H

NANYANG JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
Higher 2

CANDIDATE NAME			
CLASS		TUTOR'S NAME	
CENTRE NUMBER	S	INDEX NUMBER	

PHYSICS 9749/01

Paper 1 Multiple Choice **22 September 2023**

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, class, Centre number and index number in the spaces at the top of this page.

There are **thirty** 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 rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages.

Data

speed of light in free space	$c = 3.00 \times 10^8$ m s^{-1}
permeability of free space	$\mu_0 = 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	$\varepsilon_0 = 8.85 \times 10^{-12}$ F m^{-1}
	$(1 / (36\pi)) \times 10^{-9}$ F m^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
unified atomic mass constant	$u = 1.66 \times 10^{-27}$ kg
rest mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
rest mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
molar gas constant	$R = 8.31$ J K^{-1} mol^{-1}
the Avogadro constant	$N_A = 6.02 \times 10^{23}$ mol^{-1}
the Boltzmann constant	$k = 1.38 \times 10^{-23}$ J K^{-1}
gravitational constant	$G = 6.67 \times 10^{-11}$ N m^2 kg^{-2}
acceleration of free fall	$g = 9.81$ m s^{-2}

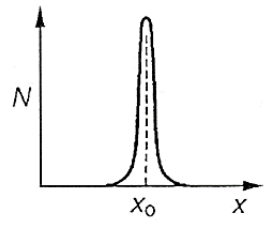
Formulae

uniformly accelerated motion	$s = ut + \frac{1}{2}at^2$
	$v^2 = u^2 + 2as$
work done on / by a gas	$W = p\Delta V$
hydrostatic pressure	$p = \rho gh$
gravitational potential	$\phi = -Gm / r$
temperature	$T / \text{K} = T / ^\circ\text{C} + 273.15$
pressure of an ideal gas	$p = \frac{1}{3}\frac{Nm}{V} < c^2 >$
mean translational kinetic energy of an ideal molecule	$E = \frac{3}{2}kT$
displacement of particle in s.h.m.	$x = x_0 \sin \omega t$
velocity of particle in s.h.m.	$v = v_0 \cos \omega t$
	$= \pm\omega\sqrt{x_0^2 - x^2}$
electric current	$I = Anvq$
resistors in series	$R = R_1 + R_2 + \ldots$
resistors in parallel	$1/R = 1/R_1 + 1/R_2 + \ldots$
electric potential	$V = \frac{Q}{4\pi\varepsilon_0 r}$
alternating current/voltage	$x = x_0 \sin \omega t$
magnetic flux density due to a long straight wire	$B = \frac{\mu_0 I}{2\pi d}$
magnetic flux density due to a flat circular coil	$B = \frac{\mu_0 NI}{2r}$
magnetic flux density due to a long solenoid	$B = \mu_0 nI$
radioactive decay	$x = x_0 \exp(-\lambda t)$
decay constant	$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$

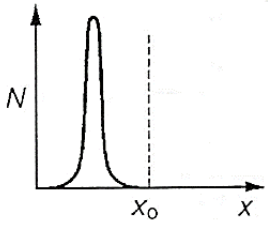
1 A quantity x is measured many times and the number N of measurements giving a value of x is plotted against x. The true value of the quantity is x_o.

Which graph best represents precise measurements with poor accuracy?

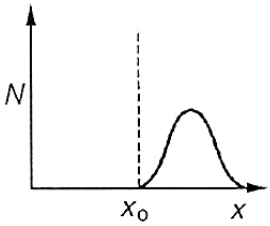
A



B



C



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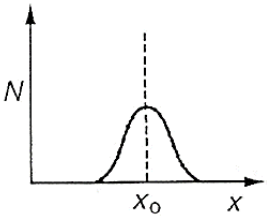


2 Errors in measurement may be either systematic or random.

Which of the following involves random error?

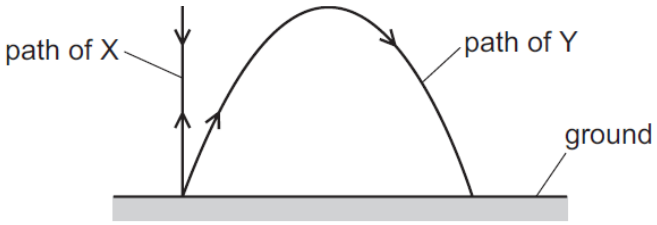
A Not allowing for zero error on an analog voltmeter

B Not subtracting background count rate when determining the count rate from a radioactive source

C Stopping a stopwatch at the end of a race

D Using the value of g as 10 N kg^{-1} when calculating weight from mass

3 Two projectiles, X and Y, are launched into the air from the same place on level ground. They reach the same maximum height as shown.



Projectile X is launched vertically upwards and projectile Y is launched at an angle to the horizontal. Air resistance is negligible.

Which statement is correct?

A X and Y are at rest at their maximum heights.

B X and Y are launched with the same speed.

C X and Y take the same time to return to the ground.

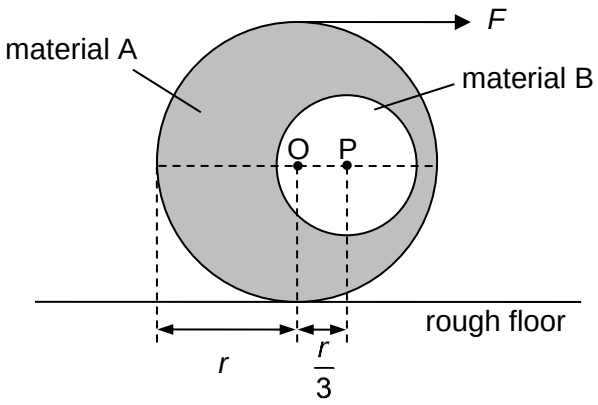
D X and Y travel the same distance.

4 A tractor of mass 1000 kg pulls a trailer of mass 1000 kg via a tow-bar. The total resistance to motion has a constant value of 4000 N. One fifth of this resistance acts on the trailer. If the maximum breaking force of the tow-bar is 3000N, what is maximum acceleration of the tractor and trailer?

A 2.2 m s^{-2} **B** 3.0 m s^{-2} **C** 3.8 m s^{-2} **D** 7.0 m s^{-2}

5 A cylinder of radius r, made of material A and B, is placed on a rough floor as shown. The portion made of material B has a radius of $0.45r$ and a density of ρ that is half that of material A. O is the centre of the cylinder and P is the centre of the portion made of material B. The distance between O and P is $\frac{r}{3}$. If the cylinder is entirely made of material A, its weight is 90 N.

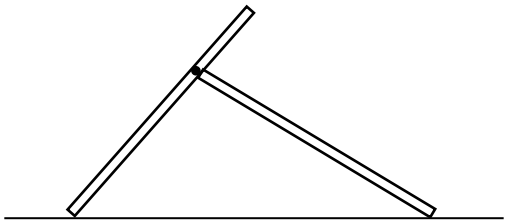
A force F is applied horizontally to the top of the cylinder so that O and P are at the same height from the floor as shown.



What is the force F required to keep the cylinder in this equilibrium position?

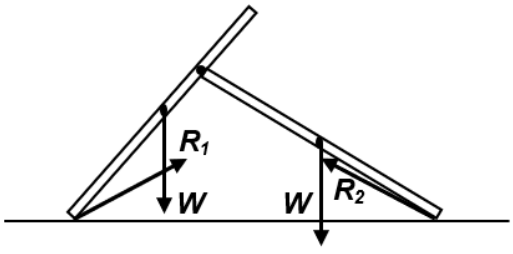
A 1.5 N **B** 2.0 N **C** 4.5 N **D** 7.5 N

6 Two identical uniform rods, each of weight W, are hinged together to form a structure which is resting on a rough floor as shown.



If the reaction forces acting on the structure by the floor are R_1 and R_2, which of the following shows the forces acting on the structure?

A



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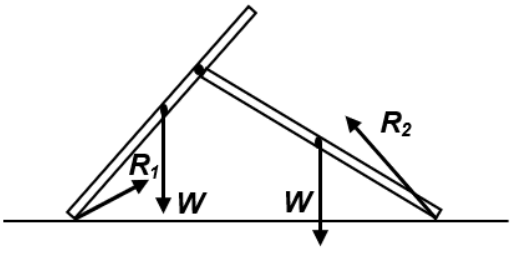
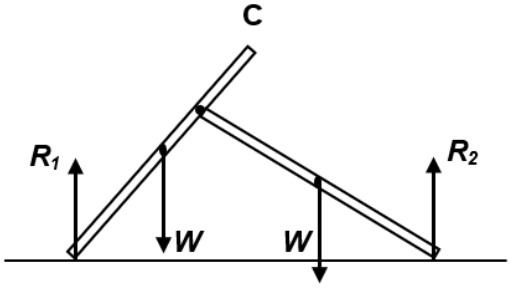
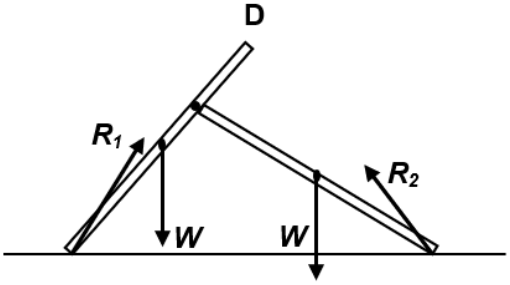


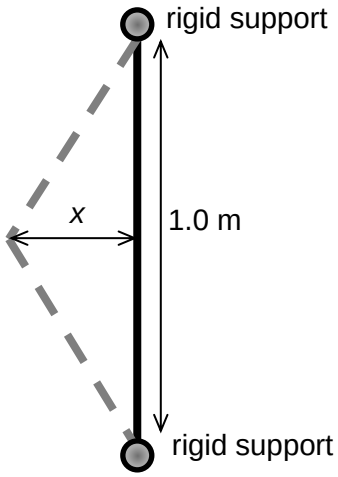
C



D



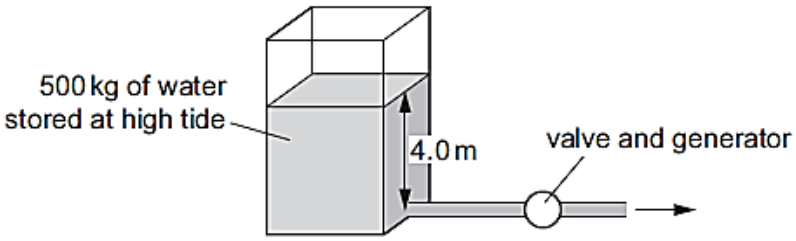
7 A student builds a launcher using an elastic cord of negligible mass and natural length of 1.0 m attached to two rigid supports.



Assuming that the elastic cord obeys Hooke's Law with a spring constant of 80 N m^{-1} and that the cord is pulled at its midpoint, what is the minimum draw length *x* needed such that a 200 g water balloon may be propelled with a speed of 10 m s^{-1}?

A 0.50 m **B** 0.56 m **C** 0.75 m **D** 1.5 m

8 A simple idea for generating electricity from the tides allows water stored in a container at high tide to flow away through a generator at low tide.



At high tide 500 kg of water is stored to a height of 4.0 m. When the valve is opened the container empties in 5.0 s and the generator operates with an efficiency of 40%.

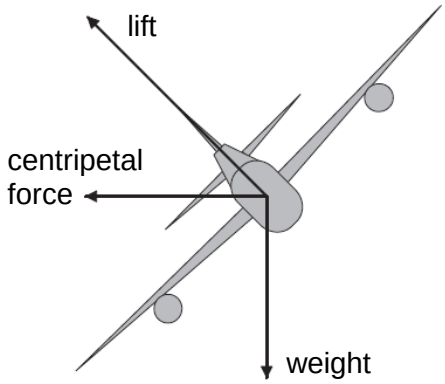
What is the average electrical power generated during the period of water flow?

A 780 W **B** 1600 W **C** 2000 W **D** 3900 W

9 An aircraft is flying at constant speed in a horizontal circle.

Which of the following diagrams best illustrates the forces acting on the aircraft?

A



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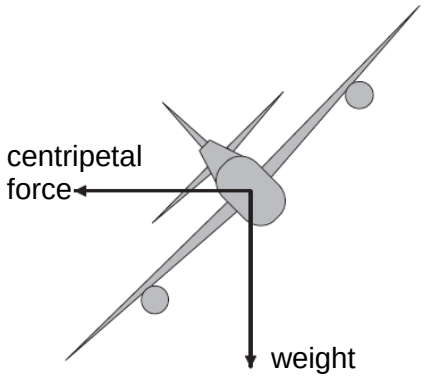

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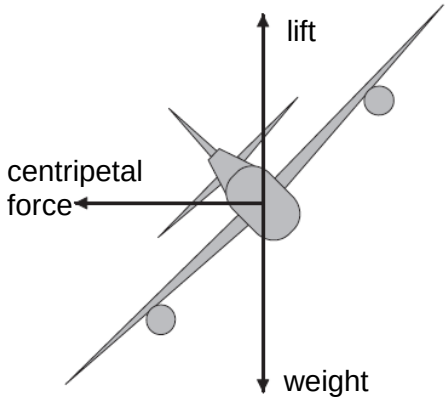

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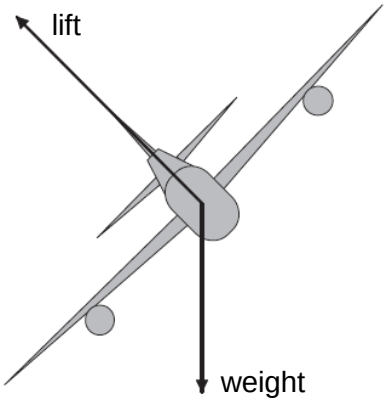
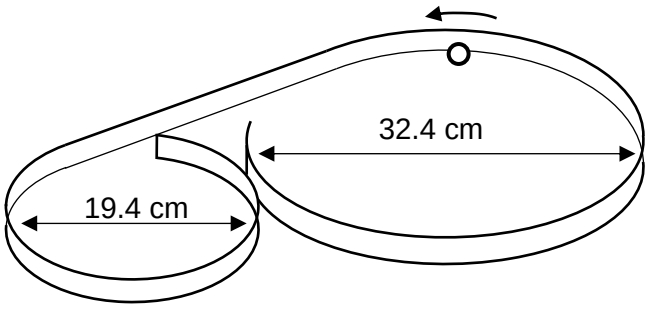


10 A small sphere is travelling horizontally around the circumference of the bigger circular loop in the figure below with an angular velocity of 63.0 rad s^{-1}.



The sphere then moves into the smaller loop and continues to move along its circumference.

What will be the angular velocity of the sphere when it is moving in the smaller loop?

A 37.7 rad s^{-1} **B** 63.0 rad s^{-1} **C** 105 rad s^{-1} **D** 126 rad s^{-1}

11 A satellite is orbiting the Earth with a radius of 6610 km at a speed of 7780 m s^{-1}. The satellite is boosted to a higher orbit of radius 6890 km. Given that the mass of the Earth is 6.0×10^{24} kg, the speed of the satellite in the new orbit is

A 7460 m s^{-1} **B** 7620 m s^{-1} **C** 7940 m s^{-1} **D** 8110 m s^{-1}

12 A small ice cube of mass 20 g is heated and changes from the solid to the liquid state. During this change in state the temperature of the substance does not change.

Which statement about this change in state is **not** correct?

A The amount of energy the ice absorbs is equal to the specific latent heat of fusion.

B The average kinetic energy of the molecules remains unchanged.

C The average potential energy of the molecules increases.

D The total mass of ice and water remains constant throughout.

13 The contents of a refrigerator are at a constant temperature, and the surroundings of the refrigerator are at a higher temperature. As a result, heat is transferred into the refrigerator from the surroundings. With the help of the cooling mechanism, heat from the refrigerator is also removed at the same rate.

The first law of thermodynamics may be applied to the contents of the refrigerator. This law is represented by $\Delta U = Q + W$, where ΔU is the increase in internal energy of the contents, Q is the net heat supplied to the contents, and W is the work done on the contents.

For the contents of the refrigerator, which of the quantities ΔU, Q and W is/ are zero?

A ΔU only **B** Q only

C W only **D** ΔU, Q and W

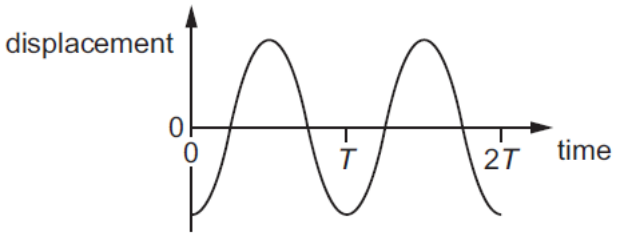
14 The air in an aircraft when travelling has the following energy as listed in the table below.

Type of energy	**As a result of**	**Amount of energy / MJ**
Kinetic energy	motion of the aircraft	8
Kinetic energy	random movement of the air molecules	30
Potential energy	altitude of the aircraft	75
Potential energy	intermolecular attraction between the air molecules	-3

What is the internal energy of the air in the aircraft?

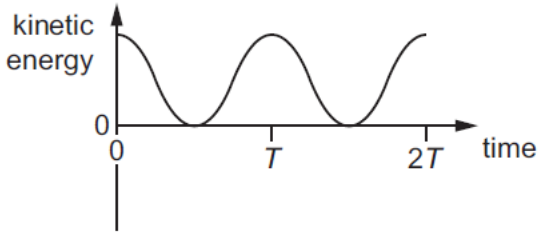
A 27 MJ **B** 33 MJ **C** 35 MJ **D** 110 MJ

15 When sound travels through air, the particles oscillate. A graph of displacement against time for a single particle is shown.

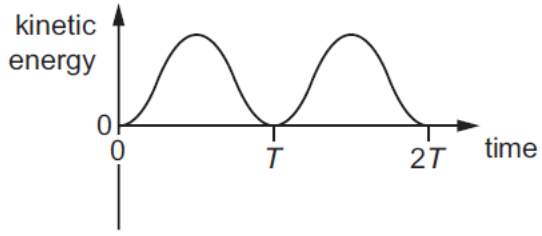


Which graph best shows how the kinetic energy of the air particle varies with time?

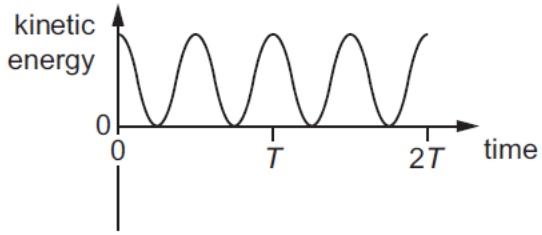
A



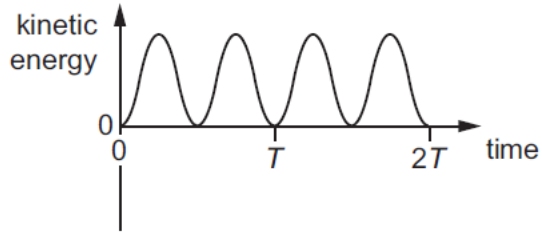
B



C



D

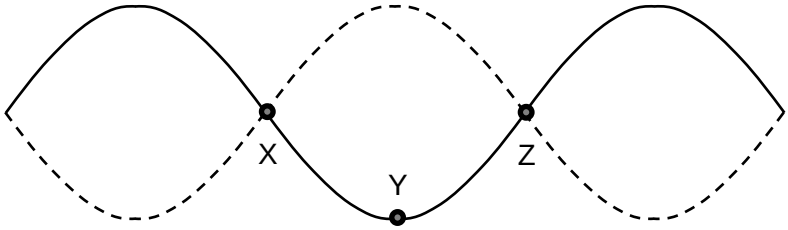


16 Two coherent light waves that are same plane polarized of equal frequency and intensity superpose at a point that is equal distance from the two sources. The intensity of light at that point is twice the intensity of light due to either wave alone.

What is a possible phase difference between the two waves at that point?

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

17 The stationary wave shown below is the result of the superposition of two identical waves travelling in opposite directions.



Which of the following best states the phase difference between the two waves at points X, Y and Z?

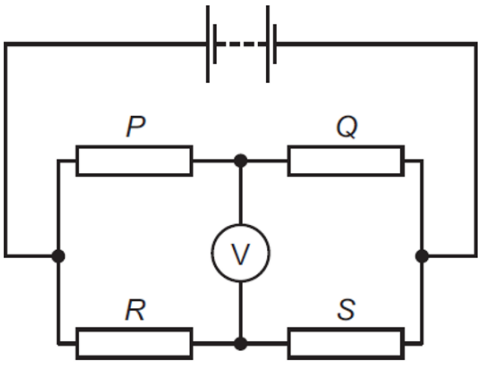
	X	Y	Z
A	$-\pi$	0	π
B	$-\pi/2$	0	$\pi/2$
C	$\pi/2$	π	$3\pi/2$
D	0	π	2π

18 A coil contains N turns of insulated copper wire wound on to a cylindrical iron core of diameter D. The copper wire has a diameter d. The resistivity of copper is ρ. Diameter D is much greater than diameter d.

What is the total resistance between the two ends of the coil?

A $\dfrac{4N\rho D}{d^2}$ **B** $\dfrac{4N\rho d}{D^2}$ **C** $\dfrac{8N\rho D}{d^2}$ **D** $\dfrac{8N\rho d}{D^2}$

19 The circuit diagram shows four resistors of different resistances P, Q, R and S connected to a battery.



The voltmeter reading is zero.

Which equation is must be correct?

A $P - Q = R - S$

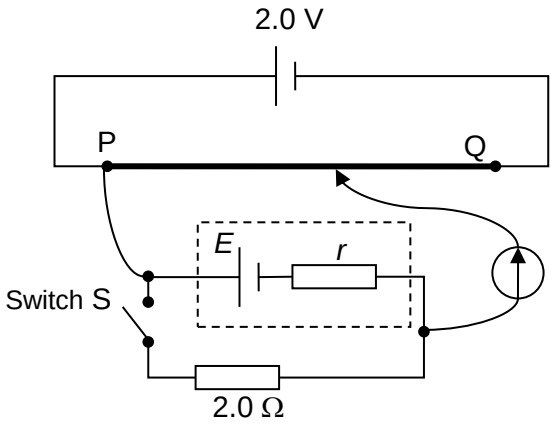
B $P - S = Q - R$

C $PQ = RS$

D $PS = QR$

20 The diagram below shows a potentiometer circuit used to determine the internal resistance *r* of a cell of e.m.f. *E*. The driver cell has an e.m.f. of 2.0 V with negligible internal resistance and the resistance wire PQ is 1.0 m long. The cell is connected in parallel with a resistor of 2.0 Ω. When the switch is open, the balance length is 0.70 m and when the switch is closed, the balance length is 0.50 m.

What is the value of *r*?



A 0.15 Ω **B** 0.40 Ω **C** 0.50 Ω **D** 0.80 Ω

21 A charged oil droplet of mass *m* is falling, initially freely, in a vacuum between two horizontal metal plates that are separated by a distance *x*.

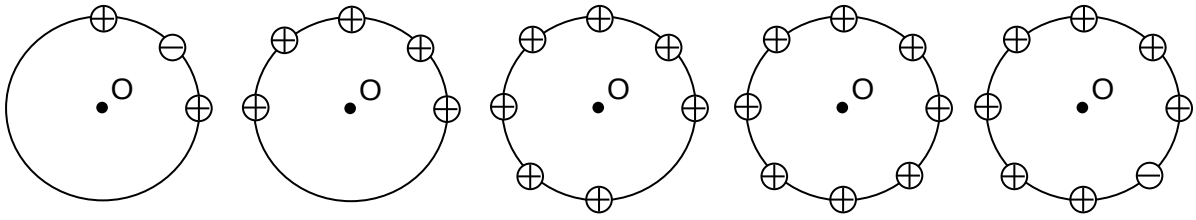
A potential difference (p.d.) *V* is then applied across the plates. This results in the oil droplet continuing to accelerate downwards but with a reduced acceleration *a*.

The polarity of the applied p.d. is then reversed so that the direction of the electric force on the droplet is reversed. This results in the downwards acceleration of the oil droplet increasing to 3*a*.

What is the magnitude of the charge on the oil droplet?

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

22 The diagrams below show 5 different arrangements of charges around a circle with centre O. Rank in *ascending* order the magnitude of the electric field strength at point O

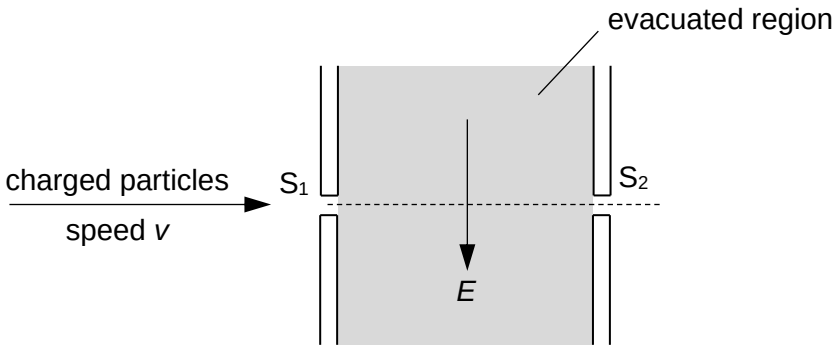


1 2 3 4 5

A 1 2 3 5 4 **B** 4 1 3 5 2 **C** 1 2 5 3 4 **D** 4 3 5 2 1

23 A narrow parallel beam of charged particles, each with speed v, passes through a slit S_1 into an evacuated region, moving in the direction towards slit S_2.

The evacuated region is shown shaded on the diagram.

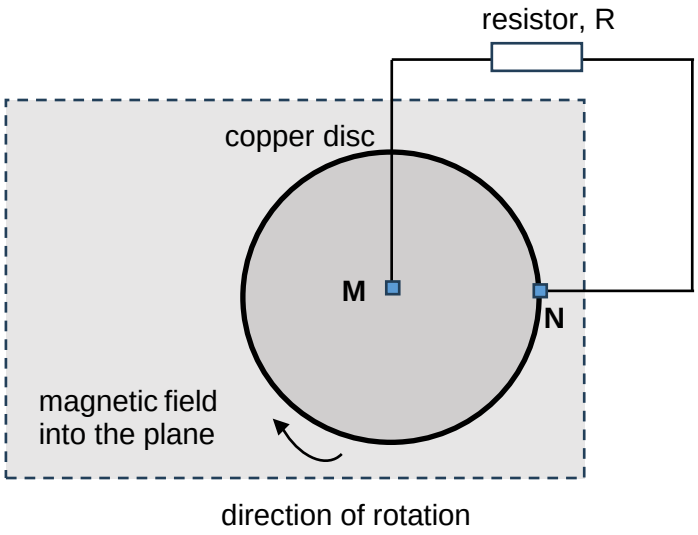


Uniform magnetic and electric fields are applied in the same evacuated region, with the electric field E in the direction shown. The particles continue to exit through slit S_2.

What is the magnitude and direction of the magnetic field?

	magnitude	direction
A	$\frac{E}{v}$	into the plane of the paper
B	$\frac{E}{v}$	out of the plane of the paper
C	Ev	into the plane of the paper
D	Ev	out of the plane of the paper

24 A copper disc rotates with a constant angular velocity in a uniform magnetic field applied perpendicular to its surface, as shown. The axle and the edge of the disc are in contact with metallic brushes M and N which are connected to a resistor R via wires.



Which of the following statements is correct?

A There is no current through R because there is no flux change through the disc.

B There is an alternating current through R.

C There is a steady current from M, through R, to N.

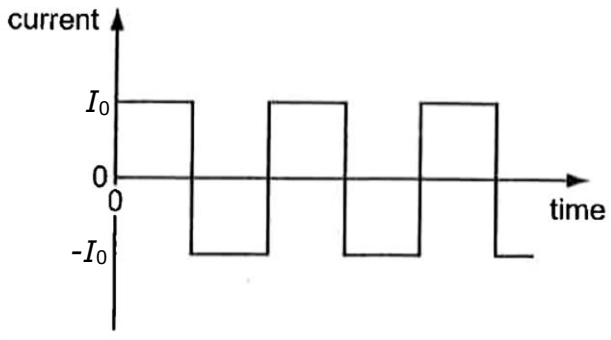
D There is a steady current from N, through R, to M.

25 A 240 V supply is connected to an ideal transformer. The output of the transformer is connected to five 12 V, 24 W lamps connected in parallel. The lamps are operating normally.

What is the current drawn from the supply?

A 0.10 A **B** 0.50 A **C** 2.0 A **D** 10.0 A

26 The graph shows an alternating current with a square waveform.



The peak value of the current is I_o and the average power dissipated in the circuit is given by *P*.

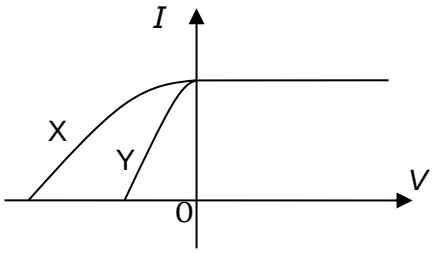
What is the new average power dissipated if the peak value is now doubled to $2I_o$?

A *P* **B** 1.4*P* **C** 2*P* **D** 4*P*

27 In a photoelectric effect experiment, a metallic surface X in an evacuated tube is illuminated with light of wavelength 275 nm causing the emission of photoelectrons which are collected at an adjacent electrode.

The experiment is repeated by replacing metallic surface X by another metallic surface Y.

The variation of photocurrent I with the potential difference V between each of the metallic surfaces and the adjacent electrode is shown in the diagram below.



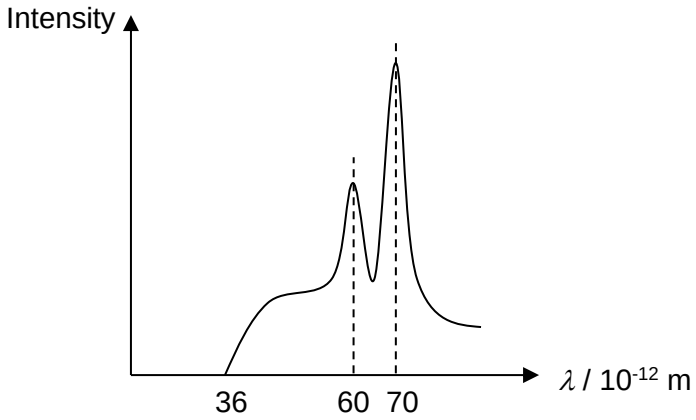
The table below lists the work functions of some elements.

Element	Work Function (eV)
Sodium	2.7
Aluminium	4.3
Copper	4.7

What materials are the metallic surfaces X and Y made of?

	metallic surface X	metallic surface Y
A	copper	copper
B	copper	aluminium
C	sodium	aluminium
D	sodium	copper

28 The x-ray spectrum produced by bombarding a metal target with electrons is shown below.



Which of the following statements is correct?

A The graph shows that electrons with a range of kinetic energies are used to bombard the target.

B The wavelength corresponding to the peaks allow the energy of the electrons used to bombard the target to be calculated.

C The smallest wavelength detected, 36×10^{-12} m, is dependent on the target material.

D The wavelength corresponding to the peaks can be used to identify the element of target.

29 The fusion of two deuterium nuclei produces a nuclide of helium and a neutron. The reaction liberates 3.27 MeV of energy.

How does the combined mass of the two deuterium nuclei, $\Sigma M_{\text{Reactants}}$, compare with the combined mass of the helium nucleus and neutron, $\Sigma M_{\text{Products}}$?

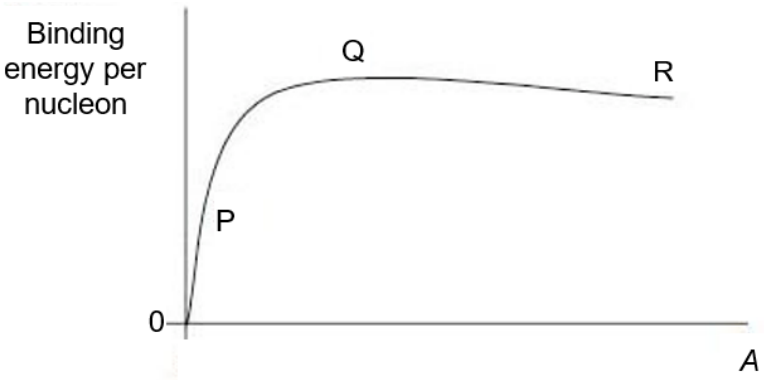
A $\Sigma M_{\text{Reactants}}$ is 5.8×10^{-30} kg greater than $\Sigma M_{\text{Products}}$.

B $\Sigma M_{\text{Reactants}}$ is 5.8×10^{-30} kg smaller than $\Sigma M_{\text{Products}}$.

C $\Sigma M_{\text{Reactants}}$ is 5.8×10^{-36} kg greater than $\Sigma M_{\text{Products}}$.

D $\Sigma M_{\text{Reactants}}$ is 5.8×10^{-36} kg smaller than $\Sigma M_{\text{Products}}$.

30 The graph shows how the binding energy per nucleon of a nucleus varies with nucleon number, *A*.



Which of the following statements is **not** true?

A Energy is released in nuclear fission reactions from nuclei in region P.

B Nuclei in region Q are more stable than nuclei in region R.

C Nuclear fusion reactions from nuclei in region P produce nuclei closer to region Q.

D The binding energy per nucleon increases most significantly when nuclei in region P undergo nuclear fusion reactions.

End of Paper