





2024 Preliminary Examinations Pre-University 3

H2 PHYSICS

Paper 1 Multiple Choice

9749/1

17 September

1 hour

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Do not turn over this page until you are told to do so.

Write in soft pencil.

Do not use staples, paper clips, highlighters, glue or correction fluid. Write your name, class and admission number on the Answer Sheet in the spaces provided.

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 OMR Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer. Any working should be done in this booklet. The use of an approved scientific calculator is expected, where appropriate. Data

speed of light in free space	С	=	$3.00\times10^8~m~s^{-1}$
permeability of free space	μ_{0}	=	$4\pi \times 10^{-7} \text{ H m}^{-1}$
permittivity of free space	E ₀	=	$\begin{array}{l} 8.85\times10^{-12}\;F\;m^{-1}\\ (1/(36\pi))\times10^{-9}\;F\;m^{-1} \end{array}$
elementary charge	е	=	$1.60\times10^{-19}\ C$
the Planck constant	h	=	6.63 × 10 ^{−34} J s
unified atomic mass constant	и	=	$1.66 \times 10^{-27} \text{ kg}$
rest mass of electron	m _e	=	$9.11 \times 10^{-31} \text{ kg}$
rest mass of proton	$m_{ m p}$	=	$1.67 \times 10^{-27} \text{ kg}$
molar gas constant	R	=	8.31 J K ⁻¹ mol ⁻¹
the Avogadro constant	NA	=	$6.02 \times 10^{23} mol^{-1}$
the Boltzmann constant	k	=	$1.38 \times 10^{-23} \text{ J K}^{-1}$
gravitational constant	G	=	$6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2}$
acceleration of free fall	g	=	9.81 m s ^{−2}

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Formulae

uniformly accelerated motion	S	=	$ut + \frac{1}{2}at^2$
	V^2	=	$u^2 + 2as$
work done on/by a gas	W	=	$\rho\Delta V$
hydrostatic pressure	p	=	ρgh
gravitational potential	ϕ	=	$-\frac{Gm}{r}$
temperature	T/K	=	T∕°C+273.15
pressure of an ideal gas	p	=	$\frac{1}{3}\frac{Nm}{V} < c^2 >$
mean kinetic energy of a molecule of an ideal gas	Е	=	$\frac{3}{2}kT$
displacement of particle in s.h.m.	X	=	x₀ sin <i>∞t</i>
velocity of particle in s.h.m.	V	=	v₀ cos <i>∞t</i>
	V	=	$\pm\omega\sqrt{(x_o^2-x^2)}$
electric current	Ι	=	Anvq
resistors in series	R	=	$R_1 + R_2 + \dots$
resistors in parallel	$\frac{1}{R}$	=	$\frac{1}{R_1} + \frac{1}{R_2} + \dots$
electric potential	V	=	$\frac{Q}{4\pi\varepsilon_{0}r}$
alternating current/voltage	x	=	x₀sin ωt
magnetic flux density due to a long straight wire	В	=	$\frac{\mu_o I}{2\pi d}$
magnetic flux density due to a flat circular coil	В	=	$\frac{\mu_o NI}{2r}$
magnetic flux density due to a long solenoid	В	=	µ₀nI
radioactive decay	x	=	$x_0 exp(-\lambda t)$
decay constant,	λ	=	$\frac{ln2}{t_{1/2}}$

1 The energy *E* stored in a certain electronic component is given by

$$E = \frac{Q^n}{2k}$$

where Q is the total charge in the component, *n* is an unknown integer and *k* is a physical quantity with SI base units $A^2 s^4 kg^{-1} m^{-2}$.

What is the value of *n*?

A -2 B -1 C 1 D 2

2 Three quantities *a*, *b* and *c* are related by the equation

 $a = b^2 c$

a and *b* have fractional uncertainties $\frac{\Delta a}{a}$ and $\frac{\Delta b}{b}$ respectively.

What is the fractional uncertainty of c?

- **A** $\frac{\Delta a}{a} + \frac{\Delta b}{b}$ **B** $\frac{\Delta a}{a} \frac{\Delta b}{b}$ **C** $\frac{\Delta a}{a} + 2\frac{\Delta b}{b}$ **D** $\frac{\Delta a}{a} 2\frac{\Delta b}{b}$
- **3** A ball is released from rest above the ground. The graph shows how the veolcity of the bouncing ball varies with time.

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



4 The acceleration of free fall on the Moon is one-sixth of that on Earth. On Earth it takes time *t* for a stone to fall from rest a distance of 2 m.

What is the time taken for a stone to fall from rest a distance of 2 m on the Moon?

- **A** $\frac{t}{6}$ **B** $\frac{t}{\sqrt{6}}$ **C** $t\sqrt{6}$ **D** 6t
- **5** The graph shows how the resultant force applied to an object of mass 4.0 kg varies with time. The force is applied in the same direction as the initial velocity.



Given that the initial speed of the object is 2.5 m s⁻¹, what is the speed of the object after 1.0 s?

- **A** 2.5 m s⁻¹
- **B** 5.0 m s⁻¹
- **C** 10 m s⁻¹
- **D** 15 m s⁻¹
- 6 An object of uniform density with uniform cross sectional area is shown in the diagram (drawn to scale). Along which vertical line is its centre of gravity most probably located?



7 A 3.50 g balloon is filled with helium (density = 0.180 kg m⁻³) to a volume of 5.00 m³ and is then connected to the top of a table via a light spring of spring constant 100 N m⁻¹. The balloon causes the spring to stretch.

What is the extension of the spring when the balloon is in equilibrium given that the density of air is 1.29 kg m^{-3} ?

Α	0.055	m

- **B** 0.201 m
- **C** 0.544 m
- **D** 0.632 m
- 8 The variation of the extension *x* of a light spring with the force *F* applied is shown below.



Slotted masses with a total weight of 3.0 N were initially hung on the spring.

What is the decrease in the elastic potential energy stored in the spring when a slotted mass weighing 0.5 N is removed from the system?

A 0.013 J B 0.015 J C 0.028 J D	0.056 J
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9 Two identical objects rest on a flat rough horizontal circular disc.



The disc starts from rest and starts spinning about its central axis with increasing rate. When the disc spins at a certain rate, one of the objects slides off the disc.

Which of the following statements is correct?

- **A** The friction experienced by P and Q are always equal.
- **B** P experiences larger friction than Q.
- **C** Q will start to slide first due to larger angular velocity.
- **D** Q will start to slide first due to larger radius.
- **10** A small bob of mass *m* is suspended from a fixed point O by a light, inextensible cord. The bob is raised until the cord is horizontal and it is then released from rest. It moves in an arc of a circle as shown.



What is the tension in the cord at the lowest point P?

- **A** zero **B** mg **C** 2mg **D** 3mg
- **11** The planet Jupiter has a radius of 7.15×10^7 m and is approximately 318 times more massive than the Earth.

Given that the Earth has a radius of 6370 km, what is the acceleration due to gravity on the surface of Jupiter?

A $2.41 \times 10^{-5} \text{ N kg}^{-1}$ **B** $2.73 \times 10^{-3} \text{ N kg}^{-1}$ **C** 24.8 N kg^{-1} **D** 273 N kg^{-1}

12 Two points in space, P and Q, have gravitational potentials of -7.0 J kg⁻¹ and -3.0 J kg⁻¹ respectively as shown below.



When a mass is moved from P to Q, it gains gravitational potential energy of 20 J. When it is moved from Q to R, it loses gravitational potential energy of 5.0 J.

What is the gravitational potential at R?

A $- 8.0 \text{ J kg}^{-1}$ **B** $- 4.0 \text{ J kg}^{-1}$ **C** $- 2.0 \text{ J kg}^{-1}$ **D** 2.0 J kg^{-1}

13 Two objects at different temperatures are in thermal contact.

Which quantity determines the transfer of thermal energy between the objects?

- A the temperature of the objects
- **B** the internal energy of the objects
- **C** the heat capacity of the objects
- **D** the mass of each object
- **14** A balloon contains 2.0 moles of helium gas at a temperature of 27 °C. The molar mass of helium is 4.0 g mol⁻¹.

What is the average translational kinetic energy of the helium atoms in the balloon?

A 5	5.6 × 10 ⁻²² J	В	$6.2 \times 10^{-21} J$	С	30 J	D	7500 J
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15 In a heating experiment, energy is supplied at a constant rate to a liquid. The temperature of the liquid rises at 4.0 K per minute just before it begins to boil. After 40 minutes of boiling, all the liquid has boiled away.

Ford	this liquid y	what is the ratio	specifi	c latent heat c	of vaporis	ation		
For this liquid, what is the ratio			specific heat capacity					
Α	<u>1</u> 160 К	В	<u>1</u> 40 К	С	40 K		D	160 K

16 An object undergoing simple harmonic motion takes 0.30 s to travel from one point of zero velocity to the next such point. The distance between these two points is 0.36 m. Which of the following shows the correct velocity-displacement graph describing the motion?



►x/m

►x/m

- **17** Which one of the following statements always applies to a damping force acting on a vibrating system?
 - A It is the same direction as the acceleration.
 - **B** It is the opposite direction to the velocity.
 - **C** It is the same direction as the displacement.
 - **D** It is proportional to the displacement.
- **18** Two coherent waves, of intensities *I* and 4*I*, meet in phase at a point. What is the resultant intensity at that point?

Α	3 <i>I</i>	В	5 I
С	9 <i>I</i>	D	25 I

19 A standing wave is set up on a rope of length 1.0 m fixed at both ends.

Which statement is correct?

- A The fundamental mode has a wavelength of 1.0 m.
- **B** The midpoint of the rope is always stationary.
- **C** There are two nodes on the rope when the fundamental frequency is doubled.
- **D** A standing wave of wavelength 0.4 m may be set up on the rope.
- **20** A camera lens with a maximum aperture of 30 mm forms an image of an object 5.0 m away. If a monochromatic light of wavelength 700 nm is used, what is the minimum distance between two points on the object that are just resolved?

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- 21 Which of the following statements about an electric field is incorrect?
 - A The electric field strength at a point is a measure of the force exerted on a unit positive charge at that point.
 - **B** The electric field strength is zero at all points where the potential is zero.
 - **C** The electric field strength at a point is a measure of the potential gradient at that point.
 - **D** The electric field strength due to a point charge varies as $\frac{1}{r^2}$ where *r* is the distance from the charge.

22 A fixed resistor and a diode are connected in series to a battery of electromotive force 6.0 V and negligible internal resistance. The graph shows the variation with potential difference V of the current *I* for the diode.



23 A potentiometer circuit is set up by connecting a cell with e.m.f. 3.0 V and internal resistance 1.0Ω across a resistance wire of length 1.0 m and resistance 6.0 Ω .

Another cell of e.m.f. 1.5 V and internal resistance 0.60 Ω is connected to the bottom of the potentiometer:



What is the balance length for the circuit?

A 0.0)86 m	В	0.10 m	С	0.50 m	D	0.58 m
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24 Positively charged particles move through a vacuum with constant velocity. The particles enter a region PQRS where there is a uniform electric field in the direction from P towards S.



A uniform magnetic field is also applied in the region PQRS and is adjusted in magnitude until the charged particles pass undeviated through the region PQRS, emerging at point X.

The strength of the magnetic field is now increased but its direction is not altered. In which direction are the particles now deviated?

- A towards PQ
- B towards SR
- **C** into the plane of the paper
- **D** out of the plane of the paper
- A single circular loop of wire moves in a uniform magnetic field of flux density 1.2 T.The graph shows how the area of the loop perpendicular to the magnetic field varies with time.



What is the e.m.f. induced?

Α	1.2 x 10 ⁻³ V	В	2.4 x 10 ⁻³ V	С	3.6 x 10 ⁻³ V	D	7.2 x 10 ⁻³ V
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26 In an ideal transformer, the ratio of the secondary turns to the primary turns is 1:60. A 120 V a.c. source is connected to the primary coil and a 3.0Ω resistor is connected to the secondary coil.

What is the current in the primary coil?

A 0.011 A **B** 0.67 A **C** 2.0 A **D** 40 A

27 The diagram shows the first five energy levels of an atom.



How many transitions between these energy levels result in the emission of visible light?

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

28 An X-ray spectrum is shown below.

Graph 1 shows the original spectrum obtained.

Graph 2 shows the new spectrum obtained after a change has been made to the accelerating voltage.

In both graphs, the two peaks correspond to the characteristic lines K_{α} and K_{β} .



Which of the following is correct?

	Ratio of accelerating voltage associated with Graph 2 to accelerating voltage associated with Graph 1	Target metal used to obtain both graphs
Α	$\frac{1}{2}$	Different
В	2	Different
с	$\frac{1}{2}$	Same
D	2	Same

29 When an isotope of boron, ${}^{10}_5 B$ captures a slow neutron, it splits into lithium ${}^{7}_3 Li$ and an alpha particle. An emission of γ -ray occurs during this reaction.

The nuclear binding energies of the reactants and products are

 ${}^{10}_{5}B$: 64.94 MeV ${}^{7}_{3}Li$: 39.25 MeV ${}^{4}_{2}He$: 28.48 MeV

If the total kinetic energies of the products produced is 2.31 MeV, what is the energy of the γ -ray emitted?

- A 0.48 MeV
- **B** 2.79 MeV
- **C** 10.77 MeV
- **D** 25.69 MeV
- **30** Which of the following is a valid observation that leads to the prediction of the existence of the neutrino?
 - **A** There is a range of energies for the emitted β -particles during β -decay.
 - **B** The total charge of the daughter nuclide and β -particle is not equal to the charge of the parent nuclide that undergoes β -decay.
 - **C** There is loss in mass during β -decay.
 - **D** The track for a particle, different from that of β -particles, can be observed in a cloud chamber for a radioactive β -emitter.

End of Paper