

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2017

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any working should be done in this booklet.

Electronic calculators may be used.

This document consists of **20** printed pages.



Data

speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
gravitational potential	$\phi = -\frac{Gm}{r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2} QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

- 1 A student creates a table to show reasonable estimates of some physical quantities.

Which row is **not** a reasonable estimate?

	quantity	value
A	current in a fan heater	12 A
B	mass of an adult person	70 kg
C	speed of an Olympic sprint runner	10 m s ⁻¹
D	water pressure at the bottom of a garden pond	10 ⁶ Pa

- 2 A particle travels in a straight line with speed v .

The particle slows down and changes direction. The new speed of the particle is $\frac{v}{2}$.

The new velocity has a component of $\frac{v}{4}$ in the same direction as the initial path of the particle.

Through which angle has the particle turned?

- A** 27° **B** 30° **C** 45° **D** 60°

- 3 The speed v of a liquid leaving a tube depends on the change in pressure ΔP and the density ρ of the liquid. The speed is given by the equation

$$v = k \left(\frac{\Delta P}{\rho} \right)^n$$

where k is a constant that has no units.

What is the value of n ?

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

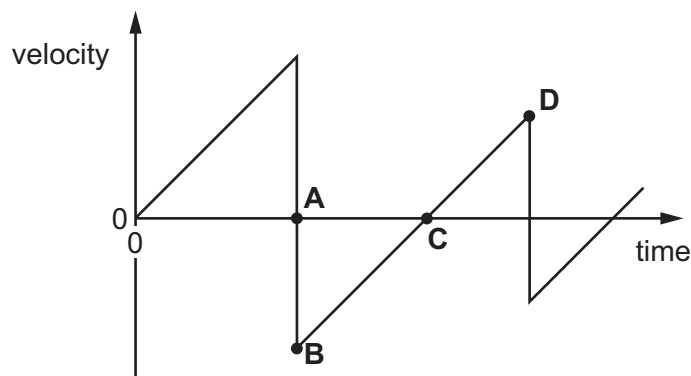
- 4 The values of displacement, velocity and acceleration of a vehicle can be deduced from graphs representing its motion. Often the areas under these graphs, or the gradients of the graphs, are used.

What would **not** give a value for a displacement, a velocity or an acceleration?

- A** area under a velocity-time graph
B gradient of a displacement-time graph
C gradient of a velocity-time graph
D gradient of an acceleration-time graph

- 5 A ball is released from rest above a hard, horizontal surface. The graph shows how the velocity of the bouncing ball varies with time.

At which point on the graph does the ball reach its maximum height after the first bounce?



- 6 A ball is kicked upwards at an angle of 45° to horizontal ground. After a short flight, the ball returns to the ground.

It may be assumed that air resistance is negligible.

What is **never** zero during the flight of the ball?

- A the horizontal component of the ball's acceleration
 - B the horizontal component of the ball's velocity
 - C the vertical component of the ball's momentum
 - D the vertical component of the ball's velocity
- 7 The mass of a rocket-propelled truck is approximately equal to the mass of the fuel in its tank. The fuel is ignited and the truck is propelled along horizontal tracks by a constant force. The effect of air resistance is negligible.

During a test run the fuel is consumed at a constant rate.

Which statement describes the acceleration of the truck during the test run?

- A The acceleration of the truck decreases as the fuel is consumed.
- B The acceleration of the truck increases as the fuel is consumed.
- C The acceleration of the truck remains constant.
- D The acceleration of the truck is zero and the truck moves at a constant velocity.

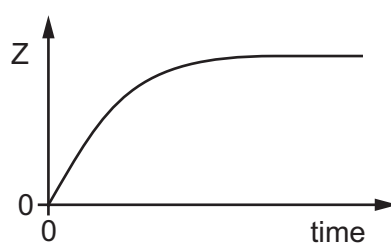
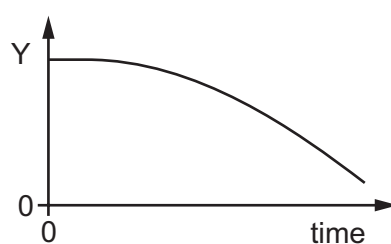
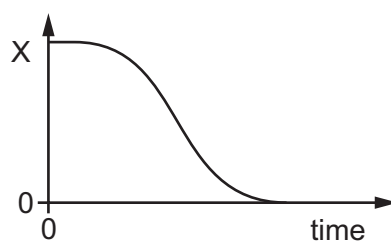
- 8 An object is dropped at time $t = 0$ from a high building. Air resistance is significant.

Three graphs are plotted against time.

the height of the object above the ground

the speed of the object

the magnitude of the resultant force on the object



What are the quantities X, Y and Z?

	height of the object above the ground	speed of the object	magnitude of the resultant force on the object
A	X	Y	Z
B	X	Z	Y
C	Y	Z	X
D	Z	Y	X

- 9 A student attempts to find the density ρ of aluminium by taking measurements of a rectangular sheet.

$$\text{mass } m = 51.6 \pm 0.1 \text{ g}$$

$$\text{length } l = 100.0 \pm 0.1 \text{ cm}$$

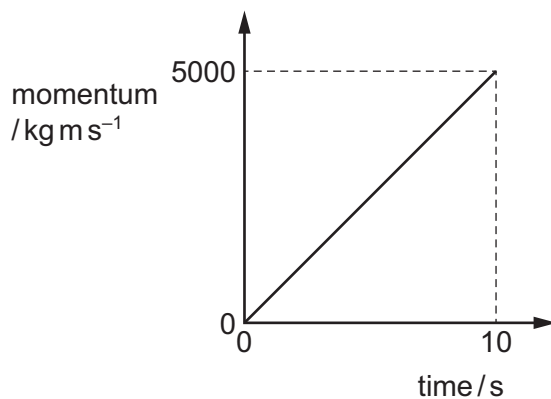
$$\text{width } w = 10.0 \pm 0.1 \text{ cm}$$

$$\text{thickness } t = 0.20 \pm 0.01 \text{ mm}$$

He uses the equation $\rho = \frac{m}{wlt}$ to calculate the density.

What is the calculated value of density with its uncertainty?

- A $0.26 \pm 0.01 \text{ g cm}^{-3}$
B $0.26 \pm 0.02 \text{ g cm}^{-3}$
C $2.6 \pm 0.1 \text{ g cm}^{-3}$
D $2.6 \pm 0.2 \text{ g cm}^{-3}$
- 10 The graph shows how the momentum of a motorcycle changes with time.



What is the resultant force on the motorcycle?

- A 500 N B 5000 N C 25 000 N D 50 000 N

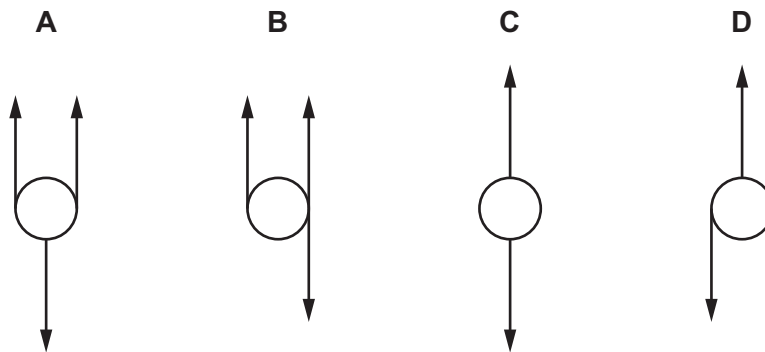
- 11** A particle with mass and charge is moving from left to right in a uniform gravitational field and a uniform electric field. The gravitational field is downwards. The gravitational force and the electric force on this particle act in opposite directions.

What could be the sign of the charge on the particle and the direction of the electric field?

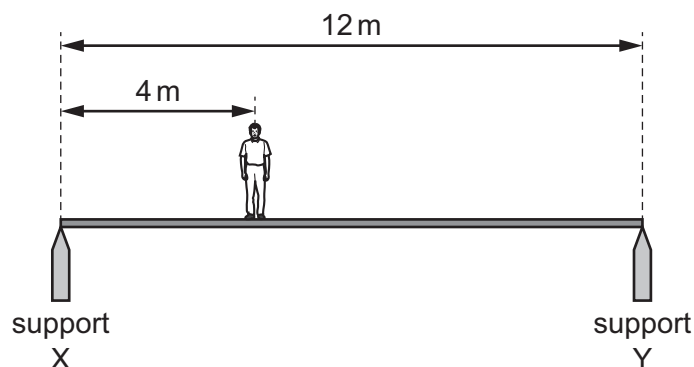
	sign of charge	direction of electric field
A	negative	down
B	negative	up
C	positive	left
D	positive	right

- 12** A sphere is acted upon by various forces, all of the same magnitude.

Which system of forces provides a resultant torque but zero resultant force on the sphere?



- 13** A uniform horizontal footbridge is 12 m long and weighs 4000 N. It rests on two supports X and Y as shown.



A man of weight 600 N is a distance of 4 m from support X.

What is the upward force on the footbridge from support X?

- A** 2200 N **B** 2300 N **C** 2400 N **D** 2600 N

- 14** A metal block has a mass of 750 g. 60% of the mass is magnesium and the remainder is copper.

The density of magnesium is 1.7 g cm^{-3} .

The density of copper is 9.0 g cm^{-3} .

What is the density of the block?

- A** 2.5 g cm^{-3} **B** 4.6 g cm^{-3} **C** 5.4 g cm^{-3} **D** 10.7 g cm^{-3}

- 15** A man climbs slowly at a steady speed to the top of a ladder.

What is the **main** energy transfer taking place for the man as he climbs?

- A** chemical potential to gravitational potential
B chemical potential to kinetic
C kinetic to gravitational potential
D thermal (heat) to kinetic

- 16** During an interval of time, fuel supplies energy X to a car.

Some of this energy is converted into kinetic energy as the car accelerates.

The rest of the energy Y is lost as thermal energy.

What is the efficiency of the car?

- A** $\frac{X}{X-Y}$ **B** $\frac{Y}{X-Y}$ **C** $\frac{X-Y}{X}$ **D** $\frac{X-Y}{Y}$

- 17** A railway engine accelerates a train of total mass 800 tonnes (1 tonne = 1000 kg) from rest to a speed of 50 m s^{-1} .

How much useful work must be done on the train to reach this speed?

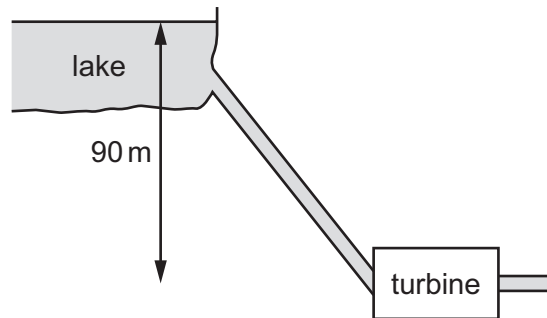
- A** $1.0 \times 10^6 \text{ J}$ **B** $2.0 \times 10^6 \text{ J}$ **C** $1.0 \times 10^9 \text{ J}$ **D** $2.0 \times 10^9 \text{ J}$

- 18** A mass is raised vertically. In time t , the increase in its gravitational potential energy is E_p and the increase in its kinetic energy is E_k .

What is the average power input to the mass?

- A** $(E_p - E_k)t$ **B** $(E_p + E_k)t$ **C** $\frac{E_p - E_k}{t}$ **D** $\frac{E_p + E_k}{t}$

- 19 Water flows from a lake into a turbine that is a vertical distance of 90 m below the lake, as shown.



The mass flow rate of the water is 2400 kg min^{-1} . The turbine has an efficiency of 75%.

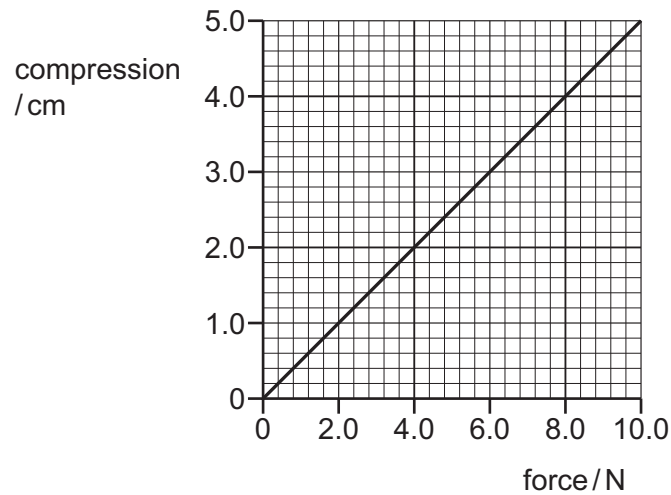
What is the output power of the turbine?

- A** 26 kW **B** 35 kW **C** 1.6 MW **D** 2.1 MW
- 20 A wire of diameter d and length l hangs vertically from a fixed point. The wire is extended by hanging a mass M on its end. The Young modulus of the wire is E . The acceleration of free fall is g .

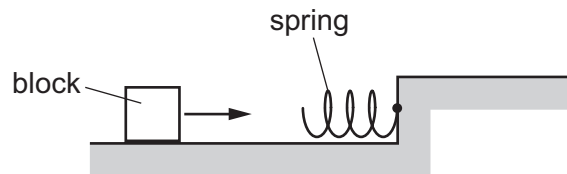
Which equation is used to determine the extension x of the wire?

- A** $x = \frac{Ml}{\pi d^2 E}$ **B** $x = \frac{Mgl}{\pi d^2 E}$ **C** $x = \frac{4Mgl}{\pi d E}$ **D** $x = \frac{4Mgl}{\pi d^2 E}$

- 21 The variation of the compression of a spring with the force applied to it is shown in the graph.



A block slides along a horizontal frictionless surface towards the spring, as shown.



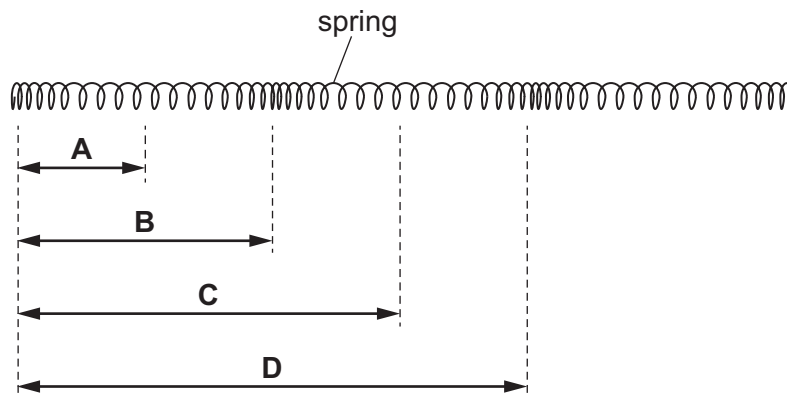
The block is brought to rest by the spring. When the spring reaches a compression of 4.0 cm, all of the kinetic energy of the block is transferred to the elastic potential energy of the spring.

What is the kinetic energy of the block when it first makes contact with the spring?

- A** 0.16 J **B** 0.32 J **C** 16 J **D** 32 J

- 22 A longitudinal wave travels through a long spring. The spring is shown at one instant.

What is the wavelength of the wave?

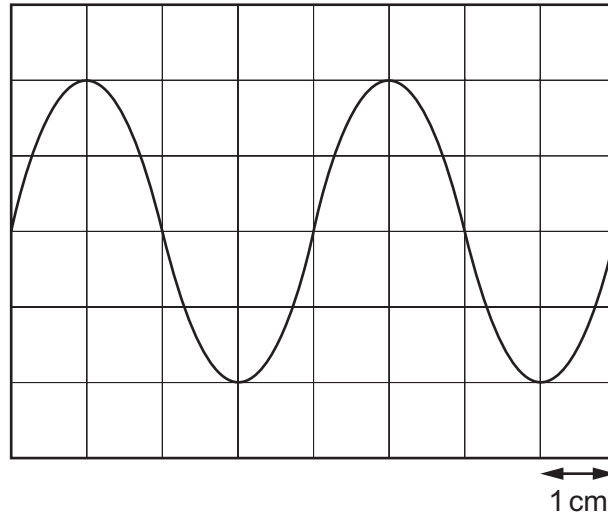


- 23** A sound wave has a frequency of 2500 Hz and a speed of 1500 ms^{-1} .

What is the shortest distance from a point of maximum pressure in the wave to a point of minimum pressure?

- A** 0.15 m **B** 0.30 m **C** 0.60 m **D** 1.20 m

- 24** A sound wave is displayed on the screen of a cathode-ray oscilloscope (c.r.o.) as shown.



The time-base of the c.r.o. is set at 2.5 ms cm^{-1} .

What is the frequency of the sound wave?

- A** 50 Hz **B** 100 Hz **C** 200 Hz **D** 400 Hz

- 25** A car travelling in a straight line at a speed of 30 ms^{-1} passes near a stationary observer while sounding its horn. The true frequency of sound from the horn is 400 Hz .

The speed of sound in air is 336 ms^{-1} .

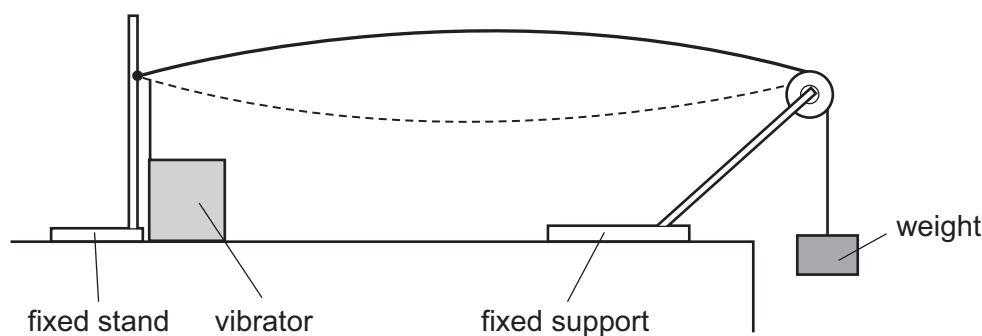
What is the change in the frequency of the sound heard by the observer as the car passes?

- A** 39 Hz **B** 66 Hz **C** 72 Hz **D** 78 Hz

- 26** Which list shows electromagnetic waves in order of increasing frequency?

- A** radio waves $\rightarrow$ gamma rays $\rightarrow$ ultraviolet $\rightarrow$ infra-red
B radio waves $\rightarrow$ infra-red $\rightarrow$ ultraviolet $\rightarrow$ gamma rays
C ultraviolet $\rightarrow$ gamma rays $\rightarrow$ radio waves $\rightarrow$ infra-red
D ultraviolet $\rightarrow$ infra-red $\rightarrow$ radio waves $\rightarrow$ gamma rays

- 27 The diagram shows a steel wire clamped at one end. The other end is attached to a weight hanging over a pulley.

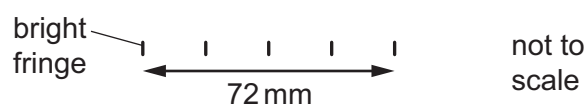


A vibrator is attached to the wire near the clamped end. A stationary wave with one loop is produced. The frequency of the vibrator is f .

Which frequency should be used to produce a stationary wave with two loops?

- A** $\frac{f}{4}$ **B** $\frac{f}{2}$ **C** $2f$ **D** $4f$
- 28 A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating. The grating has 300 lines per millimetre.
- What is the total number of intensity maxima from the grating?
- A** 1 **B** 3 **C** 11 **D** 13
- 29 A pattern of interference fringes is produced using a red laser, a double slit and a screen. The screen is 3.5 m from the double slit. The light from the laser has a wavelength of 640 nm.

The pattern of fringes is shown.

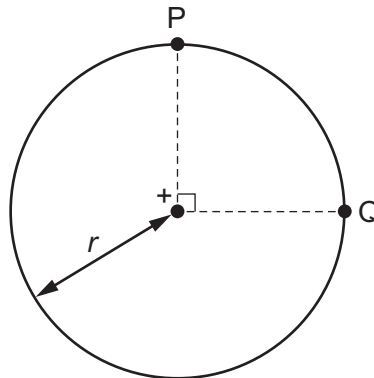


What is the separation of the slits?

- A** $1.2 \times 10^{-4} \text{ m}$ **B** $1.6 \times 10^{-4} \text{ m}$ **C** $3.1 \times 10^{-5} \text{ m}$ **D** $3.3 \times 10^{-9} \text{ m}$

- 30 The diagram shows two points P and Q which lie 90° apart on a circle of radius r .

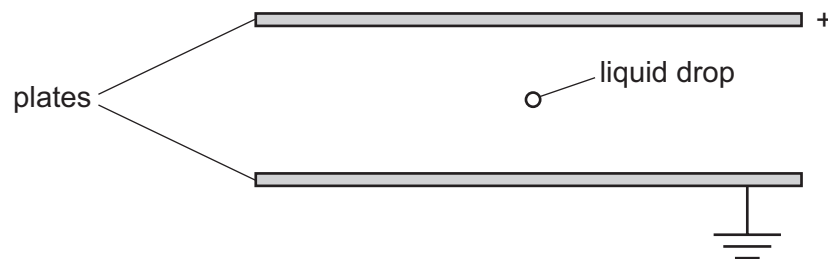
A positive point charge at the centre of the circle creates an electric field of magnitude E at both P and Q.



Which expression gives the work done in moving a unit positive charge from P to Q?

- A** 0 **B** $E \times r$ **C** $E \times \left(\frac{\pi r}{2}\right)$ **D** $E \times (\pi r)$

- 31 The diagram shows two parallel horizontal metal plates. The top plate is positively charged and the bottom plate is earthed.



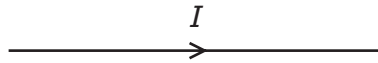
A small charged liquid drop, midway between the plates, is held in equilibrium by the combination of its weight and the electric force acting on it.

The acceleration of free fall is g and the electric field strength is E .

What is the polarity of the charge on the drop, and the ratio of charge to mass of the drop?

	polarity	$\frac{\text{charge}}{\text{mass}}$
A	negative	$\frac{E}{g}$
B	negative	$\frac{g}{E}$
C	positive	$\frac{E}{g}$
D	positive	$\frac{g}{E}$

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

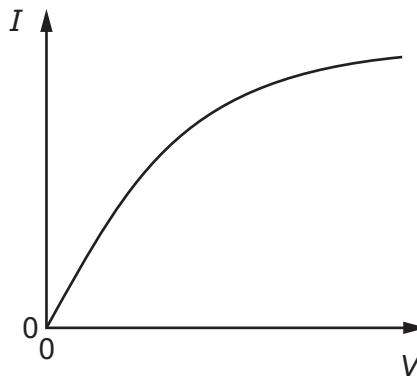


What does this current represent?

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

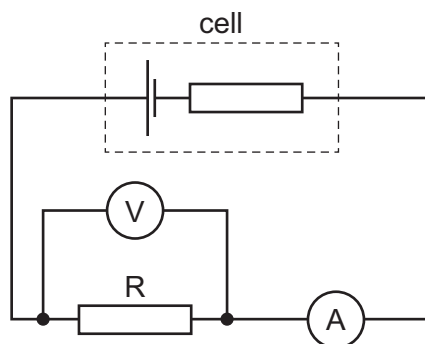
	current / A	resistance / Ω
A	1	4
B	2	8
C	4	1
D	16	1

- 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

- 35 The circuit shown includes a cell of constant internal resistance and an external resistor R.



A student records the ammeter and voltmeter readings. She then connects a second identical external resistor in parallel with the first external resistor.

What happens to the ammeter reading and to the voltmeter reading?

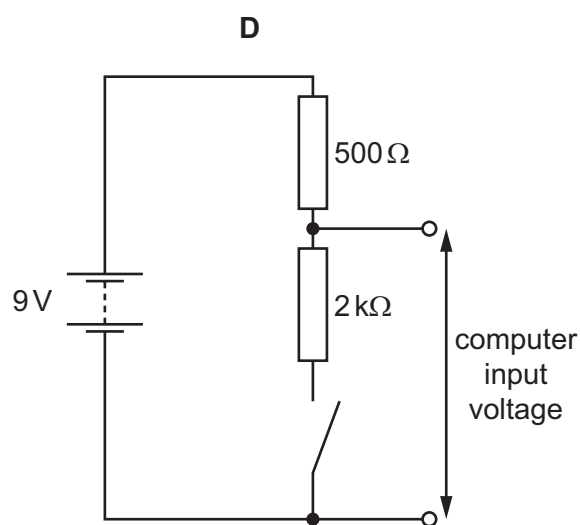
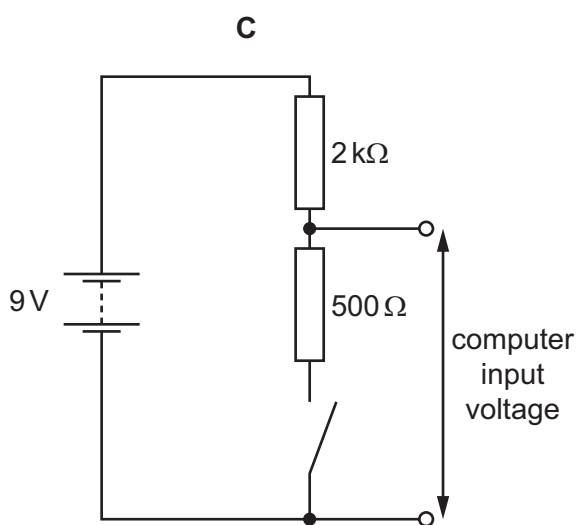
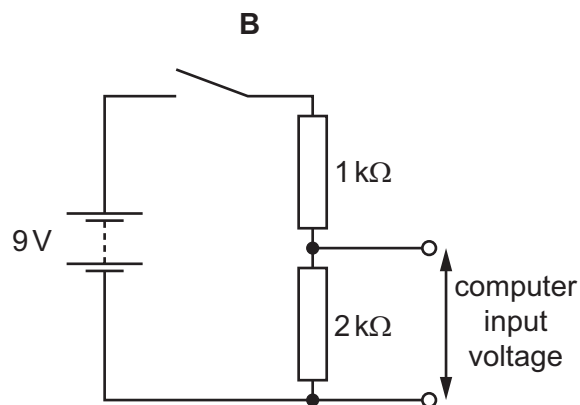
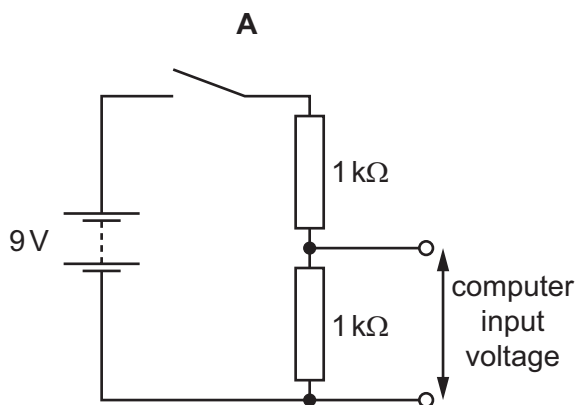
	ammeter reading	voltmeter reading
A	decreases	decreases
B	decreases	stays the same
C	increases	decreases
D	increases	stays the same

36 A computer is used to detect the change of position of a switch.

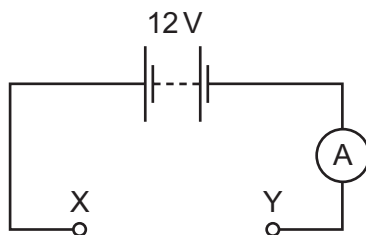
To detect the change of position, the computer requires a potential difference (p.d.) of 0 V to its input at one switch position and a p.d. of between 5 V and 7 V at the other switch position.

For each of the circuits, assume the battery has negligible internal resistance.

Which circuit provides an input voltage to the computer that enables it to detect the change of position of the switch?

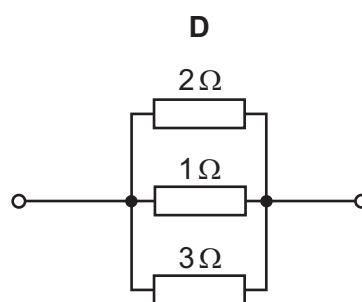
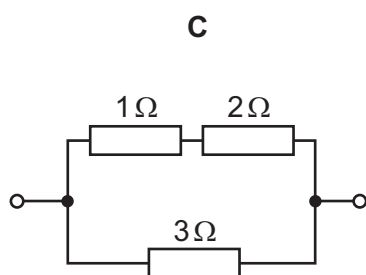
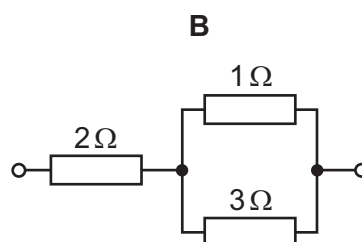
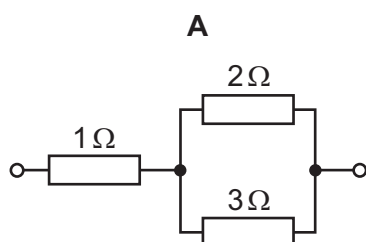


37 In the circuit shown, the battery and ammeter have negligible resistance.



The following combinations of resistors are each separately placed between the terminals X and Y of the circuit.

Which combination would give an ammeter reading of 8 A?



- 38** The table lists the nucleon number and the proton number of various nuclei. The nuclei are represented by the letters L to T.

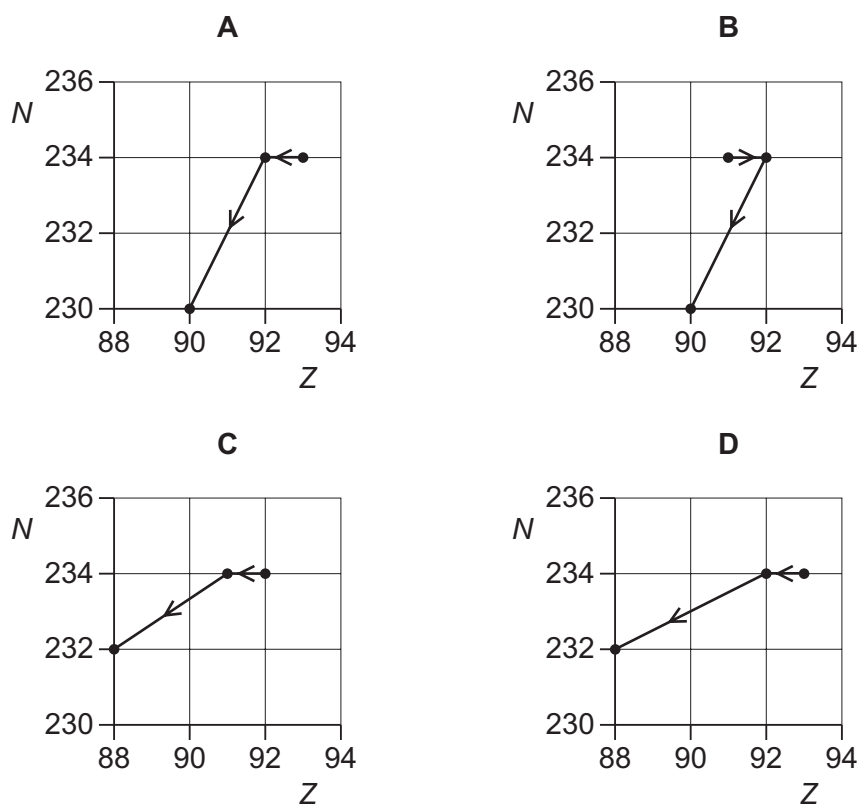
nucleus	nucleon number	proton number
L	227	89
M	226	89
N	225	89
O	227	90
P	226	90
Q	225	90
R	227	91
S	226	91
T	225	91

Which row in the following table correctly shows three nuclei of the same element, and three nuclei that have the same number of neutrons?

	same element	same number of neutrons
A	L M N	R P N
B	M P S	R S T
C	O P Q	M P S
D	R P N	O P Q

39 A radioactive nucleus is formed by β^- decay. This nucleus then decays by α -emission.

Which graph of nucleon number N plotted against proton number Z shows the β^- decay followed by the α -emission?



40 What are the structures of the proton and of the neutron in terms of quarks?

	proton		neutron	
	up quark	down quark	up quark	down quark
A	1	1	2	2
B	1	2	2	1
C	2	1	1	2
D	2	2	1	1

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May/June 2017

1 hour 15 minutes

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permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$

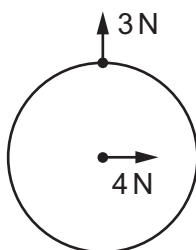
Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
gravitational potential	$\phi = -\frac{Gm}{r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

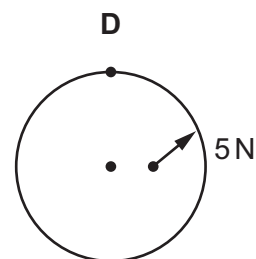
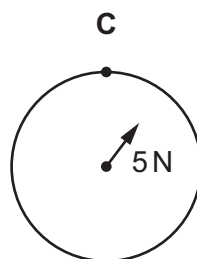
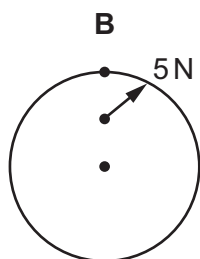
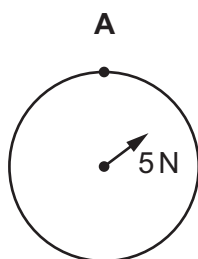
- 1 What is the approximate average speed of a winning female Olympic athlete running a 100 m race?

A 6 m s^{-1} B 9 m s^{-1} C 12 m s^{-1} D 15 m s^{-1}

- 2 Two forces act on a circular disc as shown.



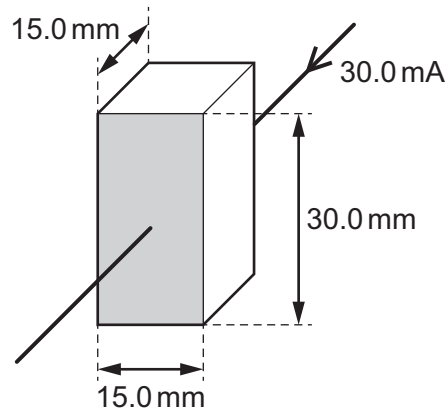
Which diagram shows the line of action of the resultant force?



- 3 What correctly expresses the volt in terms of SI base units?

A $\text{A } \Omega$
 B W A^{-1}
 C $\text{kg m}^2 \text{s}^{-1} \text{A}^{-1}$
 D $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$

- 4 The current in a block of semiconductor is 30.0 mA when there is a potential difference (p.d.) of 10.0 V across it. The dimensions of the block and the direction of the current in it are as shown.

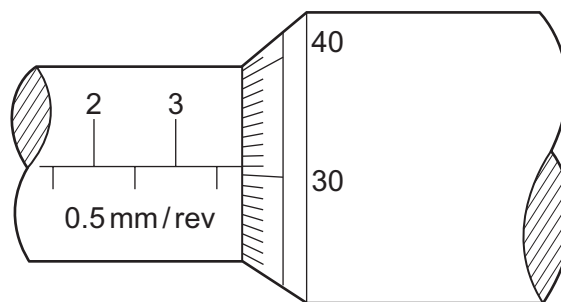


The electrical meters used are accurate to ± 0.1 mA and ± 0.1 V. The dimensions of the block are accurate to ± 0.2 mm.

What is the resistivity of the semiconductor?

- A** $10.0 \pm 0.2 \Omega \text{ m}$
B $10.0 \pm 0.3 \Omega \text{ m}$
C $10.0 \pm 0.5 \Omega \text{ m}$
D $10.0 \pm 0.8 \Omega \text{ m}$
- 5 The diameter of a cylindrical metal rod is measured using a micrometer screw gauge.

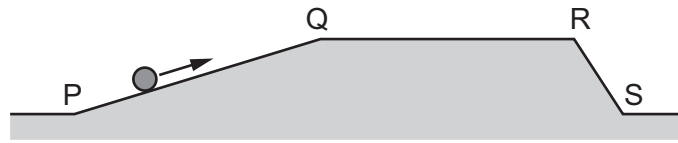
The diagram below shows an enlargement of the scale on the micrometer screw gauge when taking the measurement.



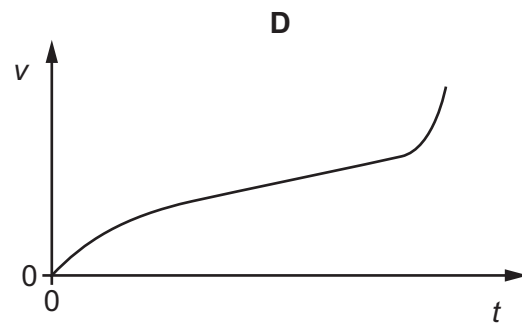
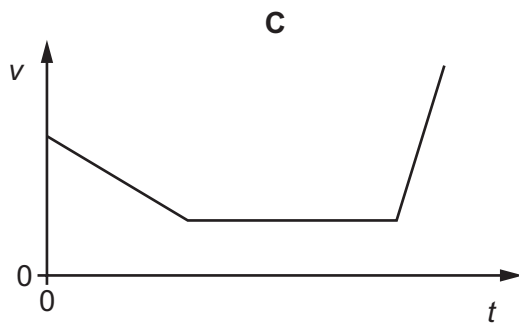
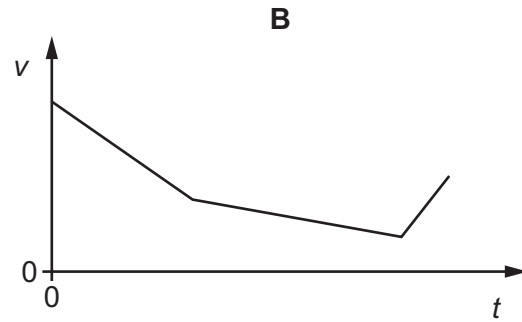
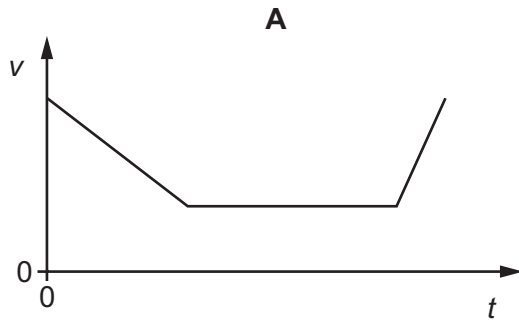
What is the cross-sectional area of the rod?

- A** 3.81 mm^2 **B** 11.4 mm^2 **C** 22.8 mm^2 **D** 45.6 mm^2

- 6 A ball is set in motion at P on a frictionless surface. It moves up slope PQ, along the horizontal surface QR and finally descends slope RS.

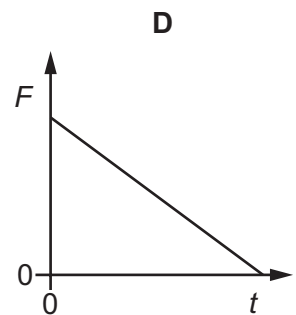
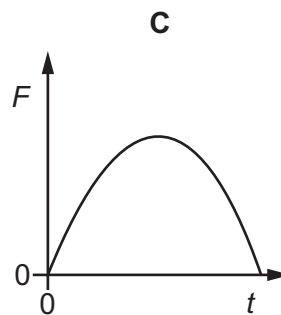
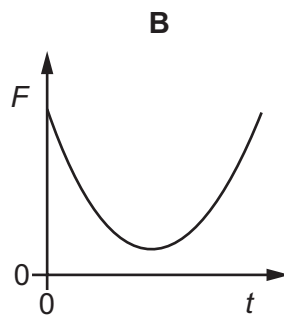
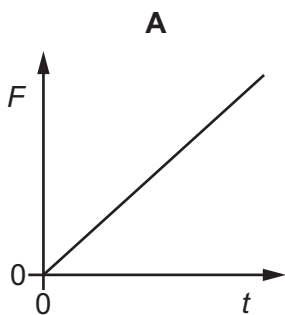


Which graph could represent the variation with time t of the ball's speed v as the ball moves from P to S?



- 7 A rubber ball is dropped onto a table and bounces back up. The table exerts a force F on the ball.

Which graph best shows the variation with time t of the force F for the short time that the ball is in contact with the table?

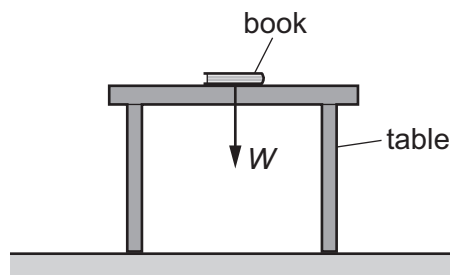


- 8 A golf ball of mass m is dropped onto a hard surface from a height h_1 and rebounds to a height h_2 .

The momentum of the golf ball just as it reaches the surface is different from its momentum just as it leaves the surface.

What is the total change in the momentum of the golf ball between these two instants? (Ignore air resistance.)

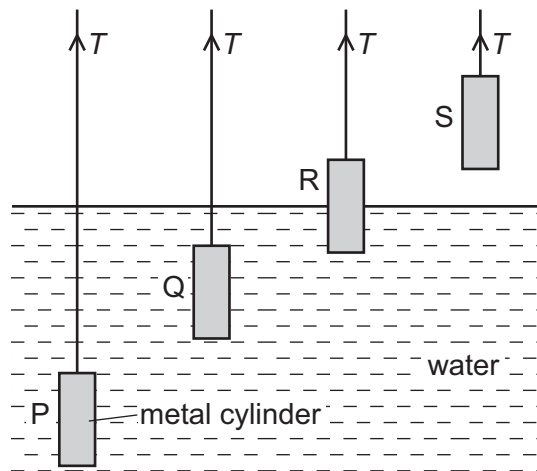
- A $m\sqrt{2gh_1} - m\sqrt{2gh_2}$
- B $m\sqrt{2gh_1} + m\sqrt{2gh_2}$
- C $m\sqrt{2g(h_1 - h_2)}$
- D $m\sqrt{2g(h_1 + h_2)}$
- 9 A book of weight W is at rest on a table. A student attempts to state Newton's third law of motion by saying that 'action equals reaction'.



If the weight of the book is the 'action' force, what is the 'reaction' force?

- A the force W acting downwards on the Earth from the table
- B the force W acting upwards on the book from the table
- C the force W acting upwards on the Earth from the book
- D the force W acting upwards on the table from the floor

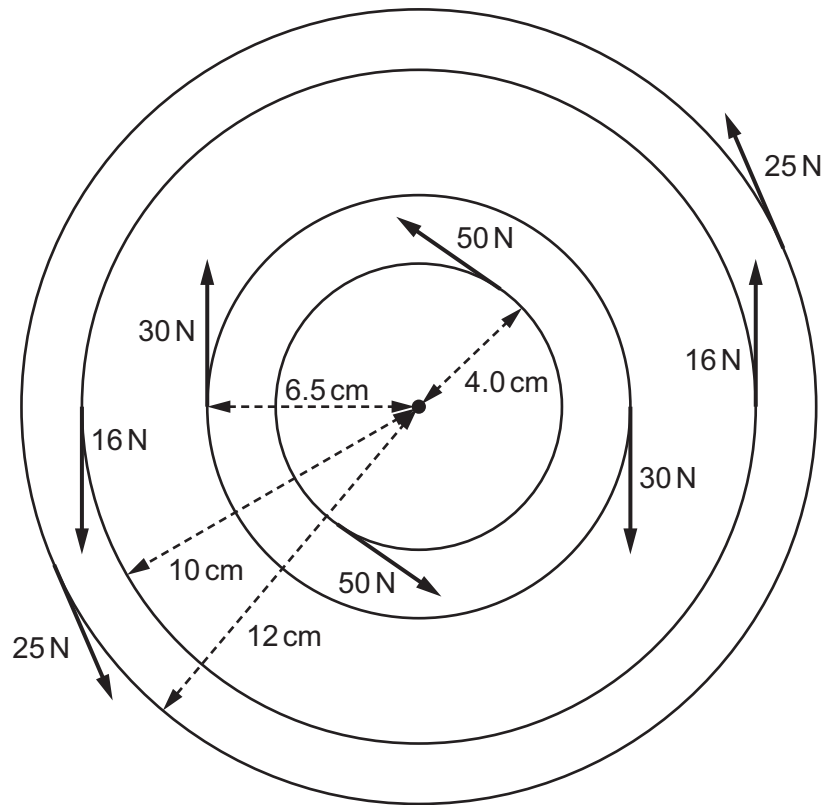
- 10 A metal cylinder is suspended vertically in equilibrium by a cord. The diagram shows the cylinder in four different positions P, Q, R and S.



Which statement explains the variation of the tension T in the cord?

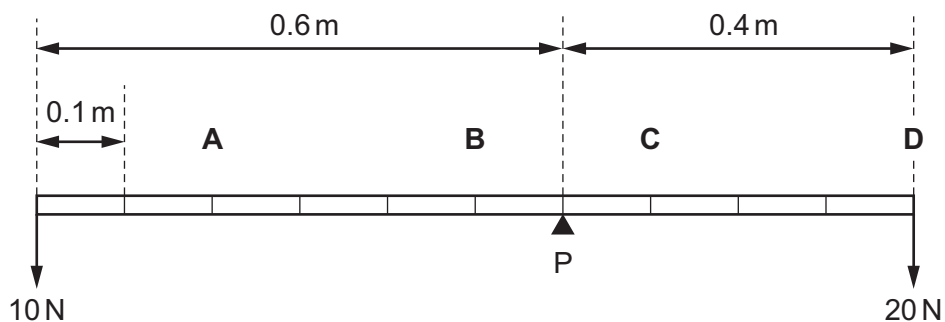
- A** At P and at Q, the tension T in the cord is the same because the difference in pressure between the top and bottom of the cylinder is the same.
- B** At Q, the tension T in the cord is less than at P because, at smaller depth, liquid pressure is smaller.
- C** At R, the tension T in the cord is less than at P because atmospheric pressure is less than water pressure.
- D** At S, the tension T in the cord is greater than at P because atmospheric pressure at S exerts no force on the top or bottom of the cylinder.

- 11 In a machine, many couples act on a rotating object as shown.



What is the resultant torque acting on the rotating object?

- A 4.7 Nm B 8.6 Nm C 9.3 Nm D 17.1 Nm
- 12 A uniform beam is pivoted at P as shown. Weights of 10 N and 20 N are attached to its ends. The length of the beam is marked at 0.1 m intervals. The weight of the beam is 100 N. At which point should a further weight of 20 N be attached to achieve equilibrium?



- 13 What are the SI base units of the quantity $\frac{\text{pressure}}{\text{density}}$?

- A s^{-2} B $\text{kg}^2 \text{s}^{-2}$ C $\text{kg}^2 \text{m}^2 \text{s}^{-2}$ D $\text{m}^2 \text{s}^{-2}$

14 Which quantities are conserved in an inelastic collision?

	kinetic energy	total energy	linear momentum
A	conserved	not conserved	conserved
B	conserved	not conserved	not conserved
C	not conserved	conserved	conserved
D	not conserved	conserved	not conserved

15 A cyclist is travelling at a constant speed up a hill. The frictional force resisting the cyclist's motion is 8.0 N.

The cyclist uses 450 J of energy to travel a distance of 20 m.

What is the increase in the gravitational potential energy of the cyclist?

- A** 160 J **B** 290 J **C** 440 J **D** 610 J

16 A stone of mass m falls from rest at the top of a cliff of height h into the sea below. Just before hitting the sea the stone has speed v .

What is the average force of air resistance acting on the stone during its fall?

- A** mg **B** $\frac{m(v^2 - 2gh)}{h}$ **C** $m\left(g - \frac{v^2}{2h}\right)$ **D** $m\left(gh - \frac{v^2}{2}\right)$

17 A railway engine accelerates a train of total mass 1200 tonnes (1 tonne = 1000 kg) from rest to a speed of 75 m s^{-1} .

How much useful work must be done on the train to reach this speed?

- A** $3.4 \times 10^6 \text{ J}$ **B** $6.8 \times 10^6 \text{ J}$ **C** $3.4 \times 10^9 \text{ J}$ **D** $6.8 \times 10^9 \text{ J}$

18 What is a correct derivation of the equation relating power, force and velocity?

A power = $\frac{\text{work done}}{\text{time taken}}$ and work done = force $\times$ displacement

so power = $\frac{\text{force} \times \text{displacement}}{\text{time taken}}$

so power = force $\times$ velocity

B power = $\frac{\text{work done}}{\text{time taken}}$ and work done = force $\times$ distance

so power = $\frac{\text{force} \times \text{distance}}{\text{time taken}}$

so power = force $\times$ velocity

C power = $\frac{\text{work done}}{\text{time taken}}$ and work done = $\frac{\text{force}}{\text{displacement}}$

so power = $\frac{\text{force}}{\text{displacement}} \times \text{time taken}$

so power = $\frac{\text{force}}{\text{velocity}}$

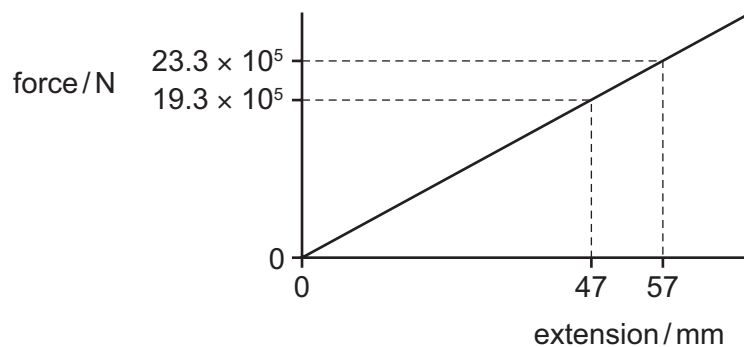
D power = $\frac{\text{work done}}{\text{time taken}}$ and work done = $\frac{\text{force}}{\text{distance}}$

so power = $\frac{\text{force}}{\text{distance}} \times \text{time taken}$

so power = $\frac{\text{force}}{\text{velocity}}$

19 A cable on a suspension bridge supports a weight of $19.3 \times 10^5 \text{ N}$. This weight causes the cable to stretch by 47 mm.

A lorry crossing the bridge then increases the force on the cable to $23.3 \times 10^5 \text{ N}$. The force-extension graph for the cable is shown.



What is the **increase** in strain energy in the cable when the lorry is crossing the bridge?

A 21 kJ

B 23 kJ

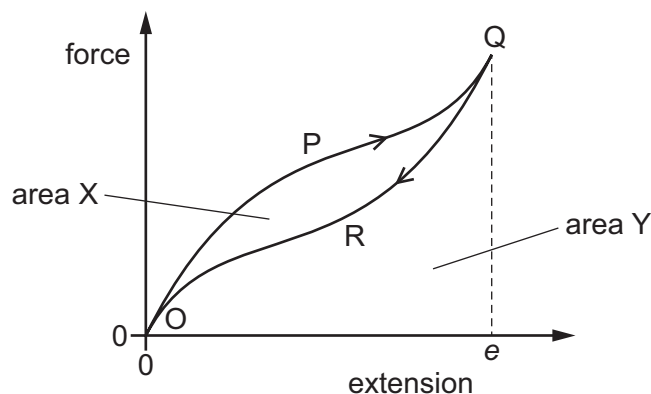
C 45 kJ

D 66 kJ

20 What are the units of stress, strain and the Young modulus?

	stress	strain	Young modulus
A	newton	metre	pascal
B	newton	no unit	newton
C	pascal	metre	newton
D	pascal	no unit	pascal

21 A rubber band is stretched and then relaxed to its original length. The diagram shows the force-extension graph for this process.



As the force is increased, the curve follows the path OPQ to extension e . As the force is reduced, the curve follows the path QRO to return to zero extension.

The area labelled X is between the curves OPQ and QRO. The area labelled Y is bounded by the curve QRO and the horizontal axis.

Which statement about the process is correct?

- A** Area X is the energy which heats the band as it is stretched to extension e .
- B** (Area X + area Y) is the minimum energy required to stretch the band to extension e .
- C** Area X is the elastic potential energy stored in the band when it is stretched to extension e .
- D** (Area Y – area X) is the net work done on the band during the process.

- 22 The period of an electromagnetic wave is 1.0 ns.

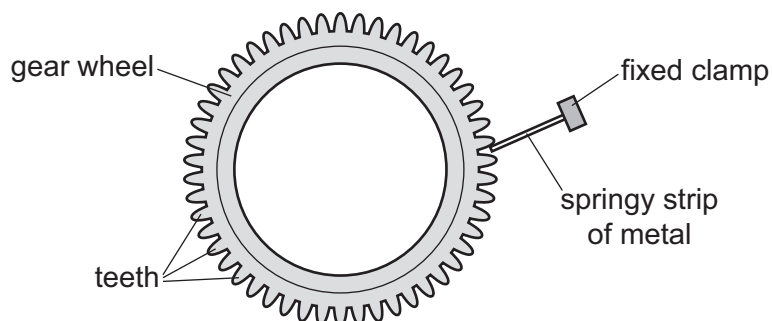
What are the frequency and wavelength of the wave?

	frequency / Hz	wavelength / m
A	1.0	3.0×10^8
B	1.0×10^6	300
C	1.0×10^9	0.30
D	1.0×10^{12}	3.0×10^{-4}

- 23 Which statement about progressive longitudinal waves is **not** correct?

- A** The oscillations of the particles are parallel to the direction of travel of the wave energy.
- B** They have a series of nodes and antinodes.
- C** They need a medium through which to travel.
- D** They transfer energy.

- 24 A bicycle gear wheel is a disc with 50 'teeth' equally spaced around its edge, as shown. The gear wheel is rotated 10 times each second. A springy strip of metal is vibrated by the rotating 'teeth'. The metal strip produces a sound of frequency that is equal to the frequency of vibration of the strip.



The speed of sound in air is 330 m s^{-1} .

What is the wavelength of the emitted sound?

- A** 0.66 m **B** 1.5 m **C** 6.6 m **D** 500 m

- 25** An ambulance travels along a straight road at a speed of 30.0 m s^{-1} . Its siren emits sound of frequency 2000 Hz . The speed of sound in the air is 340 m s^{-1} . The ambulance passes a man standing at the side of the road.

What is the frequency of the sound heard by the man as the ambulance moves towards him and as the ambulance moves away from him?

	frequency heard as ambulance moves towards man / Hz	frequency heard as ambulance moves away from man / Hz
A	1820	2180
B	1840	2190
C	2180	1820
D	2190	1840

- 26** Three different electromagnetic waves P, Q and R have the frequencies shown.

	frequency / Hz
P	3×10^{10}
Q	3×10^{13}
R	6×10^{14}

Which row identifies P, Q and R?

	P	Q	R
A	infra-red	visible	ultraviolet
B	microwave	infra-red	visible
C	ultraviolet	X-ray	gamma ray
D	visible	ultraviolet	X-ray

- 27** Which row describes the oscillations of two moving particles in a stationary wave that are separated by a distance of half a wavelength?

	phase difference	amplitude
A	90°	different
B	90°	same
C	180°	different
D	180°	same

- 28 A parallel beam of red light of wavelength 700 nm is incident normally on a diffraction grating that has 400 lines per millimetre.

What is the total number of intensity maxima from the grating?

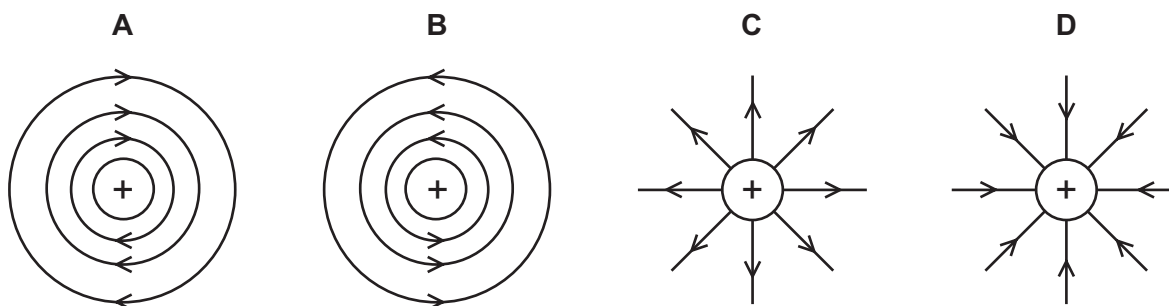
- A 6 B 7 C 8 D 9

- 29 Two wave sources are oscillating in phase. Each source produces a wave of wavelength λ . The two waves from the sources meet at point X with a phase difference of 90° .

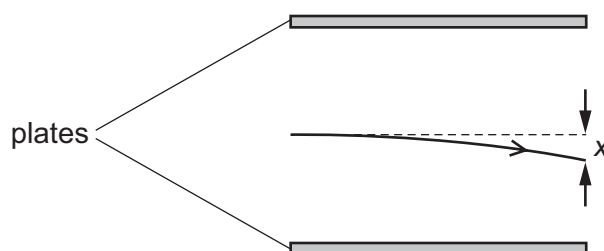
What is a possible difference in the distances from the two wave sources to point X?

- A $\frac{\lambda}{8}$ B $\frac{\lambda}{4}$ C $\frac{\lambda}{2}$ D λ

- 30 Which diagram best illustrates the electric field around a positive point charge?



- 31 The path of an electron with initial speed v in the uniform electric field between two parallel plates is shown.



The vertical deflection x is measured at the right-hand edge of the plates.

The distance between the plates is halved. The potential difference between the plates remains the same.

What will be the new deflection of the electron with the same initial speed v ?

- A x B $\sqrt{2}x$ C $2x$ D $4x$

- 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}

- 33** 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.

What is the resistance of the filament at room temperature?

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

- 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

- 35** A cell has a constant electromotive force.

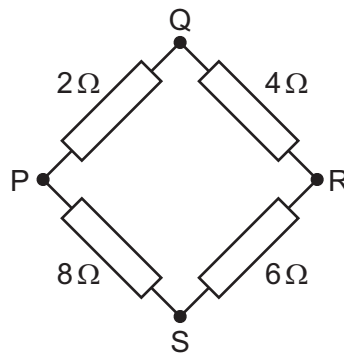
A variable resistor is connected between the terminals of the cell.

The resistance of the variable resistor is decreased.

Which statement about the change of the cell's terminal potential difference (p.d.) is correct?

- A** The terminal p.d. is decreased because more work is done moving unit charge through the internal resistance of the cell.
- B** The terminal p.d. is decreased because the current in the variable resistor is decreased.
- C** The terminal p.d. is increased because more work is done moving unit charge through the variable resistor.
- D** The terminal p.d. is increased because the current in the variable resistor is increased.

36 Four resistors are connected in a square as shown.

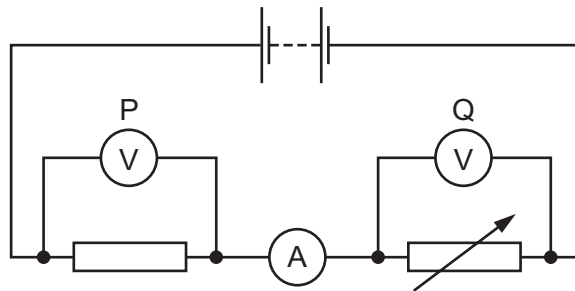


The resistance may be measured between any two junctions.

Between which two junctions is the measured resistance greatest?

- A** P and Q **B** Q and S **C** R and S **D** S and P

37 A circuit is set up as shown.



The variable resistor is adjusted so that the ammeter reading decreases.

How do the readings of the voltmeters change?

	reading on voltmeter P	reading on voltmeter Q
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 38** In a television programme to illustrate scientific models, a presenter fires a gun many times at a bale of hay. Two small cannon balls are embedded within the hay some distance apart from each other.

The hay bale measures approximately $2\text{ m} \times 2\text{ m} \times 2\text{ m}$ and the cannon balls are made of iron, approximately spherical, and about 5 cm in diameter.

What might the presenter be illustrating?

- A** α -particle scattering
- B** β^- decay
- C** conservation of momentum
- D** double-slit interference

- 39** A certain nuclide, uranium-235, has nucleon number 235, proton number 92 and neutron number 143. Data on four other nuclides are given below.

Which nuclide is an isotope of uranium-235?

	nucleon number	proton number	neutron number
A	235	91	144
B	236	92	144
C	237	94	143
D	238	95	143

- 40** During β^- decay, which change takes place to the quark composition of the nucleus that emits the β^- particle, and which other particle is emitted?

	quark change	other particle emitted
A	down to up	antineutrino
B	down to up	neutrino
C	up to down	antineutrino
D	up to down	neutrino

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PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 2017

1 hour 15 minutes

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.

DO NOT WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any working should be done in this booklet.

Electronic calculators may be used.

This document consists of **19** printed pages and **1** blank page.

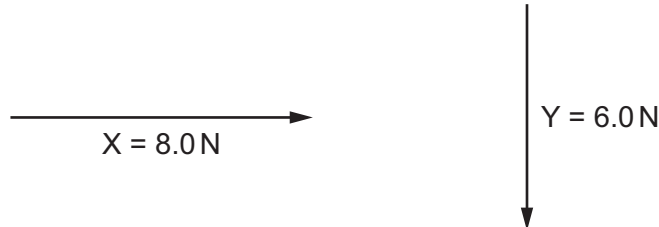
Data

speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
the Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
the Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
the Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
work done on/by a gas	$W = p\Delta V$
gravitational potential	$\phi = -\frac{Gm}{r}$
hydrostatic pressure	$p = \rho gh$
pressure of an ideal gas	$p = \frac{1}{3} \frac{Nm}{V} \langle c^2 \rangle$
simple harmonic motion	$a = -\omega^2 x$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$ $v = \pm \omega \sqrt{(x_0^2 - x^2)}$
Doppler effect	$f_o = \frac{f_s v}{v \pm v_s}$
electric potential	$V = \frac{Q}{4\pi\epsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \dots$
capacitors in parallel	$C = C_1 + C_2 + \dots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \dots$
Hall voltage	$V_H = \frac{BI}{ntq}$
alternating current/voltage	$x = x_0 \sin \omega t$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

- 1 What is the best estimate of the kinetic energy of a family car travelling at 50 km h^{-1} ?
- A** $1.5 \times 10^3 \text{ J}$ **B** $1.5 \times 10^5 \text{ J}$ **C** $1.5 \times 10^7 \text{ J}$ **D** $1.5 \times 10^9 \text{ J}$
- 2 The diagram shows two vectors X and Y. The vectors are perpendicular to one another.



What is the magnitude and direction of vector $(X - Y)$?

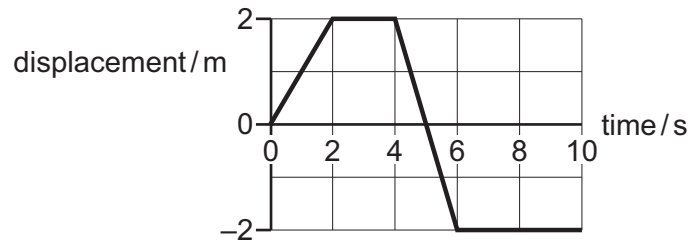
- A** 10.0 N at an angle of 37° downwards from the direction of X
- B** 10.0 N at an angle of 37° upwards from the direction of X
- C** 14.0 N at an angle of 53° downwards from the direction of X
- D** 14.0 N at an angle of 53° upwards from the direction of X
- 3 Which expression using SI base units is equivalent to the volt?
- A** $\text{kg m}^2 \text{s}^{-1} \text{A}^{-1}$
- B** $\text{kg m s}^{-2} \text{A}$
- C** $\text{kg m}^2 \text{s}^{-1} \text{A}$
- D** $\text{kg m}^2 \text{s}^{-3} \text{A}^{-1}$
- 4 A voltage is carefully measured with a high-quality instrument and found to be 2.321 V .
Two students, using two different methods, conclude that the voltage is 2.33 V and 2.344 V respectively.
Which statement is correct?
- A** 2.33 V is less accurate and less precise than 2.344 V .
- B** 2.33 V is less accurate and more precise than 2.344 V .
- C** 2.33 V is more accurate and less precise than 2.344 V .
- D** 2.33 V is more accurate and more precise than 2.344 V .

- 5 On a planet, a vertically-launched projectile takes 12.5 s to return to its starting position. The projectile gains a maximum height of 170 m. The planet does not have an atmosphere.

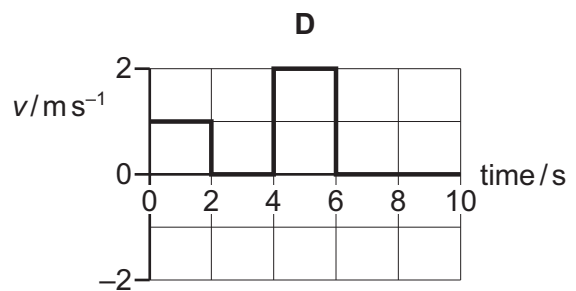
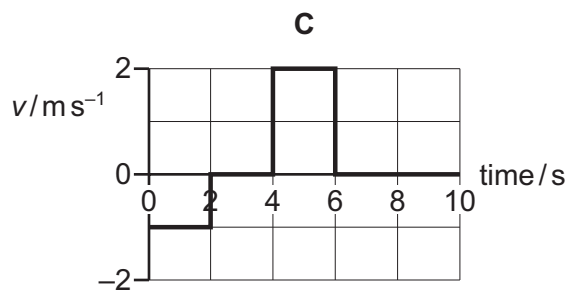
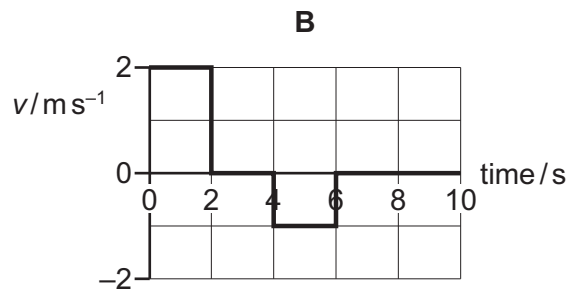
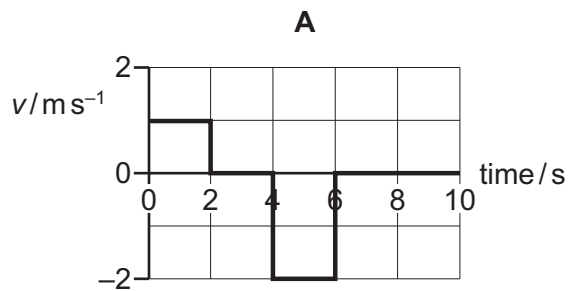
What is the acceleration of free fall on this planet?

- A 2.2 ms^{-2} B 8.7 ms^{-2} C 27 ms^{-2} D 54 ms^{-2}

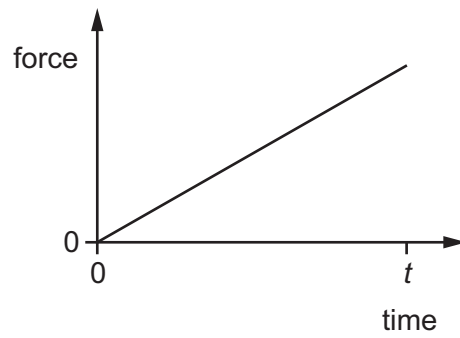
- 6 A displacement-time graph for a toy car is shown.



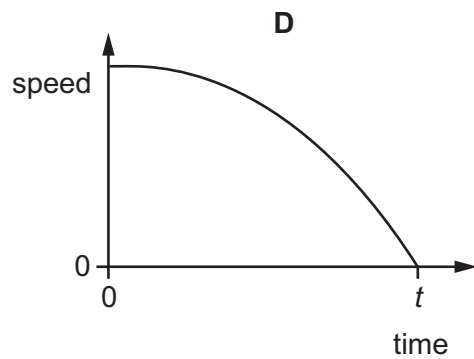
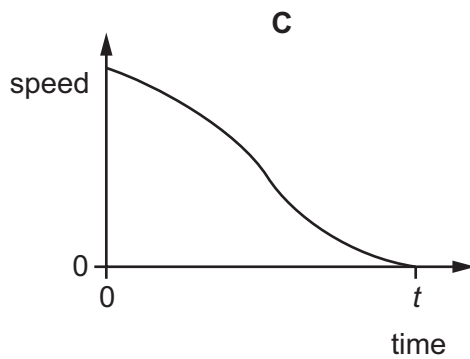
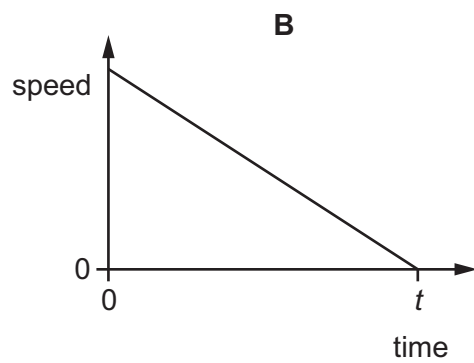
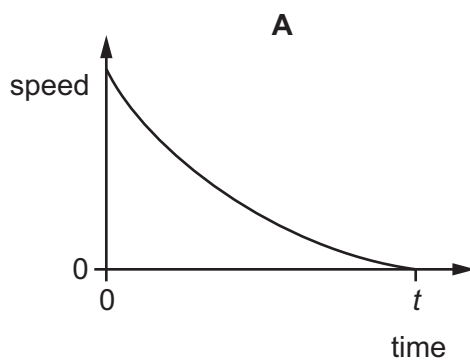
Which graph shows the variation with time of the velocity v of the car?



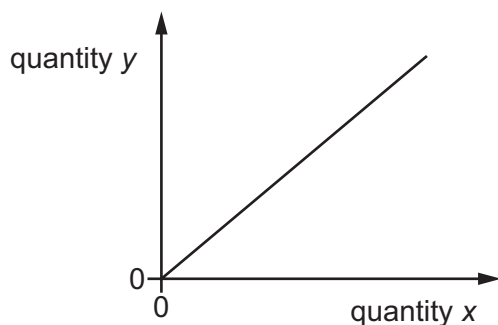
- 7 A driver stops his car in time t by gradually increasing the total braking force on the car. The graph shows the resultant force on the car.



Which graph shows how the speed of the car will vary during this time?



- 8 The graph shows the variation of a quantity y with a quantity x for a body that is falling in air at constant (terminal) velocity in a uniform gravitational field.



Which quantities could x and y represent?

	x	y
A	air resistance	acceleration
B	loss of height	gain in kinetic energy
C	loss of potential energy	work done against air resistance
D	time	velocity

- 9 A ball of mass 2.0 kg travels horizontally with a speed of 4.0 m s^{-1} . The ball collides with a wall and rebounds in the opposite direction with a speed of 2.8 m s^{-1} . The time of the collision is 150 ms .

What is the average force exerted on the wall?

- A** 16 N **B** 37 N **C** 53 N **D** 91 N

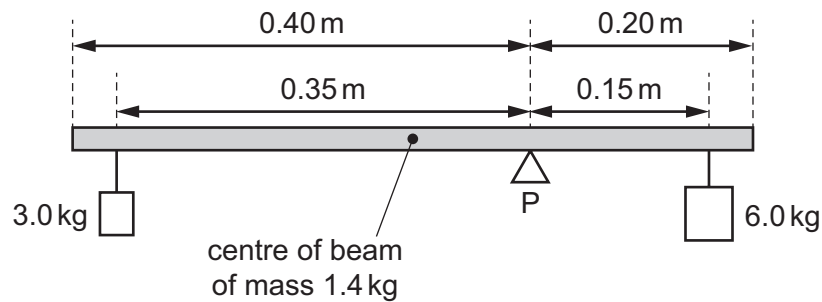
- 10 An ice-hockey puck of mass 150 g moves with an initial speed of 2.0 m s^{-1} along the surface of an ice rink.

The puck slides a distance of 30 m in a straight line before stopping.

What is the average frictional force acting on the puck?

- A** 0.010 N **B** 0.020 N **C** 0.067 N **D** 0.44 N

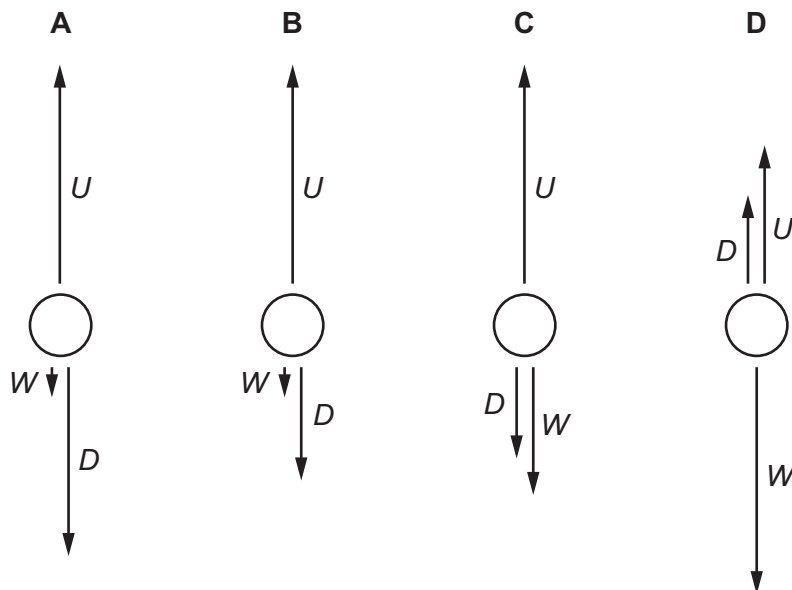
- 11 A uniform beam of mass 1.4 kg is pivoted at P as shown. The beam has a length of 0.60 m and P is 0.20 m from one end. Loads of 3.0 kg and 6.0 kg are suspended 0.35 m and 0.15 m from the pivot as shown.



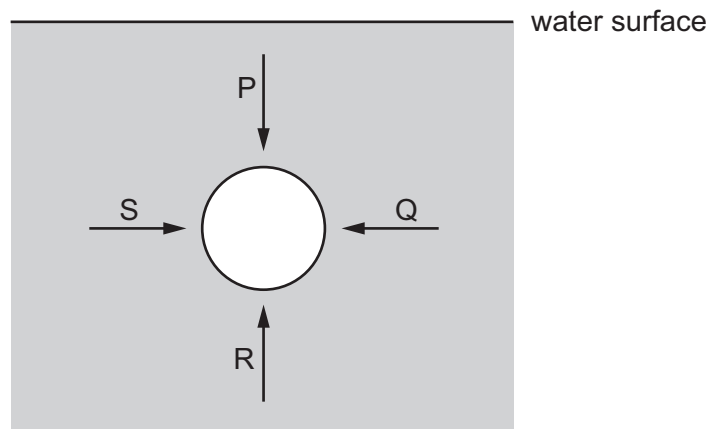
What is the torque that must be applied to the beam in order to maintain it in equilibrium?

- A 0.010 Nm B 0.10 Nm C 0.29 Nm D 2.8 Nm
- 12 An air bubble is rising through a liquid at a constant speed. The forces on it are the upthrust U , the viscous drag D and its weight W .

Which diagram shows the directions and relative sizes of the forces?



- 13 The diagram represents a sphere under water. P, Q, R and S are forces acting on the sphere due to the pressure of the water.



Each force acts perpendicularly to the sphere's surface. P and R act in opposite directions vertically. Q and S act in opposite directions horizontally.

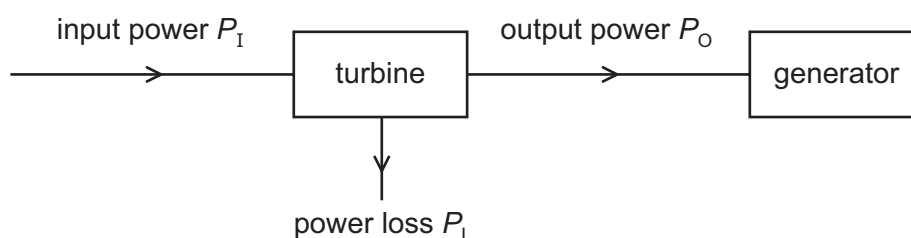
Which information about the magnitudes of the forces is correct?

- A $P < R$ and $S = Q$
- B $P > R$ and $S = Q$
- C $P = R$ and $S = Q$ and $P < S$
- D $P = R$ and $S = Q$ and $P = S$
- 14 The first column in the table gives four examples of work being done. The second column gives more detail of the action.

Which row is **not** correct?

	example	detail
A	a girl dives from a diving board into a swimming pool	work is done by the girl against the gravitational field as she falls
B	a man pushes a car along a level road	work is done by the man against friction
C	an electron is accelerated towards a positively charged plate	work is done on the electron by the electric field of the plate
D	a piston is pushed outwards as a gas expands	work is done on the atmosphere by the gas

- 15 A steam turbine is used to drive a generator. The input power to the turbine is P_I and the output power is P_O . The power loss in the turbine is P_L , as shown below.



What is the efficiency of the turbine?

- A $\frac{P_L}{P_O}$ B $\frac{P_I}{P_O}$ C $\frac{P_L}{P_I}$ D $\frac{P_O}{P_I}$
- 16 A constant force pushes a block along a horizontal frictionless surface. The block moves from rest through a fixed distance.

What is the relationship between the final speed v of the block and its mass m ?

- A $\sqrt{v} \propto \frac{1}{m}$ B $v \propto \sqrt{m}$ C $v \propto \frac{1}{\sqrt{m}}$ D $\sqrt{v} \propto m$
- 17 A man has a mass of 80 kg. He ties himself to one end of a rope which passes over a single fixed pulley. He pulls on the other end of the rope to lift himself up at an average speed of 50 cm s^{-1} .

What is the average useful power at which he is working?

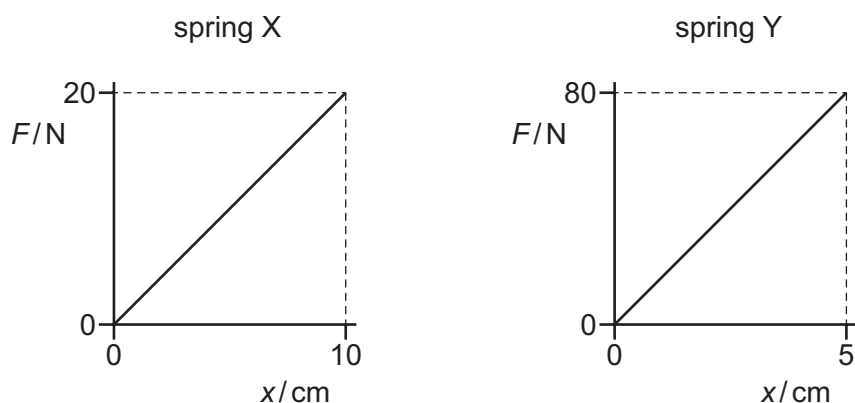
- A 40 W B 0.39 kW C 4.0 kW D 39 kW
- 18 Two wires with the same Young modulus E and cross-sectional area A , but different lengths L , are subject to different tensile forces F . The extension e of each wire is the same.

The column headings in the table show four different quantities.

Which quantities have the same value and which quantities have different values for the two wires?

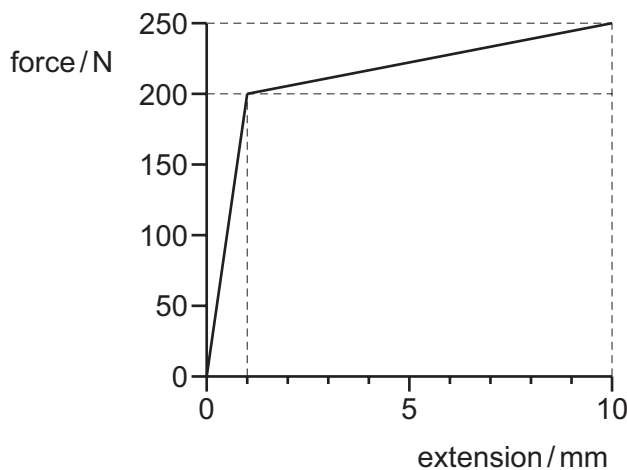
	$\frac{FL}{e}$	$\frac{Ae}{L}$	$\frac{E}{FL}$
A	different	different	same
B	different	same	same
C	same	different	different
D	same	different	same

- 19 Two springs X and Y stretch elastically. The graphs show the variation with extension x of the force F applied to each spring.



Which statement is correct?

- A** When each spring is given the same extension, the energy stored in Y is 4 times the energy stored in X.
- B** When each spring is given the same extension, the energy stored in Y is 8 times the energy stored in X.
- C** When the same force is applied to each spring, the energy stored in Y is 4 times the energy stored in X.
- D** When the same force is applied to each spring, the energy stored in Y is 8 times the energy stored in X.
- 20 The diagram shows the force-extension graph for a steel wire, up to its breaking point.



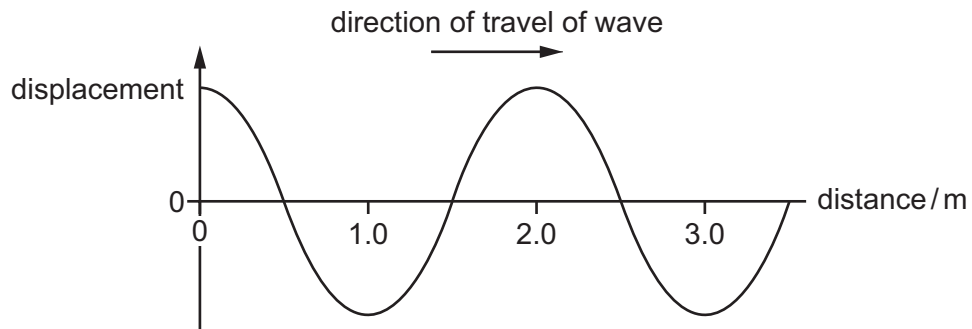
What is the best estimate of the work done to break the wire?

- A** 2.1 J **B** 2.3 J **C** 2.4 J **D** 2.5 J

21 Which statement about electromagnetic waves in a vacuum is correct?

- A Amplitude is inversely proportional to velocity.
- B Frequency is inversely proportional to wavelength.
- C Intensity is proportional to amplitude.
- D Velocity is proportional to wavelength.

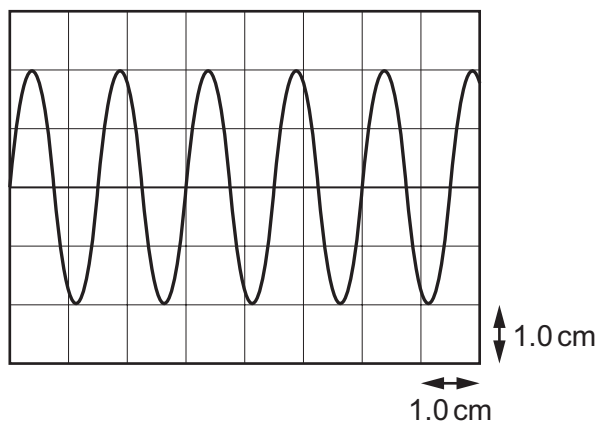
22 A transverse wave travels along a rope. The graph shows the variation of the displacement of the particles in the rope with distance along it at a particular instant.



At which distance along the rope do the particles have maximum upwards velocity?

- A 0.5 m
- B 1.0 m
- C 1.5 m
- D 2.0 m

- 23 A trace is shown on the screen of a cathode-ray oscilloscope (c.r.o.).



The time-base setting is 2.5 ms cm^{-1} and the Y-gain is 2.0 V cm^{-1} .

What is the frequency and the amplitude of the waveform displayed by the c.r.o.?

	frequency /Hz	amplitude /V
A	0.00375	4.0
B	0.00375	8.0
C	267	4.0
D	267	8.0

- 24 A high-speed train approaches a stationary observer at a speed of 80 ms^{-1} . The train's horn emits a sound of frequency 250 Hz.

The speed of sound is 340 ms^{-1} .

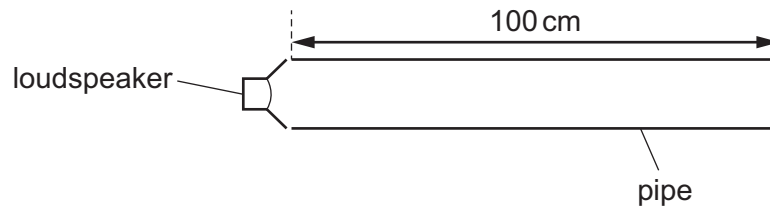
What is the observed frequency of the sound from the horn?

- A** 190 Hz **B** 200 Hz **C** 310 Hz **D** 330 Hz

- 25 Which row shows a correct frequency in Hz for each of the four principal radiations?

	X-rays	ultraviolet	microwaves	infra-red
A	10^{10}	10^{14}	10^{18}	10^{15}
B	10^{14}	10^{18}	10^{15}	10^{10}
C	10^{15}	10^{10}	10^{14}	10^{18}
D	10^{18}	10^{15}	10^{10}	10^{14}

- 26** A pipe of length 100 cm is open at both ends. A loudspeaker situated at one end of the pipe can emit sound of different wavelengths.



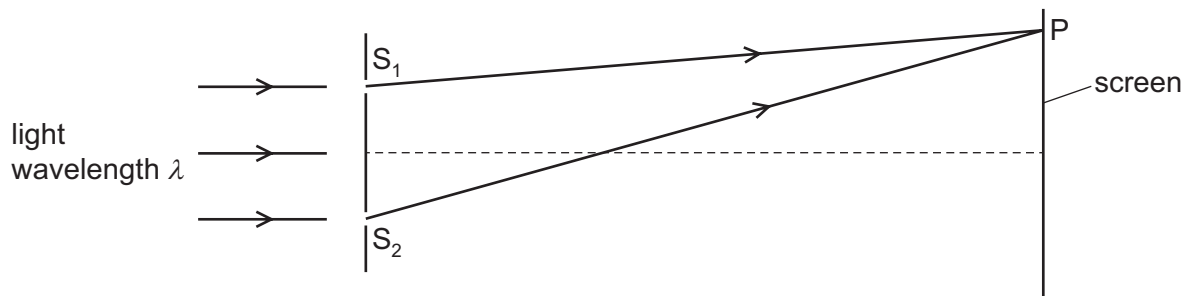
At which wavelength can a stationary wave be produced in the pipe?

- A** 50 cm **B** 75 cm **C** 150 cm **D** 300 cm
- 27** Monochromatic light is incident on a diffraction grating and a diffraction pattern is observed.

Which row shows possible effects of replacing the grating with one that has twice as many lines per millimetre?

	number of orders of diffraction visible	angle between first and second orders of diffraction
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 28 Monochromatic light of wavelength λ is incident on two narrow slits S_1 and S_2 , a small distance apart. A series of bright and dark fringes are observed on a screen a long distance away from the slits.

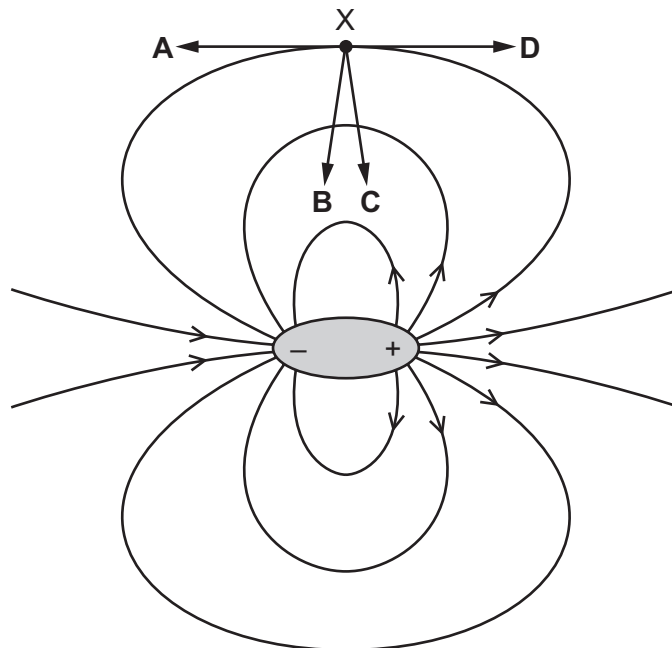


The n th **dark** fringe from the central bright fringe is observed at point P on the screen.

Which equation is correct for all positive values of n ?

- A $S_2P - S_1P = \frac{n\lambda}{2}$
- B $S_2P - S_1P = n\lambda$
- C $S_2P - S_1P = (n - \frac{1}{2})\lambda$
- D $S_2P - S_1P = (n + \frac{1}{2})\lambda$
- 29 A dipole is a pair of charges of equal magnitude, one negative and one positive. The electric field of a dipole is shown below.

In which direction does the force act on an electron when at point X?



30 In a uniform electric field, which statement is correct?

- A All charged particles experience the same force.
- B All charged particles move with the same velocity.
- C All electric field lines are directed towards positive charges.
- D All electric field lines are parallel.

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 $1.5 \times 10^6 \text{ m s}^{-1}$.

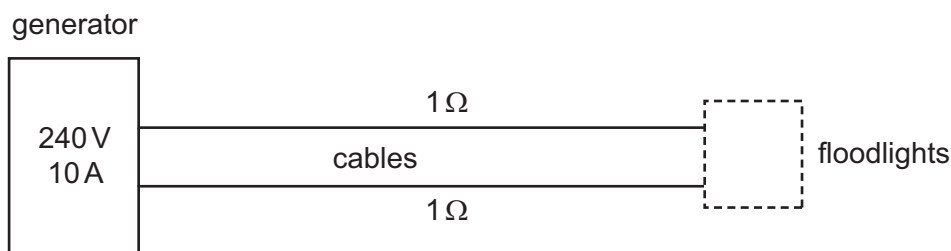
At any instant, there is always just one electron travelling between the plates.

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 $2.0 \times 10^{-7} \text{ A}$

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.

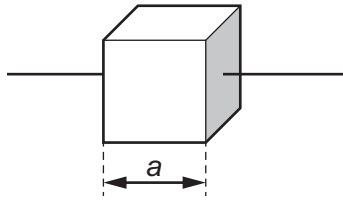
The total resistance of the cables is 2Ω .



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

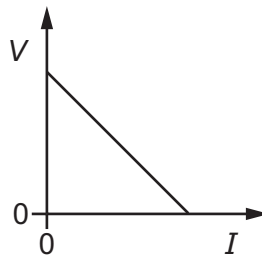
- 33 A metal cube with sides of length a has electrical resistance R between opposite faces.



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

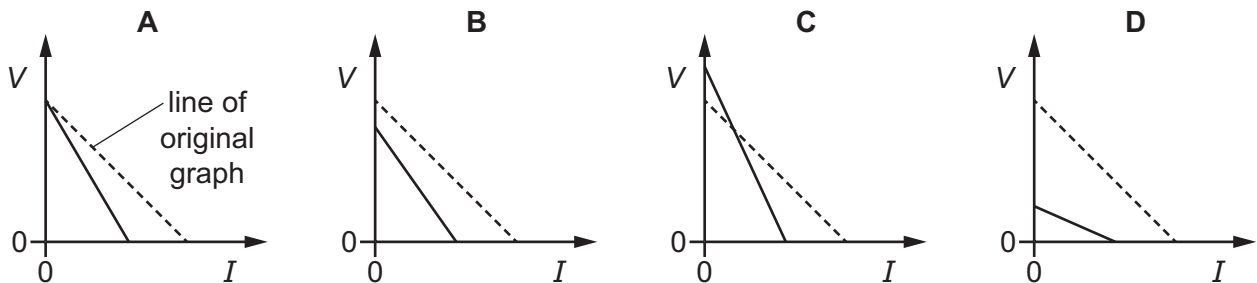
- A $9R$ B $3R$ C $\frac{R}{3}$ D $\frac{R}{9}$

- 34 A graph of potential difference (p.d.) V across a cell against current I in the cell is shown.

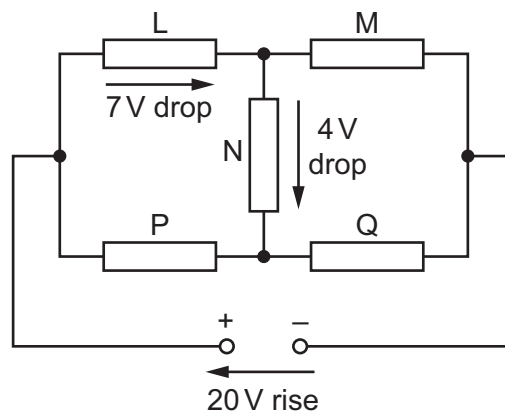


As the cell reaches the end of its useful life, its internal resistance increases and its electromotive force (e.m.f.) decreases.

Which diagram shows a graph of V against I for the cell nearing the end of its useful life?



- 35 A 20 V d.c. supply is connected to a circuit consisting of five resistors L, M, N, P and Q.

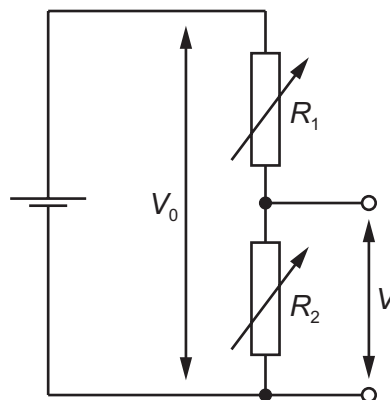


There is a potential drop of 7 V across L and a further 4 V potential drop across N.

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

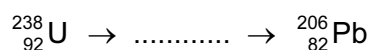
- 36 A potential divider circuit consists of a cell of negligible internal resistance in series with two variable resistors of resistances R_1 and R_2 . The potential difference (p.d.) across the cell is V_0 . The p.d. at the output is V .



Which statement is correct?

- A** When R_1 increases, it takes a greater proportion of V_0 , so V decreases.
- B** When R_1 increases, the current through R_1 and R_2 decreases, so V increases.
- C** When R_2 decreases, it takes a smaller proportion of V_0 , so V increases.
- D** When R_2 increases, the current through R_1 and R_2 decreases, so V decreases.

- 37 A nucleus of uranium-238, ${}_{92}^{238}\text{U}$, decays in a series of steps to form a nucleus of lead-206, ${}_{82}^{206}\text{Pb}$, as shown.



An α -particle or a β^- particle is emitted during each step.

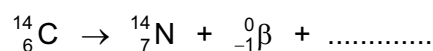
What is the total number of β^- particles that are emitted?

- A 6 B 8 C 10 D 16

- 38 Which statement about α -particles is correct?

- A α -particles emitted from a single radioactive isotope have a continuous distribution of energies.
 B α -particles have less ionising power than β -particles.
 C The charge of an α -particle is $+1.60 \times 10^{-19} \text{ C}$.
 D The speeds of α -particles can be as high as $1.5 \times 10^7 \text{ m s}^{-1}$.

- 39 The nuclear equation shown has a term missing.



What is represented by the missing term?

- A an antineutrino
 B an electron
 C a neutrino
 D a positron

- 40 Which particle is a fundamental particle?

- A electron
 B hadron
 C neutron
 D proton

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