of the wire remains constant as the wire extends.

- (a) State the name of the law that describes the relationship between F and x shown in Fig. 5.1.

..... [1]

- (b) The wire has an extension of 0.48 mm.

Determine:

- (i) the stress

stress = ... Pa [2]

- (ii) the strain.

strain = ... [2]

- (c) The resistivity of the metal of the wire is $3.7 \times 10^{-7} \Omega \text{ m}$.

Determine the change in resistance of the wire when the extension x of the wire changes from $x = 0.48 \text{ mm}$ to $x = 0.60 \text{ mm}$.

change in resistance = ... Ω [3]

- (d) A force of greater than 45 N is now applied to the wire.

Describe how it may be checked that the elastic limit of the wire has not been exceeded.

.....
..... [1]

[Total: 9]

205. 9702_s19_qp_23 Q: 1

(a) (i) Define *resistance*.

.....

.....[1]

(ii) A potential difference of 0.60 V is applied across a resistor of resistance 4.0 GΩ.

Calculate the current, in pA, in the resistor.

current = ... pA [2]

(b) The energy E transferred when charge Q moves through an electrical component is given by the equation

$$E = QV$$

where V is the potential difference across the component.

Use the equation to determine the SI base units of potential difference.

SI base units [3]

[Total: 6]

206. 9702_w18_qp_22 Q: 6

(a) Define the *volt*.

.....
[1]

(b) A battery of electromotive force (e.m.f.) 7.0 V and negligible internal resistance is connected in series with three components, as shown in Fig. 6.1.

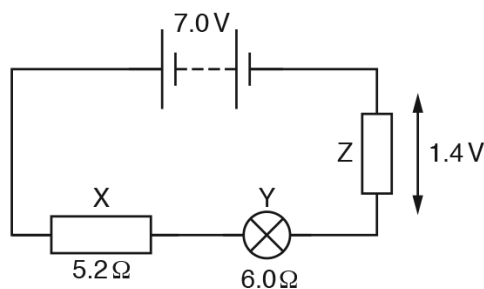


Fig. 6.1

Resistor X has a resistance of 5.2 Ω. The resistance of the filament wire of lamp Y is 6.0 Ω. The potential difference across resistor Z is 1.4 V.

(i) Calculate the current in the circuit.

current = ... A [2]

(ii) Determine the resistance of resistor Z.

resistance = ... Ω [1]

(iii) Calculate the percentage efficiency with which the battery supplies power to the lamp.

efficiency = ... % [3]

- (iv) The filament wire of the lamp is made of metal of resistivity $3.7 \times 10^{-7} \Omega \text{ m}$ at its operating temperature in the circuit.

Determine, for the filament wire, the value of α where

$$\alpha = \frac{\text{cross-sectional area}}{\text{length}} .$$

$$\alpha = \dots\dots\dots \text{ m [2]}$$

[Total: 9]

207. 9702_w17_qp_21 Q: 7

(a) Define the *ohm*.

.....[1]

(b) Wires are used to connect a battery of negligible internal resistance to a lamp, as shown in Fig. 7.1.

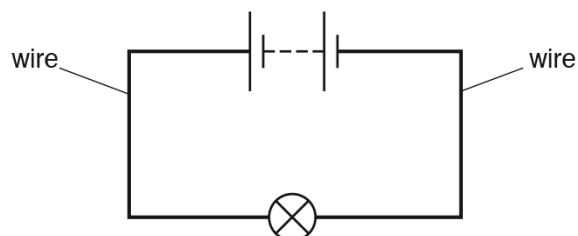


Fig. 7.1

The lamp is at its normal operating temperature. Some data for the filament wire of the lamp and for the connecting wires of the circuit are shown in Fig. 7.2.

	filament wire	connecting wires
diameter	d	$14d$
total length	L	$7.0L$
resistivity of metal (at normal operating temperature)	ρ	0.028ρ

Fig. 7.2

(i) Show that

$$\frac{\text{resistance of filament wire}}{\text{total resistance of connecting wires}} = 1000.$$

[2]

- (ii) Use the information in (i) to explain qualitatively why the power dissipated in the filament wire of the lamp is greater than the total power dissipated in the connecting wires.

.....
.....
.....[1]

- (iii) The lamp is rated as 12V, 6.0W. Use the information in (i) to determine the total resistance of the connecting wires.

total resistance of connecting wires = ... Ω [3]

- (iv) The diameter of the connecting wires is decreased. The total length of the connecting wires and the resistivity of the metal of the connecting wires remain the same.

State and explain the change, if any, that occurs to the resistance of the filament wire of the lamp.

.....
.....
.....
.....
.....[3]

[Total: 10]

208. 9702_w17_qp_22 Q: 6

- (a) State what is meant by an *electric current*.

.....[1]

- (b) A metal wire has length L and cross-sectional area A , as shown in Fig. 6.1.

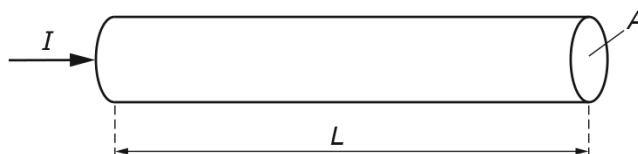


Fig. 6.1

I is the current in the wire,

n is the number of free electrons per unit volume in the wire,

v is the average drift speed of a free electron and

e is the charge on an electron.

- (i) State, in terms of A , e , L and n , an expression for the total charge of the free electrons in the wire.

.....[1]

- (ii) Use your answer in (i) to show that the current I is given by the equation

$$I = nAve.$$

[2]

- (c) A metal wire in a circuit is damaged. The resistivity of the metal is unchanged but the cross-sectional area of the wire is reduced over a length of 3.0 mm, as shown in Fig. 6.2.

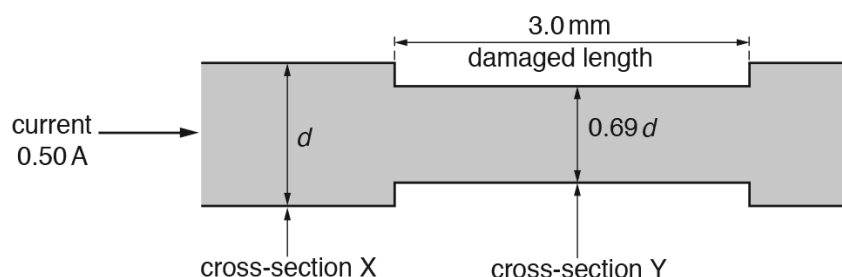


Fig. 6.2

The wire has diameter d at cross-section X and diameter $0.69d$ at cross-section Y.
The current in the wire is 0.50 A.

- (i) Determine the ratio

$$\frac{\text{average drift speed of free electrons at cross-section Y}}{\text{average drift speed of free electrons at cross-section X}}.$$

$$\text{ratio} = \dots\dots\dots [2]$$

- (ii) The main part of the wire with cross-section X has a resistance per unit length of $1.7 \times 10^{-2} \Omega \text{ m}^{-1}$.

For the damaged length of the wire, calculate

1. the resistance per unit length,

$$\text{resistance per unit length} = \dots\dots\dots \Omega \text{ m}^{-1} [2]$$

2. the power dissipated.

$$\text{power} = \dots\dots\dots \text{ W} [2]$$

- (iii) The diameter of the damaged length of the wire is further decreased. Assume that the current in the wire remains constant.

State and explain qualitatively the change, if any, to the power dissipated in the damaged length of the wire.

.....

 [2]

[Total: 12]

209. 9702_w17_qp_23 Q: 6

A filament lamp is rated as 30 W, 120 V. A potential difference of 120 V is applied across the lamp.

(a) For the filament wire of the lamp, calculate

(i) the current,

current = ... A [2]

(ii) the number of electrons passing a point in 3.0 hours.

number = ... [2]

(b) Show that the resistance of the filament wire is $480\ \Omega$.

[2]

(c) The filament wire has an uncoiled length of 580 mm and is made of metal. The metal has resistivity $6.1 \times 10^{-7}\ \Omega\text{ m}$ at the operating temperature of the lamp.

Calculate the diameter of the wire.

diameter = ... m [3]

(d) The potential difference across the lamp is now reduced. State and explain the effect, if any, on the resistance of the filament wire.

.....
..... [1]

[Total: 10]

210. 9702_s16_qp_21 Q: 6

- (a) Define the *coulomb*.

.....[1]

- (b) A resistor X is connected to a cell as shown in Fig. 6.1.

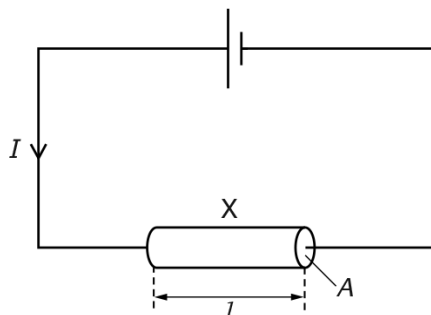


Fig. 6.1

The resistor is a wire of cross-sectional area A and length l . The current in the wire is I .

Show that the average drift speed v of the charge carriers in X is given by the equation

$$v = \frac{I}{nAe}$$

where e is the charge on a charge carrier and n is the number of charge carriers per unit volume in X.

[3]

- (c) A 12V battery with negligible internal resistance is connected to two resistors Y and Z, as shown in Fig. 6.2.

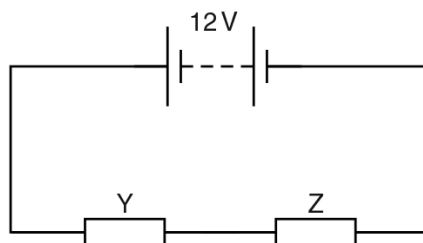


Fig. 6.2

The resistors are made from wires of the same material. The wire of Y has a diameter d and length l . The wire of Z has a diameter $2d$ and length $2l$.

(i) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in Y}}{\text{average drift speed of the charge carriers in Z}}.$$

$$\text{ratio} = \dots\dots\dots [3]$$

(ii) Show that

$$\frac{\text{resistance of Y}}{\text{resistance of Z}} = 2.$$

[2]

iii) Determine the potential difference across Y.

$$\text{potential difference} = \dots\dots\dots \text{ V } [2]$$

iv) Determine the ratio

$$\frac{\text{power dissipated in Y}}{\text{power dissipated in Z}}.$$

$$\text{ratio} = \dots\dots\dots [1]$$

[Total: 12]

211. 9702_s16_qp_23 Q: 6

(a) Define the *ohm*.

..... [1]

(b) A 15V battery with negligible internal resistance is connected to two resistors P and Q, as shown in Fig. 6.1.

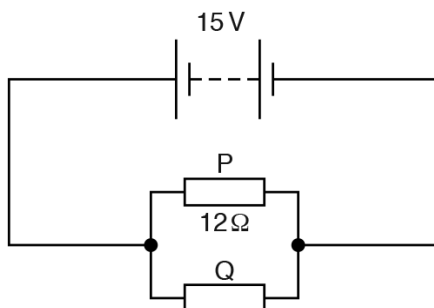


Fig. 6.1

The resistors are made of wires of the same material. The wire of P has diameter d and length $2l$. The wire of Q has diameter $2d$ and length l .

The resistance of P is 12Ω .

(i) Show that the resistance of Q is 1.5Ω .

[3]

(ii) Calculate the total power dissipated in the resistors P and Q.

power = ... W [3]

(iii) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in P}}{\text{average drift speed of the charge carriers in Q}}.$$

ratio = ... [3]

[Total: 10]

198. 9702_s15_qp_21 Q: 7

- (a) a region/space/area where a (stationary) charge experiences an (electric) force B1 [1]
- (b) (i) at least four parallel equally spaced straight lines perpendicular to plates B1
 consistent direction of an arrow on line(s) from left to right B1 [2]
- (ii) electric field strength $E = V/d$ C1
 $E = (450/16 \times 10^{-3})$
 $= 28 \times 10^3 (28\,125) \text{ V m}^{-1}$ A1 [2]
- (iii) $W = Eqd$ or Vq C1
 $q = 3.2 \times 10^{-19} \text{ (C)}$ C1
 $W = 28\,125 \times 3.2 \times 10^{-19} \times 16 \times 10^{-3}$ or $450 \times 3.2 \times 10^{-19}$
 $= 1.4(4) \times 10^{-16} \text{ J}$ A1 [3]
- (iv) ratio = $\frac{450 \times 3.2 \times 10^{-19}}{450 \times -1.6 \times 10^{-19}}$ (evidence of working required)
 $= (-) 2$ A1 [1]

199. 9702_s20_qp_23 Q: 6

	Answer	Mark
(a)	A: cross-sectional area	B1
	n : number density of <u>free</u> electrons	B1
(b)	units of I : A and units of A : m^2 and units of v : m s^{-1}	B1
	units of e : $\text{A} / (\text{m}^2 \text{ m}^{-3} \text{ m s}^{-1}) = \text{A s}$	A1
(c)	ratio = A_Q / A_P	C1
	$= [\pi r^2] / [\pi (2r^2)]$	A1
	$= 0.25$	

200. 9702_w18_qp_22 Q: 7

	Answer	Mark
(a)	A: (cross-sectional) area (of wire)	B1
	n : number of free electrons per unit volume or number density of free electrons	B1
(b)	line drawn between (X, v_x) and (Y, $4v_x$)	M1
	line has increasing gradient	A1

201. 9702_w18_qp_23 Q: 6

	Answer	Mark
(a)	(coulomb is an) ampere second	B1
(b)	$8.0 \times 10^{-19} \text{ C}$ and $1.6 \times 10^{-19} \text{ C}$ both underlined (and no others underlined)	B1
(c)	line drawn between (S, $1.00v_s$) and (T, $0.25v_s$)	M1
	line with decreasing magnitude of gradient	A1

202. 9702_w17_qp_22 Q: 5

	Answer	Mark
(a)	(coulomb is) ampere second	B1
(b)(i)	$E = V/d$ or $E = F/Q$	C1
	$F = VQ/d$	A1
	$F = (2.0 \times 10^2 \times 8.0 \times 10^{-19}) / 4.0 \times 10^{-2} = 4.0 \times 10^{-15} \text{ N}$	
(b)(ii)	arrow pointing to the left labelled 'electric force' and arrow pointing downwards labelled 'weight'	B1
(b)(iii)	1. resultant force $= \sqrt{[(3.9 \times 10^{-15})^2 + (4.0 \times 10^{-15})^2]}$	C1
	$= 5.6 \times 10^{-15} \text{ N}$	A1
	2. angle $= \tan^{-1} (3.9 \times 10^{-15} / 4.0 \times 10^{-15})$	A1
(c)	downward sloping line from (0, 2.0)	M1
	magnitude of gradient of line increases with time and line ends at (T, 0)	A1

203. 9702_s15_qp_22 Q: 1

- (a) (work =) force $\times$ distance or force $\times$ displacement or ($W =$) $F \times d$ B1
- units of work: $\text{kg m s}^{-2} \times \text{m} = \text{kg m}^2 \text{s}^{-2}$ A1 [2]
- (b) (p.d. =) $\frac{\text{work (done) or energy (transformed) (from electrical to other forms)}}{\text{charge}}$ B1 [1]
- (c) $R = V/I$ B1
- units of V : $\text{kg m}^2 \text{s}^{-2} / \text{A s}$ and units of I : A C1
- or
- $R = P/I^2$ [or $P = VI$ and $V = IR$] (B1)
- units of P : $\text{kg m}^2 \text{s}^{-3}$ and units of I : A (C1)
- or
- $R = V^2/P$ (B1)
- units of V : $\text{kg m}^2 \text{s}^{-2} / \text{A s}$ and units of P : $\text{kg m}^2 \text{s}^{-3}$ (C1)
- units of R : $(\text{kg m}^2 \text{s}^{-2} / \text{A}^2 \text{s}) = \text{kg m}^2 \text{s}^{-3} \text{A}^{-2}$ A1 [3]

204. 9702_s20_qp_22 Q: 5

	Answer	Mark
(a)	Hooke's (law)	B1
(b)(i)	$\sigma = F/A$	C1
	$= 36 / (4.1 \times 10^{-7})$	A1
	$= 8.8 \times 10^7 \text{ Pa}$	
(b)(ii)	Young modulus $= \sigma/\epsilon$ or $F/A\epsilon$	C1
	$\epsilon = 8.8 \times 10^7 / (1.7 \times 10^{11})$	A1
	$= 5.2 \times 10^{-4}$	
(c)	$R = \rho L/A$	C1
	$\Delta R = \rho \Delta x/A$	C1
	$= 3.7 \times 10^{-7} \times 0.12 \times 10^{-3} / (4.1 \times 10^{-7})$	
	$= 1.1 \times 10^{-4} \Omega$	A1
(d)	remove the force/ F and wire returns to original length	B1

205. 9702_s19_qp_23 Q: 1

	Answer	Mark
(a)(i)	potential difference / current	B1
(a)(ii)	$R = 4.0 \times 10^9 (\Omega)$	C1
	$I = 0.60 / 4.0 \times 10^9 = 1.5 \times 10^{-10} (\text{A})$	A1
	$I = 150 \text{ pA}$	
(b)	units of energy: $\text{kg m}^2 \text{s}^{-2}$	C1
	units of charge: As	C1
	units of potential difference: $(\text{kg m}^2 \text{s}^{-2} / \text{As}) = \text{kg m}^2 \text{A}^{-1} \text{s}^{-3}$	A1

206. 9702_w18_qp_22 Q: 6

	Answer	Mark
(a)	joule/coulomb	B1
(b)(i)	$7.0 = (I \times 5.2) + (I \times 6.0) + 1.4$	C1
	$I = 0.50 \text{ A}$	A1
(b)(ii)	$R = 1.4/0.50$ $= 2.8 \Omega$	A1
(b)(iii)	$P = EI$ or $P = VI$ or $P = I^2 R$ or $P = V^2/R$	C1
	efficiency $= [(0.50^2 \times 6.0) / (7.0 \times 0.50)] (\times 100)$ or efficiency $= [(0.50 \times 3.0) / (7.0 \times 0.50)] (\times 100)$ or efficiency $= [(3.0^2 / 6.0) / (7.0 \times 0.50)] (\times 100)$	C1
	efficiency $= 43\%$	A1
(b)(iv)	$R = \rho/L$	C1
	$\alpha = \rho/R$	A1
	$= 3.7 \times 10^{-7} / 6.0$ $= 6.2 \times 10^{-8} \text{ m}$	

207. 9702_w17_qp_21 Q: 7

	Answer	Mark
(a)	(the ohm is) volt / ampere	B1
(b)(i)	$R = \rho L / A$	C1
	ratio = $[\rho L / (\pi d^2 / 4)] / [0.028 \rho \times 7.0 L / \{\pi (14d)^2 / 4\}] = 1000$ or ratio = $14^2 / (0.028 \times 7) = 1000$	A1
(b)(ii)	same current (in connecting and filament wires) and the lamp/filament (wire) has greater resistance	B1
(b)(iii)	$P = V^2 / R$ or $P = VI$ or $P = I^2 R$	C1
	(for filament wire) $R = 12^2 / 6.0$ or $R = 6.0 / 0.50^2$ or $R = 12 / 0.50$	C1
	(for filament wire) $R = 24 \Omega$	A1
	(for connecting wire) $R = 24 / 1000$ $= 2.4 \times 10^{-2} \Omega$	
(b)(iv)	resistance of connecting wire increases	B1
	current in circuit/lamp/filament (wire) decreases or potential difference across lamp/filament (wire) decreases	M1
	(so) resistance of lamp/filament (wire) decreases	A1

208. 9702_w17_qp_22 Q: 6

	Answer	Mark
(a)	flow of charge carriers	B1
(b)(i)	$nALe$	B1
(b)(ii)	(t is time taken for electrons to move length L) $I = Q / t$	B1
	$I = nALe / t$ or $I = nALe / (L / v)$ or $I = nAvte / t$ and $I = nAve$	B1
(c)(i)	ratio = area at X / area at Y $= [\pi d^2 / 4] / [\pi (0.69d)^2 / 4]$ or $d^2 / (0.69d)^2$ or $1 / 0.69^2$	C1
	$= 2.1$	A1
(c)(ii)	1. $R = \rho L / A$ or $R / L \propto 1 / A$	C1
	resistance per unit length = $1.7 \times 10^{-2} \times (\text{area at X} / \text{area at Y})$ $= 1.7 \times 10^{-2} \times 2.1$ $= 3.6 \times 10^{-2} \Omega \text{m}^{-1}$	A1
	2. $P = I^2 R$ or $P = V^2 / R$	C1
	$R = 3.6 \times 10^{-2} \times 3.0 \times 10^{-3} (= 1.08 \times 10^{-4} \Omega)$ $P = 0.50^2 \times 1.08 \times 10^{-4}$ or $P = (5.4 \times 10^{-5})^2 / 1.08 \times 10^{-4}$ $= 2.7 \times 10^{-5} \text{W}$	A1

	Answer	Mark
(c)(iii)	(cross-sectional area decreases so) resistance increases	M1
	($P = I^2 R$, so) power increases	A1

209. 9702_w17_qp_23 Q: 6

	Answer	Mark
(a)(i)	$P = VI$	C1
	$I = 30 / 120$	A1
	$= 0.25 \text{ A}$	
(a)(ii)	$Q = 0.25 \times 3.0 \times 3600 (= 2700)$	C1
	number $= (0.25 \times 3.0 \times 3600) / 1.60 \times 10^{-19}$	A1
	$= 1.7 \times 10^{22}$	
(b)	$R = V/I$ or $R = P/I^2$ or $R = V^2/P$	C1
	$= 120 / 0.25$ or $= 30 / 0.25^2$ or $= 120^2 / 30 = 480 \Omega$	A1

	Answer	Mark
(c)	$R = \rho l / A$	C1
	$A = (6.1 \times 10^{-7} \times 580 \times 10^{-3}) / 480 (= 7.37 \times 10^{-10})$	C1
	$d = [(4 \times 7.37 \times 10^{-10}) / \pi]^{1/2}$	A1
	$= 3.1 \times 10^{-5} \text{ m}$	
(d)	temperature decreases and so resistance decreases	B1

210. 9702_s16_qp_21 Q: 6

(a) (coulomb is) ampere second B1 [1]

(b) (total) charge or $Q = nAle$ M1 $I = Q/t$ and $l/t = v$ M1 $I = nAle/t = nAve$ therefore $v = I/nAe$ A1 [3](c) (i) ratio $= (I/nA_Y e) / (I/nA_Z e)$ C1 $= A_Z / A_Y$ or $4A / A$ or $\pi d^2 / (\pi d^2 / 4)$ C1 $= 4$ A1 [3](ii) $R = \rho l / A$ or $R = 4\rho l / \pi d^2$ B1 $R_Y = \rho l / A$ and $R_Z = \rho(2l) / 4A$ so $R_Y / R_Z = 2$

or

 $R_Y = 4\rho l / \pi d^2$ and $R_Z = 4\rho(2l) / \pi 4d^2$ or $2\rho l / \pi d^2$ so $R_Y / R_Z = 2$ A1 [2](iii) $V = 12R_Y / (R_Y + R_Z)$ or $I = 12 / (R_Y + R_Z)$ and $V = IR_Y$ C1 $V = 12 \times 2/3$ $= 8(0) \text{ V}$ A1 [2](iv) ratio $= I^2 R_Y / I^2 R_Z$ or $(V_Y^2 / R_Y) / (V_Z^2 / R_Z)$ or $(V_Y I) / (V_Z I)$ $= 2$ A1 [1]

211. 9702_s16_qp_23 Q: 6

(a) ohm is volt per ampere or volt/ampere

B1 [1]

(b) (i) $R = \rho l / A$

B1

$$R_P = 4\rho(2l)/\pi d^2 \text{ or } 8\rho l/\pi d^2 \text{ or } R_Q = \rho l/\pi d^2$$

or

ratio idea e.g. length is halved hence R halved and diameter is halved hence R is $1/4$

C1

$$\begin{aligned} R_Q (= 4\rho l/\pi 4d^2) &= \rho l/\pi d^2 \\ &= R_P/8 \\ &= (12/8) = 1.5 \Omega \end{aligned}$$

A1 [3]

(ii) power = $I^2 R$ or V^2/R or VI

C1

$$= (1.25)^2 \times 12 + (10)^2 \times 1.5 \text{ or } (15)^2/12 + (15)^2/1.5 \text{ or } 15 \times 11.25$$

C1

$$= (18.75 + 150) = 170 \text{ (168.75) W}$$

A1 [3]

(iii) $I_P = (15/12) = 1.25 \text{ (A)}$ and $I_Q = (15/1.5) = 10 \text{ (A)}$

C1

$$V_P/V_Q = I_P n A_Q e / I_Q n A_P e \text{ or } (1.25 \times \pi d^2) / (10 \times \pi d^2/4)$$

C1

$$= 0.5$$

A1 [3]

212. 9702_m20_qp_22 Q: 6

	Answer	Mark
(a)	$E = V/d$ $d = 350 / 1.4 \times 10^4$	C1
	$= 0.025 \text{ m}$	A1
(b)(i)	$E = F/Q$	C1
	$Q = 6.7 \times 10^{-15} / 1.4 \times 10^4 (= 4.8 \times 10^{-19} \text{ C})$ $= (4.8 \times 10^{-19} / 1.6 \times 10^{-19}) e$	C1
	$= 3.0 e$	A1
(b)(ii)	mass $= 8.3 \times 10^{-27} / 1.66 \times 10^{-27}$ $= 5.0 \text{ u}$	A1
(b)(iii)	number $= 5 - 3$ $= 2$	A1

Chapter 10

Current of electricity

215. 9702_m20_qp_42 Q: 7

- (a) On Fig. 7.1, sketch the temperature characteristic of a negative temperature coefficient (n.t.c.) thermistor. Label the axes with quantity and unit.



Fig. 7.1

[2]

- (b) An n.t.c. thermistor and a resistor are connected as shown in Fig. 7.2.

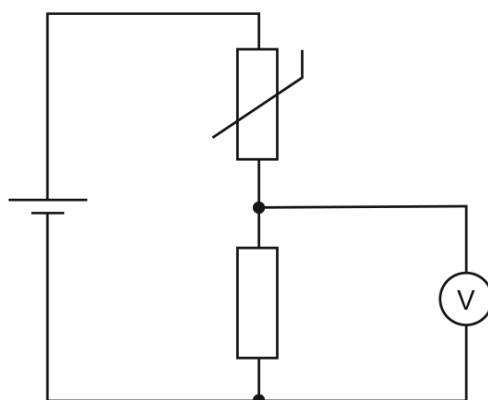


Fig. 7.2

The temperature of the thermistor is increased.

State and explain the change, if any, to the reading on the voltmeter.

.....

 [2]

- (c) The variation with the fractional change in length $\Delta x/x$ of the fractional change in resistance $\Delta R/R$ for a strain gauge is shown in Fig. 7.3.

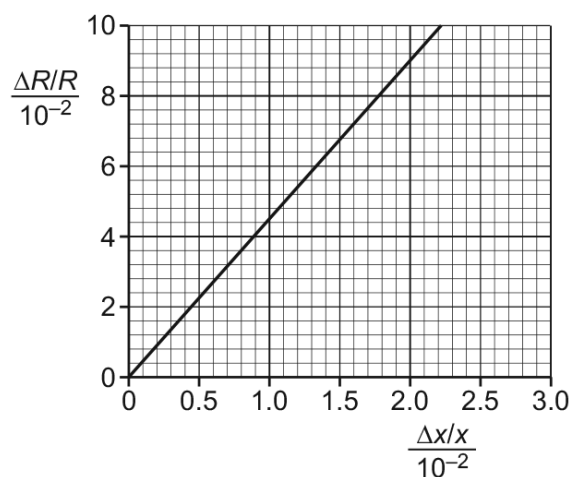


Fig. 7.3

The unstrained resistance of the gauge is $120\ \Omega$. Calculate the new resistance of the gauge when it is extended to a strain of 0.020.

resistance = ... Ω [3]

[Total: 7]

The thermistor is connected into the circuit shown in Fig. 7.2.

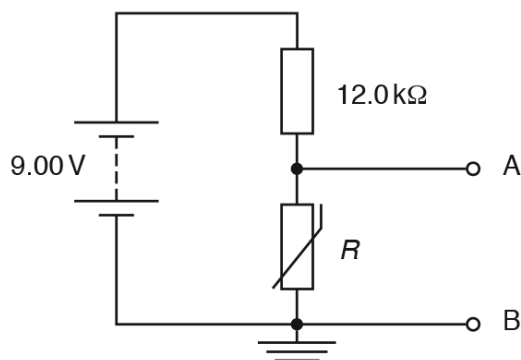


Fig. 7.2

The battery has electromotive force (e.m.f.) 9.00 V and negligible internal resistance.

When the temperature of the thermistor is 25 °C, the potential difference between the terminals A and B is 1.00 V.

The temperature of the thermistor changes from 25 °C to 10 °C.

Determine, to two significant figures, the change in potential difference between A and B.

change = ... V [3]

(c) The temperature of the thermistor in **(b)** changes from 25 °C to 10 °C at a constant rate.

State **two** reasons why the potential difference between A and B does **not** change at a constant rate.

1.
-
2.
-

[2]

[Total: 10]

217. 9702_m17_qp_42 Q: 7

- (a) Describe, with a labelled diagram, the structure of a metal-wire strain gauge.

.....

[3]

- (b) In a strain gauge, the increase in resistance ΔR depends on the increase in length ΔL . The variation of ΔR with ΔL is shown in Fig. 7.1.

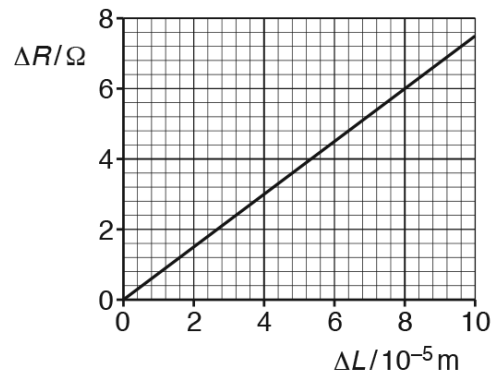


Fig. 7.1

The strain gauge is connected into a circuit incorporating an ideal operational amplifier (op-amp), as shown in Fig. 7.2.

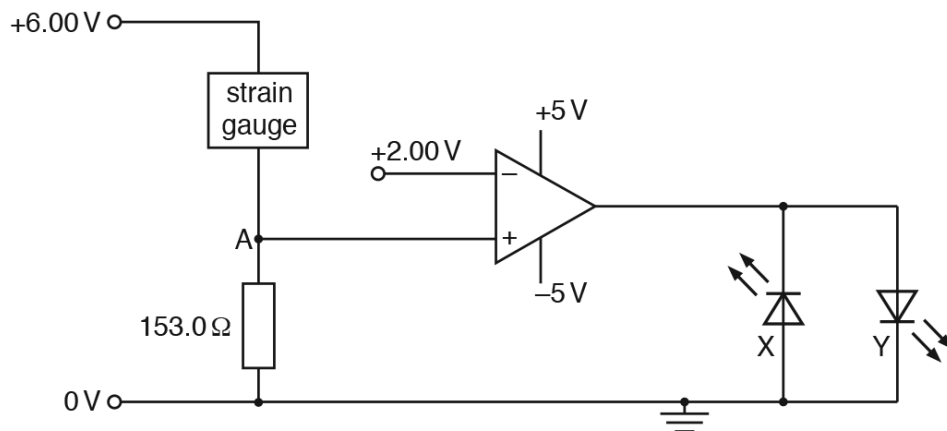


Fig. 7.2

- (i) The strain gauge is initially unstrained with resistance 300.0Ω .

Use data from Fig. 7.1 to calculate the increase in length ΔL of the strain gauge that gives rise to a potential of $+2.00\text{ V}$ at point A in Fig. 7.2.

$\Delta L = \dots\dots\dots\text{m}$ [3]

- (ii) The strain gauge undergoes a further increase in length beyond the value in (b)(i).

State and explain which one of the light-emitting diodes, X or Y, will be emitting light.

.....

[4]

[Total: 10]

214. 9702_m16_MS_42 Q: 7

- (a) (capacitance =) charge/potential (difference) B1 [1]
- (b) $V = V_1 + V_2 + V_3$ B1
 either $Q/C = Q/C_1 + Q/C_2 + Q/C_3$ or $V/Q = V_1/Q + V_2/Q + V_3/Q$
 and so $1/C = 1/C_1 + 1/C_2 + 1/C_3$ B1 [2]
- (c) (i) 1. $1/C_T = (1/200) + (1/600)$
 $C_T = 150 \mu\text{F}$ A1 [1]
2. $Q = CV$
 $= 150 \times 10^{-6} \times 12$ or $600 \times 10^{-6} \times 3.0$ or $200 \times 10^{-6} \times 9.0$
 $= 1.8 \times 10^{-3} \text{C}$ A1 [1]
3. $V = Q/C = 1.8 \times 10^{-3} / 600 \times 10^{-6}$ or $V = [200 / (200 + 600)] \times 12$
 $= 3(0) \text{V}$ A1 [1]
- (ii) energy = $\frac{1}{2}CV^2$ or energy = $\frac{1}{2}QV$ and $C = Q/V$ C1
 $\frac{1}{2} \times C \times 3^2 = 2 \times \frac{1}{2} \times C \times V^2$ C1
 $V = 2.1 \text{V}$ A1 [3]

215. 9702_m20_MS_42 Q: 7

	Answer	Marks
(a)	axes labelled with resistance and temperature	M0
	concave curve not touching temperature axis	A1
	line with negative gradient throughout	A1
(b)	resistance of thermistor decreases	B1
	total circuit resistance decreases so voltmeter reading increases or current increases so voltmeter reading increases or greater proportion of resistance in fixed resistor so voltmeter reading increases or p.d. across thermistor decreases so voltmeter reading increases	B1
(c)	(0.020 strain means) $\Delta R / R = 0.090$	C1
	$\Delta R = 0.090 \times 120 = 10.8 \Omega$	C1
	resistance = $120 + 10.8 = 130 \Omega$	A1

216. 9702_s19_MS_42 Q: 7

	Answer	Marks
(a)	Any five from: • (as temperature rises) energy of electrons increases • electrons (have enough energy to) cross forbidden band • electrons enter conduction band • leaving holes in valence band • both holes and electrons act as charge carriers • more charge carriers results in lower resistance • increased lattice vibrations outweighed by increase in (number of) charge carriers	B5
(b)	(at 10 °C resistance is) 2.55 k Ω	C1
	new potential difference = $9.00 \times 2.55 / (2.55 + 12.0)$ = 1.58 V	C1
	change in p.d. = 0.58 V	A1
(c)	change of resistance with temperature is not linear	B1
	change in potential with resistance is not linear or potential divider equation is non-linear	B1

217. 9702_m17_MS_42 Q: 7

	Answer	Marks
(a)	correct grid shape (of wire)	B1
	fine wire / foil strip	B1
	plastic / insulating envelope containing the wire	B1
(b)(i)	$2.00 / 6.00 = 153.0 / (R + 153.0)$ or $4.00 / 6.00 = R / (R + 153.0)$ (so $R = 306.0$)	C1
	$\Delta R = 306.0 - 300.0 = 6.0 (\Omega)$	C1
	so $\Delta L = 8(0) \times 10^{-5} \text{ m}$	A1

	Answer	Marks
(b)(ii)	R or ΔR increases	B1
	$V^+ < V^-$ or $V_A < 2.00$ or V^+ / V_A decreases	M1
	output is negative / $-5V$	A1
	diode X emits light / is 'on'	A1

218. 9702_s21_MS_42 Q: 7

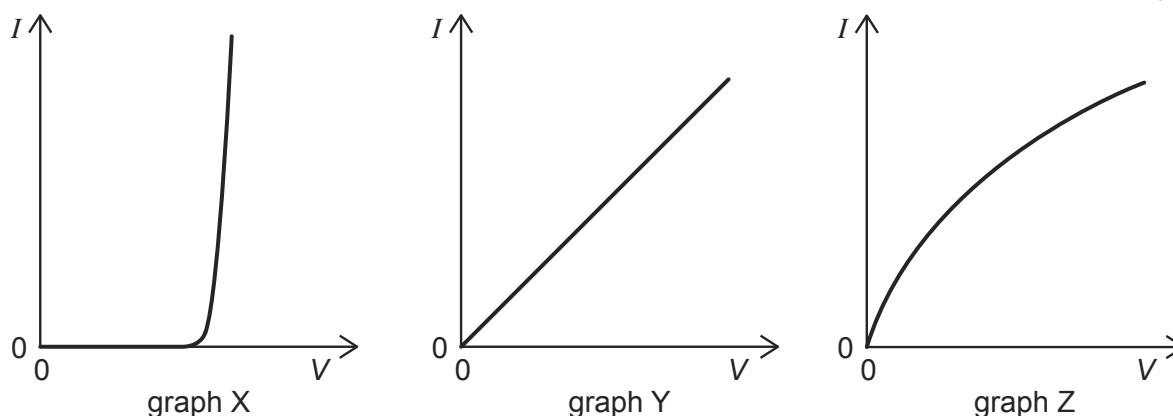
	Answer	Marks
(a)(i)	no current enters/leaves the input	B1
(a)(ii)	gain is the same for all frequencies	B1
(b)(i)	$V_{IN} = 1.5 \times 400 / (400 + 1100) = 0.40 V$ or $V_{IN} = 1.5 - (1.5 \times 1100 / 1500) = 0.40 V$ or $(1.5 - V_{IN}) / 1100 = V_{IN} / 400$ so $V_{IN} = 0.40 V$	A1
(b)(ii)	gain = $(-R_f / R_i)$	C1
	$V_{OUT} / 0.40 = (360 + 100) / 96$	C1
	$V_{OUT} = 1.9 V$	A1
(b)(iii)	resistance of thermistor decreases	B1
	(magnitude of) gain decreases so reading decreases	B1
(b)(iv)	(at gain 12.5) V_{OUT} is $5.0 V$, so (above gain 12.5) output becomes saturated	B1

219. 9702_w21_MS_42 Q: 7

	Answer	Marks
(a)	output voltage / input voltage	M1
	input (voltage) is difference between (inverting and non-inverting) inputs	A1
(b)	- reduces the gain - greater bandwidth - more stable Any two points, 1 mark each	B2
(c)(i)	inverting amplifier	B1
(c)(ii)	X marked anywhere between right-hand edge of 480Ω resistor, left-hand edge of $1.2k\Omega$ resistor and the inverting input	B1
(c)(iii)	gain = $(-R_f / R_i)$	C1
	= $(-1200 / 480)$	A1
	= -2.5	
(c)(iv)	$V_{IN} = 6.5 / (-2.5)$ = $-2.6 V$	A1
(c)(v)	$(-2.5) \times (-5.4) = +13.5 V$, and so output saturates $V_{OUT} = (+)8.0 V$	A1

- 1 The graphs show the variation with potential difference V of the current I for three circuit elements.

9702/1/M/J/02/Q30



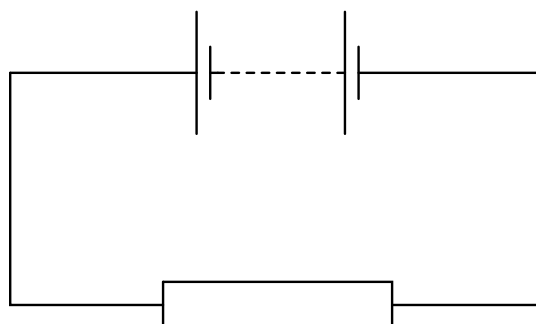
The three circuit elements are a metal wire at constant temperature, a semiconductor diode and a filament lamp.

Which row of the table correctly identifies these graphs?

	metal wire at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

- 2 In the circuit below, the battery converts an amount E of chemical energy to electrical energy when charge Q passes through the resistor in time t .

9702/1/M/J/02/Q31



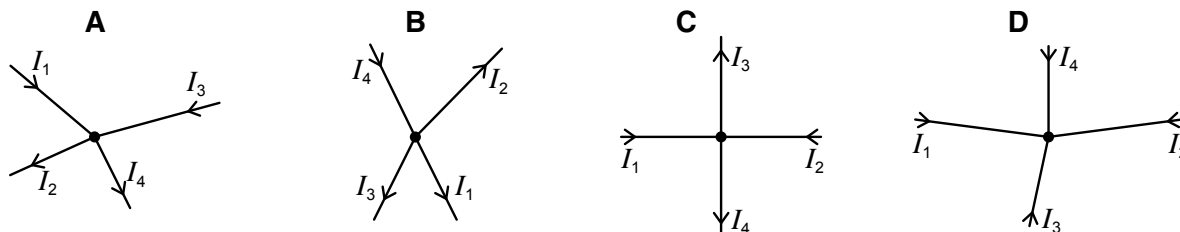
Which expressions give the e.m.f. of the battery and the current in the resistor?

	e.m.f.	current
A	EQ	Q/t
B	EQ	Qt
C	E/Q	Q/t
D	E/Q	Qt

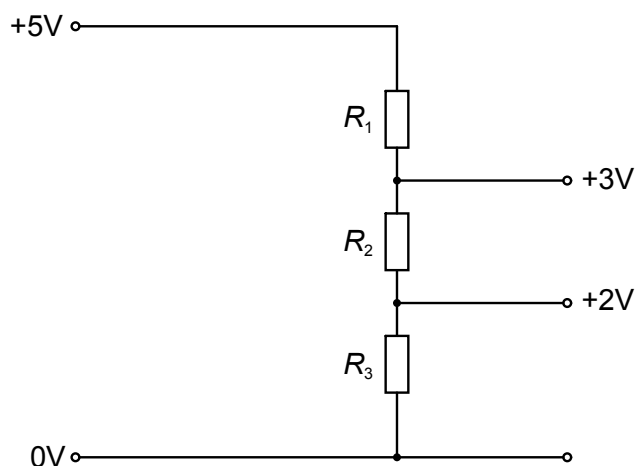
- 3 The diagrams show connected wires which carry currents I_1 , I_2 , I_3 and I_4 .

The currents are related by the equation $I_1 + I_2 = I_3 + I_4$.

To which diagram does this equation apply?



- 4 A potential divider is used to give outputs of 2 V and 3 V from a 5 V source, as shown. 9702/1/M/J/02/Q35



What are possible values for the resistances R_1 , R_2 and R_3 ?

	$R_1/\text{k}\Omega$	$R_2/\text{k}\Omega$	$R_3/\text{k}\Omega$
A	2	1	5
B	3	2	2
C	4	2	4
D	4	6	10

- 5 Which equation is used to define resistance?

- A** power = (current)² × resistance
- B** resistivity = resistance × area ÷ length
- C** potential difference = current × resistance
- D** energy = (current)² × resistance × time

- 6 When four identical lamps P, Q, R and S are connected as shown in diagram 1, they have normal brightness.

9702/1/M/J/02/Q34

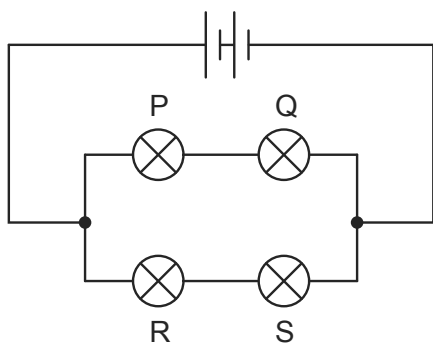


diagram 1

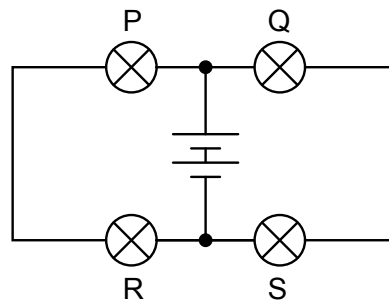


diagram 2

When the four lamps are connected as shown in diagram 2, which statement is correct?

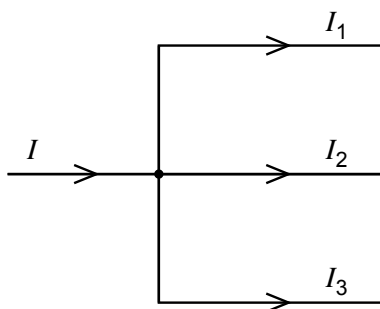
- A The lamps do not light.
 B The lamps are less bright than normal.
 C The lamps have normal brightness.
 D The lamps are brighter than normal.
- 7 The filament of a 240 V, 100 W electric lamp heats up from room temperature to its operating temperature. As it heats up, its resistance increases by a factor of 16.

9702/1/M/J/02/Q32

What is the resistance of this lamp at room temperature?

- A 36 Ω B 580 Ω C 1.5 k Ω D 9.2 k Ω
- 8 At a circuit junction, a current I divides into currents I_1 , I_2 and I_3 .

9702/1/O/N/02/Q33



These currents are related by the equation

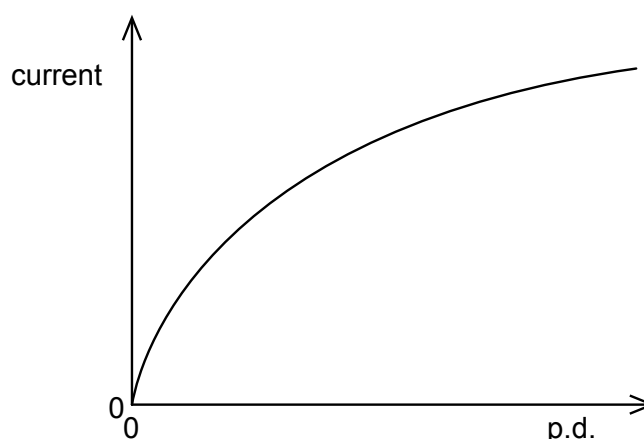
$$I = I_1 + I_2 + I_3.$$

Which law does this statement illustrate and on what principle is the law based?

- A Kirchhoff's first law based on conservation of charge
 B Kirchhoff's first law based on conservation of energy
 C Kirchhoff's second law based on conservation of charge
 D Kirchhoff's second law based on conservation of energy

- 9 The graph shows how the current through a lamp filament varies with the potential difference across it.

9702/1/O/N/02/Q31



Which statement explains the shape of this graph?

- A As the filament temperature rises, electrons can pass more easily through the filament.
 B It takes time for the filament to reach its working temperature.
 C The power output of the filament is proportional to the square of the current through it.
 D The resistance of the filament increases with a rise in temperature.
- 10 The combined resistance R_T of two resistors of resistances R_1 and R_2 connected in parallel is given by the formula

9702/1/O/N/02/Q34

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Which statement is used in the derivation of this formula?

- A The currents through the two resistors are equal.
 B The potential difference across each resistor is the same.
 C The supply current is split between the two resistors in the same ratio as the ratio of their resistances.
 D The total power dissipated is the sum of the powers dissipated in the two resistors separately.
- 11 The sum of the electrical currents into a point in a circuit is equal to the sum of the currents out of the point.

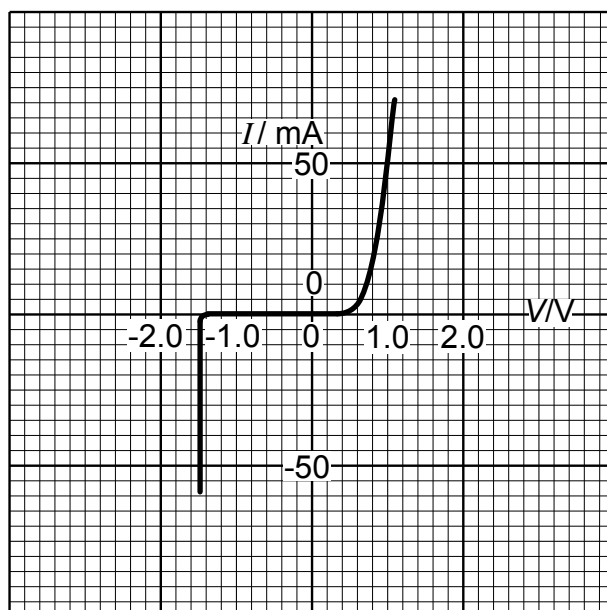
9702/01/M/J/03/Q31

Which of the following is correct?

- A This is Kirchhoff's first law, which results from the conservation of charge.
 B This is Kirchhoff's first law, which results from the conservation of energy.
 C This is Kirchhoff's second law, which results from the conservation of charge.
 D This is Kirchhoff's second law, which results from the conservation of energy.

- 12 The variation with potential difference V of the current I in a semiconductor diode is shown below.

9702/1/O/N/02/Q32

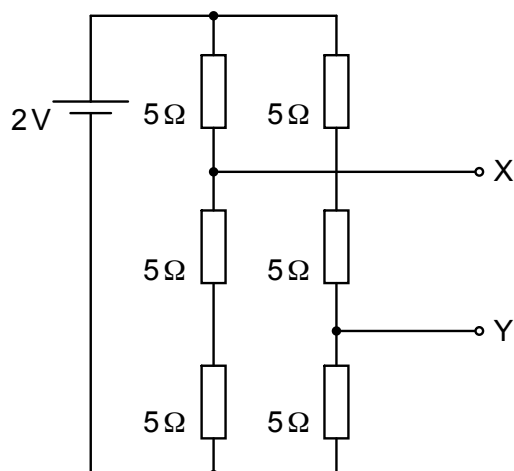


What is the resistance of the diode for applied potential differences of $+1.0\text{ V}$ and -1.0 V ?

	resistance	
	at $+1.0\text{ V}$	at -1.0 V
A	$20\ \Omega$	infinite
B	$20\ \Omega$	zero
C	$0.05\ \Omega$	infinite
D	$0.05\ \Omega$	zero

- 13 Six resistors, each of resistance $5\ \Omega$, are connected to a 2 V cell of negligible internal resistance.

9702/1/O/N/02/Q36

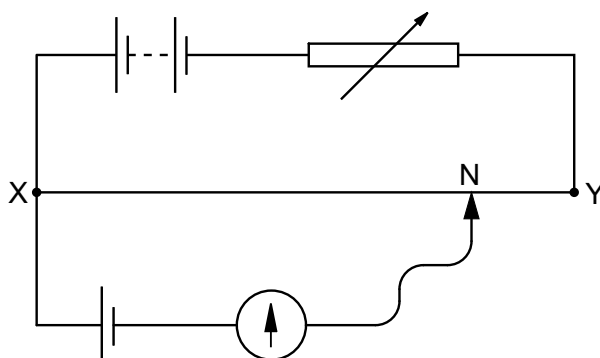


What is the potential difference between terminals X and Y?

- A** $\frac{2}{3}\text{ V}$ **B** $\frac{8}{9}\text{ V}$ **C** $\frac{4}{3}\text{ V}$ **D** 2 V

- 14 In the potentiometer circuit below, the moveable contact is placed at N on the bare wire XY, such that the galvanometer shows zero deflection.

9702/1/O/N/02/Q35



The resistance of the variable resistor is now increased.

What is the effect of this increase on the potential difference across the wire XY and on the position of the moveable contact for zero deflection?

	potential difference across XY	position of moveable contact
A	increases	nearer to X
B	increases	nearer to Y
C	decreases	nearer to X
D	decreases	nearer to Y

- 15 The current in a component is reduced uniformly from 100 mA to 20 mA over a period of 8.0 s.

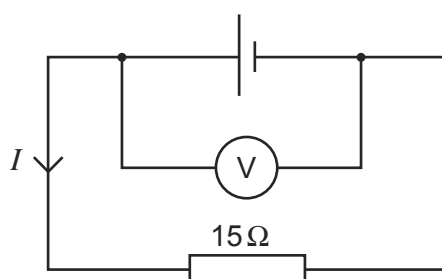
9702/01/M/J/03/Q30

What is the charge that flows during this time?

- A** 160 mC **B** 320 mC **C** 480 mC **D** 640 mC

- 16 The e.m.f. of the cell in the following circuit is 9.0 V. The reading on the high-resistance voltmeter is 7.5 V.

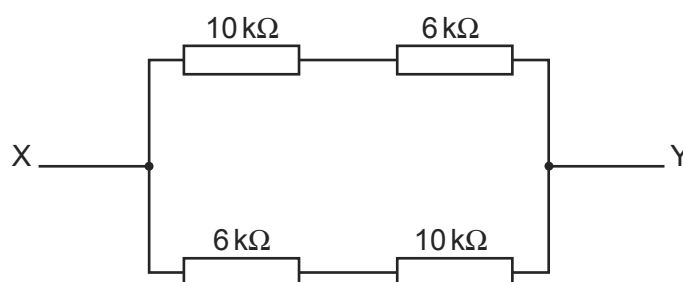
9702/01/M/J/08/Q32



What is the current I ?

- A** 0.1 A **B** 0.5 A **C** 0.6 A **D** 2.0 A

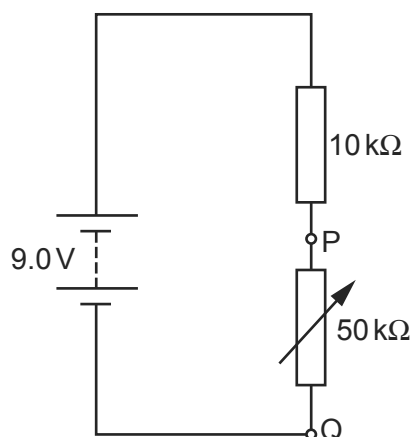
- 17 The diagram shows an arrangement of four resistors.



What is the resistance between X and Y?

- A** 4 kΩ **B** 8 kΩ **C** 16 kΩ **D** 32 kΩ
- 18 The diagram shows a potential divider connected to a 9.0 V supply of negligible internal resistance.

9702/01/M/J/03/Q34



What range of voltages can be obtained between P and Q?

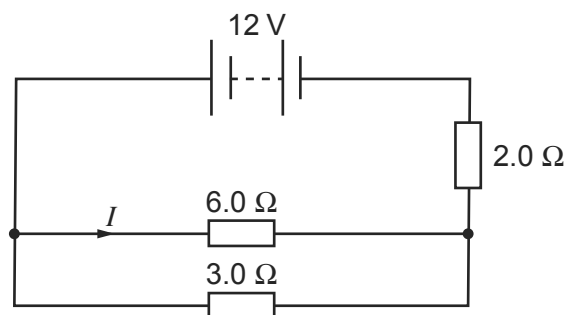
- A** zero to 1.5 V
B zero to 7.5 V
C 1.5 V to 7.5 V
D 1.5 V to 9.0 V
- 19 A wire carries a current of 2.0 amperes for 1.0 hour.

9702/01/O/N/03/Q30

How many electrons pass a point in the wire in this time?

- A** 1.2×10^{-15}
B 7.2×10^3
C 1.3×10^{19}
D 4.5×10^{22}

- 20 The diagram shows a circuit in which the battery has negligible internal resistance.



What is the value of the current I ?

- A** 1.0 A **B** 1.6 A **C** 2.0 A **D** 3.0 A

- 21 Two wires made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has a diameter of 2 mm. Wire Q has a diameter of 1 mm.

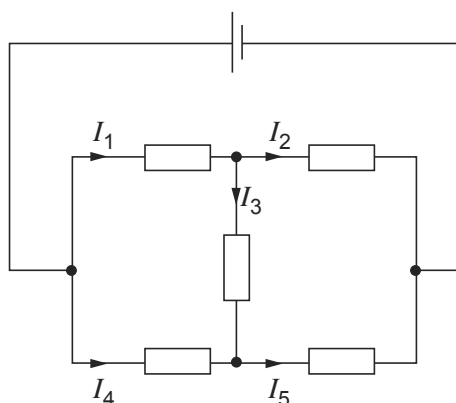
9702/01/M/J/04/Q31

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

- 22 The diagram shows currents I_1 , I_2 , I_3 , I_4 and I_5 in different branches of a circuit.

9702/01/O/N/03/Q32

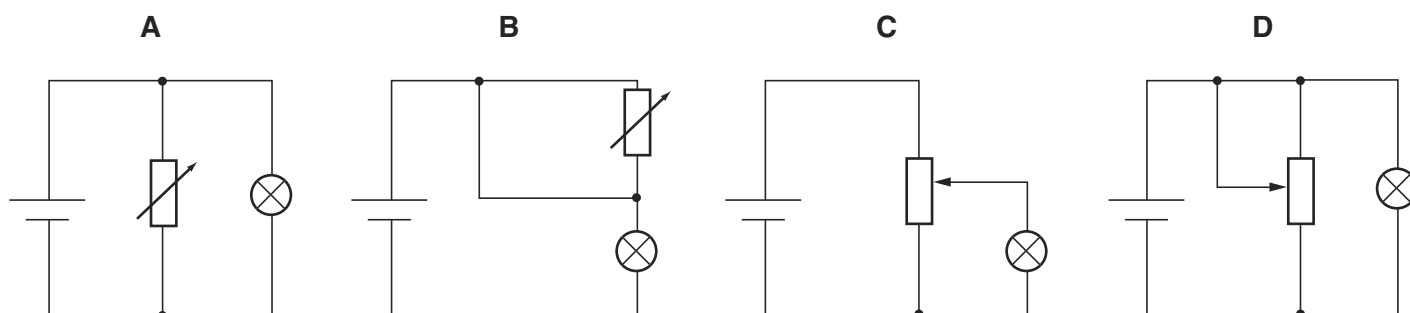


Which one of the following is correct?

- A** $I_1 = I_2 + I_3$
B $I_2 = I_1 + I_3$
C $I_3 = I_4 + I_5$
D $I_4 = I_5 + I_3$

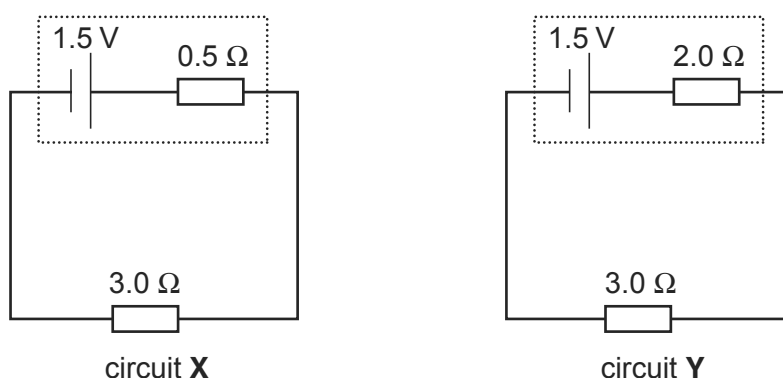
23 Which diagram shows a potential divider circuit that can vary the voltage across the lamp?

9702/01/O/N/03/Q33



24 The diagram shows two circuits. In these circuits, only the internal resistances differ.

9702/01/O/N/03/Q34



Which line in the table is correct?

	potential difference across $3.0\ \Omega$ resistor	power dissipated in $3.0\ \Omega$ resistor
A	greater in X than in Y	less in X than in Y
B	greater in X than in Y	greater in X than in Y
C	less in X than in Y	less in X than in Y
D	less in X than in Y	greater in X than in Y

25 What is an equivalent unit to 1 volt?

9702/01/M/J/04/Q32

- A 1 J A^{-1} B 1 J C^{-1} C 1 W C^{-1} D 1 W s^{-1}

26 The potential difference between point X and point Y is 20V. The time taken for charge carriers to move from X to Y is 15 s, and, in this time, the energy of the charge carriers changes by 12 J.

9702/01/M/J/04/Q34

What is the current between X and Y?

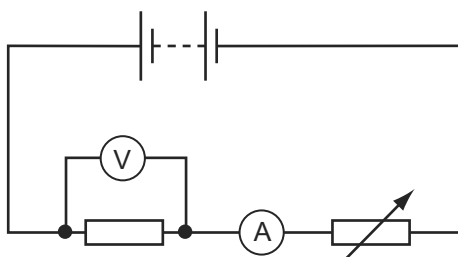
- A 0.040 A B 0.11 A C 9.0 A D 25 A

- 27 The terminal voltage of a battery is observed to fall when the battery supplies a current to an external resistor. 9702/01/M/J/04/Q33

What quantities are needed to calculate the fall in voltage?

- A** the battery's e.m.f. and its internal resistance
B the battery's e.m.f. and the current
C the current and the battery's internal resistance
D the current and the external resistance
- 28 The diagram shows a battery, a fixed resistor, an ammeter and a variable resistor connected in series. 9702/01/M/J/04/Q35

A voltmeter is connected across the fixed resistor.



The value of the variable resistor is reduced.

Which correctly describes the changes in the readings of the ammeter and of the voltmeter?

	ammeter	voltmeter
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

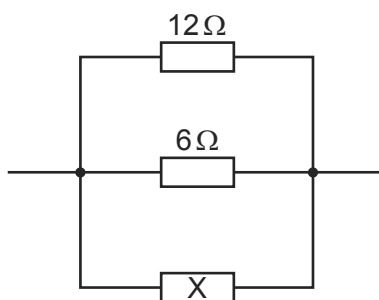
- 29 Kirchhoff's two laws for electric circuits can be derived by using conservation laws. 9702/01/M/J/04/Q36

On which conservation laws do Kirchhoff's laws depend?

	Kirchhoff's first law	Kirchhoff's second law
A	charge	current
B	charge	energy
C	current	mass
D	energy	current

- 30 The diagram shows a parallel combination of three resistors. The total resistance of the combination is 3Ω .

9702/01/M/J/04/Q37



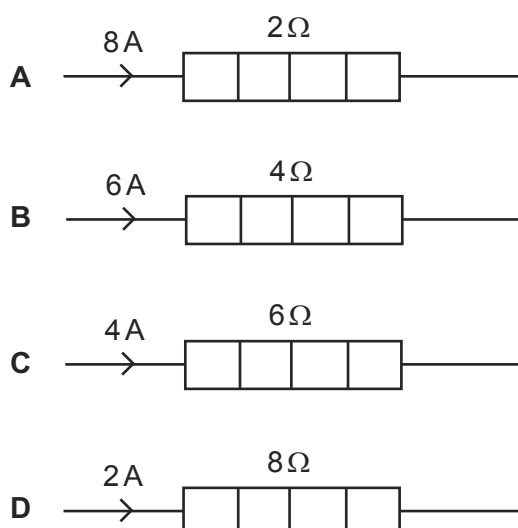
What is the resistance of resistor X?

- A** 2Ω **B** 3Ω **C** 6Ω **D** 12Ω

- 31 The diagram shows four heaters and the current in each.

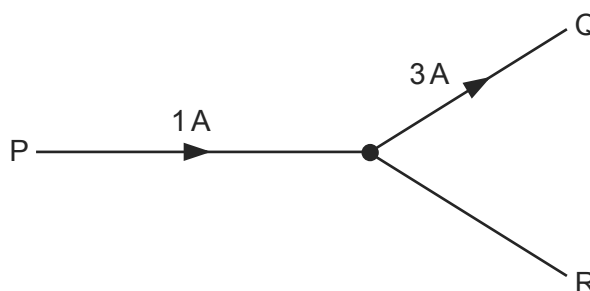
9702/01/O/N/04/Q32

Which heater has the greatest power dissipation?



- 32 The diagram shows a junction in a circuit where three wires P, Q and R meet. The currents in P and Q are 1 A and 3 A respectively, in the directions shown.

9702/01/O/N/04/Q35



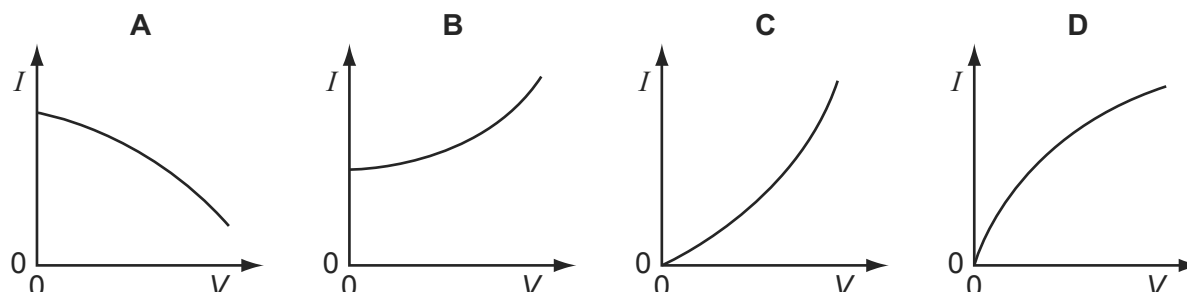
How many coulombs of charge pass a given point in wire R in 5 seconds?

- A** 0.4 **B** 0.8 **C** 2 **D** 10

- 33 The resistance of a thermistor decreases significantly as its temperature increases. 9702/01/O/N/04/Q34

The thermistor is kept in air. The air is at room temperature.

Which graph best represents the way in which the current I in the thermistor depends upon the potential difference V across it?

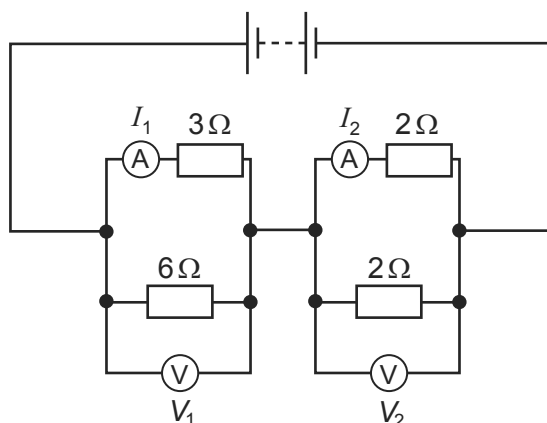


- 34 When a potential difference V is applied between the ends of a wire of diameter d and length l , the current in the wire is I . 9702/01/O/N/04/Q33

What is the current when a potential difference of $2V$ is applied between the ends of a wire of the same material of diameter $2d$ and the length $2l$? Assume that the temperature of the wire remains constant.

- A** I **B** $2I$ **C** $4I$ **D** $8I$

- 35 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance. 9702/01/O/N/04/Q37



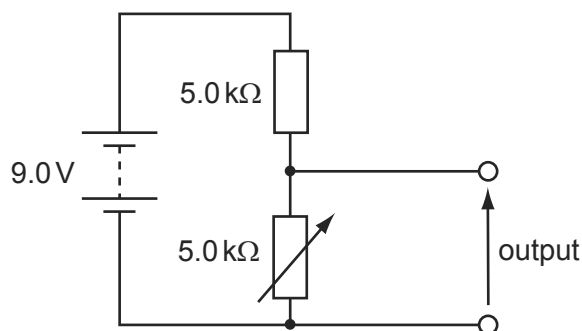
The readings on the meters are I_1 , I_2 , V_1 and V_2 , as labelled on the diagram.

Which is correct?

- A** $I_1 > I_2$ and $V_1 > V_2$
B $I_1 > I_2$ and $V_1 < V_2$
C $I_1 < I_2$ and $V_1 > V_2$
D $I_1 < I_2$ and $V_1 < V_2$

- 36 The diagram shows a potential divider circuit designed to provide a variable output p.d.

9702/01/O/N/04/Q36



Which gives the available range of output p.d?

	maximum output	minimum output
A	3.0 V	0
B	4.5 V	0
C	9.0 V	0
D	9.0 V	4.5 V

- 37 A copper wire of cross-sectional area 2.0 mm^2 carries a current of 10 A.

9702/01/M/J/05/Q32

How many electrons pass through a given cross-section of the wire in one second?

- A** 1.0×10^1 **B** 5.0×10^6 **C** 6.3×10^{19} **D** 3.1×10^{25}

- 38 A cylindrical piece of a soft, electrically-conducting material has resistance R . It is rolled out so that its length is doubled but its volume stays constant.

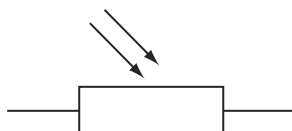
9702/01/M/J/05/Q33

What is its new resistance?

- A** $\frac{R}{2}$ **B** R **C** $2R$ **D** $4R$

- 39 Which electrical component is represented by the following symbol?

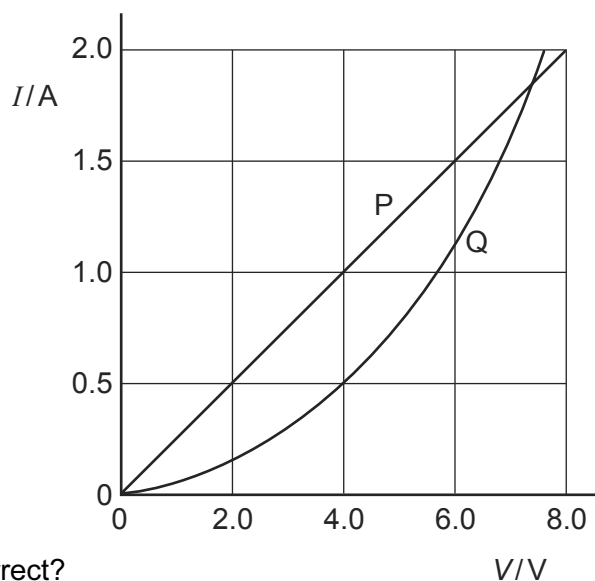
9702/01/M/J/05/Q35



- A** a diode
B a light-dependent resistor
C a resistor
D a thermistor

40 The I - V characteristics of two electrical components P and Q are shown below.

9702/01/M/J/05/Q34

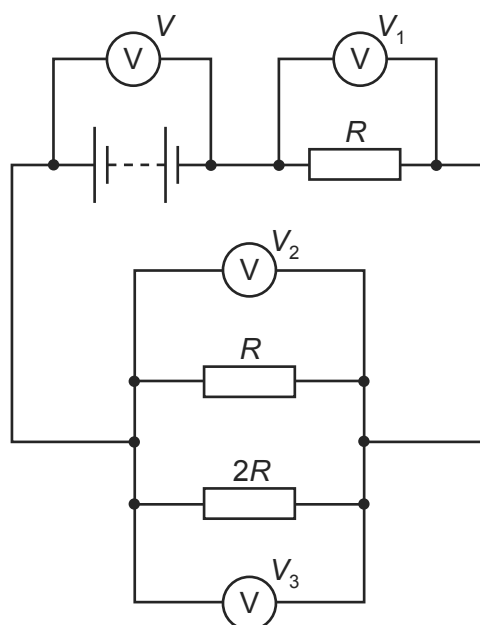


Which statement is correct?

- A** P is a resistor and Q is a filament lamp.
- B** The resistance of Q increases as the current in it increases.
- C** At 1.9 A the resistance of Q is approximately half that of P.
- D** At 0.5 A the power dissipated in Q is double that in P.

41 The diagram shows a circuit with four voltmeter readings V , V_1 , V_2 and V_3 .

9702/01/M/J/05/Q36

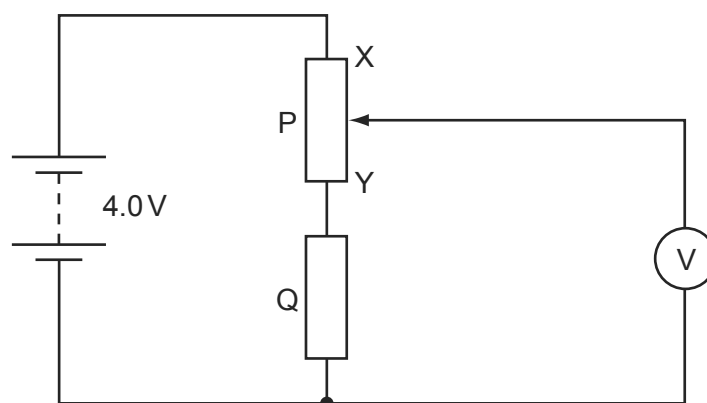


Which equation relating the voltmeter readings must be true?

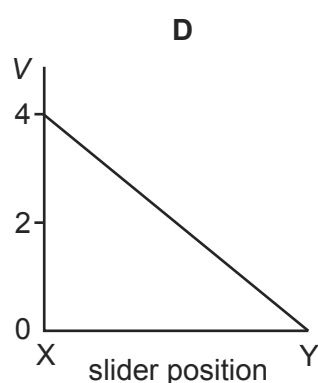
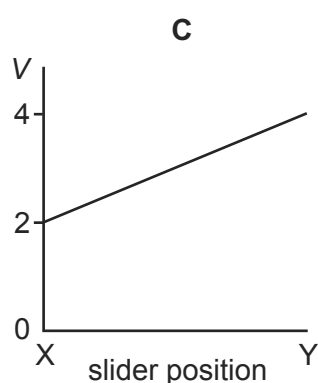
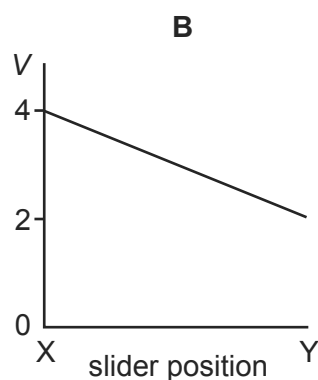
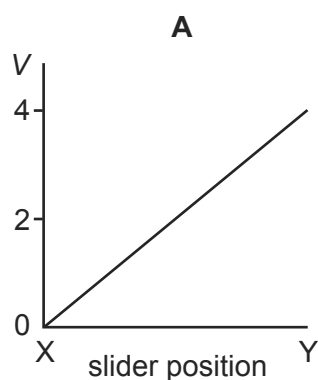
- A** $V = V_1 + V_2 + V_3$
- B** $V + V_1 = V_2 + V_3$
- C** $V_3 = 2(V_2)$
- D** $V - V_1 = V_3$

- 42 In the circuit below, P is a potentiometer of total resistance $10\ \Omega$ and Q is a fixed resistor of resistance $10\ \Omega$. The battery has an e.m.f. of $4.0\ \text{V}$ and negligible internal resistance. The voltmeter has a very high resistance. The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

9702/01/M/J/05/Q37



Which graph is obtained?

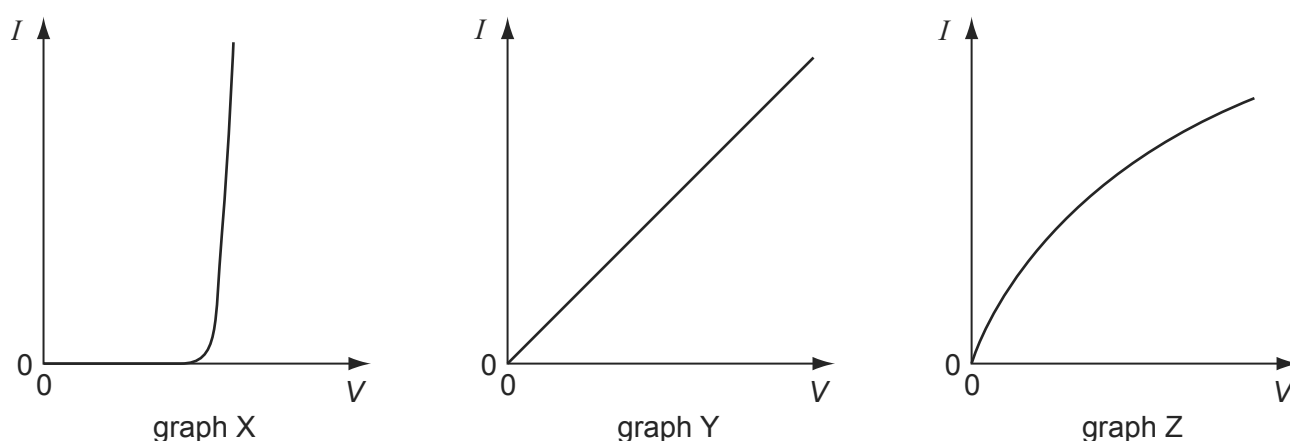


- 43 Which equation is used to define resistance?

9702/01/M/J/06/Q32

- A** energy = (current)² × resistance × time
- B** potential difference = current × resistance
- C** power = (current)² × resistance
- D** resistivity = resistance × area ÷ length

- 44 The graphs show the variation with potential difference V of the current I for three circuit components. 9702/01/O/N/05/Q32

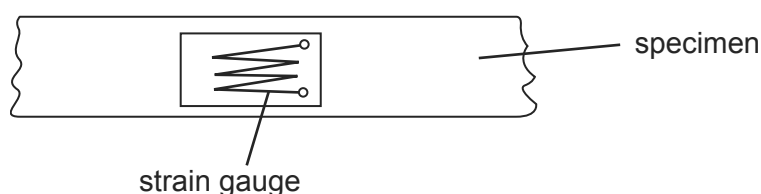


The components are a metal wire at constant temperature, a semiconductor diode and a filament lamp.

Which row of the table correctly identifies these graphs?

	metal wire at constant temperature	semiconductor diode	filament lamp
A	X	Z	Y
B	Y	X	Z
C	Y	Z	X
D	Z	X	Y

- 45 Tensile strain may be measured by the change in electrical resistance of a strain gauge. A strain gauge consists of folded fine metal wire mounted on a flexible insulating backing sheet. The strain gauge is firmly attached to the specimen, so that the strain in the metal wire is always identical to that in the specimen. 9702/01/O/N/05/Q33

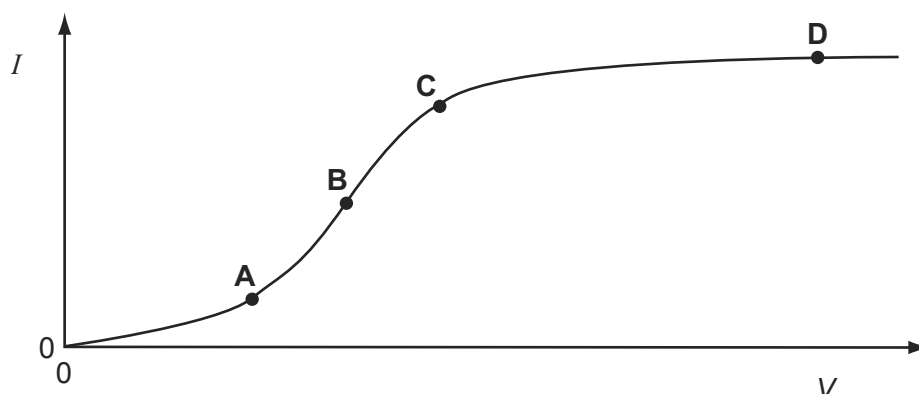


When the strain in the specimen is increased, what happens to the resistance of the wire?

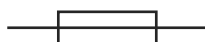
- A** It decreases, because the length decreases and the cross-sectional area increases.
- B** It decreases, because the length increases and the cross-sectional area decreases.
- C** It increases, because the length decreases and the cross-sectional area increases.
- D** It increases, because the length increases and the cross-sectional area decreases.

- 46 The graph shows how the electric current I through a conducting liquid varies with the potential difference V across it. 9702/01/O/N/05/Q34

At which point on the graph does the liquid have the smallest resistance?

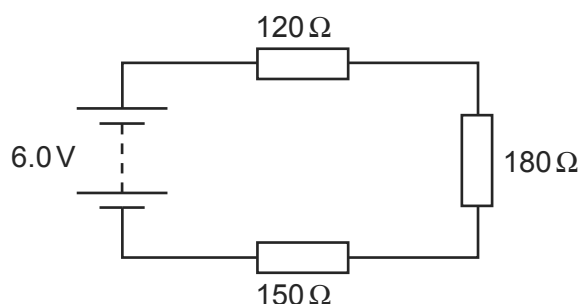


- 47 An electrical component has the following circuit symbol. 9702/01/O/N/05/Q35



What does this symbol represent?

- A** variable resistor (rheostat)
B fuse
C light-dependent resistor
D thermistor
- 48 Three resistors are connected in series with a battery as shown in the diagram. The battery has negligible internal resistance. 9702/01/O/N/05/Q36



What is the potential difference across the $180\ \Omega$ resistor?

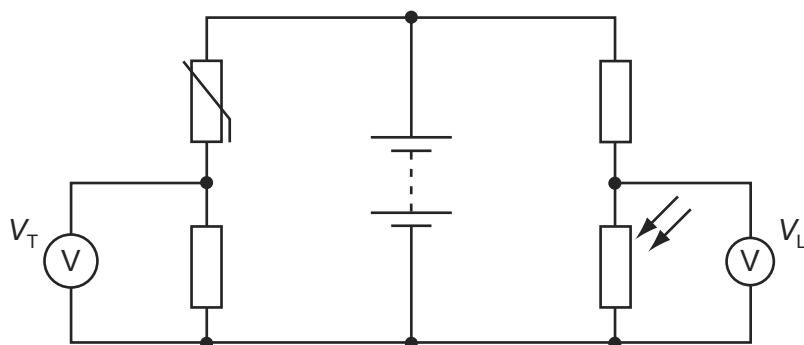
- A** 1.6 V **B** 2.4 V **C** 3.6 V **D** 6.0 V
- 49 Two heating coils X and Y, of resistance R_X and R_Y respectively, deliver the same power when 12 V is applied across X and 6 V is applied across Y. 9702/01/O/N/07/Q29

What is the ratio R_X/R_Y ?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

- 50 In the circuit below, the reading V_T on the voltmeter changes from high to low as the temperature of the thermistor changes. The reading V_L on the voltmeter changes from high to low as the level of light on the light-dependent resistor (LDR) changes.

9702/01/O/N/05/Q37



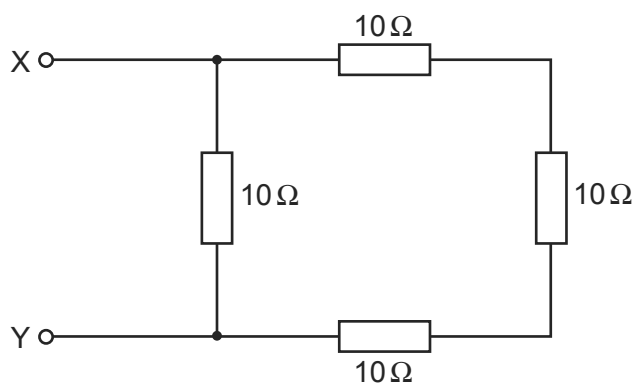
The readings on V_T and V_L are both high.

What are the conditions of temperature and light level?

	temperature	light level
A	low	low
B	low	high
C	high	low
D	high	high

- 51 The diagram shows an arrangement of resistors.

9702/01/M/J/06/Q35

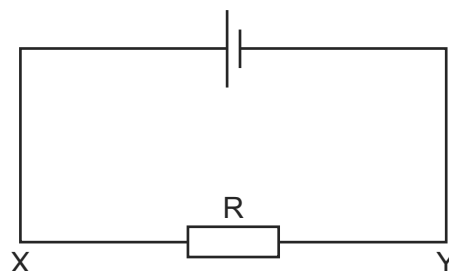


What is the total electrical resistance between X and Y?

- A** less than $1\ \Omega$
- B** between $1\ \Omega$ and $10\ \Omega$
- C** between $10\ \Omega$ and $30\ \Omega$
- D** $40\ \Omega$

- 52 The current in the circuit is 4.8 A.

9702/01/M/J/06/Q31

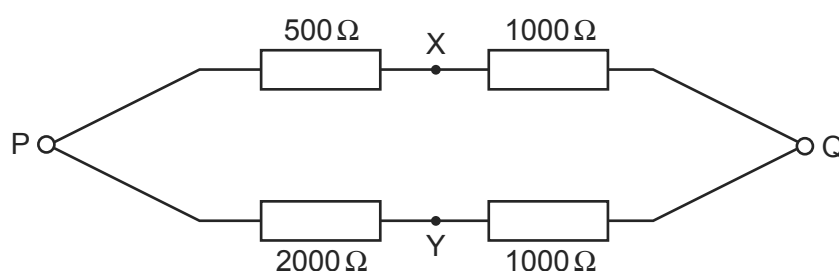


What is the rate of flow and the direction of flow of electrons through the resistor R?

- A** $3.0 \times 10^{19} \text{ s}^{-1}$ in direction X to Y
B $6.0 \times 10^{18} \text{ s}^{-1}$ in direction X to Y
C $3.0 \times 10^{19} \text{ s}^{-1}$ in direction Y to X
D $6.0 \times 10^{18} \text{ s}^{-1}$ in direction Y to X

- 53 A p.d. of 12 V is connected between P and Q.

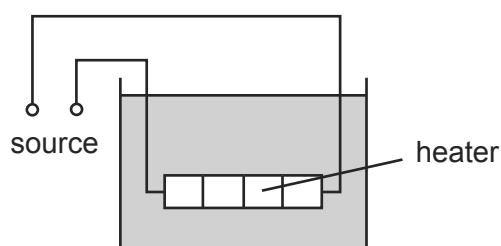
9702/01/M/J/06/Q33



What is the p.d. between X and Y?

- A** 0 V **B** 4 V **C** 6 V **D** 8 V
- 54 The diagram shows a low-voltage circuit for heating the water in a fish tank.

9702/01/M/J/06/Q34



The heater has a resistance of $3.0 \, \Omega$. The voltage source has an e.m.f. of 12 V and an internal resistance of $1.0 \, \Omega$.

At what rate does the voltage source supply energy to the heater?

- A** 27 W **B** 36 W **C** 48 W **D** 64 W

- 55 When four identical lamps P, Q, R and S are connected as shown in diagram 1, they have normal brightness. 9702/01/M/J/06/Q36

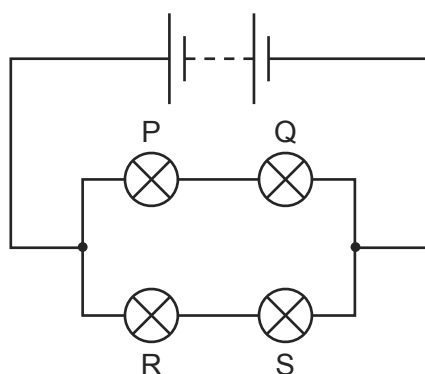


diagram 1

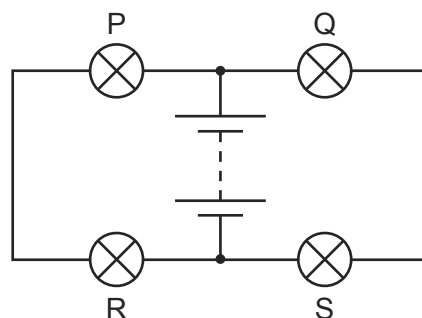
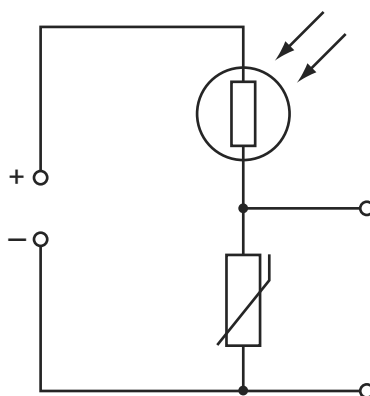


diagram 2

The four lamps and the battery are then connected as shown in diagram 2.

Which statement is correct?

- A** The lamps do not light.
 - B** The lamps are less bright than normal.
 - C** The lamps have normal brightness.
 - D** The lamps are brighter than normal.
- 56 The diagram shows a light-dependent resistor (LDR) and a thermistor forming a potential divider. 9702/01/M/J/06/Q37

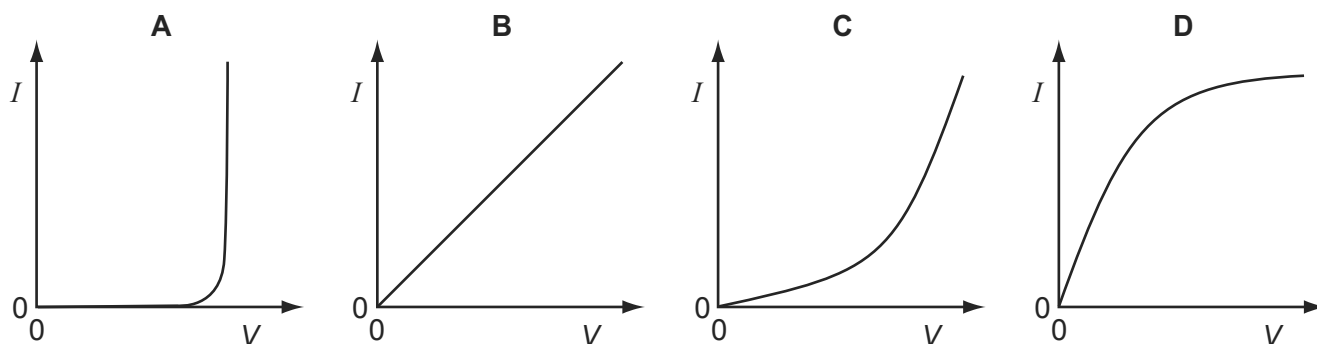


Under which set of conditions will the potential difference across the thermistor have the greatest value?

	illumination	temperature
A	low	low
B	high	low
C	low	high
D	high	high

57 Which graph shows the $I - V$ characteristic of a filament lamp?

9702/01/O/N/06/Q32



58 The resistance of a device is designed to change with temperature.

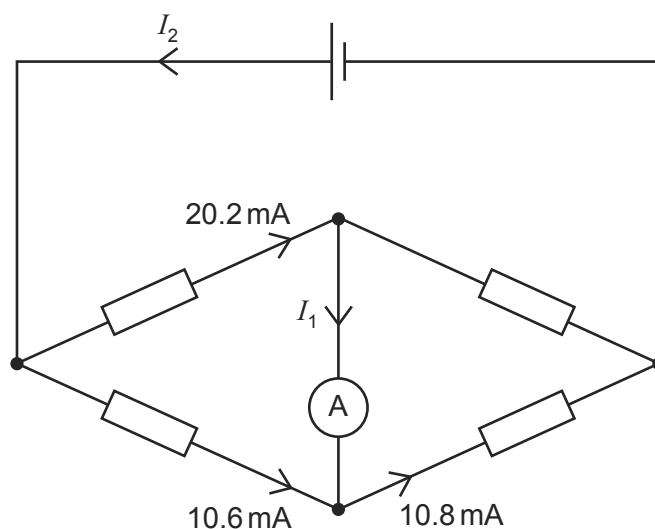
9702/01/O/N/06/Q35

What is the device?

- A** a light-dependent resistor
- B** a potential divider
- C** a semiconductor diode
- D** a thermistor

59 The diagram represents a circuit.

9702/01/O/N/06/Q36



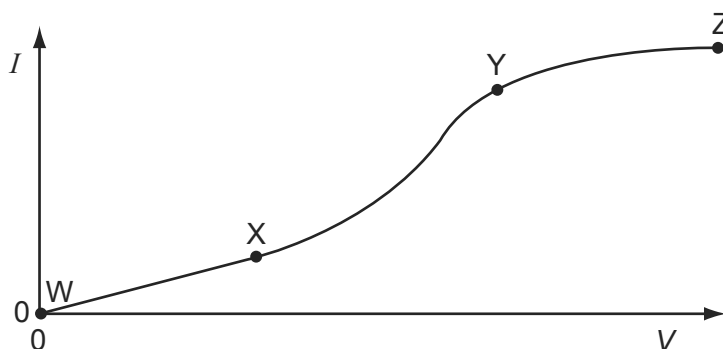
Some currents have been shown on the diagram.

What are the currents I_1 and I_2 ?

	I_1	I_2
A	0.2 mA	10.8 mA
B	0.2 mA	30.8 mA
C	-0.2 mA	20.0 mA
D	-0.2 mA	30.8 mA

- 60 An electrical component has a potential difference V across it and a current I through it. A graph of I against V is drawn and is marked in three sections WX, XY and YZ.

9702/01/O/N/06/Q33

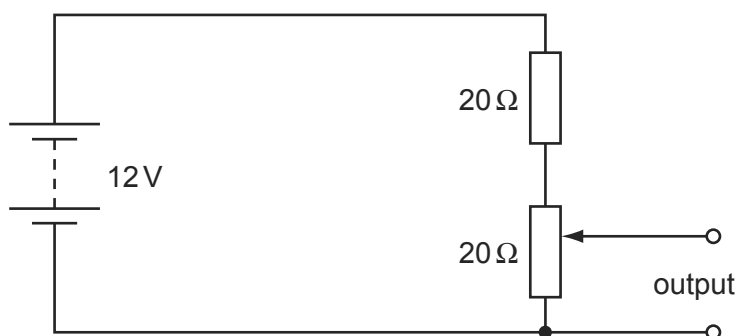


In which ways does the resistance of the component vary within each of the three sections?

	WX	XY	YZ
A	constant	decreases	increases
B	constant	increases	increases
C	increases	decreases	constant
D	increases	increases	decreases

- 61 The diagram shows a potentiometer and a fixed resistor connected across a 12 V battery of negligible internal resistance.

9702/01/O/N/06/Q34



The fixed resistor and the potentiometer each have resistance $20\ \Omega$. The circuit is designed to provide a variable output voltage.

What is the range of output voltages?

- A** 0–6 V **B** 0–12 V **C** 6–12 V **D** 12–20 V
- 62 The current in a resistor is 8.0 mA.

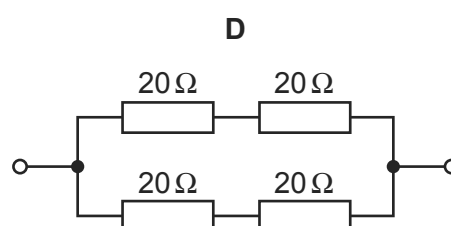
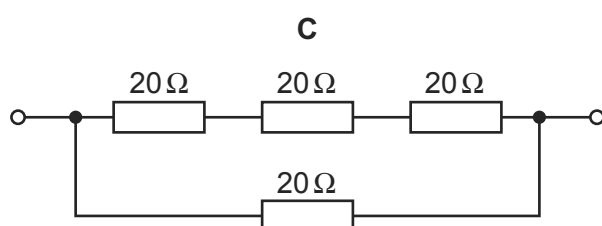
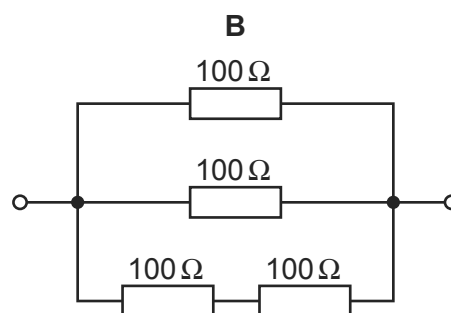
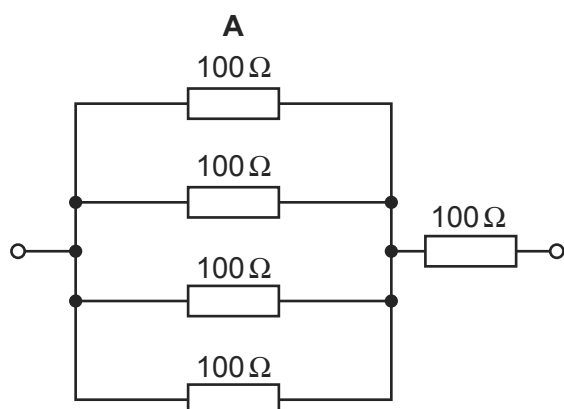
9702/01/M/J/07/Q32

What charge flows through the resistor in 0.020 s?

- A** 0.16 mC **B** 1.6 mC **C** 4.0 mC **D** 0.40 C

63 Which circuit has a resistance of $40\ \Omega$ between the terminals?

9702/01/O/N/06/Q37



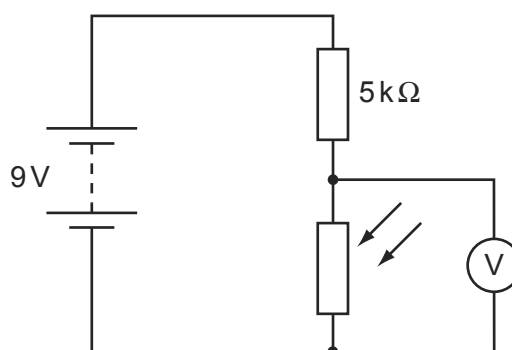
64 What is a correct statement of Ohm's law?

9702/01/M/J/07/Q31

- A** The potential difference across a component equals the current providing the resistance and other physical conditions stay constant.
- B** The potential difference across a component equals the current multiplied by the resistance.
- C** The potential difference across a component is proportional to its resistance.
- D** The potential difference across a component is proportional to the current in it providing physical conditions stay constant.

65 A circuit is set up with an LDR and a fixed resistor as shown.

9702/01/M/J/07/Q34



The voltmeter reads 4 V .

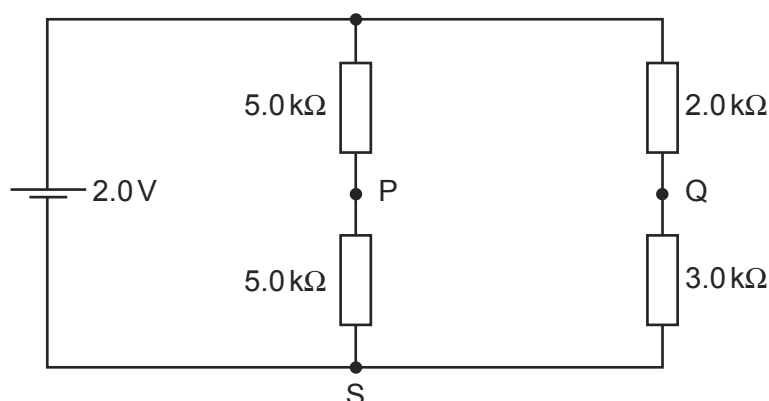
The light intensity is increased.

What is a possible voltmeter reading?

- A** 3 V
- B** 4 V
- C** 6 V
- D** 8 V

- 66 A cell of e.m.f. 2.0 V and negligible internal resistance is connected to the network of resistors shown.

9702/01/M/J/07/Q33

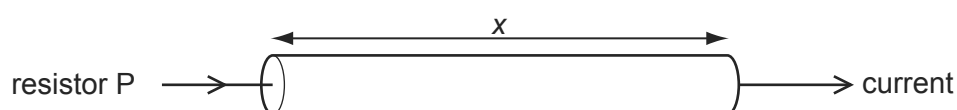


V_1 is the potential difference between S and P. V_2 is the potential difference between S and Q.

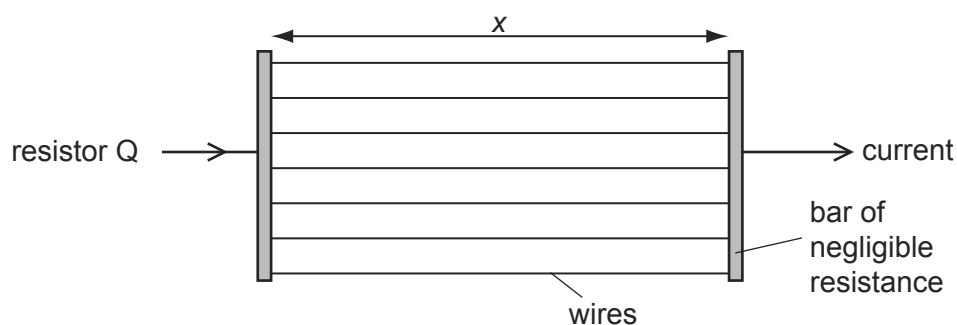
What is the value of $V_1 - V_2$?

- A** $+0.50\text{ V}$ **B** $+0.20\text{ V}$ **C** -0.20 V **D** -0.50 V
- 67 A researcher has two pieces of copper of the same volume. All of the first piece is made into a cylindrical resistor P of length x .

9702/01/M/J/07/Q37



All of the second piece is made into uniform wires each of the same length x which he connects between two bars of negligible resistance to form a resistor Q.

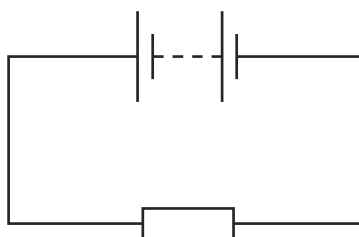


How do the electrical resistances of P and Q compare?

- A** P has a larger resistance than Q.
B Q has a larger resistance than P.
C P and Q have equal resistance.
D Q may have a larger or smaller resistance than P, depending on the number of wires made.

- 68 In the circuit below, the battery converts an amount E of chemical energy to electrical energy when charge Q passes through the resistor in time t .

9702/01/M/J/07/Q35

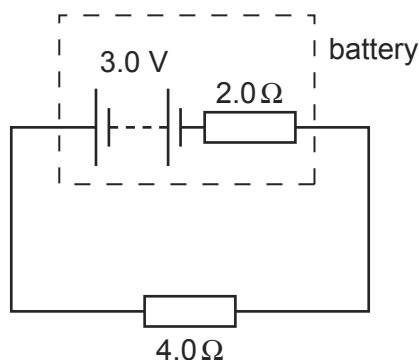


Which expressions give the e.m.f. of the battery and the current in the resistor?

	e.m.f.	current
A	EQ	Q/t
B	EQ	Qt
C	E/Q	Q/t
D	E/Q	Qt

- 69 A battery has an e.m.f. of 3.0 V and an internal resistance of $2.0\ \Omega$.

9702/01/M/J/07/Q36



The battery is connected to a load of $4.0\ \Omega$.

What are the terminal potential difference V and output power P ?

	V/V	P/W
A	1.0	0.50
B	1.0	1.5
C	2.0	1.0
D	2.0	1.5

- 70 Two wires P and Q have resistances R_P and R_Q respectively. Wire P is twice as long as wire Q and has twice the diameter of wire Q. The wires are made of the same material.

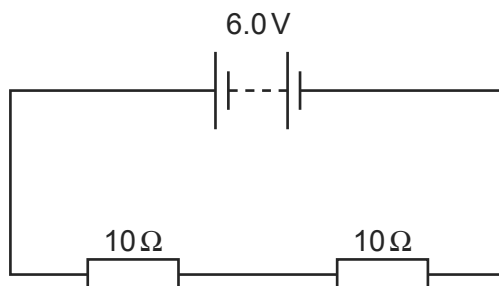
9702/01/O/N/07/Q31

What is the ratio $\frac{R_P}{R_Q}$?

- A** 0.5 **B** 1 **C** 2 **D** 4

- 71 A battery of negligible internal resistance is connected to two 10Ω resistors in series.

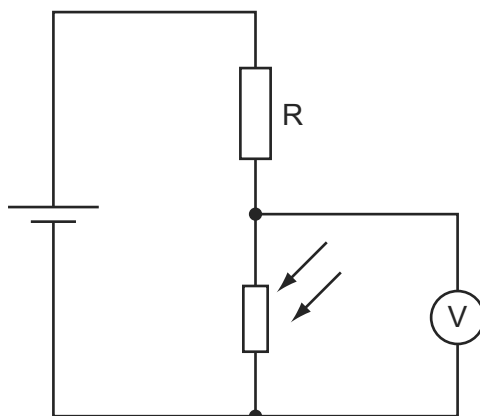
9702/01/O/N/07/Q30



What charge flows through each of the 10Ω resistors in 1 minute?

- A** 0.30 C **B** 0.60 C **C** 3.0 C **D** 18 C

- 72 A potential divider consists of a fixed resistor R and a light-dependent resistor (LDR). 9702/01/O/N/07/Q32



What happens to the voltmeter reading, and why does it happen, when the intensity of light on the LDR increases?

- A** The voltmeter reading decreases because the LDR resistance decreases.
B The voltmeter reading decreases because the LDR resistance increases.
C The voltmeter reading increases because the LDR resistance decreases.
D The voltmeter reading increases because the LDR resistance increases.

- 73 A power cable X has a resistance R and carries current I .

9702/01/M/J/08/Q32

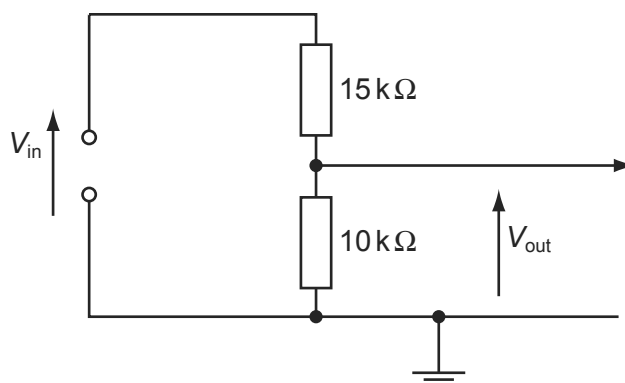
A second cable Y has a resistance $2R$ and carries current $\frac{1}{2}I$.

What is the ratio $\frac{\text{power dissipated in Y}}{\text{power dissipated in X}}$?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

- 74 The circuit is designed to trigger an alarm system when the input voltage exceeds some preset value. It does this by comparing V_{out} with a fixed reference voltage, which is set at 4.8 V.

9702/01/O/N/07/Q33



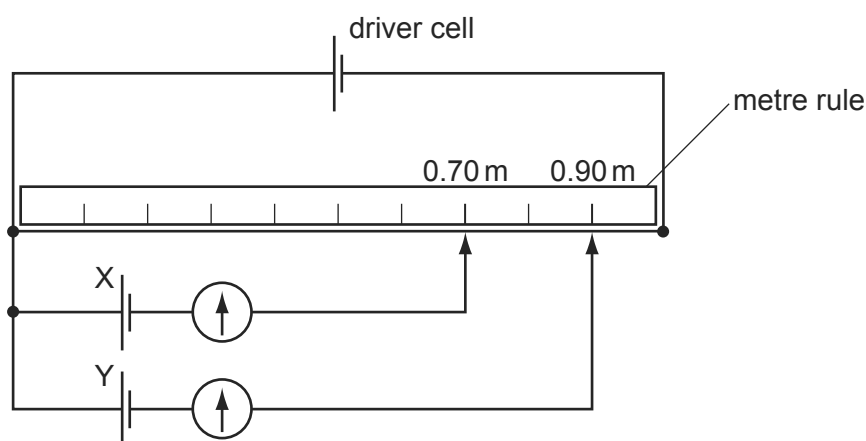
V_{out} is equal to 4.8 V.

What is the input voltage V_{in} ?

- A** 4.8 V **B** 7.2 V **C** 9.6 V **D** 12 V

- 75 A potentiometer is used as shown to compare the e.m.f.s of two cells.

9702/01/O/N/07/Q34



The balance points for cells X and Y are 0.70 m and 0.90 m respectively.

If the e.m.f. of cell X is 1.1 V, what is the e.m.f. of cell Y?

- A** 0.69 V **B** 0.86 V **C** 0.99 V **D** 1.4 V

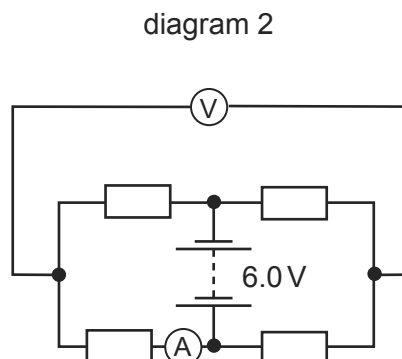
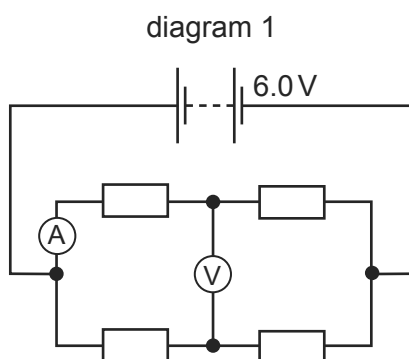
- 76 Which electrical quantity would be the result of a calculation in which energy transfer is divided by charge?

9702/01/O/N/07/Q28

- A** current
B potential difference
C power
D resistance

- 77 When four identical resistors are connected as shown in diagram 1, the ammeter reads 1.0 A and the voltmeter reads zero.

9702/01/O/N/07/Q35



The resistors and meters are reconnected to the supply as shown in diagram 2.

What are the meter readings in diagram 2?

	voltmeter reading / V	ammeter reading / A
A	0	1.0
B	3.0	0.5
C	3.0	1.0
D	6.0	0

- 78 A total charge of 100 C flows through a 12 W light bulb in a time of 50 s.

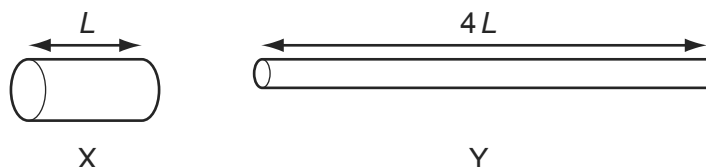
9702/01/M/J/08/Q33

What is the potential difference across the bulb during this time?

- A** 0.12 V **B** 2.0 V **C** 6.0 V **D** 24 V

- 79 Two copper wires X and Y have the same volume. Wire Y is four times as long as wire X.

9702/01/M/J/08/Q34



What is the ratio $\frac{\text{resistance of wire Y}}{\text{resistance of wire X}}$?

- A** 4 **B** 8 **C** 16 **D** 64

- 80 The charge that a fully-charged 12 V car battery can supply is 100 kC. The starter motor of the car requires a current of 200 A for an average period of 2.0 s. The battery does not recharge because of a fault.

9702/01/O/N/08/Q34

What is the maximum number of times the starter motor of the car can be used?

- A** 21 **B** 25 **C** 42 **D** 250

- 81 The potential difference across a resistor is 12 V. The current in the resistor is 2.0 A. 4.0 C passes through the resistor.

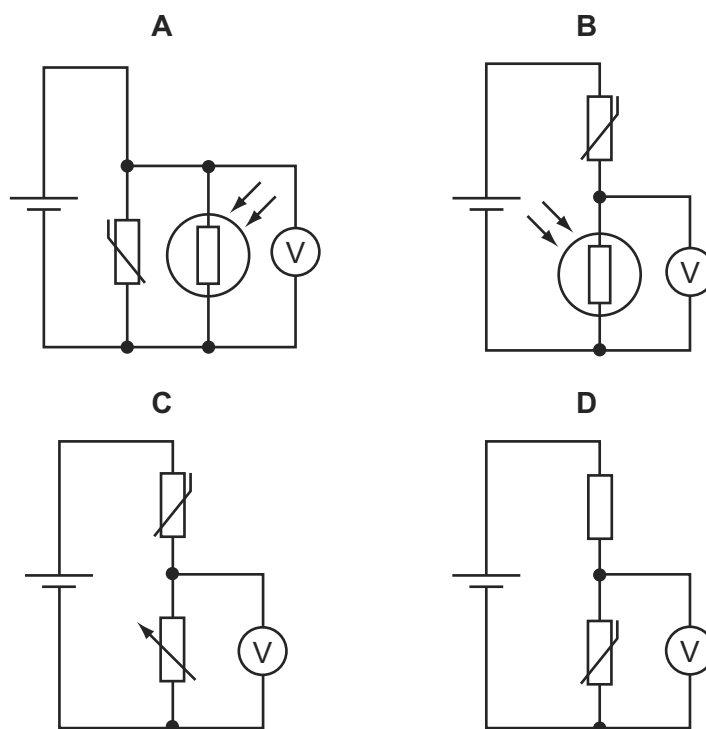
What is the energy transferred and the time taken?

	energy / J	time / s
A	3.0	2.0
B	3.0	8.0
C	48	2.0
D	48	8.0

- 82 A thermistor and another component are connected to a constant voltage supply. A voltmeter is connected across one of the components. The temperature of the thermistor is then reduced but no other changes are made.

9702/01/M/J/08/Q36

In which circuit will the voltmeter reading increase?



- 83 Two wires P and Q made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has diameter 2 mm and wire Q has diameter 1 mm.

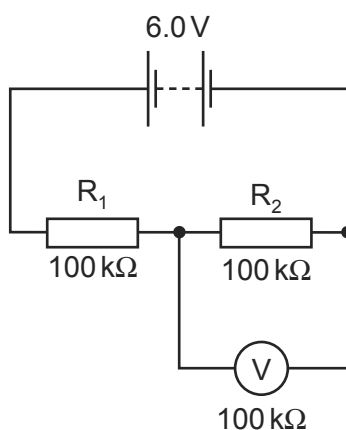
9702/01/O/N/08/Q31

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

- 84 In the circuit shown, the 6.0 V battery has negligible internal resistance. Resistors R_1 and R_2 and the voltmeter have resistance $100\text{ k}\Omega$.

9702/01/M/J/08/Q37



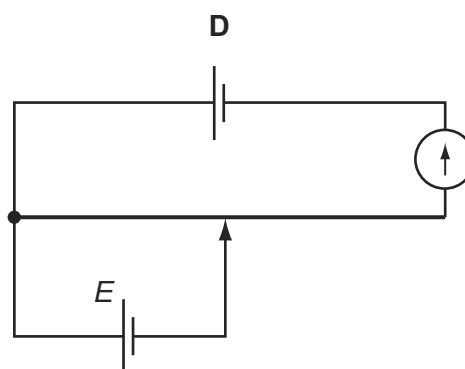
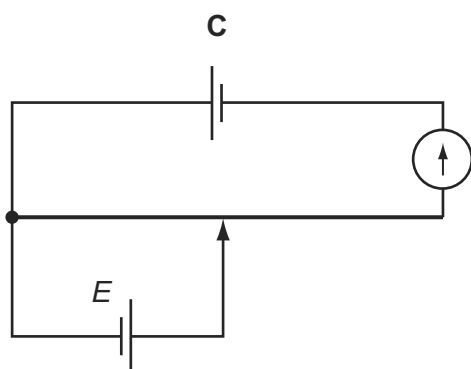
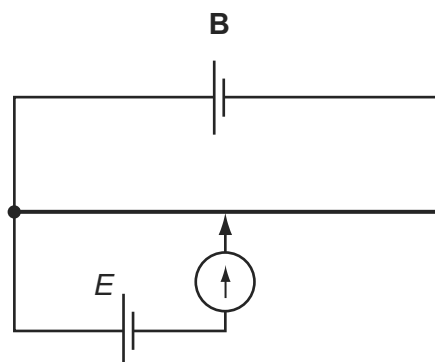
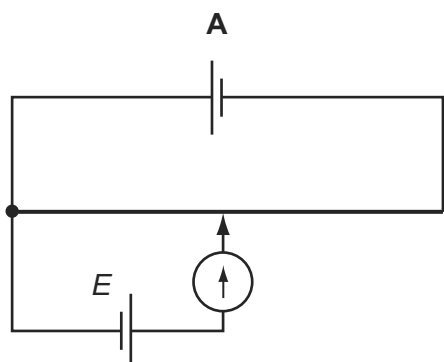
What is the current in the resistor R_2 ?

- A** $20\text{ }\mu\text{A}$ **B** $30\text{ }\mu\text{A}$ **C** $40\text{ }\mu\text{A}$ **D** $60\text{ }\mu\text{A}$

- 85 The unknown e.m.f. E of a cell is to be determined using a potentiometer circuit. The balance length is to be measured when the galvanometer records a null reading.

9702/01/M/J/08/Q38

What is the correct circuit to use?



- 86 A 12 V battery is charged for 20 minutes by connecting it to a source of electromotive force (e.m.f.). The battery is supplied with $7.2 \times 10^4\text{ J}$ of energy in this time.

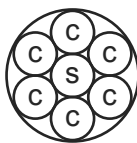
9702/01/M/J/09/Q31

How much charge flows into the battery?

- A** 5.0 C **B** 60 C **C** 100 C **D** 6000 C

- 87 An electric power cable consists of six copper wires c surrounding a steel core s .

9702/01/O/N/08/Q32



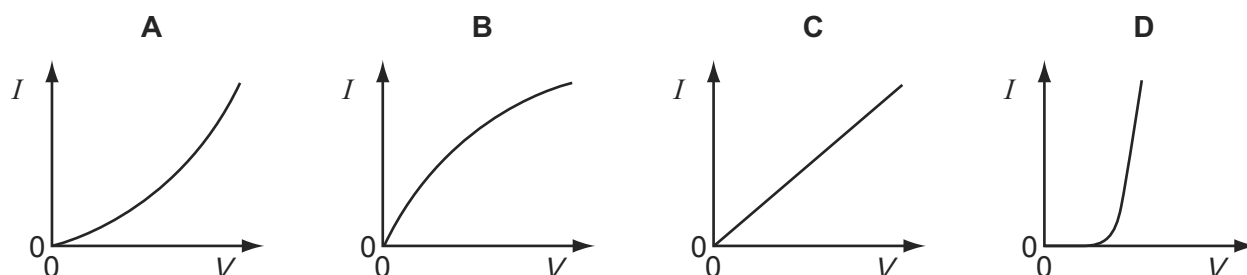
1.0 km of one of the copper wires has a resistance of $10\ \Omega$ and 1.0 km of the steel core has a resistance of $100\ \Omega$.

What is the approximate resistance of a 1.0 km length of the power cable?

- A** $0.61\ \Omega$ **B** $1.6\ \Omega$ **C** $160\ \Omega$ **D** $610\ \Omega$

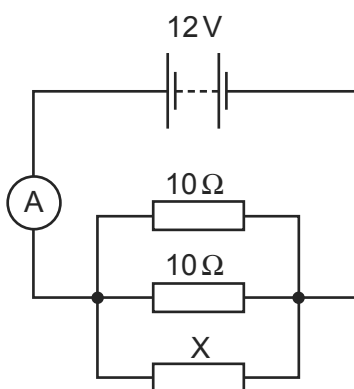
- 88 Which graph best represents the way the current I through a filament lamp varies with the potential difference V across it?

9702/01/O/N/08/Q33



- 89 The diagram shows a circuit containing three resistors in parallel.

9702/01/O/N/08/Q35



The battery has e.m.f. 12 V and negligible internal resistance. The ammeter reading is 3.2 A .

What is the resistance of X ?

- A** $2.1\ \Omega$ **B** $4.6\ \Omega$ **C** $6.0\ \Omega$ **D** $15\ \Omega$

- 90 A copper wire is cylindrical and has resistance R .

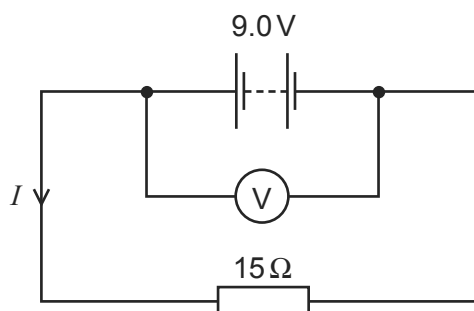
9702/11/O/N/10/Q33

What will be the resistance of a copper wire of twice the length and twice the radius?

- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

- 91 The e.m.f. of the battery is 9.0 V. The reading on the high-resistance voltmeter is 7.5 V.

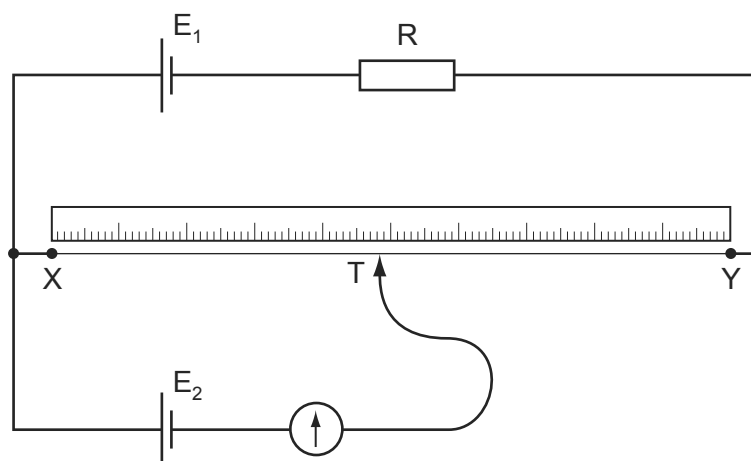
9702/01/O/N/08/Q36



What is the current I ?

- 92 The diagram shows a potentiometer circuit.

9702/01/O/N/08/Q37



The contact T is placed on the wire and moved along the wire until the galvanometer reading is zero. The length XT is then noted.

In order to calculate the potential difference per unit length on the wire XY , which value must also be known?

- A** the e.m.f. of the cell E_1
 - B** the e.m.f. of the cell E_2
 - C** the resistance of resistor R
 - D** the resistance of the wire XY
- 93 What is the unit of resistivity?

9702/11/M/J/10/Q31

- A** $\Omega \text{ m}^{-2}$
- B** $\Omega \text{ m}^{-1}$
- C** Ω
- D** $\Omega \text{ m}$

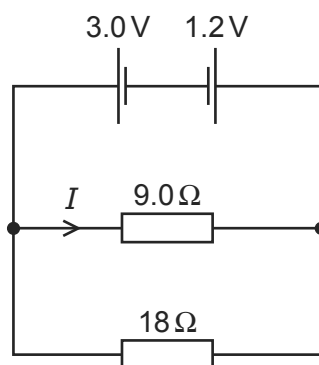
94 What is meant by the electromotive force (e.m.f.) of a cell?

9702/01/M/J/09/Q32

- A** The e.m.f. of a cell is the energy converted into electrical energy when unit charge passes through the cell.
- B** The e.m.f. of a cell is the energy transferred by the cell in driving unit charge through the external resistance.
- C** The e.m.f. of a cell is the energy transferred by the cell in driving unit charge through the internal resistance of the cell.
- D** The e.m.f. of a cell is the amount of energy needed to bring a unit positive charge from infinity to its positive pole.

95 Two cells of e.m.f. 3.0 V and 1.2 V and negligible internal resistance are connected to resistors of resistance 9.0Ω and 18Ω as shown.

9702/01/M/J/09/Q33



What is the value of the current I in the 9.0Ω resistor?

- A** 0.10 A
- B** 0.20 A
- C** 0.30 A
- D** 0.47 A

96 Which amount of charge, flowing in the given time, will produce the largest current? 9702/01/M/J/09/Q30

	charge / C	time / s
A	4	$\frac{1}{4}$
B	4	1
C	1	4
D	$\frac{1}{4}$	4

97 A source of e.m.f. of 9.0 mV has an internal resistance of 6.0Ω .

9702/11/M/J/10/Q35

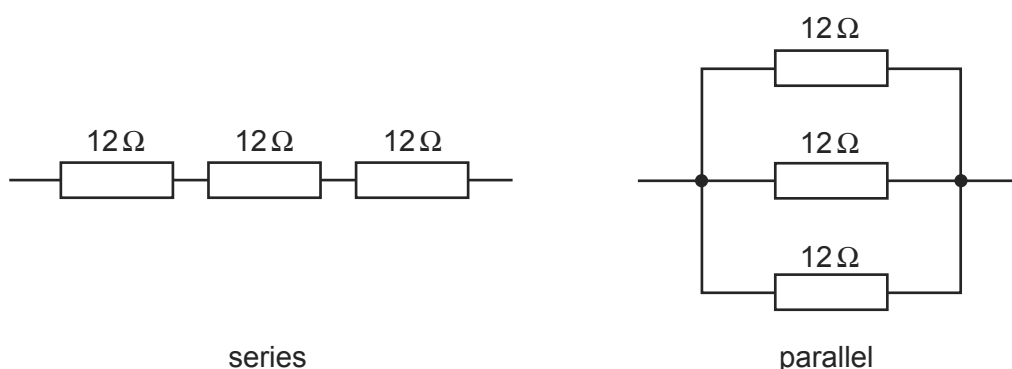
It is connected across a galvanometer of resistance 30Ω .

What will be the current in the galvanometer?

- A** $250\mu\text{A}$
- B** $300\mu\text{A}$
- C** 1.5 mA
- D** 2.5 mA

- 98 Six identical 12Ω resistors are arranged in two groups, one with three in series and the other with three in parallel.

9702/01/M/J/09/Q34

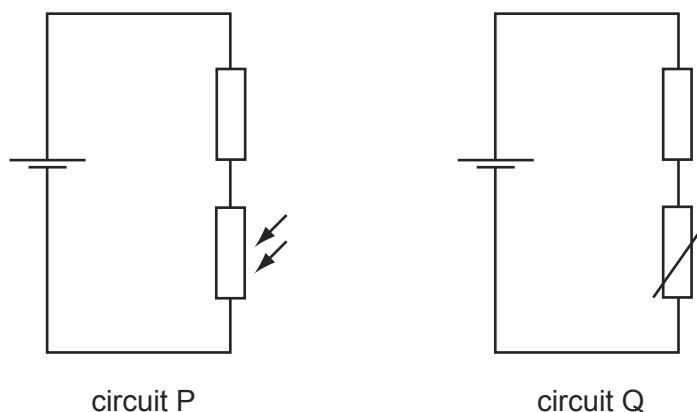


What are the combined resistances of each of these two arrangements?

	series	parallel
A	4.0Ω	0.25Ω
B	4.0Ω	36Ω
C	36Ω	0.25Ω
D	36Ω	4.0Ω

- 99 The diagrams show a light-dependent resistor in circuit P, and a thermistor in circuit Q.

9702/01/M/J/09/Q35



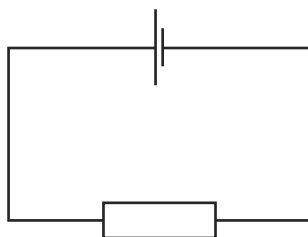
How does the potential difference across the fixed resistor in each circuit change when both the brightness of the light on the light-dependent resistor and the temperature of the thermistor are increased?

	circuit P	circuit Q
A	decrease	decrease
B	decrease	increase
C	increase	decrease
D	increase	increase

- 100 A cell is connected to a resistor.

9702/11/O/N/09/Q30

At any given moment, the potential difference across the cell is less than its electromotive force.



Which statement explains this?

- A** The cell is continually discharging.
- B** The connecting wire has some resistance.
- C** Energy is needed to drive charge through the cell.
- D** Power is used when there is a current in the resistor.

- 101 Which values of current and resistance will produce a rate of energy transfer of
- 16 J s^{-1}
- ?

9702/11/O/N/09/Q31

	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

- 102 A cylindrical wire 4.0 m long has a resistance of
- 31Ω
- and is made of metal of resistivity
- $1.0 \times 10^{-6} \Omega \text{ m}$
- .

9702/11/O/N/09/Q32

What is the radius of cross-section of the wire?

- A** $1.0 \times 10^{-8} \text{ m}$
- B** $2.0 \times 10^{-8} \text{ m}$
- C** $6.4 \times 10^{-8} \text{ m}$
- D** $2.0 \times 10^{-4} \text{ m}$

- 103 A source of e.m.f. of 9.0 mV has an internal resistance of
- 6.0Ω
- .

9702/12/M/J/10/Q33

It is connected across a galvanometer of resistance 30Ω .

What will be the current in the galvanometer?

- A** $250 \mu\text{A}$
- B** $300 \mu\text{A}$
- C** 1.5 mA
- D** 2.5 mA

104 Each of Kirchhoff's two laws presumes that some quantity is conserved.

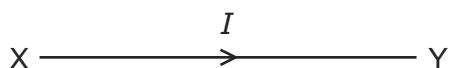
9702/11/O/N/09/Q33

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

	statement	quantity
A	the algebraic sum of currents into a junction is zero	charge
B	the algebraic sum of currents into a junction is zero	energy
C	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	charge
D	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	energy

105 The diagram shows the symbol for a wire carrying a current I .

9702/11/O/N/09/Q34

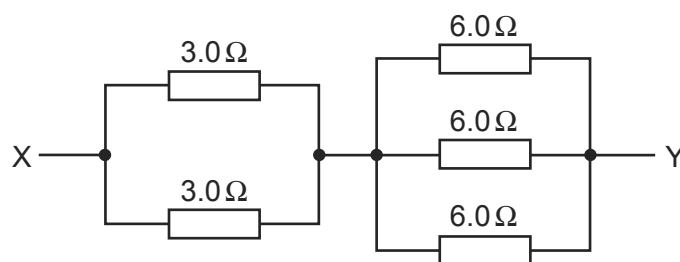


What does this current represent?

- A** the amount of charge flowing past a point in XY per second
- B** the number of electrons flowing past a point in XY per second
- C** the number of positive ions flowing past a point in XY per second
- D** the number of protons flowing past a point in XY per second

106 A network of resistors consists of two 3.0Ω resistors and three 6.0Ω resistors.

9702/11/O/N/09/Q36

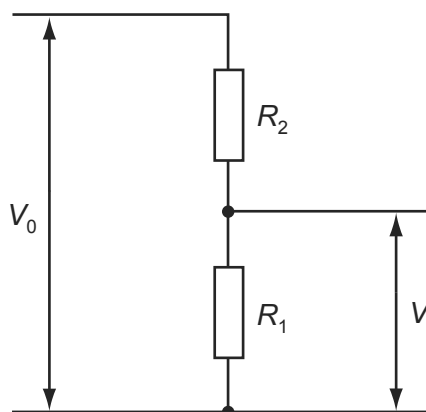


What is the combined resistance of this network between points X and Y?

- A** 0.86Ω
- B** 1.2Ω
- C** 3.5Ω
- D** 24Ω

- 107 A potential divider consisting of resistors of resistance R_1 and R_2 is connected to an input potential difference of V_0 and gives an output p.d. of V .

9702/11/O/N/09/Q35



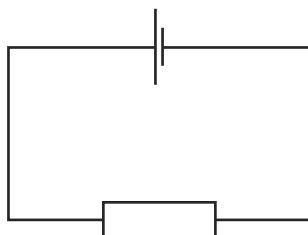
What is the value of V ?

- A** $\frac{V_0 R_1}{R_2}$ **B** $\frac{V_0 R_1}{R_1 + R_2}$ **C** $\frac{V_0 R_2}{R_1 + R_2}$ **D** $\frac{V_0 (R_1 + R_2)}{R_1}$

- 108 A cell is connected to a resistor.

9702/12/O/N/09/Q29

At any given moment, the potential difference across the cell is less than its electromotive force.



Which statement explains this?

- A** The cell is continually discharging.
B The connecting wire has some resistance.
C Energy is needed to drive charge through the cell.
D Power is used when there is a current in the resistor.

- 109 A cylindrical wire 4.0 m long has a resistance of $31 \, \Omega$ and is made of metal of resistivity $1.0 \times 10^{-6} \, \Omega \text{ m}$.

9702/12/O/N/09/Q31

What is the radius of cross-section of the wire?

- A** $1.0 \times 10^{-8} \text{ m}$
B $2.0 \times 10^{-8} \text{ m}$
C $6.4 \times 10^{-8} \text{ m}$
D $2.0 \times 10^{-4} \text{ m}$

- 110 Which values of current and resistance will produce a rate of energy transfer of 16 J s^{-1} ?

9702/12/O/N/09/Q30

	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

- 111 Each of Kirchhoff's two laws presumes that some quantity is conserved.

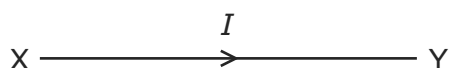
9702/12/O/N/09/Q32

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C	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	charge
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- 112 The diagram shows the symbol for a wire carrying a current I .

9702/12/O/N/09/Q33

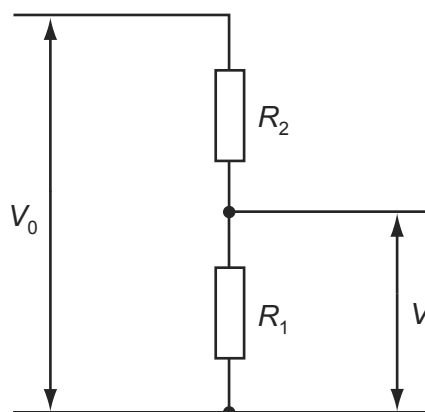


What does this current represent?

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- C** the number of positive ions flowing past a point in XY per second
- D** the number of protons flowing past a point in XY per second

- 113 A potential divider consisting of resistors of resistance R_1 and R_2 is connected to an input potential difference of V_0 and gives an output p.d. of V .

9702/12/O/N/09/Q34

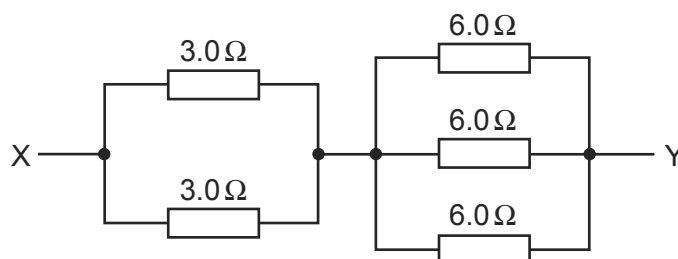


What is the value of V ?

- A** $\frac{V_0 R_1}{R_2}$
 B $\frac{V_0 R_1}{R_1 + R_2}$
 C $\frac{V_0 R_2}{R_1 + R_2}$
 D $\frac{V_0 (R_1 + R_2)}{R_1}$

- 114 A network of resistors consists of two 3.0Ω resistors and three 6.0Ω resistors.

9702/12/O/N/09/Q35

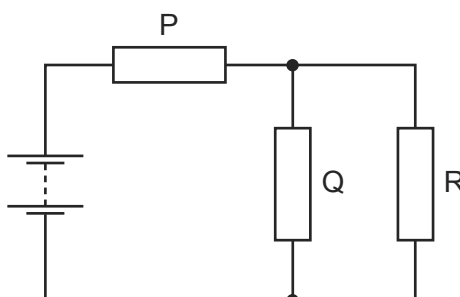


What is the combined resistance of this network between points X and Y?

- A** 0.86Ω
 B 1.2Ω
 C 3.5Ω
 D 24Ω

- 115 The resistors P, Q and R in the circuit have equal resistance.

9702/11/M/J/10/Q33



The battery, of negligible internal resistance, supplies a total power of 12W .

What is the power dissipated by heating in resistor R?

- A** 2W
 B 3W
 C 4W
 D 6W

- 116 The resistance of a thermistor depends on its temperature, and the resistance of a light-dependent resistor (LDR) depends on the illumination. 9702/11/M/J/10/Q32

Under which conditions will the resistance of both a thermistor and an LDR be highest?

	thermistor	LDR
A	highest temperature	highest illumination
B	highest temperature	lowest illumination
C	lowest temperature	highest illumination
D	lowest temperature	lowest illumination

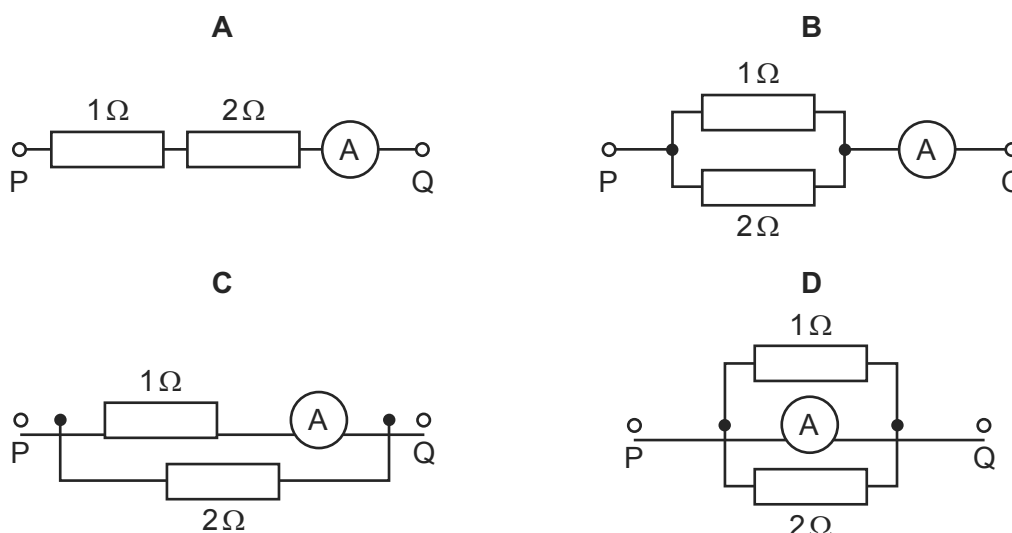
- 117 In deriving a formula for the combined resistance of three different resistors in series, Kirchhoff's laws are used. 9702/11/M/J/10/Q34

Which physics principle is involved in this derivation?

- A** the conservation of charge
- B** the direction of the flow of charge is from negative to positive
- C** the potential difference across each resistor is the same
- D** the current varies in each resistor, in proportion to the resistor value

- 118 In each arrangement of resistors, the ammeter has a resistance of 2Ω . 9702/11/M/J/10/Q36

Which arrangement gives the largest reading on the ammeter when the same potential difference is applied between points P and Q?



- 119 What is the unit of resistivity? 9702/12/M/J/10/Q36
- A** Ωm^{-2}
 - B** Ωm^{-1}
 - C** Ω
 - D** Ωm

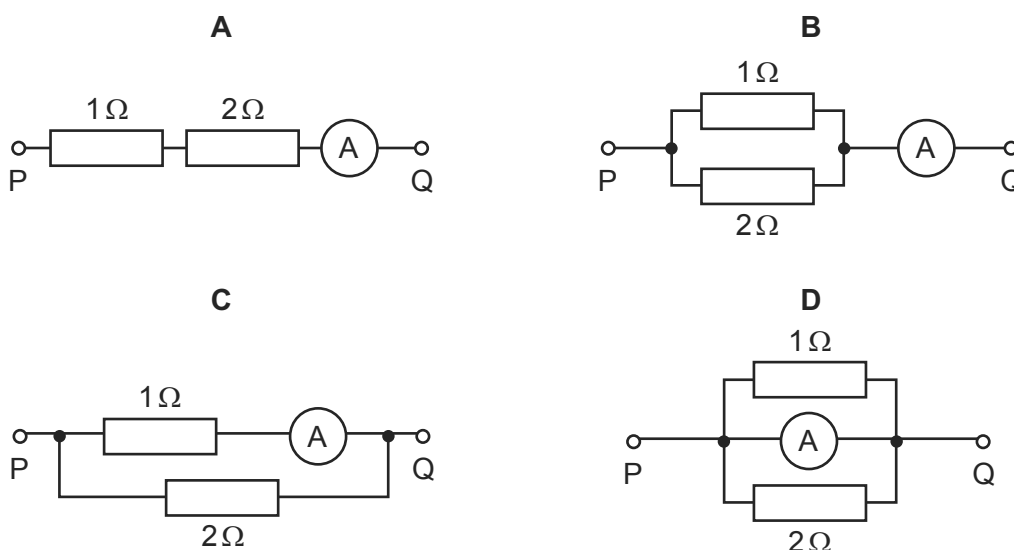
- 120 The resistance of a thermistor depends on its temperature, and the resistance of a light-dependent resistor (LDR) depends on the illumination. 9702/12/M/J/10/Q30

Under which conditions will the resistance of both a thermistor and an LDR be highest?

	thermistor	LDR
A	highest temperature	highest illumination
B	highest temperature	lowest illumination
C	lowest temperature	highest illumination
D	lowest temperature	lowest illumination

- 121 In each arrangement of resistors, the ammeter has a resistance of 2Ω . 9702/12/M/J/10/Q32

Which arrangement gives the largest reading on the ammeter when the same potential difference is applied between points P and Q?



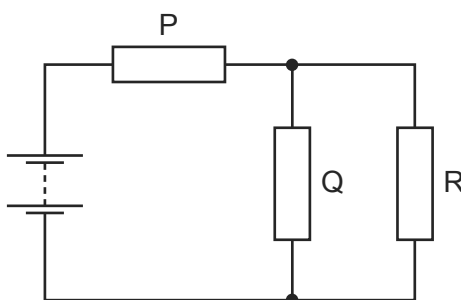
- 122 The resistance of a thermistor depends on its temperature, and the resistance of a light-dependent resistor (LDR) depends on the illumination. 9702/13/M/J/10/Q33

Under which conditions will the resistance of both a thermistor and an LDR be highest?

	thermistor	LDR
A	highest temperature	highest illumination
B	highest temperature	lowest illumination
C	lowest temperature	highest illumination
D	lowest temperature	lowest illumination

123 The resistors P, Q and R in the circuit have equal resistance.

9702/12/M/J/10/Q34



The battery, of negligible internal resistance, supplies a total power of 12 W.

What is the power dissipated by heating in resistor R?

- A** 2 W **B** 3 W **C** 4 W **D** 6 W

124 In deriving a formula for the combined resistance of three different resistors in series, Kirchhoff's laws are used.

9702/12/M/J/10/Q35

Which physics principle is involved in this derivation?

- A** the conservation of charge
B the direction of the flow of charge is from negative to positive
C the potential difference across each resistor is the same
D the current varies in each resistor, in proportion to the resistor value

125 A source of e.m.f. of 9.0 mV has an internal resistance of $6.0\ \Omega$.

9702/13/M/J/10/Q31

It is connected across a galvanometer of resistance $30\ \Omega$.

What will be the current in the galvanometer?

- A** $250\ \mu\text{A}$ **B** $300\ \mu\text{A}$ **C** 1.5 mA **D** 2.5 mA

126 In deriving a formula for the combined resistance of three different resistors in series, Kirchhoff's laws are used.

9702/13/M/J/10/Q36

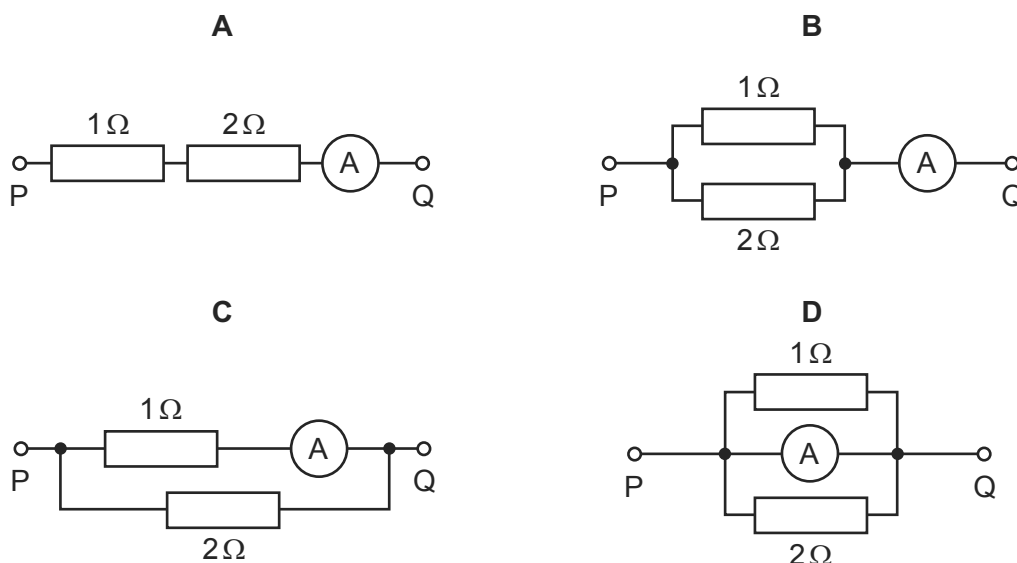
Which physics principle is involved in this derivation?

- A** the conservation of charge
B the direction of the flow of charge is from negative to positive
C the potential difference across each resistor is the same
D the current varies in each resistor, in proportion to the resistor value

127 In each arrangement of resistors, the ammeter has a resistance of 2Ω .

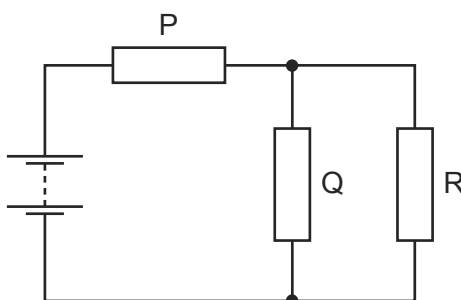
9702/13/M/J/10/Q34

Which arrangement gives the largest reading on the ammeter when the same potential difference is applied between points P and Q?



128 The resistors P, Q and R in the circuit have equal resistance.

9702/13/M/J/10/Q35



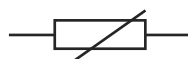
The battery, of negligible internal resistance, supplies a total power of 12W .

What is the power dissipated by heating in resistor R?

- A** 2W **B** 3W **C** 4W **D** 6W

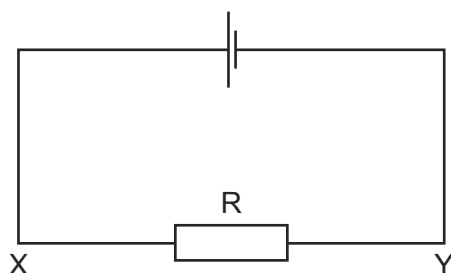
129 Which electrical component is represented by the following symbol?

9702/12/O/N/10/Q30



- A** a diode
B a potentiometer
C a resistor
D a thermistor

130 The current in the circuit shown is 4.8 A.

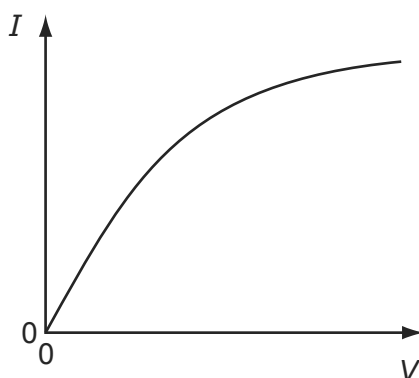


What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19} \text{ s}^{-1}$
B	X to Y	$6.0 \times 10^{18} \text{ s}^{-1}$
C	Y to X	$3.0 \times 10^{19} \text{ s}^{-1}$
D	Y to X	$6.0 \times 10^{18} \text{ s}^{-1}$

131 Which component has the I - V graph shown?

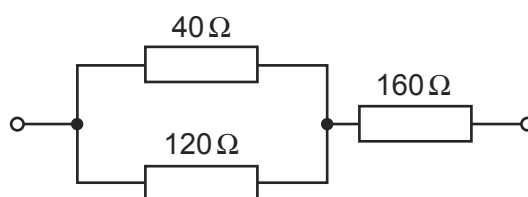
9702/11/O/N/10/Q32



- A** filament lamp
- B** light-dependent resistor
- C** semiconductor diode
- D** thermistor

132 The diagram shows part of a circuit.

9702/11/O/N/10/Q35

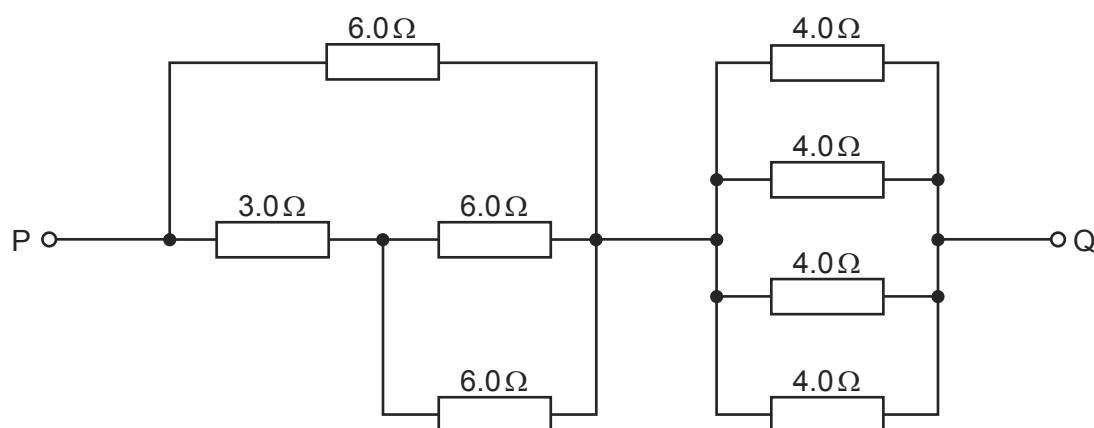


What is the total resistance of the combination of the three resistors?

- A** 320Ω
- B** 240Ω
- C** 190Ω
- D** 80Ω

133 The diagram shows part of a circuit.

9702/12/O/N/10/Q35

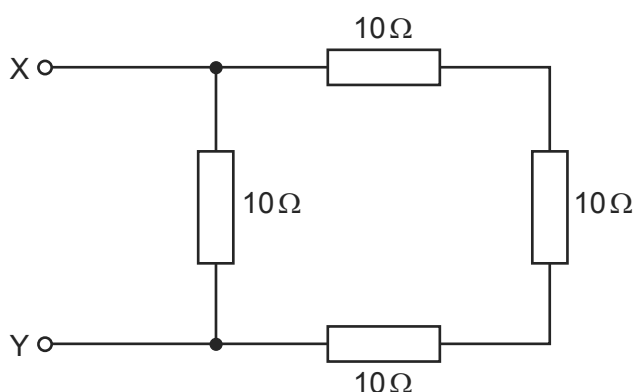


What is the resistance between the points P and Q due to the resistance network?

- A** $1.3\ \Omega$ **B** $4.0\ \Omega$ **C** $10\ \Omega$ **D** $37\ \Omega$

134 The diagram shows an arrangement of resistors.

9702/11/O/N/10/Q36



What is the total electrical resistance between X and Y?

- A** less than $1\ \Omega$
B between $1\ \Omega$ and $10\ \Omega$
C between $10\ \Omega$ and $30\ \Omega$
D $40\ \Omega$

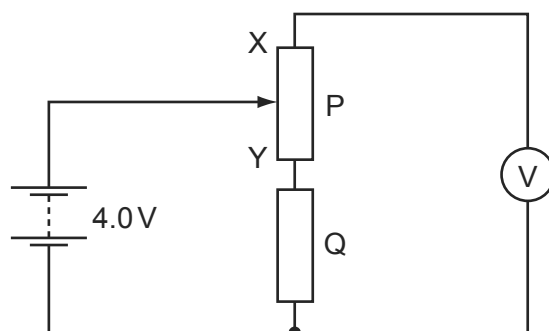
135 When there is **no current** in a wire, which statement about the conduction electrons in that wire is correct?

9702/12/O/N/10/Q31

- A** Electrons in the wire are moving totally randomly within the wire.
B Equal numbers of electrons move at the same speed, but in opposite directions, along the wire.
C No current is flowing therefore the electrons in the wire are stationary.
D No current is flowing therefore the electrons in the wire are vibrating around a fixed point.

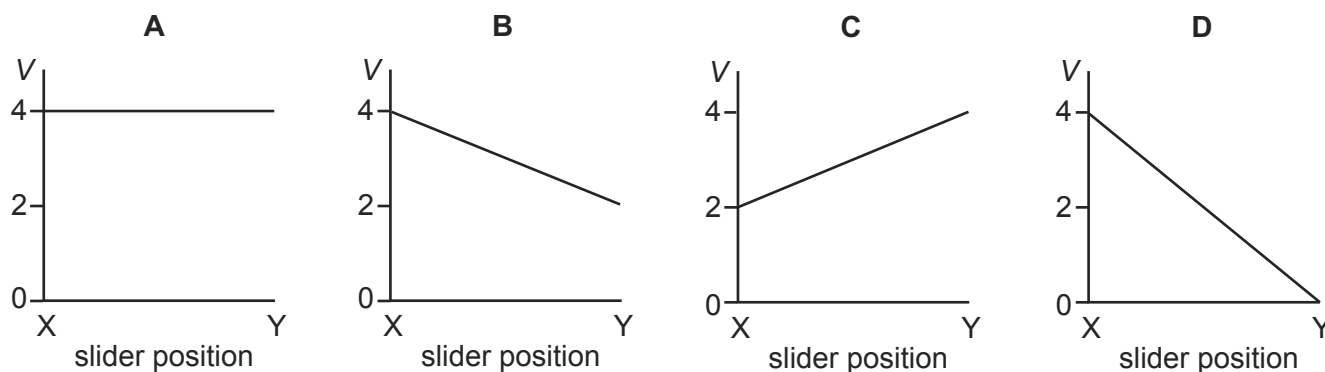
- 136 In the circuit below, P is a potentiometer of total resistance $10\ \Omega$ and Q is a fixed resistor of resistance $10\ \Omega$. The battery has an e.m.f. of $4.0\ \text{V}$ and negligible internal resistance. The voltmeter has a very high resistance.

9702/11/O/N/10/Q37



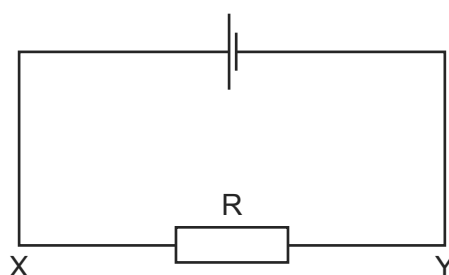
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?



- 137 The current in the circuit shown is $4.8\ \text{A}$.

9702/13/O/N/10/Q32



What is the direction of flow and the rate of flow of electrons through the resistor R?

	direction of flow	rate of flow
A	X to Y	$3.0 \times 10^{19}\ \text{s}^{-1}$
B	X to Y	$6.0 \times 10^{18}\ \text{s}^{-1}$
C	Y to X	$3.0 \times 10^{19}\ \text{s}^{-1}$
D	Y to X	$6.0 \times 10^{18}\ \text{s}^{-1}$

138 A high-resistance voltmeter connected across a battery reads 6.0 V.

9702/12/O/N/10/Q32

When the battery is connected in series with a lamp of resistance of $10\ \Omega$, the voltmeter reading falls to 5.6 V.

Which statement explains this observation?

- A** The electromotive force (e.m.f.) of the battery decreases because more work is done across its internal resistance.
- B** The e.m.f. of the battery decreases because work is done across the lamp.
- C** The potential difference (p.d.) across the battery decreases because more work is done across its internal resistance.
- D** The p.d. across the battery decreases because work is done across the lamp.

139 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate. 9702/13/O/N/10/Q31

A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

The resistance of each of these wires is $0.0050\ \Omega$ per metre.

What is the minimum output e.m.f. of the power supply?

- A** 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

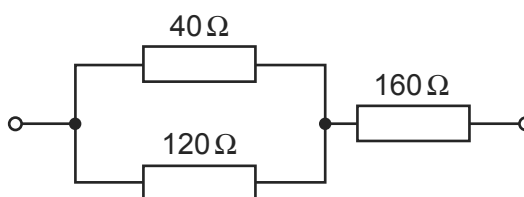
140 What is the unit of resistivity?

9702/13/M/J/10/Q30

- A** Ωm^{-2} **B** Ωm^{-1} **C** Ω **D** Ωm

141 The diagram shows part of a circuit.

9702/13/O/N/10/Q33



What is the total resistance of the combination of the three resistors?

- A** $320\ \Omega$ **B** $240\ \Omega$ **C** $190\ \Omega$ **D** $80\ \Omega$

142 A copper wire of cross-sectional area 2.0 mm^2 carries a current of 10 A.

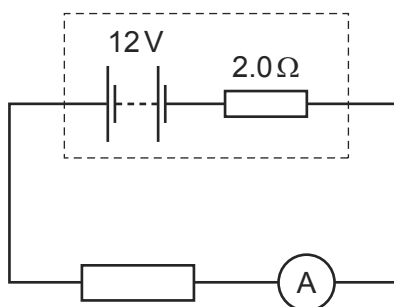
9702/11/M/J/11/Q31

How many electrons pass through a given cross-section of the wire in one second?

- A** 1.0×10^1 **B** 5.0×10^6 **C** 6.3×10^{19} **D** 3.1×10^{25}

- 143 A battery of e.m.f. 12 V and internal resistance $2.0\ \Omega$ is connected in series with an ammeter of negligible resistance and an external resistor. External resistors of various different values are used.

9702/12/O/N/10/Q33

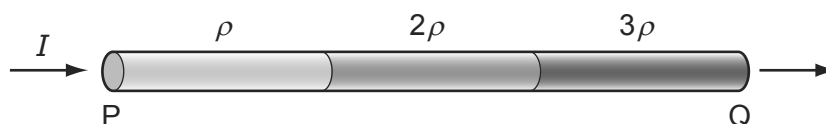


Which combination of current and resistor value is **not** correct?

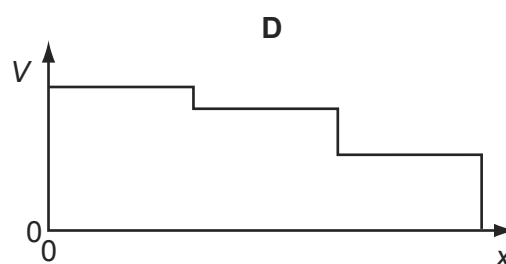
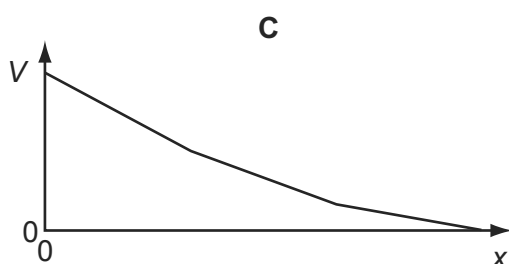
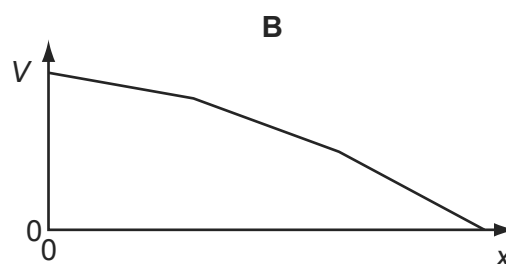
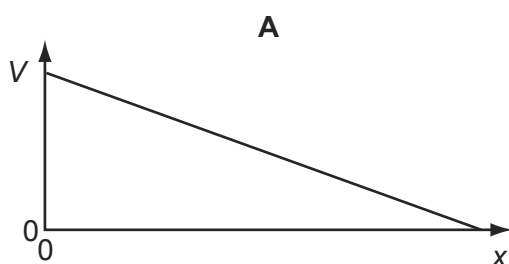
	current / A	external resistor value / Ω
A	1.0	10
B	1.2	8
C	1.5	6
D	1.8	4

- 144 A wire PQ is made of three different materials, with resistivities ρ , 2ρ and 3ρ . There is a current I in this composite wire, as shown.

9702/12/O/N/10/Q34

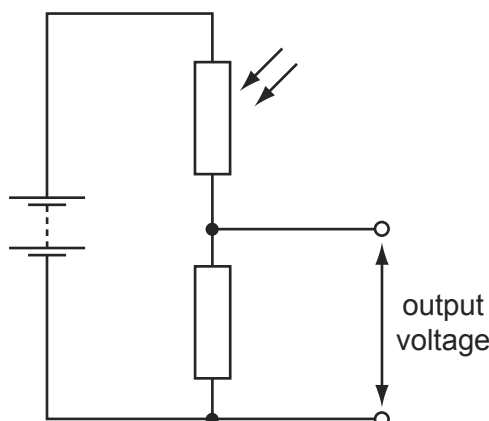


Which graph best shows how the potential V along the wire varies with distance x from P?



145 The diagram shows a potential divider circuit.

9702/12/O/N/10/Q36



The light level increases.

What is the effect on the resistance of the light-dependent resistor (LDR) and on the output voltage?

	resistance of the LDR	output voltage
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

146 A relay is required to operate 800 m from its power supply. The power supply has negligible internal resistance. The relay requires 16.0 V and a current of 0.60 A to operate. 9702/11/O/N/10/Q34

A cable connects the relay to the power supply and two of the wires in the cable are used to supply power to the relay.

The resistance of each of these wires is $0.0050\ \Omega$ per metre.

What is the minimum output e.m.f. of the power supply?

- A** 16.6 V **B** 18.4 V **C** 20.8 V **D** 29.3 V

147 A battery is marked 9.0 V.

9702/11/M/J/11/Q32

What does this mean?

- A** Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.
- B** The battery supplies 9.0 J to an external circuit for each coulomb of charge.
- C** The potential difference across any component connected to the battery will be 9.0 V.
- D** There will always be 9.0 V across the battery terminals.

- 148 Three resistors, with resistances R_1 , R_2 and R_3 , are connected in series and are found to have a combined resistance of $500\ \Omega$. When connected in parallel, the combined resistance is found to be $50\ \Omega$.

9702/12/O/N/10/Q37

Which values will correspond to these results?

	R_1/Ω	R_2/Ω	R_3/Ω
A	160	160	80
B	200	200	100
C	225	225	50
D	230	230	40

- 149 A copper wire is cylindrical and has resistance R .

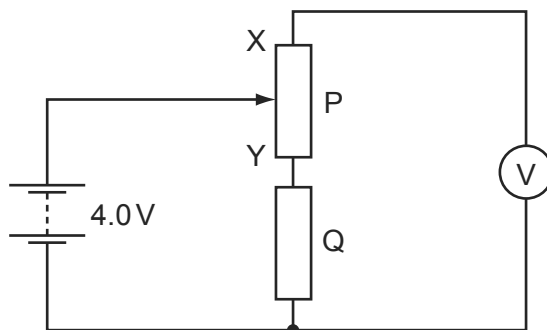
9702/13/O/N/10/Q34

What will be the resistance of a copper wire of twice the length and twice the radius?

- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

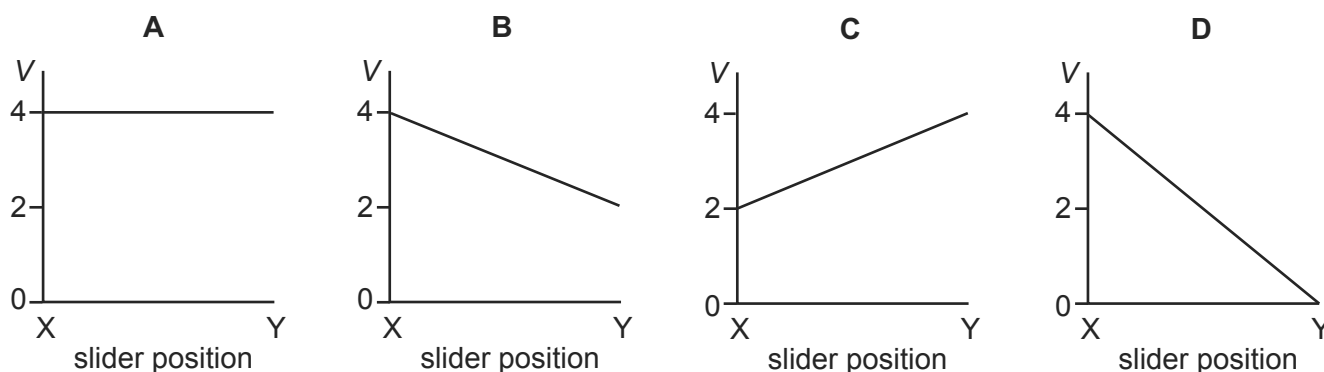
- 150 In the circuit below, P is a potentiometer of total resistance $10\ \Omega$ and Q is a fixed resistor of resistance $10\ \Omega$. The battery has an e.m.f. of $4.0\ \text{V}$ and negligible internal resistance. The voltmeter has a very high resistance.

9702/13/O/N/10/Q35



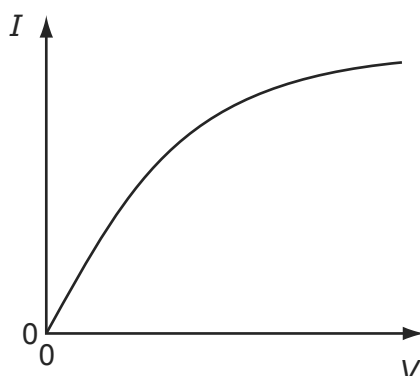
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?



151 Which component has the I - V graph shown?

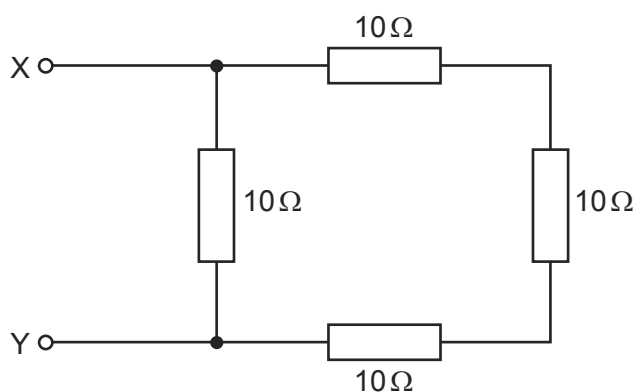
9702/13/O/N/10/Q36



- A filament lamp
- B light-dependent resistor
- C semiconductor diode
- D thermistor

152 The diagram shows an arrangement of resistors.

9702/13/O/N/10/Q37



What is the total electrical resistance between X and Y?

- A less than $1\ \Omega$
- B between $1\ \Omega$ and $10\ \Omega$
- C between $10\ \Omega$ and $30\ \Omega$
- D $40\ \Omega$

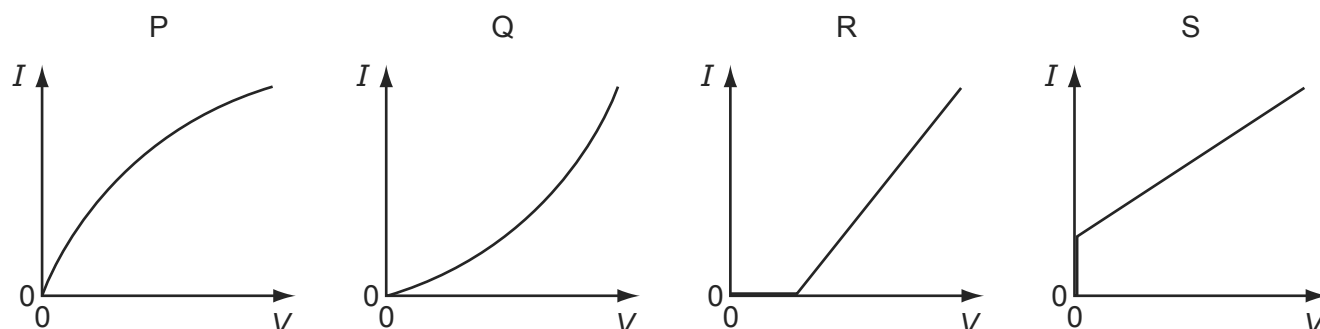
153 What describes the electric potential difference between two points in a wire that carries a current?

9702/12/M/J/11/Q32

- A the force required to move a unit positive charge between the points
- B the ratio of the energy dissipated between the points to the current
- C the ratio of the power dissipated between the points to the current
- D the ratio of the power dissipated between the points to the charge moved

- 154 The graphs show possible current-voltage (I - V) relationships for a filament lamp and for a semiconductor diode.

9702/11/M/J/11/Q33

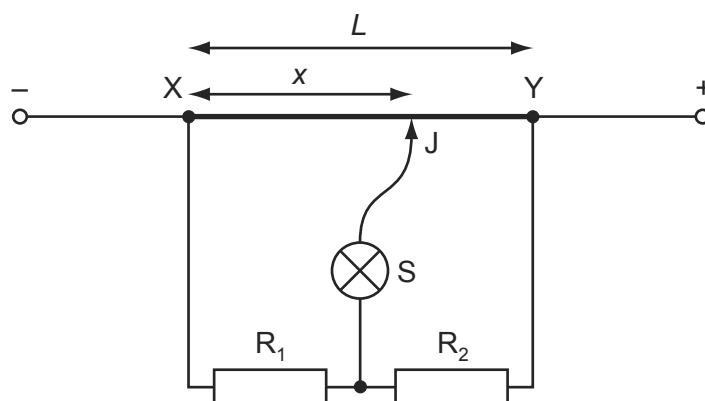


Which row best specifies the correct I - V graphs for the lamp and the diode?

	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

- 155 In the circuit shown, XY is a length L of uniform resistance wire. R_1 and R_2 are unknown resistors. J is a sliding contact that joins the junction of R_1 and R_2 to points on XY through a small signal lamp S.

9702/11/M/J/11/Q37



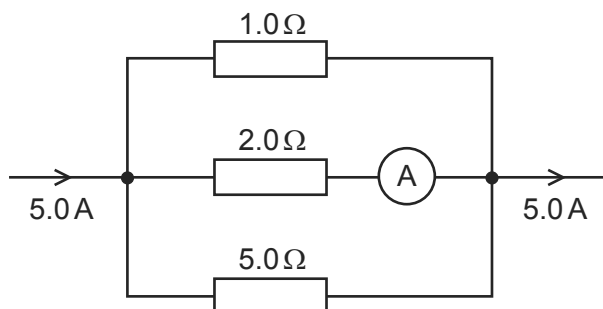
To determine the ratio $\frac{V_1}{V_2}$ of the potential differences across R_1 and R_2 , a point is found on XY at which the lamp is off. This point is at a distance x from X.

What is the value of the ratio $\frac{V_1}{V_2}$?

- A** $\frac{L}{x}$ **B** $\frac{x}{L}$ **C** $\frac{L-x}{x}$ **D** $\frac{x}{L-x}$

- 156 The diagram shows part of a current-carrying circuit. The ammeter has negligible internal resistance.

9702/11/M/J/11/Q35

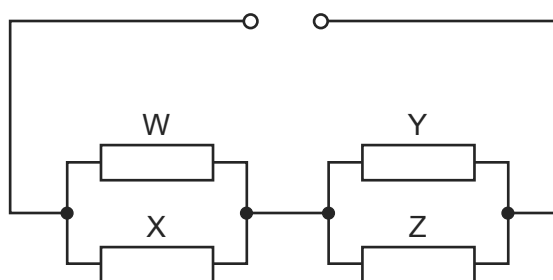


What is the reading on the ammeter?

- A** 0.7 A **B** 1.3 A **C** 1.5 A **D** 1.7 A

- 157 Four resistors of equal value are connected as shown.

9702/11/M/J/11/Q36

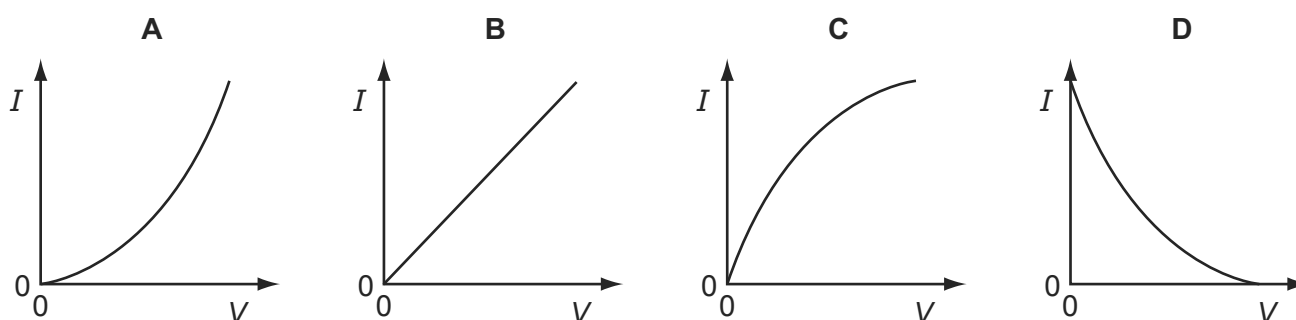


How will the powers to the resistors change when resistor W is removed?

- A** The powers to X, Y and Z will all increase.
B The power to X will decrease and the powers to Y and Z will increase.
C The power to X will increase and the powers to Y and Z will decrease.
D The power to X will increase and the powers to Y and Z will remain unaltered.

- 158 Which graph best represents the way in which the current I through a thermistor depends upon the potential difference V across it?

9702/12/M/J/11/Q35



- 159 A cylindrical piece of a soft, electrically-conducting material has resistance R . It is rolled out so that its length is doubled but its volume stays constant.

9702/12/M/J/11/Q33

What is its new resistance?

- A** $\frac{R}{2}$ **B** R **C** $2R$ **D** $4R$

- 160 A source of electromotive force (e.m.f.) E has a constant internal resistance r and is connected to an external variable resistor of resistance R .

9702/12/M/J/11/Q34

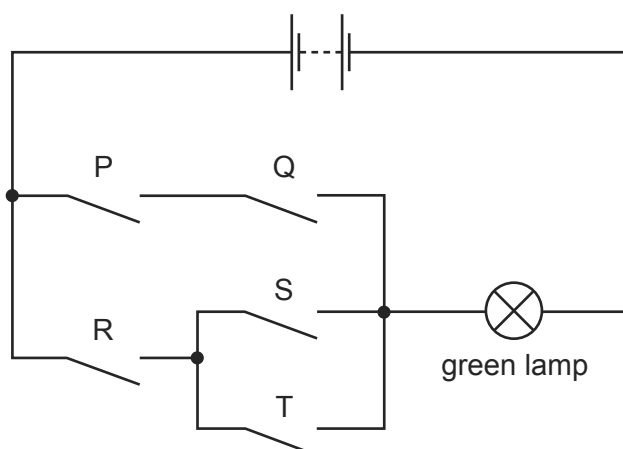
As R is increased from a value below r to a value above r , which statement is correct?

- A** The terminal potential difference remains constant.
B The current in the circuit increases.
C The e.m.f. of the source increases.
D The largest output power is obtained when R reaches r .

- 161 Safety on railways is increased by using several electrical switches.

9702/12/M/J/11/Q36

In the diagram, switches P, Q, R, S and T control the current through a green lamp.

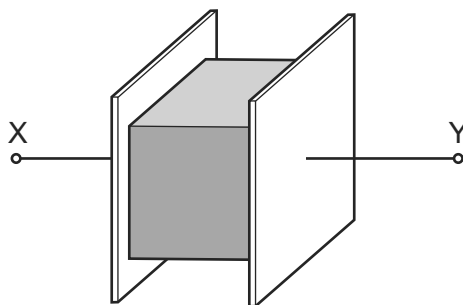


Which row does **not** allow the green lamp to light?

	P	Q	R	S	T
A	closed	closed	closed	open	closed
B	closed	open	closed	closed	open
C	closed	open	open	closed	closed
D	open	open	closed	open	closed

162 The resistance of a metal cube is measured by placing it between two parallel plates, as shown.

9702/11/M/J/11/Q34



The cube has volume V and is made of a material with resistivity ρ . The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

A $\rho V^{\frac{1}{3}}$

B $\rho V^{\frac{2}{3}}$

C $\frac{\rho}{V^{\frac{1}{3}}}$

D $\frac{\rho}{V^{\frac{2}{3}}}$

163 A battery is marked 9.0 V.

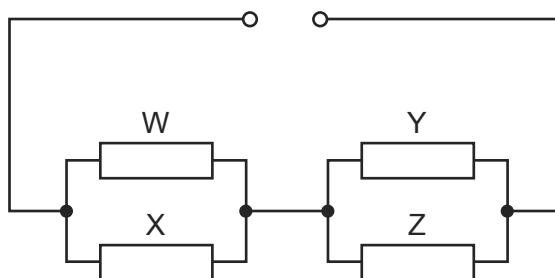
9702/13/M/J/11/Q31

What does this mean?

- A** Each coulomb of charge from the battery supplies 9.0 J of electrical energy to the whole circuit.
- B** The battery supplies 9.0 J to an external circuit for each coulomb of charge.
- C** The potential difference across any component connected to the battery will be 9.0 V.
- D** There will always be 9.0 V across the battery terminals.

164 Four resistors of equal value are connected as shown.

9702/13/M/J/11/Q33

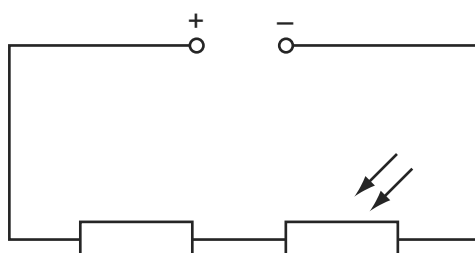


How will the powers to the resistors change when resistor W is removed?

- A** The powers to X, Y and Z will all increase.
- B** The power to X will decrease and the powers to Y and Z will increase.
- C** The power to X will increase and the powers to Y and Z will decrease.
- D** The power to X will increase and the powers to Y and Z will remain unaltered.

- 165 The diagram shows a fixed resistor and a light-dependent resistor (LDR) in series with a constant low-voltage supply.

9702/12/M/J/11/Q37



When the LDR is in the dark, the fixed resistor and the LDR have the same value of resistance.

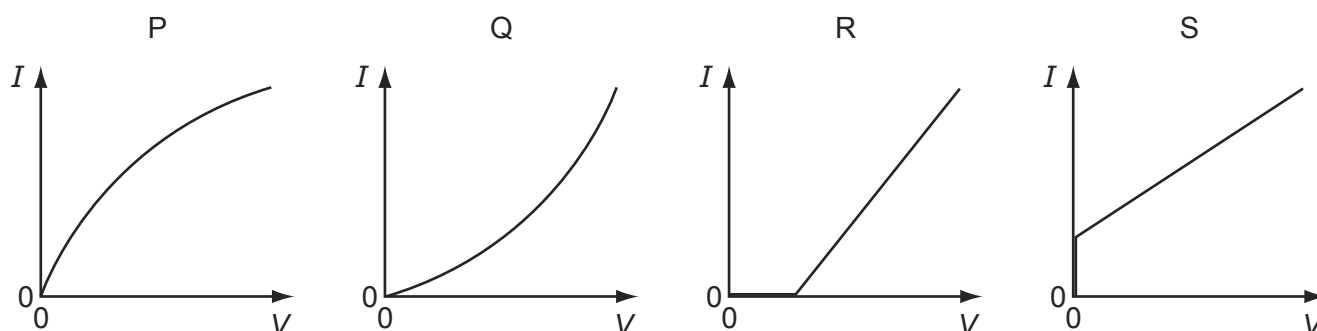
Light is shone on the LDR.

What happens to the potential differences across the two components?

	p.d. across resistor	p.d. across LDR
A	decreased	increased
B	increased	decreased
C	no change	increased
D	no change	decreased

- 166 The graphs show possible current-voltage (I - V) relationships for a filament lamp and for a semiconductor diode.

9702/13/M/J/11/Q34

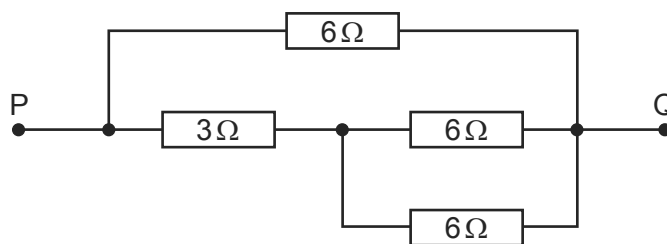


Which row best specifies the correct I - V graphs for the lamp and the diode?

	filament lamp	semiconductor diode
A	P	R
B	P	S
C	Q	R
D	Q	S

167 The diagram shows a d.c. circuit.

9702/12/M/J/11/Q38



What is the resistance between the points P and Q due to the resistance network?

- A** 0.47Ω **B** 2.1Ω **C** 3.0Ω **D** 21Ω

168 A copper wire of cross-sectional area 2.0 mm^2 carries a current of 10 A .

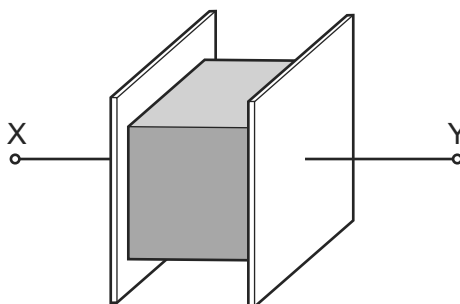
9702/13/M/J/11/Q32

How many electrons pass through a given cross-section of the wire in one second?

- A** 1.0×10^1 **B** 5.0×10^6 **C** 6.3×10^{19} **D** 3.1×10^{25}

169 The resistance of a metal cube is measured by placing it between two parallel plates, as shown.

9702/13/M/J/11/Q35



The cube has volume V and is made of a material with resistivity ρ . The connections to the cube have negligible resistance.

Which expression gives the electrical resistance of the metal cube between X and Y?

- A** $\rho V^{\frac{1}{3}}$ **B** $\rho V^{\frac{2}{3}}$ **C** $\frac{\rho}{V^{\frac{1}{3}}}$ **D** $\frac{\rho}{V^{\frac{2}{3}}}$

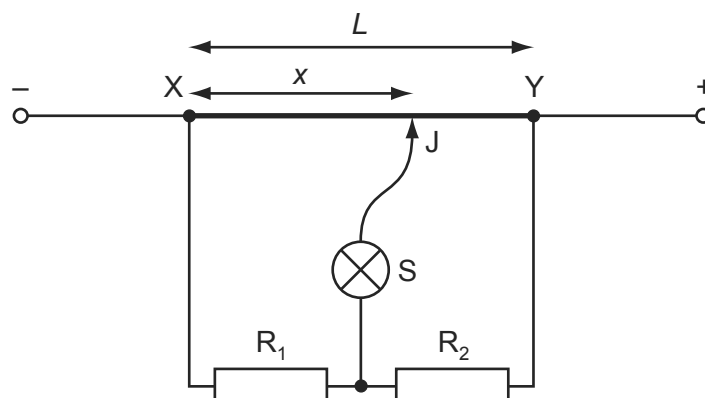
170 Which statement is **not** valid?

9702/11/O/N/11/Q35

- A** Current is the speed of the charged particles that carry it.
- B** Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.
- C** The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.
- D** The resistance between two points is the p.d. between the two points, per unit current.

- 171 In the circuit shown, XY is a length L of uniform resistance wire. R_1 and R_2 are unknown resistors. J is a sliding contact that joins the junction of R_1 and R_2 to points on XY through a small signal lamp S.

9702/13/M/J/11/Q36



To determine the ratio $\frac{V_1}{V_2}$ of the potential differences across R_1 and R_2 , a point is found on XY at which the lamp is off. This point is at a distance x from X.

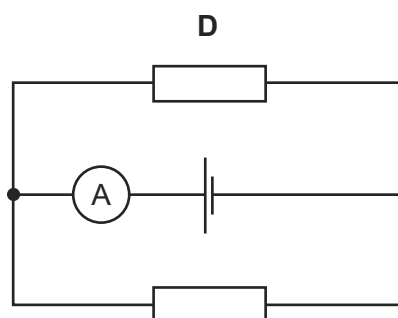
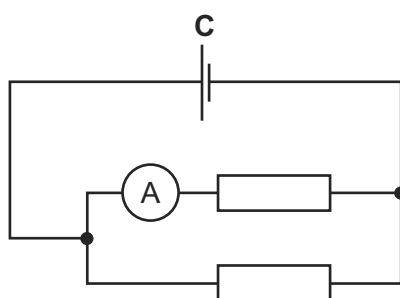
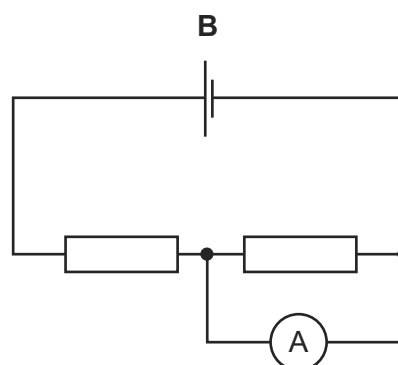
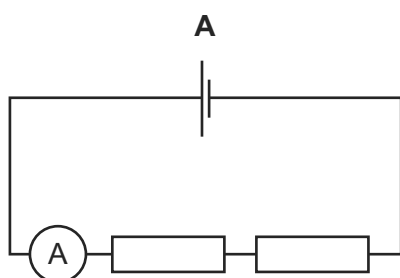
What is the value of the ratio $\frac{V_1}{V_2}$?

- A $\frac{L}{x}$ B $\frac{x}{L}$ C $\frac{L-x}{x}$ D $\frac{x}{L-x}$

- 172 A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance.

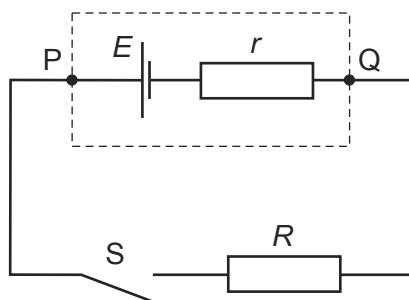
9702/11/O/N/11/Q37

In which circuit will the ammeter show the greatest reading?



- 173 A cell of e.m.f. E and internal resistance r is connected in series with a switch S and an external resistor of resistance R .

9702/11/O/N/11/Q36



The p.d. between P and Q is V .

When S is closed,

- A** V decreases because there is a p.d. across R .
- B** V decreases because there is a p.d. across r .
- C** V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R .
- D** V remains the same because the sum of the p.d.s across r and R is still equal to E .

- 174 Which of the equations that link some of the following terms is correct?

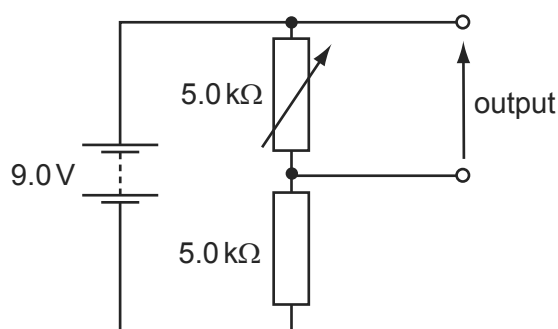
9702/11/O/N/11/Q34

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

- A** $P = \frac{Q^2 R}{t}$
- B** $ER^2 = V^2 t$
- C** $\frac{VI}{P} = t$
- D** $PQ = EI$

175 The diagram shows a potential divider circuit designed to provide a variable output p.d.

9702/11/O/N/11/Q39

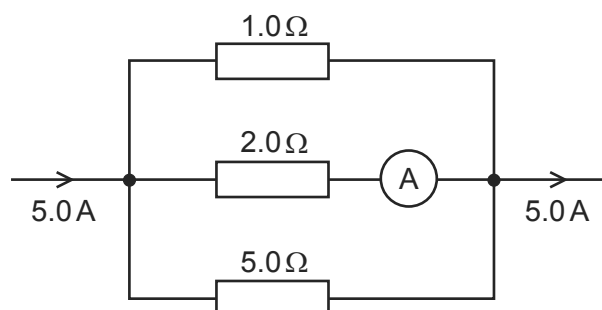


Which row gives the available range of output p.d.?

	maximum output	minimum output
A	3.0 V	0
B	4.5 V	0
C	9.0 V	0
D	9.0 V	4.5 V

176 The diagram shows part of a current-carrying circuit. The ammeter has negligible internal resistance.

9702/13/M/J/11/Q37



What is the reading on the ammeter?

- A** 0.7 A **B** 1.3 A **C** 1.5 A **D** 1.7 A

177 There is a current of 10 mA in a conductor for half an hour.

9702/11/M/J/12/Q33

How much charge passes a point in the conductor in this time?

- A** 0.3 C **B** 5 C **C** 18 C **D** 300 C

178 A charge of 8.0 C passes through a resistor of resistance $30\ \Omega$ at a constant rate in a time of 20 s.

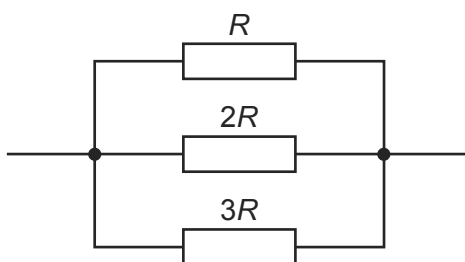
9702/12/O/N/11/Q32

What is the potential difference across the resistor?

- A** 0.40 V **B** 5.3 V **C** 12 V **D** 75 V

179 Three resistors of resistance R , $2R$ and $3R$ are connected in parallel.

9702/11/O/N/11/Q38



Using I to represent the current through the resistor of resistance R , which row represents the relationships between the currents through the resistors?

	resistor resistance		
	R	$2R$	$3R$
A	I	$\frac{1}{3} I$	$\frac{1}{2} I$
B	I	$\frac{1}{2} I$	$\frac{1}{3} I$
C	I	$\frac{2}{3} I$	$\frac{1}{3} I$
D	I	$2I$	$3I$

180 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R .

9702/11/M/J/12/Q34

A second iron wire has length 2.0 m and diameter 1.0 mm.

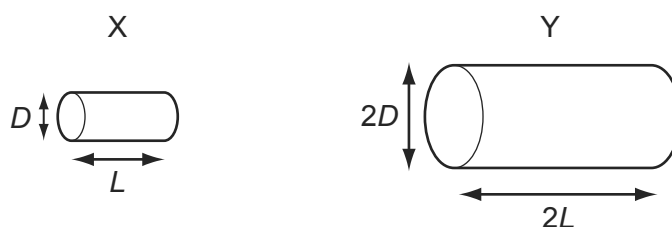
What is the resistance of the second wire?

- A** $\frac{R}{16}$ **B** $\frac{R}{8}$ **C** $\frac{R}{2}$ **D** R

181 Two electrically-conducting cylinders X and Y are made from the same material.

9702/12/O/N/11/Q34

Their dimensions are as shown.



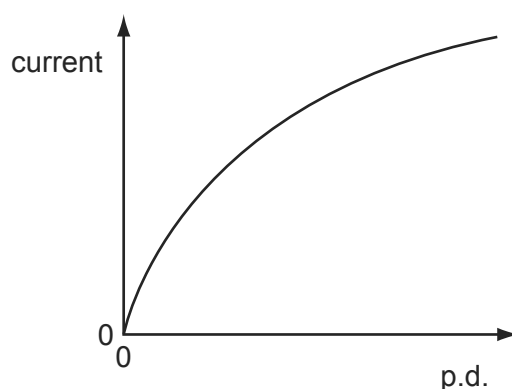
The resistance of each cylinder is measured between its ends.

What is the ratio $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

- A** $\frac{2}{1}$ **B** $\frac{1}{1}$ **C** $\frac{1}{2}$ **D** $\frac{1}{4}$

182 The graph shows the variation with potential difference (p.d.) of the current in a lamp filament.

9702/12/O/N/11/Q33



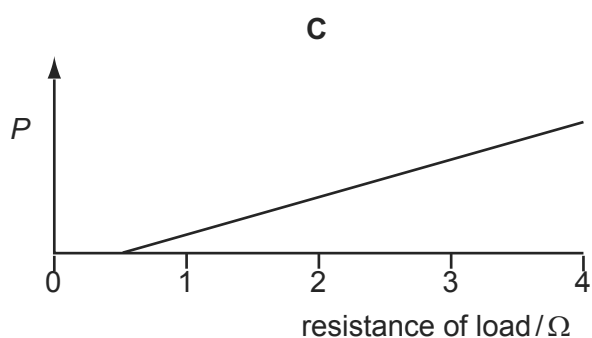
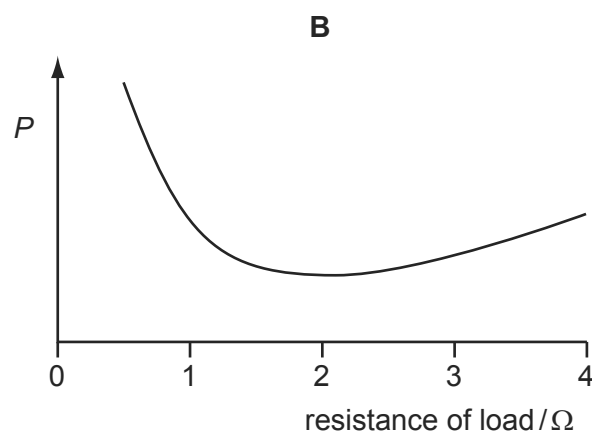
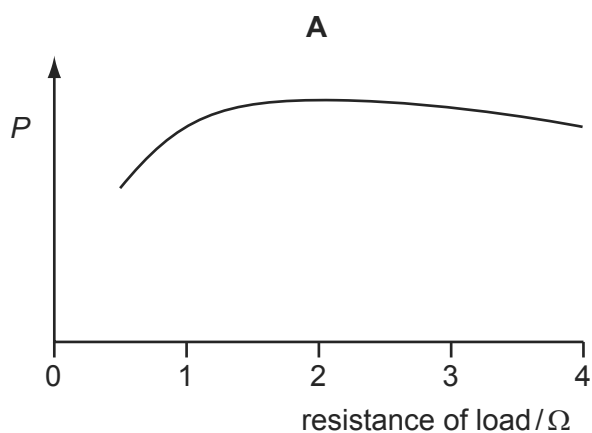
Which statement explains the shape of this graph?

- A** As the filament temperature rises, electrons can pass more easily through the filament.
- B** It takes time for the filament to reach its working temperature.
- C** The power output of the filament is proportional to the square of the current in it.
- D** The resistance of the filament increases with a rise in temperature.

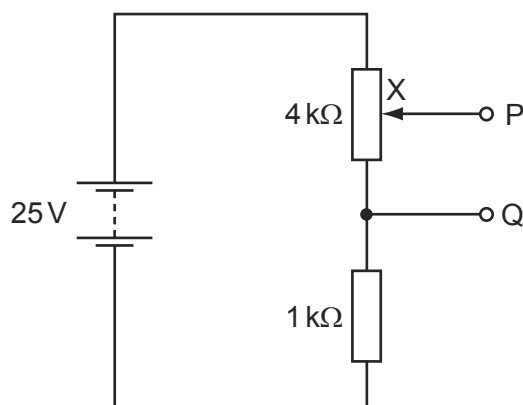
183 A power supply of electromotive force (e.m.f.) 12 V and internal resistance 2Ω is connected in series with a load resistor. The value of the load resistor is varied from 0.5Ω to 4Ω .

Which graph shows how the power P dissipated in the load resistor varies with the resistance of the load resistor?

9702/12/O/N/11/Q35



- 184 The diagram shows a potential divider circuit which, by adjustment of the contact X, can be used to provide a variable potential difference between the terminals P and Q. 9702/12/O/N/11/Q37



What are the limits of this potential difference?

- A** 0 and 5 V **B** 0 and 20 V **C** 0 and 25 V **D** 5 V and 25 V
- 185 Each of Kirchhoff's laws is linked to the conservation of a physical quantity. 9702/12/O/N/11/Q36

Which physical quantities are assumed to be conserved in the formulation of Kirchhoff's first law and of Kirchhoff's second law?

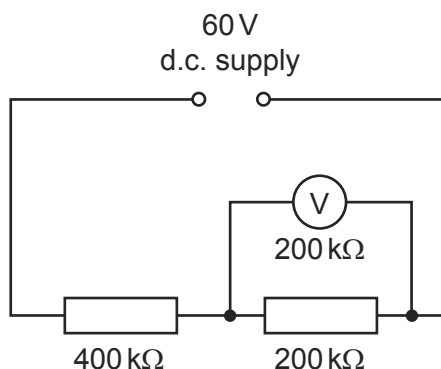
	Kirchhoff's first law	Kirchhoff's second law
A	energy	charge
B	energy	momentum
C	charge	energy
D	momentum	energy

- 186 Which statement about electrical resistivity is correct? 9702/11/O/N/11/Q33

- A** The resistivity of a material is numerically equal to the resistance in ohms of a cube of that material, the cube being of side length one metre and the resistance being measured between opposite faces.
- B** The resistivity of a material is numerically equal to the resistance in ohms of a one metre length of wire of that material, the area of cross-section of the wire being one square millimetre and the resistance being measured between the ends of the wire.
- C** The resistivity of a material is proportional to the cross-sectional area of the sample of the material used in the measurement.
- D** The resistivity of a material is proportional to the length of the sample of the material used in the measurement.

187 A constant 60 V d.c. supply is connected across two resistors of resistance 400 k Ω and 200 k Ω .

9702/12/O/N/11/Q38



What is the reading on a voltmeter, also of resistance 200 k Ω , when connected across the 200 k Ω resistor as shown in the diagram?

- A** 12 V **B** 15 V **C** 20 V **D** 30 V

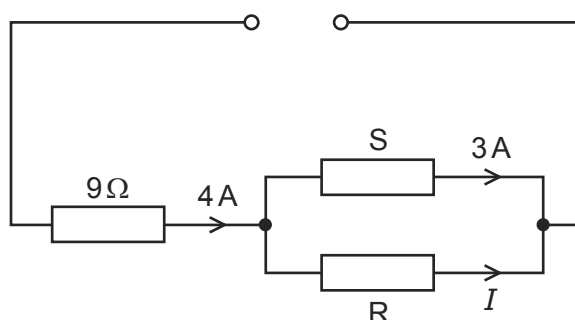
188 Which statement is **not** valid?

9702/13/O/N/11/Q34

- A** Current is the speed of the charged particles that carry it.
B Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms, per unit charge.
C The potential difference (p.d.) between two points is the work done in moving unit charge from one point to the other.
D The resistance between two points is the p.d. between the two points, per unit current.

189 The circuit below has a current I in the resistor R.

9702/11/M/J/12/Q38

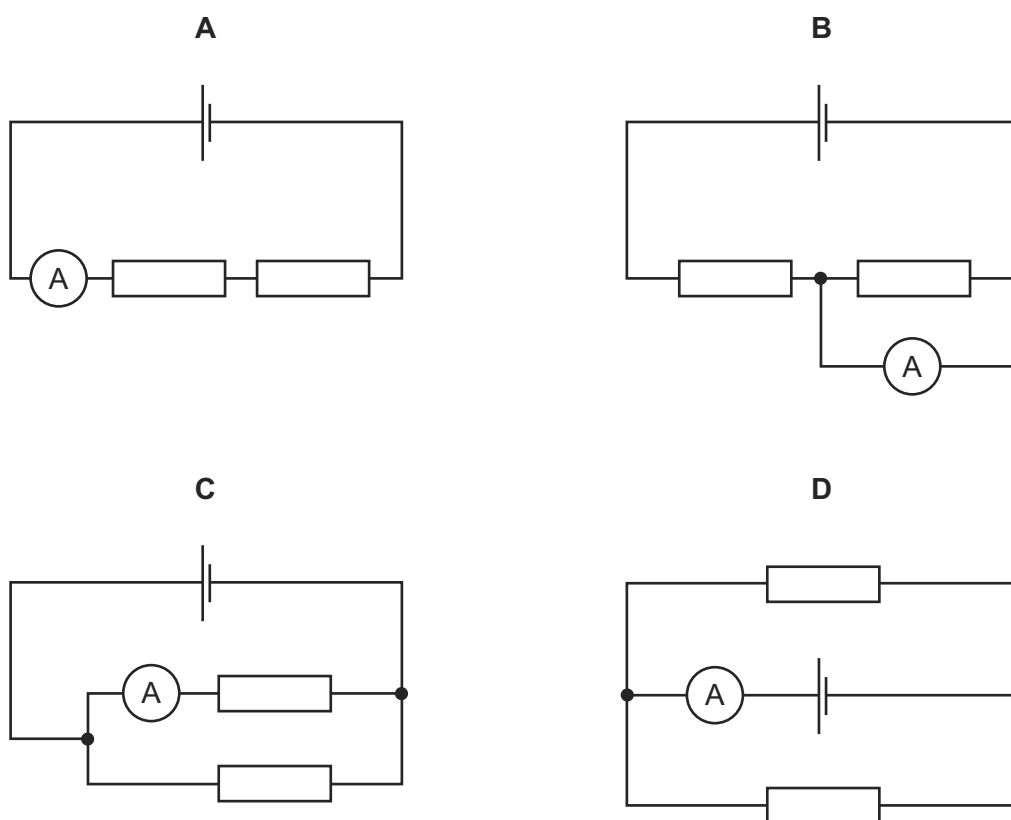


What must be known in order to determine the value of I ?

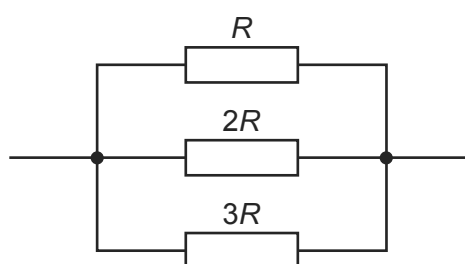
- A** e.m.f. of the power supply
B resistance of resistor S
C Kirchhoff's first law
D Kirchhoff's second law

- 190 A cell, two resistors of equal resistance and an ammeter are used to construct four circuits. The resistors are the only parts of the circuits that have resistance. 9702/13/O/N/11/Q36

In which circuit will the ammeter show the greatest reading?



- 191 Three resistors of resistance R , $2R$ and $3R$ are connected in parallel. 9702/13/O/N/11/Q37

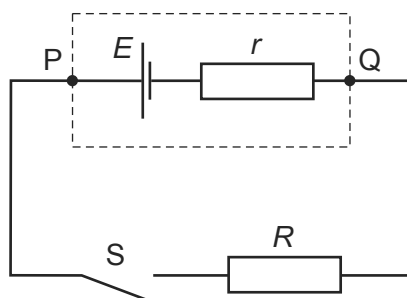


Using I to represent the current through the resistor of resistance R , which row represents the relationships between the currents through the resistors?

	resistor resistance		
	R	$2R$	$3R$
A	I	$\frac{1}{3}I$	$\frac{1}{2}I$
B	I	$\frac{1}{2}I$	$\frac{1}{3}I$
C	I	$\frac{2}{3}I$	$\frac{1}{3}I$
D	I	$2I$	$3I$

- 192 A cell of e.m.f. E and internal resistance r is connected in series with a switch S and an external resistor of resistance R .

9702/13/O/N/11/Q38

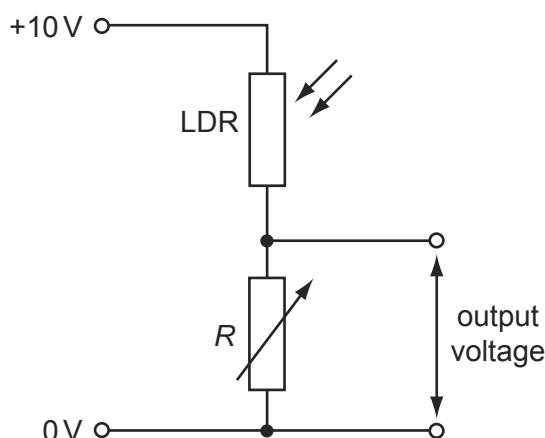


The p.d. between P and Q is V .

When S is closed,

- A** V decreases because there is a p.d. across R .
 - B** V decreases because there is a p.d. across r .
 - C** V remains the same because the decrease of p.d. across r is balanced by the increase of p.d. across R .
 - D** V remains the same because the sum of the p.d.s across r and R is still equal to E .
- 193 A potential divider consists of a light-dependent resistor (LDR) in series with a variable resistor of resistance R . The resistance of the LDR decreases when the light level increases. The variable resistor can be set at either high resistance or low resistance.

9702/11/M/J/12/Q37

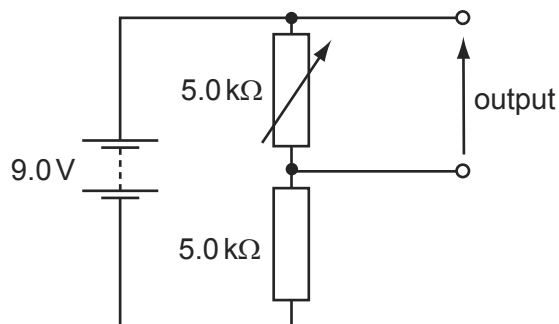


Which situation gives the largest output voltage?

	light level at LDR	R
A	high	high
B	high	low
C	low	high
D	low	low

194 The diagram shows a potential divider circuit designed to provide a variable output p.d.

9702/13/O/N/11/Q40



Which row gives the available range of output p.d.?

	maximum output	minimum output
A	3.0 V	0
B	4.5 V	0
C	9.0 V	0
D	9.0 V	4.5 V

195 Two copper wires of the same length but different diameters carry the same current. 9702/12/M/J/12/Q33

Which statement about the flow of charged particles through the wires is correct?

- A** Charged particles are provided by the power supply. Therefore the speed at which they travel depends only on the voltage of the supply.
- B** The charged particles in both wires move with the same average speed because the current in both wires is the same.
- C** The charged particles move faster through the wire with the larger diameter because there is a greater volume through which to flow.
- D** The charged particles move faster through the wire with the smaller diameter because it has a larger potential difference applied to it.

196 A power cable X has resistance R and carries current I .

9702/12/M/J/12/Q34

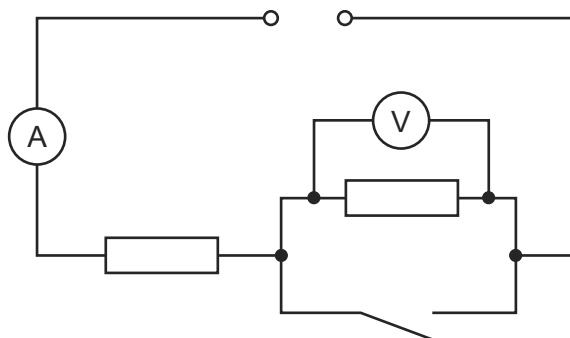
A second cable Y has resistance $2R$ and carries current $\frac{1}{2}I$.

What is the ratio $\frac{\text{power dissipated in Y}}{\text{power dissipated in X}}$?

- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

197 In the circuit below, the ammeter reading is I and the voltmeter reading is V .

9702/11/M/J/12/Q36

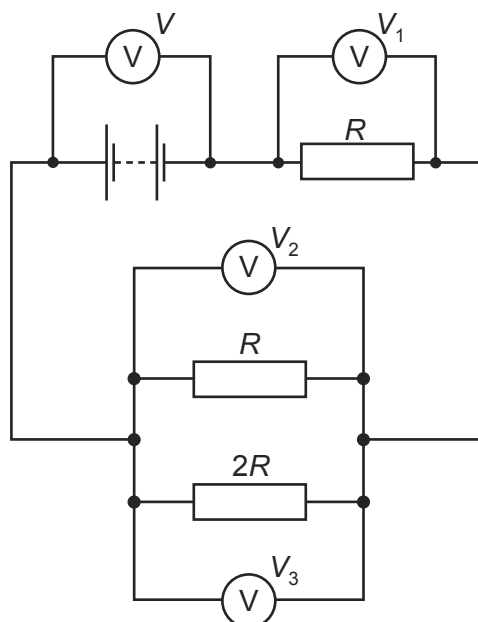


When the switch is closed, which row describes what happens to I and V ?

	I	V
A	decreases	decreases to zero
B	increases	decreases to zero
C	increases	stays the same
D	stays the same	increases

198 The diagram shows a circuit with four voltmeter readings V , V_1 , V_2 and V_3 .

9702/12/M/J/12/Q35



Which equation relating the voltmeter readings must be true?

- A** $V = V_1 + V_2 + V_3$
- B** $V + V_1 = V_2 + V_3$
- C** $V_3 = 2(V_2)$
- D** $V - V_1 = V_3$

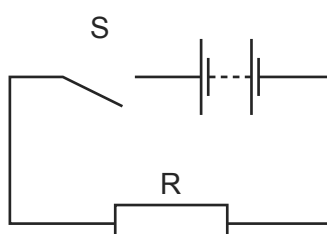
199 Which statement about electrical resistivity is correct?

9702/13/O/N/11/Q35

- A** The resistivity of a material is numerically equal to the resistance in ohms of a cube of that material, the cube being of side length one metre and the resistance being measured between opposite faces.
- B** The resistivity of a material is numerically equal to the resistance in ohms of a one metre length of wire of that material, the area of cross-section of the wire being one square millimetre and the resistance being measured between the ends of the wire.
- C** The resistivity of a material is proportional to the cross-sectional area of the sample of the material used in the measurement.
- D** The resistivity of a material is proportional to the length of the sample of the material used in the measurement.

200 The diagram shows a simple circuit.

9702/11/M/J/12/Q35



Which statement is correct?

- A** When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.
- B** When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.
- C** When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.
- D** When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

201 An iron wire has length 8.0 m and diameter 0.50 mm. The wire has resistance R .

9702/13/M/J/12/Q32

A second iron wire has length 2.0 m and diameter 1.0 mm.

What is the resistance of the second wire?

- A** $\frac{R}{16}$ **B** $\frac{R}{8}$ **C** $\frac{R}{2}$ **D** R

202 There is a current of 10 mA in a conductor for half an hour.

9702/13/M/J/12/Q34

How much charge passes a point in the conductor in this time?

- A** 0.3 C **B** 5 C **C** 18 C **D** 300 C

203 Which of the equations that link some of the following terms is correct?

9702/13/O/N/11/Q39

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

A $P = \frac{Q^2 R}{t}$

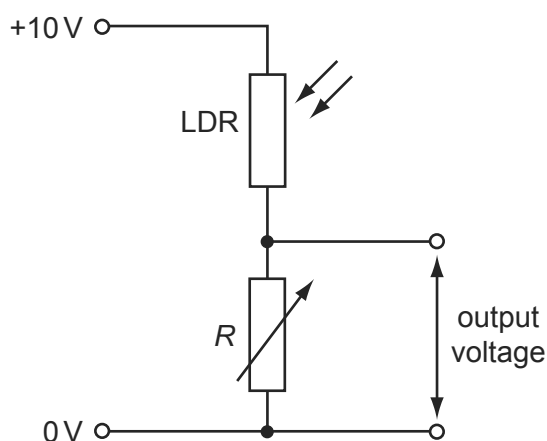
B $ER^2 = V^2 t$

C $\frac{VI}{P} = t$

D $PQ = EI$

- 204 A potential divider consists of a light-dependent resistor (LDR) in series with a variable resistor of resistance R . The resistance of the LDR decreases when the light level increases. The variable resistor can be set at either high resistance or low resistance.

9702/13/M/J/12/Q38

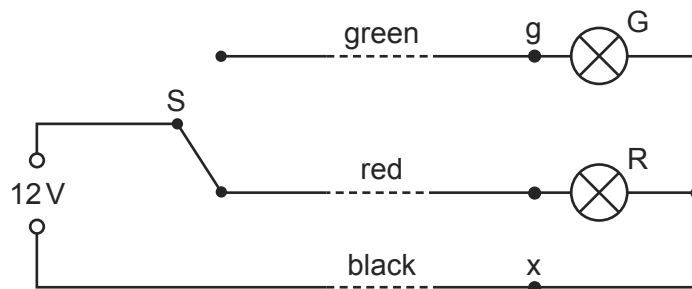


Which situation gives the largest output voltage?

	light level at LDR	R
A	high	high
B	high	low
C	low	high
D	low	low

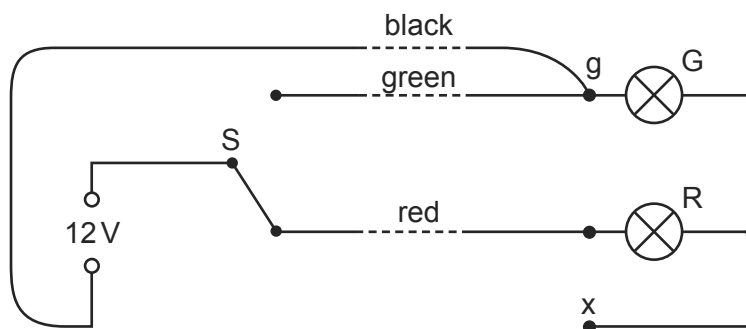
- 205 The diagram shows the circuit for a signal to display a green or a red light. It is controlled by the switch S.

9702/12/M/J/12/Q37



The signal is some way from S to which it is connected by a cable with green, red and black wires. At the signal, the green and red wires are connected to the corresponding lamp and the black wire is connected to a terminal x to provide a common return. The arrangement is shown correctly connected and with the switch set to illuminate the red lamp.

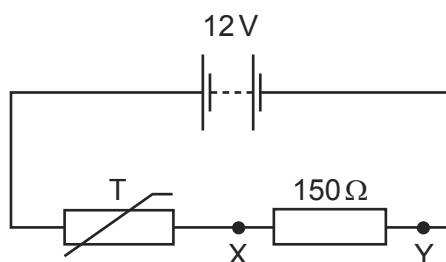
During maintenance, the wires at the signal are disconnected and, when reconnected, the black wire is connected in error to the green lamp (terminal g) instead of terminal x. The red wire is connected correctly to its lamp and connections at S remain as in the diagram.



When the system is tested with the switch connection to the red wire, what does the signal show?

- A the green lamp illuminated normally
 - B the red lamp illuminated normally
 - C the red and green lamps both illuminated normally
 - D the red and green lamps both illuminated dimly
- 206 In a fire alarm system, a thermistor T has a resistance of 2000Ω at room temperature. Its resistance decreases as the temperature increases. The alarm is triggered when the potential difference between X and Y reaches 4.5 V.

9702/11/O/N/12/Q35

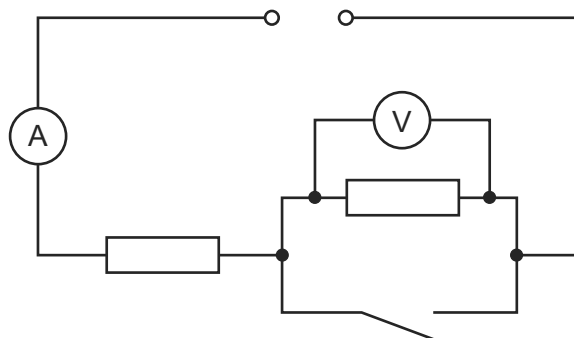


What is the resistance of the thermistor when the alarm is triggered?

- A 90Ω
- B 150Ω
- C 250Ω
- D 1300Ω

207 In the circuit below, the ammeter reading is I and the voltmeter reading is V .

9702/13/M/J/12/Q35

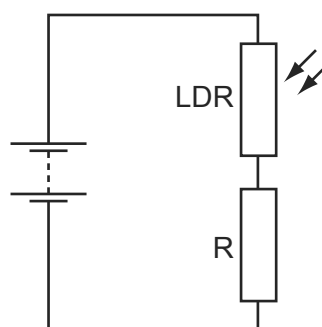


When the switch is closed, which row describes what happens to I and V ?

	I	V
A	decreases	decreases to zero
B	increases	decreases to zero
C	increases	stays the same
D	stays the same	increases

208 A light-dependent resistor (LDR) is connected in series with a resistor R and a battery.

9702/12/M/J/12/Q36



The resistance of the LDR is equal to the resistance of R when no light falls on the LDR.

When the light intensity falling on the LDR increases, which statement is correct?

- A** The current in R decreases.
- B** The current in the LDR decreases.
- C** The p.d. across R decreases.
- D** The p.d. across the LDR decreases.

209 The potential difference between point X and point Y in a circuit is 20V. The time taken for charge carriers to move from X to Y is 15 s. In this time, the energy of the charge carriers changes by 12 J.

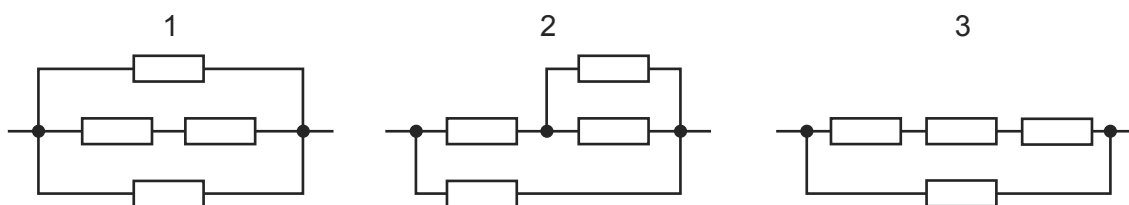
9702/11/O/N/12/Q32

What is the current between X and Y?

- A** 0.040 A
- B** 0.11 A
- C** 9.0 A
- D** 25 A

210 Four identical resistors are connected in the three networks below.

9702/12/M/J/12/Q38

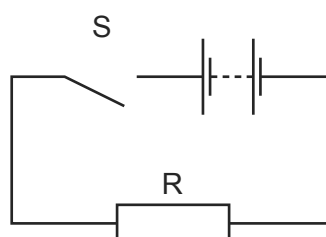


Which arrangement has the highest total resistance and which has the lowest?

	highest	lowest
A	1	2
B	1	3
C	3	1
D	3	2

211 The diagram shows a simple circuit.

9702/13/M/J/12/Q36



Which statement is correct?

- A** When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.
- B** When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.
- C** When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.
- D** When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

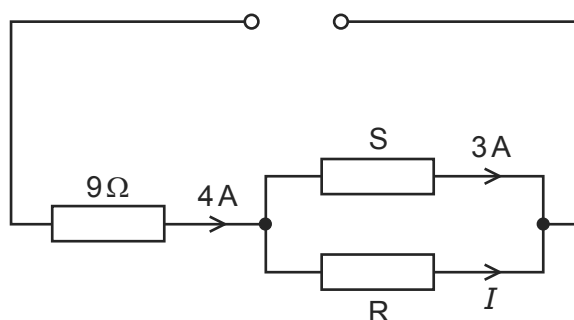
212 A cylindrical wire of length 10 m and diameter 2.0 mm has a resistance of $0.050\ \Omega$. 9702/11/O/N/12/Q33

From which material is the wire made?

	material	resistivity/ $\Omega\text{ m}$
A	bronze	1.6×10^{-7}
B	nichrome	1.6×10^{-6}
C	silver	1.6×10^{-8}
D	zinc	6.3×10^{-8}

213 The circuit below has a current I in the resistor R.

9702/13/M/J/12/Q37

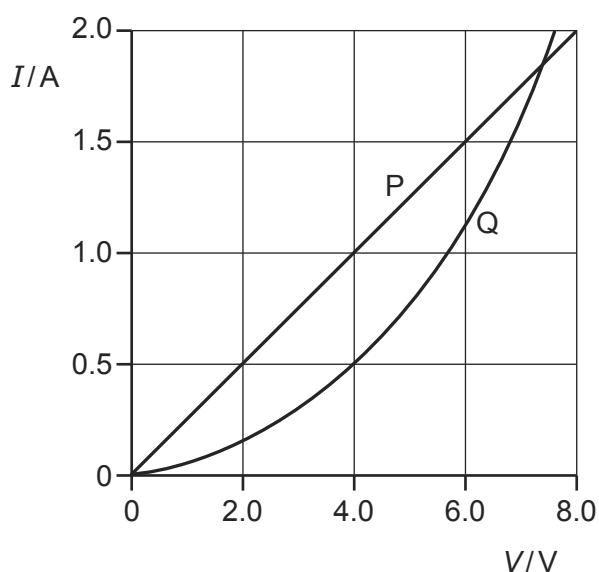


What must be known in order to determine the value of I ?

- A** e.m.f. of the power supply
- B** resistance of resistor S
- C** Kirchhoff's first law
- D** Kirchhoff's second law

214 The I - V characteristics of two electrical components P and Q are shown below.

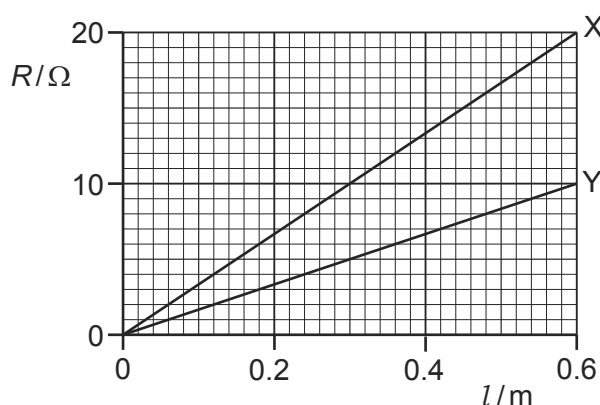
9702/11/O/N/12/Q34



Which statement is correct?

- A** P is a resistor and Q is a filament lamp.
- B** The resistance of Q increases as the current in it increases.
- C** For a current of 1.9 A, the resistance of Q is approximately half that of P.
- D** For a current of 0.5 A, the power dissipated in Q is double that in P.

- 215 The graph shows the variation with length l of resistance R for two wires X and Y made from the same material. 9702/12/O/N/12/Q34

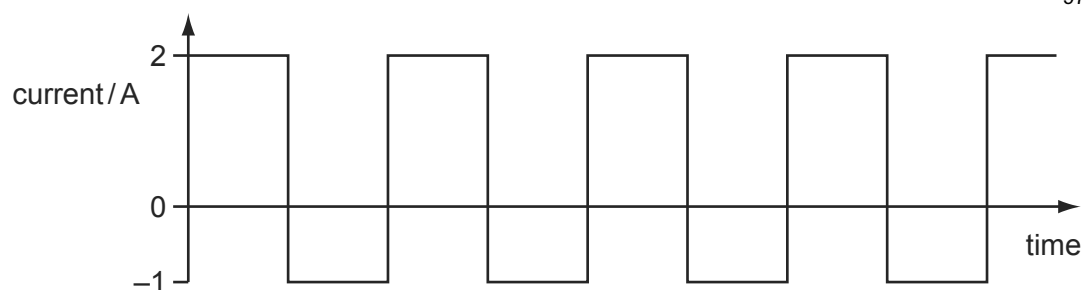


What does the graph show?

- A** cross-sectional area of X = $2 \times$ cross-sectional area of Y
B resistivity of X = $2 \times$ resistivity of Y
C when equal lengths of X and Y are connected in series to a battery, power in X = $2 \times$ power in Y
D when equal lengths of X and Y are connected in parallel to a battery, current in X = $2 \times$ current in Y
- 216 A cell of internal resistance 2.0Ω and electromotive force (e.m.f.) 1.5 V is connected to a resistor of resistance 3.0Ω . 9702/12/O/N/12/Q35

What is the potential difference across the 3.0Ω resistor?

- A** 1.5 V **B** 1.2 V **C** 0.9 V **D** 0.6 V
- 217 A 100Ω resistor conducts a current with changing direction and magnitude, as shown. 9702/12/O/N/12/Q36

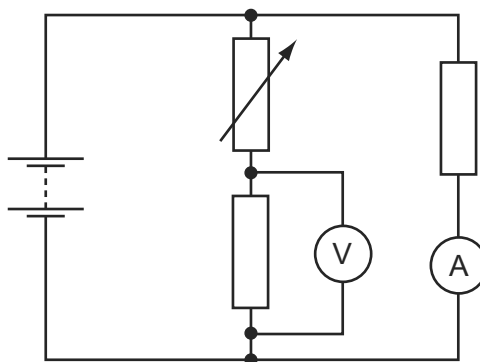


What is the mean power dissipated in the resistor?

- A** 100 W **B** 150 W **C** 250 W **D** 400 W

- 218 A network of electrical components is connected across a battery of negligible internal resistance, as shown.

9702/11/O/N/12/Q36



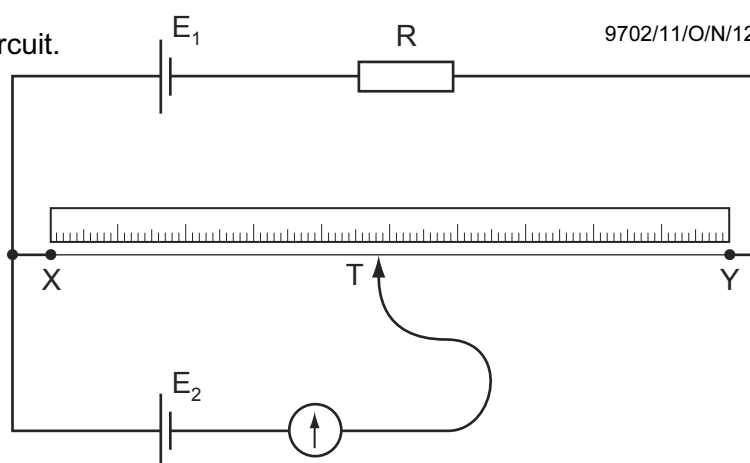
The resistance of the variable resistor is increased.

What is the effect on the readings of the ammeter and voltmeter?

	ammeter	voltmeter
A	decreases	increases
B	increases	decreases
C	unchanged	decreases
D	unchanged	increases

- 219 The diagram shows a potentiometer circuit.

9702/11/O/N/12/Q37



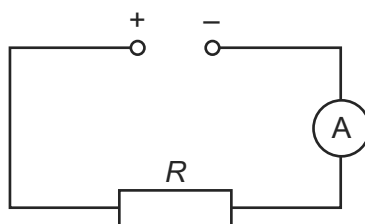
The contact T is placed on the wire and moved along the wire until the galvanometer reading is zero. The length XT is then noted.

In order to calculate the potential difference per unit length of the wire XY, which value must also be known?

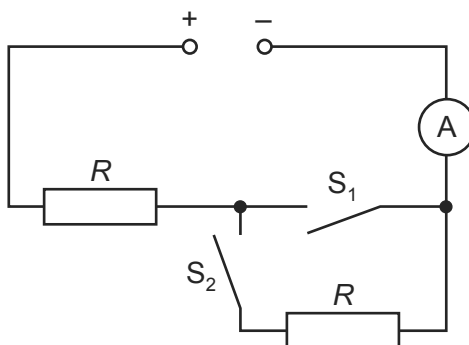
- A** the e.m.f. of the cell E_1
- B** the e.m.f. of the cell E_2
- C** the resistance of resistor R
- D** the resistance of the wire XY

220 The ammeter reading in the circuit below is I .

9702/12/O/N/12/Q37



Another circuit containing the same voltage supply, two switches, an ammeter and two resistors each of resistance R , is shown.

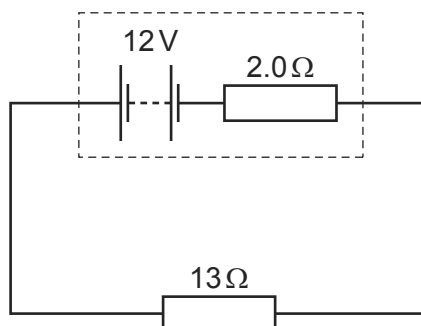


Which row is **not** correct?

	S_1	S_2	ammeter reading
A	closed	closed	I
B	closed	open	I
C	open	closed	I
D	open	open	0

221 A power supply of electromotive force (e.m.f.) 12 V and internal resistance $2.0\ \Omega$ is connected in series with a $13\ \Omega$ resistor.

9702/11/M/J/13/Q32

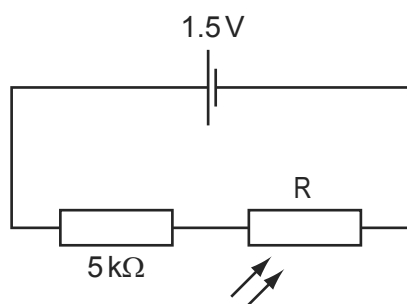


What is the power dissipated in the $13\ \Omega$ resistor?

- A** 8.3 W **B** 9.6 W **C** 10 W **D** 11 W

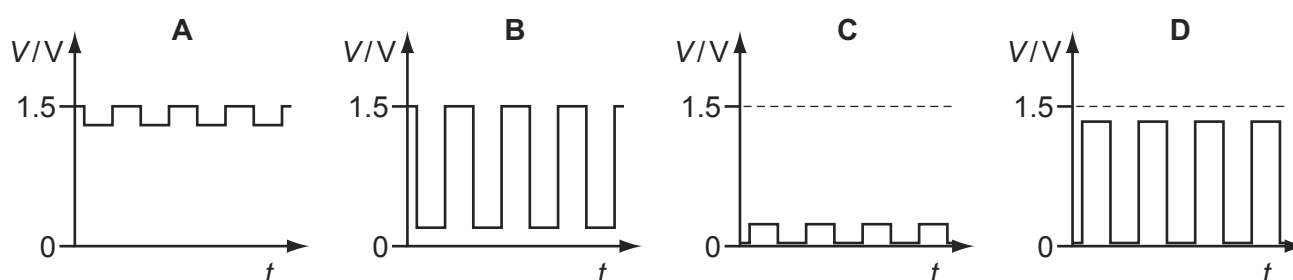
- 222 A light-dependent resistor R has resistance of about $1\text{ M}\Omega$ in the dark and about $1\text{ k}\Omega$ when illuminated. It is connected in series with a $5\text{ k}\Omega$ resistor to a 1.5 V cell of negligible internal resistance.

9702/12/O/N/12/Q38



The light-dependent resistor is illuminated (in an otherwise dark room) by a flashing light.

Which graph best shows the variation with time t of potential difference V across R ?



- 223 A copper wire is stretched so that its diameter is reduced from 1.0 mm to a uniform 0.5 mm .

9702/12/O/N/12/Q33

The resistance of the unstretched copper wire is 0.2Ω .

What will be the resistance of the stretched wire?

- A** 0.4Ω **B** 0.8Ω **C** 1.6Ω **D** 3.2Ω

- 224 Four statements about potential difference or electromotive force are listed.

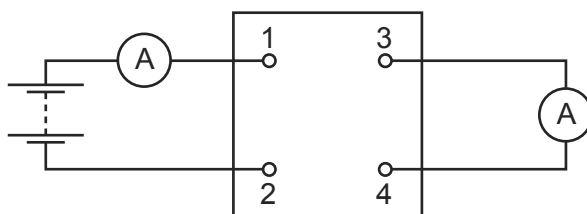
9702/12/O/N/12/Q34

- 1 It involves changing electrical energy into other forms.
- 2 It involves changing other energy forms into electrical energy.
- 3 It is the energy per unit charge to move charge right round a circuit.
- 4 It is the work done per unit charge by the charge moving from one point to another.

Which statements apply to potential difference and which apply to electromotive force?

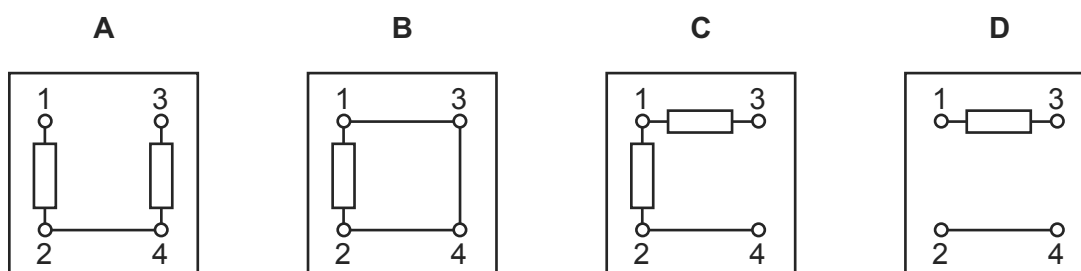
	potential difference	electromotive force
A	1 and 3	2 and 4
B	1 and 4	2 and 3
C	2 and 3	1 and 4
D	2 and 4	1 and 3

- 225 The diagram shows a four-terminal box connected to a battery and two ammeters. 9702/12/O/N/12/Q35

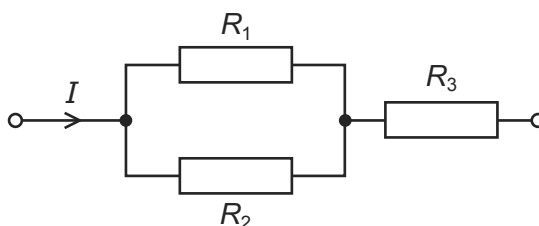


The currents in the two meters are identical.

Which circuit, within the box, will give this result?



- 226 The diagram shows a resistor network. The potential difference across the network is V . 9702/12/O/N/12/Q37



Is the equation shown below correct for the network?

$$V = I(1/R_1 + 1/R_2 + R_3)$$

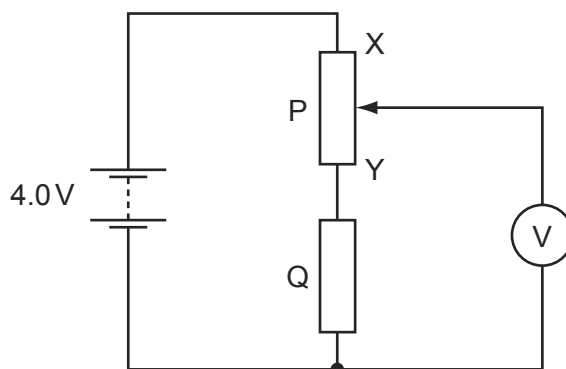
- A** Yes, it correctly combines two series resistors with one parallel resistor, and correctly uses Ohm's Law.
- B** Yes, it correctly combines two parallel resistors with one series resistor, and correctly uses Ohm's Law.
- C** No, because it should read $V = I \div (1/R_1 + 1/R_2 + R_3)$.
- D** No, because the terms $1/R_2$ and R_3 have different units and cannot be added.
- 227 A low-voltage supply with an e.m.f. of 20 V and an internal resistance of 1.5Ω is used to supply power to a heater of resistance 6.5Ω in a fish tank. 9702/12/M/J/13/Q33

What is the power supplied to the water in the fish tank?

- A** 41 W **B** 50 W **C** 53 W **D** 62 W

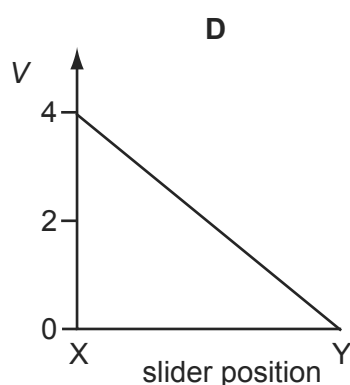
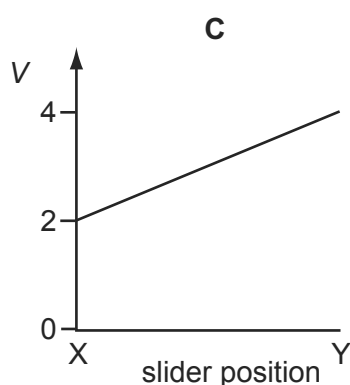
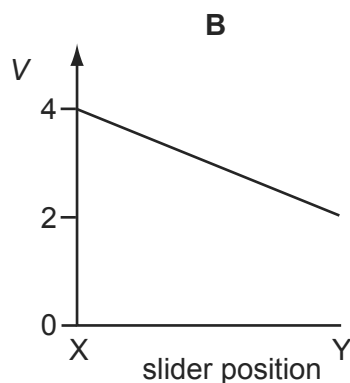
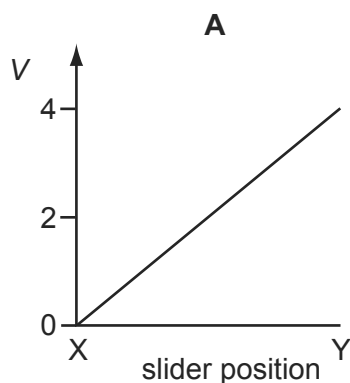
- 228 In the circuit below, P is a potentiometer of total resistance 10Ω and Q is a fixed resistor of resistance 10Ω . The battery has an e.m.f. of 4.0V and negligible internal resistance. The voltmeter has a very high resistance.

9702/12/O/N/12/Q36



The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph is obtained?



- 229 A power cable has length 2000m . The cable is made of twelve parallel strands of copper wire, each with diameter 0.51mm .

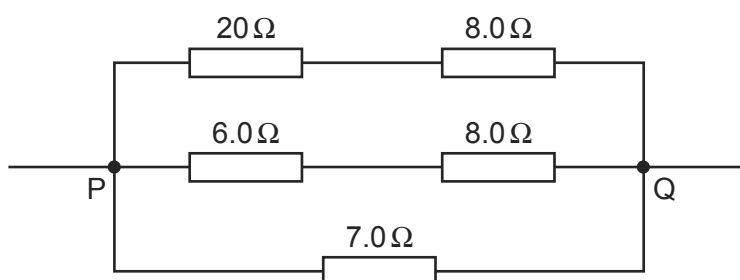
9702/12/M/J/13/Q32

What is the resistance of the cable? (resistivity of copper = $1.7 \times 10^{-8}\Omega\text{m}$)

- A** 0.014Ω **B** 3.5Ω **C** 14Ω **D** 166Ω

230 Five resistors are connected as shown.

9702/12/M/J/13/Q37



What is the total resistance between P and Q?

- A** $0.25\ \Omega$ **B** $0.61\ \Omega$ **C** $4.0\ \Omega$ **D** $16\ \Omega$

231 When a battery is connected to a resistor, the battery gradually becomes warm. This causes the internal resistance of the battery to increase whilst its e.m.f. stays unchanged.

As the internal resistance of the battery increases, how do the terminal potential difference and the output power change, if at all?

9702/11/M/J/13/Q33

	terminal potential difference	output power
A	decrease	decrease
B	decrease	unchanged
C	unchanged	decrease
D	unchanged	unchanged

232 The principles of conservation of which two quantities are associated with Kirchhoff's first and second laws?

9702/11/M/J/13/Q34

	first law	second law
A	charge	energy
B	charge	voltage
C	energy	charge
D	voltage	charge

233 A filament lamp has a resistance of $180\ \Omega$ when the current in it is 500 mA.

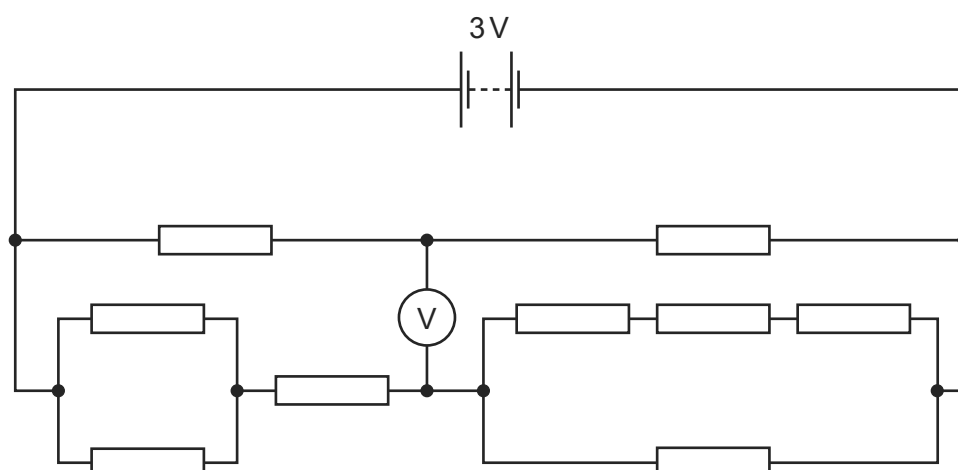
9702/12/M/J/13/Q34

What is the power transformed in the lamp?

- A** 45 W **B** 50 W **C** 90 W **D** 1400 W

234 A circuit is set up as shown, supplied by a 3V battery. All resistances are $1\text{ k}\Omega$.

9702/11/M/J/13/Q35

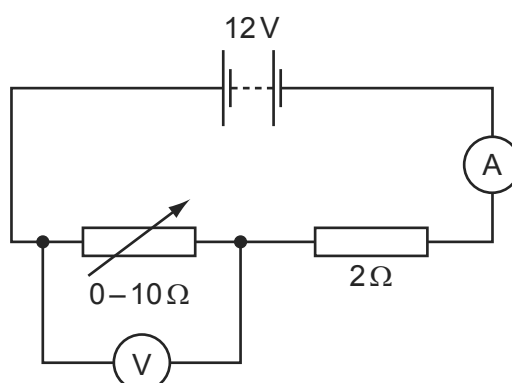


What will be the reading on the voltmeter?

- A** 0 **B** 0.5 V **C** 1.0 V **D** 1.5 V

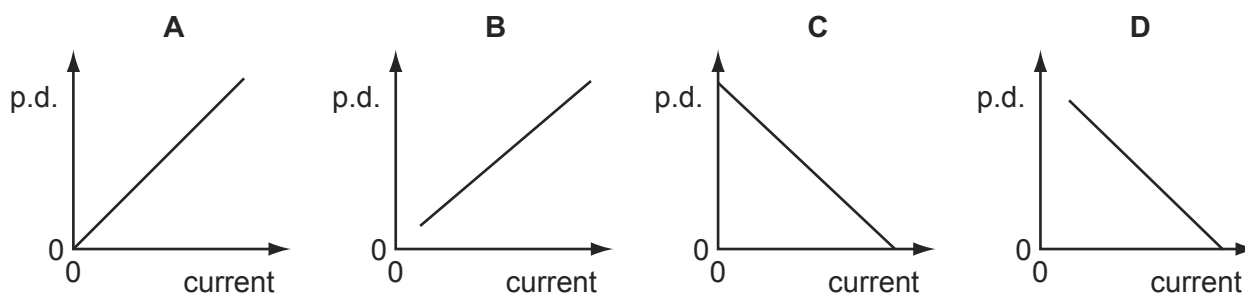
235 A 12V battery is in series with an ammeter, a $2\text{ }\Omega$ fixed resistor and a $0\text{--}10\text{ }\Omega$ variable resistor. A high-resistance voltmeter is connected across the variable resistor.

9702/11/M/J/13/Q37



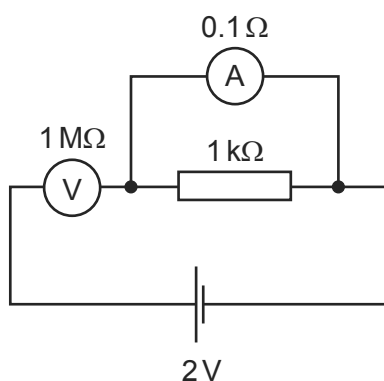
The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



- 236 The diagram shows an incorrectly connected circuit. The ammeter has a resistance of $0.1\ \Omega$ and the voltmeter has a resistance of $1\ \text{M}\Omega$.

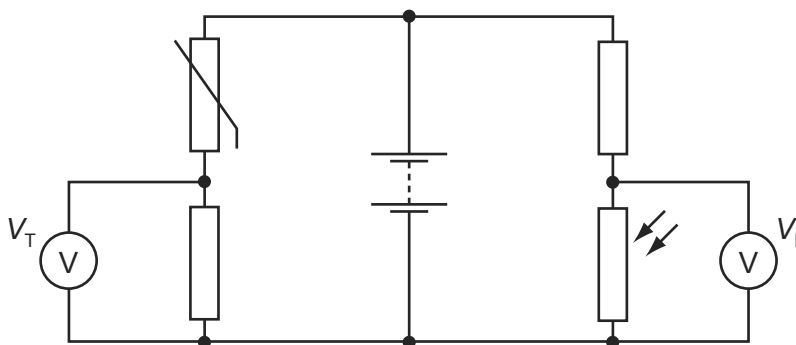
9702/11/M/J/13/Q36



Which statement is correct?

- A** The ammeter reads 2 mA.
B The ammeter reads 20 A.
C The voltmeter reads zero.
D The voltmeter reads 2 V.
- 237 In the circuit below, the reading V_T on the voltmeter changes from high to low as the temperature of the thermistor changes. The reading V_L on the voltmeter changes from high to low as the level of light on the light-dependent resistor (LDR) changes.

9702/12/M/J/13/Q38



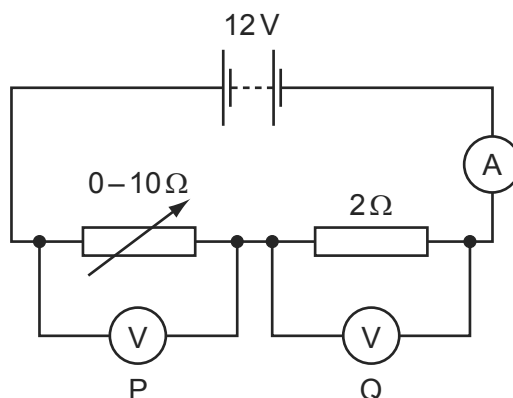
The readings V_T and V_L are both high.

What are the conditions of temperature and light level?

	temperature	light level
A	low	low
B	low	high
C	high	low
D	high	high

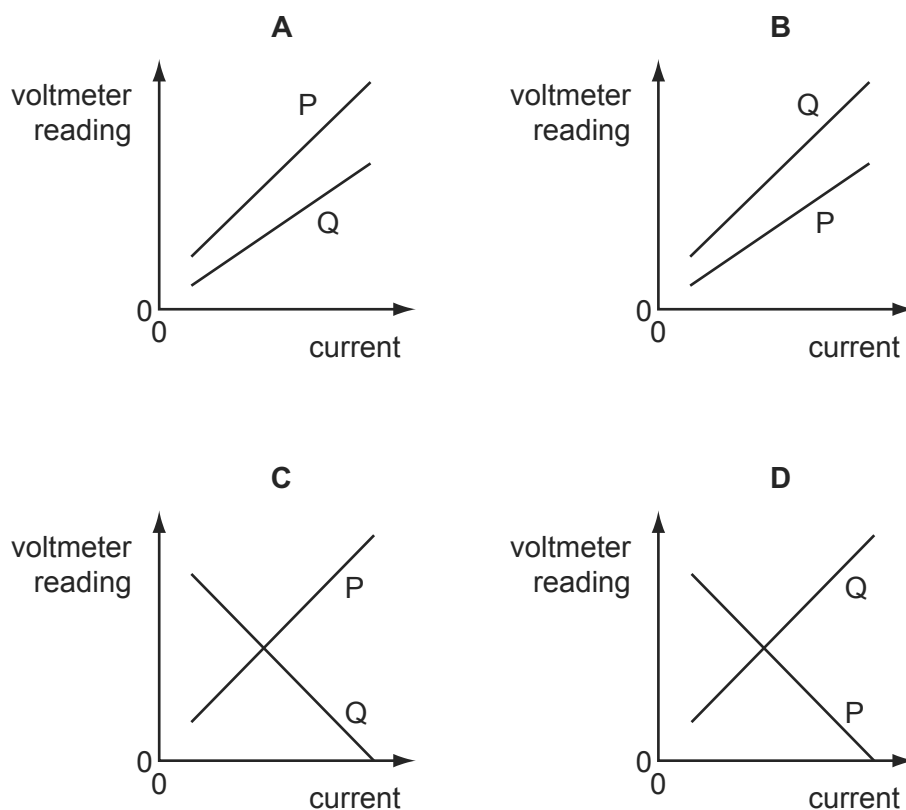
- 238 A 12V battery is in series with an ammeter, a 2Ω fixed resistor and a $0-10\Omega$ variable resistor. High-resistance voltmeters P and Q are connected across the variable resistor and the fixed resistor respectively, as shown.

9702/12/M/J/13/Q36



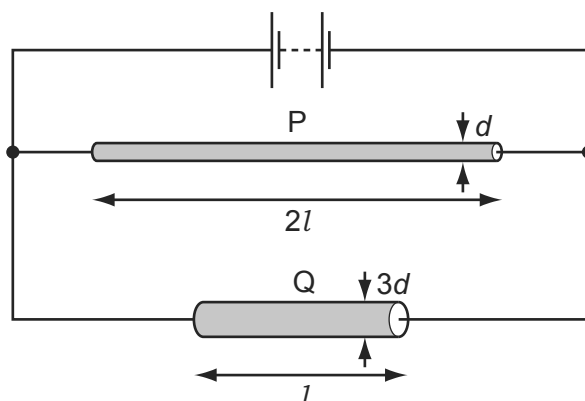
The resistance of the variable resistor is changed from its maximum value to zero.

Which graph shows the variation with current of the voltmeter readings?



- 239 Two wires P and Q made of the same material are connected to the same electrical supply. P has twice the length of Q and one-third of the diameter of Q, as shown in the diagram.

9702/12/M/J/13/Q35

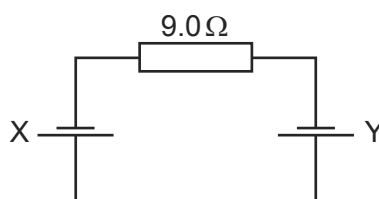


What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

- A** $\frac{2}{3}$ **B** $\frac{2}{9}$ **C** $\frac{1}{6}$ **D** $\frac{1}{18}$

- 240 Two cells X and Y are connected in series with a resistor of resistance 9.0Ω , as shown.

9702/13/M/J/13/Q31



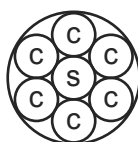
Cell X has an electromotive force (e.m.f.) of 1.0V and an internal resistance of 1.0Ω . Cell Y has an e.m.f. of 2.0V and an internal resistance of 2.0Ω .

What is the current in the circuit?

- A** 0.25A **B** 0.17A **C** 0.10A **D** 0.083A

- 241 An electric power cable consists of six copper wires c surrounding a steel core s.

9702/13/M/J/13/Q34



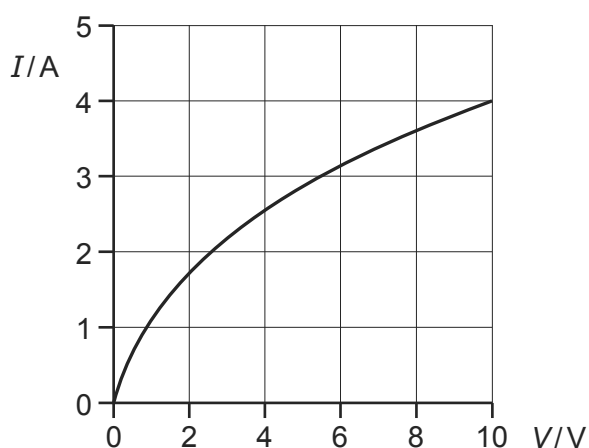
A length of 1.0km of one of the copper wires has a resistance of 10Ω and 1.0km of the steel core has a resistance of 100Ω .

What is the approximate resistance of a 1.0km length of the power cable?

- A** 0.61Ω **B** 1.6Ω **C** 160Ω **D** 610Ω

242 The graph shows how current I varies with voltage V for a filament lamp.

9702/13/M/J/13/Q33



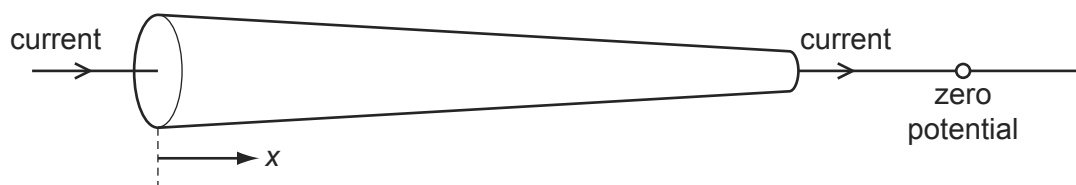
Since the graph is not a straight line, the resistance of the lamp varies with V

Which row gives the correct resistance at the stated value of V ?

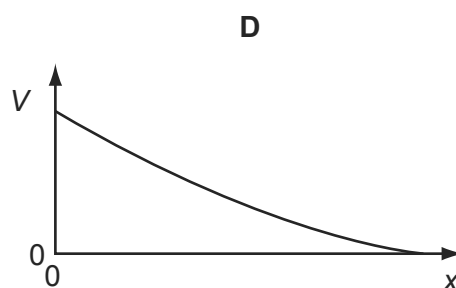
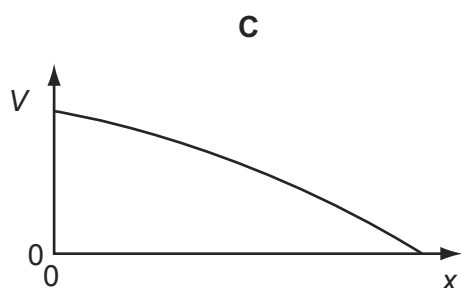
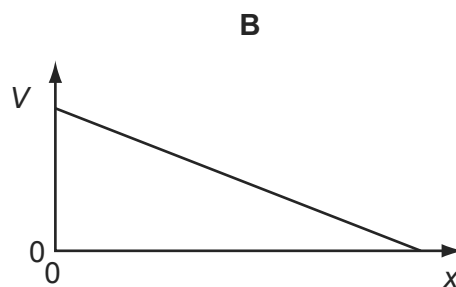
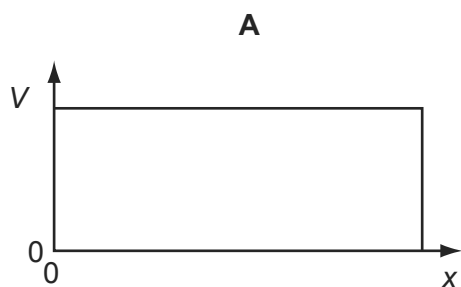
	V/V	R/Ω
A	2.0	1.5
B	4.0	3.2
C	6.0	1.9
D	8.0	0.9

243 The circular cross-sectional area of a metal wire varies along its length. There is a current in the wire. The narrow end of the wire is at a reference potential of zero.

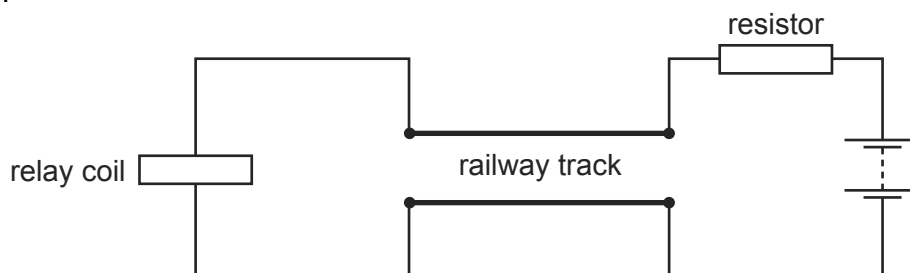
9702/13/M/J/13/Q32



Which graph best represents the variation with distance x along the wire of the potential difference V relative to the reference zero?



- 244 The diagram shows a length of track from a model railway connected to a battery, a resistor and a relay coil. 9702/13/M/J/13/Q35

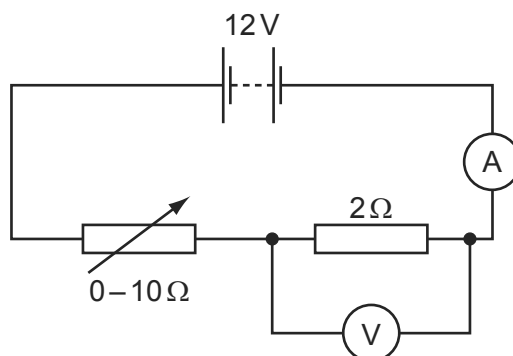


With no train present, there is a current in the relay coil which operates a switch to turn on a light.

When a train occupies the section of track, most of the current flows through the wheels and axles of the train in preference to the relay coil. The switch in the relay turns off the light.

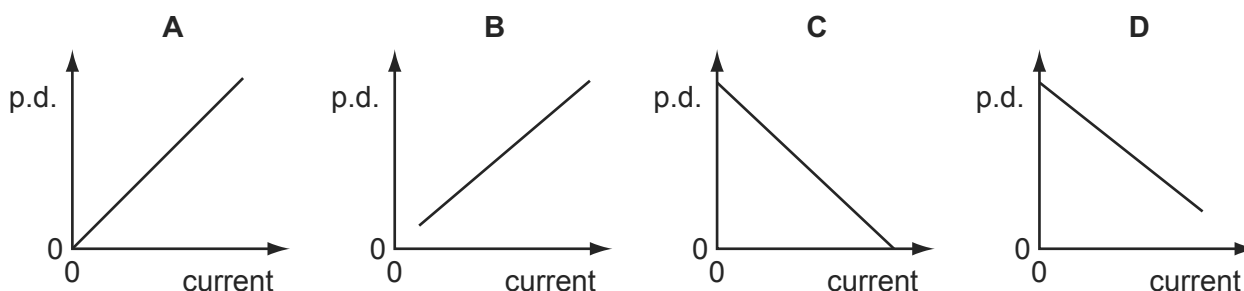
Why is a resistor placed between the battery and the track?

- A** to limit the heating of the wheels of the train
 - B** to limit the energy lost in the relay coil when a train is present
 - C** to prevent a short circuit of the battery when a train is present
 - D** to protect the relay when a train is present
- 245 A 12 V battery is in series with an ammeter, a 2Ω fixed resistor and a $0-10\Omega$ variable resistor. A high-resistance voltmeter is connected across the fixed resistor. 9702/13/M/J/13/Q36



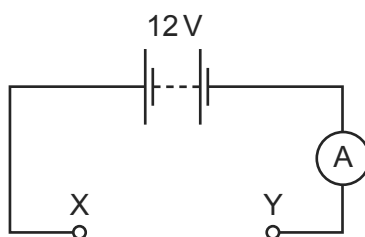
The resistance of the variable resistor is changed from zero to its maximum value.

Which graph shows how the potential difference (p.d.) measured by the voltmeter varies with the current measured by the ammeter?



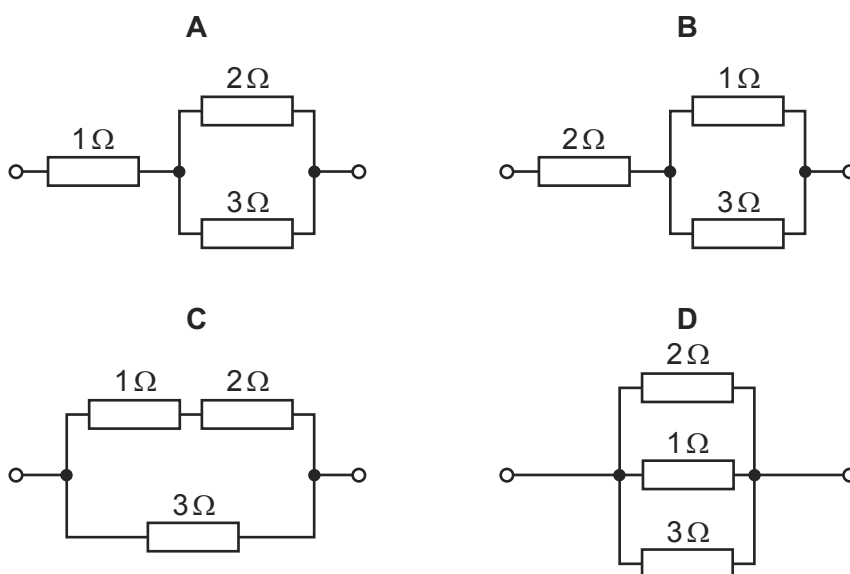
246 In the circuit shown, the battery and ammeter each have negligible resistance.

9702/13/M/J/13/Q37



The following combinations of resistors are placed in turn between the terminals X and Y of the circuit.

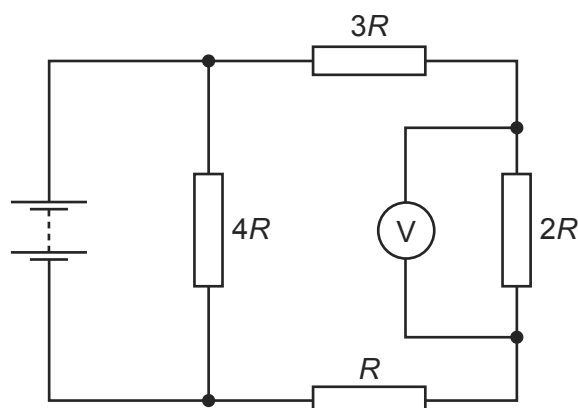
Which combination would give an ammeter reading of 8 A?



247 Four resistors of resistance R , $2R$, $3R$ and $4R$ are connected to form a network.

9702/11/O/N/13/Q38

A battery of negligible internal resistance and a voltmeter are connected to the resistor network as shown.



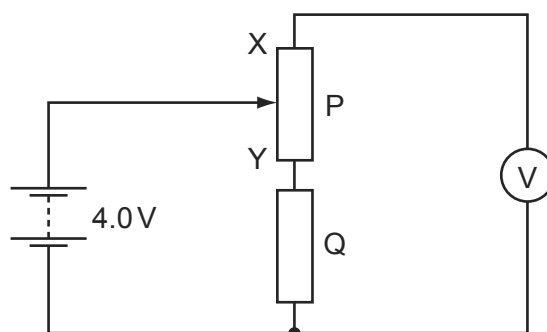
The voltmeter reading is 2 V.

What is the electromotive force (e.m.f.) of the battery?

- A** 2 V **B** 4 V **C** 6 V **D** 10 V

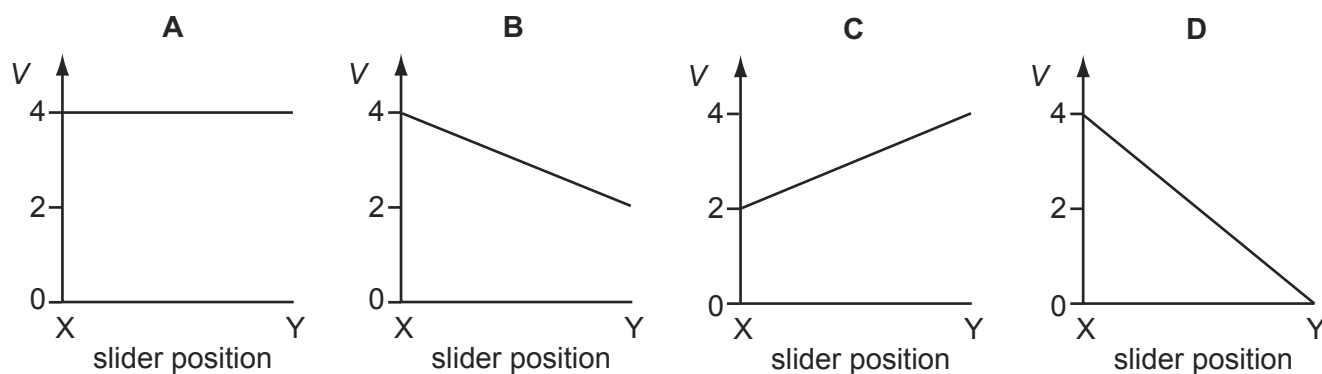
- 248 In the circuit below, P is a potentiometer of total resistance 10Ω and Q is a fixed resistor of resistance 10Ω . The battery has an electromotive force (e.m.f.) of 4.0V and negligible internal resistance. The voltmeter has a very high resistance.

9702/11/O/N/13/Q36



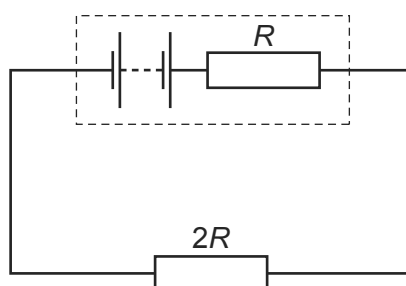
The slider on the potentiometer is moved from X to Y and a graph of voltmeter reading V is plotted against slider position.

Which graph would be obtained?



- 249 The diagram shows an electric circuit in which the resistance of the external resistor is $2R$ and the internal resistance of the source is R .

9702/11/O/N/13/Q33

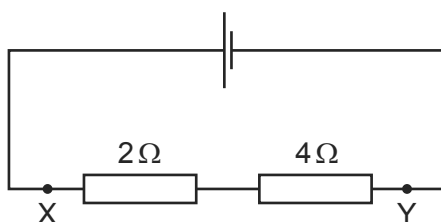


What is the ratio $\frac{\text{power in external resistor}}{\text{power in internal resistance}}$?

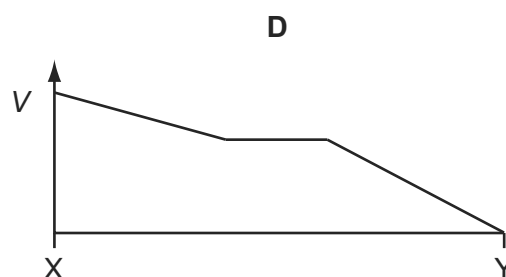
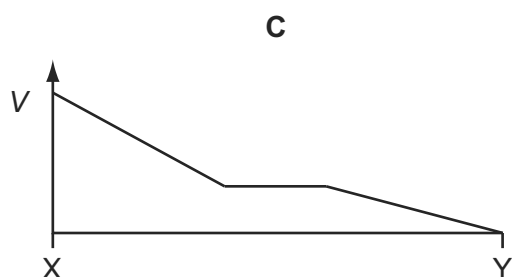
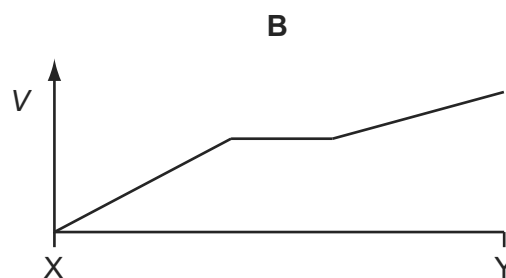
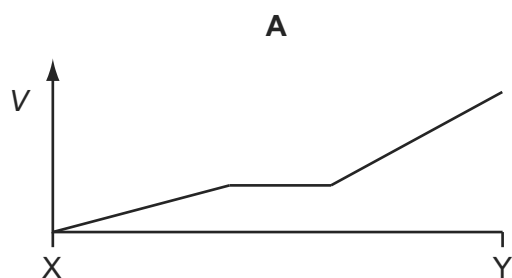
- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** 2 **D** 4

250 A 2Ω resistor and a 4Ω resistor are connected to a cell.

9702/11/O/N/13/Q37



Which graph shows how the potential V varies with distance between X and Y?



251 The wire of a heating element has resistance R . The wire breaks and is replaced by a different wire.

9702/11/O/N/13/Q35

Data for the original wire and the replacement wire are shown in the table.

	length	diameter	resistivity of metal
original wire	l	d	ρ
replacement wire	l	$2d$	2ρ

What is the resistance of the replacement wire?

- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

252 The current in a component is reduced uniformly from 100 mA to 20 mA over a period of 8.0 s.

9702/13/O/N/13/Q32

What is the charge that flows during this time?

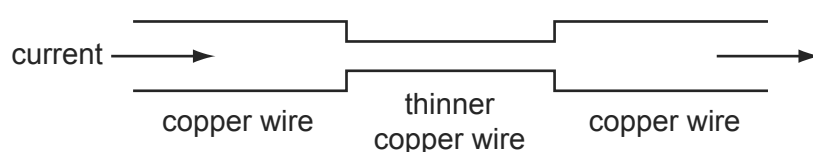
- A** 160 mC **B** 320 mC **C** 480 mC **D** 640 mC

- 253 Two lamps are connected in series to a 250 V power supply. One lamp is rated 240 V, 60 W and the other is rated 10 V, 2.5 W. 9702/11/O/N/13/Q34

Which statement most accurately describes what happens?

- A** Both lamps light at less than their normal brightness.
- B** Both lamps light normally.
- C** Only the 60 W lamp lights.
- D** The 10 V lamp blows.

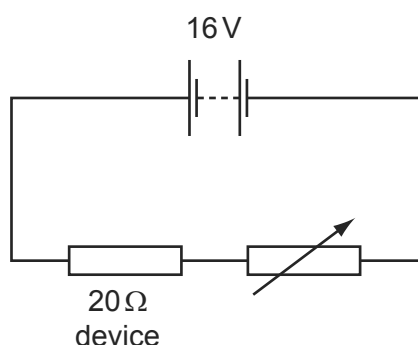
- 254 An electric current is passed from a thick copper wire through a section of thinner copper wire before entering a second thick copper wire as shown. 9702/13/O/N/13/Q33



Which statement about the current and the speed of electrons in the wires is correct?

- A** The current and the speed of the electrons in the thinner wire are both less than in the thicker copper wires.
- B** The current and the speed of the electrons is the same in all the wires.
- C** The current is the same in all the wires but the speed of the electrons in the thinner wire is greater than in the thicker wires.
- D** The current is the same in all the wires but the speed of the electrons in the thinner wire is less than in the thicker wire.

- 255 An electrical device of fixed resistance 20Ω is connected in series with a variable resistor and a battery of electromotive force (e.m.f.) 16 V and negligible internal resistance. 9702/13/O/N/13/Q34



What is the resistance of the variable resistor when the power dissipated in the electrical device is 4.0 W?

- A** 16Ω
- B** 36Ω
- C** 44Ω
- D** 60Ω

- 256 A copper wire is cylindrical and has resistance R .

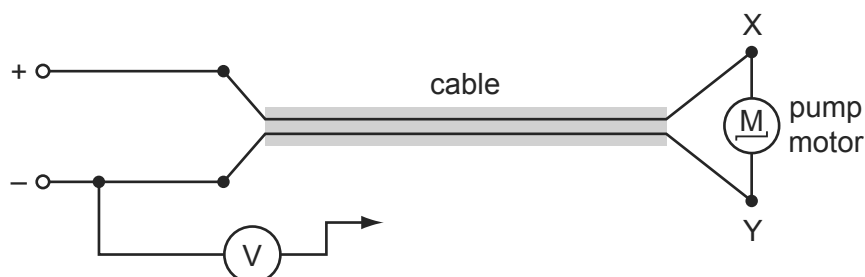
9702/13/O/N/13/Q35

What will be the resistance of a copper wire of twice the length and twice the radius?

- A** $\frac{R}{4}$ **B** $\frac{R}{2}$ **C** R **D** $2R$

- 257 The diagram shows the electric motor for a garden pump connected to a 24 V power supply by an insulated two-core cable.

9702/13/O/N/13/Q36



The motor does not work so, to find the fault, the negative terminal of a voltmeter is connected to the negative terminal of the power supply and its other end is connected in turn to terminals X and Y at the motor.

Which row represents two readings and a correct conclusion?

	voltmeter reading when connected to X/V	voltmeter reading when connected to Y/V	conclusion
A	24	0	break in positive wire of cable
B	24	12	break in negative wire of cable
C	24	24	break in connection within the motor
D	24	24	break in negative wire of cable

- 258 Two wires P and Q made of the same material and of the same length are connected in parallel to the same voltage supply. Wire P has diameter 2 mm and wire Q has diameter 1 mm.

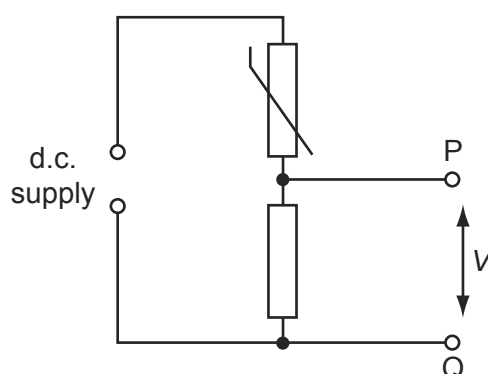
9702/13/M/J/14/Q33

What is the ratio $\frac{\text{current in P}}{\text{current in Q}}$?

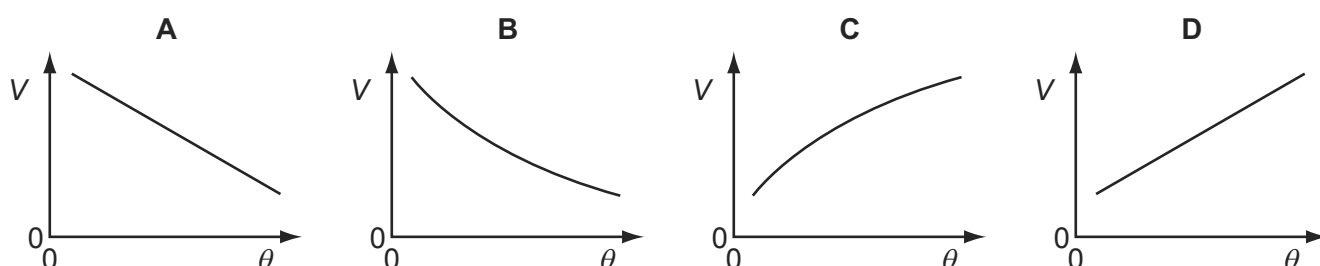
- A** $\frac{1}{4}$ **B** $\frac{1}{2}$ **C** $\frac{2}{1}$ **D** $\frac{4}{1}$

259 In the circuit shown, the resistance of the thermistor decreases as temperature increases.

9702/13/O/N/13/Q37

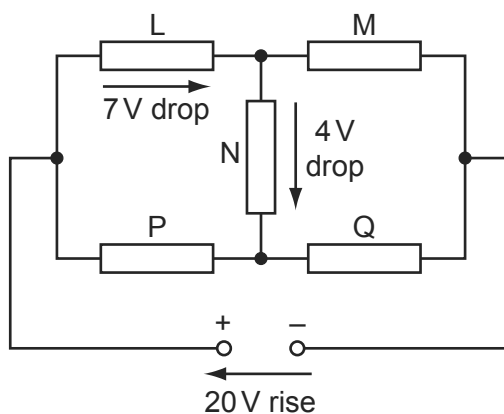


Which graph shows the variation with Celsius temperature θ of potential difference V between points P and Q?



260 A 20V d.c. supply is connected to a circuit consisting of five resistors L, M, N, P and Q.

9702/13/O/N/13/Q38



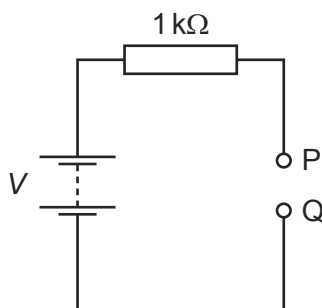
There is a potential drop of 7 V across L and a further 4 V potential drop across N.

What are the potential drops across M, P and Q?

	potential drop across M/V	potential drop across P/V	potential drop across Q/V
A	9	7	13
B	13	7	13
C	13	11	9
D	17	3	17

- 261 A battery of electromotive force (e.m.f.) V and negligible internal resistance is connected to a $1\text{ k}\Omega$ resistor, as shown.

9702/12/M/J/14/Q30



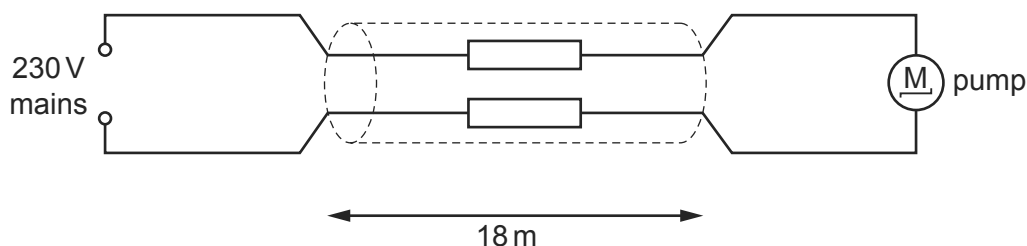
A student attempts to measure the potential difference (p.d.) between points P and Q using two voltmeters, one at a time. The first voltmeter has a resistance of $1\text{ k}\Omega$ and the second voltmeter has a resistance of $1\text{ M}\Omega$.

What are the readings of the voltmeters?

	reading on voltmeter with $1\text{ k}\Omega$ resistance	reading on voltmeter with $1\text{ M}\Omega$ resistance
A	$\frac{V}{2}$	$\frac{V}{2}$
B	$\frac{V}{2}$	V
C	V	$\frac{V}{2}$
D	V	V

- 262 The diagram shows an electric pump for a garden fountain connected by an 18 m cable to a 230 V mains electrical supply.

9702/12/M/J/14/Q32



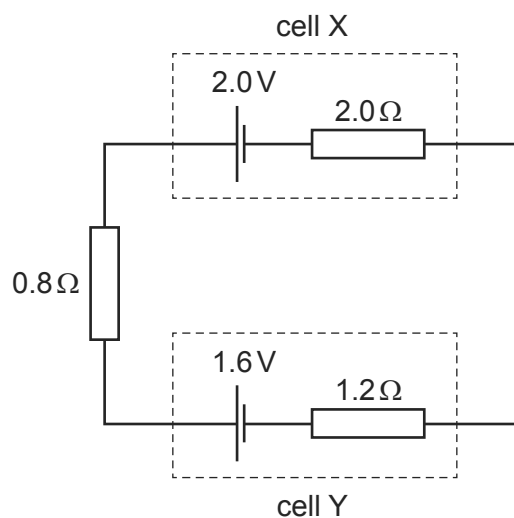
The performance of the pump is acceptable if the potential difference (p.d.) across it is at least 218 V . The current through it is then 0.83 A .

What is the maximum resistance per metre of each of the two wires in the cable if the pump is to perform acceptably?

- A** $0.40\text{ }\Omega\text{ m}^{-1}$ **B** $0.80\text{ }\Omega\text{ m}^{-1}$ **C** $1.3\text{ }\Omega\text{ m}^{-1}$ **D** $1.4\text{ }\Omega\text{ m}^{-1}$

- 263 Cell X has an e.m.f. of 2.0 V and an internal resistance of $2.0\ \Omega$. Cell Y has an e.m.f. of 1.6 V and an internal resistance of $1.2\ \Omega$. These two cells are connected to a resistor of resistance $0.8\ \Omega$, as shown.

9702/12/M/J/14/Q33

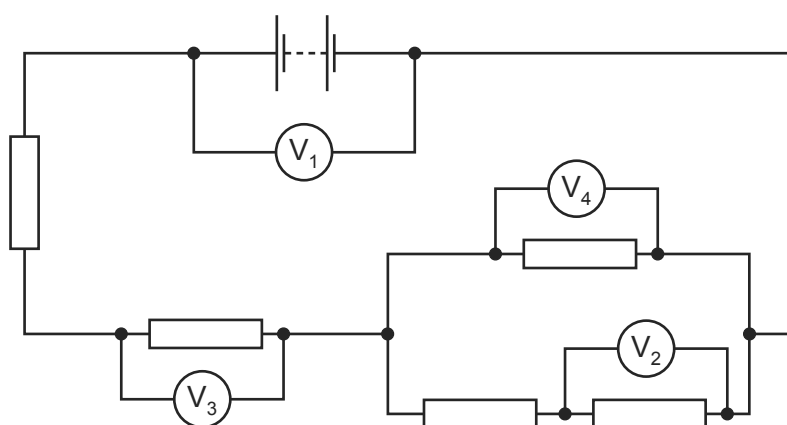


What is the current in cell X?

- A** 0.10 A **B** 0.50 A **C** 0.90 A **D** 1.0 A

- 264 In the circuit shown, all the resistors are identical.

9702/12/M/J/14/Q36



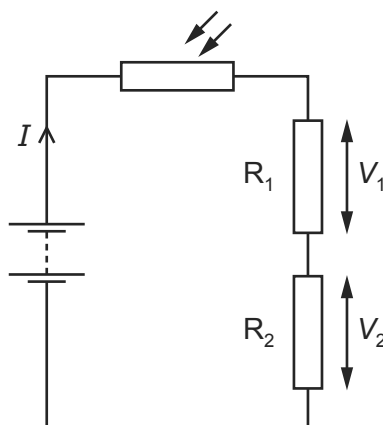
The reading on voltmeter V_1 is 8.0 V and the reading on voltmeter V_2 is 1.0 V .

What are the readings on the other voltmeters?

	reading on voltmeter V_3/V	reading on voltmeter V_4/V
A	1.5	1.0
B	3.0	2.0
C	4.5	3.0
D	6.0	4.0

- 265 In the circuit shown, a light-dependent resistor (LDR) is connected to two resistors R_1 and R_2 . The potential difference (p.d.) across R_1 is V_1 and the p.d. across R_2 is V_2 . The current in the circuit is I .

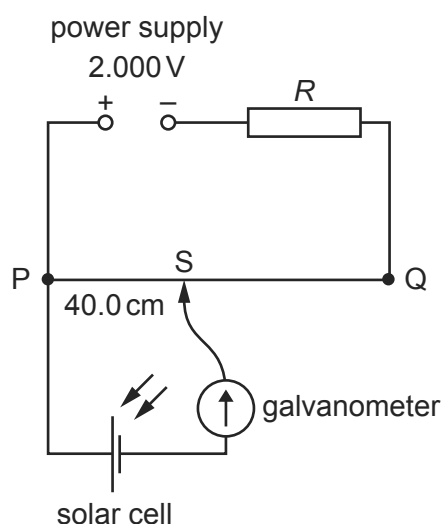
9702/12/M/J/14/Q34



Which statement about this circuit is correct?

- A** The current I increases when the light intensity decreases.
- B** The LDR is an ohmic conductor.
- C** The p.d. V_2 increases when the light intensity decreases.
- D** The ratio $\frac{V_1}{V_2}$ is independent of light intensity.

- 266 A power supply and a solar cell are compared using the potentiometer circuit shown. 9702/12/M/J/14/Q35



The e.m.f. produced by the solar cell is measured on the potentiometer.

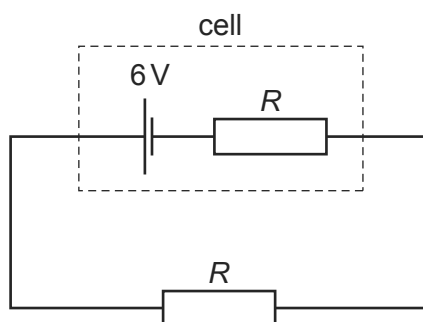
The potentiometer wire PQ is 100.0 cm long and has a resistance of $5.00\ \Omega$. The power supply has an e.m.f. of 2.000 V and the solar cell has an e.m.f. of 5.00 mV.

Which resistance R must be used so that the galvanometer reads zero when $PS = 40.0\text{ cm}$?

- A** $395\ \Omega$
- B** $795\ \Omega$
- C** $995\ \Omega$
- D** $1055\ \Omega$

- 267 A cell has an electromotive force (e.m.f.) of 6 V and internal resistance R . An external resistor, also of resistance R , is connected across this cell, as shown.

9702/13/M/J/14/Q34



Power P is dissipated by the external resistor.

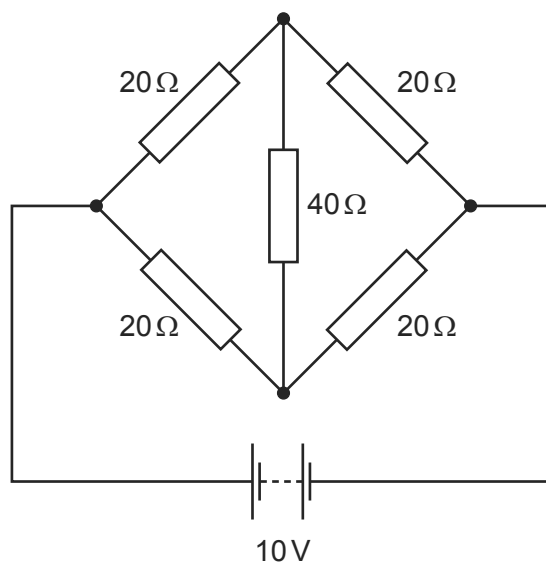
The cell is replaced by a different cell that has an e.m.f. of 6 V and negligible internal resistance.

What is the new power that is dissipated in the external resistor?

- A** $0.5P$ **B** P **C** $2P$ **D** $4P$

- 268 What is the current in the $40\ \Omega$ resistor of the circuit shown?

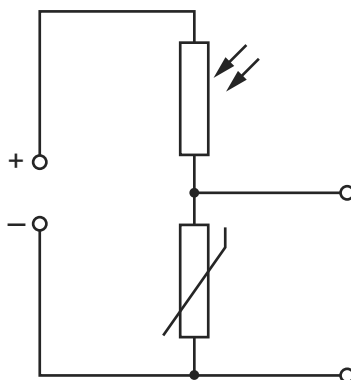
9702/13/M/J/14/Q37



- A** zero **B** 0.13 A **C** 0.25 A **D** 0.50 A

- 269 The diagram shows a light-dependent resistor (LDR) and a thermistor forming a potential divider.

9702/13/M/J/14/Q37

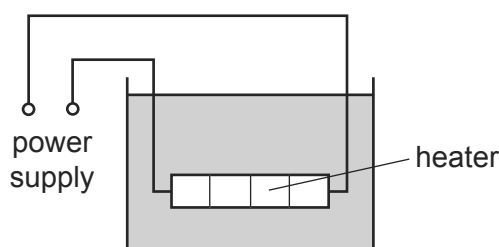


Under which set of conditions will the potential difference across the thermistor have the greatest value?

	illumination	temperature
A	low	low
B	high	low
C	low	high
D	high	high

- 270 The diagram shows a low-voltage circuit for heating the water in a fish tank.

9702/13/M/J/14/Q35



The heater has a resistance of 3.0Ω . The power supply has an e.m.f. of 12V and an internal resistance of 1.0Ω .

At which rate is energy supplied to the heater?

- A** 27 W **B** 36 W **C** 48 W **D** 64 W

- 271 A copper wire is to be replaced by an aluminium alloy wire of the same length and resistance. Copper has half the resistivity of the alloy.

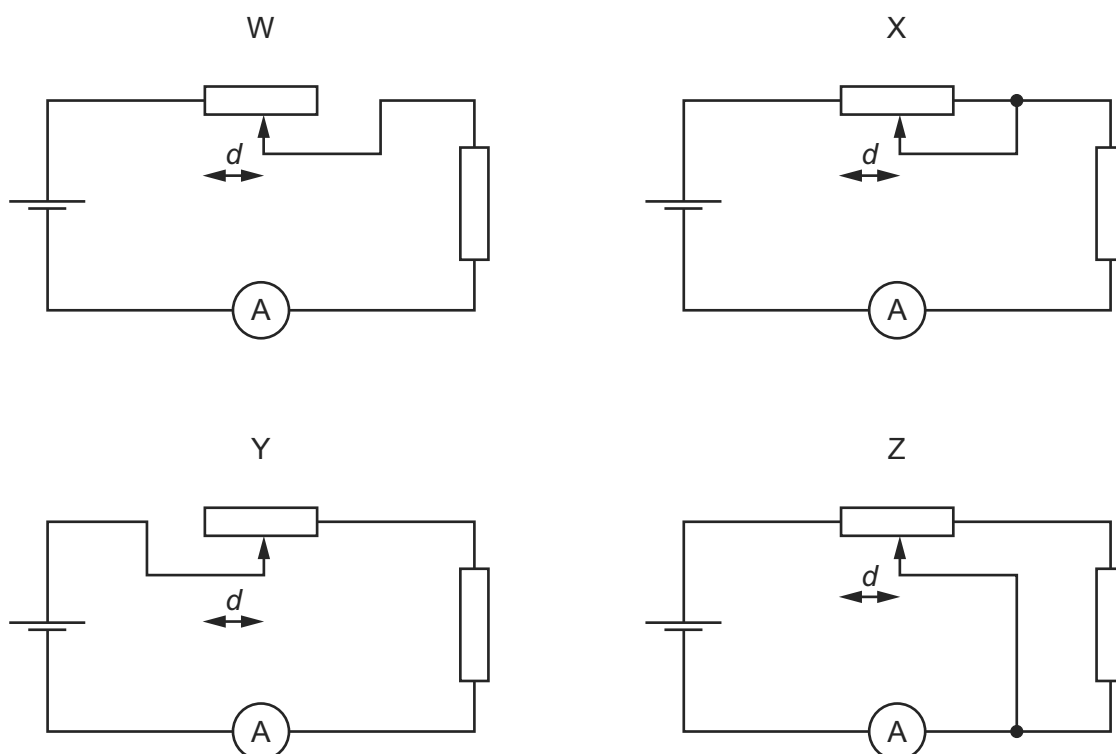
9702/12/M/J/14/Q31

What is the ratio $\frac{\text{diameter of alloy wire}}{\text{diameter of copper wire}}$?

- A** $\sqrt{2}$ **B** 2 **C** $2\sqrt{2}$ **D** 4

- 272 The diagrams show the same cell, ammeter, potentiometer and fixed resistor connected in different ways.

9702/13/M/J/14/Q36



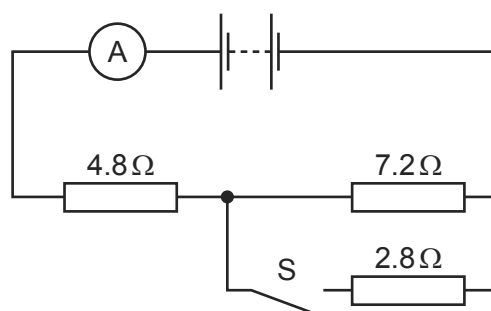
The distance d between the sliding contact and a particular end of the potentiometer is varied. The current measured is then plotted against the distance d .

For which two circuits will the graphs be identical?

- A** W and X **B** W and Y **C** X and Y **D** Y and Z

- 273 A battery of negligible internal resistance is connected to a resistor network, an ammeter and a switch S, as shown.

9702/13/M/J/14/Q38



When S is open, the reading on the ammeter is 250 mA.

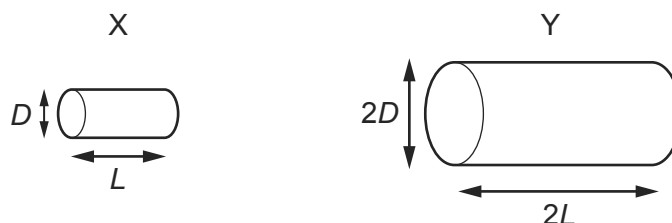
When S is closed, what is the **change** in the reading on the ammeter?

- A** 1.07 A **B** 1.32 A **C** 190 mA **D** 440 mA

- 274 Two electrically-conducting cylinders X and Y are made from the same material.

9702/11/M/J/14/Q30

Their dimensions are as shown.



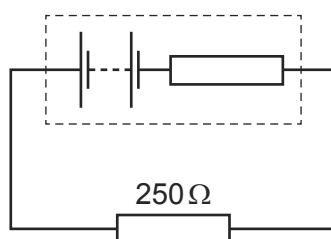
The resistance between the ends of each cylinder is measured.

What is the ratio $\frac{\text{resistance of X}}{\text{resistance of Y}}$?

- A $\frac{2}{1}$ B $\frac{1}{1}$ C $\frac{1}{2}$ D $\frac{1}{4}$

- 275 A battery, with a constant internal resistance, is connected to a resistor of resistance 250Ω , as shown.

9702/11/M/J/14/Q31



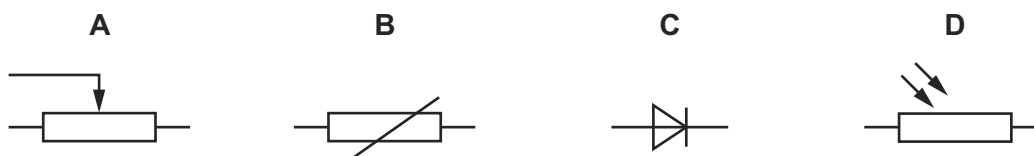
The current in the resistor is 40mA for a time of 60s . During this time 6.0J of energy is lost in the internal resistance.

What are the energy supplied to the external resistor during the 60s and the e.m.f. of the battery?

	energy / J	e.m.f. / V
A	2.4	2.4
B	2.4	7.5
C	24	10.0
D	24	12.5

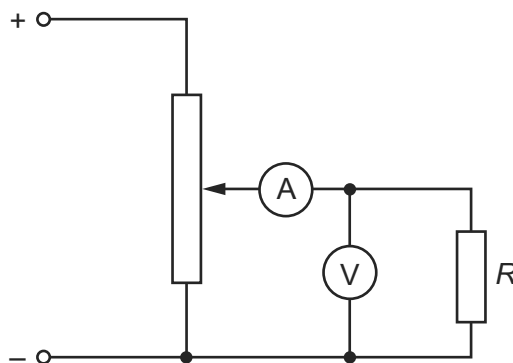
- 276 Which symbol represents a component whose resistance is designed to change with temperature?

9702/11/M/J/14/Q32



- 277 In the circuit below, a voltmeter of resistance R_V and an ammeter of resistance R_A are used to measure the resistance R of the fixed resistor.

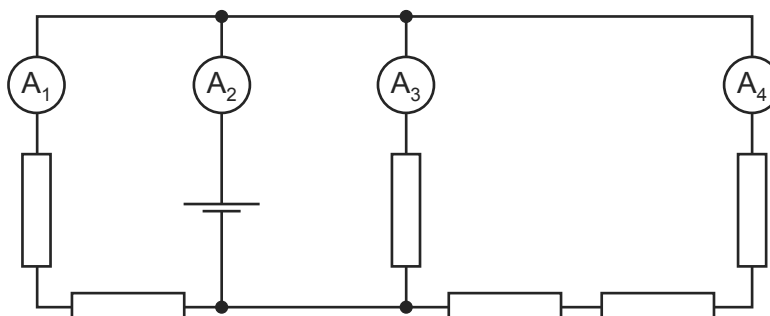
9702/11/M/J/14/Q33



Which condition is necessary for an accurate value to be obtained for R ?

- A** R is much smaller than R_V .
B R is much smaller than R_A .
C R is much greater than R_V .
D R is much greater than R_A .
- 278 In the circuit shown, all the resistors are identical and all the ammeters have negligible resistance.

9702/11/M/J/14/Q34



The reading on ammeter A_1 is 0.6 A.

What are the readings on the other ammeters?

	reading on ammeter A_2 / A	reading on ammeter A_3 / A	reading on ammeter A_4 / A
A	1.0	0.3	0.1
B	1.4	0.6	0.2
C	1.8	0.9	0.3
D	2.2	1.2	0.4

279 The potential difference across a component in a circuit is 2.0 V.

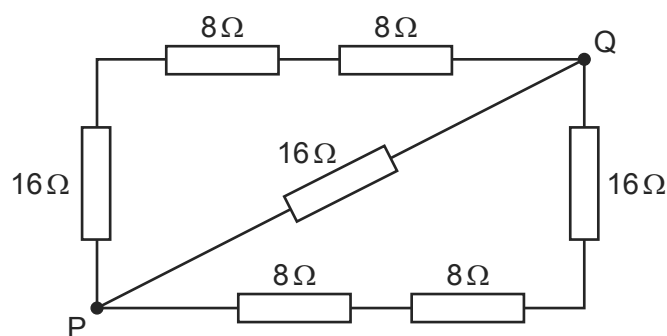
9702/11/M/J/14/Q35

How many electrons must flow through this component in order for it to be supplied with 4.8 J of energy?

- A** 2.6×10^{18} **B** 1.5×10^{19} **C** 3.0×10^{19} **D** 6.0×10^{19}

280 What is the total resistance between points P and Q in this network of resistors?

9702/11/M/J/14/Q36



- A** 8Ω **B** 16Ω **C** 24Ω **D** 32Ω

281 The combined resistance R_T of two resistors of resistances R_1 and R_2 connected in parallel is given by the formula shown.

9702/11/O/N/14/Q35

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$$

Which statement is used in the derivation of this formula?

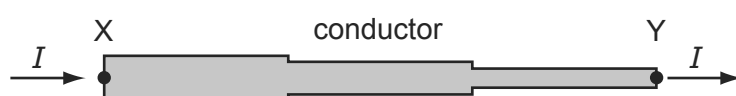
- A** The currents through the two resistors are equal.
B The potential difference across each resistor is the same.
C The supply current is split between the two resistors in the same ratio as the ratio of their resistances.
D The total power dissipated is the sum of the powers dissipated in the two resistors separately.

- 282 A pencil is used to draw a line of length 30 cm and width 1.2 mm. The resistivity of the material in the pencil is $2.0 \times 10^{-5} \Omega \text{ m}$ and the resistance of the line is 40 k Ω .
9702/11/O/N/14/Q32

What is the thickness of the line?

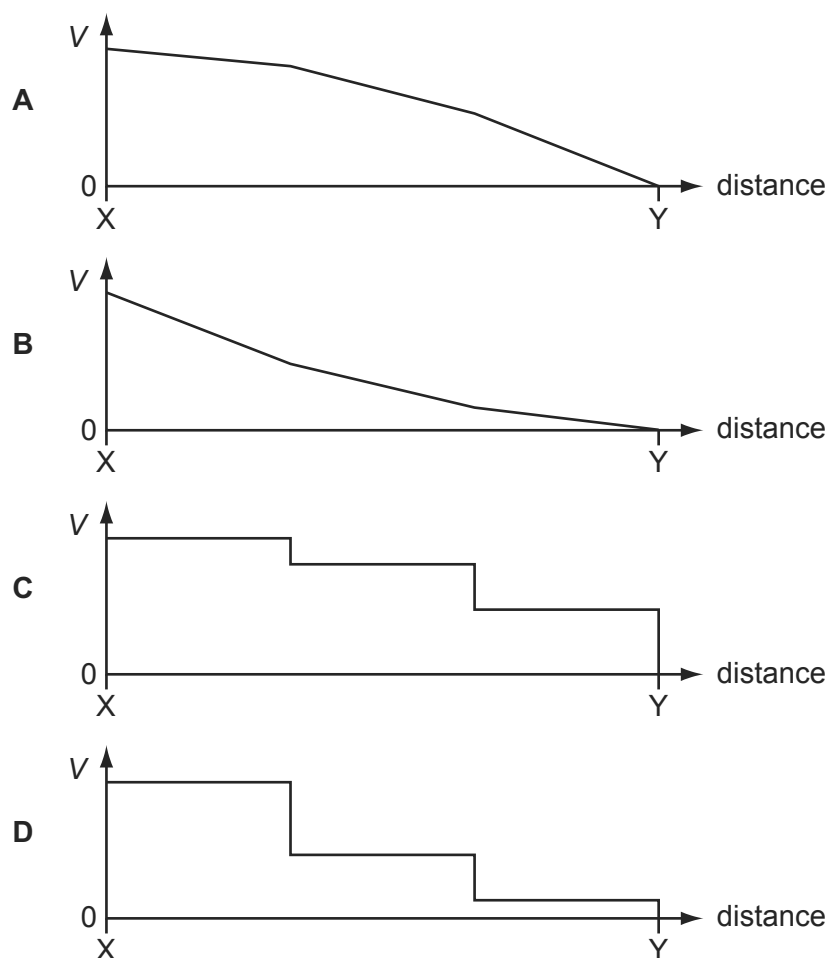
- A** $1.25 \times 10^{-10} \text{ m}$
B $1.25 \times 10^{-8} \text{ m}$
C $1.25 \times 10^{-7} \text{ m}$
D $1.25 \times 10^{-5} \text{ m}$

- 283 A conductor consists of three wires connected in series. The wires are all made of the same metal but have different cross-sectional areas. There is a current I in the conductor.
9702/11/O/N/14/Q33



Point Y on the conductor is at zero potential.

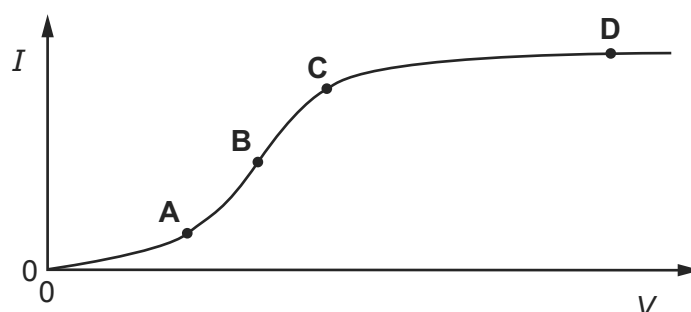
Which graph best shows the variation of potential V with distance along the conductor?



- 284 The graph shows how the electric current I through a conducting liquid varies with the potential difference V across it.

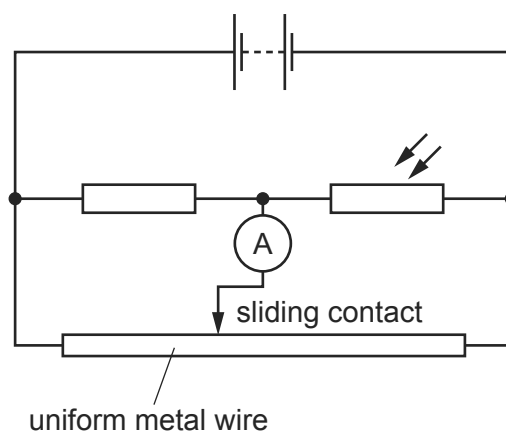
9702/11/O/N/14/Q34

At which point on the graph does the liquid have the smallest resistance?



- 285 In the potentiometer circuit shown, the reading on the ammeter is zero.

9702/11/O/N/14/Q36



The light-dependent resistor (LDR) is then covered up and the ammeter gives a non-zero reading.

Which change could return the ammeter reading to zero?

- A** Decrease the supply voltage.
- B** Increase the supply voltage.
- C** Move the sliding contact to the left.
- D** Move the sliding contact to the right.

- 286 A metal wire of length 0.50 m has a resistance of $12\ \Omega$.

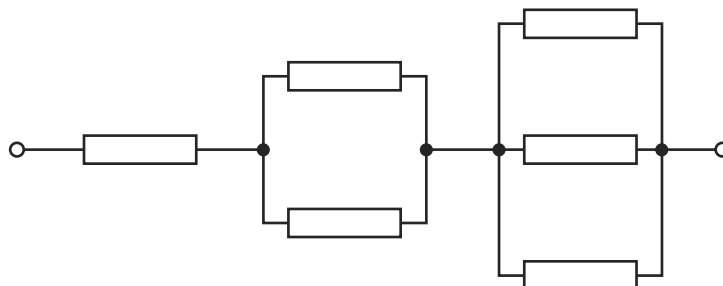
9702/13/O/N/14/Q33

What is the resistance of a wire of length 2.0 m and made of the same material, but with half the diameter?

- A** $12\ \Omega$
- B** $48\ \Omega$
- C** $96\ \Omega$
- D** $192\ \Omega$

287 Six resistors, each of resistance R , are connected as shown.

9702/11/O/N/14/Q37



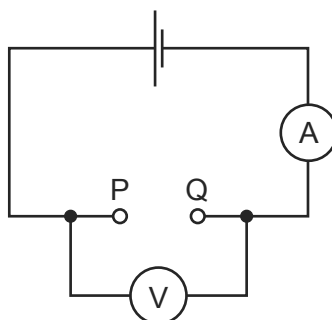
The combined resistance is $66\text{ k}\Omega$.

What is the value of R ?

- A** $11\text{ k}\Omega$ **B** $18\text{ k}\Omega$ **C** $22\text{ k}\Omega$ **D** $36\text{ k}\Omega$

288 A student found two unmarked resistors. To determine the resistance of the resistors, the circuit below was set up. The resistors were connected in turn between P and Q, noting the current readings. The voltage readings were noted without the resistors and with each resistor in turn.

9702/13/O/N/14/Q34



The results were entered into a spreadsheet as shown.

1.5	1.3	28	46
1.5	1.4	14	100

The student forgot to enter the column headings.

Which order of the headings would be correct?

- A**

e.m.f./V	V/V	R/Ω	I/mA
----------	-----	------------	---------------
- B**

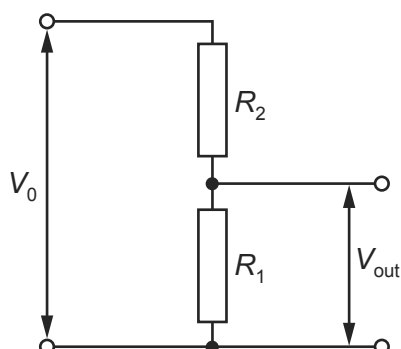
V/V	e.m.f./V	R/Ω	I/mA
-----	----------	------------	---------------
- C**

V/V	e.m.f./V	I/mA	R/Ω
-----	----------	---------------	------------
- D**

e.m.f./V	V/V	I/mA	R/Ω
----------	-----	---------------	------------

- 289 A potential divider consists of resistors of resistance R_1 and R_2 connected in series across a source of potential difference V_0 . The potential difference across R_1 is V_{out} .

9702/13/O/N/14/Q35

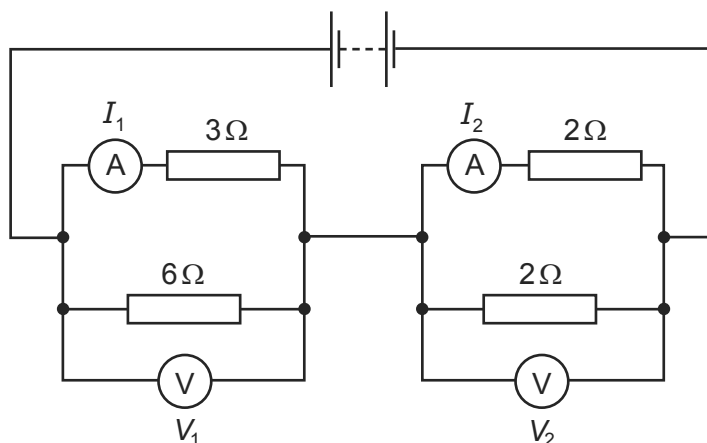


Which changes to R_1 and R_2 will increase the value of V_{out} ?

	R_1	R_2
A	doubled	doubled
B	doubled	halved
C	halved	doubled
D	halved	halved

- 290 In the circuit shown, the ammeters have negligible resistance and the voltmeters have infinite resistance.

9702/13/O/N/14/Q37

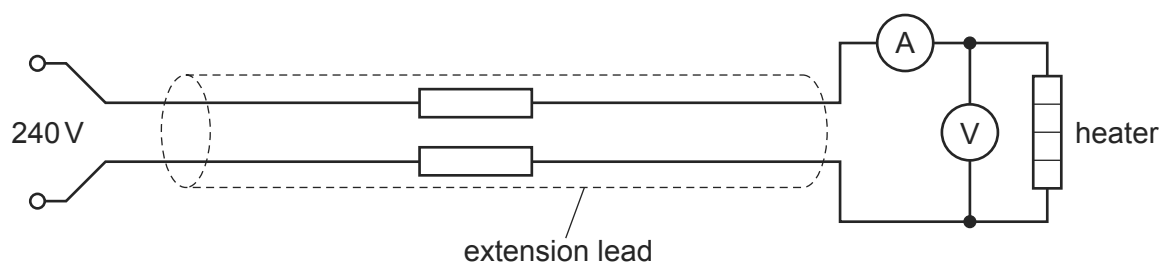


The readings on the meters are I_1 , I_2 , V_1 and V_2 , as labelled on the diagram.

Which statement is correct?

- A** $I_1 > I_2$ and $V_1 > V_2$
B $I_1 > I_2$ and $V_1 < V_2$
C $I_1 < I_2$ and $V_1 > V_2$
D $I_1 < I_2$ and $V_1 < V_2$

- 291 An extension lead is used to connect a 240 V electrical supply to a heater as shown. 9702/13/O/N/14/Q36



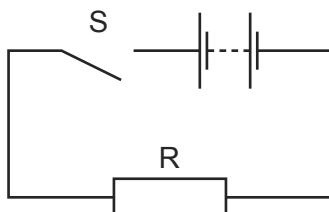
A voltmeter measures the potential difference (p.d.) across the heater as 216 V and an ammeter measures the current through the heater as 7.7 A.

What is the total resistance of the extension lead?

- A** $3.1\ \Omega$ **B** $6.2\ \Omega$ **C** $28\ \Omega$ **D** $31\ \Omega$
- 292 A pedal bicycle is fitted with an electric motor. The rider switches on the motor for a time of 3.0 minutes. A constant current of 3.5 A in the electric motor is provided from a battery with a terminal voltage of 24 V. 9702/13/M/J/15/Q32

What is the energy supplied by the battery?

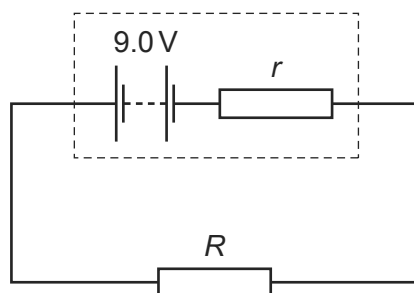
- A** 84 J **B** 250 J **C** 630 J **D** 15 000 J
- 293 The diagram shows a simple circuit. 9702/13/M/J/15/Q33



Which statement is correct?

- A** When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.
- B** When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance of R.
- C** When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.
- D** When switch S is closed, the potential difference across the battery falls because work is done against the resistance of R.

- 294 A simple circuit is formed by connecting a resistor of resistance R between the terminals of a battery of electromotive force (e.m.f.) 9.0 V and constant internal resistance r . 9702/13/M/J/15/Q34



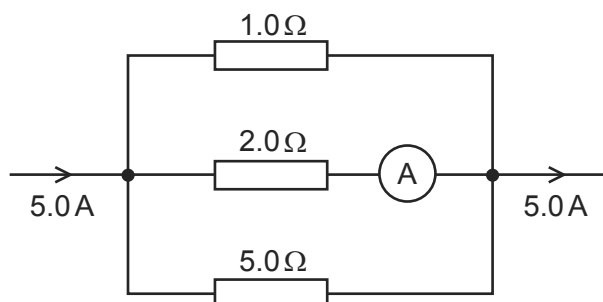
A charge of 6.0 C flows through the resistor in a time of 2.0 minutes causing it to dissipate 48 J of thermal energy.

What is the internal resistance r of the battery?

- A** $0.17\ \Omega$ **B** $0.33\ \Omega$ **C** $20\ \Omega$ **D** $160\ \Omega$

- 295 The diagram shows part of a current-carrying circuit. The ammeter has negligible resistance.

9702/13/M/J/15/Q37



What is the reading on the ammeter?

- A** 0.7 A **B** 1.3 A **C** 1.5 A **D** 1.7 A

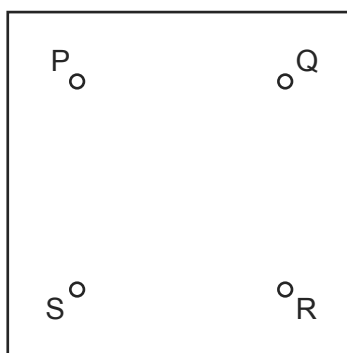
- 296 Which statement is **not** valid?

9702/12/M/J/15/Q33

- A** Current is the speed of the charged particles that carry it.
- B** Electromotive force (e.m.f.) is the energy converted to electrical energy from other forms per unit charge.
- C** The potential difference (p.d.) between two points is the work done per unit charge when moving charge from one point to the other.
- D** The resistance between two points is the p.d. between the two points per unit current.

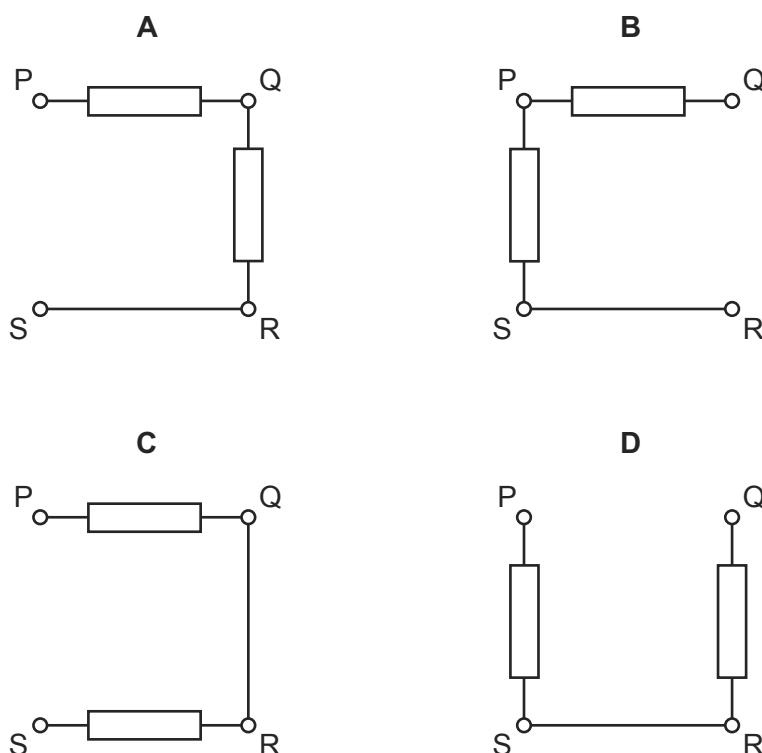
297 A box with four terminals P, Q, R and S contains two identical resistors.

9702/13/M/J/15/Q36



When a battery of electromotive force (e.m.f.) E and negligible internal resistance is connected across PS, a high-resistance voltmeter connected across QR reads $\frac{E}{2}$.

Which diagram shows the correct arrangement of the two resistors inside the box?



298 A source of e.m.f. 9.0 mV has an internal resistance of $6.0\ \Omega$.

9702/13/M/J/15/Q35

It is connected across a galvanometer of resistance $30\ \Omega$.

What is the current in the galvanometer?

- A** $250\ \mu\text{A}$ **B** $300\ \mu\text{A}$ **C** $1.5\ \text{mA}$ **D** $2.5\ \text{mA}$

299 Which unit is **not** used in either the definition of the coulomb or the definition of the volt?

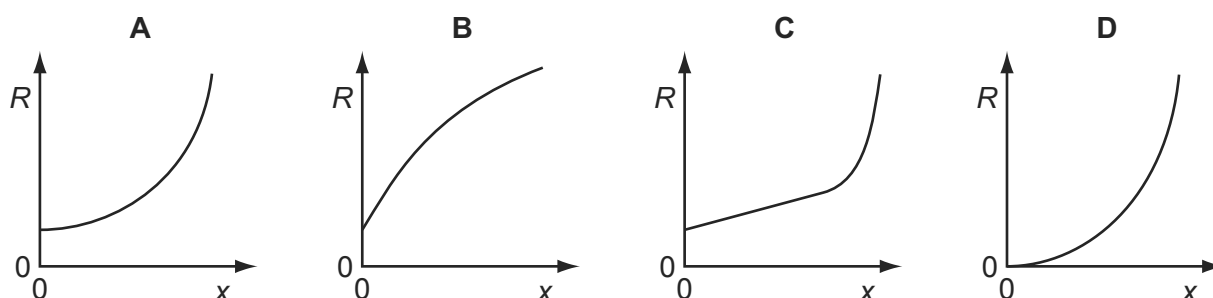
9702/12/M/J/15/Q31

- A ampere
- B joule
- C ohm
- D second

300 When a thin metal wire is stretched, it becomes longer and thinner. This causes a change in the resistance of the wire. The volume of the wire remains constant.

9702/12/M/J/15/Q32

Which graph could represent the variation with extension x of the resistance R of the wire?



301 A cell of e.m.f. E delivers a charge Q to an external circuit.

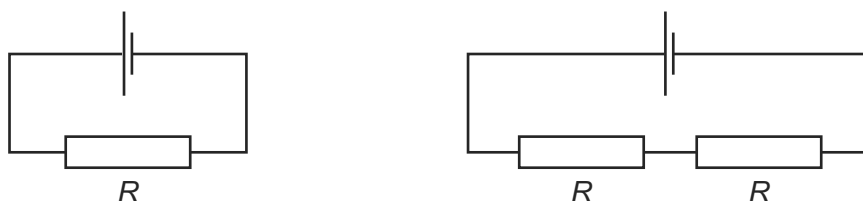
9702/12/M/J/15/Q34

Which statement is correct?

- A The energy dissipation in the external circuit is EQ .
- B The energy dissipation within the cell is EQ .
- C The external resistance is EQ .
- D The total energy dissipation in the cell and the external circuit is EQ .

302 The diagrams show two different circuits.

9702/11/M/J/15/Q33



The cells in each circuit have the same electromotive force and zero internal resistance. The three resistors each have the same resistance R .

In the circuit on the left, the power dissipated in the resistor is P .

What is the total power dissipated in the circuit on the right?

- A $\frac{P}{4}$
- B $\frac{P}{2}$
- C P
- D $2P$

303 Each of Kirchhoff's two laws presumes that some quantity is conserved.

9702/12/M/J/15/Q35

Which row states Kirchhoff's **first** law and names the quantity that is conserved?

	statement	quantity
A	the algebraic sum of currents into a junction is zero	charge
B	the algebraic sum of currents into a junction is zero	energy
C	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	charge
D	the e.m.f. in a loop is equal to the algebraic sum of the product of current and resistance round the loop	energy

304 Which equation that links some of the following terms is correct?

9702/11/M/J/15/Q34

potential difference (p.d.)	V
current	I
resistance	R
charge	Q
energy	E
power	P
time	t

A $P = \frac{Q^2 R}{t}$

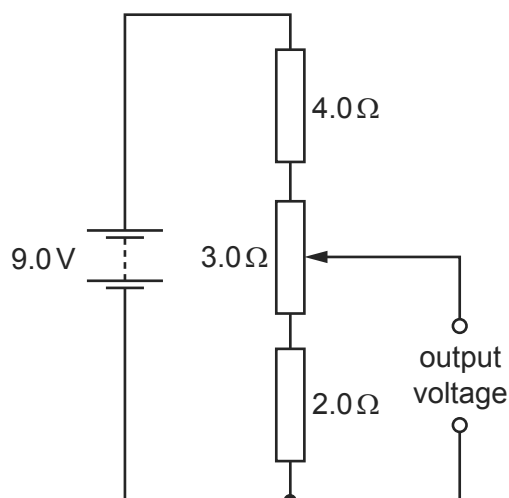
B $ER^2 = V^2 t$

C $\frac{VI}{P} = t$

D $PQ = EI$

- 305 A potential divider circuit consists of fixed resistors of resistance 2.0Ω and 4.0Ω connected in series with a 3.0Ω resistor fitted with a sliding contact. These are connected across a battery of e.m.f. 9.0V and zero internal resistance, as shown.

9702/12/M/J/15/Q36

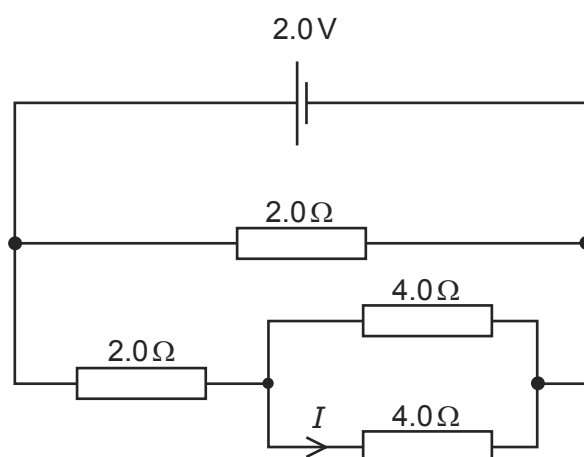


What are the maximum and the minimum output voltages of this potential divider circuit?

	maximum voltage / V	minimum voltage / V
A	4.0	2.0
B	5.0	2.0
C	9.0	0
D	9.0	2.0

- 306 A cell of e.m.f. 2.0V and negligible internal resistance is connected to a network of resistors as shown.

9702/12/M/J/15/Q37

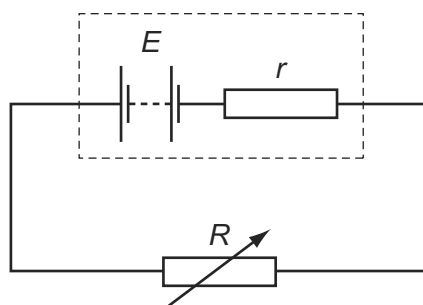


What is the current I ?

- A** 0.25A **B** 0.33A **C** 0.50A **D** 1.5A

- 307 A battery with e.m.f. E and internal resistance r is connected in series with a variable external resistor.

9702/11/M/J/15/Q36

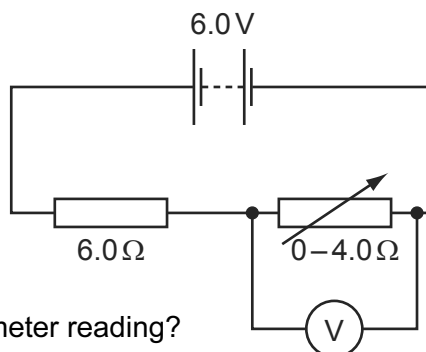


The value of the external resistance R is slowly increased from zero.

Which statement is correct? (Ignore any temperature effects.)

- A** The potential difference across the external resistance decreases.
 - B** The potential difference across the internal resistance increases.
 - C** The power dissipated in r increases and then decreases.
 - D** The power dissipated in R increases and then decreases.
- 308 A battery of electromotive force (e.m.f.) 6.0V and negligible internal resistance is connected in series with a resistor of resistance 6.0Ω and a variable resistor of resistance from zero to 4.0Ω . A voltmeter is connected across the variable resistor. The resistance of the variable resistor is changed.

9702/11/M/J/15/Q37



What is the range of the voltmeter reading?

- A** $0\text{V} - 2.4\text{V}$
 - B** $0\text{V} - 3.6\text{V}$
 - C** $2.4\text{V} - 6.0\text{V}$
 - D** $3.6\text{V} - 6.0\text{V}$
- 309 The charge that an electric battery can deliver is specified in ampere-hours.

9702/11/M/J/15/Q35

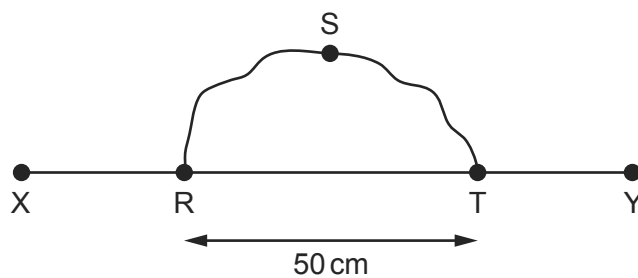
For example, a battery of capacity 40 ampere-hours could supply, when fully charged, 0.2A for 200 hours.

What is the maximum energy that a fully charged 12V , 40 ampere-hour battery could supply?

- A** 1.7kJ
- B** 29kJ
- C** 1.7MJ
- D** 29MJ

310 A wire RST is connected to another wire XY as shown.

9702/11/M/J/15/Q38



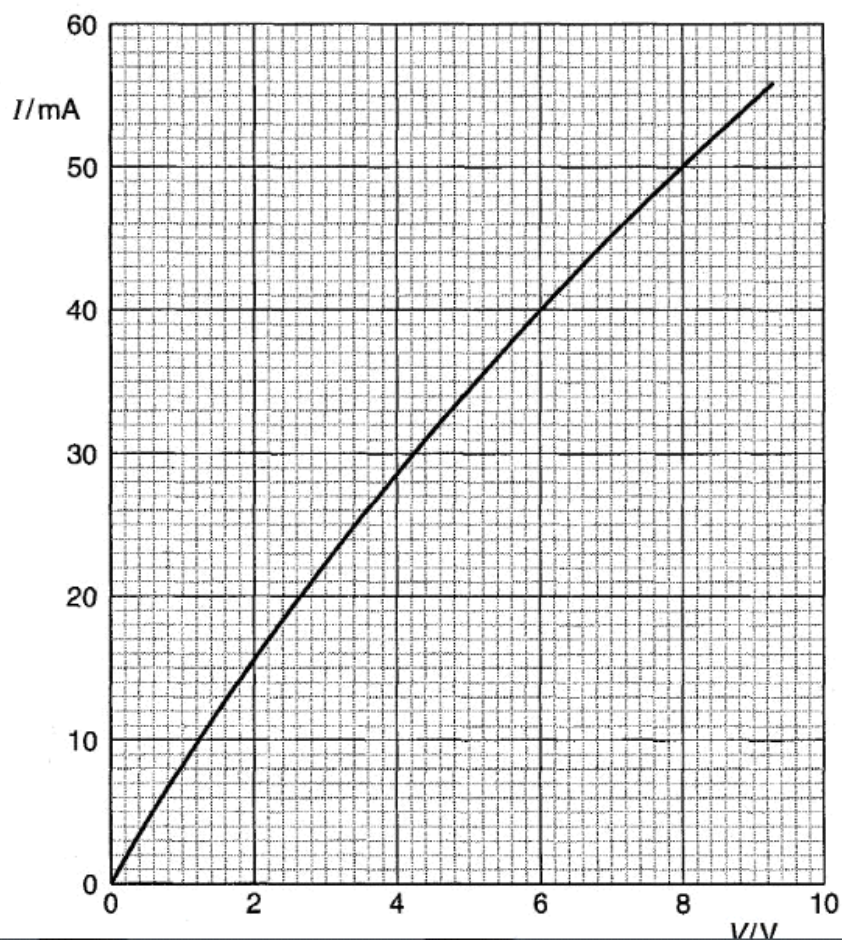
Each wire is 100 cm long with a resistance per unit length of $10\Omega\text{ m}^{-1}$.

What is the total resistance between X and Y?

- A** 3.3Ω **B** 5.0Ω **C** 8.3Ω **D** 13.3Ω

Q1.

- 5 A filament lamp operates normally at a potential difference (p.d.) of 6.0 V. The variation with p.d. V of the current I in the lamp is shown in Fig. 5.1.



- (a) Use Fig. 5.1 to determine, for this lamp,
 (i) the resistance when it is operating at a p.d. of 6.0 V,

resistance = ... Ω

- (ii) the change in resistance when the p.d. increases from 6.0 V to 8.0 V.

change in resistance = ... Ω
 [4]

- (b) The lamp is connected into the circuit of Fig. 5.2.

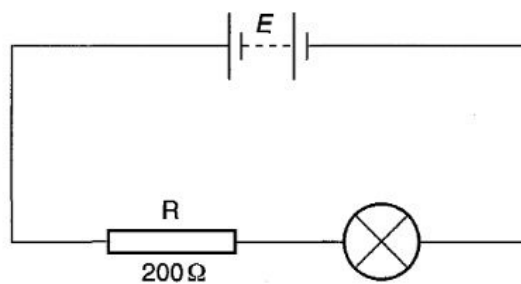


Fig. 5.2

R is a fixed resistor of resistance $200\ \Omega$. The battery has e.m.f. E and negligible internal resistance.

- (i) On Fig. 5.1, draw a line to show the variation with p.d. V of the current I in the resistor R.
- (ii) Determine the e.m.f. of the battery for the lamp to operate normally.

e.m.f. = ... V
[4]

Q2.

- 7 A household electric lamp is rated as 240 V, 60 W. The filament of the lamp is made from tungsten and is a wire of constant radius $6.0 \times 10^{-6}\text{ m}$. The resistivity of tungsten at the normal operating temperature of the lamp is $7.9 \times 10^{-7}\ \Omega\text{ m}$.

- (a) For the lamp at its normal operating temperature,
 - (i) calculate the current in the lamp,

current = ... A

(ii) show that the resistance of the filament is $960\ \Omega$.

[3]

(b) Calculate the length of the filament.

length = ... m [3]

(c) Comment on your answer to (b).

.....
..... [1]

Q3.

- 8 A thermistor has resistance $3900\ \Omega$ at 0°C and resistance $1250\ \Omega$ at 30°C . The thermistor is connected into the circuit of Fig. 8.1 in order to monitor temperature changes.

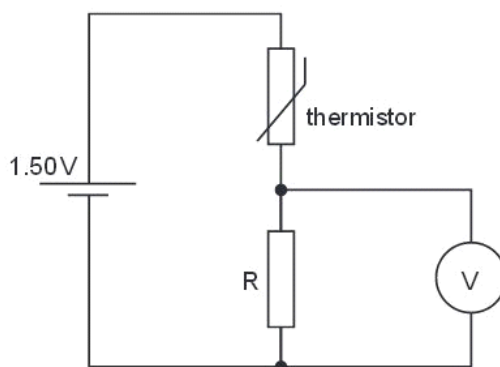


Fig. 8.1

The battery of e.m.f. 1.50 V has negligible internal resistance and the voltmeter has infinite resistance.

- (a) The voltmeter is to read 1.00 V at 0°C . Show that the resistance of resistor R is $7800\ \Omega$.

[2]

- (b) The temperature of the thermistor is increased to 30°C . Determine the reading on the voltmeter.

reading = ... V [2]

- (c) The voltmeter in Fig. 8.1 is replaced with one having a resistance of $7800\ \Omega$. Calculate the reading on this voltmeter for the thermistor at a temperature of 0°C .

reading = ... V [2]

Q4.

- 6 Two parallel metal plates P and Q are situated 8.0 cm apart in air, as shown in Fig. 6.1.

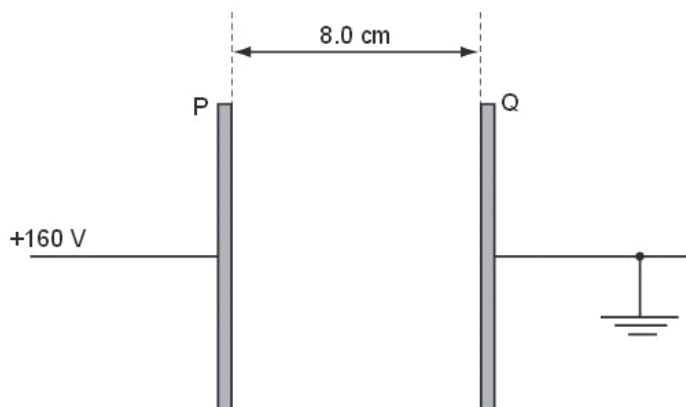


Fig. 6.1

Plate Q is earthed and plate P is maintained at a potential of $+160\text{ V}$.

- (a) (i) On Fig. 6.1, draw lines to represent the electric field in the region between the plates. [2]
 (ii) Show that the magnitude of the electric field between the plates is $2.0 \times 10^3\text{ V m}^{-1}$.

[1]

- (b) A dust particle is suspended in the air between the plates. The particle has charges of $+1.2 \times 10^{-15} \text{ C}$ and $-1.2 \times 10^{-15} \text{ C}$ near its ends. The charges may be considered to be point charges separated by a distance of 2.5 mm, as shown in Fig. 6.2.

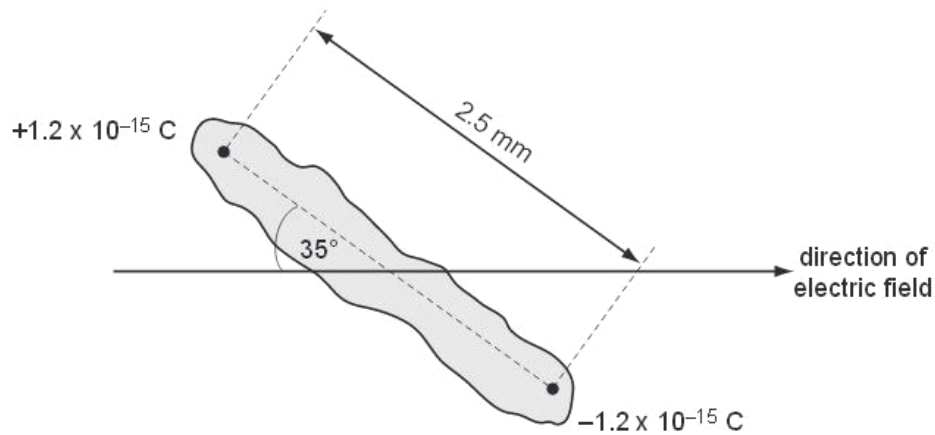


Fig. 6.2

The particle makes an angle of 35° with the direction of the electric field.

- (i) On Fig. 6.2, draw arrows to show the direction of the force on each charge due to the electric field. [1]
- (ii) Calculate the magnitude of the force on each charge due to the electric field.

force = ... N [2]

- (iii) Determine the magnitude of the couple acting on the particle.

couple = ... Nm [2]

- (iv) Suggest the subsequent motion of the particle in the electric field.

.....

[2]

Q5.

- 7 (a) Define the *resistance* of a resistor.

.....
[1]

- (b) In the circuit of Fig. 7.1, the battery has an e.m.f. of 3.00 V and an internal resistance r . R is a variable resistor. The resistance of the ammeter is negligible and the voltmeter has an infinite resistance.

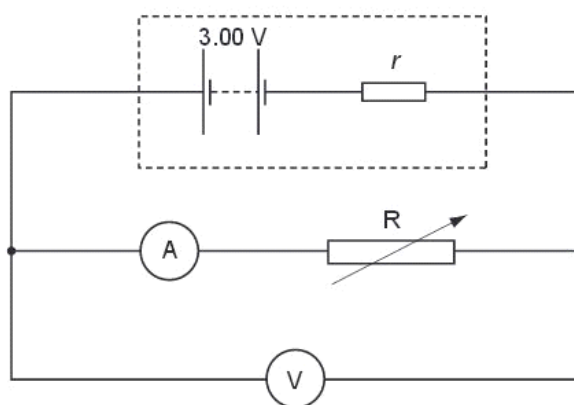


Fig. 7.1

Fr
Ex am
U

The resistance of R is varied. Fig. 7.2 shows the variation of the power P dissipated in R with the potential difference V across R .

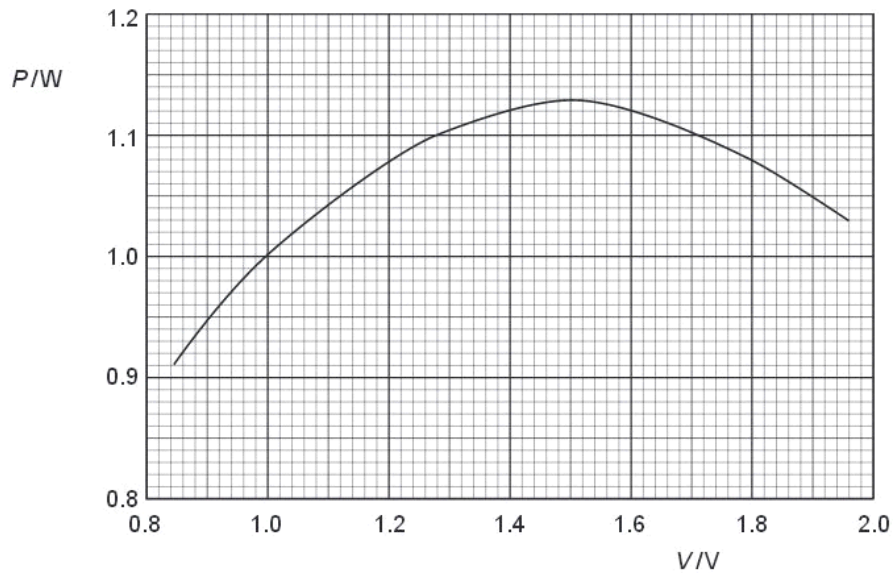


Fig. 7.2

(i) Use Fig. 7.2 to determine

1. the maximum power dissipation in R ,

maximum power = ... W

2. the potential difference across R when the maximum power is dissipated.

potential difference = ... V
[1]

(ii) Hence calculate the resistance of R when the maximum power is dissipated.

resistance = ... Ω [2]

*F0
Exami
Us*

(iii) Use your answers in (i) and (ii) to determine the internal resistance r of the battery.

$$r = \dots\dots\dots \Omega \quad [3]$$

(c) By reference to Fig. 7.2, it can be seen that there are two values of potential difference V for which the power dissipation is 1.05 W.
State, with a reason, which value of V will result in less power being dissipated in the internal resistance.

.....

[3]

Q6.

7 A circuit contains three similar lamps A, B and C. The circuit also contains three switches, S_1 , S_2 and S_3 , as shown in Fig. 7.1.

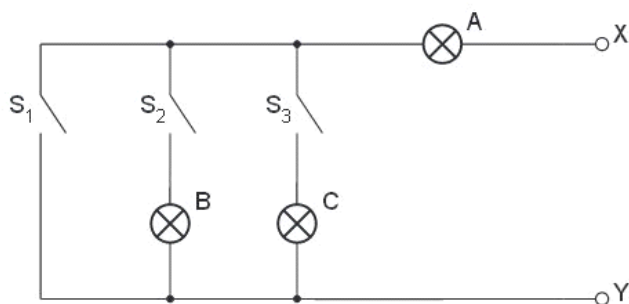


Fig. 7.1

One of the lamps is faulty. In order to detect the fault, an ohm-meter (a meter that measures resistance) is connected between terminals X and Y. When measuring resistance, the ohm-meter causes negligible current in the circuit.

Fig. 7.2 shows the readings of the ohm-meter for different switch positions.