LRN International AS & A Level: Physics (6328)

Candidate Name	
Candidate Number	
Centre Name	
Centre Number	

Paper 2: Physics For Examination December 2023

(2 hours)

It is necessary to respond on the answer sheets provided alongside this question paper. Additionally, you must have a soft pencil (preferably of type B or HB),a clean eraser and a dark blue or black pen.

INSTRUCTIONS:

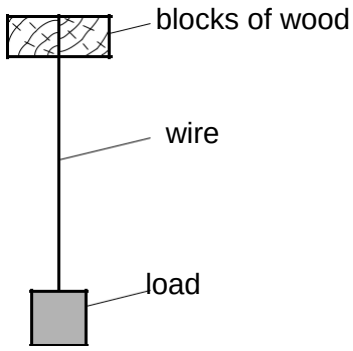
- You must write your name, candidate number, centre name and centre number on the answer sheets in the designated spaces.
- Objective section consists of 40 questions, and it is essential that you attempt all of them.
- Each question has four options labelled A, B, C, and D. Select the option that you think is correct. Mark it on the multiple choice answer sheet using a soft pencil.
- Attempt all the questions from subjective section using a dark blue or black pen.
- It is important to follow the instructions provided on the answer sheets.
- Do not use correction fluid.
- Avoid writing on any bar codes.
- You are allowed to use a calculator if needed.

INFORMATION:

- This paper has a total of 85 marks.
- In objective section there are 25 questions, each carries one mark. There is no negative marking for incorrect responses.
- In subjective section, 30 marks are for extended theory and 15 marks for practical component.
- The number of marks assigned for every question or its parts is indicated within brackets [ ]

Section A: Multiple Choice Questions (40 marks)

1. The diagram shows a wire of diameter *D* and length *L* that is firmly clamped at one end between two blocks of wood. A load is applied to the wire which extends its length by *x*.



A second wire is made of the same material, but of diameter 2*D* and length 3*L*. Both wires obey Hooke's law.

What is the extension of the second wire when the same load is applied?

A $\frac{2}{3}x$ **B** $\frac{3}{4}x$ **C** $\frac{4}{3}x$ **D** $\frac{3}{2}x$

2. Which elementary particle is a lepton?

A proton **B** neutron **C** electron **D** quark

3. How many down quarks are in a nucleus of hydrogen-3, ${}^{3}_{1}\mathrm{H}$?

A 2 **B** 3 **C** 4 **D** 5

4 What is the correct equation for β^{+} decay?

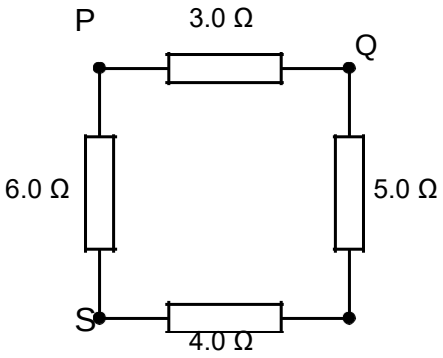
A neutron → proton + electron + electron antineutrino

B neutron → proton + electron + electron neutrino

C proton → neutron + positron + electron antineutrino

D proton → neutron + positron + electron neutrino

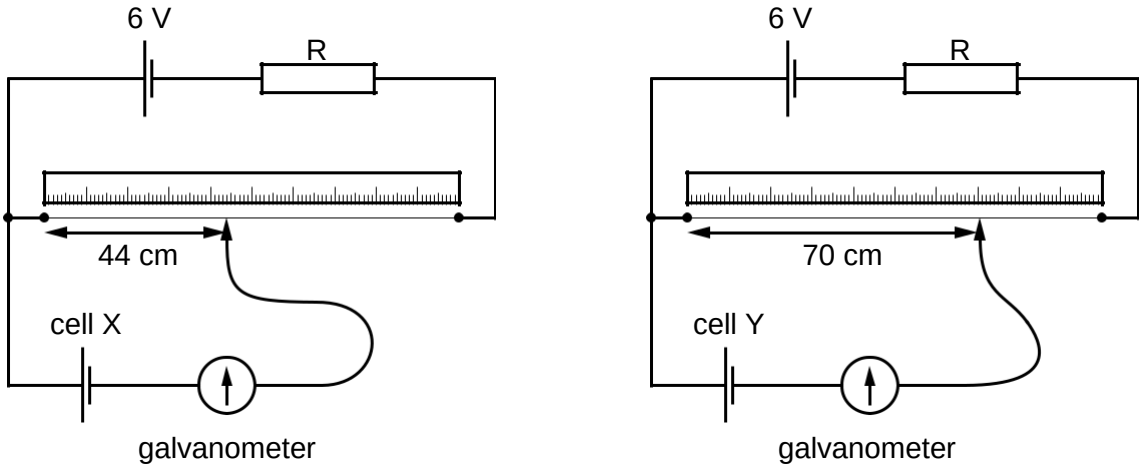
5 A battery of negligible internal resistance may be connected between any two points P, Q, R and S of the network of resistors shown.



Which connections will give the largest current and the smallest current in the battery?

	largest current	smallest current
A	PQ	PR
B	PQ	QS
C	RS	PR
D	RS	QS

6 Two cells are investigated using a potentiometer. At the balance point, cell X gives a reading of 44 cm and cell Y gives a reading of 70 cm.



Which statement is **not** correct?

A A potentiometer balance point results in zero current through the galvanometer.

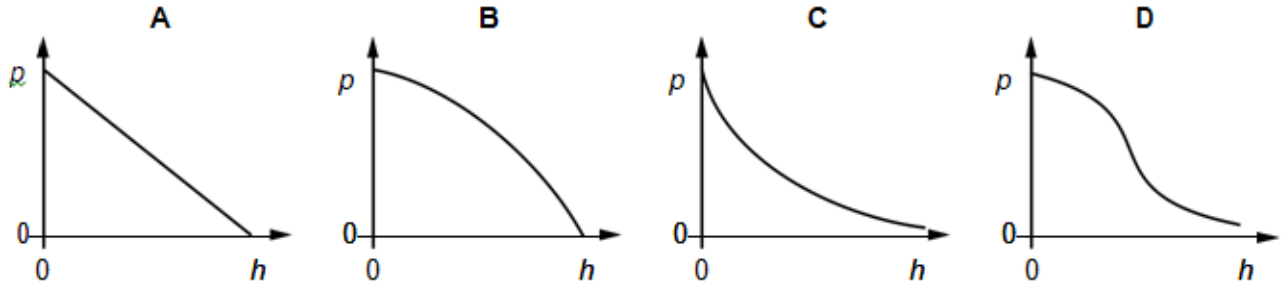
B At the balance point, the current through resistor R in both circuits is the same.

C The electromotive force (e.m.f.) of cell X is larger than that of cell Y.

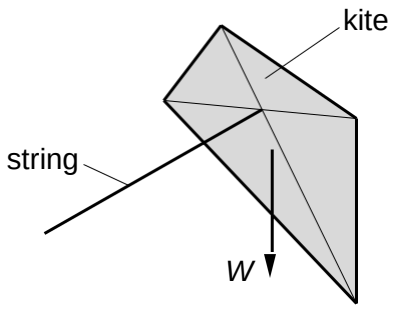
D The value of the e.m.f. of each of the cells X and Y is less than 6 V.

7 The density of the air in the atmosphere decreases as the height *h* above the surface of the Earth increases.

Which graph best shows the variation with height *h* of the pressure *p* of the air?

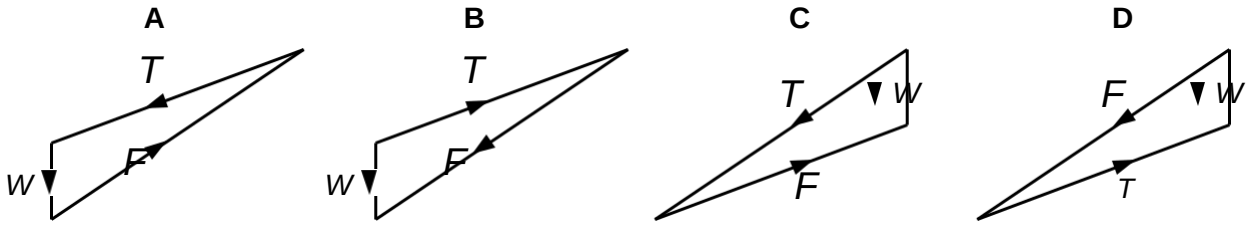


8 A kite is in equilibrium at the end of a string, as shown.

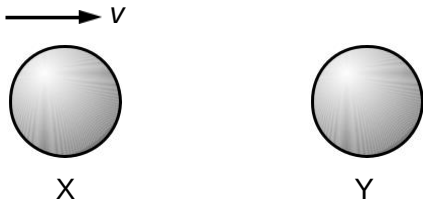


The kite has three forces acting on it: the weight *W*, the tension *T* in the string, and the force *F* from the wind.

Which vector diagram represents the forces acting on the kite?



9 The diagram shows two identical spheres X and Y.



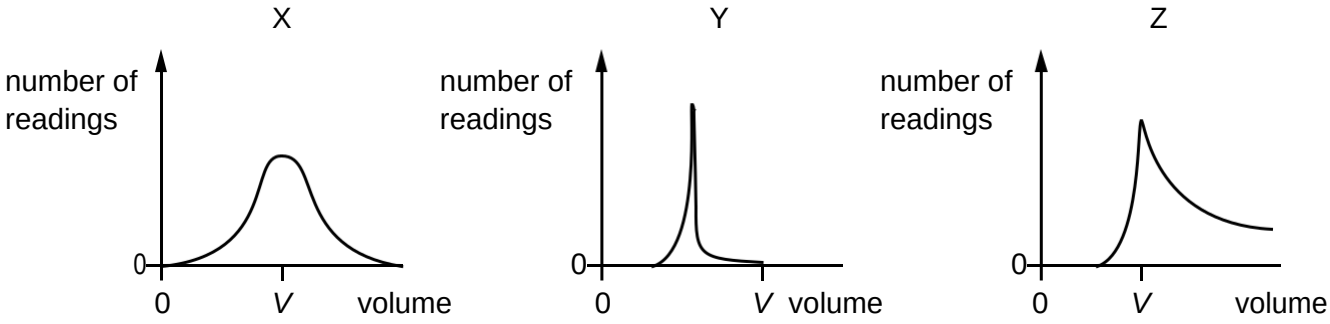
Initially, X moves with speed *v* directly towards Y. Y is stationary. The spheres collide elastically. What happens?

	X	**Y**
A	Moves with speed ½ v to the right	Moves with speed ½ v to the right
B	Moves with speed v to the left	Remains stationary
C	Moves with speed ½ v to the left	Moves with speed ½ v to the right
D	Stops	Moves with speed v to the right

10 Students take readings of the volume of a liquid using three different pieces of measuring equipment X, Y and Z.

The true value of the volume of the liquid is *V*.

The students' results are shown.



How many pieces of equipment are precise and how many are accurate?

	number of precise pieces of equipment	number of accurate pieces of equipment
A	1	1
B	1	2
C	2	1
D	2	2

11 A sprinter runs a 100 m race. The sprinter has a constant acceleration from rest of 2.5 m s^{-2} until reaching a speed of 10 m s^{-1}. The speed then remains constant until the end of the race.

Which time does it take the sprinter to run the race?

A 8.9 s **B** 10 s **C** 12 s **D** 14 s

12 What is the unit of resistance when expressed in SI base units?

A kg m^2 s^{-2} A^{-1}

B kg m^2 s^{-3} A^{-2}

C kg m s^{-2} A^{-1}

D kg m s^{-3} A^{-1}

13 Which list contains both scalar and vector quantities?

A acceleration, momentum, velocity, weight

B area, current, force, work

C distance, kinetic energy, power, pressure

D mass, temperature, time, speed

14 Which two units are used to define the coulomb?

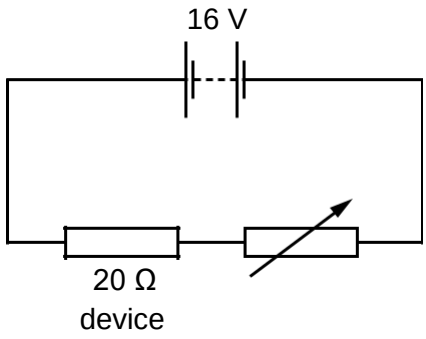
A ampere and second

B ampere and volt

C volt and ohm

D volt and second

15 An electrical device of fixed resistance 20 Ω is connected in series with a variable resistor and a battery of electromotive force (e.m.f.) 16 V and negligible internal resistance.



What is the resistance of the variable resistor when the power dissipated in the electrical device is 4.0 W?

A 16Ω **B** 36Ω **C** 44Ω **D** 60Ω

16 When a force F moves its point of application through a displacement s in the direction of the force, the work W done by the force is given by

$$W = F\,s.$$

How many vector quantities and scalar quantities does this equation contain?

A one scalar quantity and two vector quantities

B one vector quantity and two scalar quantities

C three scalar quantities

D three vector quantities

17 What is a possible unit for the product VI, where V is the potential difference across a resistor and I is the current through the same resistor?

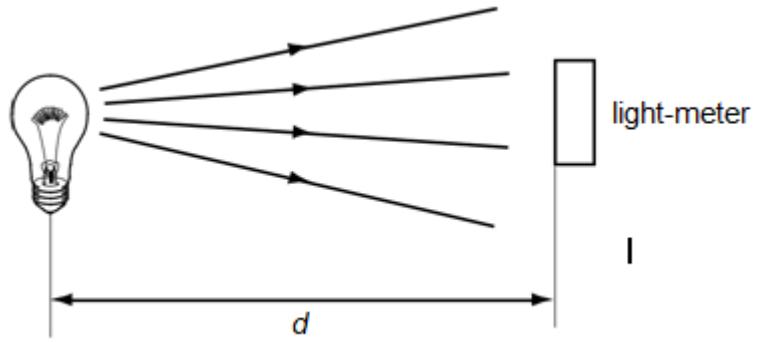
A newton per second (N s^{-1})

B newton second (N s)

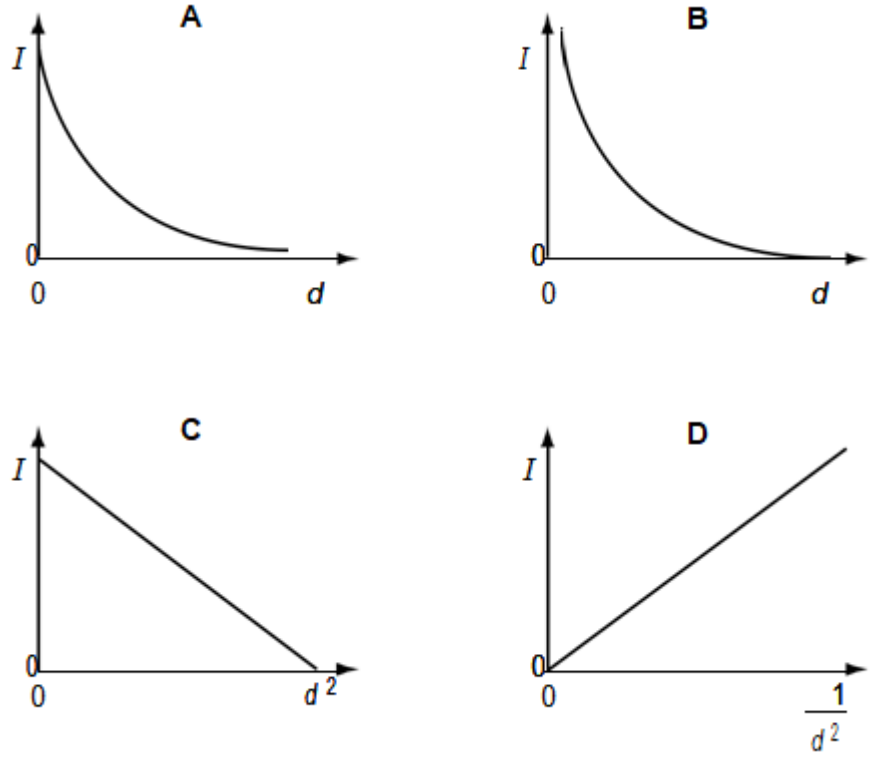
C newton metre (N m)

D newton metre per second (N m s^{-1})

18 A light-meter measures the intensity I of the light falling on it. Theory suggests that I varies inversely as the square of the distance d.



Which graph of the results supports the theory?



19 In an experiment, a radio-controlled car takes 2.50 ± 0.05s to travel 40.0 ± 0.1 m. What is the car's average speed and the uncertainty in this value?

A 16 ± 1 m s^{-1}

B 16.0 ± 0.2 m s^{-1}

C 16.0 ± 0.4 m s^{-1}

D 16.00 ± 0.36 m s^{-1}

20 In an experiment to determine the acceleration of free fall using a falling body, what would lead to a value that is too large?

A air resistance

B dimensions of the body are too large

C measured distance longer than true distance

D measured time longer than true time

21 Which feature of a graph allows acceleration to be determined?

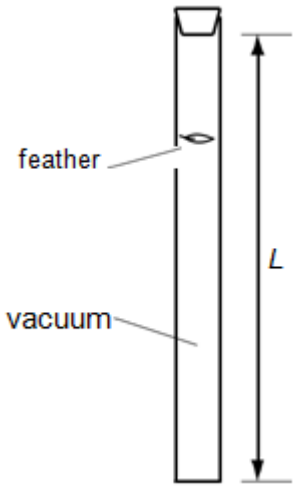
A the area under a displacement-time graph

B the area under a velocity-time graph

C the slope of a displacement-time graph

D the slope of a velocity-time graph

22 The diagram shows a laboratory experiment in which a feather falls from rest in a long evacuated vertical tube of length L.

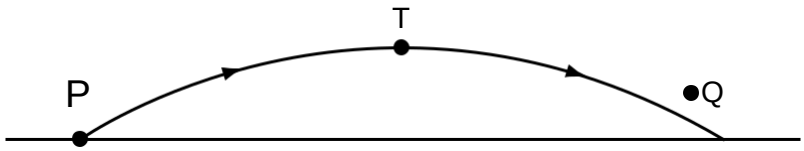


The feather takes time T to fall from the top to the bottom of the tube.

How far will the feather have fallen from the top of the tube in time 0.50 T?

A 0.13 L B 0.25 L C 0.38 L D 0.50 L

23 In the absence of air resistance, a stone is thrown from P and follows a parabolic path in which the highest point reached is T. The stone reaches point Q just before landing.



The vertical component of acceleration of the stone is

A zero at T.

B larger at T than at Q.

C larger at Q than at T.

D the same at Q as at T.

24 Each option gives a correct word equation involving force.

Which option gives the definition of force?

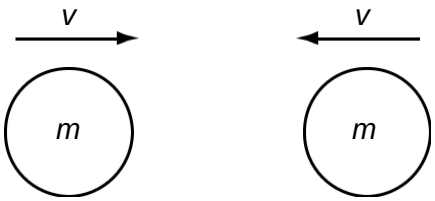
A force = energy divided by displacement

B force = mass × acceleration

C force = pressure × area

D force = rate of change of momentum

25 Two similar spheres, each of mass m and travelling with speed v, are moving towards each other.



The spheres have a head-on elastic collision.

Which statement is correct?

A The spheres stick together on impact.

B The total kinetic energy after impact is mv^2.

C The total kinetic energy before impact is zero.

D The total momentum before impact is 2 mv.

26 A cylindrical block of wood has cross-sectional area A and weight W. It is totally immersed in water with its axis vertical. The block experiences pressures p_t and p_b at its top and bottom surfaces respectively.

Which expression is equal to the upthrust on the block?

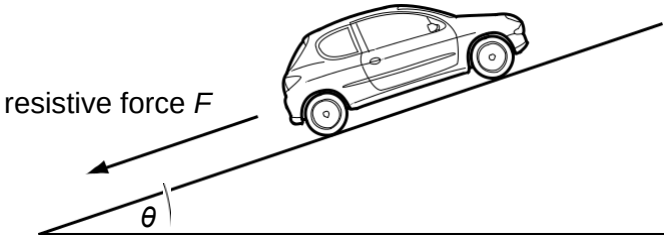
A $(p_b - p_t)A + W$

B $(p_b - p_t)$ C

$(p_b - p_t)A$

D $(p_b - p_t)A - W$

27 A car of mass m travels at constant speed up a slope at an angle θ to the horizontal, as shown in the diagram. Air resistance and friction provide a resistive force F.



What force is needed to propel the car at this constant speed?

A mg cos θ

B mg sin θ

C mg cos θ + F

D mg sin θ + F

28 At room temperature, the density of liquid mercury is five times greater than the density of solid aluminium.

What is the reason for this?

A Aluminium atoms are spaced widely apart.

B Aluminium atoms move more freely than mercury atoms.

C Atoms in a liquid take up less space than atoms in a solid.

D Mercury atoms have greater mass than aluminium atoms.

29 Which property of a metal wire depends on its Young modulus?

A ductility

B elastic limit

C spring constant

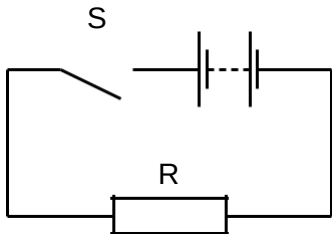
D ultimate tensile stress

30 There is a current of 10 mA in a conductor for half an hour.

How much charge passes a point in the conductor in this time?

A 0.3C B 5C C 18C D 300C

31 The diagram shows a simple circuit.



Which statement is correct?

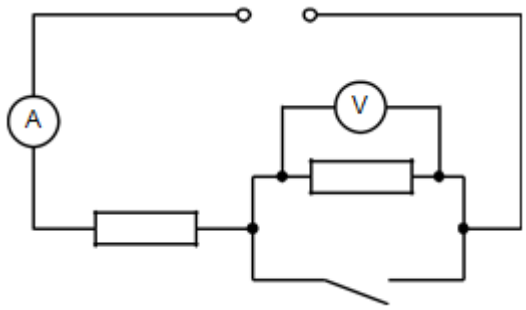
A When switch S is closed, the electromotive force (e.m.f.) of the battery falls because work is done against the internal resistance of the battery.

B When switch S is closed, the e.m.f. of the battery falls because work is done against the resistance R.

C When switch S is closed, the potential difference across the battery falls because work is done against the internal resistance of the battery.

D When switch S is closed, the potential difference across the battery falls because work is done against the resistance R.

32 In the circuit below, the ammeter reading is I and the voltmeter reading is V.

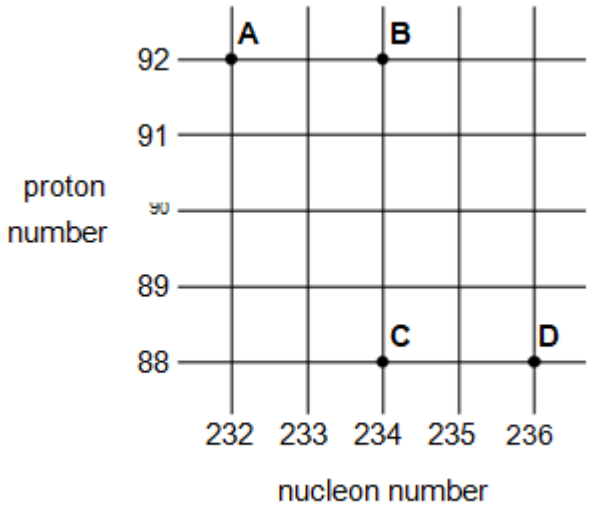


When the switch is closed, which row describes what happens to I and V ?

	I	V
A	decreases	decreases to zero
B	increases	decreases to zero
C	increases	stays the same
D	stays the same	increases

33 Thorium-234 ($^{234}_{90}$Th) decays by β-emission into a daughter product which in turn decays by further β-emission into a granddaughter product.

Which letter in the diagram represents the granddaughter product?



A. A B. B C. C D. D

34 Two copper wires of the same length but different diameters carry the same current.

Which statement about the flow of charged particles through the wires is correct?

A Charged particles are provided by the power supply. Therefore the speed at which they travel depends only on the voltage of the supply.

B The charged particles in both wires move with the same average speed because the current in both wires is the same.

C The charged particles move faster through the wire with the larger diameter because there is a greater volume through which to flow.

D The charged particles move faster through the wire with the smaller diameter because it has a larger potential difference applied to it.

35 Nuclear decay is both spontaneous and random in nature.

Which row gives the correct experimental evidence for these properties?

	spontaneous nature of decay	random nature of decay
A	the decay rate is not affected by pressure	the decay rate is not affected by temperature
B	the decay rate is not affected by pressure	the rate at which radiation is received at a counter fluctuates
C	the decay rate is not affected by temperature	the decay rate is not affected by pressure
D	the rate at which radiation is received at a counter fluctuates	the decay rate is not affected by pressure

36 Radon $^{222}_{86}$ Rn is the start of a decay chain that forms bismuth $^{214}_{83}$ Bi by alpha and beta emission. For the decay of each nucleus of radon, how many α−particles and β−particles are emitted?

	α−particles	β−particles
A	1	1
B	2	1
C	1	2
D	2	2

37 When will 1 C of charge pass a point in an electrical circuit?

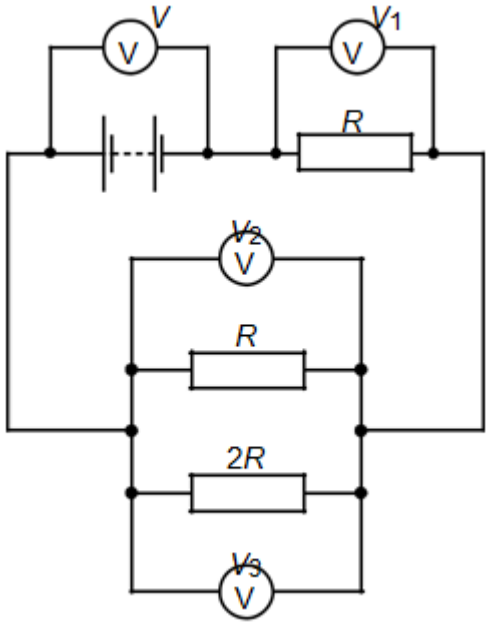
A when 1 A moves through a potential difference of 1V

B when a power of 1 W is used for 1 s

C when the current is 5 mA for 200s

D when the current is 10 A for 10 s

38 The diagram shows a circuit with four voltmeter readings V, V_1, V_2 and V_3.



Which equation relating the voltmeter readings must be true?

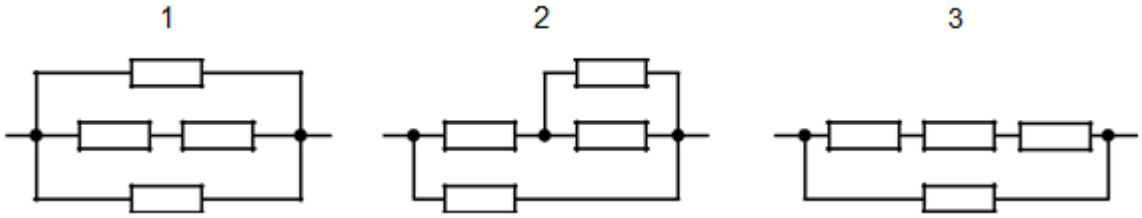
A. $V=V_1+V_2+V_3$

B. $V+V_1=V_2+V_3$

C. $V_3 = 2(V_2)$

D. $V–V_1=V_3$

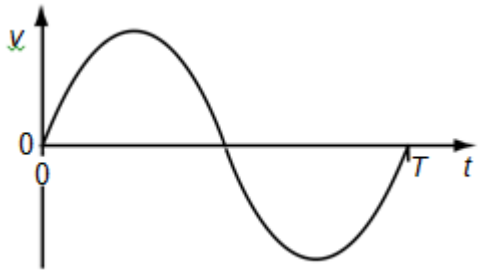
39 Four identical resistors are connected in the three networks below.



Which arrangement has the highest total resistance and which has the lowest?

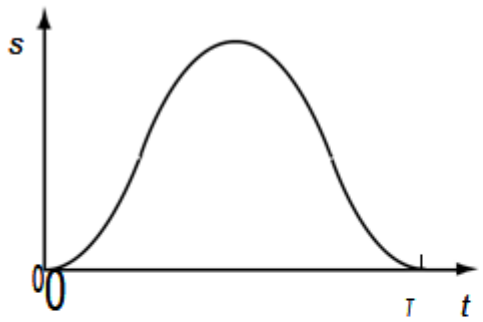
	highest	lowest
A	1	2
B	1	3
C	3	1
D	3	2

40 The graph shows how the velocity v of an object moving in a straight line varies over time t = 0 to t = T.

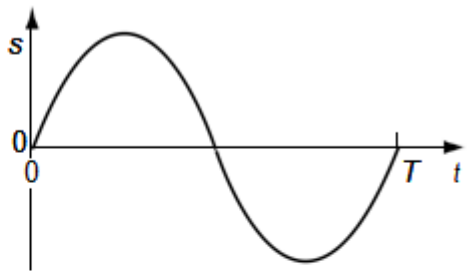


Which graph represents the displacement s of the object in the time t = 0 to t = T?

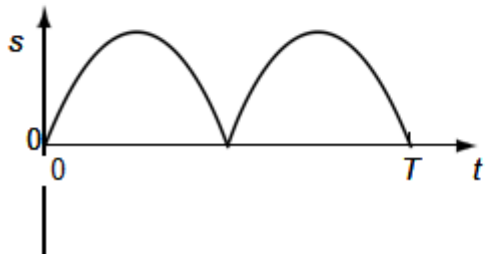
A



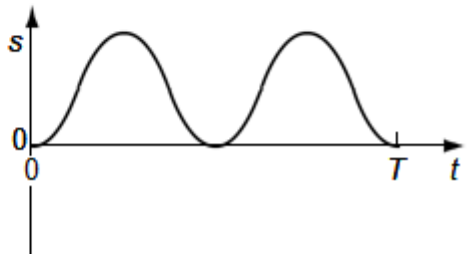
B



C



D



Section B (Short- and Extended- Responses)

Answer **all** the questions in the spaces provided.

Question 1

(a) Define *velocity*.

.....

.....[1]

(b) The speed v of a sound wave through a gas of pressure P and density ρ is given by the equation

$$v = \sqrt{\frac{kP}{\rho}}$$

where k is a constant that has no units.

An experiment is performed to determine the value of k. The data from the experiment are shown in Fig. 1.1.

quantity	value	uncertainty
v	3.3×10^{2} m s^{-1}	± 3%
P	9.9×10^{4} Pa	± 2%
ρ	1.29 kg m^{-3}	± 4%

Fig. 1.1

(b)(i) Use data from Fig. 1.1 to calculate k.

k = ... [2]

(c) Use your answer in **(b)(i)** and data from Fig. 1.1 to determine the value of k, with its absolute uncertainty, to an appropriate number of significant figures.

k = ... ± ..... [3]

[Total: 6]

Question 2

(a) Complete Table 2.1 by stating whether each of the quantities is a vector or a scalar.

Table 1.1

quantity	vector or scalar
acceleration	
power	
work	

[3]

The variation with time *t* of the velocity *v* of an object is shown in Fig. 2.1

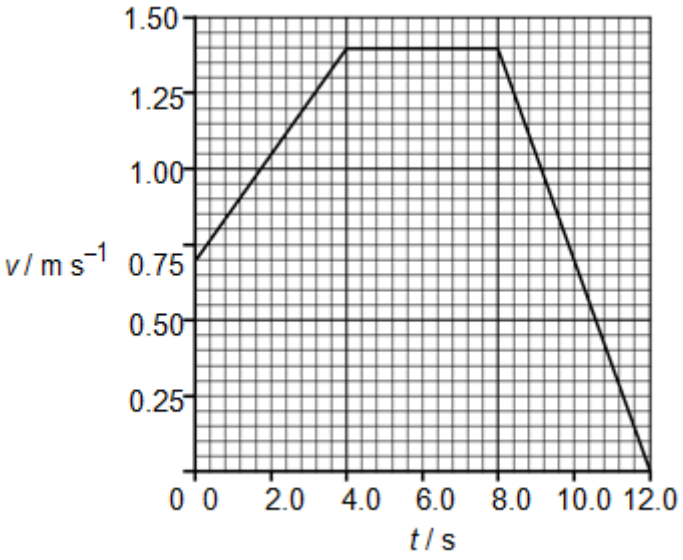


Figure 2.1

(i) Determine the acceleration of the object from time $t = 0$ to time $t = 4.0$ s.

acceleration = ... m s^{-2} [2]

(b) Determine the distance moved by the object from time t = 0 to time t = 4.0 s.

distance = ... m [2]

(c) The motion represented in Fig. 2.1 is caused by a resultant force F acting on the object.

On Fig. 2.2, sketch the variation of F with time t from t = 0 to t = 12.0 s.
Numerical values of F are not required.

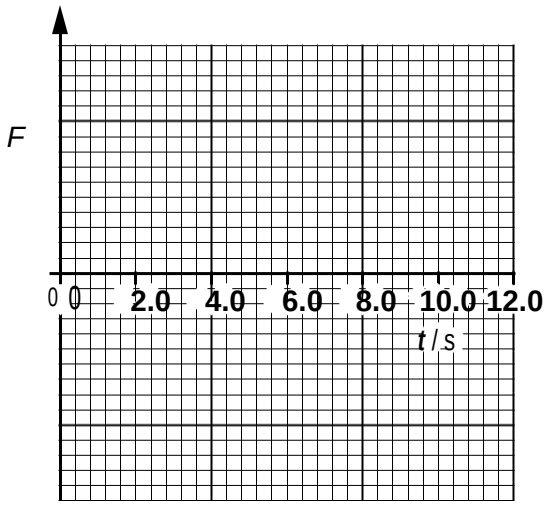


Fig. 2.2

[3]

[Total: 10]

Question 3

(a) The results of the α-particle scattering experiment provide evidence for the structure of the atom.

Result 1: The vast majority of the α-particles pass straight through the metal foil or are deviated by small angles.

Result 2: A very small minority of α-particles is scattered through angles greater than 90°.

State what may be inferred (deduced) from:

A result 1

.....

..... [1]

(b) result 2.

.....

.....

..... [2]

(b) A radioactive decay sequence contains four nuclei, P, Q, R and S, as shown.

$$^{218}_{84}\text{P} \rightarrow {}^{214}_{82}\text{Q} \rightarrow {}^{214}_{83}\text{R} \rightarrow \text{S}$$

Nucleus S is an isotope of nucleus P.

i) Determine the proton number and the nucleon number of nucleus S.

proton number = ...

nucleon number = ...
[2]

ii) The quark composition of a nucleon in Q changes as Q decays to form

R. Describe this change to the quark composition of the nucleon.

.....

..... [1]

[Total: 6]

Question 4

A sphere of radius 2.1 mm falls with terminal (constant) velocity through a liquid, as shown in Fig. 3.1.

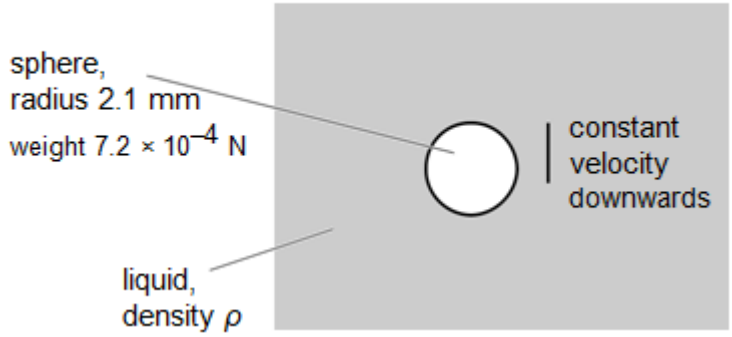


Figure 3.1

Three forces act on the moving sphere. The weight of the sphere is 7.2×10^{-4} N and the upthrust acting on it is 4.8×10^{-4} N. The viscous force F_V acting on the sphere is given by

$$F_V = krv$$

where r is the radius of the sphere, v is its velocity and k is a constant. The value of k in SI units is 17.

(i) Determine the SI base units of k.

SI base units ..... [2]

(ii) Use the value of the upthrust acting on the sphere to calculate the density ρ of the liquid.

ρ = ... kg m^{-3} [3]

(iii) On the sphere in Fig. 3.1, draw three arrows to show the directions of the weight *W*, the upthrust *U* and the viscous force F_V. Label these arrows *W*, *U* and F_V respectively. [1]

(iv) Determine the magnitude of the terminal (constant) velocity of the sphere.

velocity = ... m s^{-1} [2]

[Total: 8]

Section C (Practical-based questions) – 15 marks

Question 1

When a current passes through a wire, the wire becomes hot and expands.

This can be investigated in a laboratory by passing a current through a wire of diameter *d* and measuring the displacement *y*, as shown in Fig. 4.1.

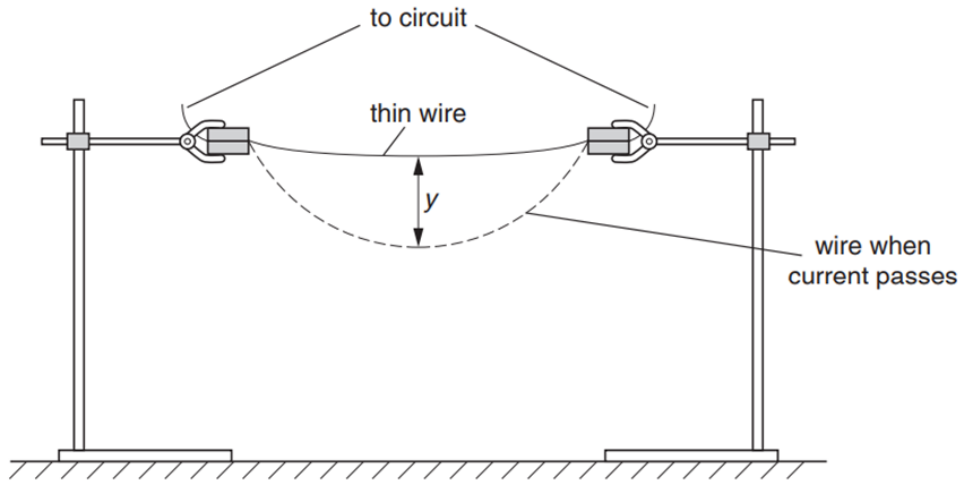


Fig 4.1

It is suggested that the diameter *d* of the wire is related to *y* by the equation

$$y = pd^{q}$$

where *p* and *q* are constants.

Design a laboratory experiment to investigate the relationship between *d* and *y*, so as to determine a value for *q*. You should draw a diagram showing the arrangement of your equipment.

In your account you should pay particular attention to

a) the procedure to be followed,

b) the measurements to be taken,

c) the control of variables,

d) the analysis of the data,

e) the safety precautions to be taken.

[15]

Diagram

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[Total:15]

End of Paper

Data and Formulae

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	$\varepsilon_0 = 8.85 \times 10^{-12}\,\mathrm{F\,m^{-1}}$
	$(\frac{1}{4\pi\varepsilon_0} = 8.99 \times 10^{9}\,\mathrm{m\,F^{-1}})$
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	$g = 9.81\,\mathrm{m\,s^{-2}}$

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