Cambridge International AS & A Level

Cambridge International Examinations
Cambridge International Advanced Subsidiary and Advanced Level

PHYSICS **9702/11**

Paper 1 Multiple Choice **May/June 2017**

1 hour 15 minutes

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

* 0 9 1 6 9 6 2 2 1 3 *

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, Centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any working should be done in this booklet.
Electronic calculators may be used.

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

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Data

speed of light in free space	$c = 3.00 \times 10^{8}\,\mathrm{m\,s^{-1}}$
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}\,\mathrm{H\,m^{-1}}$
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$
	$\left(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\mathrm{m\,F^{-1}}\right)$
elementary charge	$e = 1.60 \times 10^{-19}\,\mathrm{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\,\mathrm{J\,s}$
unified atomic mass unit	$1\,\mathrm{u} = 1.66 \times 10^{-27}\,\mathrm{kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$
molar gas constant	$R = 8.31\,\mathrm{J\,K^{-1}\,mol^{-1}}$
the Avogadro constant	$N_A = 6.02 \times 10^{23}\,\mathrm{mol^{-1}}$
the Boltzmann constant	$k = 1.38 \times 10^{-23}\,\mathrm{J\,K^{-1}}$
gravitational constant	$G = 6.67 \times 10^{-11}\,\mathrm{N\,m^{2}\,kg^{-2}}$
acceleration of free fall	$g = 9.81\,\mathrm{m\,s^{-2}}$

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

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

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

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

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

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

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

Through which angle has the particle turned?

A 27° **B** 30° **C** 45° **D** 60°

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

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

where k is a constant that has no units.

What is the value of n?

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

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

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

A area under a velocity-time graph

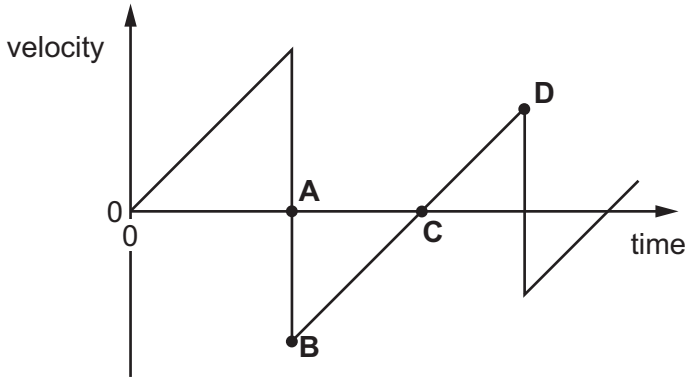
B gradient of a displacement-time graph

C gradient of a velocity-time graph

D gradient of an acceleration-time graph

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

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



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

It may be assumed that air resistance is negligible.

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

A the horizontal component of the ball's acceleration

B the horizontal component of the ball's velocity

C the vertical component of the ball's momentum

D the vertical component of the ball's velocity

7 The mass of a rocket-propelled truck is approximately equal to the mass of the fuel in its tank. The fuel is ignited and the truck is propelled along horizontal tracks by a constant force. The effect of air resistance is negligible.

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

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

A The acceleration of the truck decreases as the fuel is consumed.

B The acceleration of the truck increases as the fuel is consumed.

C The acceleration of the truck remains constant.

D The acceleration of the truck is zero and the truck moves at a constant velocity.

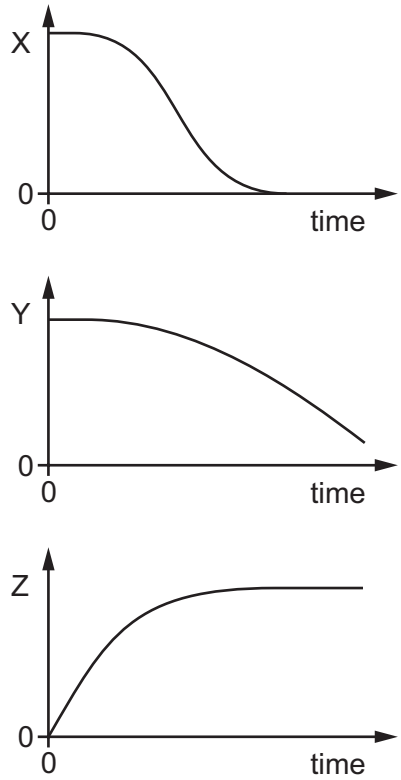
8 An object is dropped at time $t = 0$ from a high building. Air resistance is significant.

Three graphs are plotted against time.

the height of the object above the ground

the speed of the object

the magnitude of the resultant force on the object



What are the quantities X, Y and Z?

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

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

mass $m = 51.6 \pm 0.1$ g

length $l = 100.0 \pm 0.1$ cm

width $w = 10.0 \pm 0.1$ cm

thickness $t = 0.20 \pm 0.01$ mm

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

What is the calculated value of density with its uncertainty?

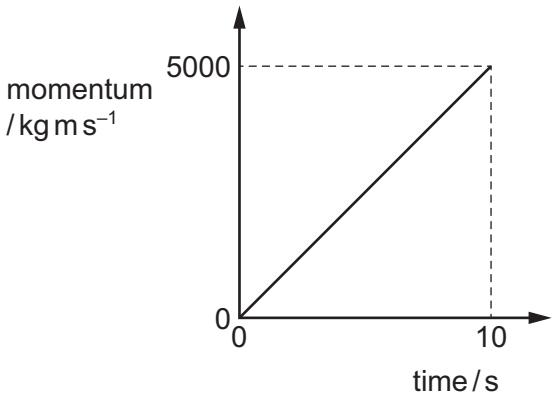
A $0.26 \pm 0.01\,\text{g cm}^{-3}$

B $0.26 \pm 0.02\,\text{g cm}^{-3}$

C $2.6 \pm 0.1\,\text{g cm}^{-3}$

D $2.6 \pm 0.2\,\text{g cm}^{-3}$

10 The graph shows how the momentum of a motorcycle changes with time.



What is the resultant force on the motorcycle?

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

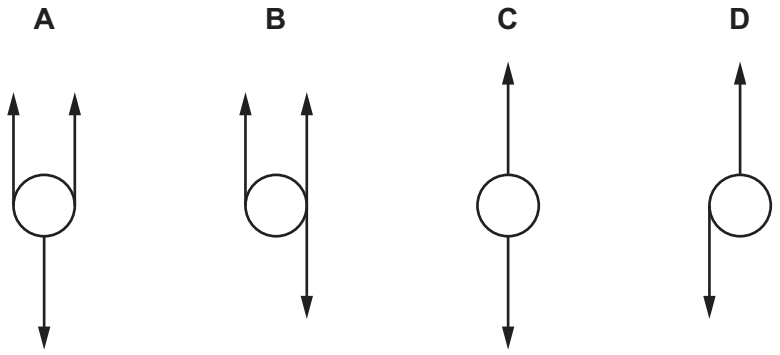
11 A particle with mass and charge is moving from left to right in a uniform gravitational field and a uniform electric field. The gravitational field is downwards. The gravitational force and the electric force on this particle act in opposite directions.

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

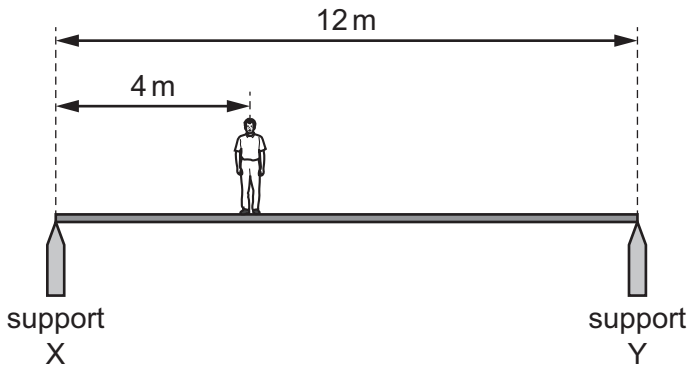
	sign of charge	direction of electric field
A	negative	down
B	negative	up
C	positive	left
D	positive	right

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

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



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



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

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

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

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

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

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

What is the density of the block?

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

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

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

A chemical potential to gravitational potential

B chemical potential to kinetic

C kinetic to gravitational potential

D thermal (heat) to kinetic

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

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

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

What is the efficiency of the car?

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

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

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

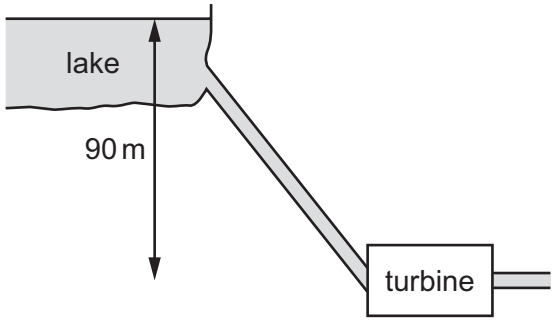
A $1.0 \times 10^6\,J$ **B** $2.0 \times 10^6\,J$ **C** $1.0 \times 10^9\,J$ **D** $2.0 \times 10^9\,J$

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

What is the average power input to the mass?

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

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



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

What is the output power of the turbine?

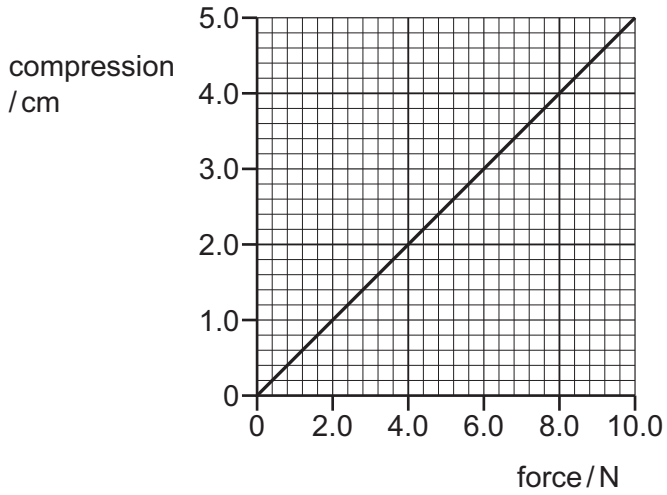
A 26 kW **B** 35 kW **C** 1.6 MW **D** 2.1 MW

20 A wire of diameter d and length l hangs vertically from a fixed point. The wire is extended by hanging a mass M on its end. The Young modulus of the wire is E. The acceleration of free fall is g.

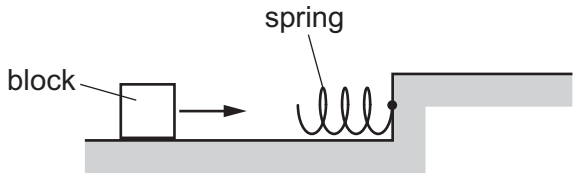
Which equation is used to determine the extension x of the wire?

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

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



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



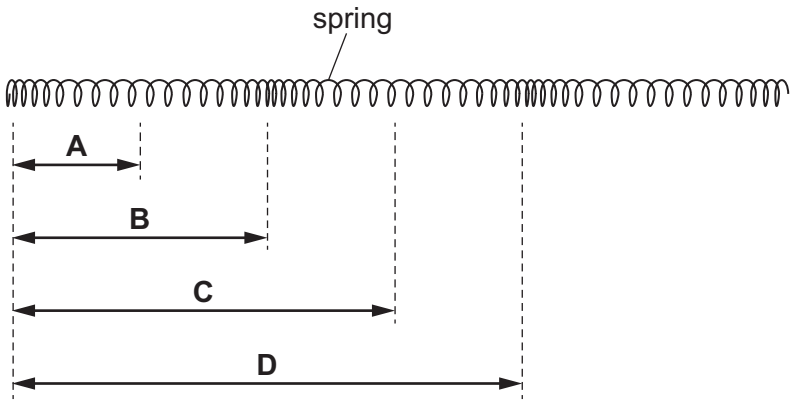
The block is brought to rest by the spring. When the spring reaches a compression of 4.0 cm, all of the kinetic energy of the block is transferred to the elastic potential energy of the spring.

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

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

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

What is the wavelength of the wave?

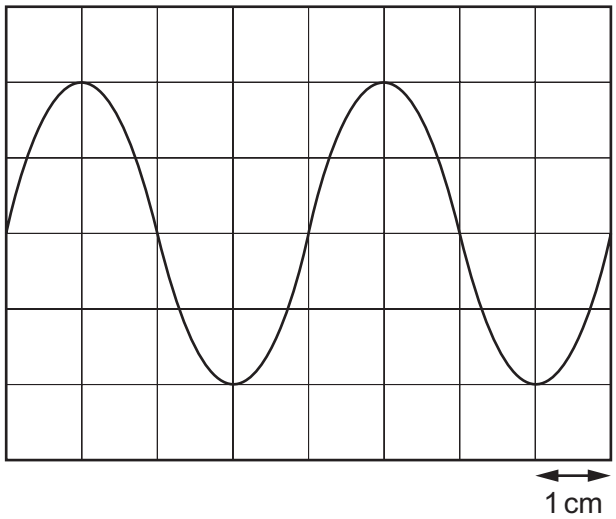


23 A sound wave has a frequency of 2500 Hz and a speed of 1500 m s^{-1}.

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

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

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



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

What is the frequency of the sound wave?

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

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

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

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

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

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

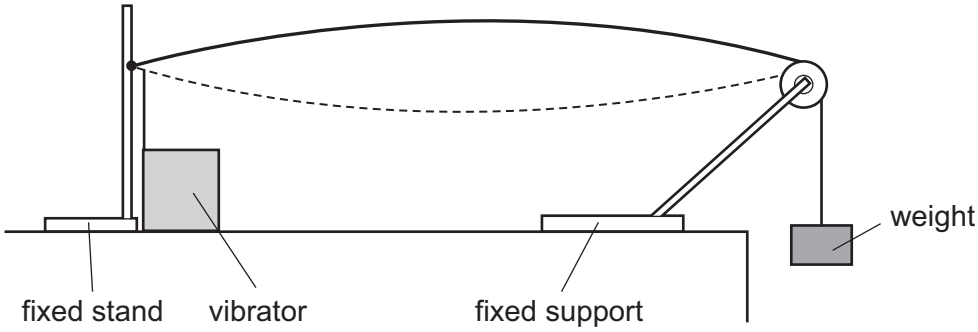
A radio waves → gamma rays → ultraviolet → infra-red

B radio waves → infra-red → ultraviolet → gamma rays

C ultraviolet → gamma rays → radio waves → infra-red

D ultraviolet → infra-red → radio waves → gamma rays

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



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

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

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

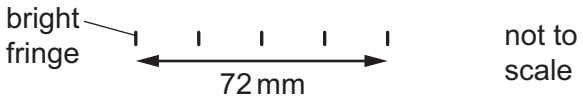
28 A parallel beam of light of wavelength 600 nm is incident normally on a diffraction grating. The grating has 300 lines per millimetre.

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

A 1 **B** 3 **C** 11 **D** 13

29 A pattern of interference fringes is produced using a red laser, a double slit and a screen. The screen is 3.5 m from the double slit. The light from the laser has a wavelength of 640 nm.

The pattern of fringes is shown.

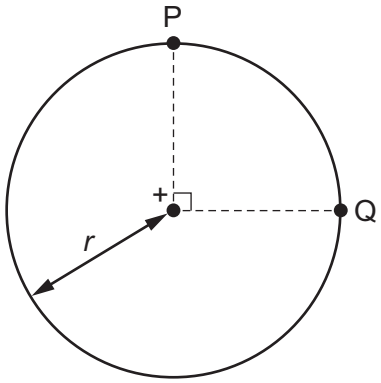


What is the separation of the slits?

A 1.2×10^{-4} m **B** 1.6×10^{-4} m **C** 3.1×10^{-5} m **D** 3.3×10^{-9} m

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

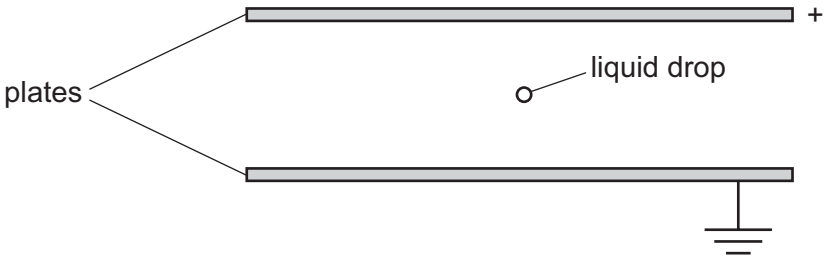
A positive point charge at the centre of the circle creates an electric field of magnitude *E* at both P and Q.



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

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

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



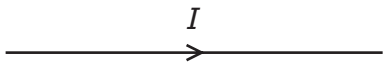
A small charged liquid drop, midway between the plates, is held in equilibrium by the combination of its weight and the electric force acting on it.

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

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

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

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



What does this current represent?

A the charge flowing past a point in the wire per unit time

B the number of electrons flowing past a point in the wire per unit time

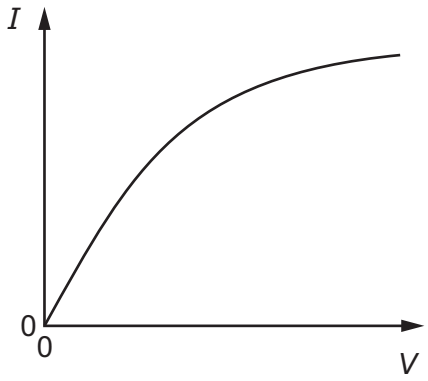
C the number of positive ions flowing past a point in the wire per unit time

D the number of protons flowing past a point in the wire per unit time

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

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

34 Which component has the I-V graph shown?



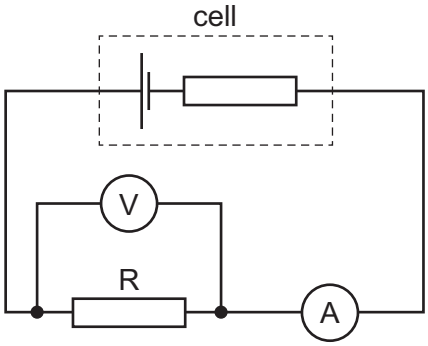
A filament lamp

B metallic conductor at constant temperature

C resistor of fixed resistance

D semiconductor diode

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



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

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

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

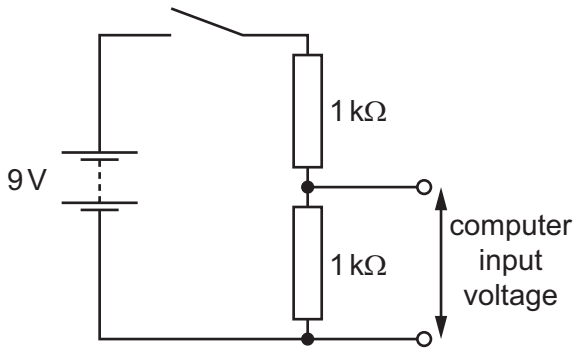
36 A computer is used to detect the change of position of a switch.

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

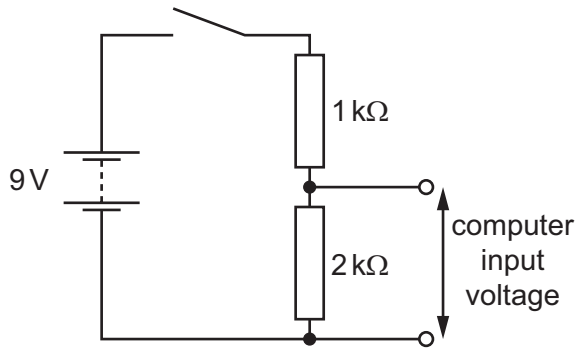
For each of the circuits, assume the battery has negligible internal resistance.

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

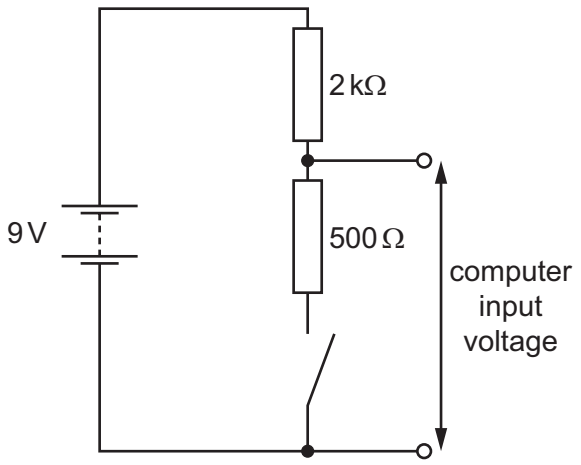
A



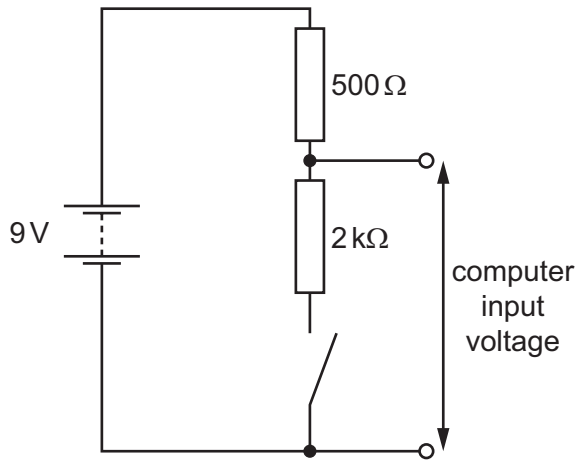
B



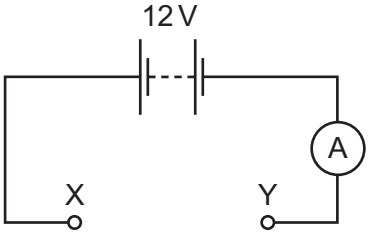
C



D



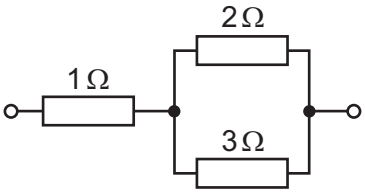
37 In the circuit shown, the battery and ammeter have negligible resistance.



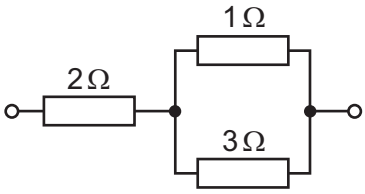
The following combinations of resistors are each separately placed between the terminals X and Y of the circuit.

Which combination would give an ammeter reading of 8 A?

A



B



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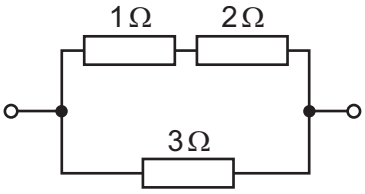

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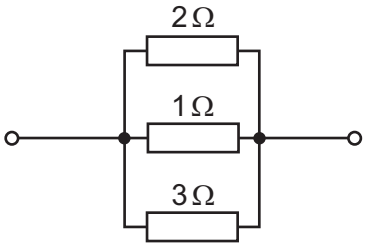


38 The table lists the nucleon number and the proton number of various nuclei. The nuclei are represented by the letters L to T.

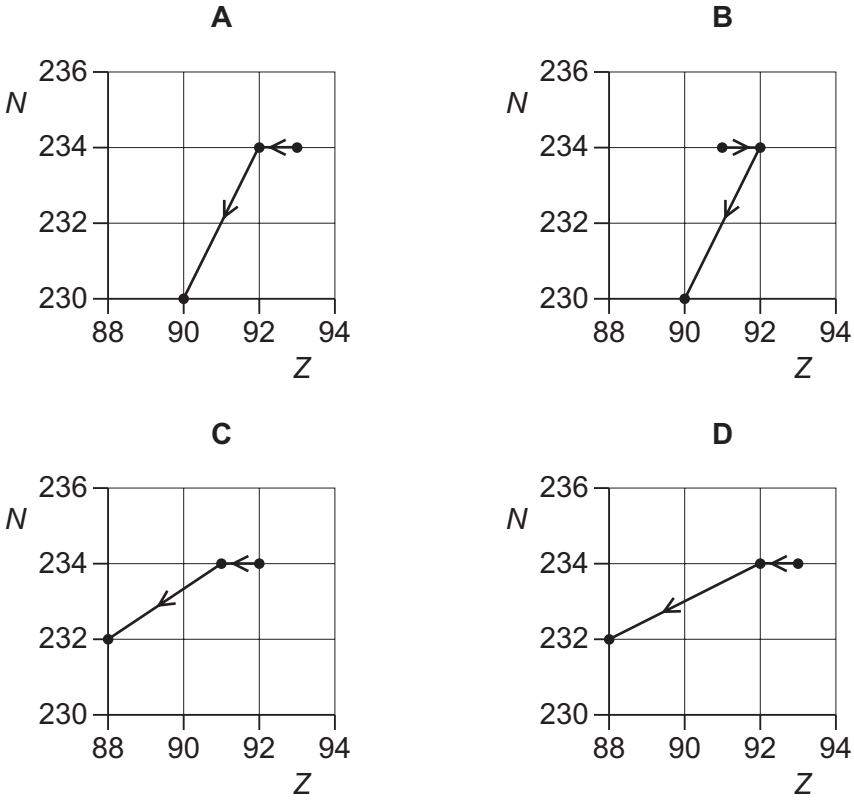
nucleus	nucleon number	proton number
L	227	89
M	226	89
N	225	89
O	227	90
P	226	90
Q	225	90
R	227	91
S	226	91
T	225	91

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

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

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

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



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

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

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