RAFFLES INSTITUTION 2024 Preliminary Examination

PHYSICS Higher 1

8867/01

Paper 1 Multiple Choice Questions

25 September 2024 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 working should be done in this booklet. The use of an appropriate scientific calculator is expected, where necessary.

Data

	speed of light in free space	С	=	$3.00 \times 10^8 \text{ m s}^{-1}$
	elementary charge	е	=	1.60×10^{-19} C
	unified atomic mass constant	и	=	$1.66 \times 10^{-27} \text{ kg}$
	rest mass of electron	me	=	9.11×10^{-31} kg
	rest mass of proton	$m_{ m p}$	=	$1.67 \times 10^{-27} \text{ kg}$
	the Avogadro constant	NA	=	$6.02 \times 10^{23} \text{ mol}^{-1}$
	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
Form	ulae			
	uniformly accelerated motion	S	=	$ut + \frac{1}{2}at^2$
		v^2	=	$u^{2} + 2as$
		_		

resistors in series $R = R_1 + R_2 + \dots$ resistors in parallel $1/R = 1/R_1 + 1/R_2 + \dots$

- 1 Which of the following is a reasonable estimate?
 - **A** The weight of a basketball is 6.0 N.
 - **B** The height of an 80-storey building is 1.0×10^3 m.
 - **C** The volume of an orange is 1.5×10^{-2} m³.
 - **D** The distance between two adjacent Singapore MRT stations is 1.0×10^5 m.
- **2** The speed *v* of a liquid leaving a tube depends on the difference in pressure ΔP between the ends of the tube and the density ρ of the liquid according to the equation

$$\boldsymbol{v} = \boldsymbol{k} \left(\frac{\Delta \boldsymbol{P}}{\rho}\right)^n$$

where k is a unitless constant.

What is the value of n?

	1		3	
Α	$\overline{2}$	B 1	$\mathbf{C} = \frac{1}{2}$	D 2

3 A micrometer screw gauge is used to measure the diameters of two cylinders. The measurements of the diameters, with their actual uncertainties, are given as follows:

diameter of first cylinder = (12.78 ± 0.02) mm diameter of second cylinder = (16.24 ± 0.03) mm

What is the percentage uncertainty in the difference of the two diameters?

A 0.29% **B** 0.58% **C** 0.87% **D** 1.4%

4 To determine the acceleration of free fall, a steel ball is dropped above two light gates as shown. The ball passes light gate 1 and 2 at time t_1 and t_2 , respectively, after release.



What is the acceleration of free fall?



5 The velocity-time graph of a ball released from rest above a floor is shown below.

At which time does the ball reach its maximum height after bouncing from the floor?



6 A force is applied on a stationary object at time t = 0 s. The graph shows how the acceleration *a* of the object varies with time *t*.



Which graph shows how the velocity v or displacement s of the object varies with t?



7 A student is standing on a weighing balance inside an ascending lift. The weighing balance gives a reading in newtons.

Which statement about the balance reading is correct?

- **A** The reading is less than the student's weight.
- **B** The reading is equal to the student's weight.
- **C** The reading is more than the student's weight.
- **D** The reading can be less than, equal to or more than the student's weight.

8 Two crates of masses 2.0 kg and 3.0 kg, connected by a cable, are lifted by a force of 100 N.



What is the tension in the cable between the crates?

Α	40 N	В	51 N	С	60 N	D	80 N
		_		-		_	

9 A motorcycle of mass 400 kg is travelling at a speed of 4.5 m s⁻¹ when it experiences an accelerating force for 1.0 s, followed by a retarding force for 2.0 s as shown.



What is the speed of the motorcycle after 3.0 s?

- **A** 1.5 m s^{-1} **B** 3.0 m s^{-1} **C** 4.5 m s^{-1} **D** 6.0 m s^{-1}
- **10** A ball rests on two frictionless walls X and Y. The angles of the walls to the horizontal are shown below.



What is the ratio of the normal contact force on the ball due to wall X to that due to wall Y?

A 0.71 **B** 0.82 **C** 1.0 **D** 1.4

11 A clown on a unicycle accelerates to the left.



What is the direction of the resultant force due to the road on the wheel of the unicycle?



12 A rectangular signboard of mass 40 kg, width 3.0 m and height 1.8 m is attached to a vertical wall by two hinges and a cable. The cable is at an angle of 30° to the horizontal as shown.



What is the magnitude and direction of the horizontal component of the force exerted by the top hinge on the signboard?

	magnitude of force	direction of force
A	13 N	to the right
в	13 N	to the left
С	160 N	to the right
D	160 N	to the left

13 A spring of unstretched length L_0 is extended to length L_1 by an applied force that is increased from zero until *F*. Upon removal of the force, the spring is damaged and has a new unstretched length L_2 . The graph shows the variation of the length of the spring with the applied force.



Which combination of areas give the work done by the force to extend the spring from L_0 to L_1 and which area gives the increase in potential energy of the particles in the spring when its unstretched length is increased from L_0 to L_2 ?

	work done by force from L_0 to L_1	increase in potential energy from L_0 to L_2
Α	<i>P</i> + Q	Q
в	<i>R</i> + S	Q
С	<i>P</i> + Q	Р
D	<i>R</i> + S	Р

14 When a car is travelling along a straight road at a constant speed of 72 km h⁻¹, the power delivered by its engine is 12 kW. The efficiency of the engine is 30% and each kilogram of petrol produces 40 MJ of energy.

What is the total resistive force on the car and the mass of petrol required for a one-hour drive?

	total resistive force	mass of petrol
Α	170 N	0.32 kg
В	600 N	0.32 kg
С	170 N	3.6 kg
D	600 N	3.6 kg

15 A block of mass 1.6 kg slides down a rough slope at a constant speed of 2.0 m s⁻¹. The slope is at an angle of 25° to the horizontal.

What is the rate of work done by the frictional force on the block?

- **A** -28 W **B** -13 W **C** 13 W **D** 28 W
- **16** The minute hand on a clock is 1.5 times the length of its hour hand.



The average tangential speeds of the tips of the minute hand and the hour hand are v_m and v_h respectively.

Wh	hat is the ratio $\frac{V_{\rm m}}{V_{\rm h}}$?						
Α	0.125	в	1.5	С	18	D	90

17 A car is travelling at a constant speed on a circular track of radius 150 m.

The track is banked at an angle of 15° to the horizontal such that the frictional force due to the track on the car has no radial component.

What is the speed of the car?

A 13 m s^{-1} **B** 20 m s^{-1} **C** 28 m s^{-1} **D** 38 m s^{-1}

18 A binary star system consists of two stars X and Y orbiting about a common centre due to their mutual gravitational forces on each other.

The mass of star X is larger than the mass of star Y.

Which diagram shows the possible positions of stars X and Y and the directions of their velocities?



19 Two wires X and Y are of the same length. The resistivity of wire X is half the resistivity of wire Y. The diameter of wire X is one quarter the diameter of wire Y. X and Y are connected in parallel to a battery with negligible internal resistance.

What fraction of the total current passes through wire X?

A
$$\frac{1}{9}$$
 B $\frac{1}{8}$ **C** $\frac{1}{3}$ **D** $\frac{1}{2}$

20 An ionized gas of electrons and positive ions in a discharge tube carries a current of 12.2 mA.

The number of electrons per unit time passing through the gas is 2.58×10^{16} s⁻¹ and the charge on each positive ion is 3.20×10^{-19} C.

What is the number of positive ions per unit time passing through the gas?

 21 A cell of e.m.f. *E* and internal resistance *r* is connected to a variable resistor R as shown below.



The variation of the voltmeter reading *V* with the ammeter reading *I* as R is varied is shown.



What is the internal resistance r of the cell?

A 1.152 D 2.952 C 4.052 D 5.1	1.1 Ω	Β 2.9 Ω	C 4.0 Ω	D 5.1 Ω
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22 In the circuit shown, the ammeter reading is zero.



A 40 Ω B 100 Ω C 200 Ω D 400 Ω

23 Four resistors are connected to a cell of e.m.f. 6.0 V as shown.



What is the potential difference between the points A and B?

- **A** 0 V **B** 3.5 V **C** 4.5 V **D** 7.5 V
- **24** Five resistors of the same resistance are connected as shown.



Which two points give the highest resistance?

A PR B PS C QR	D	QS
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25 An electron enters perpendicularly into a region of uniform electric field as shown.



What is the direction of the force on the electron when it enters the field and the speed of the electron when it exits the field?

	force	speed
Α	into page	unchanged
в	upwards	increased
С	out of page	unchanged
D	downwards	increased

26 An electron is accelerated from rest in a uniform electric field produced by two parallel charged plates J and K.

The distance between the plates is 0.080 m and the electric field strength between the plate is 3.0×10^5 N C⁻¹.



What is the gain in kinetic energy of the electron as it travels from plate J to plate K?

 $\label{eq:alpha} \begin{array}{ccc} \textbf{A} & 4.3 \times 10^{-26} \ J & \textbf{B} & 3.8 \times 10^{-15} \ J & \textbf{C} & 4.8 \times 10^{-14} \ J & \textbf{D} & 6.0 \times 10^{-13} \ J \end{array}$

27 A long straight wire X is placed along the central axis of a flat circular coil Y. The wire and the coil each carry a current as shown.



Which statement about the force acting on each part of coil Y due to the current in wire X is correct?

- A The force is towards wire X.
- **B** The force is away from wire X.
- **C** There is no force in all directions.
- **D** The force is perpendicular to the plane of coil Y.
- **28** A nuclear fission reaction is represented by the following equation:

$$^{235}_{92}$$
U + $^{1}_{0}$ n $\rightarrow ^{89}_{36}$ Kr + $^{144}_{56}$ Ba + 3^{1}_{0} n

The binding energy per nucleon of the nuclides involved are given as follows:

nuclide	binding energy per nucleon / MeV
²³⁵ ₉₂ U	7.5909
¹⁴⁴ ₅₆ Ba	8.2656
⁸⁹ ₃₆ Kr	8.6169

What is the energy released in this reaction?

Α	9.29 MeV	В	74.7 MeV	С	173 MeV	D	193 MeV
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- **29** Which series of radioactive decays will result in the formation of a different isotope of the parent nuclide?
 - A gamma decay
 - **B** one alpha decay and one beta decay
 - **C** one alpha decay and two beta decays
 - D two alpha decays and one beta decay

30 A sample consists of a radioactive nuclide X, while another sample consists of a radioactive nuclide Y. After an interval of time, it is found that $\frac{7}{8}$ of the atoms of X and $\frac{3}{4}$ of the atoms of Y have decayed.

Wł	nat is the ratio	half life of X $half$ life of Y?				
Α	0.46	B 0.67	С	1.5	D	2.2

End of Paper 1