Cambridge Assessment International Education

Cambridge International AS & A Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **May/June 2020**

1 hour 15 minutes

You must answer on the multiple choice answer sheet.

You will need: Multiple choice answer sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)

INSTRUCTIONS

- 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 multiple choice answer sheet.
- Follow the instructions on the multiple choice answer sheet.
- Write in soft pencil.
- Write your name, centre number and candidate number on the multiple choice answer sheet in the spaces provided unless this has been done for you.
- Do **not** use correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.

INFORMATION

- The total mark for this paper is 40.
- Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
- Any rough working should be done on this question paper.

This document has **20** pages. Blank pages are indicated.

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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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1})$
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	$m_\text{e} = 9.11 \times 10^{-31}\,\text{kg}$
rest mass of proton	$m_\text{p} = 1.67 \times 10^{-27}\,\text{kg}$
molar gas constant	$R = 8.31\,\text{J K}^{-1}\,\text{mol}^{-1}$
the Avogadro constant	$N_\text{A} = 6.02 \times 10^{23}\,\text{mol}^{-1}$
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	$g = 9.81\,\text{m s}^{-2}$

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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	$V = \frac{Q}{4\pi\varepsilon_0 r}$
capacitors in series	$1/C = 1/C_1 + 1/C_2 + \ldots$
capacitors in parallel	$C = C_1 + C_2 + \ldots$
energy of charged capacitor	$W = \frac{1}{2}QV$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
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	$\lambda = \frac{0.693}{t_{\frac{1}{2}}}$

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[Turn over

1 What is a reasonable estimate of the kinetic energy of a car travelling at a speed of $30\,\text{m}\,\text{s}^{-1}$?

A $10^2\,\text{J}$ **B** $10^4\,\text{J}$ **C** $10^6\,\text{J}$ **D** $10^8\,\text{J}$

2 The frequency f of vibration of a mass m supported by a spring with spring constant k is given by the equation

$$f = Cm^p k^q$$

where C is a constant with no units.

What are the values of p and q?

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

3 The power produced by a force moving an object is given by the equation shown.

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

Which quantities are scalars and which are vectors?

	scalars	vectors
A	displacement, time	force, power
B	power, work	displacement, force
C	power, force	displacement, work
D	work, time	power, displacement

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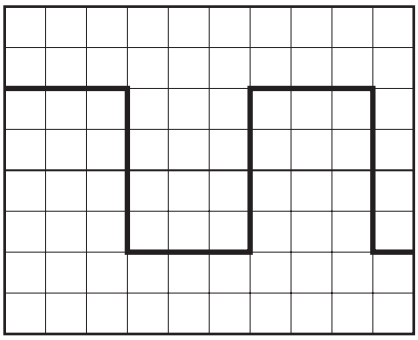
4 A cathode-ray oscilloscope displays a square wave, as shown.



The time-base setting is 0.20 ms per division.

What is the frequency of the square wave?

A 0.83 Hz **B** 830 Hz **C** 1300 Hz **D** 1700 Hz

5 A measurement is taken correctly but with a ruler at a significantly higher temperature than that at which the ruler was calibrated. The higher temperature causes the ruler to expand.

What describes the effect on the measurement caused by the higher temperature and how the measurement may be improved?

A The measurement will be subject to a random error. The measurement can be made more accurate by taking the average of several repeated measurements.

B The measurement will be subject to a random error. The measurement can be made more precise by taking the average of several repeated measurements.

C The measurement will be subject to a systematic error. The measurement can be made more accurate by taking the average of several repeated measurements.

D The measurement will be subject to a systematic error. The measurement can be made more precise by taking the average of several repeated measurements.

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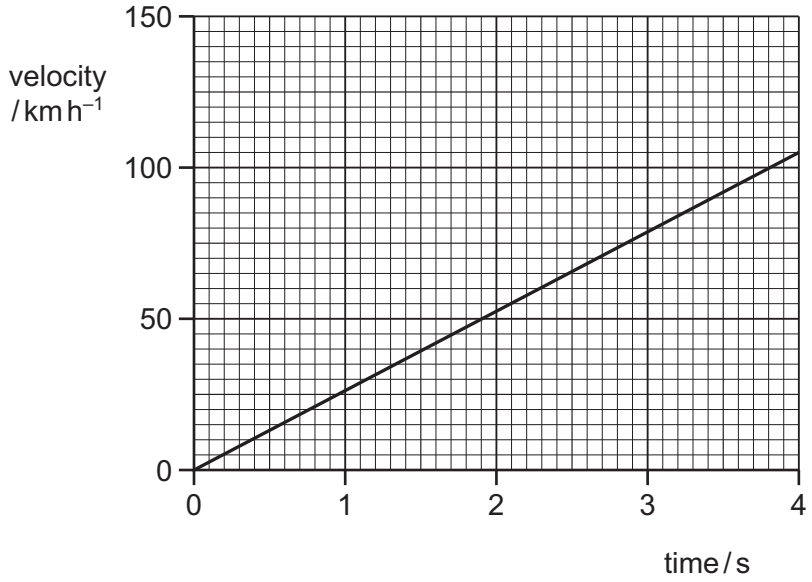
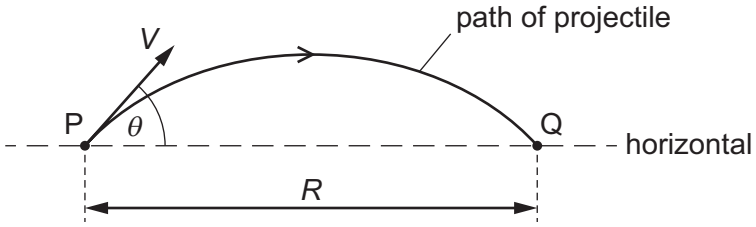
6 The velocity of an electric car changes as shown.



What is the acceleration of the car?

A 210 m s^{-2} **B** 58 m s^{-2} **C** 26 m s^{-2} **D** 7.3 m s^{-2}

7 A projectile is fired from point P with velocity V at an angle θ to the horizontal. It lands at point Q, a horizontal distance R from P, after time T.



The acceleration of free fall is g. Air resistance is negligible.

Which equation is correct?

A $R = VT\cos\theta$

B $R = VT\sin\theta$

C $R = VT\cos\theta - \frac{1}{2}gT^2$

D $R = VT\sin\theta - \frac{1}{2}gT^2$

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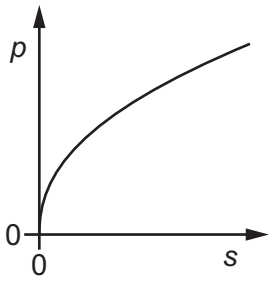
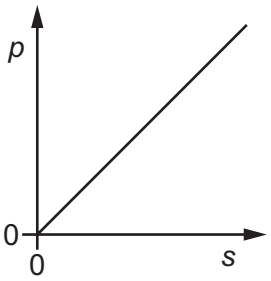
8 A car accelerates from rest in a straight line with constant acceleration.

Which graph best represents the variation of the momentum p of the car with the distance s travelled by the car?

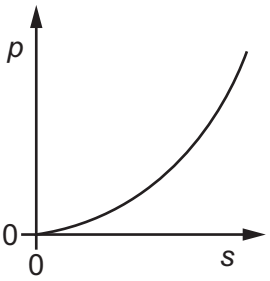
A



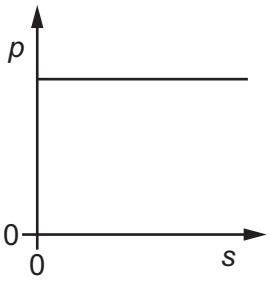
B



C



D



9 The resultant force F on a raindrop of mass m falling with velocity v is given by the equation

$$F = mg - kv^2$$

where k is a constant and g is the acceleration of free fall.

What is the velocity of the raindrop when it reaches a constant (terminal) velocity?

A $\sqrt{\frac{k}{mg}}$ **B** $\frac{k}{mg}$ **C** $\sqrt{\frac{mg}{k}}$ **D** $\frac{mg}{k}$

10 A stationary toy gun fires a bullet.

Which statement about the bullet and the gun, immediately after firing, is **not** correct?

A The force exerted on the bullet by the gun has the same magnitude as the force exerted on the gun by the bullet.

B The force exerted on the bullet by the gun is in the opposite direction to the force exerted on the gun by the bullet.

C The gun and the bullet have the same magnitude of momentum.

D The kinetic energy of the gun must equal the kinetic energy of the bullet.

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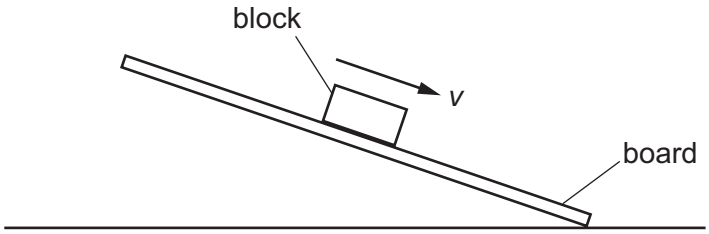
11 A wooden block rests on the rough surface of a board. One end of the board is then raised until the block slides down the board at constant velocity *v*.



What describes the forces acting on the block when it is sliding with constant velocity?

	frictional force on block	resultant force on block
A	down the board	down the board
B	down the board	zero
C	up the board	down the board
D	up the board	zero

12 Which statement best describes a couple?

A a pair of forces of equal magnitude acting in opposite directions which produce rotational motion but not translational motion

B a pair of forces of equal magnitude acting in opposite directions which produce translational motion but not rotational motion

C a pair of forces of equal magnitude acting in the same direction which produce rotational motion but not translational motion

D a pair of forces of equal magnitude acting in the same direction which produce translational motion but not rotational motion

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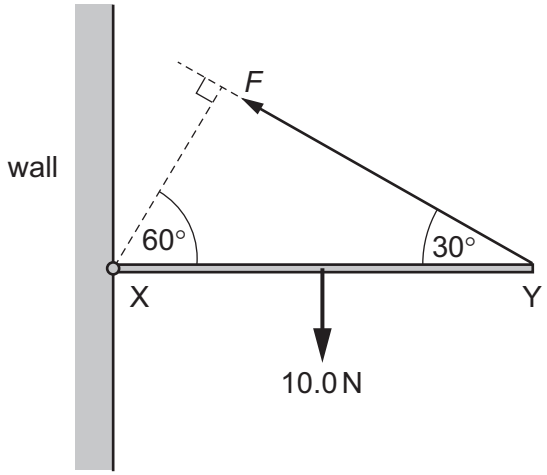
13 A uniform rod XY of weight 10.0 N is freely hinged to a wall at X. It is held horizontal by a force *F* acting from Y at an angle of 30° to the horizontal, as shown.



What is the value of *F*?

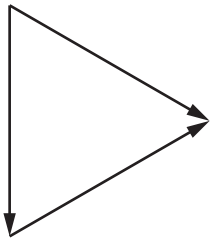
A 5.0 N **B** 8.7 N **C** 10.0 N **D** 20.0 N

14 Four combinations of vectors are shown, each representing all the forces acting on an object. The forces all act in the same plane.

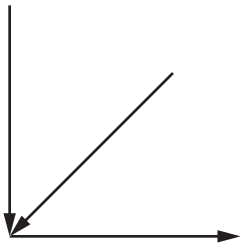
The object is in equilibrium.

Which combination of vectors could represent the forces acting on the object?

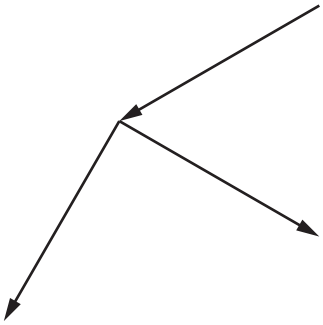
A



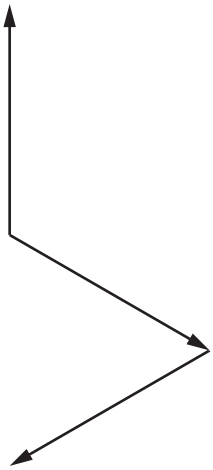
B



C



D



15 A rectangular metal bar exerts a pressure of 15 200 Pa on the horizontal surface on which it rests.

The height of the metal bar is 80 cm.

What is the density of the metal?

A 190 kg m^{-3}

B 1900 kg m^{-3}

C 19 000 kg m^{-3}

D 190 000 kg m^{-3}

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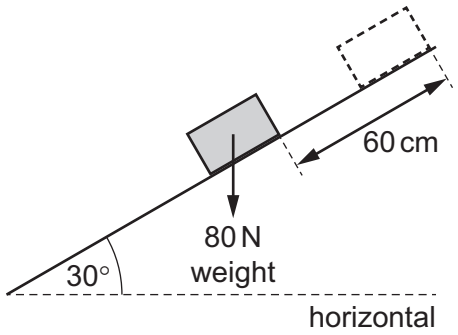
16 A mass attached to the lower end of a spring bounces up and down.

At which points in the path of the mass do the gravitational potential energy of the mass (GPE), the elastic potential energy in the spring (EPE) and the kinetic energy of the mass (KE) have their highest values?

	GPE	EPE	KE
A	bottom	middle	top
B	bottom	top	middle
C	top	bottom	middle
D	top	bottom	top

17 A block of weight 80 N is pushed a distance of 60 cm up a slope inclined at 30° to the horizontal. There is a frictional force of 25 N between the block and the surface of the slope.



What is the work W_g done against the gravitational force and the work W_f done against the frictional force?

	W_g / J	W_f / J
A	24	7.5
B	24	15
C	48	7.5
D	48	15

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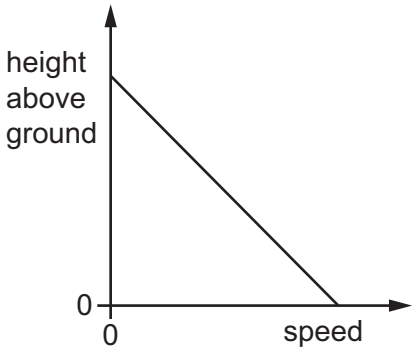
[Turn over

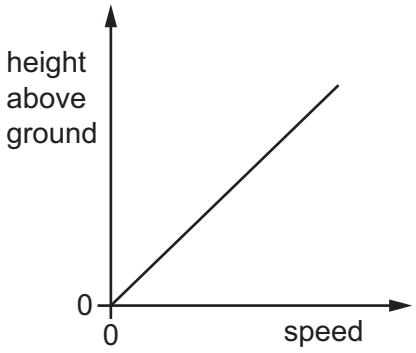
18 A ball is dropped from rest and falls towards the ground. Air resistance is negligible.

Which graph shows the variation with speed of the height of the ball above the ground?

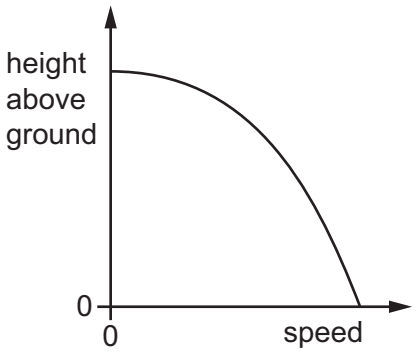
A



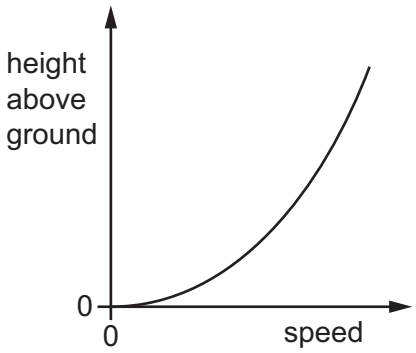
B



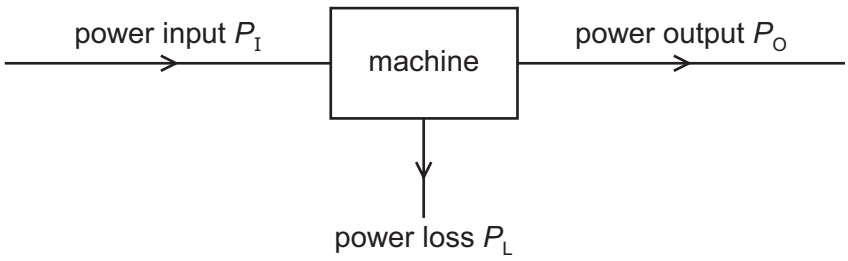
C



D



19 Power is transferred through a machine as shown.



What is the efficiency of the machine?

A $\frac{P_I}{P_O + P_L}$ **B** $\frac{P_L}{P_I}$ **C** $\frac{P_L}{P_O}$ **D** $\frac{P_O}{P_I}$

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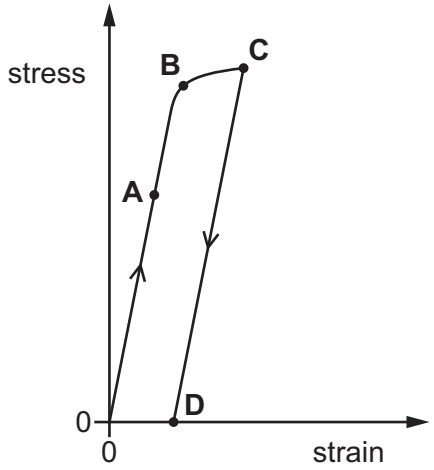
20 A tensile force is used to extend a sample of a material. The force is then removed.

The variation with strain of the applied stress is shown on the graph.

Which point on the graph could represent the elastic limit for the material?



21 A tensile force is applied to an unstretched rubber band, causing it to stretch. The tensile force is then removed.

Which statement about the rubber band **must** be correct?

A If the rubber band stretches elastically and plastically, all the work done by the force is converted to thermal energy in the rubber.

B If the rubber band stretches elastically, it obeys Hooke's law.

C If the rubber band stretches elastically, the gradient of the force–extension graph represents the work done by the force.

D If the rubber band stretches plastically, the rubber band will be longer after the force is removed than it was before the force is applied.

22 A sound wave reduces in intensity but maintains a constant frequency as it travels through air.

Which statement is correct?

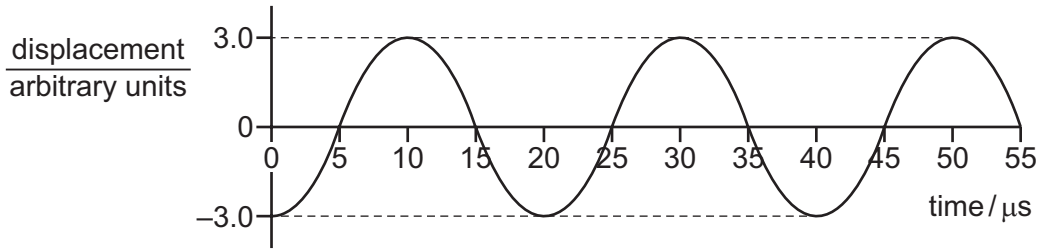
A The maximum displacement of the particles changes between one particle and the next particle.

B The phase difference between adjacent particles is zero.

C The wavelength is the distance between two particles that have a phase difference of 180°.

D Two particles that have a phase difference of 360° have the same maximum displacement.

23 The graph shows the variation with time of the displacement of an electromagnetic wave at a point.



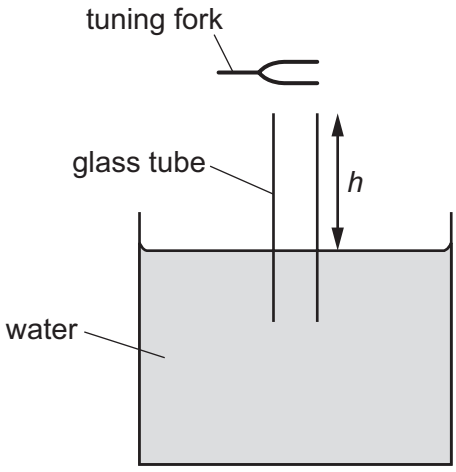
The wave is travelling in a vacuum.

What is the amplitude and what is the wavelength of the wave?

	amplitude / arbitrary units	wavelength / m
A	3.0	6000
B	6.0	6000
C	3.0	7500
D	6.0	7500

24 A long glass tube is almost completely immersed in a large tank of water. A tuning fork is struck and held just above the open end of the tube as it is slowly raised.

A louder sound is first heard when the height *h* of the end of the tube above the water is 18.8 cm. A louder sound is next heard when *h* is 56.4 cm. The speed of sound in air is 330 m s^{-1}.



What is the frequency of the sound produced by the tuning fork?

A 220 Hz **B** 440 Hz **C** 660 Hz **D** 880 Hz

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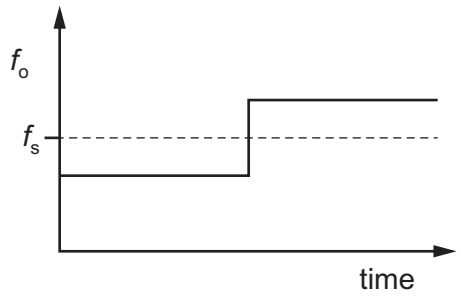
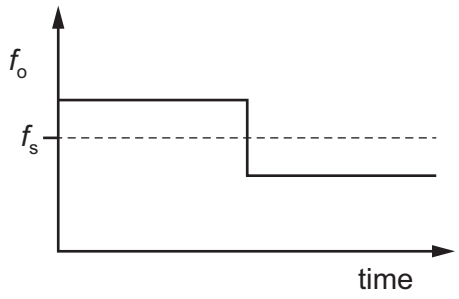
25 A source emitting sound of a single frequency f_s travels at constant speed directly towards an observer. The source then passes the observer and continues to move directly away from the observer. The velocity of the source remains constant.

Which graph represents the variation with time of the frequency f_o of the sound heard by the observer?

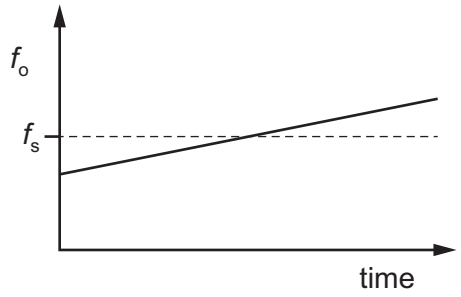
A



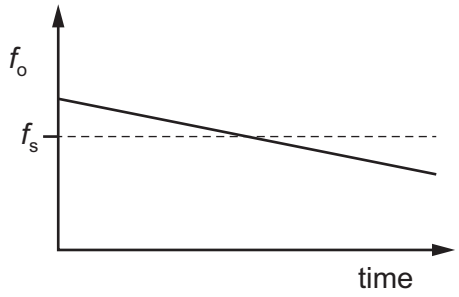
B



C



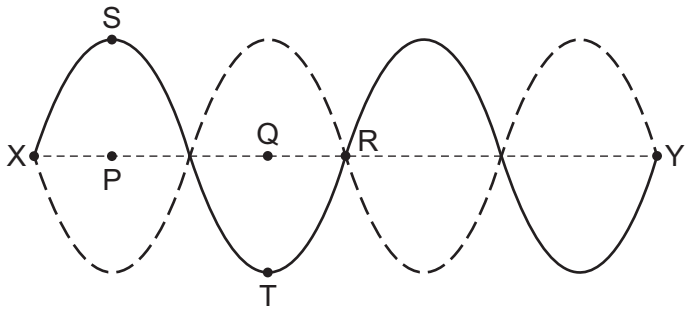
D



26 What are the names of the electromagnetic waves that have wavelengths in a vacuum of 100 pm and of 100 μm?

	wavelength 100 pm	wavelength 100 μm
A	γ-rays	infrared
B	γ-rays	red light
C	X-rays	infrared
D	X-rays	red light

27 The diagram shows a string stretched between fixed points X and Y. There is a stationary wave on the string.



The solid curve shows the string at a position of maximum displacement. The dashed curve shows the other position of maximum displacement. The straight central dashed line shows the mean position of the string. Point S on the string is directly above point P. Point T on the string is directly below Q.

Which statement is correct?

A A short time later, point R on the string will be displaced.

B Points S and T on the string move in opposite directions.

C The distance between P and Q is one wavelength.

D Two points on the string that are equal distances from point R vibrate in phase.

28 Which statement **must** be true for diffraction to occur when a wave passes through a gap?

A The wave is able to travel in a vacuum.

B The wave is progressive.

C The wave has a large amplitude.

D The wave has a long wavelength.

29 Light of a single wavelength is incident normally on two slits that are 0.20 mm apart. Interference fringes are observed on a screen that is 5.4 m away from the slits. The distance between successive bright fringes is 12 mm.

What is the wavelength of the light?

A 440 nm **B** 540 nm **C** 650 nm **D** 900 nm

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30 A diffraction grating and a screen are used to determine the single wavelength λ of the light from a source.

What is an essential feature of this experiment?

A A curved screen must be used.

B The diffraction angle θ must be measured for at least two interference maxima.

C The light waves incident on the grating must be coherent.

D The third order intensity maximum must be produced.

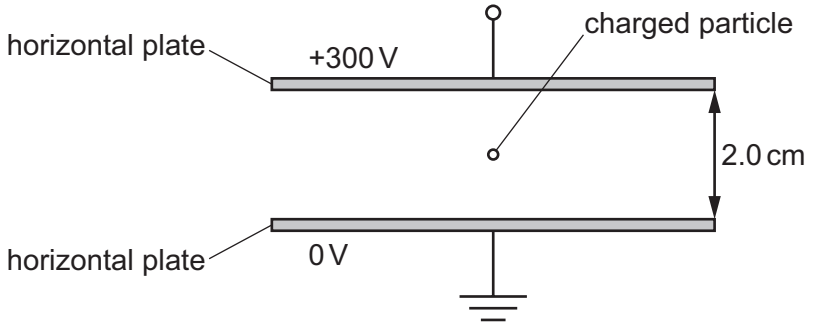
31 A small charge q is placed in the electric field of a large charge Q.

Both charges experience a force F.

What is the electric field strength of the charge Q at the position of the charge q?

A $\frac{F}{Qq}$ **B** $\frac{F}{Q}$ **C** FqQ **D** $\frac{F}{q}$

32 A charged particle is in a vacuum between two horizontal metal plates as shown.



The acceleration of the particle is $7.15 \times 10^{11}\,\text{m s}^{-2}$ downwards. The particle has a mass of $3.34 \times 10^{-27}\,\text{kg}$.

What is the charge on the particle?

A $+1.6 \times 10^{-19}\,\text{C}$

B $-1.6 \times 10^{-19}\,\text{C}$

C $+1.6 \times 10^{-17}\,\text{C}$

D $-1.6 \times 10^{-17}\,\text{C}$

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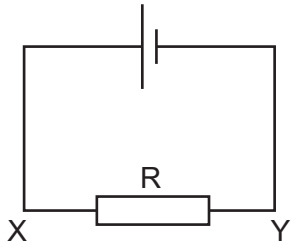
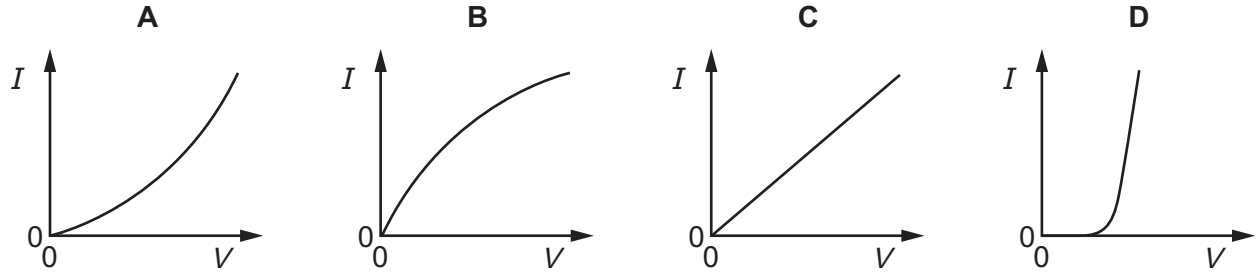
33 The current in the circuit shown is 3.2 mA.



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

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

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



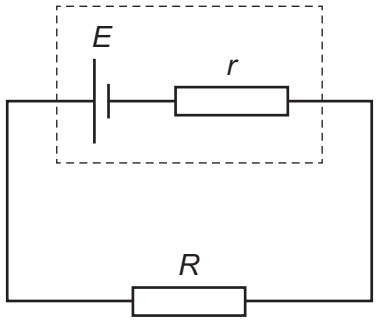
35 A cylindrical metal wire X has resistance R. The same volume of the same metal is made into a cylindrical wire Y of double the length.

What is the resistance of wire Y?

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

36 A cell of electromotive force (e.m.f.) E and internal resistance r is connected to a resistor of resistance R.

A maximum power P can be dissipated by the resistor without overheating.



What is the maximum value of E if the resistor does not overheat?

A $R\sqrt{\dfrac{P}{(R-r)}}$ **B** $R\sqrt{\dfrac{P}{(R+r)}}$ **C** $(R-r)\sqrt{\dfrac{P}{R}}$ **D** $(R+r)\sqrt{\dfrac{P}{R}}$

37 Three identical resistors can be connected together in four different ways.

The resistances of two of these combinations are $4.0\,\Omega$ and $9.0\,\Omega$.

What is the resistance of each individual resistor?

A $3.0\,\Omega$ **B** $6.0\,\Omega$ **C** $12\,\Omega$ **D** $18\,\Omega$

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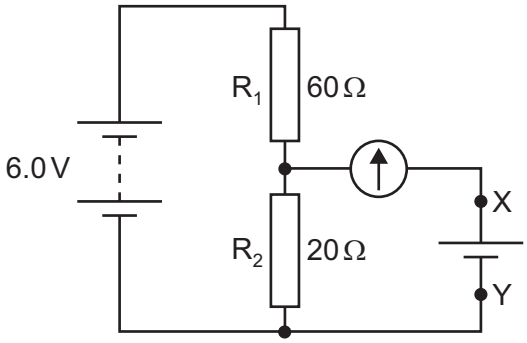
38 In the circuit shown, a battery of negligible internal resistance is connected in series with a pair of fixed resistors R_1 and R_2.



The circuit is to be used to test whether the electromotive force (e.m.f.) of a particular cell is 1.5 V. The cell is connected between terminals X and Y in parallel with R_2 and in series with a galvanometer.

Which statement about the test is correct?

A Any non-zero reading on the galvanometer means the cell has an e.m.f. of 1.5 V.

B The battery does not need to have an e.m.f. of 6.0 V.

C The cell may be connected either way round between X and Y.

D The galvanometer does not need a scale calibrated in amperes.

39 An element has two isotopic forms.

What are the nuclear arrangements of these two isotopes?

A They have different nucleon numbers and different proton numbers.

B They have different nucleon numbers but the same proton number.

C They have the same nucleon number and the same proton number.

D They have the same nucleon number but different proton numbers.

40 A hadron has a charge +*e*, where *e* is the elementary charge.

Which combination of up (u) and down (d) quarks could form this hadron?

A ddd **B** udd **C** uud **D** uuu

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