
Student Number

Gosford High School

2023

Trial HSC Examination

Physics

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- A data sheet, formulae sheet and Periodic Table are provided at the back of this paper
- Extra writing space is available at the back of this paper
- Write your student number at the top of this page

Total marks:
100

Section I – 20 marks (pages 3–11)

- Attempt Questions 1–20
- Allow about 35 minutes for this section

Section II – 80 marks (pages 12–26)

- Attempt Questions 21–33
- Allow about 2 hours and 25 minutes for this section

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Section I

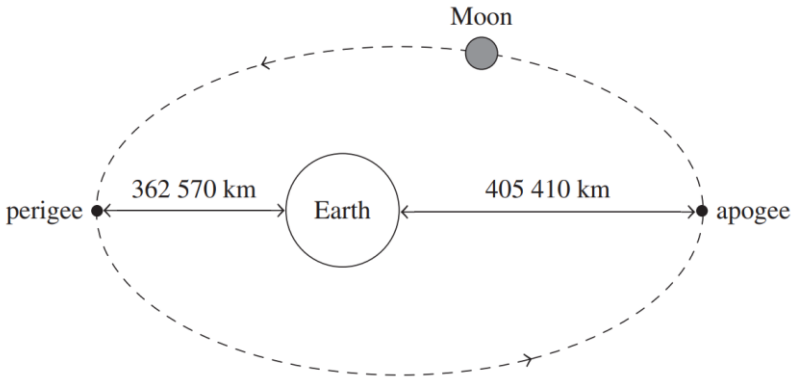
20 marks
Attempt Questions 1–20
Allow about 35 minutes for this section

Use the multiple-choice answer sheet for Questions 1–20.

1 The primary coil in a transformer has 50 turns and a voltage of 168 V. The secondary coil has a voltage of 4200 V.
What is the ratio of primary turns to secondary turns in the transformer?

A. 1 : 25
B. 1 : 1250
C. 25 : 1
D. 1250 : 1

2 The diagram shows the perigee and apogee of the Moon – two points in the Moon's elliptical orbit around Earth



Which of the following statements is correct?

A. When the Moon reaches the apogee, its gravitational potential energy and kinetic energy will be at minimums. It will move at a low velocity.
B. When the Moon reaches the apogee, its gravitational potential energy and kinetic energy will be at maximums. It will move at a high velocity.
C. When the Moon reaches the perigee, its gravitational potential energy will be at a minimum and its kinetic energy will be at a maximum. It will move at a high velocity.
D. When the Moon reaches the perigee, its gravitational potential energy will be at a maximum and its kinetic energy will be at a minimum. It will move at a low velocity.

3 If two projectiles are launched at the same initial velocity but at different launch angles, which projectile will reach its maximum height first?

A. The projectile launched at a smaller angle
B. The projectile launched at a larger angle
C. Both projectiles will reach maximum height at the same time
D. It depends on the mass of the projectiles

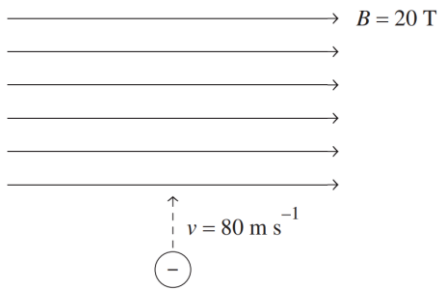
4 A student with a mass of 65 kg is asked to determine their weight while they travel in an elevator. The elevator goes through three stages of movement.

- During stage 1, the elevator moves upwards at a constant velocity of 9.8 ms^{-1}
- During stage 2, the elevator accelerates upwards at 5 ms^{-2}
- During stage 3, the elevator accelerates downwards at 5 ms^{-2}

Which row of the table correctly identifies the students' apparent weight during the different stages of the elevator's movement?

	Stage 1	*Stage 2*	*Stage 3*
A.	65 kg	115 kg	15 kg
B.	65 kg	15 kg	115 kg
C.	637 N	312 N	962 N
D.	637 N	962 N	312 N

5 An electron travels into a uniform magnetic field as shown below



What is the force acting on the electron?

A. 0.4×10^{-20} N up the page
B. 4.0×10^{-20} N out of the page
C. 2.6×10^{-16} N out of the page
D. 2.6×10^{-16} N into the page

6 Galaxies *X* and *Y* are on opposite sides of Earth and are moving away from Earth at a speed approaching the speed of light, which is approximately $0.95c$.
Which of the following statements is correct?

A. Light from galaxy *Y* will hit Earth and Galaxy *X* at a speed of 3.00×10^8 ms^{-1} as the speed of light is constant relative to all observers
B. Light from galaxy *Y* will hit Earth at a speed of 3.00×10^8 ms^{-1} and galaxy *X* at a speed of $0.95c$
C. Light from galaxy *Y* will hit galaxy *X* at a speed of 3.00×10^8 ms^{-2} and Earth at a speed of $0.95c$
D. Light from galaxy *Y* will hit Earth and galaxy *X* at a speed of $0.95c$

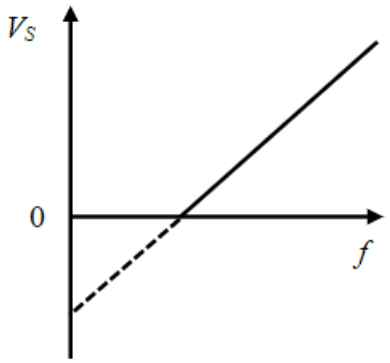
7 The Geiger-Marsden experiment led to a number of observations and conclusions.
Which of the following is correct?

	Observation	Conclusion
A.	Most alpha particles go straight through	The atom is mainly empty space
B.	Most alpha particles come straight back	The nucleus is charged
C.	Most alpha particles come straight back	The atom is mainly empty space
D.	Most alpha particles go straight through	The nucleus is charged

8 Students plotted the radiation of stars against their wavelengths.
If a star has a surface temperature of 4000 K, what is the maximum wavelength of the radiation emitted by the star?

A. 0.725×10^{-7} m
B. 7.25×10^{-6} m
C. 725×10^{-7} m
D. 725 nm

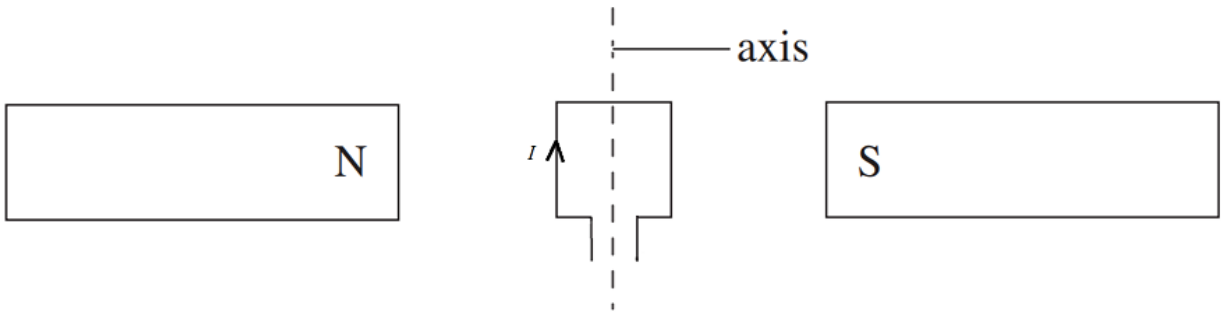
9 UV light is shone on a zinc surface causing photoelectrons to be emitted. The graph shows how the stopping voltage V_S varies with respect to the frequency of incident photons (f)



Planck's constant can be found from the charge of an electron multiplied by

A. The y-intercept
B. The x-intercept
C. The area under the graph
D. The gradient of the linear trend line

10 A rectangular coil has the dimensions 3.0 cm × 4.0 cm and carries a current of 15.0 mA in a uniform magnetic field of 3.0 T. The coil has 20 turns of wire and is free to rotate about the axis as shown



If the coil is rotated by 25°, what is the torque acting on the coil and the direction of rotation?

A. 9.79×10^{-4} Nm clockwise
B. 9.79×10^{-4} Nm anticlockwise
C. 4.56×10^{-4} Nm clockwise
D. 4.56×10^{-4} Nm anticlockwise

11 Particles of mass m, each with a charge q, travelling with a speed v, enter a magnetic field of strength B, at right angles to the field.

Which of the following changes would decrease the radius of the path of the particles?

A. An increase in q
B. A decrease in B
C. An increase in v
D. An increase in m

12 A scientist finds that the frequency of incident light on a piece of metal is greater than the threshold frequency.

The scientist decides to investigate how changing the light may affect the photoelectrons emitted by the piece of metal. They apply the following two conditions as part of their investigation:

1. The intensity of the light is decreased, and the frequency is kept constant
2. The frequency of the light is increased, and the intensity is kept constant

The scientist records the maximum kinetic energy of the photoelectrons and the number of photoelectrons emitted under each condition, and compares these results to the initial observations.

Which row of the table best describes the results of the scientist's investigation?

	Maximum kinetic energy of the photoelectrons	*Number of photoelectrons emitted*
A.	Increases under conditions 1 and 2	Increases under conditions 1 and 2
B.	Increased under condition 1 and remains constant under condition 2	Decreases under condition 1 and remains constant under condition 2
C.	Remains constant under condition 1 and increases under condition 2	Decreases under condition 1 and remains constant under condition 2
D.	Remains constant under condition 1 and decreases under condition 2	Decreases under conditions 1 and 2

13 If Mars were moved twice as far from the Sun as it is at the present moment, the gravitational force that the Sun exerts on Mars would become:

A. One-quarter as large
B. Half as large
C. Twice as large
D. Four times as large

14 Two current-carrying wires are parallel to each other and separated by a distance of 0.05 m. They carry currents of 0.5 A and 0.3 A in opposite directions.
If the distance between the wires were increased to 0.1 m, the force acting on the 0.3 A wire would be

A. A quarter of the original value
B. Half of the original value
C. 60% of the original value
D. Double the original value

15 The engines of a space cruiser travelling space-north at $0.830c$ have suddenly stopped, leaving the cruiser on a collision course with an asteroid. The crew enables their distress beacon, which plays a message that loops every 42.0 seconds. Meanwhile, the passengers are moved to the escape pods which travel at $0.370c$ space-west relative to the cruiser. How long would a passenger on an escape pod observe the distress message to last for before repeating?

A. $42.0\ \text{s}$
B. $100\ \text{s}$
C. $75.3\ \text{s}$
D. $45.2\ \text{s}$

16 The wheels on a car have a diameter of 45.0 cm. What is the angular velocity of the wheels if the car travels 135 m in 6.20 s at a constant speed?

A. $9.80\ \text{rad s}^{-1}$
B. $96.8\ \text{rad s}^{-1}$
C. $48.4\ \text{rad s}^{-1}$
D. $4.90\ \text{rad s}^{-1}$

17 In a Physics class, students conduct three experiments in which they observe various light sources through a spectroscope

- Experiment 1 uses an incandescent lamp
- Experiment 2 uses a sodium lamp
- Experiment 3 uses an incandescent lamp and passed the light through sodium vapour

Which row of the table identifies what the students would observe through the spectroscope?

	Experiment 1	*Experiment 2*	*Experiment 3*
A.	Continuous spectrum of colours	Two yellow lines on a dark background	Fully coloured background with two black lines
B.	Continuous spectrum of colours	Fully coloured background with two black lines	Two yellow lines on a dark background
C.	Two yellow lines on a dark background	Full spectrum of colours	Fully coloured background with two black lines
D.	Fully coloured background with two black lines	Two yellow lines on a dark background	Full spectrum of colours

18 In the year 2224, there is a space race from the Ultima space station to the Extrema space station. Ren and Annika are two competitors in this race. After a collision with space junk, Ren experiences issues with her navigation system. While waiting for the system to reboot, she observes Annika race past her. Annika moves straight ahead on a path parallel to Ren's. While observing Annika, Ren considers the following conclusions about their positions.

1. She and Annika are both moving towards the Extrema space station; however, Annika is moving faster
2. She is moving backwards towards the Ultima space station, and Annika is stationary
3. She is moving faster than Annika, and they are both moving backwards towards the Ultima space station

Which of Ren's conclusions could be correct?

A. Conclusion 1 only
B. Conclusions 1 and 3 only
C. Conclusions 1, 2 and 3
D. None of the conclusions

19 A circular coil of 150 turns and radius 30 cm is placed in a magnetic field of intensity 2.7×10^{-2} T so that the plane of the coil is perpendicular to the magnetic field lines. If the field is reduced to zero in 0.01 s, what EMF is induced in the coil?

A. $36.45\ \mathrm{V}$
B. $-36.45\ \mathrm{V}$
C. $-114.5\ \mathrm{V}$
D. $114.5\ \mathrm{V}$

20 Ella has a mass of 65.00 kg and boards a ride at an amusement park. The ride has a central structure with four 15.00 m steel arms extending from it. Each arm is attached to a steel carriage that has a mass of 550.0 kg and can carry one occupant. When the ride is activated, the arms rotate around the central structure, completing 10 full rotations per minute. What is the magnitude of the force that the steel arm needs to apply to Ella's carriage so that it continues to move in uniform circular motion?

A. $6744\ \text{N}$
B. $9037\ \text{N}$
C. $10116\ \text{N}$
D. $363819\ \text{N}$

End of Section I

Section II

80 marks
Attempt Questions 21–33
Allow about 2 hours and 25 minutes for this section

Question 21 (8 marks)

A 1300 kg car makes a turn on a circular bend of road at a speed of 80 km/h. The bend is not banked and has a radius of 40 m.

(a) What is the magnitude of the centripetal force required for the car to make this turn? 2

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(b) What is the magnitude of the centripetal acceleration of the car around the bend? 2

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(c) If the bend were banked at an angle of 8.0°, calculate the amount of centripetal force that no longer needs to be provided by friction. Support your answer with a diagram that identifies the relevant forces and vector components 4

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Question 22 (4 marks)

Assess the following statement: 4
Lenz's law is a logical consequence of the law of conservation of energy

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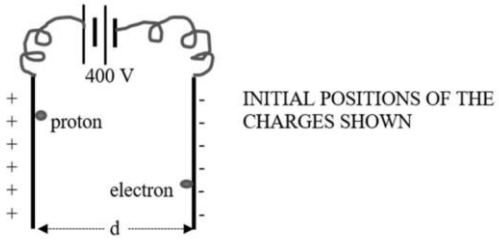
Question 23 (5 marks)

A proton and an electron are accelerated from one charged parallel plate to the opposite plate. The plates have a potential difference of 400 V across them and are separated by 20 cm. 5



Quantitatively and qualitatively compare the accelerations of both particles as they move between the two charged plates

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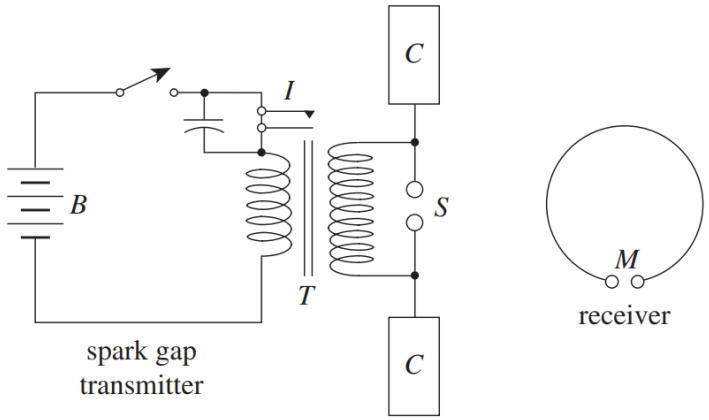
Question 24 (6 marks)

In 1888, Heinrich Hertz produced and detected radio waves using the apparatus shown in the diagram. The transmitting antenna (*C*) oscillated electrons up and down at a known frequency when a spark was present in the spark gap (*S*). Hertz conducted his work in a dark room so he could observe this spark easily.



Source: Based on Chetvorno (2018), *Hertz transmitter and receiver – English* [diagram]. Accessed December 2022. https://commons.wikimedia.org/wiki/File:Hertz_transmitter_and_receiver_-_English.svg. Licensed under CC BY-SA 3.0, https://creativecommons.org/licenses/by-sa/3.0/legalcode.

(a) Using a diagram, describe how radio waves are propagated 3

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Question 24 continues on page 15

(b) Hertz was able to demonstrate that radio waves have many wave properties including polarisation. Explain how Hertz could have used the receiver to determine if radio waves were polarised. 3

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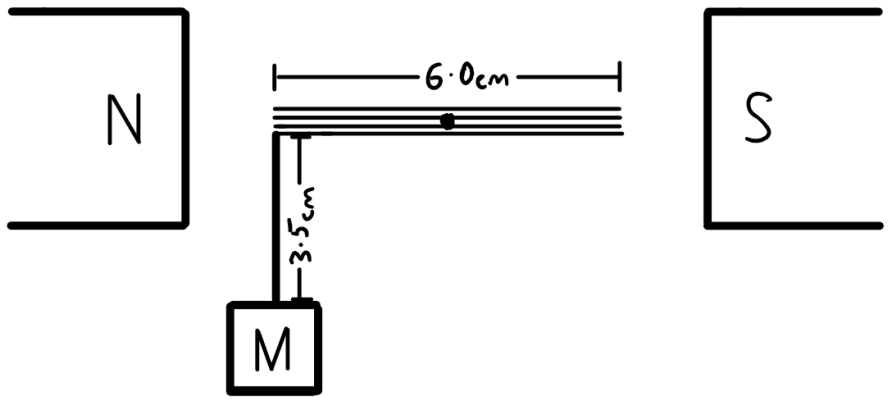
End of Question 24

Question 25 (3 marks)

A square coil (6.0 cm x 6.0 cm) with 8 turns positioned within a magnetic field of 0.30 T. A mass M is suspended from the end of the coil by a 3.5 cm long string, as shown below. The coil is free to rotate about an axis passing through its centre. 3



What mass will cause the coil to remain stationary when a current of 2.0 A is supplied to the coil?

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Question 26 (4 marks)

One of Einstein's thought experiments involved a train, lights, and mirrors. 4
A student conducts a similar thought experiment in which an observer inside a train carriage directs light so that it bounces off a mirror and reaches a detector. Diagram 1 shows the path of light in the frame of reference of the observer inside the train, and diagram 2 shows the path of the light in the frame of reference of the observer outside of the train.

Diagram 1: Frame of reference of observer inside the train

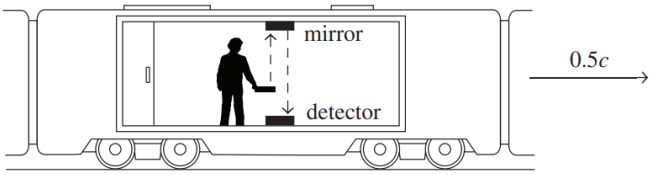
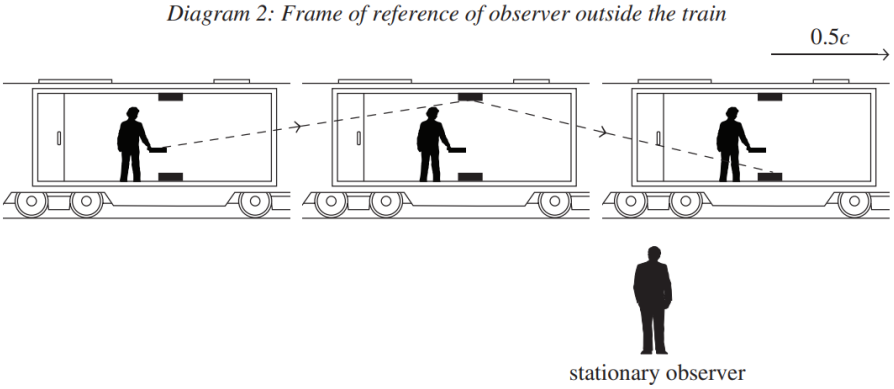


Diagram 2: Frame of reference of observer outside the train



Analyse the diagrams and explain any differences between what the two observers see

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Question 27 (6 marks)

A group of students conducted an experiment in which they directed a red laser of wavelength 633 nm at a screen through a piece of equipment with a double slit in it.

(a) Identify ONE risk and ONE appropriate control measure for this experiment 2

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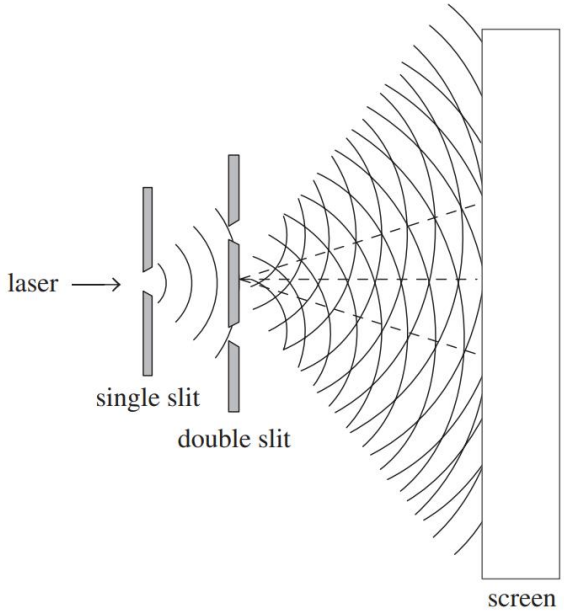
(b) Consider the experiment shown in the diagram. 2



Sketch the bands that would be expected to appear on the screen.

(c) If the students directed the red laser onto a double slit separated by 0.42 mm, how far from the central maximum would the second dark spot appear on a screen 1.2 m away? 2

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Question 28 (5 marks)

A satellite is orbiting the Earth. Any charge carried by the satellite could damage its electronic components. Because of this, satellites are designed to minimise photoelectric emission from their surfaces.

(a) Explain the process of photoelectric emission. 3

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(b) The satellite is coated with platinum, which has a work function of 1.02×10^{-18} J. Determine the longest wavelength of incident sunlight that can eject an electron from the platinum coating. 2

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Question 29 (4 marks)

(a) Explain how back EMF is produced in a DC motor, and how it affects the motor's performance 4

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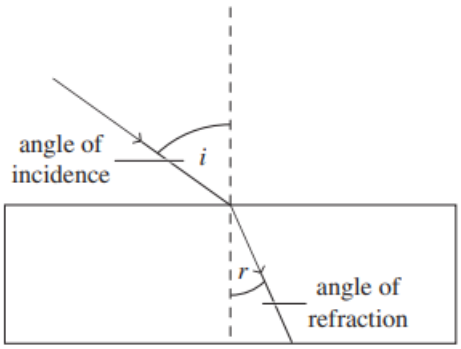
Question 30 (5 marks)

The diagram shows light moving from air into a glass prism. 5



Compare how Huygens's and Newton's models would explain the movement of light through the glass prism.

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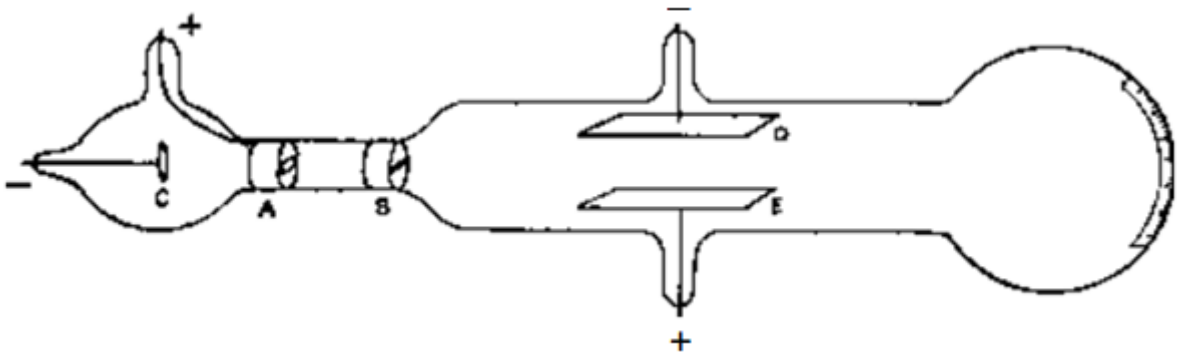
Question 31 (12 marks)

Following their discovery, physicists debated whether cathode rays were composed of waves or particles. In his 1897 paper titled 'Cathode Rays', published in *Philosophical Magazine*, J.J. Thomson detailed an experiment he conducted using the apparatus shown below to measure the charge-to-mass ratio of these cathode rays.



(a) Outline how Thomson used fields to determine the charge-to-mass ratio of the electron. Make appropriate annotations on the diagram to support your response. 5

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Question 31 continues on page 22

(b) Thomson determined that the speed of the cathode rays in his experiment was approximately 10^9 cm/s. Explain, with supporting calculations, why Thomson was able to neglect the gravitational force in his experiment. Assume the distance from the cathode to the fluorescent screen was approximately 1 m. 3

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(c) Determine the magnitude of the charge-to-mass ratio of an unknown particle if it experiences no net force when it passes between two parallel plates separated by 5.00 mm with a potential difference of 24 V while being subjected to a magnetic field of 240 mT, and traces a path of radius 1.54 mm when the electric field is removed. 4

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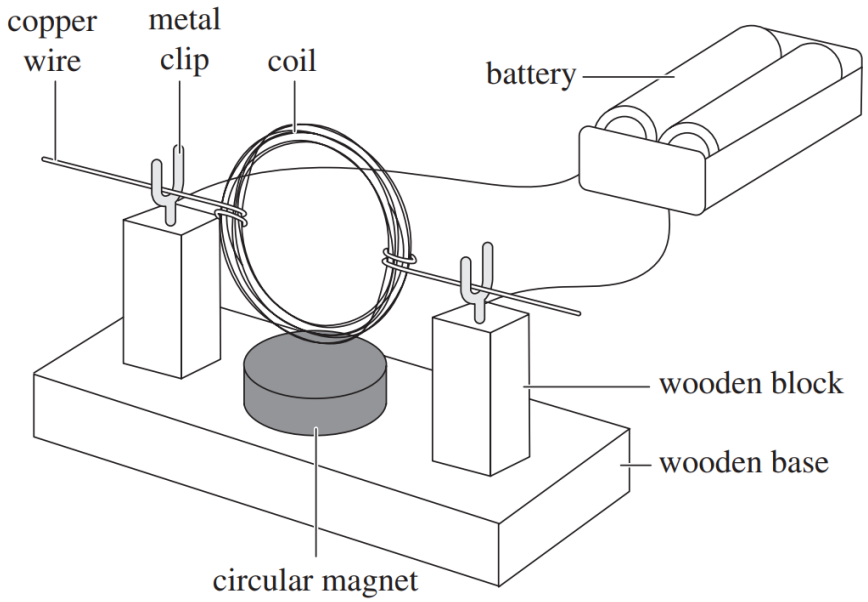
Question 32 (9 marks)

In a Physics class, students are investigating the use of models. Their teacher sets up a series of models in the classroom. The diagram shows model 1, which is a working motor. The students observe the coil rotating about its central axis when it is connected to the batteries.



Model 2 is a plate of plum pudding labelled as 'an early atomic model'.

Assess the effectiveness of models 1 and 2 in improving the students' understanding of the concepts represented by the models. 9

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Exam continues on following page

Question 33 (9 marks)

Rex Astrus, space adventurer, is making a hasty retreat from the planet Gruhl-XV in his state-of-the-art Jirun starfighter. The Jirun starfighter has a mass of 2,350 kilograms (including the pilot), and its thrusters can provide a maximum thrust of 162,000 N. 9

In order to escape Rex immediately puts the engine to full power at an angle of 32.3° above the horizon, starting from rest. However, after 1.45 seconds, a Kroznar ion cannon disables his ship's engines without changing the ship's momentum. When Rex's ship hits the ground it does not bounce, and it experiences a friction force of 18,600 N.

Calculate the displacement of the Jirun starfighter during this period of motion if the acceleration due to gravity on Gruhl-XV is 6.24 ms^{-2}.

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End of paper

Section II extra writing space

If you use this space, clearly indicate which question you are answering.

Student Number

Multiple Choice Answer Grid

Write your student number on this sheet and carefully tear it from the booklet. Use it to answer questions 1-20, indicating your answers with a cross (X).

	A	B	C	D
1				
2				
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	A	B	C	D
11				
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16				
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18				
19				
20				

Physics

DATA SHEET

Charge on electron, q_e	-1.602×10^{-19} C
Mass of electron, m_e	9.109×10^{-31} kg
Mass of neutron, m_n	1.675×10^{-27} kg
Mass of proton, m_p	1.673×10^{-27} kg
Speed of sound in air	340 m s^{-1}
Earth's gravitational acceleration, g	9.8 m s^{-2}
Speed of light, c	3.00×10^8 m s^{-1}
Electric permittivity constant, ε_0	8.854×10^{-12} A^2 s^4 kg^{-1} m^{-3}
Magnetic permeability constant, μ_0	$4\pi \times 10^{-7}$ N A^{-2}
Universal gravitational constant, G	6.67×10^{-11} N m^2 kg^{-2}
Mass of Earth, M_E	6.0×10^{24} kg
Radius of Earth, r_E	6.371×10^6 m
Planck constant, h	6.626×10^{-34} J s
Rydberg constant, R (hydrogen)	1.097×10^7 m^{-1}
Atomic mass unit, u	1.661×10^{-27} kg 931.5 MeV/c^2
1 eV	1.602×10^{-19} J
Density of water, ρ	1.00×10^3 kg m^{-3}
Specific heat capacity of water	4.18×10^3 J kg^{-1} K^{-1}
Wien's displacement constant, b	2.898×10^{-3} m K

FORMULAE SHEET

Motion, forces and gravity

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

$$\Delta U = mg\Delta h$$

$$P = \frac{\Delta E}{\Delta t}$$

$$\sum \frac{1}{2}mv^2_{\text{before}} = \sum \frac{1}{2}mv^2_{\text{after}}$$

$$\Delta \vec{p} = \vec{F}_{\text{net}}\Delta t$$

$$\omega = \frac{\Delta \theta}{t}$$

$$\tau = r_{\perp}F = rF\sin\theta$$

$$v = \frac{2\pi r}{T}$$

$$U = -\frac{GMm}{r}$$

$$v = u + at$$

$$\vec{F}_{\text{net}} = m\vec{a}$$

$$W = F_{||}s = Fs\cos\theta$$

$$K = \frac{1}{2}mv^2$$

$$P = F_{||}v = Fv\cos\theta$$

$$\sum m\vec{v}_{\text{before}} = \sum m\vec{v}_{\text{after}}$$

$$a_{\text{c}} = \frac{v^2}{r}$$

$$F_{\text{c}} = \frac{mv^2}{r}$$

$$F = \frac{GMm}{r^2}$$

$$\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$$

Waves and thermodynamics

$$v = f\lambda$$

$$f = \frac{1}{T}$$

$$d\sin\theta = m\lambda$$

$$n_{\text{x}} = \frac{c}{v_{\text{x}}}$$

$$I = I_{\text{max}}\cos^2\theta$$

$$Q = mc\Delta T$$

$$f_{\text{beat}} = \left| f_2 - f_1 \right|$$

$$f' = f\frac{\left(v_{\text{wave}} + v_{\text{observer}}\right)}{\left(v_{\text{wave}} - v_{\text{source}}\right)}$$

$$n_1\sin\theta_1 = n_2\sin\theta_2$$

$$\sin\theta_{\text{c}} = \frac{n_2}{n_1}$$

$$I_1r_1^2 = I_2r_2^2$$

$$\frac{Q}{t} = \frac{kA\Delta T}{d}$$

Electricity and magnetism

$$E = \frac{V}{d}$$

$$V = \frac{\Delta U}{q}$$

$$W = qV$$

$$W = qEd$$

$$B = \frac{\mu_0 I}{2\pi r}$$

$$B = \frac{\mu_0 NI}{L}$$

$$\Phi = B_{||}A = BA\cos\theta$$

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$

$$\frac{V_\mathrm{p}}{V_\mathrm{s}} = \frac{N_\mathrm{p}}{N_\mathrm{s}}$$

$$\vec{F} = q\vec{E}$$

$$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r^2}$$

$$I = \frac{q}{t}$$

$$V = IR$$

$$P = VI$$

$$F = qv_\perp B = qvB\sin\theta$$

$$F = lI_\perp B = lIB\sin\theta$$

$$\frac{F}{l} = \frac{\mu_0}{2\pi}\frac{I_1 I_2}{r}$$

$$\tau = nIA_\perp B = nIAB\sin\theta$$

$$V_\mathrm{p} I_\mathrm{p} = V_\mathrm{s} I_\mathrm{s}$$

Quantum, special relativity and nuclear

$$\lambda = \frac{h}{mv}$$

$$K_\mathrm{max} = hf - \phi$$

$$\lambda_\mathrm{max} = \frac{b}{T}$$

$$E = mc^2$$

$$E = hf$$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_\mathrm{f}^2} - \frac{1}{n_\mathrm{i}^2}\right)$$

$$t = \frac{t_0}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$l = l_0\sqrt{\left(1 - \frac{v^2}{c^2}\right)}$$

$$p_\mathrm{v} = \frac{m_0 v}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}}$$

$$N_\mathrm{t} = N_0 e^{-\lambda t}$$

$$\lambda = \frac{\ln 2}{t_{\frac{1}{2}}}$$

PERIODIC TABLE OF THE ELEMENTS

KEY

Atomic Number	79
Symbol	Au
Standard Atomic Weight	197.0
Name	Gold

1 H 1.008 Hydrogen																	2 He 4.003 Helium
3 Li 6.941 Lithium	4 Be 9.012 Beryllium											5 B 10.81 Boron	6 C 12.01 Carbon	7 N 14.01 Nitrogen	8 O 16.00 Oxygen	9 F 19.00 Fluorine	10 Ne 20.18 Neon
11 Na 22.99 Sodium	12 Mg 24.31 Magnesium											13 Al 26.98 Aluminium	14 Si 28.09 Silicon	15 P 30.97 Phosphorus	16 S 32.07 Sulfur	17 Cl 35.45 Chlorine	18 Ar 39.95 Argon
19 K 39.10 Potassium	20 Ca 40.08 Calcium	21 Sc 44.96 Scandium	22 Ti 47.87 Titanium	23 V 50.94 Vanadium	24 Cr 52.00 Chromium	25 Mn 54.94 Manganese	26 Fe 55.85 Iron	27 Co 58.93 Cobalt	28 Ni 58.69 Nickel	29 Cu 63.55 Copper	30 Zn 65.38 Zinc	31 Ga 69.72 Gallium	32 Ge 72.64 Germanium	33 As 74.92 Arsenic	34 Se 78.96 Selenium	35 Br 79.90 Bromine	36 Kr 83.80 Krypton
37 Rb 85.47 Rubidium	38 Sr 87.61 Strontium	39 Y 88.91 Yttrium	40 Zr 91.22 Zirconium	41 Nb 92.91 Niobium	42 Mo 95.96 Molybdenum	43 Tc Technetium	44 Ru 101.1 Ruthenium	45 Rh 102.9 Rhodium	46 Pd 106.4 Palladium	47 Ag 107.9 Silver	48 Cd 112.4 Cadmium	49 In 114.8 Indium	50 Sn 118.7 Tin	51 Sb 121.8 Antimony	52 Te 127.6 Tellurium	53 I 126.9 Iodine	54 Xe 131.3 Xenon
55 Cs 132.9 Caesium	56 Ba 137.3 Barium	57–71 Lanthanoids	72 Hf 178.5 Hafnium	73 Ta 180.9 Tantalum	74 W 183.9 Tungsten	75 Re 186.2 Rhenium	76 Os 190.2 Osmium	77 Ir 192.2 Iridium	78 Pt 195.1 Platinum	79 Au 197.0 Gold	80 Hg 200.6 Mercury	81 Tl 204.4 Thallium	82 Pb 207.2 Lead	83 Bi 209.0 Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89–103 Actinoids	104 Rf Rutherfordium	105 Db Dubnium	106 Sg Seaborgium	107 Bh Bohrium	108 Hs Hassium	109 Mt Meitnerium	110 Ds Darmstadtium	111 Rg Roentgenium	112 Cn Copernicium	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson

Lanthanoids

57 La 138.9 Lanthanum	58 Ce 140.1 Cerium	59 Pr 140.9 Praseodymium	60 Nd 144.2 Neodymium	61 Pm Promethium	62 Sm 150.4 Samarium	63 Eu 152.0 Europium	64 Gd 157.3 Gadolinium	65 Tb 158.9 Terbium	66 Dy 162.5 Dysprosium	67 Ho 164.9 Holmium	68 Er 167.3 Erbium	69 Tm 168.9 Thulium	70 Yb 173.1 Ytterbium	71 Lu 175.0 Lutetium

Actinoids

89 Ac Actinium	90 Th 232.0 Thorium	91 Pa 231.0 Protactinium	92 U 238.0 Uranium	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium

Standard atomic weights are abridged to four significant figures.

Elements with no reported values in the table have no stable nuclides.

Information on elements with atomic numbers 113 and above is sourced from the International Union of Pure and Applied Chemistry Periodic Table of the Elements (November 2016 version).

The International Union of Pure and Applied Chemistry Periodic Table of the Elements (February 2010 version) is the principal source of all other data. Some data may have been modified.