



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2011

1 hour

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, highlighters, 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.

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.

This document consists of **28** 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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 constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
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.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{x_0^2 - x^2}$$

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,

$$W = \frac{1}{2} QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

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 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} .

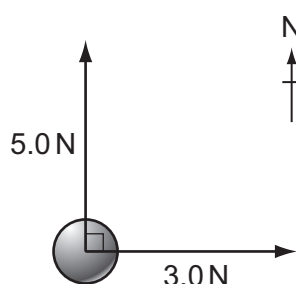
Which row gives the sub-multiples or multiples represented by pico (p) and giga (G)?

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

- 2 Which definition is correct and uses only quantities rather than units?

- A** Density is mass per cubic metre.
B Potential difference is energy per unit current.
C Pressure is force per unit area.
D Speed is distance travelled per second.

- 3 A force of 5.0 N pushes a ball due north and another force of 3.0 N pushes it due east.



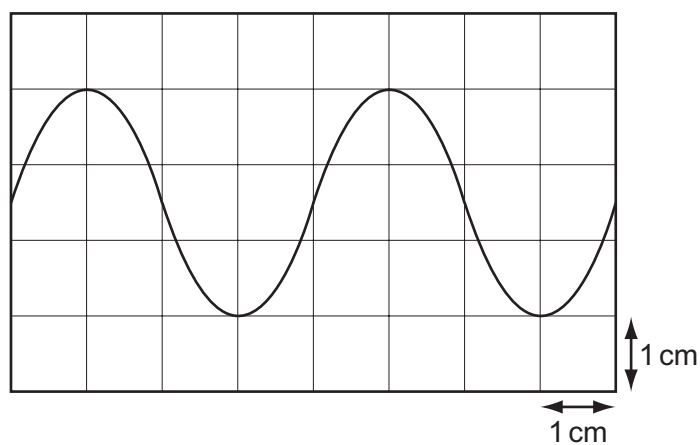
What is the magnitude of the net force acting on the ball?

- A** 2.8 N **B** 4.0 N **C** 5.8 N **D** 8.0 N

Space for working

- 4 The diagram shows a trace of a wave on a cathode-ray oscilloscope.

The vertical and horizontal gridlines have a spacing of 1.0 cm. The voltage scaling is 4 V cm^{-1} and the time scaling is 5 ms cm^{-1} .

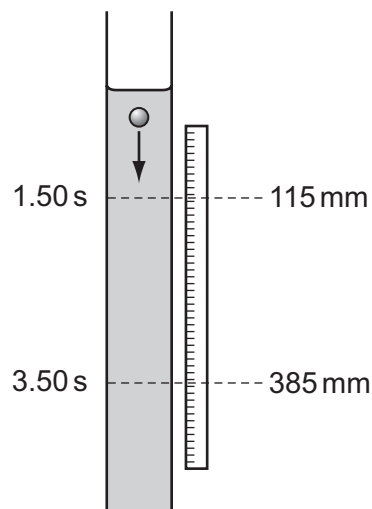


What are the amplitude and period of the wave?

	amplitude / V	period / ms
A	1.5	4
B	5.0	10
C	6.0	20
D	12.0	20

Space for working

- 5 The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.



There are two marks on the tube. The top mark is positioned at 115 ± 1 mm on the adjacent rule and the lower mark at 385 ± 1 mm. The ball passes the top mark at 1.50 ± 0.02 s and passes the lower mark at 3.50 ± 0.02 s.

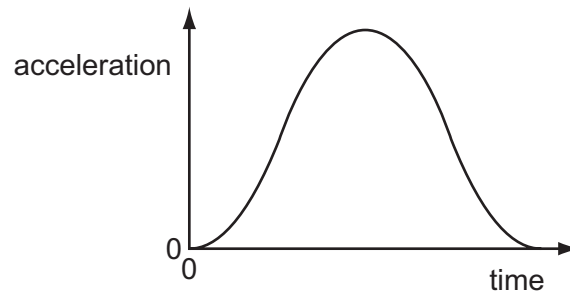
The constant speed of the ball is calculated by $\frac{385 - 115}{3.50 - 1.50} = \frac{270}{2.00} = 135 \text{ mm s}^{-1}$.

Which expression calculates the fractional uncertainty in the value of this speed?

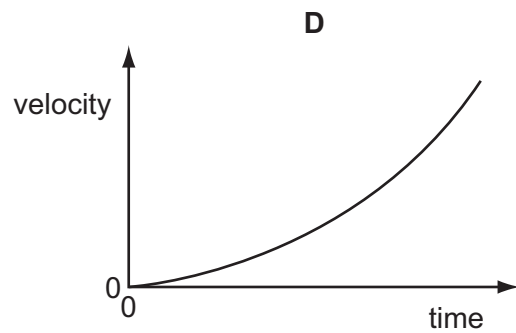
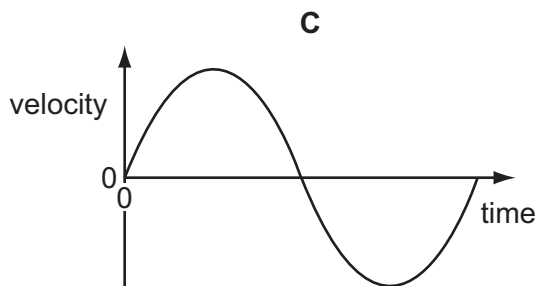
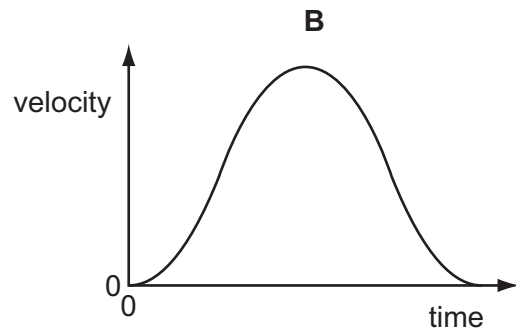
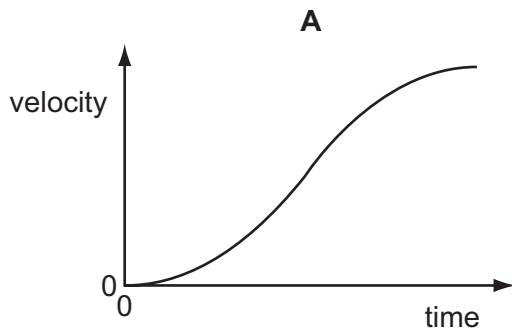
- A $\frac{2}{270} + \frac{0.04}{2.00}$
- B $\frac{2}{270} - \frac{0.04}{2.00}$
- C $\frac{1}{270} \times \frac{0.02}{2.00}$
- D $\frac{1}{270} \div \frac{0.02}{2.00}$

Space for working

- 6 The graph shows how the acceleration of an object moving in a straight line varies with time.

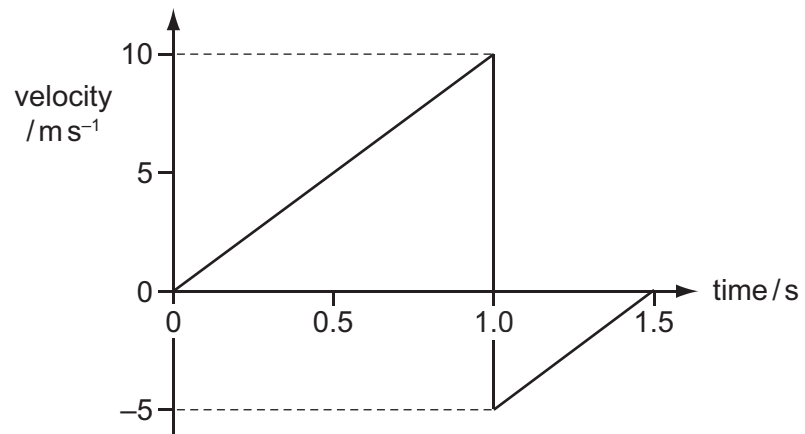


Which graph shows the variation with time of the velocity of the object?



Space for working

- 7 A ball is released from rest at time zero. After 1.0 s it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce after 1.5 s.



What is the total displacement of the ball from its original position after 1.5 s?

- A** 1.25 m **B** 3.75 m **C** 5.00 m **D** 6.25 m

Space for working

- 8 A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is 1.64 ms^{-2} .

What are the weight and the mass of the body when it is on the Moon?

	weight / N	mass / kg
A	9.85	1.00
B	9.85	6.00
C	58.9	1.00
D	58.9	6.00

- 9 A body of mass m , moving at velocity v , collides with a stationary body of the same mass and sticks to it.

Which row describes the momentum and kinetic energy of the two bodies after the collision?

	momentum	kinetic energy
A	mv	$\frac{1}{4}mv^2$
B	mv	$\frac{1}{8}mv^2$
C	$2mv$	$\frac{1}{2}mv^2$
D	$2mv$	mv^2

Space for working

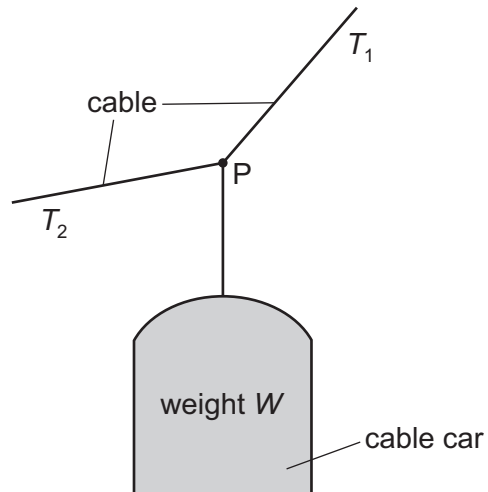
- 10 A molecule of mass m travelling horizontally with velocity u hits a vertical wall at right-angles to its velocity. It then rebounds horizontally with the same speed.

What is its change in momentum?

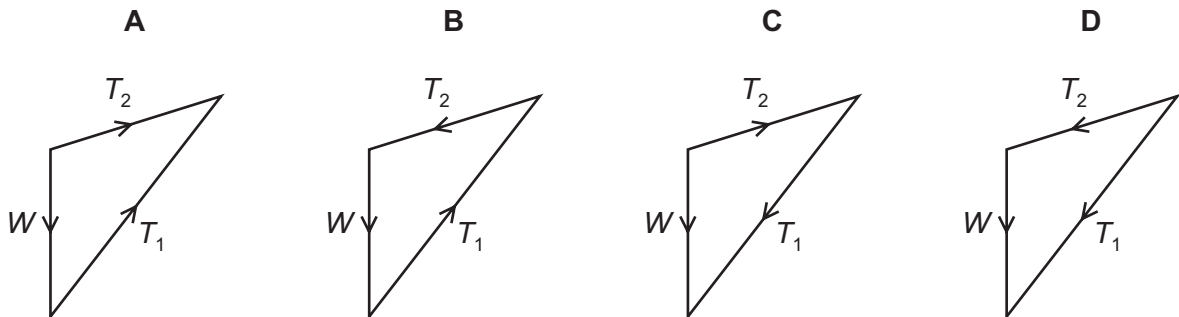
- A zero B mu C $-mu$ D $-2mu$

- 11 A cable car of weight W hangs in equilibrium from its cable at point P.

The cable has tensions T_1 and T_2 as shown.

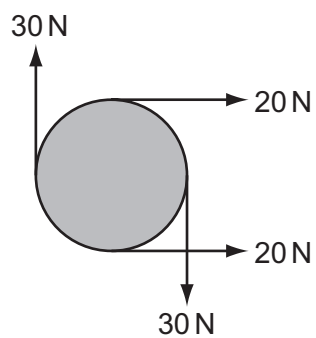


Which diagram correctly represents the forces acting at point P?



Space for working

12 The diagram shows four forces applied to a circular object.

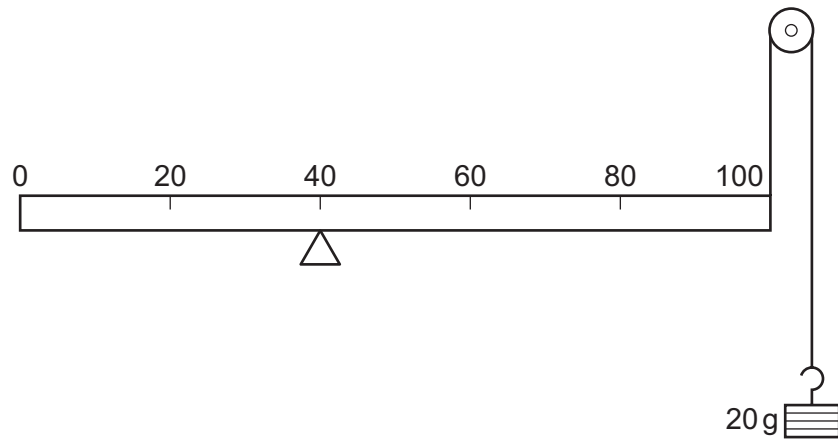


Which row describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

Space for working

- 13** A uniform metre rule of mass 100 g is supported by a pivot at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.



At which mark on the rule must a 50 g mass be suspended so that the rule balances?

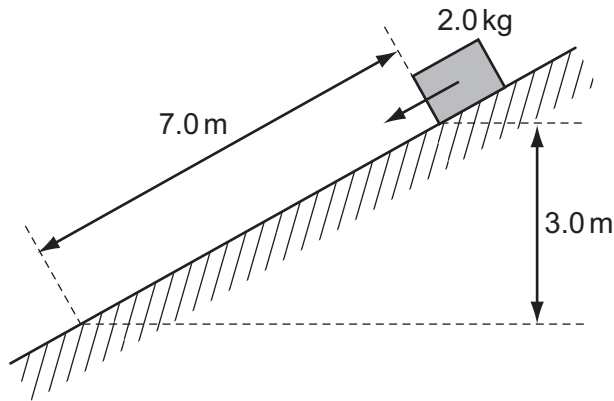
- A** 4 cm **B** 36 cm **C** 44 cm **D** 64 cm
- 14** A steel sphere is dropped vertically onto a horizontal metal plate. The sphere hits the plate with a speed u , leaves it at a speed v , and rebounds vertically to half of its original height.

Which expression gives the value of $\frac{v}{u}$?

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

Space for working

- 15** A block of mass 2.0 kg is released from rest on a slope. It travels 7.0 m down the slope and falls a vertical distance of 3.0 m . The block experiences a frictional force parallel to the slope of 5.0 N .



What is the speed of the block after falling this distance?

- A** 4.9 ms^{-1} **B** 6.6 ms^{-1} **C** 8.6 ms^{-1} **D** 10.1 ms^{-1}
- 16** 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

Space for working

17 A body travelling with a speed of 10 m s^{-1} has kinetic energy 1500 J.

If the speed of the body is increased to 40 m s^{-1} , what is its new kinetic energy?

- A 4500 J B 6000 J C 24 000 J D 1 350 000 J

18 Which process does **not** require energy to be supplied?

- A boiling
B evaporation
C freezing
D melting

19 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 kg m^{-3} and the density of alcohol is 800 kg m^{-3} .

What is the density of the mixture with volume 2.0 m^3 ?

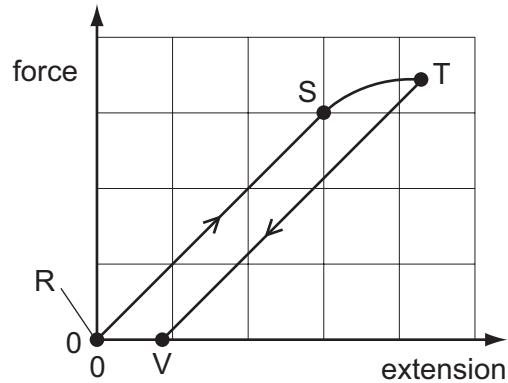
- A 850 kg m^{-3} B 900 kg m^{-3} C 940 kg m^{-3} D 950 kg m^{-3}

Space for working

- 20 A long, thin metal wire is suspended from a fixed support and hangs vertically. Masses are suspended from its lower end.

The load on the lower end is increased from zero and then decreased again back to zero.

The diagram shows the force-extension graph produced.



Where on the graph would the elastic limit be found?

- A anywhere between point R and point S
- B beyond point S but before point T
- C exactly at point S
- D exactly at point T

Space for working

21 The Young modulus E can be determined from measurements made when a wire is stretched.

Which quantities would be measured in order to determine E ?

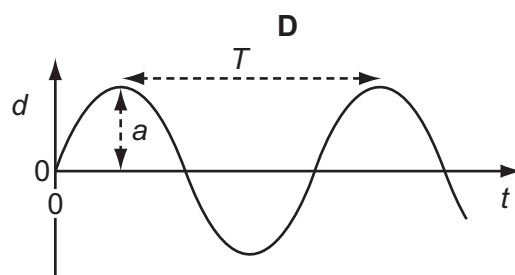
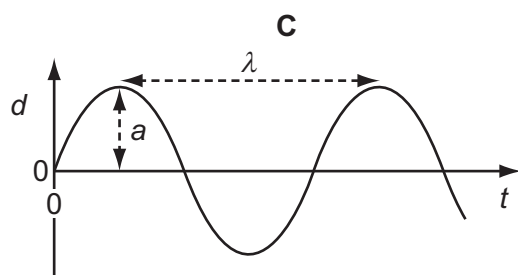
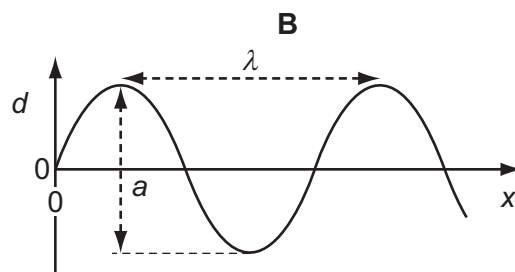
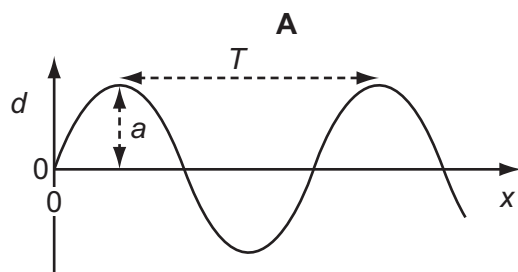
A	mass of stretching load	original length of wire	diameter of wire	extension of wire
B	mass of stretching load	new length of wire	cross-sectional area of wire	diameter of wire
C	mass of wire	original length of wire	cross-sectional area of wire	new length of wire
D	mass of wire	new length of wire	diameter of wire	extension of wire

Space for working

- 22** The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x .

The labels on the graphs are intended to show the wavelength λ , the period T and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?



Space for working

23 Which statement about sound waves in air at constant temperature is correct?

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

24 A source of sound of constant power P is situated in an open space. The intensity I of sound at distance r from this source is given by

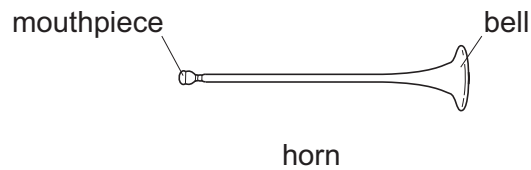
$$I = \frac{P}{4\pi r^2}.$$

How does the amplitude a of the vibrating air molecules vary with the distance r from the source?

- A** $a \propto \frac{1}{r}$ **B** $a \propto \frac{1}{r^2}$ **C** $a \propto r$ **D** $a \propto r^2$

Space for working

- 25 The basic principle of note production in a horn is to set up a stationary wave in an air column.



For the lowest note produced by a horn, a node is formed at the mouthpiece and the antinode is formed at the bell. The frequency of this note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

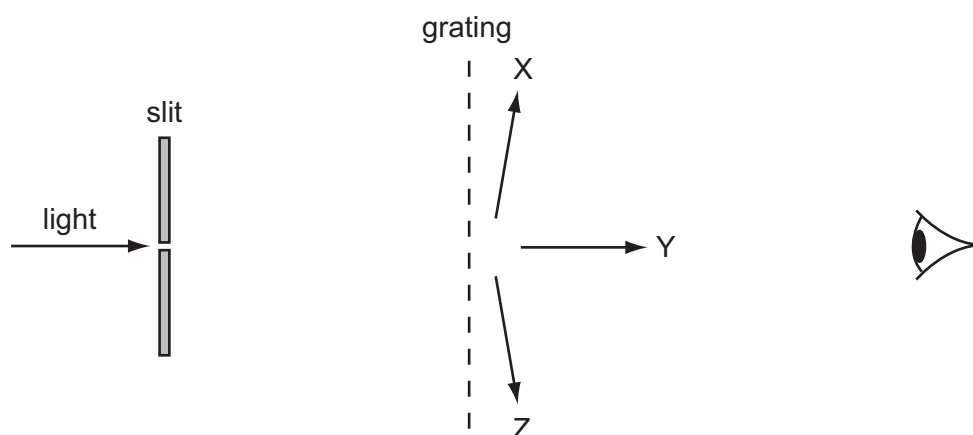
	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

- 26 Which electromagnetic wave phenomenon is needed to explain the spectrum produced when white light falls on a diffraction grating?
- A** coherence
 - B** interference
 - C** polarisation
 - D** refraction

Space for working

- 27** A diffraction grating with 500 lines per mm is used to observe diffraction of monochromatic light of wavelength 600 nm.

The light is passed through a narrow slit and the grating is placed so that its lines are parallel to the slit. Light passes through the slit and then the grating.



An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

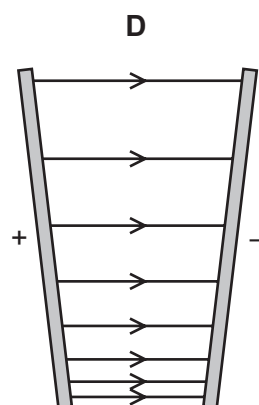
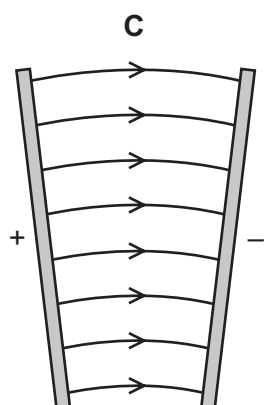
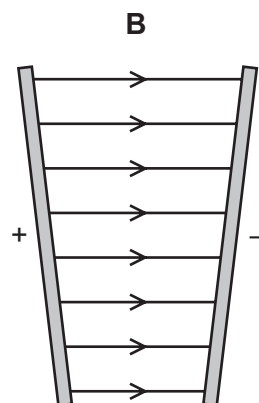
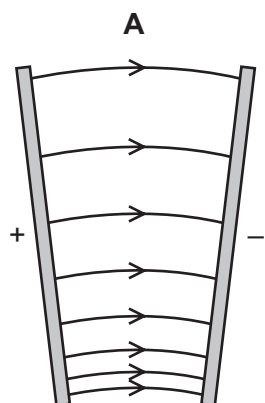
How many images of the slit does he see?

- A** 3 **B** 4 **C** 6 **D** 7

Space for working

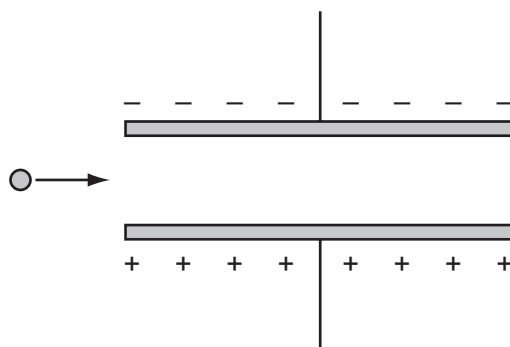
28 A potential difference is applied between two metal plates that are **not** parallel.

Which diagram shows the electric field between the plates?



Space for working

- 29 The diagram shows a charged particle as it approaches a pair of charged parallel plates in a vacuum.



Which row describes the horizontal and vertical components of its motion as it travels between the plates?

	horizontal component	vertical component
A	constant acceleration	constant acceleration
B	constant acceleration	constant velocity
C	constant velocity	constant acceleration
D	constant velocity	constant velocity

- 30 Two parallel plates, a distance 25 mm apart, have a potential difference between them of 12 kV.

What is the force on an electron when it is in the uniform electric field between the plates?

- A** $4.8 \times 10^{-20} \text{ N}$
B $7.7 \times 10^{-20} \text{ N}$
C $4.8 \times 10^{-17} \text{ N}$
D $7.7 \times 10^{-14} \text{ N}$

Space for working

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

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}

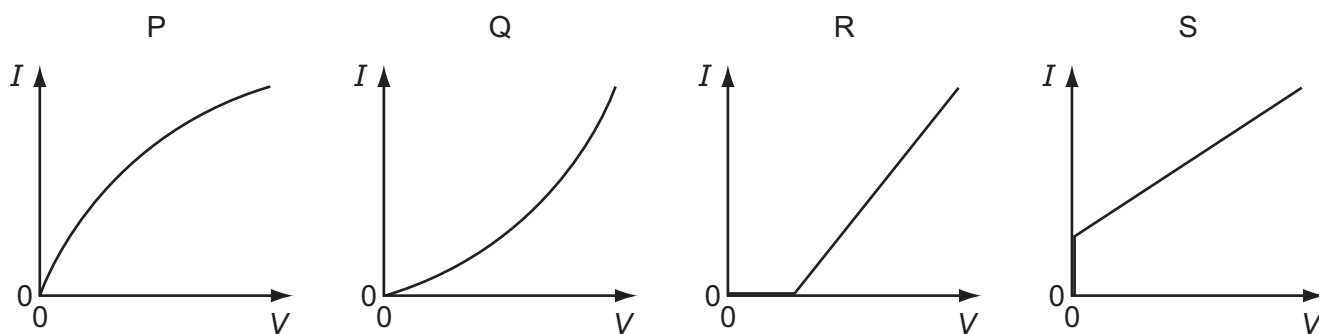
- 32** A battery is marked 9.0 V.

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.

Space for working

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

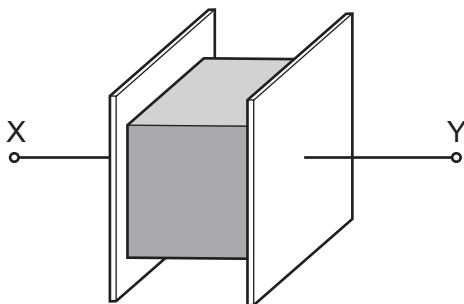


Which row best specifies the correct I - V graphs for the lamp and the diode?

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

Space for working

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

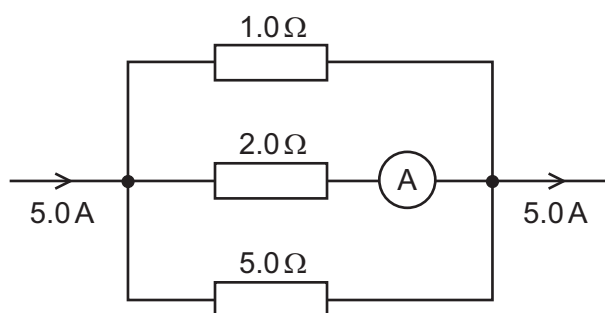


The cube has volume V and is made of a material with resistivity ρ . The connections to the cube have negligible resistance.

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

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

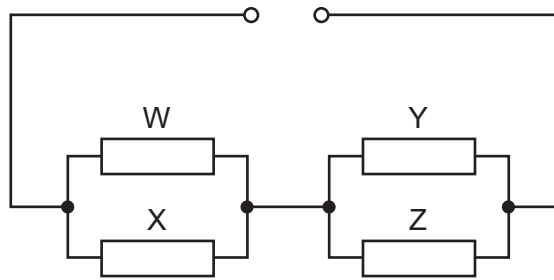


What is the reading on the ammeter?

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

Space for working

36 Four resistors of equal value are connected as shown.

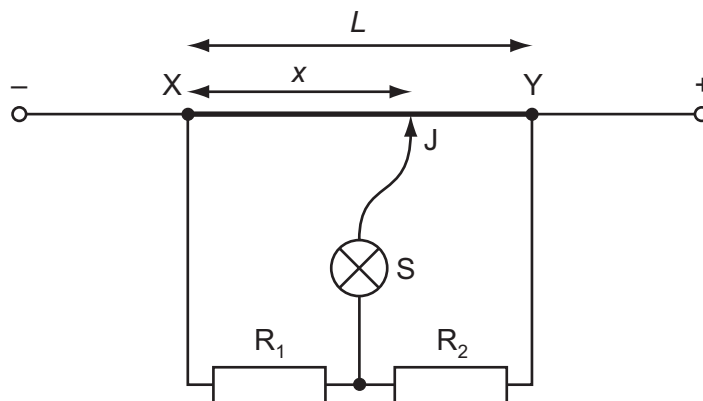


How will the powers to the resistors change when resistor W is removed?

- 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.

Space for working

- 37 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.



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 $\frac{x}{L-x}$

- 38 The first artificial radioactive substance was made by bombarding aluminium, $^{27}_{13}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, $^{30}_{15}\text{P}$.

What was the by-product of this reaction?

- A an α -particle
B a β -particle
C a γ -ray
D a neutron

Space for working

- 39 Uranium-238, ${}^{238}_{92}\text{U}$, decays by α -emission into a daughter product which in turn decays by β -emission into a grand-daughter product.

What is the grand-daughter product?

- A ${}^{234}_{90}\text{Th}$ B ${}^{234}_{91}\text{Pa}$ C ${}^{234}_{92}\text{U}$ D ${}^{230}_{90}\text{Th}$

- 40 Which statement about nuclei is correct?

- A Different isotopic nuclei have different proton numbers.
B For some nuclei, the nucleon number can be less than the proton number.
C In some nuclear processes, mass-energy is not conserved.
D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

Space for working



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PHYSICS

9702/12

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1 hour

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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.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{x_0^2 - x^2}$$

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,

$$W = \frac{1}{2} QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

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 Stress has the same SI base units as

- A $\frac{\text{force}}{\text{mass}}$.
- B $\frac{\text{force}}{\text{length}}$.
- C $\frac{\text{force}}{\text{area}}$.
- D energy.

2 To check calculations, the units are put into the following equations together with the numbers.

Which equation must be **incorrect**?

- A force = 300 J / 6 m
- B power = 6000 J $\times$ 20 s
- C time = 6 m / 30 m s⁻¹
- D velocity = 4 m s⁻² $\times$ 30 s

Space for working

- 3 In making reasonable estimates of physical quantities, which statement is **not** correct?
- A The frequency of sound can be of the order of GHz.
 - B The wavelength of light can be of the order of 600 nm.
 - C The Young modulus can be of the order of 10^{11} Pa.
 - D Beta radiation is associated with one unit of negative charge.
- 4 The uncertainty in the value of the momentum of a trolley passing between two points X and Y varies with the choice of measuring devices.

Measurements for the same trolley made by different instruments were recorded.

- 1 distance between X and Y using a metre rule with cm divisions = 0.55 m
- 2 distance between X and Y using a metre rule with mm divisions = 0.547 m
- 3 timings using a wristwatch measuring to the nearest 0.5 s at X = 0.0 s and at Y = 4.5 s
- 4 timings using light gates measuring to the nearest 0.1 s at X = 0.0 s and at Y = 4.3 s
- 5 mass of trolley using a balance measuring to the nearest g = 6.4×10^{-2} kg
- 6 mass of trolley using a balance measuring to the nearest 10 g = 6×10^{-2} kg

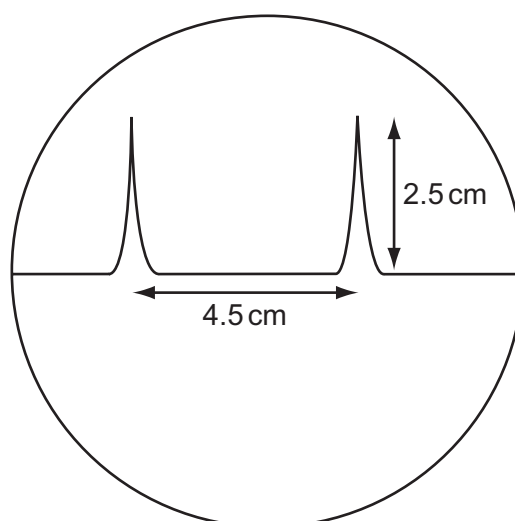
Which measurements, one for each quantity measured, lead to the least uncertainty in the value of the momentum of the trolley?

- A 1, 3 and 6 B 1, 4 and 6 C 2, 3 and 6 D 2, 4 and 5

Space for working

- 5 The time-base on a cathode-ray oscilloscope is set at 6 ms/cm .

A trace consisting of two pulses is recorded as shown in the diagram.



What is the time interval between the two pulses?

- A** 0.42 ms **B** 0.75 ms **C** 1.33 ms **D** 27 ms
- 6 A bullet is fired horizontally with speed v from a rifle. For a short time t after leaving the rifle, the only force affecting its motion is gravity. The acceleration of free fall is g .

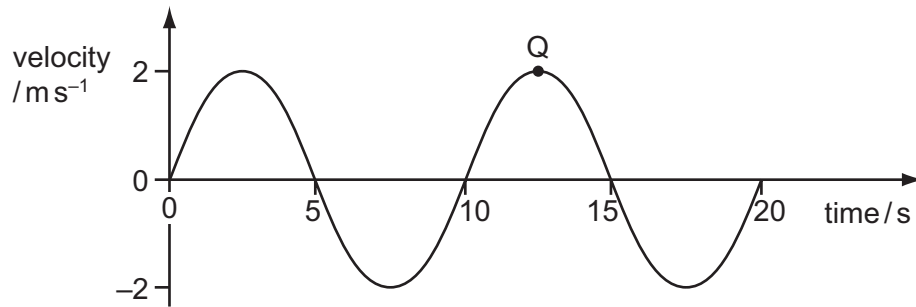
Which expression gives the value of $\frac{\text{the horizontal distance travelled in time } t}{\text{the vertical distance travelled in time } t}$?

- A** $\frac{vt}{g}$ **B** $\frac{v}{gt}$ **C** $\frac{2vt}{g}$ **D** $\frac{2v}{gt}$

Space for working

- 7 A particle moves in the manner shown by the velocity-time graph.

The displacement of the particle has been measured so that it is zero at $t = 0$. Point Q refers to a point in its motion.



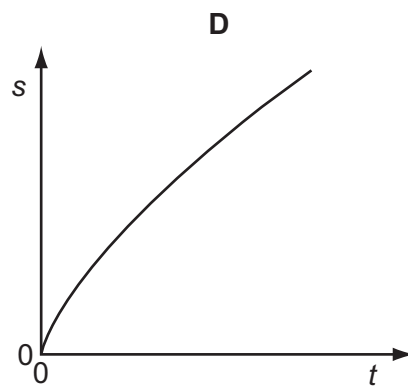
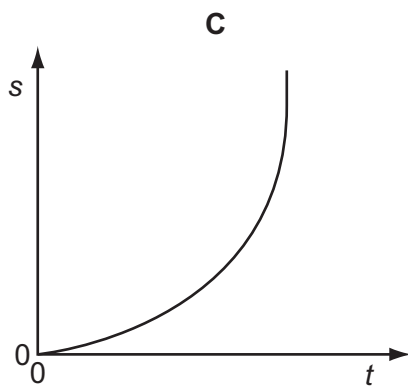
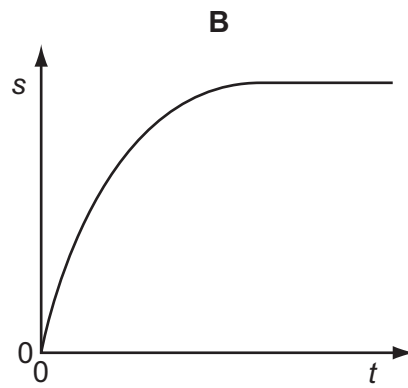
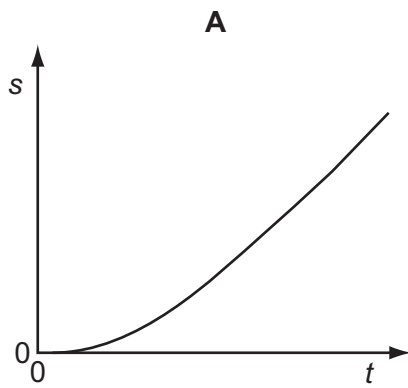
Which row of the table is correct?

	times for maximum displacement/s		acceleration at point Q/ m s^{-2}
A	2.5	12.5	2
B	5	15	2
C	2.5	12.5	0
D	5	15	0

Space for working

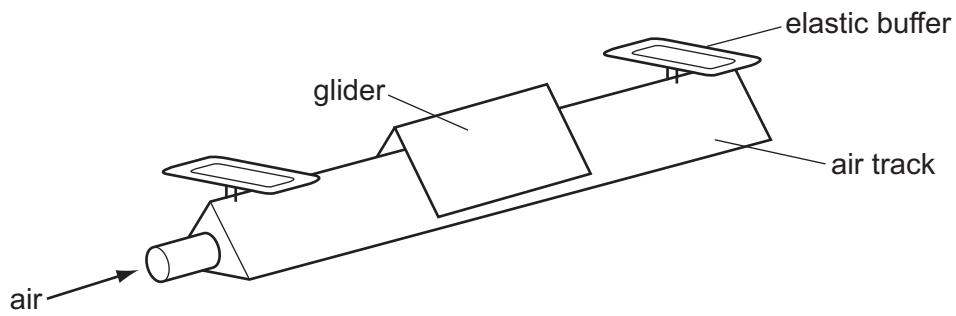
- 8 A tennis ball falls freely, in air, from the top of a tall building.

Which graph best represents the variation of distance s fallen with time t ?



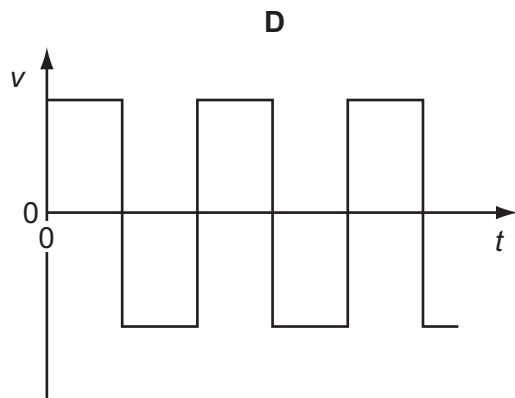
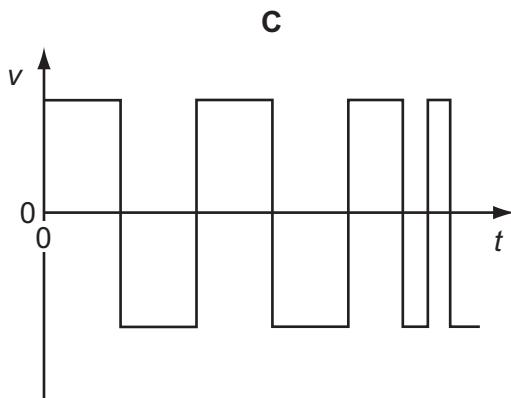
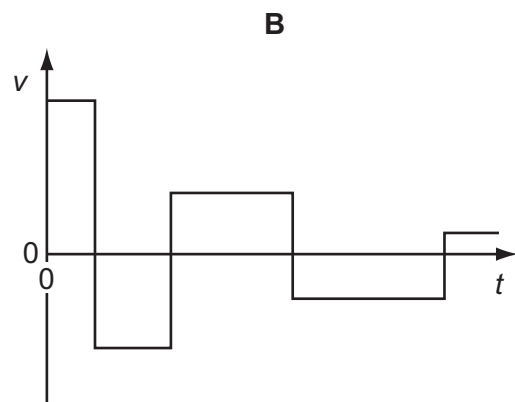
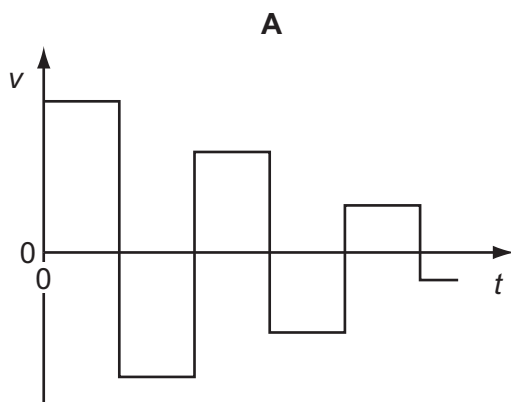
Space for working

- 9 A small glider moves along a friction-free horizontal air track as shown below.



At each end of the air track there is a perfectly elastic buffer.

Which graph represents the variation with time t of the velocity v of the glider as it moves between the two buffers?



Space for working

- 10 A force F is applied to a freely moving object. At one instant of time, the object has velocity v and acceleration a .

Which quantities **must** be in the same direction?

- A a and v only
 - B a and F only
 - C v and F only
 - D v , F and a
- 11 The momentum of an object changes from 160 kg m s^{-1} to 240 kg m s^{-1} in 2 s.

What is the mean resultant force on the object during the change?

- A 40 N B 80 N C 200 N D 400 N

- 12 A car accelerates in a straight line.

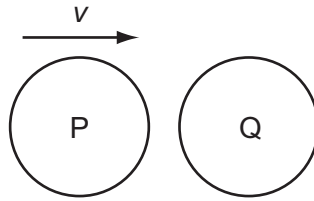
A graph of the momentum of the car is plotted against time.

What is evaluated by finding the gradient of the graph at a particular time?

- A the acceleration of the car
- B the resultant force on the car
- C the kinetic energy of the car
- D the power supplied to the car

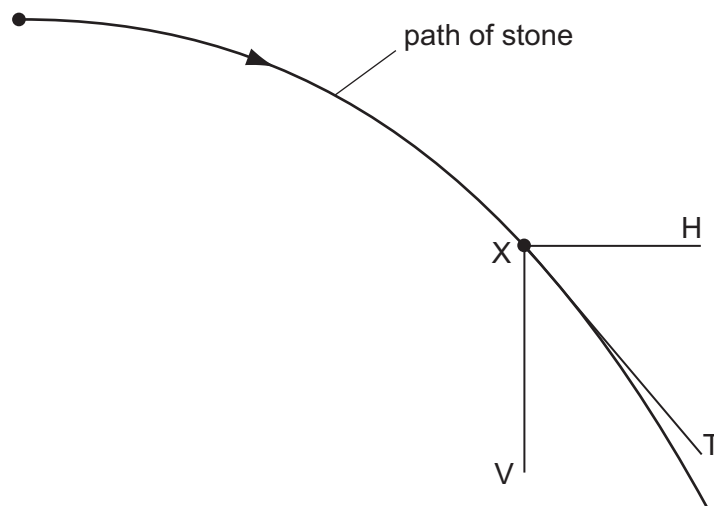
Space for working

- 13 The diagram shows a particle P, travelling at speed v , about to collide with a stationary particle Q of the same mass. The collision is perfectly elastic.



Which statement describes the motion of P and of Q immediately after the collision?

- A** P rebounds with speed $\frac{1}{2}v$ and Q acquires speed $\frac{1}{2}v$.
B P rebounds with speed v and Q remains stationary.
C P and Q both travel in the same direction with speed $\frac{1}{2}v$.
D P comes to a standstill and Q acquires speed v .
- 14 A stone is projected horizontally in a vacuum and moves along the path shown.



X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.

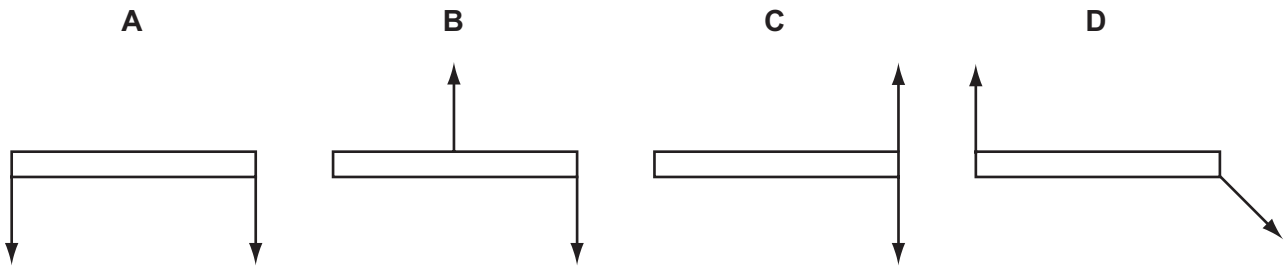
Along which directions do forces act on the stone at X?

- A** XV only **B** XH only **C** XV and XH **D** XT only

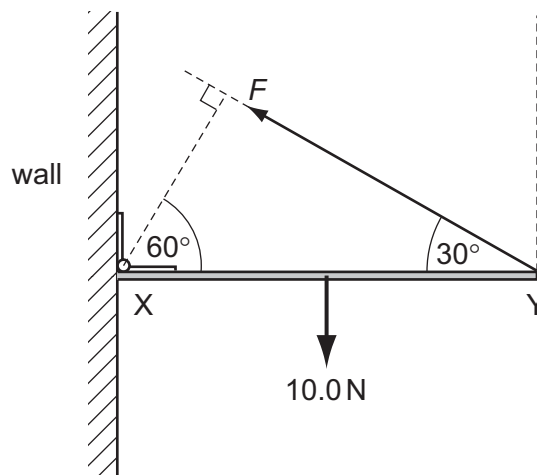
Space for working

15 The diagrams all show a pair of equal forces acting on a metre rule.

Which diagram shows forces that provide a couple and zero resultant force?



16 A uniform rod XY of weight 10.0 N is freely hinged to a wall at X. It is held horizontal by a force F acting from Y at an angle of 30° to the horizontal, as shown.

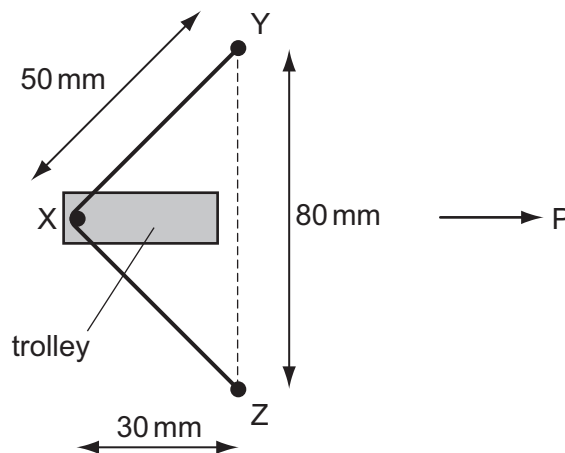


What is the value of F ?

- A 5.0 N B 8.7 N C 10.0 N D 20.0 N

Space for working

- 17 The diagram shows two fixed pins, Y and Z. A length of elastic is stretched between Y and Z and around pin X, which is attached to a trolley.



X is at the centre of the elastic and the trolley is to be propelled in the direction P at right angles to YZ. The tension in the elastic is 4 N.

What is the force accelerating the trolley in the direction P when the trolley is released?

- A** 2.4 N **B** 3.2 N **C** 4.8 N **D** 6.4 N

- 18 An electric motor produces 120 W of useful mechanical output power. The efficiency of the motor is 60 %.

Which row is correct?

	electrical power input/W	waste heat power output/W
A	72	48
B	192	72
C	200	72
D	200	80

Space for working

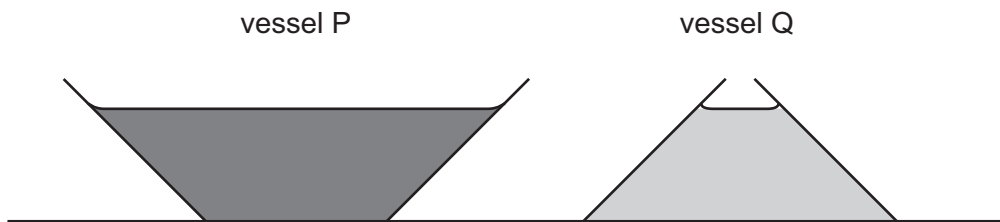
- 19 A hammer with 10 J of kinetic energy hits a nail and pushes it 5.0 mm into a plank.

Both the hammer and nail come to rest after the collision.

What is the average force that acts on the nail while it moves the 5.0 mm?

- A** 0.050 N **B** 2.0 N **C** 50 N **D** 2000 N

- 20 The diagram shows two vessels, P and Q, both with sides inclined at 45° .



Vessel P tapers outwards and vessel Q tapers inwards, as shown.

Both vessels contain a liquid. The depth of the liquid in the vessels is the same. The liquid in vessel P is twice as dense as the liquid in vessel Q.

What is the ratio $\frac{\text{pressure due to the liquid on the base of P}}{\text{pressure due to the liquid on the base of Q}}$?

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

Space for working

- 21 Two solid substances P and Q have atoms of mass M_P and M_Q respectively. They have n_P and n_Q atoms per unit volume.

The density of P is greater than the density of Q.

What **must** be correct?

- A $M_P > M_Q$
- B $n_P > n_Q$
- C $M_P n_P > M_Q n_Q$
- D $\frac{M_P}{n_P} > \frac{M_Q}{n_Q}$

- 22 The table summarises some descriptions of evaporation.

Which row of the table is correct?

	involves a change in state from liquid to vapour	occurs at a fixed temperature	involves a reduction in the average kinetic energy of the remaining atoms
A	true	true	true
B	true	false	true
C	true	false	false
D	false	true	false

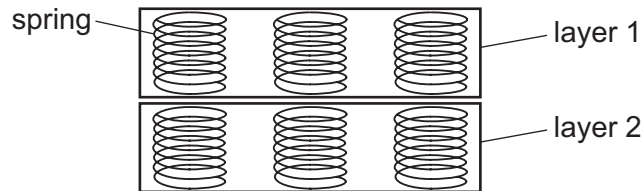
Space for working

- 23 The behaviour of a wire under tensile stress may be described in terms of the Young modulus E of the material of the wire and of the force per unit extension k of the wire.

For a wire of length L and cross-sectional area A , what is the relation between E and k ?

- A $E = \frac{A}{kL}$ B $E = \frac{kA}{L}$ C $E = \frac{kL}{A}$ D $E = \frac{L}{kA}$

- 24 The diagram shows the structure of part of a mattress.



The manufacturer wants to design a softer mattress (one which will compress more for the same load).

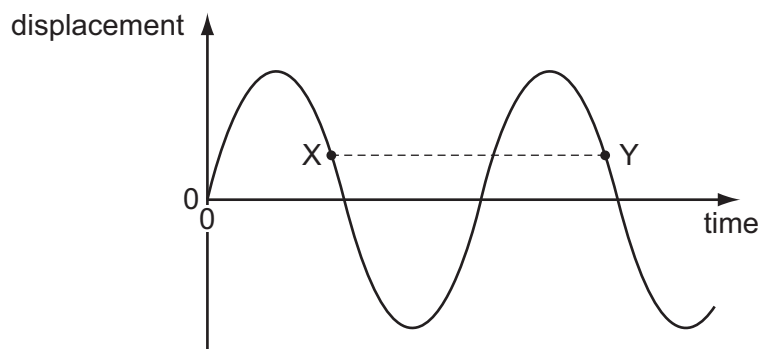
Which change will **not** have the desired effect?

- A using more layers of springs
 B using more springs per unit area
 C using springs with a smaller spring constant
 D using springs made from wire with a smaller Young modulus
- 25 In which order of magnitude are the frequencies of electromagnetic waves in the visible spectrum?
- A 10^{12} Hz B 10^{13} Hz C 10^{14} Hz D 10^{15} Hz

Space for working

26 A transverse progressive wave is set up on a string.

The graph shows the variation with time of displacement for a point on this string.



The separation XY on the graph represents the 1..... of the wave.

X and Y have equal 2..... .

Which words correctly complete gaps 1 and 2?

	1	2
A	time period	amplitudes
B	time period	displacements
C	wavelength	amplitudes
D	wavelength	displacements

27 If a wave can be polarised, it **must** be

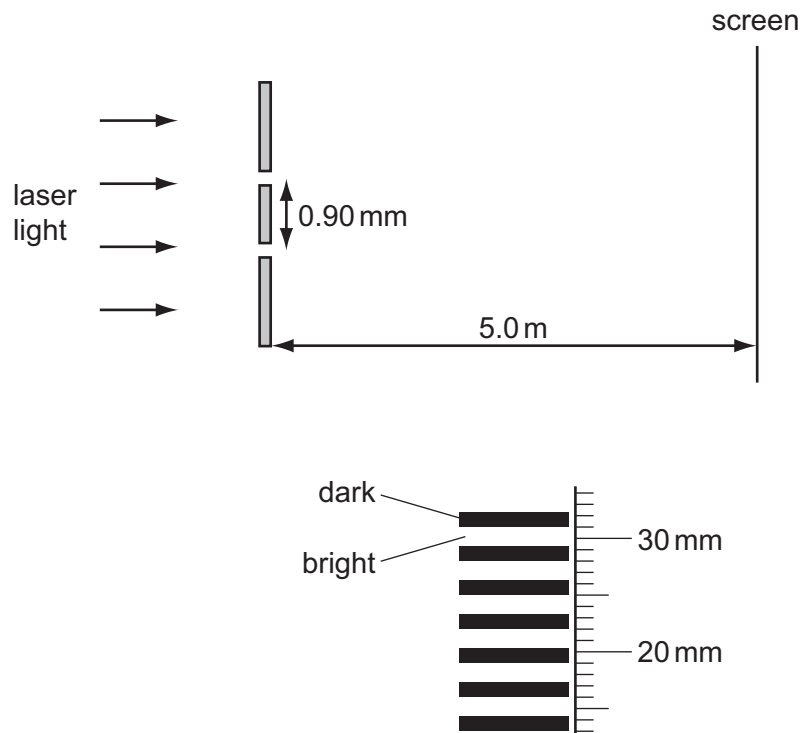
- A** a longitudinal wave.
- B** an electromagnetic wave.
- C** a sound wave.
- D** a transverse wave.

Space for working

28 In which situation does diffraction occur?

- A A wave bounces back from a surface.
- B A wave passes from one medium into another.
- C A wave passes through an aperture.
- D Waves from two identical sources are superposed.

29 The diagrams show the arrangement of apparatus for a Young's slits experiment and also part of the pattern formed on the screen with a ruler placed next to it.

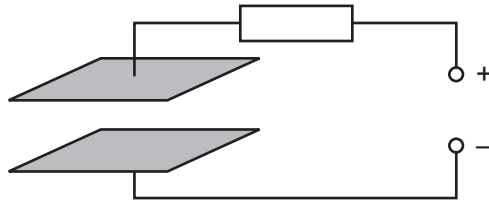


What is the wavelength of the light?

- A $4.8 \times 10^{-7} \text{ m}$ B $5.4 \times 10^{-7} \text{ m}$ C $3.2 \times 10^{-6} \text{ m}$ D $3.4 \times 10^{-6} \text{ m}$

Space for working

30 The diagram shows two parallel metal plates connected to a d.c. power supply through a resistor.



There is a uniform electric field in the region between the plates.

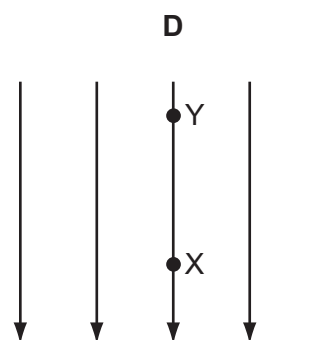
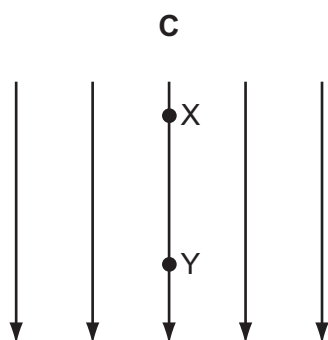
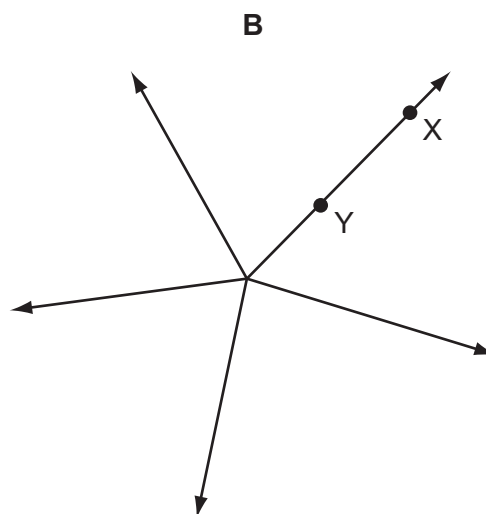
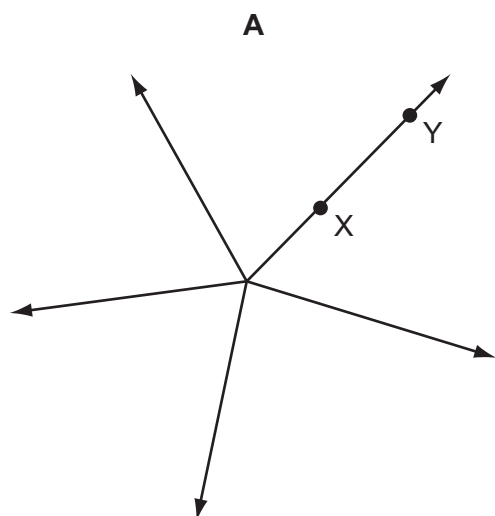
Which change would cause a **decrease** in the strength of the electric field?

- A a small increase in the distance between the plates
- B a small increase in the potential difference between the plates
- C a small increase in the value of the resistor
- D a small increase to the area of both plates

Space for working

31 In each electric field diagram, a positively charged particle is moved from X to Y.

In which diagram would the particle experience an increasing repulsive force?



32 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

Space for working

- 33 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?

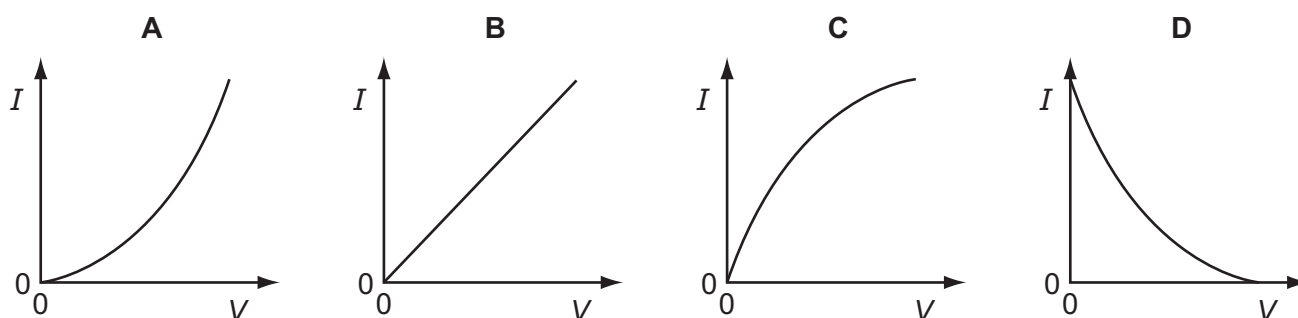
- A $\frac{R}{2}$ B R C $2R$ D $4R$

- 34 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 .

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 .

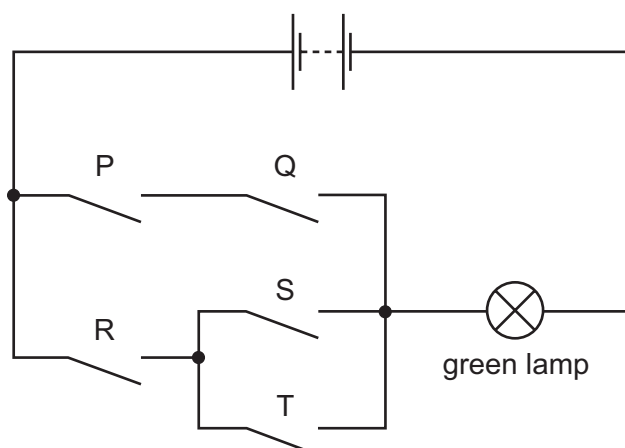
- 35 Which graph best represents the way in which the current I through a thermistor depends upon the potential difference V across it?



Space for working

36 Safety on railways is increased by using several electrical switches.

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

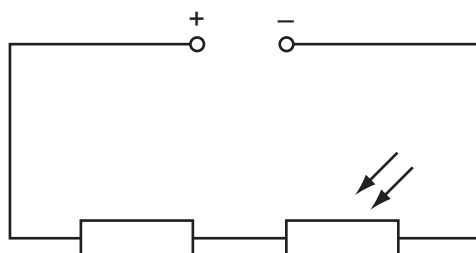


Which row does **not** allow the green lamp to light?

	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

Space for working

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



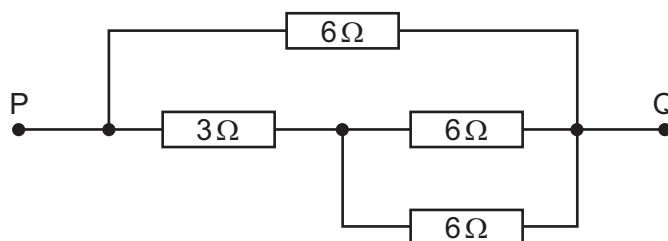
When the LDR is in the dark, the fixed resistor and the LDR have the same value of resistance.

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

- 38 The diagram shows a d.c. circuit.



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

- A** $0.47\ \Omega$ **B** $2.1\ \Omega$ **C** $3.0\ \Omega$ **D** $21\ \Omega$

Space for working

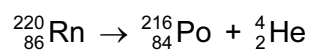
- 39 The uranium nucleus ${}_{92}^{238}\text{U}$ undergoes α -decay, producing nucleus X.

Nucleus X undergoes β -decay, producing nucleus Y.

For nucleus Y, what are the values of the proton number and nucleon number?

	proton number	nucleon number
A	89	234
B	89	236
C	91	234
D	91	236

- 40 Radon-220 is radioactive and decays to polonium-216 with the emission of an α -particle. The equation for the radioactive decay is shown.



How many neutrons are in the radon and polonium nuclei?

	Rn	Po
A	86	84
B	134	132
C	220	212
D	220	216

Space for working



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
General Certificate of Education
Advanced Subsidiary Level and Advanced Level

PHYSICS

9702/13

Paper 1 Multiple Choice

May/June 2011

1 hour

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, highlighters, 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.

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.

This document consists of **28** 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,	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$
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 constant,	$u = 1.66 \times 10^{-27} \text{ kg}$
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

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$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

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.,

$$v = v_0 \cos \omega t$$

$$v = \pm \omega \sqrt{x_0^2 - x^2}$$

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,

$$W = \frac{1}{2}QV$$

resistors in series,

$$R = R_1 + R_2 + \dots$$

resistors in parallel,

$$1/R = 1/R_1 + 1/R_2 + \dots$$

alternating current/voltage,

$$x = x_0 \sin \omega t$$

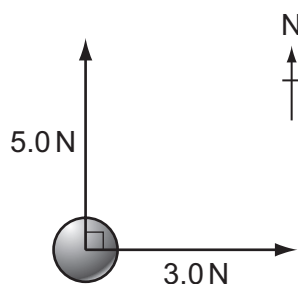
radioactive decay,

$$x = x_0 \exp(-\lambda t)$$

decay constant,

$$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$$

- 1 A force of 5.0 N pushes a ball due north and another force of 3.0 N pushes it due east.



What is the magnitude of the net force acting on the ball?

- A** 2.8 N **B** 4.0 N **C** 5.8 N **D** 8.0 N
- 2 Decimal sub-multiples and multiples of units are indicated using a prefix to the unit. For example, the prefix milli (m) represents 10^{-3} .

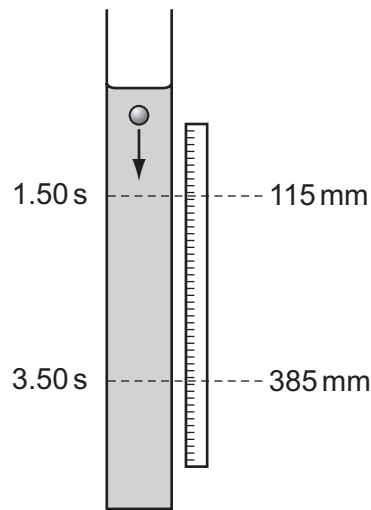
Which row gives the sub-multiples or multiples represented by pico (p) and giga (G)?

	pico (p)	giga (G)
A	10^{-9}	10^9
B	10^{-9}	10^{12}
C	10^{-12}	10^9
D	10^{-12}	10^{12}

- 3 Which definition is correct and uses only quantities rather than units?
- A** Density is mass per cubic metre.
- B** Potential difference is energy per unit current.
- C** Pressure is force per unit area.
- D** Speed is distance travelled per second.

Space for working

- 4 The diagram shows an experiment to measure the speed of a small ball falling at constant speed through a clear liquid in a glass tube.



There are two marks on the tube. The top mark is positioned at 115 ± 1 mm on the adjacent rule and the lower mark at 385 ± 1 mm. The ball passes the top mark at 1.50 ± 0.02 s and passes the lower mark at 3.50 ± 0.02 s.

The constant speed of the ball is calculated by $\frac{385 - 115}{3.50 - 1.50} = \frac{270}{2.00} = 135 \text{ mm s}^{-1}$.

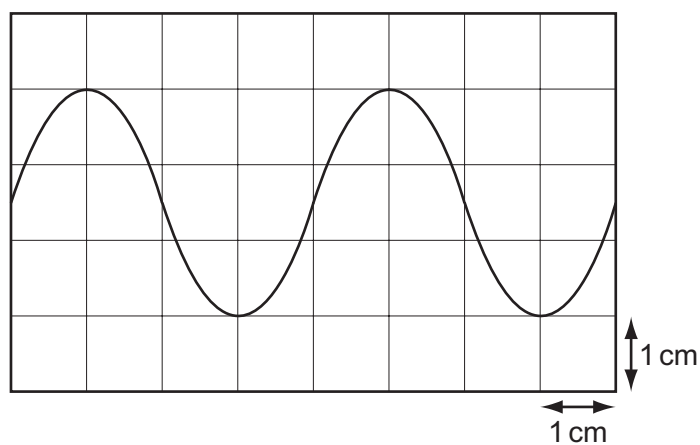
Which expression calculates the fractional uncertainty in the value of this speed?

- A $\frac{2}{270} + \frac{0.04}{2.00}$
- B $\frac{2}{270} - \frac{0.04}{2.00}$
- C $\frac{1}{270} \times \frac{0.02}{2.00}$
- D $\frac{1}{270} \div \frac{0.02}{2.00}$

Space for working

- 5 The diagram shows a trace of a wave on a cathode-ray oscilloscope.

The vertical and horizontal gridlines have a spacing of 1.0 cm. The voltage scaling is 4 V cm^{-1} and the time scaling is 5 ms cm^{-1} .



What are the amplitude and period of the wave?

	amplitude / V	period / ms
A	1.5	4
B	5.0	10
C	6.0	20
D	12.0	20

Space for working

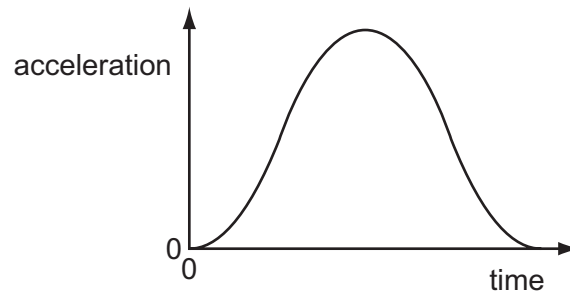
- 6 A body has a weight of 58.9 N when on the Earth. On the Moon, the acceleration of free fall is 1.64 ms^{-2} .

What are the weight and the mass of the body when it is on the Moon?

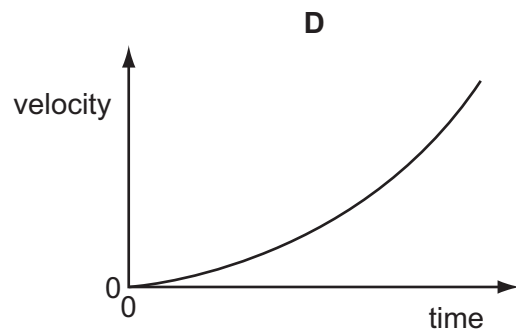
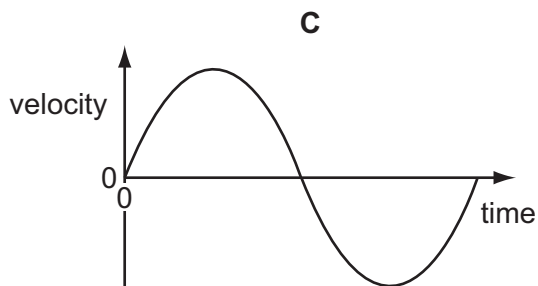
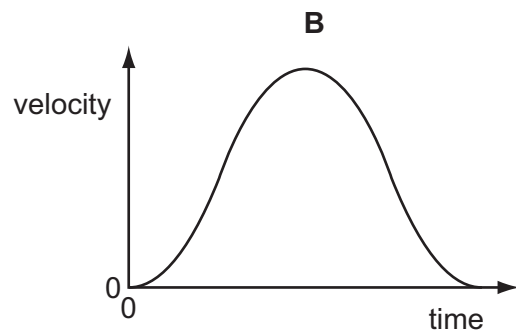
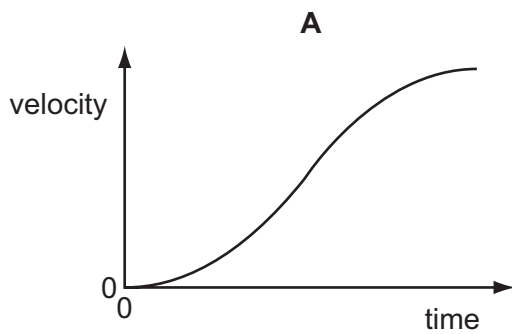
	weight / N	mass / kg
A	9.85	1.00
B	9.85	6.00
C	58.9	1.00
D	58.9	6.00

Space for working

- 7 The graph shows how the acceleration of an object moving in a straight line varies with time.

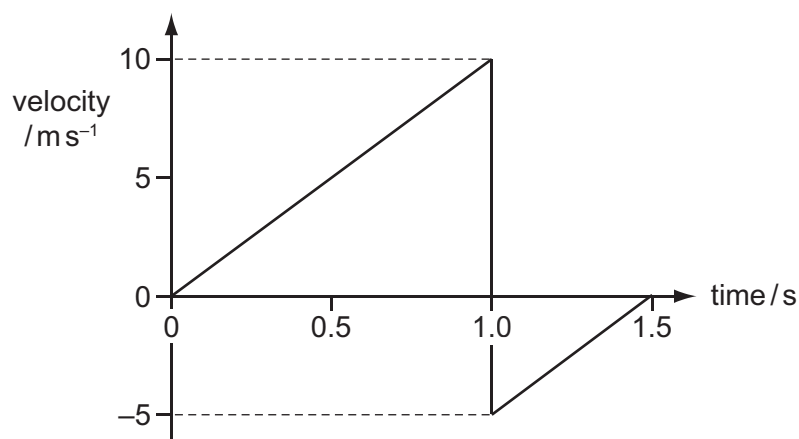


Which graph shows the variation with time of the velocity of the object?



Space for working

- 8 A ball is released from rest at time zero. After 1.0 s it bounces inelastically from a horizontal surface and rebounds, reaching the top of its first bounce after 1.5 s.



What is the total displacement of the ball from its original position after 1.5 s?

- A** 1.25 m **B** 3.75 m **C** 5.00 m **D** 6.25 m
- 9 A molecule of mass m travelling horizontally with velocity u hits a vertical wall at right-angles to its velocity. It then rebounds horizontally with the same speed.

What is its change in momentum?

- A** zero **B** mu **C** $-mu$ **D** $-2mu$

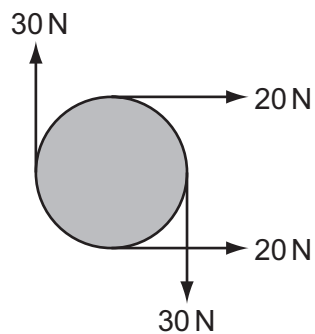
Space for working

- 10 A body of mass m , moving at velocity v , collides with a stationary body of the same mass and sticks to it.

Which row describes the momentum and kinetic energy of the two bodies after the collision?

	momentum	kinetic energy
A	mv	$\frac{1}{4}mv^2$
B	mv	$\frac{1}{8}mv^2$
C	$2mv$	$\frac{1}{2}mv^2$
D	$2mv$	mv^2

- 11 The diagram shows four forces applied to a circular object.

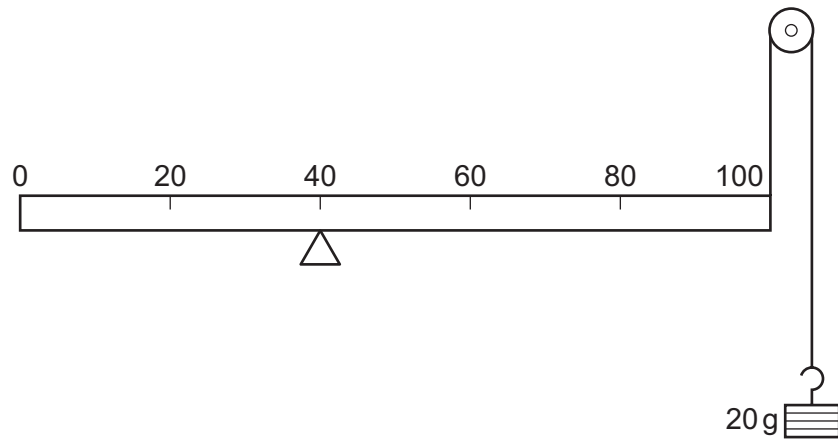


Which row describes the resultant force and resultant torque on the object?

	resultant force	resultant torque
A	zero	zero
B	zero	non-zero
C	non-zero	zero
D	non-zero	non-zero

Space for working

- 12 A uniform metre rule of mass 100 g is supported by a pivot at the 40 cm mark and a string at the 100 cm mark. The string passes round a frictionless pulley and carries a mass of 20 g as shown in the diagram.



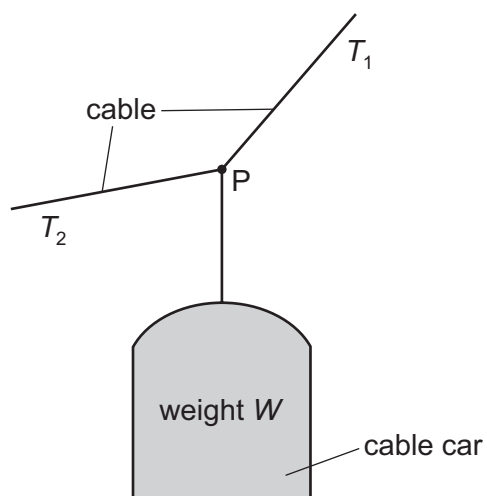
At which mark on the rule must a 50 g mass be suspended so that the rule balances?

- A** 4 cm **B** 36 cm **C** 44 cm **D** 64 cm

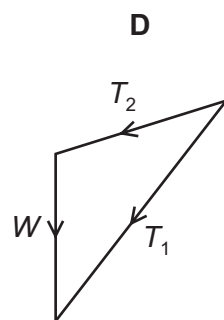
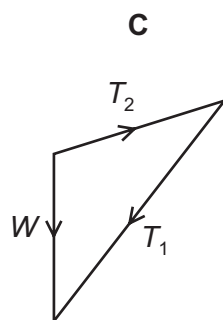
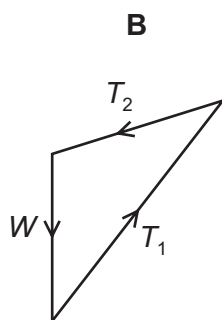
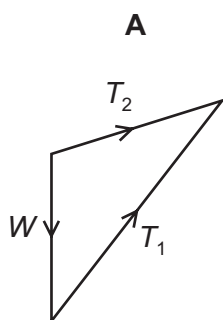
Space for working

13 A cable car of weight W hangs in equilibrium from its cable at point P.

The cable has tensions T_1 and T_2 as shown.



Which diagram correctly represents the forces acting at point P?



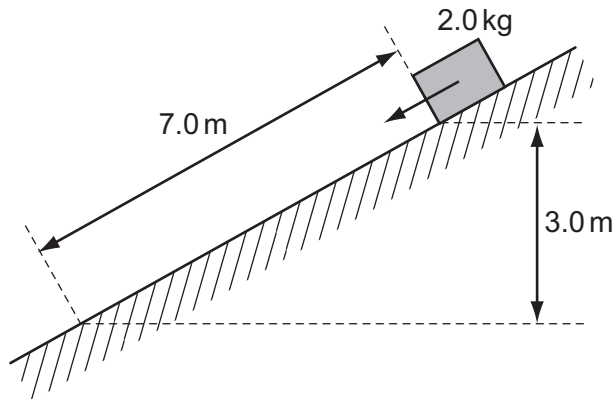
Space for working

- 14** A steel sphere is dropped vertically onto a horizontal metal plate. The sphere hits the plate with a speed u , leaves it at a speed v , and rebounds vertically to half of its original height.

Which expression gives the value of $\frac{v}{u}$?

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

- 15** A block of mass 2.0 kg is released from rest on a slope. It travels 7.0 m down the slope and falls a vertical distance of 3.0 m. The block experiences a frictional force parallel to the slope of 5.0 N.



What is the speed of the block after falling this distance?

- A** 4.9 ms^{-1} **B** 6.6 ms^{-1} **C** 8.6 ms^{-1} **D** 10.1 ms^{-1}
- 16** A body travelling with a speed of 10 ms^{-1} has kinetic energy 1500 J.

If the speed of the body is increased to 40 ms^{-1} , what is its new kinetic energy?

- A** 4500 J **B** 6000 J **C** 24 000 J **D** 1 350 000 J

Space for working

- 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 Which process does **not** require energy to be supplied?

- A boiling
B evaporation
C freezing
D melting

- 19 1.5 m^3 of water is mixed with 0.50 m^3 of alcohol. The density of water is 1000 kg m^{-3} and the density of alcohol is 800 kg m^{-3} .

What is the density of the mixture with volume 2.0 m^3 ?

- A 850 kg m^{-3} B 900 kg m^{-3} C 940 kg m^{-3} D 950 kg m^{-3}

Space for working

20 The Young modulus E can be determined from measurements made when a wire is stretched.

Which quantities would be measured in order to determine E ?

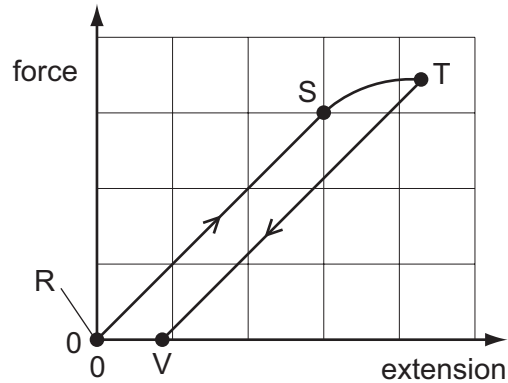
A	mass of stretching load	original length of wire	diameter of wire	extension of wire
B	mass of stretching load	new length of wire	cross-sectional area of wire	diameter of wire
C	mass of wire	original length of wire	cross-sectional area of wire	new length of wire
D	mass of wire	new length of wire	diameter of wire	extension of wire

Space for working

- 21 A long, thin metal wire is suspended from a fixed support and hangs vertically. Masses are suspended from its lower end.

The load on the lower end is increased from zero and then decreased again back to zero.

The diagram shows the force-extension graph produced.



Where on the graph would the elastic limit be found?

- A anywhere between point R and point S
- B beyond point S but before point T
- C exactly at point S
- D exactly at point T

Space for working

- 22** A source of sound of constant power P is situated in an open space. The intensity I of sound at distance r from this source is given by

$$I = \frac{P}{4\pi r^2}.$$

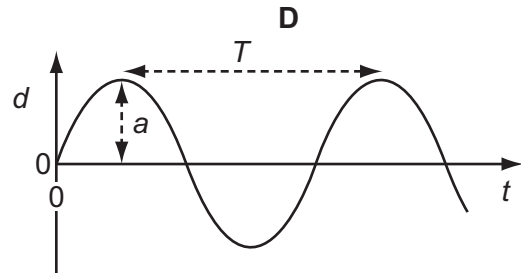
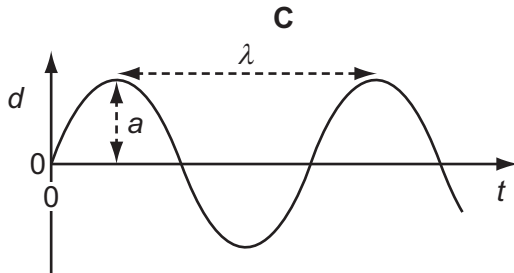
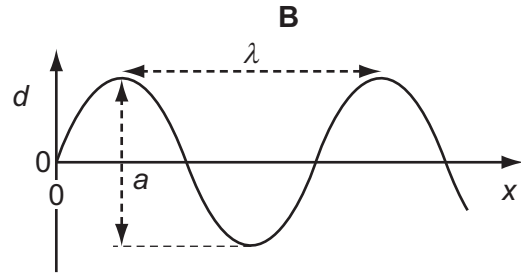
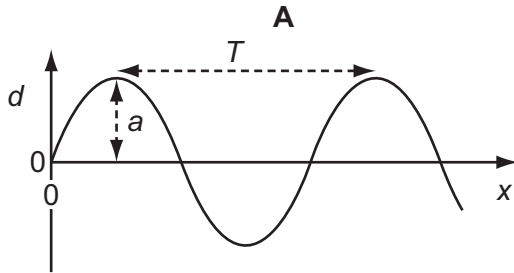
How does the amplitude a of the vibrating air molecules vary with the distance r from the source?

- A** $a \propto \frac{1}{r}$ **B** $a \propto \frac{1}{r^2}$ **C** $a \propto r$ **D** $a \propto r^2$

- 23** The four graphs represent a progressive wave on a stretched string. Graphs **A** and **B** show how the displacement d varies with distance x along the string at one instant. Graphs **C** and **D** show how the displacement d varies with time t at a particular value of x .

The labels on the graphs are intended to show the wavelength λ , the period T and the amplitude a of the wave, but only one graph is correctly labelled.

Which graph is correctly labelled?



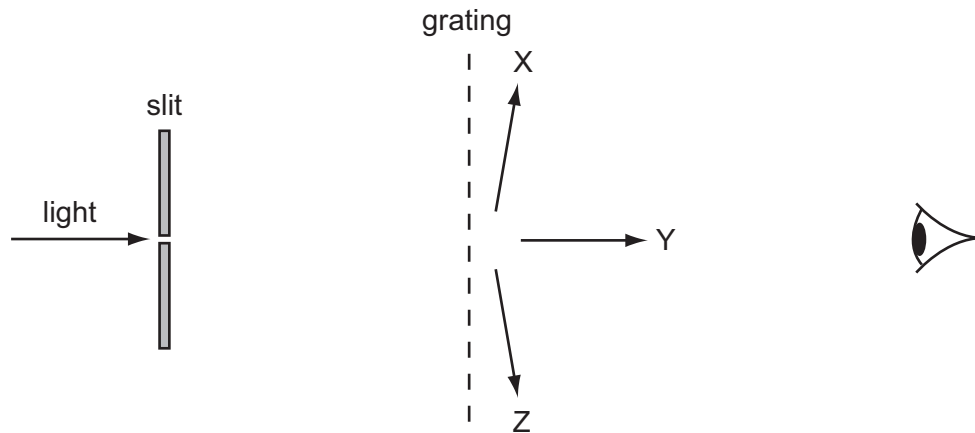
Space for working

- 24** Which statement about sound waves in air at constant temperature is correct?
- A** Amplitude is inversely proportional to velocity.
 - B** Frequency is inversely proportional to wavelength.
 - C** Velocity is proportional to wavelength.
 - D** Wavelength is proportional to amplitude.
- 25** Which electromagnetic wave phenomenon is needed to explain the spectrum produced when white light falls on a diffraction grating?
- A** coherence
 - B** interference
 - C** polarisation
 - D** refraction

Space for working

- 26 A diffraction grating with 500 lines per mm is used to observe diffraction of monochromatic light of wavelength 600 nm.

The light is passed through a narrow slit and the grating is placed so that its lines are parallel to the slit. Light passes through the slit and then the grating.



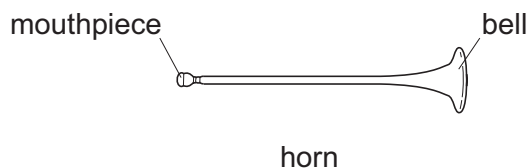
An observer views the slit through the grating at different angles, moving his head from X parallel to the grating, through Y, opposite the slit, to Z parallel to the grating on the opposite side.

How many images of the slit does he see?

- A 3 B 4 C 6 D 7

Space for working

- 27 The basic principle of note production in a horn is to set up a stationary wave in an air column.



For the lowest note produced by a horn, a node is formed at the mouthpiece and the antinode is formed at the bell. The frequency of this note is 75 Hz.

What are the frequencies of the next two higher notes for this air column?

	first higher note / Hz	second higher note / Hz
A	113	150
B	150	225
C	150	300
D	225	375

- 28 Two parallel plates, a distance 25 mm apart, have a potential difference between them of 12 kV.

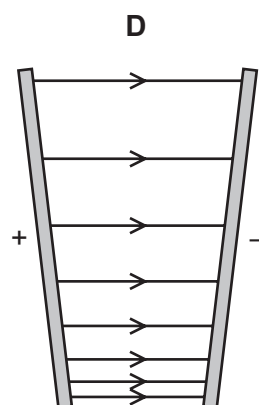
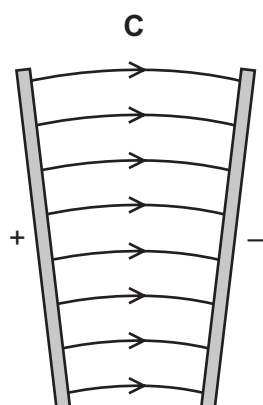
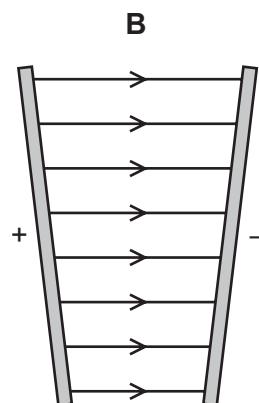
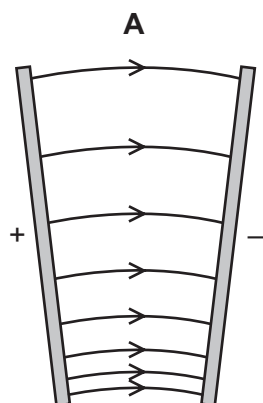
What is the force on an electron when it is in the uniform electric field between the plates?

- A** $4.8 \times 10^{-20} \text{ N}$
B $7.7 \times 10^{-20} \text{ N}$
C $4.8 \times 10^{-17} \text{ N}$
D $7.7 \times 10^{-14} \text{ N}$

Space for working

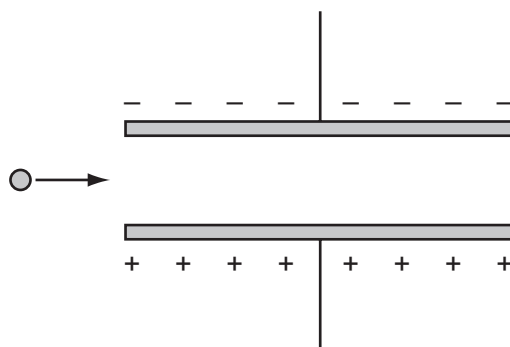
29 A potential difference is applied between two metal plates that are **not** parallel.

Which diagram shows the electric field between the plates?



Space for working

- 30 The diagram shows a charged particle as it approaches a pair of charged parallel plates in a vacuum.



Which row describes the horizontal and vertical components of its motion as it travels between the plates?

	horizontal component	vertical component
A	constant acceleration	constant acceleration
B	constant acceleration	constant velocity
C	constant velocity	constant acceleration
D	constant velocity	constant velocity

- 31 A battery is marked 9.0 V.

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.

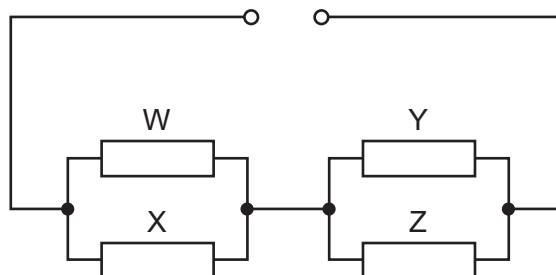
Space for working

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

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}

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

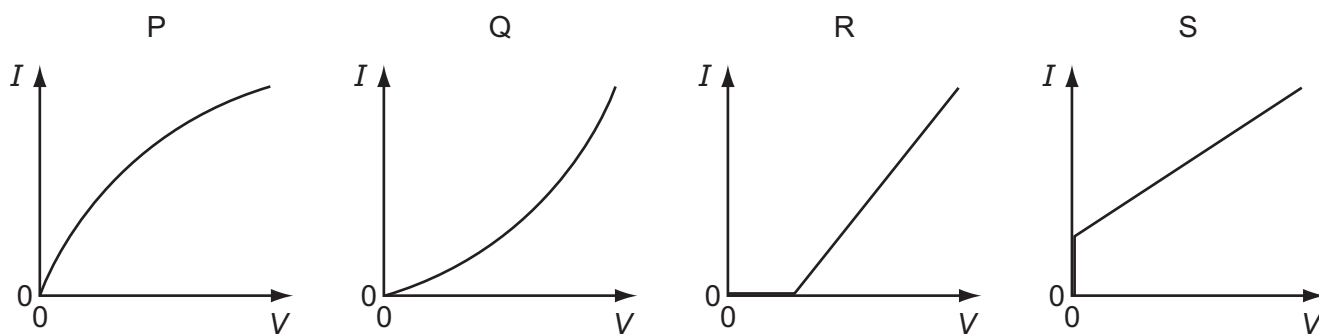


How will the powers to the resistors change when resistor W is removed?

- 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.

Space for working

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

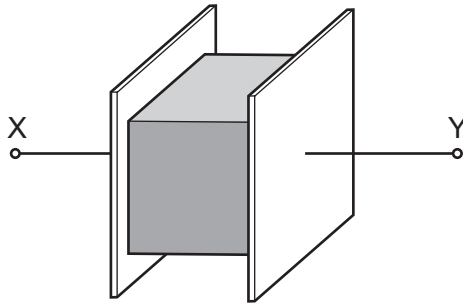


Which row best specifies the correct I - V graphs for the lamp and the diode?

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

Space for working

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



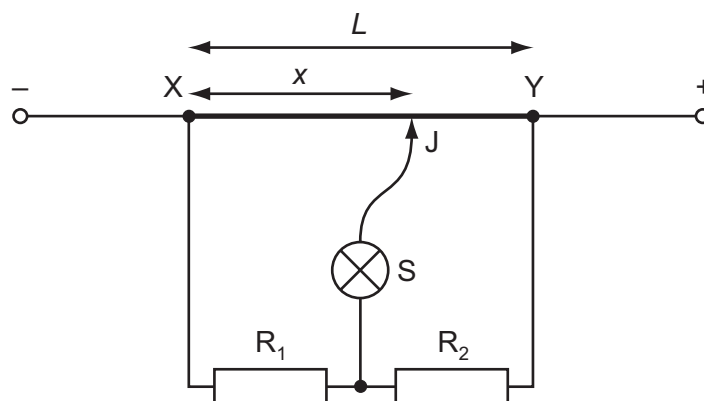
The cube has volume V and is made of a material with resistivity ρ . The connections to the cube have negligible resistance.

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

Space for working

- 36 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.



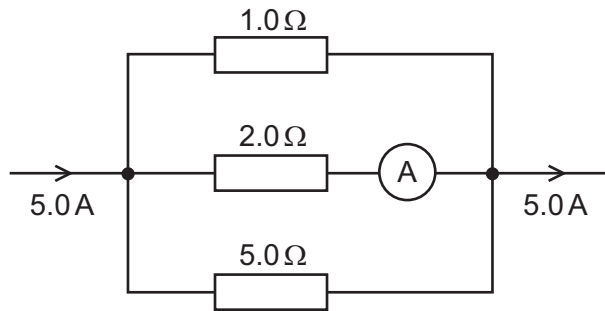
To determine the ratio $\frac{V_1}{V_2}$ of the potential differences across R_1 and R_2 , a point is found on XY at which the lamp is off. This point is at a distance x from X.

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 $\frac{x}{L-x}$

Space for working

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



What is the reading on the ammeter?

- A** 0.7 A **B** 1.3 A **C** 1.5 A **D** 1.7 A
- 38 Which statement about nuclei is correct?
- A** Different isotopic nuclei have different proton numbers.
B For some nuclei, the nucleon number can be less than the proton number.
C In some nuclear processes, mass-energy is not conserved.
D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

Space for working

- 39 The first artificial radioactive substance was made by bombarding aluminium, ${}_{13}^{27}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, ${}_{15}^{30}\text{P}$.

What was the by-product of this reaction?

- A an α -particle
- B a β -particle
- C a γ -ray
- D a neutron

- 40 Uranium-238, ${}_{92}^{238}\text{U}$, decays by α -emission into a daughter product which in turn decays by β -emission into a grand-daughter product.

What is the grand-daughter product?

- A ${}_{90}^{234}\text{Th}$ B ${}_{91}^{234}\text{Pa}$ C ${}_{92}^{234}\text{U}$ D ${}_{90}^{230}\text{Th}$

Space for working