RAFFLES INSTITUTION
2021 Preliminary Examination

PHYSICS | **9749/01**
Higher 2 | **September 2021**
Paper 1 Multiple Choice Questions | **1 hour**

Additional Materials: OMR Form

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your index number, name and class on the OMR Form in the spaces provided. Shade the appropriate boxes.

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 OMR Form.

Read the instructions on the OMR Form 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 appropriate scientific calculator is expected, where appropriate.

This document consists of **14** printed pages.

Data

speed of light in free space	c	$= 3.00 \times 10^{8}$ m s^{-1}
permeability of free space	μ_0	$= 4\pi \times 10^{-7}$ H m^{-1}
permittivity of free space	ε_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	ϕ	$= -Gm/r$
temperature	T/K	$= T/°C + 273.15$
pressure of an ideal gas	p	$= \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$
mean translational kinetic energy of an ideal gas 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	$= \frac{\mu_0 N I}{2r}$
magnetic flux density due to a long solenoid	B	$= \mu_0 n I$
radioactive decay	x	$= x_0 \exp(-\lambda t)$
decay constant	λ	$= \frac{\ln 2}{t_{\frac{1}{2}}}$

1 In an experiment to determine the density of a sphere, the following measurements are made.

mass = (80 ± 2) g

diameter = (4.0 ± 0.1) cm

How should the value of density of the sphere be expressed?

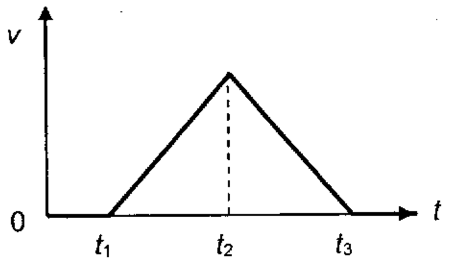
A (2.4 ± 0.1) g cm^{-3}

B (2.4 ± 0.2) g cm^{-3}

C (2.4 ± 0.4) g cm^{-3}

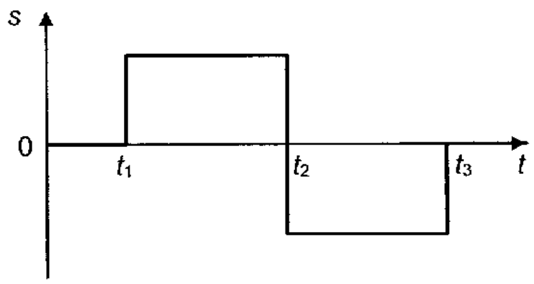
D (2 ± 2) g cm^{-3}

2 The diagram shows the variation with time *t* of the velocity *v* of an object moving along a straight line. The intial displacement of the object is zero.

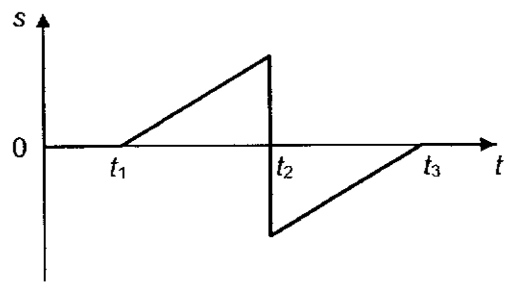


Which graph shows the variation with time *t* of the displacement *s* of the object?

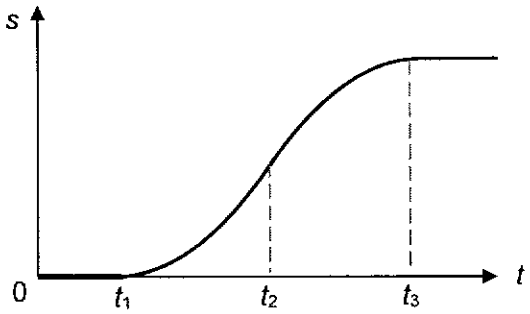
A



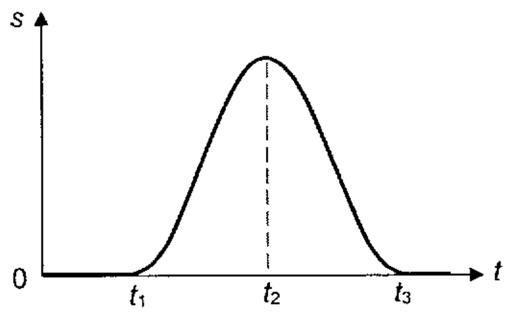
B



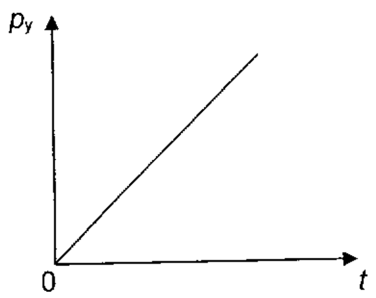
C

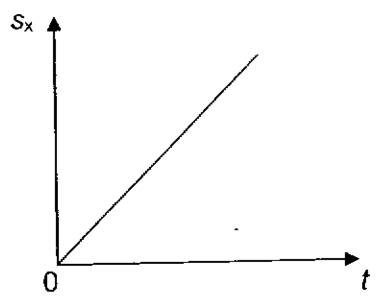


D



3 An object moves in the x-y plane. The graph on the left shows the variation with time t of the y-component of its momentum p_y and the graph on the right shows the variation with t of the x-component of its displacement s_x.





Which statement describes the motion of the object?

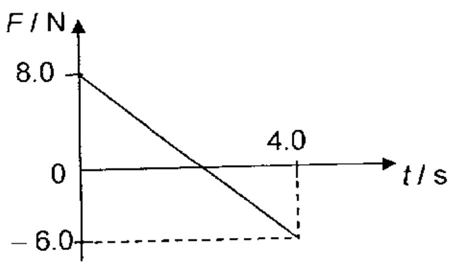
A It is moving in a circular path.

B It is moving in a parabolic path.

C It is moving with simple harmonic motion.

D It is moving with constant velocity in a straight line.

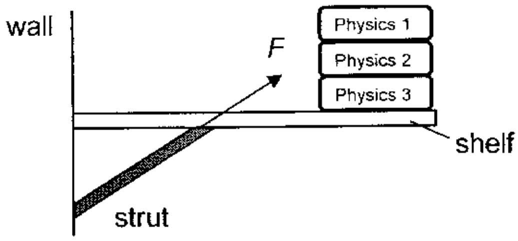
4 A body is acted upon by a resultant force F for a duration of 4.0 s. The graph below shows the variation with time t of F.



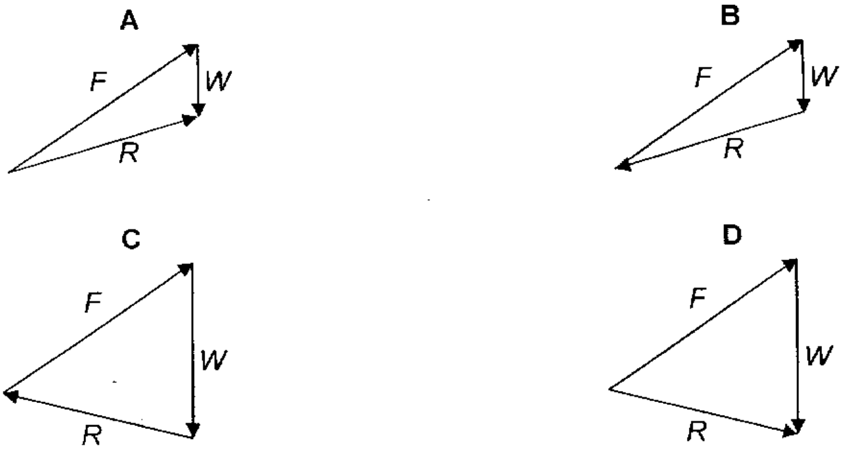
Assuming that the body is moving in a straight line, what is the change in momentum of the body?

A 2.0 N s **B** 2.8 N s **C** 4.0 N s **D** 14 N s

5 The figure below shows a light wall-mounted shelf supported by a strut. The shelf experiences a force F due to the strut along the axis of the strut, as well as a force R due to the wall. A stack of Physics Revision Packages of weight W is placed near the edge of the shelf.

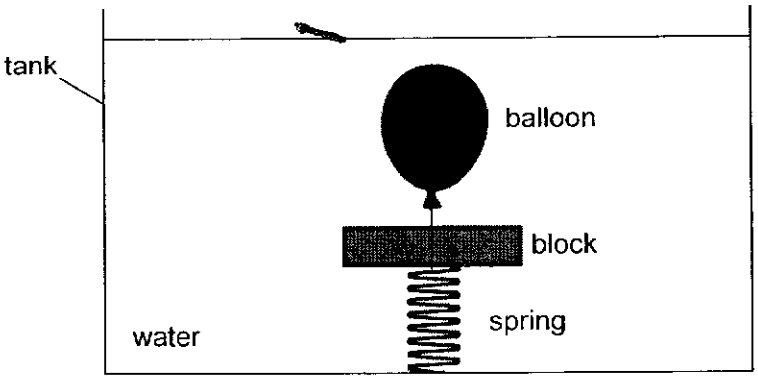


Which vector diagram correctly shows the forces acting on the shelf?



6 A uniform plastic block with a light balloon attached to its centre is supported by a spring that is fixed to the bottom of a tank. The tank is completely filled with water of density 1000 kg m^{-3} as shown.

The block is in equilibrium and has a weight of 60 N and a volume of 5.0×10^{-3} m^3. The spring has a spring constant of 5000 N m^{-1}. The balloon displaces 0.015 m^3 of water.



What is the extension of the spring?

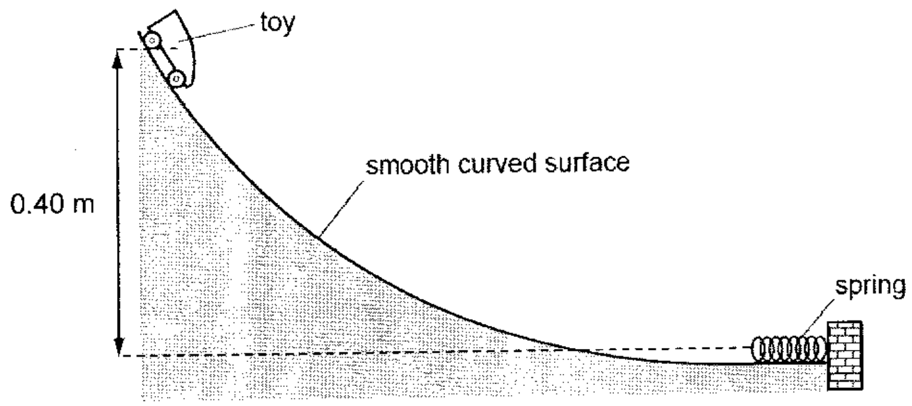
A 0.0076 m **B** 0.017 m **C** 0.027 m **D** 0.051 m

7 A motor is used to lift a load of mass 0.80 kg vertically upward at an acceleration of 1.0 m s^{-2} for a distance of 2.0 m. The efficiency of the motor is 60%.

What is the electrical energy supplied to the motor in performing this task?

A 2.7 J **B** 17 J **C** 26 J **D** 29 J

8 A toy car of mass 0.22 kg is released from rest and runs down a smooth curved surface through a vertical distance of 0.40 m, as shown. It strikes a horizontal spring of force constant 350 N m^{-1} and compresses it by a distance *x* before coming to rest.



Assuming no losses in mechanical energy, what is the value of *x*?

A 4.9×10^{-3} m **B** 6.2×10^{-3} m **C** 3.5×10^{-2} m **D** 7.0×10^{-2} m

9 The capsules in the Singapore Flyer move in a circle of radius 75 m with an average period of 30 minutes.

What is the centripetal acceleration of the capsules?

A 9.1×10^{-4} m s^{-2} **B** 0.26 m s^{-2} **C** 3.3 m s^{-2} **D** 9.8 m s^{-2}

10 A body of mass m moves in uniform circular motion with radius r, linear speed v and angular speed ω.

Which change does **not** affect the value of the centripetal force on the body?

A Mass of body is decreased to $\frac{m}{2}$.

B Radius is increased to $2r$ and angular speed is decreased to $\frac{\omega}{2}$.

C Radius is decreased to $\frac{r}{2}$ and linear speed is decreased to $\frac{v}{2}$.

D Linear speed is decreased to $\frac{v}{2}$, angular speed is increased to 2ω and radius is decreased to $\frac{r}{4}$.

11 The Earth may be considered to be a uniform sphere of mass M and radius R. An apple of mass m falls from rest from a height h to the ground, where $h << R$ such that the gravitational field strength g experienced by the apple during its fall may be assumed to be constant.

What is the gain in kinetic energy of the apple?

A mgR

B $\frac{GMmh}{R^2}$

C $\frac{GM}{R} - \frac{GM}{R+h}$

D $m\left(\frac{GM}{R+h} - \frac{GM}{R}\right)$

12 An object has weight W on the surface of the Earth.

The radius of Mars is 0.50 times that of the Earth.
The density of Mars is 0.70 times that of the Earth.

What is the weight of the object on the surface of Mars?

A 0.35 W **B** 0.50 W **C** 0.70 W **D** 2.8 W

13 A horizontal plate is oscillating vertically in simple harmonic motion at a frequency of 3.2 Hz.

What is the maximum amplitude of oscillation such that a coin placed on the plate will always remain in contact with the plate?

A 0.024 m **B** 0.15 m **C** 0.49 m **D** 0.96 m

14 In the derivation of the relationship $pV = \frac{1}{3}Nm<c^2>$, where N is the number of gas molecules, which statement is **not** an essential assumption?

A The average kinetic energy of a molecule is proportional to the temperature of the gas.

B The volume of molecules is negligible compared with the volume occupied by the gas.

C The molecules exert no intermolecular forces on one another except during collisions.

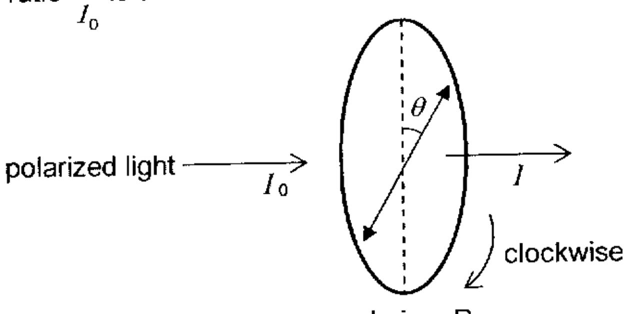
D The molecules are in continuous random motion.

15 A fixed mass of ideal gas undergoes a contraction in volume from 80×10^{-3} m^3 to 40×10^{-3} m^3 at a constant pressure of 25 kPA. During this contraction, 2500 J of heat is removed from the gas.

What is the change in internal energy of the gas?

A –3500 J **B** –1500 J **C** 1500 J **D** 3500 J

16 A beam of vertically polarised light of intensity I_0 is incident on a polariser P. The axis of polarisation of P is initially at an angle θ from the vertical. Light after passing through P has an intensity I. The ratio $\frac{I}{I_0}$ is 0.25.



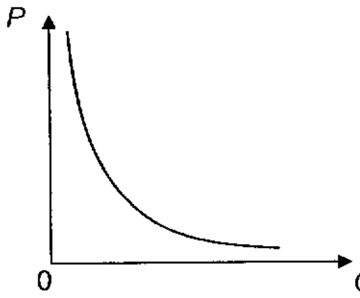
P is rotated 30° clockwise such that the axis of polarisation is now θ +30° from the vertical.

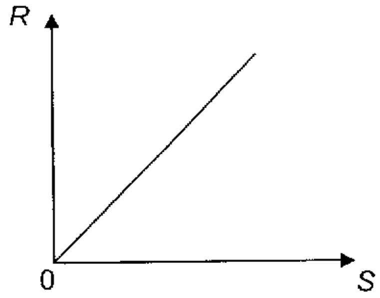
What is the new ratio $\frac{I}{I_0}$?

A 0 **B** 0.27 **C** 0.75 **D** 0.87

17 Light waves from a particular point source travel without the loss of energy. At various distances from the source, the intensity and amplitude of the light are measured.

The following graphs illustrate the relationship between these quantities.





Which row of the table below shows what the variables *P*, *Q*, *R* and *S* represent?

	P	*Q*	*R*	*S*
A	amplitude	distance	intensity	amplitude
B	amplitude	distance	intensity	$(\text{amplitude})^2$
C	intensity	$(\text{distance})^2$	intensity	amplitude
D	intensity	amplitude	intensity	$(\text{distance})^2$

18 In a double-slit interference experiment a pair of slits 0.45 mm apart were placed 0.70 m from the screen. When monochromatic light from a laser was incident normally on the slits, an interference pattern was formed on the screen. The distance between the central bright fringe and the 10th dark fringe was found to be 7.5 mm.

What was the wavelength of the incident light?

A 4.6×10^{-7} m **B** 4.8×10^{-7} m **C** 5.1×10^{-7} m **D** 4.8×10^{-6} m

19 Monochromatic light of wavelength 633 nm is passed through a diffraction grating with 500 lines per mm.

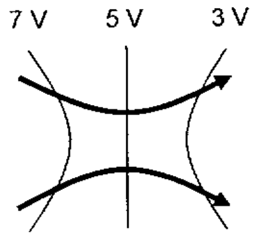
What is the maximum number of intensity maxima that can be observed?

A 3 **B** 4 **C** 6 **D** 7

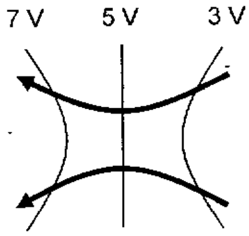
20 In the diagrams, the thin lines show equipotential lines and the bold arrows show the electric field lines and their directions.

Which set of equipotential lines and field lines is correct?

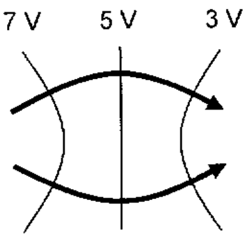
A



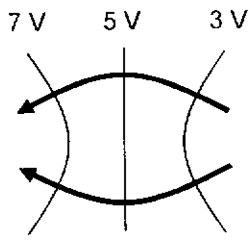
B



C

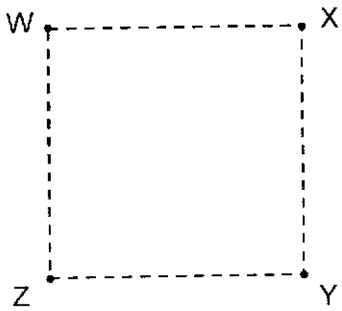


D



21 The diagram shows the positions W, X, Y and Z at the corners of a square.

A point charge +Q is fixed at position W while another point charge –Q is moved from position X to position Y.



Which statement is correct?

A The electric potential at Z will increase.

B The magnitude of the electric field strength at Z will increase.

C The attractive force between the two charges will increase.

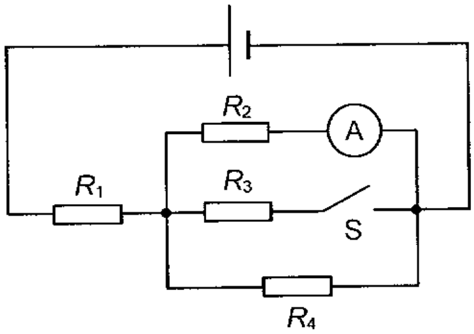
D The electric potential energy of the system will decrease.

22 A battery is connected in series with a resistor R. The battery drives 1500 C of charge completely round the circuit. During this process, 2500 J of energy is dissipated in the resistor R and 500 J is dissipated in the battery.

What is the e.m.f. of the battery?

A 0.50 V **B** 0.33 V **C** 1.7 V **D** 2.0 V

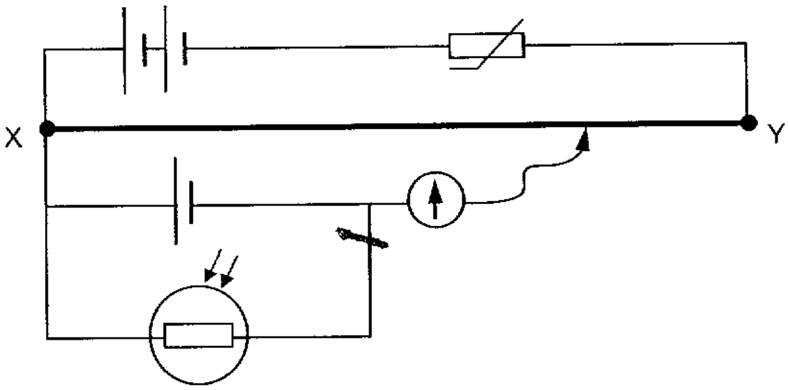
23 Four resistors R_1, R_2, R_3, R_4 are connected in a circuit. R_2 is in series with an ammeter, while R_3 is in series with switch S. Switch S is initially open.



Which of the following changes, when made independently, would increase the reading on the ammeter?

A Increase R_1 **B** Increase R_2 **C** Increase R_4 **D** Close S

24 A NTC thermistor and a light-dependent resistor are connected in a potentiometer circuit. The batteries have finite internal resistance. XY is a resistance wire.



Which row of environmental conditions maximizes the balance length of the potentiometer?

	temperature	lighting condition
A	high	bright
B	high	dark
C	low	bright
D	low	dark

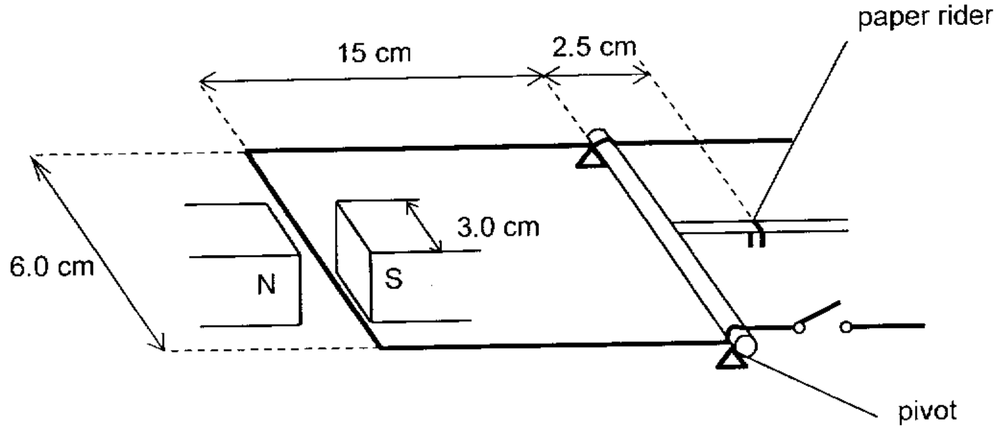
 [Turn over

25 A current balance consists of a U-shaped wire frame of length 15 cm and breadth 6.0 cm.

3.0 cm of the wire is in a uniform magnetic field of flux density 60 mT.

When the switch is open, the current balance is horizontal and in equilibrium when a paper rider of mass 5.0 g is placed at 2.5 cm to the right of the pivot as shown in the diagram.

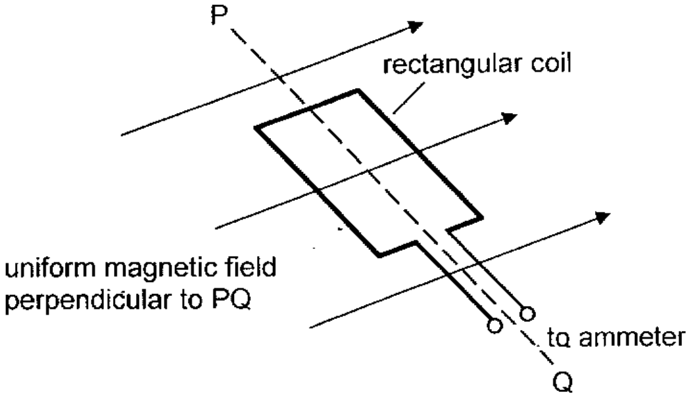
When the switch is closed, the current balance is in equilibrium when the same paper rider is placed 6.8 cm to the right of the pivot.



What is the value of the current in the wire when the switch is closed?

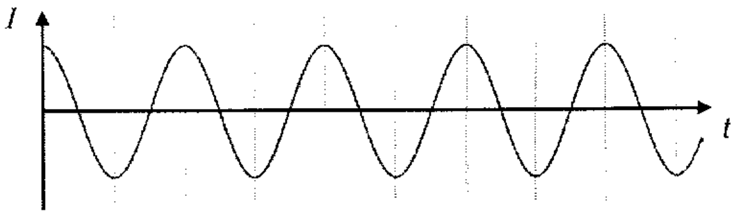
A 1.2 A **B** 3.9 A **C** 7.8 A **D** 12 A

26 A rectangular coil, which is free to rotate about the axis PQ, is placed in a uniform magnetic field perpendicular to PQ. The coil is connected to an ammeter and given an initial angular speed to start rotation.

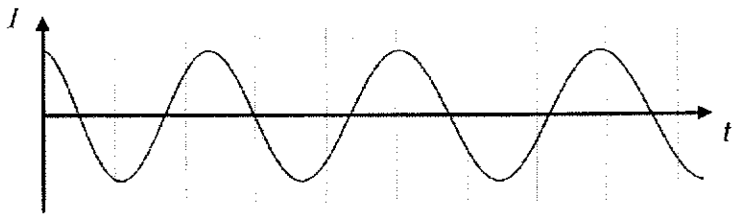


Which graph correctly shows the variation with time of the reading on the ammeter? Ignore the effects of air resistance.

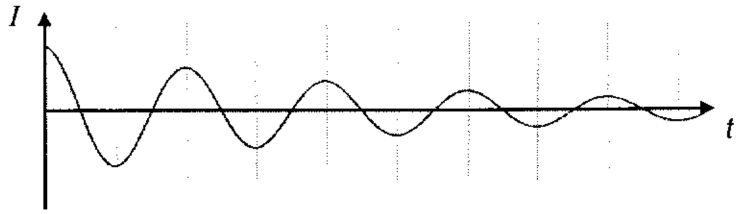
A



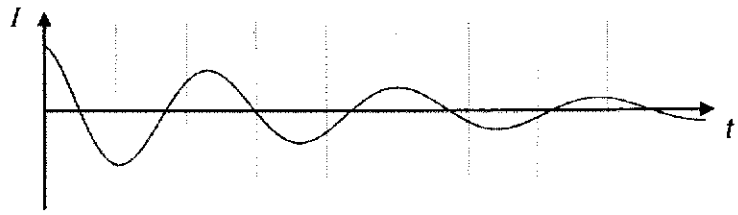
B



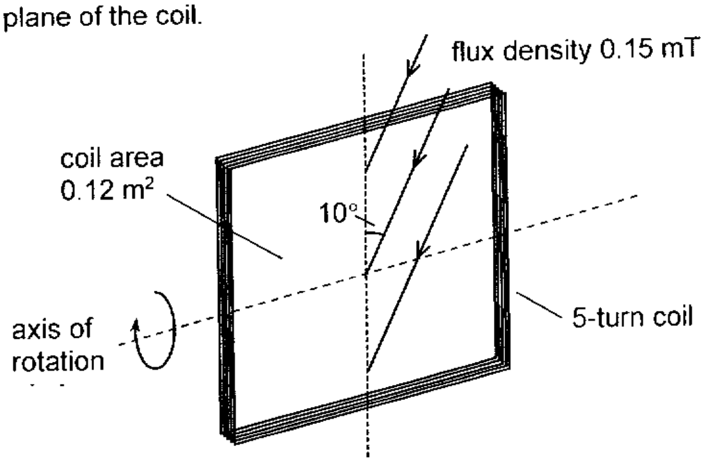
C



D



27 A coil has area 0.12 m^2 and 5 turns. A uniform magnetic field of flux density 0.15 mT acts at an angle 10° to the plane of the coil.



What is the change in magnetic flux linkage when the coil rotates such that the angle between the flux density and the plane of the coil is reduced to zero?

A 1.56×10^{-5} Wb **B** 8.86×10^{-5} Wb **C** 1.56×10^{-2} Wb **D** 8.86×10^{-2} Wb

28 When an alternating current, $I = I_0 \sin \omega t$, passes through a resistor, the mean power dissipated in the resistor is P. The peak value of the alternating current is then changed to $2\,I_0$ and the frequency is halved.

What is now the mean power dissipated in the resistor?

A P **B** $\sqrt{2}\,P$ **C** $2P$ **D** $4P$

29 A proton travelling in a straight line with momentum p has an uncertainty of 0.10% in its kinetic energy.

What is the minimum uncertainty in its position, in terms of p and the Planck constant h?

A $0.0005\frac{h}{p}$ **B** $0.001\frac{h}{p}$ **C** $1000\frac{h}{p}$ **D** $2000\frac{h}{p}$

30 In a photoelectric effect experiment, white light shone on a piece of metal causes the emission of photoelectrons. The threshold wavelength for this metal is 580 nm (yellow light).

Which statement is correct?

A If a violet filter is placed in front of the light source, the rate of emission of photoelectrons will increase.

B If a red filter is placed in front of the light source, the rate of emission of photoelectrons will decrease to zero.

C If the light source is focused onto a smaller surface area of the metal, photoelectrons will be emitted with greater maximum kinetic energy.

D If another metal of twice the work function of the original metal is used, there will still be photoemission.

2021 Raffles Institution Preliminary Examinations H2 Physics Paper 1 Solutions

1 **B** $\rho = \dfrac{m}{V} = \dfrac{m}{\frac{4}{3}\pi r^3} = \dfrac{80}{\frac{4}{3}\pi (2.0)^3} = 2.3873 \text{ g cm}^{-3}$

$\dfrac{\Delta\rho}{\rho} = \dfrac{\Delta m}{m} + 3\dfrac{\Delta d}{d} \left(\text{or } \dfrac{\Delta\rho}{\rho} = \dfrac{\Delta m}{m} + 3\dfrac{\Delta r}{r} \right)$

$\dfrac{\Delta\rho}{\rho} = \dfrac{2}{80} + 3\dfrac{0.1}{4.0}$

$\Delta\rho = 0.24 = 0.2$ (1 s.f.)

$\rho = (2.4 \pm 0.4)$ g cm^{-3}

2 **C** Between t_1 and t_2, displacement increases at increasing rate. Between t_2 and t_3, displacement increases at decreasing rate. After t_3, the displacement remains constant as velocity is zero.

3 **B** Gradient of the first graph gives resultant force in the *y*-direction, which is a constant. Hence, acceleration in the y-direction is constant.
Gradient of the second graph gives velocity in the *x*-direction, which is a constant.
This is similar to a scenario of an object moving in a projectile (parabolic path) under constant acceleration of free fall.

4 **C** Gradient = $\dfrac{14}{4}$ $\Rightarrow$ $\dfrac{8}{t_1} = \dfrac{14}{4}$

t_1 = 2.29 s

change in momentum = area under graph
= ½ (2.29)(8) − ½ (4 − 2.29)(6)
= 4.03 N s

5 **B** For equilibrium, the lines of action of three non-parallel forces must intersect at a single point. The three forces should form a closed triangle.

6 **C**

$$U_{balloon} + U_{block} = kx + W$$
$$(0.015)(1000)g + (0.005)(1000)g = 5000x + 60$$
$$x = 0.0272 \text{ m}$$

7 **D**

$$F - mg = ma$$
$$F - 0.80 \times 9.81 = 0.80 \times 1.0$$
$$F = 8.648 \text{ N}$$
$$W = F \times d = 8.648 \times 2.0 = 17.296 \text{ J}$$

Energy Input $= \dfrac{10}{6} \times 17.296 = 28.8\ J$

8 **D** $\dfrac{1}{2}kx^2 = mgh$

$x = \sqrt{\dfrac{2mgh}{k}} = \sqrt{\dfrac{2 \times 0.22 \times 9.81 \times 0.40}{350}} = 7.02 \times 10^{-2}$ m

9 **A**
$$a = r\omega^2 = (75)\left(\frac{2\pi}{30 \times 60}\right)^2 = 9.14 \times 10^{-4} \text{ m s}^{-2}$$

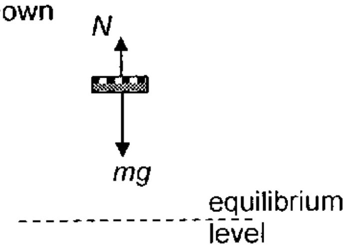
10 **D**
$$F = mr\omega^2 = \frac{mv^2}{r} = mv\omega$$
$$F' = m\left(\frac{v}{2}\right)(2\omega) = F$$

11 **B**
$$\text{Gain in KE} = \text{Loss in PE} = mgh = m\left(\frac{GM}{R^2}\right)h = \frac{GMmh}{R^2}$$

12 **A**
$$g = \frac{GM}{R^2} = \frac{G}{R^2}\left(\frac{4}{3}\pi R^3 \rho\right) = \frac{4\pi G}{3}\rho R$$
Hence, $\frac{g_M}{g_E} = \frac{\rho_M R_M}{\rho_E R_E} = 0.50 \times 0.70 = 0.35$

Therefore, $\frac{W_M}{W} = \frac{mg_M}{mg_E} = 0.35$

13 **A** When the platform is above the equilibrium level, and moving down



$$mg - N = m\omega^2 x$$
When the coin loses contact with the platform, $N = 0$

$\therefore mg = m\omega^2 x_0 \quad \Rightarrow \quad \omega^2 x_0 = g$

$$\Rightarrow x_0 = \frac{g}{\omega^2} = \frac{9.81}{(2\pi \times 3.2)^2} = 0.0243 \text{ m}$$

14 **A** This is derived from $pV = \frac{1}{3}N\,m \langle c^2 \rangle$ and is not an assumption.

15 **B** Work done on gas = $25 \times 10^3 \times (80 - 40) \times 10^{-3} = 1000$ J
$\Delta U = Q + W = -2500 + 1000 = -1500$ J
Avoid using $\Delta U = \frac{3}{2}\Delta(PV)$ as the gas may not be monatomic.

16 **A**
$$\frac{I}{I_0} = \cos^2\theta \quad \Rightarrow \quad 0.25 = \cos^2\theta \quad \Rightarrow \quad \theta = 60^0$$
new $\frac{I}{I_0} = \cos^2 90 = 0$

17 **B**
$$I = \frac{P}{4\pi r^2}, \qquad I = kA^2$$
$$kA^2 = \frac{P}{4\pi r^2} \quad \Rightarrow \quad A = \sqrt{\frac{P}{4\pi k}} \times \frac{1}{r}$$
Amplitude is inversely proportional to distance (first graph).
Intensity is proportional to amplitude^2 (second graph).

18 C $x = \dfrac{7.5 \times 10^{-3}}{9.5}$

$$\frac{\lambda}{d} = \frac{x}{D} \quad \Rightarrow \quad \lambda = d\left(\frac{x}{D}\right) = 0.45 \times 10^{-3}\left(\frac{7.5 \times 10^{-3}}{0.70 \times 9.5}\right) = 5.08 \times 10^{-7}\ \text{m}$$

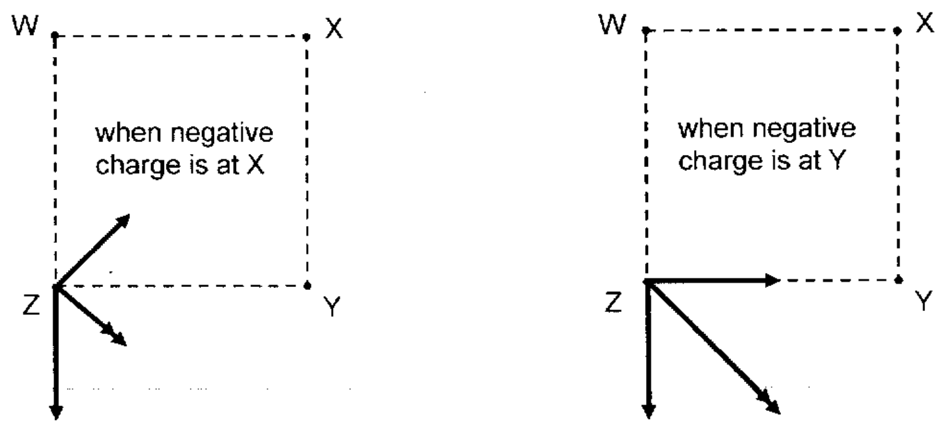
19 D $d \sin\theta = n\lambda$, where $\sin\theta = 1$ at max. order

$$n_{max} = \frac{d}{\lambda} = \frac{\left(\dfrac{10^{-3}}{500}\right)}{633 \times 10^{-7}} = 3.16 \quad \rightarrow \quad n = 3$$

number of maximas = 7 (3 maximas on both sides of the central maxima)

20 C Electric field lines point from higher potential to lower potential and must be perpendicular to equipotential lines.

21 B



When negative charge is moved to Y, distance to Z is shorter. In addition, the vector sum of the two perpendicular electric field strengths will result in a resultant field strength of higher magnitude as shown above.

22 D total energy delivered by the battery = 2500 + 500 = 3000 J

$$\text{e.m.f.} = \frac{\text{total energy}}{\text{total charge}} = \frac{3000}{1500} = 2.00\ \text{V}$$

23 C Increasing R_4 increases the effective resistance of the combination of R_2 and R_4 in parallel. By potential divider rule, the p.d. across the parallel combination increases. Since R_2 remains constant, the ammeter reading will increase.

24 D In the driver circuit, the p.d. across XY should be minimized, so the resistance of the NTC thermistor needs to be maximised, according to potential divider rule. Hence, the temperature should be low.
The terminal p.d. of the test circuit should be maximised, so the resistance of the LDR needs to be maximised. Hence, the environment should be dark.

25 C For coil to remain horizontal,

torque due to magnetic force $= mg\left(\frac{6.8-2.5}{100}\right)$

$$BIL\left(\frac{15}{100}\right) = mg\left(\frac{6.8-2.5}{100}\right)$$

$$(60\times10^{-3})(I)\left(\frac{3.0}{100}\right)\left(\frac{15}{100}\right) = \left(\frac{5.0}{1000}\right)(9.81)\left(\frac{4.3}{100}\right)$$

$$I = 7.81\text{ A}$$

26 D The coil is connected to an ammeter (a closed circuit), so there is induced current in the circuit. By Lenz's law, the magnetic force acting on the induced current should oppose the rotation of the coil. Hence, the rotation will slow down, the period of rotation will increase. So, the answer is either B or D.
According to Faraday's law, the emf induced is proportional to the rate of change of the flux linkage. If the rotation slows down, the rate of change of the flux linkage decreases, hence the amplitude of the graph will decrease. The answer is **D**.
Mathematically,

$$\text{emf} = -\frac{d\Phi}{dt} = -NBA\frac{d}{dt}\cos\omega t = NBA\omega\sin\omega t$$

As the rotation of the coil slows down, the period T increases and $\omega = 2\pi f = \frac{2\pi}{T}$ (hence the amplitude $NBA\omega$) decreases.

Note: The magnetic force damps the rotation of the coil. But take note of the difference between this damping and the other examples of damping of SHM, such as a spring-mass system in water. For a spring-mass system in water, its amplitude and period of oscillation are unrelated. When damped, its amplitude will decrease exponentially in time, but its period (or frequency) can be taken to be unchanged.

27 A In the initial orientation, the component of B perpendicular to the area is
$B_{\perp} = 0.15 \times 10^{-3} \times \sin 10° = 2.60 \times 10^{-5}$ T
initial flux linkage, $\Phi_{ini} = B_{\perp}nA = 2.60 \times 10^{-5} \times 5 \times 0.12 = 1.56 \times 10^{-5}$ Wb.
The final flux linkage is 0 when the angle becomes 0.
Hence, the change in flux linkage is 1.56×10^{-5} Wb.

28 D mean power $P = \frac{I_0^2 R}{2}$

new mean power $P' = \frac{(2I_0)^2 R}{2} = \frac{4I_0^2 R}{2} = 4P$

29 D

$$p = \sqrt{2mE_k}$$

$$\frac{\Delta p}{p} = \frac{1}{2}\frac{\Delta E_k}{E_k} = \frac{1}{2}(0.0010) = 0.00050$$

$$\Delta p = 0.00050p$$

$$\Delta x \geq \frac{h}{\Delta p} = \frac{h}{0.00050p} = 2000\frac{h}{p}$$

30 B If a red filter is used, only red light incidents on the metal. Red light photons have lower energy than yellow. Hence, no photoelectric effect will be observed.