RAFFLES INSTITUTION 2023 Preliminary Examination

PHYSICS Higher 1

Paper 1 Multiple Choice

8867/01 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 and index number on the Answer Sheet in the spaces provided. Shade your index number on the Answer Sheet.

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.

Data

speed of light in free space	С	=	3.00 × 10 ⁸ m s ⁻¹
elementary charge	е	=	1.60 × 10⁻¹ ⁹ C
unified atomic mass constant	и	=	1.66 × 10 ^{−27} kg
rest mass of electron	me	=	9.11 × 10 ^{−31} kg
rest mass of proton	mp	=	1.67 × 10 ^{−27} kg
the Avogadro constant	NA	=	6.02 × 10 ²³ mol ⁻¹
gravitational constant	G	=	6.67 × 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	=	$u^{2} + 2as$
resistors in series	R	=	$R_1 + R_2 + \dots$
resistors in parallel	1/ <i>R</i>	=	$1/R_1 + 1/R_2 + \dots$

- 1 What are the SI base units of the *volt*?
 - **A** kg m² s⁻² A **B** kg m² s⁻¹ A **C** kg m² s⁻¹ A⁻¹ **D** kg m² s⁻³ A⁻¹
- 2 What is the order of magnitude of the weight of an apple?

Α	10 ⁻⁴ N	В	10 ^{−2} N	С	1 N	D	10 ² N

3 A vector *F* can be resolved into two perpendicular components F_1 and F_2 . The angle between *F* and F_2 is θ .



How do the magnitudes of F_1 and F_2 change as θ is increased from 0° to 90°?

	F_1	F_2
Α	increase	increase
в	increase	decrease
С	decrease	increase
D	decrease	decrease

4 Two cars, initially next to each other and at rest, accelerate in the same direction constant accelerations. After 4.0 s, they are 16 m apart.

If the two cars continue with the same accelerations, how far apart will they be 8.0 s after they started?

A 32 m **B** 48 m **C** 64 m **D** 140 m

3

5 A stone falling vertically strikes some soft ground at speed *u* and slows down with a constant deceleration until it stops.

Which graph best represents the variation with the downward displacement *s* from the surface of the ground of the stone's speed v?



6 Three paths of a kicked football are shown.



Ignoring the effects of air resistance, which of the following statements is not correct?

- **A** The initial speed for path Z is the largest.
- **B** The three paths have the same time of flight.
- **C** The vertical component of the initial velocity for path X is the largest.
- **D** The horizontal component of the initial velocity for path X is the smallest.

7 Two forces F_1 and F_2 are applied to an object initially at rest. F_1 is constant while F_2 acts in the opposite direction of F_1 with a magnitude that is proportional to the square of the speed of the object.

Which statement best describes the motion of the object?

- A Its speed will increase from zero to a maximum.
- **B** Its speed will increase from zero to a maximum and then decrease.
- **C** Its acceleration will increase from zero to a maximum.
- **D** Its acceleration will increase from zero to a maximum and then decrease.
- 8 A brick rests on the floor. The forces on it are its weight *W* and a support force *S* from the floor. According to Newton's third law, what are the equal and opposite forces to these two forces?

	equal and opposite force to W	equal and opposite force to S
Α	the force the brick exerts on the Earth	the force the brick exerts on the floor
в	the force the Earth exerts on the brick	the force the floor exerts on the brick
С	the force the floor exerts on the brick	the force the brick exerts on the floor
D	the force the floor exerts on the brick	the force the Earth exerts on the brick

9 In an experiment, a trolley runs down a slope with a constant acceleration *a*.

The experiment is repeated. The mass of the trolley is now doubled and the trolley is allowed to run down the same slope.

In both cases, effects of friction and air resistance are negligible.

Which statement is correct for the second experiment?

- **A** The accelerating force is the same.
- **B** The acceleration is $\frac{1}{2}a$.
- **C** The acceleration is *a*.
- **D** The acceleration is 2*a*.

10 The diagram shows two spheres of masses 2 kg and 3 kg moving at constant speed along a straight line towards one another.



The speeds of the spheres are 4 m s⁻¹ and 6 m s⁻¹ respectively.

The spheres collide elastically.

Which statement explains why the spheres cannot come to rest at the same time?

- A The speeds of the spheres are not equal.
- **B** The masses of the two spheres are not equal.
- **C** The impulses during the collision are not equal and opposite.
- **D** The initial momenta of the spheres are not equal and opposite.
- 11 A uniform bar PQ is hinged at a vertical wall at end P and tied to a string at end Q.

Which arrow best represents the direction of the force exerted by the wall on the bar?



12 A student turns her head from right to left.

What does this action involve?

- A a resultant force only
- B a couple only
- C two parallel but unequal forces
- **D** a couple and a resultant force

13 A uniform rod has a wooden section and a solid plastic handle.

The length of the handle is x and the length of the wooden section is 5.0x. The rod balances at a distance 2.5x from the plastic end.



14 The variation with force *F* of the extension *x* of a spring is shown.



Which area represents the work done in stretching the spring from x_1 to x_2 ?



15 Two bodies, P and Q, of masses 3.0 kg and 4.0 kg respectively, are connected by a light cord passing over a light, frictionless pulley. P is held at rest on a rough slope inclined at 30° to the horizontal as shown.



When P and Q are released, P experiences a constant frictional force of 2.5 N from the slope.

What is the total kinetic energy of P and Q when P has travelled 1.5 m up the slope?

A 11 J **B** 18 J **C** 33 J **D** 41 J

16 A car of mass 800 kg travels in a straight at a constant speed of 25 m s⁻¹ along a level road against resistive forces of 400 N. The efficiency of the car to convert the energy of the fuel into work done against the resistive forces is 16%.

One kilogram of fuel has an energy value of 45 MJ.

How much fuel does the car use to travel one kilometre?

A 56 g **B** 90 g **C** 140 g **D** 280 g

17 A constant force is applied to a body that is initially at rest and is free to move.

Assume that frictional forces acting on the body are negligible. Which of the following graphs best represents the variation with time *t* of the power *P* provided by the force?



18 A small ball of mass 0.040 kg is attached to a light string and rotates in a vertical circle of radius 0.30 m. When the ball is vertically above the centre of the circle, the tension in the string is 1.2 N.



What is the centripetal acceleration of the ball when it is vertically below the centre of the circle?

A 40 m s^{-2} **B** 59 m s^{-2} **C** 69 m s^{-2} **D** 79 m s^{-2}

19 X and Y are two points on a turntable that rotates at constant angular velocity about its centre.



The angular velocity of X is ω and the angular displacement of X in time *t* is 0.5π rad.

	angular velocity	angular displacement / rad
Α	ω	0.5π
В	ω	less than 0.5π
С	greater than ω	0.5π
D	less than ω	less than 0.5π

What is the corresponding angular velocity and angular displacement of Y?

20 Two satellites P and Q orbit the Earth due to the gravitational field of the Earth. P and Q are at distances *x* and 3*x* from the Earth's centre respectively. The speed of P is *v*.

What is the speed of Q?

A
$$\sqrt{\frac{1}{3}}v$$
 B $\frac{1}{3}v$ **C** $\sqrt{3}v$ **D** $3v$

21 Bulb A, with a rating of 60 W, 120 V, has a filament wire that is of the same length as the filament wire in bulb B, that is rated at 65 W, 12 V. The filament wires of both the bulbs are made from tungsten.

What is the value of the ratio		diameter of	filament	in bulb A 2				
• • •			diameter of filament in bulb B					
Α	0.0092	B 0	.096	С	10		D	110

22 Three resistors are arranged in a part of a circuit. The resistance of each resistor is labelled as shown.



The current in the 120 Ω resistor is *I*.

۱۸/۲	What is the value of the ratio		power	power dissipated in the 120 $\boldsymbol{\Omega}$ resistor ,			>	
vvi			power	dissipated	in t	he 600 Ω resistor		
Α	0.20	B ().50		С	1.3	D	5.0

23 A circuit is connected as shown. The internal resistance of each cell is negligible.



What is the potential difference between point X and point Y?

A 0.80 V **B** 1.2 V **C** 3.0 V **D** 4.2 V

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24 The diagram shows a plan view of a current-carrying rectangular coil in a uniform magnetic field. Side X carries a current perpendicularly into the plane of the paper. Side Y carries a current out of the plane of the paper.



Which of the following correctly shows the directions of the forces that act on the sides of the coil?



25 The diagram shows a straight vertical current-carrying wire that lies perpendicular to a horizontal magnetic field of flux density *B*. A magnetic force of 7.5 mN acts on the wire.

The wire is rotated through 20° and the magnetic flux density of the magnetic field is reduced to $\frac{1}{2}B$.



What is the magnetic force acting on the wire now?



26 In a mass spectrometer, lithium ions with charge +e and oxygen ions with charge –2e travel perpendicular to a uniform magnetic field with the same speed. The mass numbers of lithium and oxygen are 7 and 16 respectively.

What is the ratio		radius of circular pat	h of lithium ,	2			
~ ~ 1		radius of circular path of oxygen					
Α	7:16	B 1:2	С	7:8		D	7:1

27 $^{241}_{94}$ Pu nuclide undergoes a series of radioactive decays and the final product is $^{209}_{83}$ Bi.

How many α and β particles are emitted in this series?

	α	β
Α	8	5
в	16	11
С	16	21
D	32	11

28 The rest mass of the deuteron, ${}_{1}^{2}H$, is equivalent to an energy of 1876 MeV. The rest masses of a proton and a neutron are equivalent to 939 MeV and 940 MeV respectively.

Which of the following occurs when a deuteron disintegrates into a proton and neutron?

- **A** The deuteron emits a γ -ray photon of energy 2 MeV.
- **B** The deuteron captures a γ -ray photon of energy 2 MeV.
- **C** The deuteron emits a γ -ray photon of energy 3 MeV.
- **D** The deuteron captures a γ -ray photon of energy 3 MeV.
- **29** A radioactive isotope can be used as a trace element in the fields of medicine, agriculture and industries. When used on an animal, the movement of certain chemicals can be traced.

In the selection of such a radioactive isotope, which of the following is given the least consideration?

- A half-life of radioactive isotope
- B daughter nuclide of nucleus
- **C** intensity of radiation emitted
- D mass of the radioactive isotope
- 30 Which of the following illustrates the random nature of radioactive decay?
 - A Activity of a radioactive sample decreases with time.
 - **B** Fluctuations in the count rate from a radioactive sample.
 - **C** Activity of a radioactive sample does not change upon heating.
 - **D** Some isotopes of an element are radioactive while others are not.