



Cambridge International AS & A Level

PHYSICS

9702/11

Paper 1 Multiple Choice

May/June 2024

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.
- Any rough working should be done on this question paper.

This document has **16** pages. Any blank pages are indicated.



2

Data

acceleration of free fall	$g = 9.81 \text{ m s}^{-2}$
speed of light in free space	$c = 3.00 \times 10^8 \text{ m s}^{-1}$
elementary charge	$e = 1.60 \times 10^{-19} \text{ C}$
unified atomic mass unit	$1 \text{ u} = 1.66 \times 10^{-27} \text{ kg}$
rest mass of proton	$m_p = 1.67 \times 10^{-27} \text{ kg}$
rest mass of electron	$m_e = 9.11 \times 10^{-31} \text{ kg}$
Avogadro constant	$N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$
molar gas constant	$R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$
Boltzmann constant	$k = 1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ F m}^{-1}$ $(\frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ m F}^{-1})$
Planck constant	$h = 6.63 \times 10^{-34} \text{ J s}$
Stefan–Boltzmann constant	$\sigma = 5.67 \times 10^{-8} \text{ W m}^{-2} \text{ K}^{-4}$

Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$
hydrostatic pressure	$\Delta p = \rho g \Delta h$
upthrust	$F = \rho g V$
Doppler effect for sound waves	$f_o = \frac{f_s v}{v \pm v_s}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$

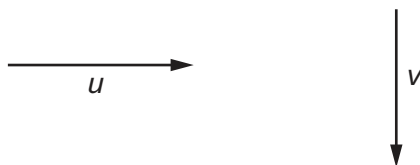
1 Which unit is an SI base unit?

- A ampere
- B coulomb
- C degree Celsius
- D gram

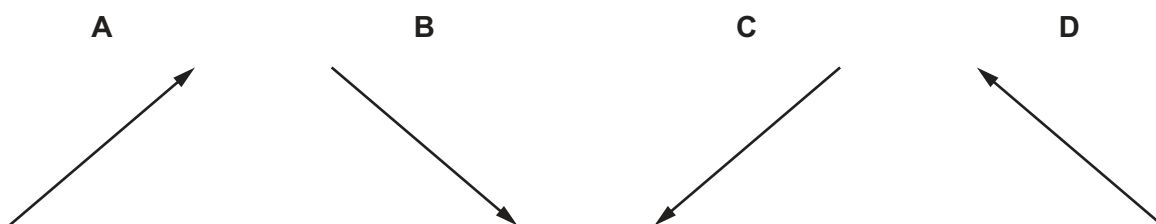
2 Which of the following could have the same units as force?

- A $\frac{\text{energy}}{\text{distance}}$
- B $\frac{\text{energy}}{\text{time}}$
- C momentum $\times$ distance
- D momentum $\times$ time

3 The velocity of an object changes from an initial velocity u to a final velocity v . The vectors represent these velocities.



Which single vector represents the change in velocity of the object?



4 An object is moving with initial velocity u . The object then moves with uniform acceleration a for time t until it reaches final velocity v .

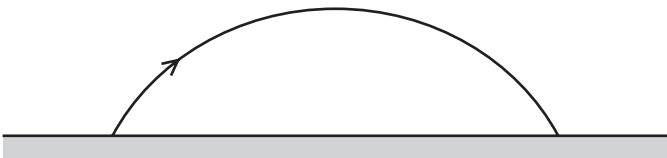
Which equation describes the motion of the object?

- A $u = v - 2at$ B $u = v - at$ C $v = u + at^2$ D $v = u + 2at^2$

- 5 Which calculation produces a vector quantity?
- A current $\times$ time
- B final displacement – initial displacement
- C $\frac{\text{work done}}{\text{time}}$
- D $\frac{1}{2} \times \text{mass} \times (\text{speed})^2$
- 6 A thermometer can be read to an accuracy of $\pm 0.5^\circ\text{C}$. This thermometer is used to measure a temperature rise from 40°C to 100°C .

What is the percentage uncertainty in the measurement of the temperature rise?

- A 0.5% B 0.8% C 1.3% D 1.7%
- 7 The diagram shows the path of a golf ball.



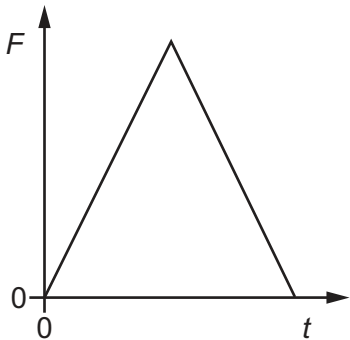
Which row describes changes in the horizontal and vertical components of the golf ball's velocity when air resistance is ignored?

	horizontal	vertical
A	constant deceleration	constant acceleration downwards
B	constant deceleration	acceleration decreases upwards then increases downwards
C	constant velocity	constant acceleration downwards
D	constant velocity	acceleration decreases upwards then increases downwards

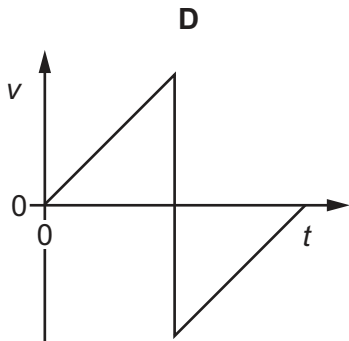
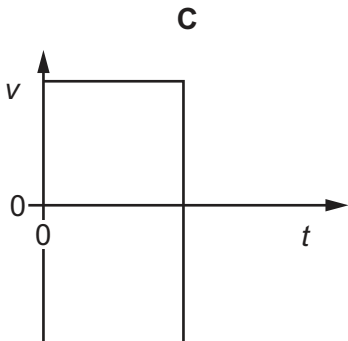
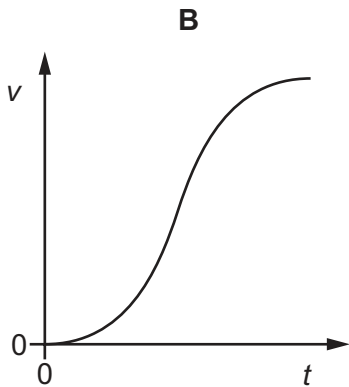
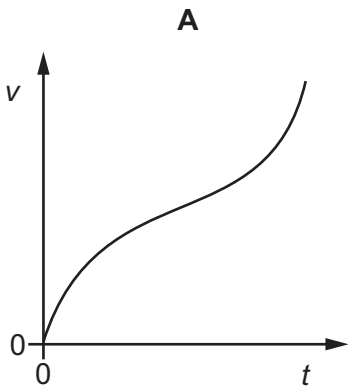
- 8 An aircraft flies from London to Sydney in a time of 21 hours 40 minutes.
- The distance travelled is 17 000 km.
- What is the average speed of the aircraft?
- A 2.2 m s^{-1}
- B $2.2 \times 10^7\text{ }\mu\text{m s}^{-1}$
- C $2.2 \times 10^{11}\text{ nm s}^{-1}$
- D $2.2 \times 10^6\text{ mm s}^{-1}$

5

9 A golf club hits a golf ball. The graph shows how the force F on the ball varies with time t .



Which graph shows how the velocity v of the ball varies with time t ?



10 What is meant by the mass and by the weight of an object on the Earth?

	mass	weight
A	its momentum divided by its velocity	the work done in lifting it one metre
B	the gravitational force on it	the property that resists its acceleration
C	the pull of the Earth on it	its mass divided by the acceleration of free fall
D	the property that resists its acceleration	the pull of the Earth on it

6

- 11 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

- 12 Spheres X and Y form an isolated system. The mass of Y is greater than the mass of X.

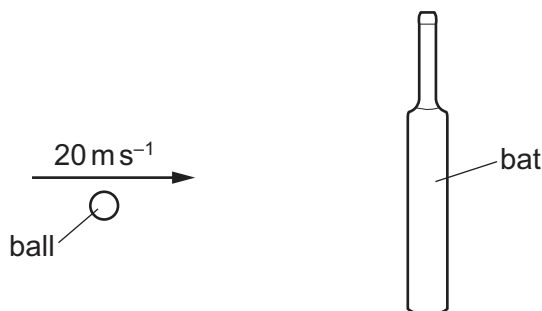
Sphere Y is initially stationary.

Sphere X collides elastically with sphere Y.

The speed of sphere X before the collision is u .

Which statement **must** be correct?

- A Sphere X rebounds with a speed that is greater than u , and sphere Y moves off with a speed that is less than u .
- B Sphere X rebounds with a speed that is less than u , and sphere Y moves off with a speed that is also less than u .
- C Sphere X rebounds with speed u , and sphere Y remains stationary.
- D Sphere X remains stationary, and sphere Y moves off with a speed that is less than u .
- 13 A ball of mass 0.10 kg is thrown towards a stationary vertical bat. The ball hits the bat with a horizontal velocity of 20 m s^{-1} .



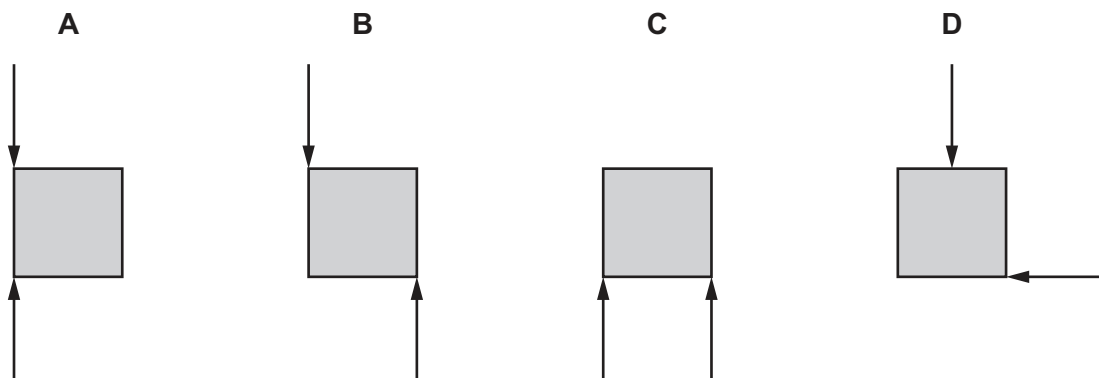
The ball rebounds and leaves the bat with a horizontal velocity of 15 m s^{-1} .

What is the change in momentum of the ball?

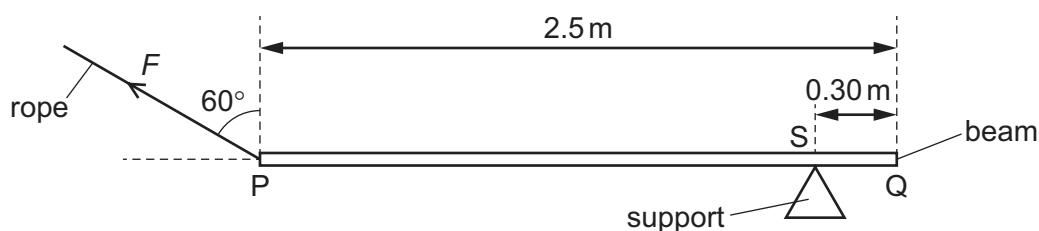
- A 0.20 Ns B 0.50 Ns C 1.5 Ns D 3.5 Ns

- 14** An isolated object of negligible weight is acted on by two coplanar forces of the same magnitude.

In which diagram is the object in equilibrium?



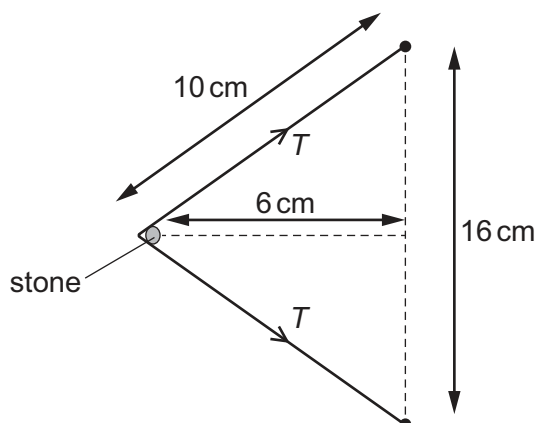
- 15** A uniform beam PQ rests horizontally on a support at point S.



A rope is attached at one end of the beam. The rope is at an angle of 60° to the vertical and exerts a force F , in newtons, on the beam.

What is the moment, in N m, of the force F about the point S?

- A** $1.1F$ **B** $1.3F$ **C** $1.9F$ **D** $2.2F$
- 16** The diagram shows the dimensions of an elastic cord used to project a stone. The tension in the cord is T when the cord is pulled into the shape shown.



Which force does the elastic cord exert on the stone?

- A** $\frac{3}{5}T$ **B** $\frac{6}{5}T$ **C** $\frac{8}{5}T$ **D** $2T$

- 17** A box of weight 40 N is pushed with a horizontal force of 20 N along level ground for a distance of 2.4 m.

The box is then lifted at constant velocity through a height of 1.6 m by a vertical force.

What is the total work done on the box by the two forces?

- A** 80 J **B** 110 J **C** 120 J **D** 160 J

- 18** Which statement about efficiency is correct?

- A** Efficiency does **not** have a unit.
B The joule is a unit of efficiency.
C The metre is a unit of efficiency.
D The watt is a unit of efficiency.

- 19** A plane wave of amplitude A is incident on a surface of area S placed so that it is perpendicular to the direction of travel of the wave. The energy per unit time reaching the surface is E .

The amplitude of the wave is increased to $2A$ and the area of the surface is reduced to $\frac{1}{2}S$.

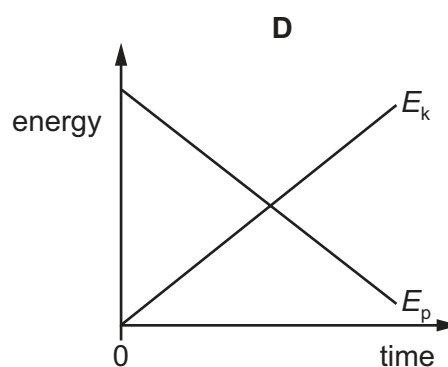
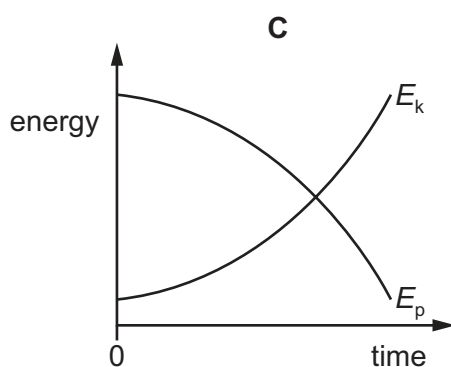
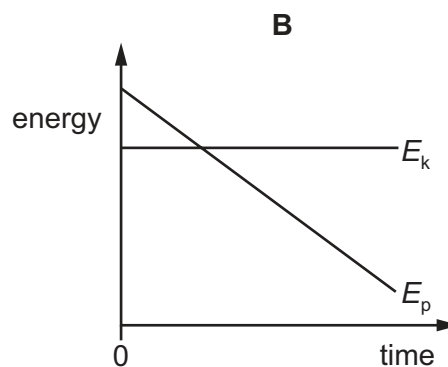
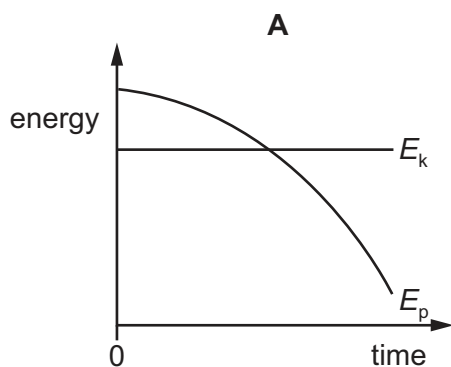
How much energy per unit time reaches this smaller surface?

- A** $4E$ **B** $2E$ **C** E **D** $\frac{1}{2}E$

9

20 A steel ball is falling at constant speed in oil.

Which graph shows the variation with time of the gravitational potential energy E_p and the kinetic energy E_k of the ball?



21 When a force of 0.80 N is applied to a spring, the length of the spring is 90 mm.

When a force of 1.30 N is applied to the same spring, its length is 115 mm.

The spring obeys Hooke's law.

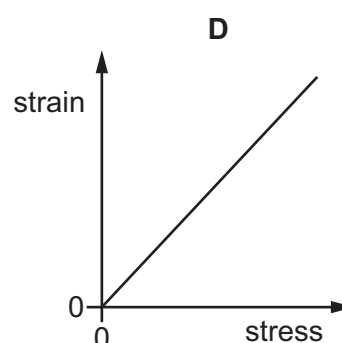
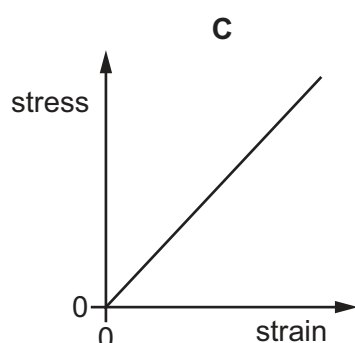
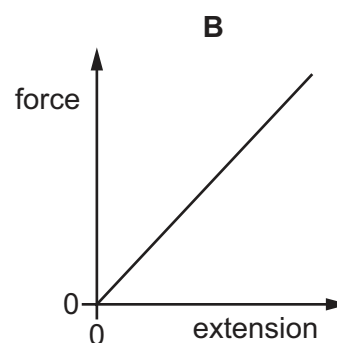
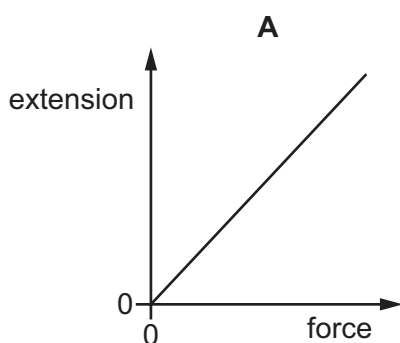
What is the spring constant of the spring?

- A** 8.9 N m^{-1} **B** 10 N m^{-1} **C** 11 N m^{-1} **D** 20 N m^{-1}

10

- 22** An experiment is carried out using a metal wire to investigate how it responds to a varying tensile force. The cross-sectional area of the wire is constant.

Which graph has a gradient that is equal to the Young modulus of the metal?



- 23** For a wire, Hooke's law is obeyed for a tension F and extension x . The Young modulus for the material of the wire is E .

Which expression represents the elastic potential energy stored in the wire?

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

- 24** A plane polarised wave has amplitude A . The wave is incident normally on a polarising filter.

The transmission axis of the filter is at angle θ to the plane of polarisation of the incident wave.

What is the amplitude of the wave that emerges from the filter?

- A** $A \cos \theta$ **B** $A \cos^2 \theta$ **C** $A^2 \cos \theta$ **D** $A^2 \cos^2 \theta$

25 An electromagnetic wave is travelling through a vacuum.

What could be the wavelength and period of the electromagnetic wave?

	wavelength	period
A	$1.2 \times 10^{-10} \text{ Tm}$	2.5 Ms
B	1.2 pm	$2.5 \times 10^{11} \text{ Gs}$
C	$1.2 \times 10^2 \text{ pm}$	$4.0 \times 10^{-10} \text{ ns}$
D	$1.2 \times 10^3 \mu\text{m}$	4.0 ns

26 Light of frequency $6.7 \times 10^{14} \text{ Hz}$ in a vacuum is incident normally on a diffraction grating that contains $4.0 \times 10^5 \text{ lines m}^{-1}$.

What is the angle between the adjacent second and third order intensity maxima?

- A 12° B 21° C 33° D 54°

27 The siren of a moving police car emits a sound wave with a frequency of 440 Hz. A stationary observer hears sound of frequency 494 Hz. The speed of sound in the air is 340 ms^{-1} .

What could be the speed and the direction of movement of the car?

- A 37 ms^{-1} directly away from the observer
B 37 ms^{-1} directly towards the observer
C 42 ms^{-1} directly away from the observer
D 42 ms^{-1} directly towards the observer

28 The diagram shows the shape at one instant in time of part of a stretched string as a wave travels along it from left to right.



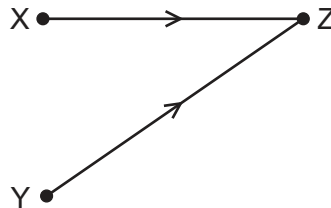
What are the directions of the velocities of the points 1, 2 and 3 on the string at this instant in time?

	point 1	point 2	point 3
A	→	→	→
B	→	←	→
C	↑	↓	↑
D	↓	↑	↓

29 Which wave **cannot** be a longitudinal wave?

- A a diffracted wave
- B a polarised wave
- C a reflected wave
- D a stationary wave

30 Microwaves are emitted from two sources at points X and Y. The two waves meet at point Z. The diagram shows the paths of the two waves.



The waves emitted from points X and Y are coherent.

What is a direct consequence of the two waves being coherent?

- A There is a constant difference in the path lengths YZ and XZ.
- B There is a constant difference in phase between the two waves at Z.
- C There is a constant non-zero difference in frequency of the two waves at Z.
- D There is a constant non-zero difference in amplitude of the two waves at Z.

31 What is the unit of resistivity?

- A $\Omega \text{ m}^{-2}$
- B $\Omega \text{ m}^{-1}$
- C Ω
- D $\Omega \text{ m}$

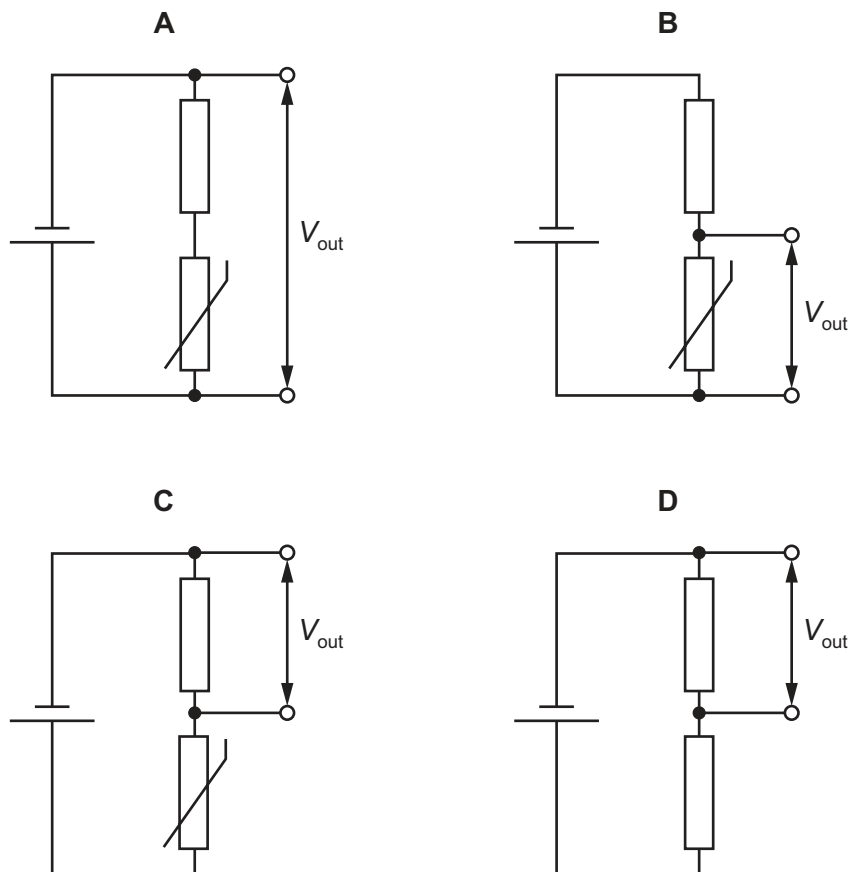
32 A kettle is connected to a 250 V mains supply.

What are possible values for the power of the kettle and the current in the kettle?

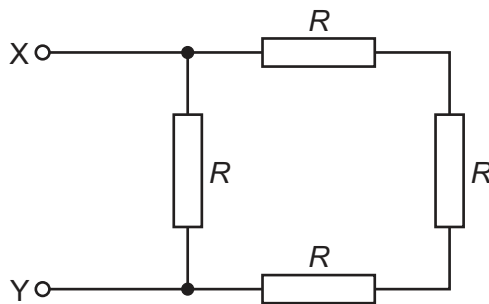
	power / W	current / A
A	500	0.5
B	500	5.0
C	2500	0.1
D	2500	10

13

33 Which circuit results in output voltage V_{out} increasing with increasing temperature?



34 Four resistors, each of resistance R , are connected as shown.



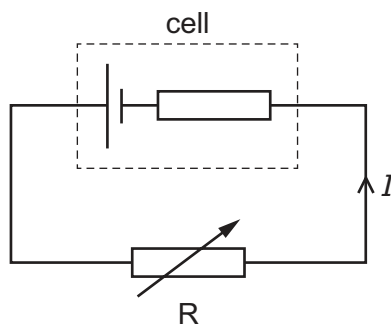
The total resistance between point X and point Y is $120\ \Omega$.

What is the magnitude of the resistance R ?

- A** $30\ \Omega$ **B** $90\ \Omega$ **C** $160\ \Omega$ **D** $480\ \Omega$

14

- 35** A cell with internal resistance is connected to a variable resistor R as shown.



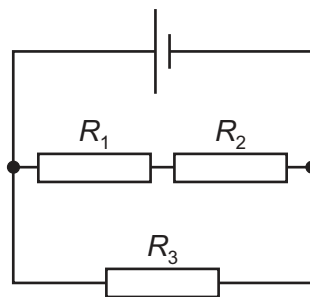
The resistance of R is gradually decreased.

How do the current I and the terminal potential difference (p.d.) across the cell change?

	current I	terminal p.d. across cell
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

- 36** The diagram shows a circuit with a cell and three resistors with resistances R_1 , R_2 and R_3 .

The cell has negligible internal resistance.



The total resistance of the circuit is R_T .

Which equation for R_T is correct?

- A** $R_T = R_1 + R_2 + R_3$
- B** $R_T = \frac{1}{R_1 + R_2} + \frac{1}{R_3}$
- C** $\frac{1}{R_T} = \frac{1}{R_1 + R_2 + R_3}$
- D** $\frac{1}{R_T} = \frac{1}{R_1 + R_2} + \frac{1}{R_3}$

- 37 Hydrogen and deuterium can be represented by the nuclide symbols ${}^1_1\text{H}$ and ${}^2_1\text{H}$ respectively.

What is a difference between hydrogen and deuterium?

- A The deuterium atom has twice the number of electrons as the hydrogen atom.
- B The deuterium nucleus has a charge, but the hydrogen nucleus has no charge.
- C The deuterium nucleus has less mass than the hydrogen nucleus.
- D The deuterium nucleus has half the charge per unit mass of the hydrogen nucleus.

- 38 A radioactive sample decays by emitting β^- particles.

The energy released in the decay process is the same for each nucleus that decays, but the β^- particles emitted have a continuous range of kinetic energies.

Which statement explains why the β^- particles are emitted with a continuous range of kinetic energies?

- A Some of the energy released is given to the remaining nucleons in the nucleus.
- B Some of the energy released is taken by an emitted antineutrino.
- C Some of the energy released is used to create the β^- particle.
- D Some of the energy released is used to create a new nucleon.

- 39 Which particle is **not** a fundamental particle?

- A electron
- B neutrino
- C neutron
- D top quark

- 40 What is the charge of an anti-top quark?

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

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