Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/13**

Paper 1 Multiple Choice **October/November 2017**

1 hour 15 minutes

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

9755943697

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.

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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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\text{F m}^{-1}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\text{m F}^{-1}\right)$
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 How many cubic nanometres, nm^3, are in a cubic micrometre, μm^3?

A 10^3 **B** 10^6 **C** 10^9 **D** 10^{12}

2 The maximum theoretical power P of a wind turbine is given by the equation

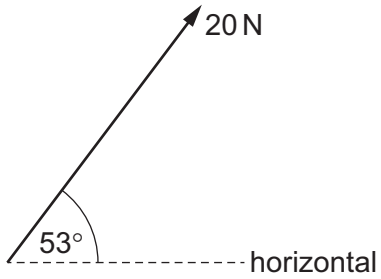
$$P = k\rho A v^n$$

where ρ is the density of air, A is the area swept by the turbine blades, v is the speed of the air and k is a constant with no units.

What is the value of n?

A 1 **B** 2 **C** 3 **D** 4

3 What is the horizontal component of the force shown?



A 12 N **B** 16 N **C** 20 N **D** 27 N

4 A school has a piece of aluminium that it uses for radioactivity experiments. Its thickness is marked as 3.2 mm. A student decides to check this value. He has vernier calipers which give measurements to 0.1 mm and a micrometer which gives measurements to 0.01 mm.

Which statement **must** be correct?

A The micrometer gives a more accurate measurement.

B The micrometer gives a more precise measurement.

C The vernier calipers give a more accurate measurement.

D The vernier calipers give a more precise measurement.

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5 Four possible sources of error in a series of measurements are listed.

1 an analogue meter whose scale is read from different angles

2 a meter which always measures 5% too high

3 a meter with a needle that is not frictionless, so the needle sometimes sticks slightly

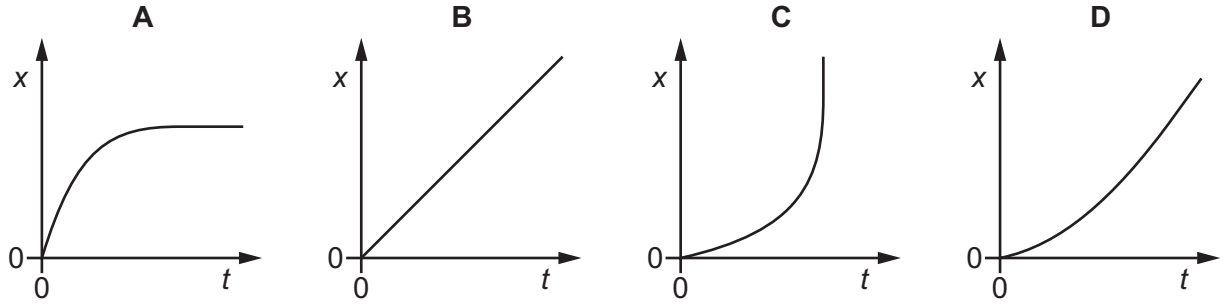
4 a meter with a zero error

Which errors are random and which are systematic?

	random error	systematic error
A	1 and 2	3 and 4
B	1 and 3	2 and 4
C	2 and 4	1 and 3
D	3 and 4	1 and 2

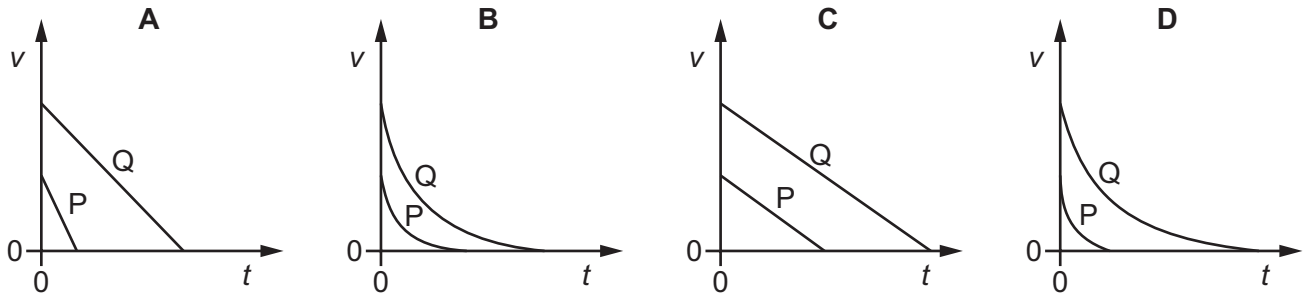
6 A football falls from the top of a tall building.

Which graph best represents the way in which the distance *x* fallen varies with time *t*?

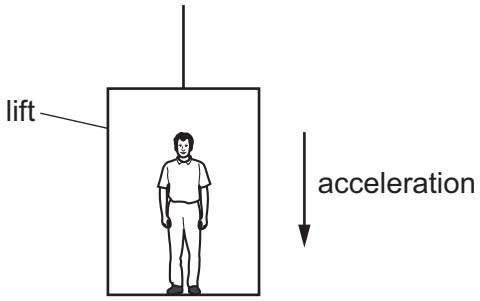


7 Two identical cars P and Q are travelling along a straight road. Car Q is travelling at twice the speed of car P. The brakes are applied to both cars, producing the same constant deceleration.

Which graph shows how the velocity *v* of each car varies with time *t*?



8 A man stands in a lift that is accelerating vertically downwards, as shown.



Which statement describes the force exerted by the man on the floor?

A It is equal to the weight of the man.

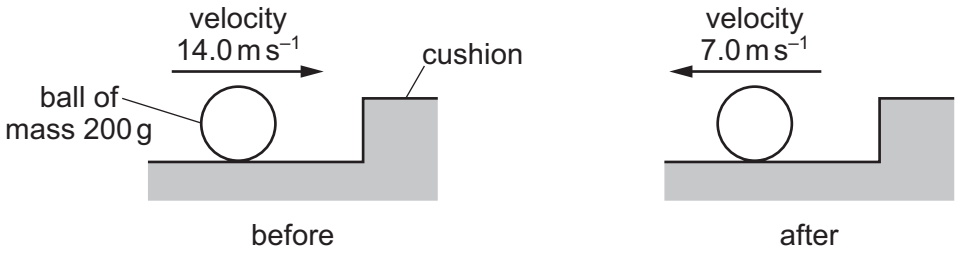
B It is greater than the force exerted by the floor on the man.

C It is less than the force exerted by the floor on the man.

D It is less than the weight of the man.

9 A snooker ball of mass 200 g hits the cushion of a snooker table at right-angles with a speed of $14.0\,m\,s^{-1}$.

The ball rebounds with half of its initial speed. The ball is in contact with the cushion for 0.60 s.



What is the average force exerted on the ball by the cushion?

A 2.3 N **B** 7.0 N **C** 2300 N **D** 7000 N

10 Two railway trucks of masses m and $3m$ move towards each other in opposite directions with speeds $2v$ and v respectively. These trucks collide and stick together.

What is the speed of the trucks after the collision?

A $\frac{v}{4}$ **B** $\frac{v}{2}$ **C** v **D** $\frac{5v}{4}$

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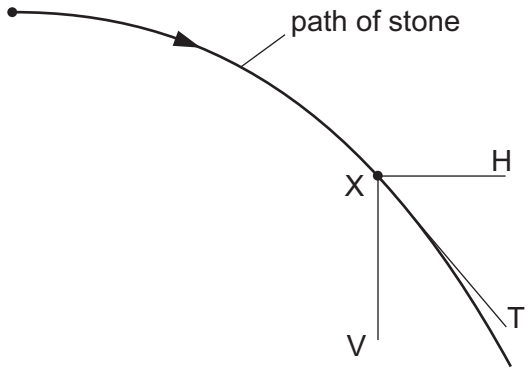
11 A stone is projected horizontally in a vacuum and moves along the path shown.

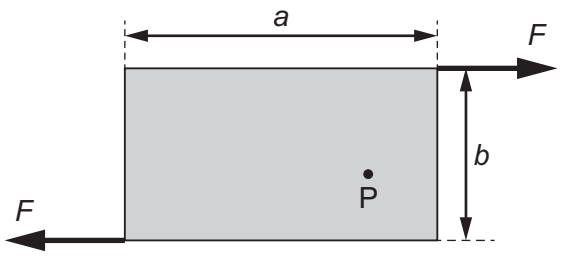


X is a point on this path. XV and XH are vertical and horizontal lines respectively through X. XT is the tangent to the path at X.

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

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

12 Two forces, each of magnitude *F*, act along the edges of a rectangular metal plate, as shown.

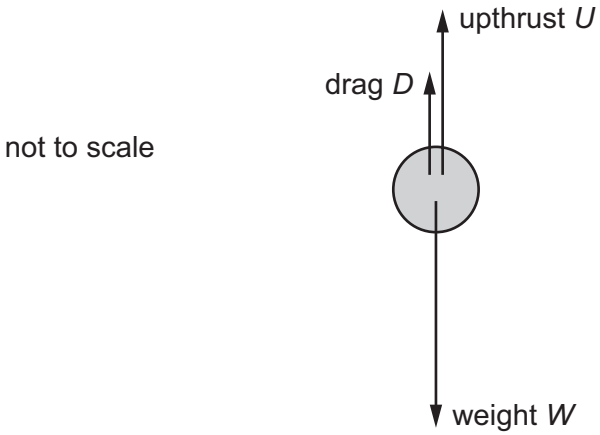


The plate has length *a* and width *b*.

What is the torque about point P?

A *Fa* **B** *Fb* **C** 2*Fa* **D** 2*Fb*

13 A solid sphere falls at constant (terminal) velocity in a liquid. The three forces acting on the sphere are shown in the diagram.



How are the three forces related?

A $W + D = U$

B $W > U + D$

C $W - U = D$

D $W < D + U$

14 A thin horizontal plate of area $0.036\,m^2$ is beneath the surface of a liquid of density $930\,kg\,m^{-3}$. The force on one side of the plate due to the pressure of the liquid is 290 N.

What is the depth of the plate beneath the surface of the liquid?

A 0.88 m **B** 1.1 m **C** 1.8 m **D** 8.7 m

15 A ball is thrown vertically upwards. Air resistance is negligible.

Which statement is correct?

A By the principle of conservation of energy, the total energy of the ball is constant throughout its motion.

B By the principle of conservation of momentum, the momentum of the ball is constant throughout its motion.

C The kinetic energy of the ball is greatest at the greatest height attained.

D The potential energy of the ball increases at a constant rate during its ascent.

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16 A car of total mass 1560 kg is travelling with a constant speed of 32 m s^{-1}. The driving force provided by the car is 680 N. The kinetic energy of the car is 800 kJ and its momentum is 50 000 N s.

Which two items of data could be used to calculate the useful power output of the car?

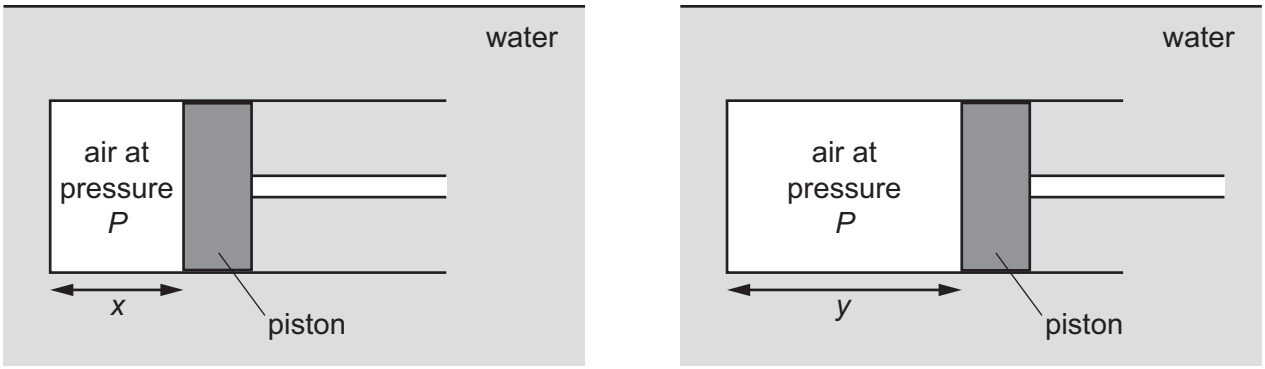
A driving force and momentum

B kinetic energy and mass

C mass and momentum

D speed and driving force

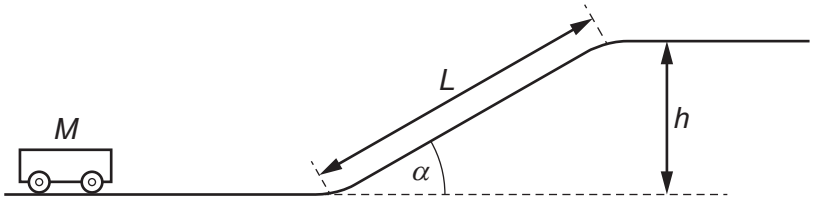
17 A horizontal cylinder of cross-sectional area A is fitted with a frictionless piston and contains air at pressure P. It is immersed in hot water and the length of the air column increases from x to y. The pressure P is constant.



Which equation represents the work done by the trapped air during this process?

A PAy **B** $-PAy$ **C** $PA(y - x)$ **D** $-PA(y - x)$

18 A trolley rolls along a horizontal surface and then travels up a slope before reaching a second horizontal surface. The slope is of length L. The trolley has mass M. The slope is at an angle α to the horizontal surface. The second horizontal surface is at height h above the first surface.



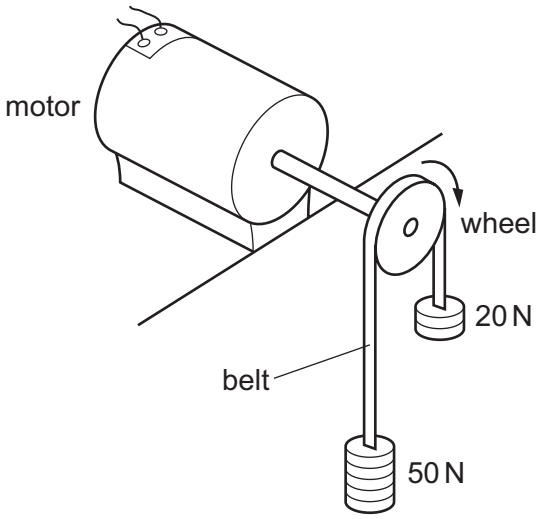
Assume negligible frictional forces. The acceleration of free fall is known.

In order to determine the minimum initial velocity of the trolley for it to reach the top of the slope, which additional values are needed?

A h and M **B** M, L and h **C** α, L, M **D** h only

19 The diagram shows an arrangement used to find the output power of an electric motor.

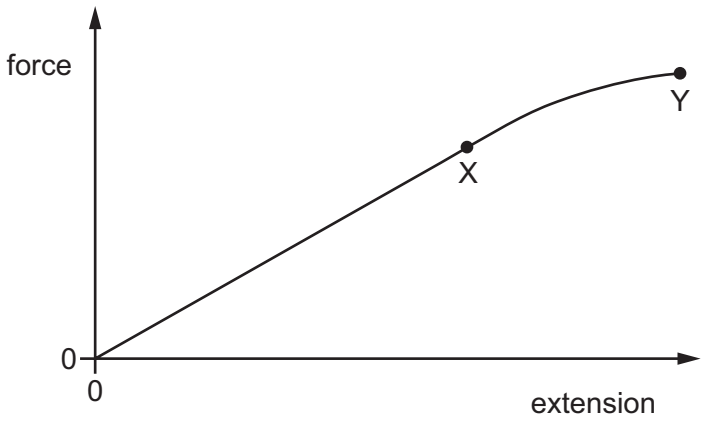
The wheel attached to the motor's axle has a circumference of 0.5 m and the belt which passes over it is stationary when the weights have the values shown.



When the wheel is making 20 revolutions per second, what is the output power of the motor?

A 300 W **B** 500 W **C** 600 W **D** 700 W

20 A sample of metal is subjected to a force which increases to a maximum value and then decreases back to zero. A force-extension graph for the sample is shown.



When the sample contracts, it follows the same force-extension curve as when it was being stretched.

What is the behaviour of the metal between X and Y?

A both elastic and plastic

B not elastic and not plastic

C plastic but not elastic

D elastic but not plastic

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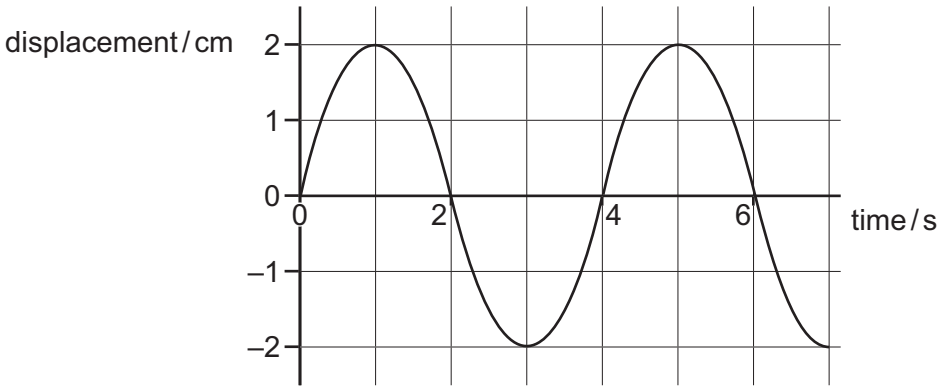
21 A load is hung from the end of a metal wire. The load is increased and the wire stretches elastically. The table shows the length of the wire for different loads.

load / kN	length / mm
0	500.0
1.0	502.0
2.0	504.0
3.0	506.0
4.0	508.0

When the load is 4.0 kN, what is the strain energy stored in the wire?

A 16 J **B** 32 J **C** 1.0 kJ **D** 2.0 kJ

22 The graph shows how the displacement of a particle in a wave varies with time.



Which statement is correct?

A The wave has a period of 2 s and could be either transverse or longitudinal.

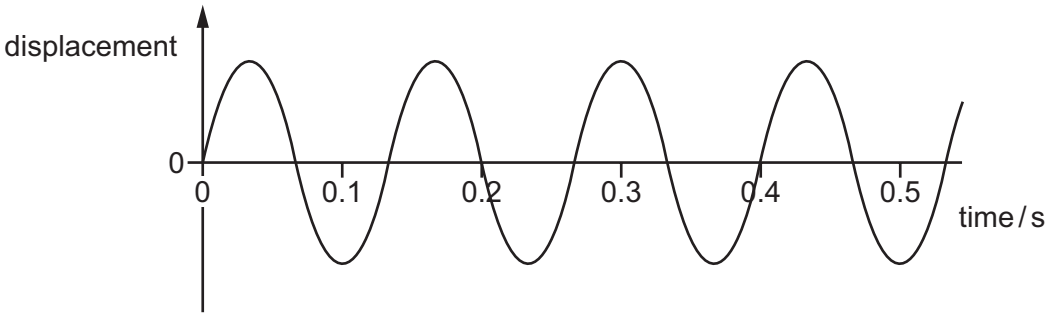
B The wave has a period of 2 s and must be transverse.

C The wave has a period of 4 s and could be either transverse or longitudinal.

D The wave has a period of 4 s and must be transverse.

23 A wave travels along a coiled spring.

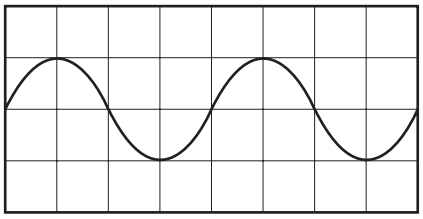
The graph shows the variation with time of the displacement of a point on the spring.



What is the frequency of the wave?

A 0.13 Hz **B** 0.20 Hz **C** 5.0 Hz **D** 7.5 Hz

24 An electrical signal is displayed on a cathode-ray oscilloscope (c.r.o.).



The time-base setting is 50 ms div^{-1}.

The Y-gain setting is 2 V div^{-1}.

What is the amplitude of the signal?

A 2 V **B** 4 V **C** 5 V **D** 10 V

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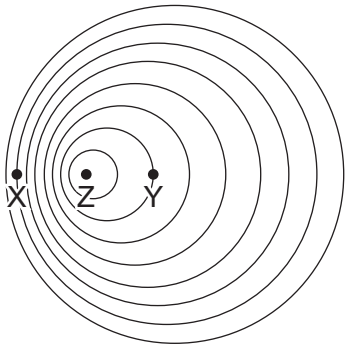
25 A source of sound of frequency *F* at point Z is moving at a steady speed. The pattern of the emitted wavefronts is shown.



Which row describes the frequencies of the sound heard by stationary observers at X and Y?

	frequency heard at X	frequency heard at Y
A	$<F$	$<F$
B	$<F$	$>F$
C	$>F$	$<F$
D	$>F$	$>F$

26 A car travelling at a steady speed in a straight line passes close to a stationary observer. The observer measures the frequency of the sound from the engine.

As the car approaches, the observed frequency is 220 Hz. When the car moves away, the observed frequency is 180 Hz.

The speed of sound in air is $340\,m\,s^{-1}$.

What is the speed of the car?

A $8.5\,m\,s^{-1}$ **B** $31\,m\,s^{-1}$ **C** $34\,m\,s^{-1}$ **D** $38\,m\,s^{-1}$

27 Which frequency of electromagnetic radiation could be ultraviolet?

A 1.0×10^{6} Hz

B 1.0×10^{9} Hz

C 1.0×10^{12} Hz

D 1.0×10^{15} Hz

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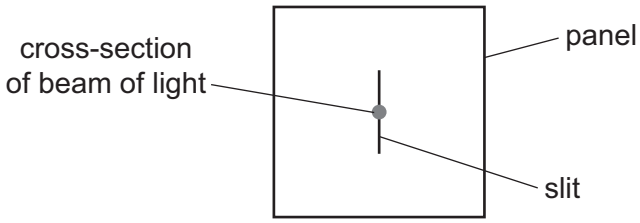
28 An electromagnetic wave travels in a straight line through a vacuum. The wave has a frequency of 6.0 THz.

What is the number of wavelengths in a distance of 1.0 m along the wave?

A 5.0×10^{-5} **B** 2.0×10^{1} **C** 2.0×10^{4} **D** 5.0×10^{7}

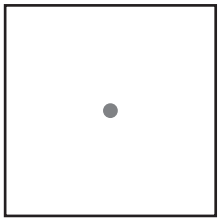
29 A beam of laser light is directed towards a narrow slit.



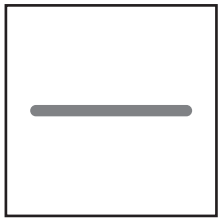
After emerging from the other side of the slit, the light then falls on a screen.

What is the pattern of light seen on the screen?

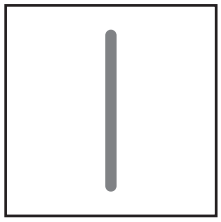
A



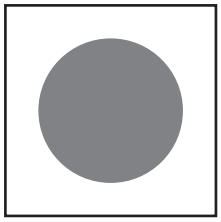
B



C



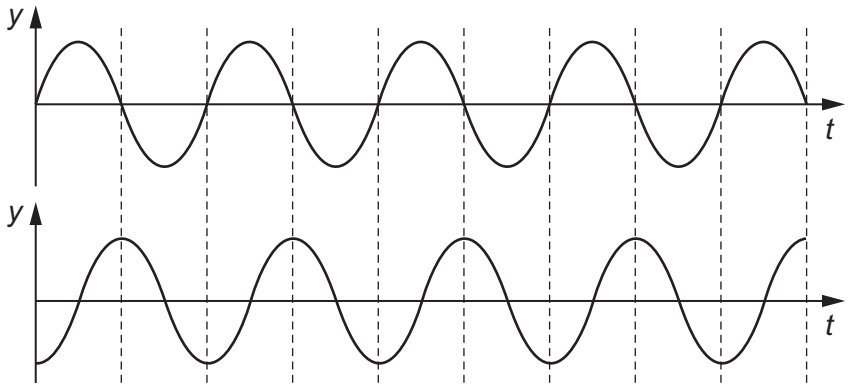
D



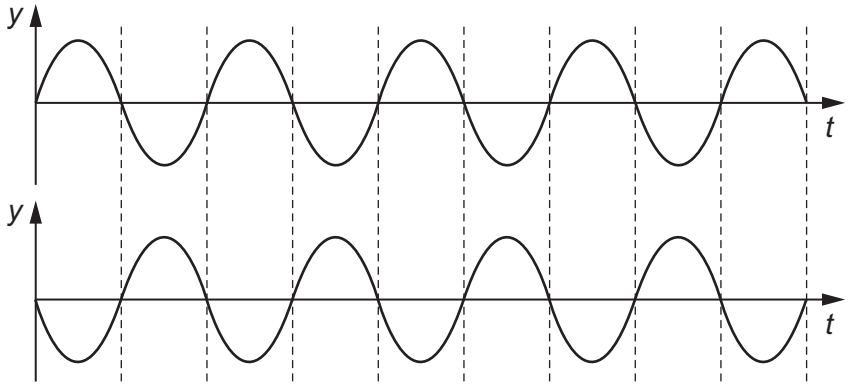
30 The diagrams show four pairs of waves. In each case the displacement *y* measured at a fixed point is plotted against time *t*.

Which pair of waves is **not** coherent?

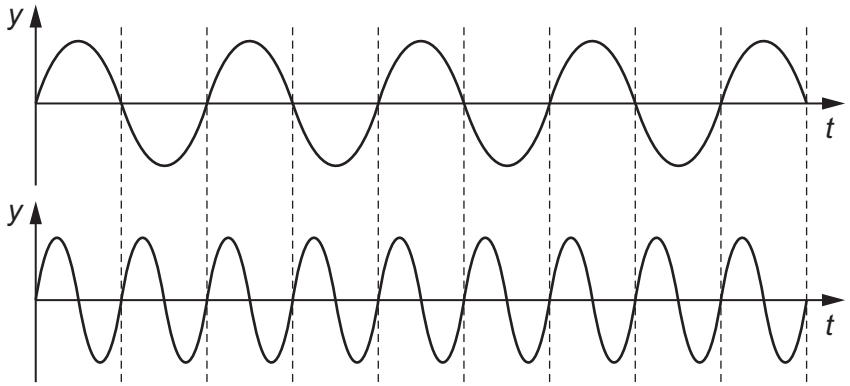
A



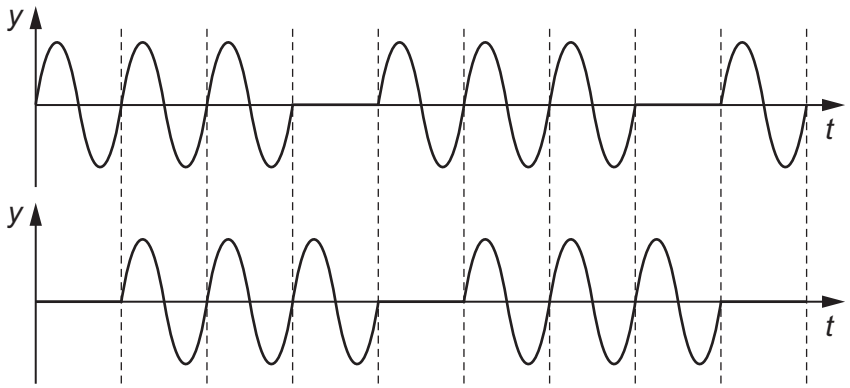
B



C



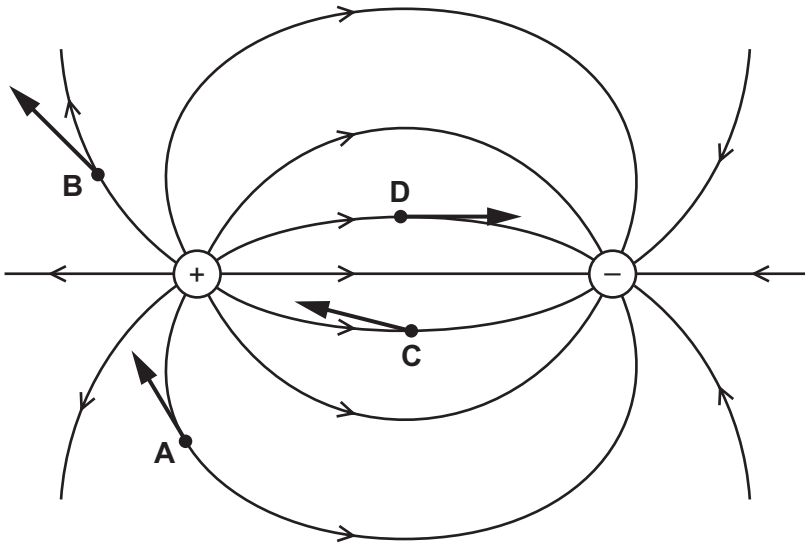
D



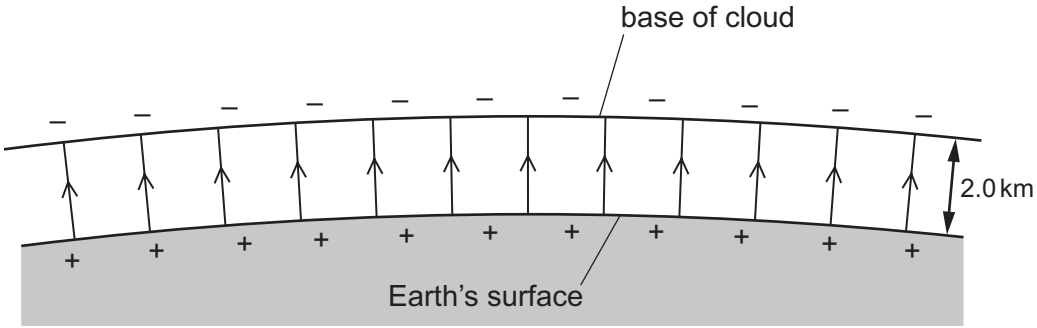
31 The diagram shows the electric field near a positively charged sphere and a negatively charged sphere.

Four electrons **A**, **B**, **C** and **D** are shown at different positions in the field.

On which electron is the direction of the force on the electron shown correctly?



32 Lightning can occur between a charged cloud and the Earth's surface when the electric field strength in the intervening atmosphere reaches 25 kN C^{-1}. The diagram shows the electric field between the base of a cloud and the Earth's surface.



What is the minimum potential difference between the Earth and the base of a cloud, 2.0 km high, for lightning to occur?

A 12.5 MV **B** 25 MV **C** 50 MV **D** 100 MV

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

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

A $8.0 \times 10^{-11}\,\text{m s}^{-1}$

B $3.2 \times 10^{-10}\,\text{m s}^{-1}$

C $8.0 \times 10^{-5}\,\text{m s}^{-1}$

D $3.2 \times 10^{-4}\,\text{m s}^{-1}$

34 A simple circuit comprises a source of electromotive force (e.m.f.) connected to a load.

How does the output power P of the source depend on the internal resistance r of the source and the resistance R of the load?

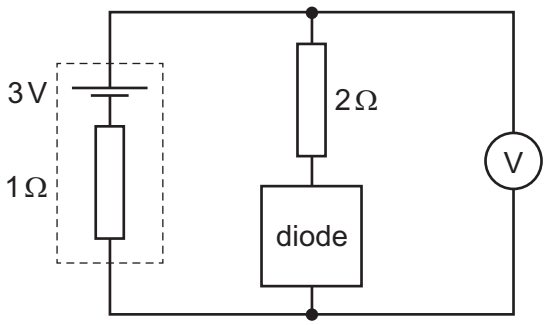
A P is independent of both r and R.

B P depends on r but not on R.

C P depends on R but not on r.

D P depends on both r and R.

35 An ideal diode has zero resistance when forward biased and infinite resistance when reverse biased. The diode is connected in series with a 2 Ω resistor across the terminals of a source having electromotive force (e.m.f.) 3 V and internal resistance 1 Ω, as shown.

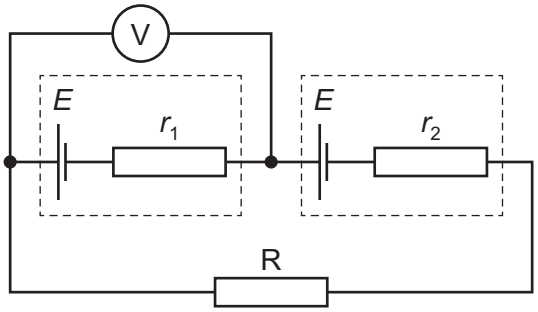


A high-resistance voltmeter is connected across the diode and resistor.

Which row gives the readings of the voltmeter for the two ways of connecting the diode?

	forward biased	reverse biased
A	1 V	3 V
B	2 V	0 V
C	2 V	3 V
D	3 V	0 V

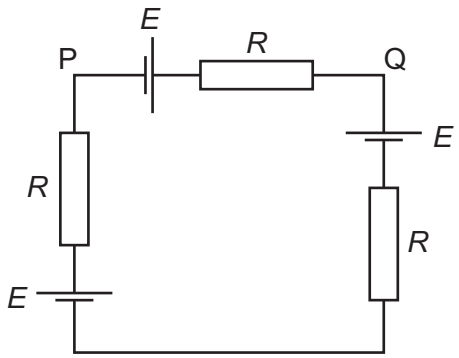
36 Two cells, each with electromotive force (e.m.f.) E, but different internal resistances r_1 and r_2, are connected in series to a resistor R. The reading on the voltmeter is 0 V.



What is the resistance of R?

A 0 **B** $r_1 - r_2$ **C** $r_1 + r_2$ **D** $\frac{r_1 r_2}{r_1 + r_2}$

37 Three identical cells each have electromotive force (e.m.f.) E and negligible internal resistance. The cells are connected to three identical resistors, each of resistance R, as shown.



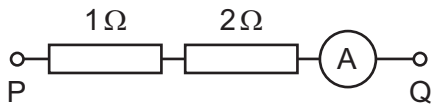
What is the potential difference between P and Q?

A 0 **B** $\frac{E}{3}$ **C** $\frac{2E}{3}$ **D** E

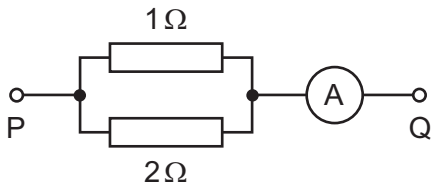
38 In each arrangement of resistors, the ammeter has a resistance of 2 Ω.

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

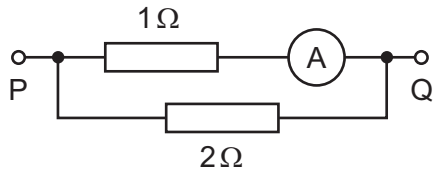
A



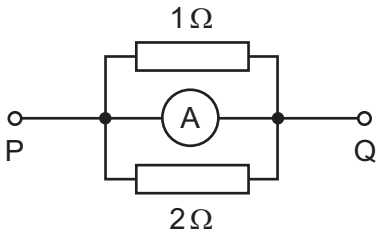
B



C



D



39 Each option shows the number of neutrons, protons and electrons in two atoms, some of which are ionised.

Which pair of atoms in the table are isotopes of the same element?

	neutron	proton	electron
A	20 20	17 19	20 20
B	28 28	23 24	23 24
C	34 36	29 29	29 28
D	40 42	32 31	32 32

40 Which combination of up (u) and down (d) quarks forms a proton?

A u u u **B** u u d **C** u d d **D** d d d

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