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ABBOTSLEIGH

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Centre Number

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Student Number

**2025** TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

# Physics

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General  
Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using black pen
- Draw diagrams using pencil
- Calculators approved by NESA may be used
- A data sheet, formula sheet and Periodic Table are provided at the back of this paper

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Total marks:  
100

Section I - 20 marks (pages 2 – 7)

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

Section II - 80 marks (pages 9 – 28)

- Attempt Questions 21–35
- Allow about 2 hours and 25 minutes for this section

**Section 1**  
**(20 marks)**

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

Use the multiple-choice answer sheet at the back of this paper for Questions 1–20.

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- 1 Which of the following CANNOT be attributed to Maxwell?
  - (A) Prediction of the existence of electromagnetic waves
  - (B) Prediction of the speed of electromagnetic waves
  - (C) Unification of electricity and magnetism
  - (D) Discovery of electromagnetic induction
  
- 2 Which of the following experiments or laws could be used in support of Newton's model of light?
  - (A) Youngs double slit experiment
  - (B) Malus's Law
  - (C) Measurements of the speed of light in water
  - (D) Snell's Law
  
- 3 If the distance between the Sun and the Earth is increased by three times, the attraction between them will:
  - (A) remain constant
  - (B) decrease by 63%
  - (C) increase by 63%
  - (D) decrease by 89%
  
- 4 What role does friction play when cars are turning a corner on a banked track?
  - (A) Friction does not affect the maximum speed.
  - (B) It will always increase the maximum speed the car can travel.
  - (C) It will only increase the maximum speed if the bank is facing towards the centre of the turn.
  - (D) Cars cannot turn on banked tracks without friction.
  
- 5 Which of the following results in a decrease in overall mass?
  - (A) Splitting a helium nucleus
  - (B) Lifting an object off the ground
  - (C) An exothermic reaction
  - (D) Compressing a spring

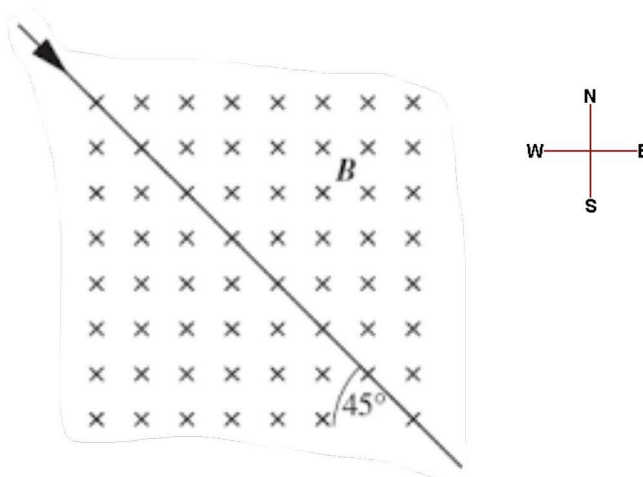
- 6 Which row of the table corresponds with the predictions of the Hafele–Keating experiment due to special relativity?

|     | <i>Eastbound clock</i> | <i>Westbound clock</i> |
|-----|------------------------|------------------------|
| (A) | Runs faster            | Runs faster            |
| (B) | Runs faster            | Runs slower            |
| (C) | Runs slower            | Runs faster            |
| (D) | Runs slower            | Runs slower            |

- 7 A radioactive nucleus Y decays into a nucleus Z. Given that Y and Z are isotopes of the same element, which of the following combination of particles could have been emitted during this decay process?

- (A) One alpha particle followed by a beta negative emission.  
 (B) One alpha particle followed by two beta negative particles.  
 (C) Two alpha particles followed by a beta negative emission.  
 (D) Two alpha particles followed by two beta negative emissions.

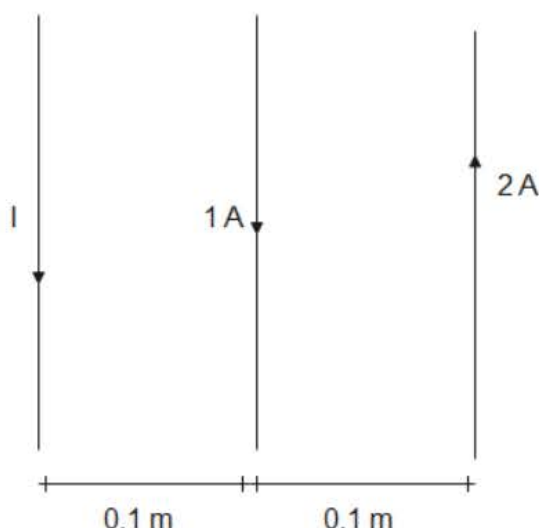
- 8 A wire carrying 2.4 A of current is placed in a 3.8 mT magnetic field as shown:



Calculate the force on the wire assuming 2.0 m of it passes through the field.

- (A)  $1.3 \times 10^{-2}$  N NE  
 (B)  $1.3 \times 10^{-2}$  N SW  
 (C)  $1.8 \times 10^{-2}$  N NE  
 (D)  $1.8 \times 10^{-2}$  N SW
- 9 Which of the following statements about a blackbody is false?
- (A) They absorb all electromagnetic radiation striking them.  
 (B) They only exist in theory.  
 (C) As the temperature of a blackbody increases the wavelength corresponding to peak intensity of the graph increases.  
 (D) They emit radiation over a range of frequencies.

- 10 By what percentage is the acceleration due to gravity at 300 km altitude above the Earth less than that on the surface of the Earth?
- (A) 0.810%
- (B) 8.24%
- (C) 44.9%
- (D) 91.2%
- 11 Three 1.0 m long parallel current carrying wires are arranged as shown:



The middle wire carries 1.0 A of current and the right wire carries 2.0 A of current. What is the net force on the left-hand wire if it carries  $I$  A downwards?

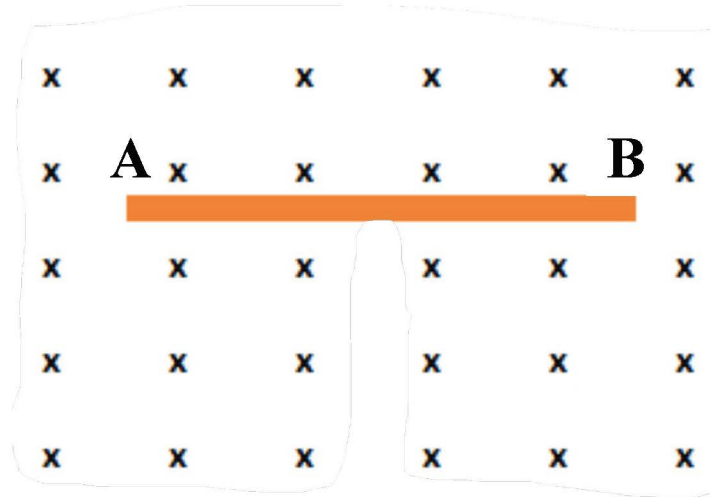
- (A) 0.0 N
- (B)  $I \times (1.0 \times 10^{-5})$  N left
- (C)  $I \times (1.0 \times 10^{-5})$  N right
- (D)  $I^2 \times (1.0 \times 10^{-5})$  N left
- 12 The diagram below shows the visible spectrum of hydrogen (Balmer series)



What is the value of the longest wavelength in this spectrum?

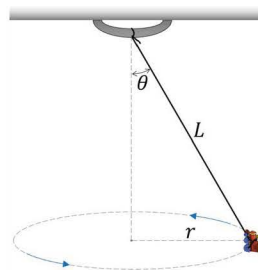
- (A)  $1.097 \times 10^7$  m
- (B)  $1.523 \times 10^6$  m
- (C) 656.3 nm
- (D) 328.1 nm

- 13 A conductive rod is placed in a magnetic field as shown:



The rod is now rotated clockwise around its midpoint. Identify the charge at points “A” and “B”.

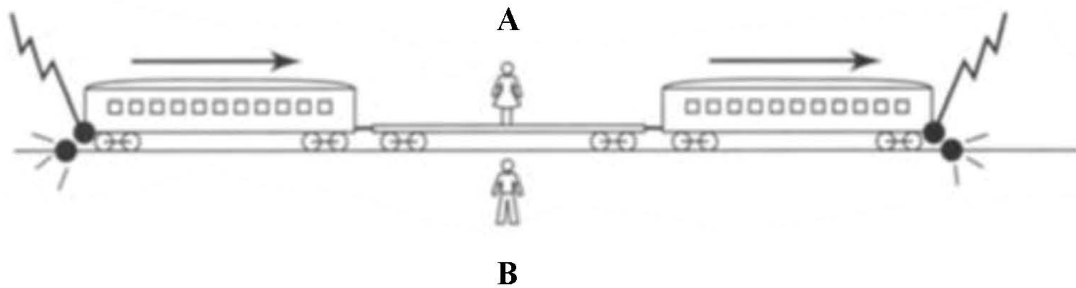
- (A) Point A becomes positively charged and point B becomes negatively charged.
  - (B) Point A becomes negatively charged and point B becomes positively charged.
  - (C) Both points become positively charged.
  - (D) Both points become negatively charged.
- 14 The diagram below shows a conical pendulum rotating at a radius of  $r$  as shown in the diagram below.



What is the correct expression for the frequency of rotation of the pendulum?

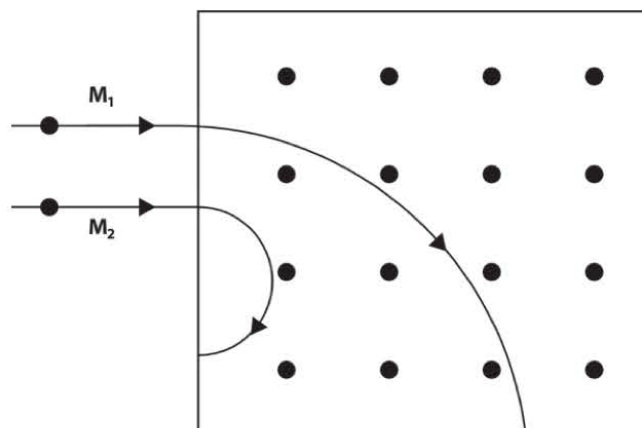
- (A)  $f = \frac{\sqrt{g \tan \theta}}{2\pi\sqrt{r}}$
- (B)  $f = \frac{\sqrt{g \tan \theta}}{\sqrt{r}}$
- (C)  $f = g \tan \theta$
- (D)  $f = rg \tan \theta$

- 15 The diagram below shows two observers A and B observing two lightning bolts hitting the front and back of a train moving to the right as seen by observer B. Observer A is on the centre of the train and observer B is on the platform directly across from the centre of the train when the bolts strike.



- Which of the following statements is correct?
- (A) Both observers A and B observe the lightning bolts hit the front and back of the train simultaneously.
  - (B) Observer B observes the lightning bolts hit the front and back of the train simultaneously while observer A sees the bolt hit the front of the train first.
  - (C) Observer A observes the lightning bolts hit the front and back of the train simultaneously while observer B sees the bolt hit the front of the train first.
  - (D) Observer B observes the lightning bolts hit the front and back of the train simultaneously while observer A sees the bolt hit the back of the train first.
- 16 In Fizeau's measurements of the speed of light he found that the lowest rotational speed which blocked the light was 200 rad/s. Which other rotational speed is guaranteed to block the light?
- (A) 300 rad/s
  - (B) 400 rad/s
  - (C) 500 rad/s
  - (D) 600 rad/s
- 17 For an object thrown at  $45^\circ$  to the horizontal, what is the relationship between the horizontal range R and the maximum height H?
- (A)  $R = 16 H$
  - (B)  $R = 8 H$
  - (C)  $R = 4 H$
  - (D)  $R = 2 H$

- 18 Two charged particles enter a magnetic field and follow a path as shown (diagram not to scale).

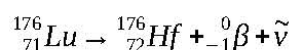


What could  $M_1$  and  $M_2$  be?

|     | $M_1$   | $M_2$          |
|-----|---------|----------------|
| (A) | Proton  | Alpha Particle |
| (B) | Proton  | Positron       |
| (C) | Proton  | Electron       |
| (D) | $H^{-}$ | Electron       |

- 19 A 400 nm laser is pointed at a diffraction grating with 500 lines/mm. What is the distance between the central and first maximum if the screen is placed 2.0 m from the grating?
- (A) 0.41 m  
 (B) 0.40 m  
 (C)  $1.6 \times 10^{-6}$  m  
 (D)  $1.5 \times 10^{-6}$  m

- 20 What is the maximum velocity that the beta particle in the following reaction can have given that the anti-neutrino has  $9.0871105 \times 10^{-14}$  J of energy and negligible mass?



Mass of Lu = 175.942694 amu      Mass of Hf = 175.941420 amu

- (A)  $1.545 \times 10^8 \text{ ms}^{-1}$   
 (B)  $1.97 \times 10^8 \text{ ms}^{-1}$   
 (C)  $3.00 \times 10^8 \text{ ms}^{-1}$   
 (D)  $3.102 \times 10^8 \text{ ms}^{-1}$

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**End of Section 1**

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Student Number

# Physics

## Section II Answer Booklet

80 marks

Attempt Questions 21–35

Allow about 2 hours and 25 minutes for this section

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**Instructions**

- Write your Student Number at the top of this page.
  - Answer the questions in the spaces provided. These spaces provide guidance for the expected length of response.
  - Show all relevant working in questions involving calculations.
  - Extra writing space is provided at the back of this booklet. If you use this space, clearly indicate which question you are answering.
- 

Please turn over

**Question 21** (3 marks)

The photograph below shows a humpback bridge that is present in certain parts of the world. **3**



The road surface is curved, describing an arc of a circle. The local traffic authority set the speed limit to  $15\text{ kmh}^{-1}$  for a radius of curvature of  $10.0\text{ m}$ . Assess the suitability of the set speed limit for this bridge.

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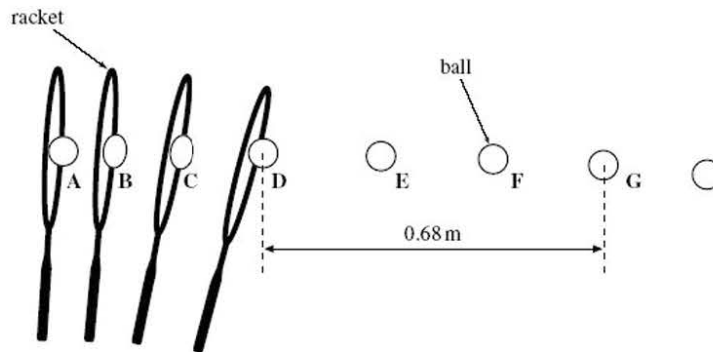
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**Question 22** (5 marks)

The diagram below shows a sequence of images of a tennis ball being hit by a racket as captured by a digital camera. The camera was set to take a photo every 5.00 ms.



The ball has achieved a constant horizontal velocity at position D which is 2.30 m above the ground.

- (a) Calculate the horizontal velocity of the ball at D.

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- (b) If a 1.00 m net is placed 30.0 m from point D, will the ball clear the net?

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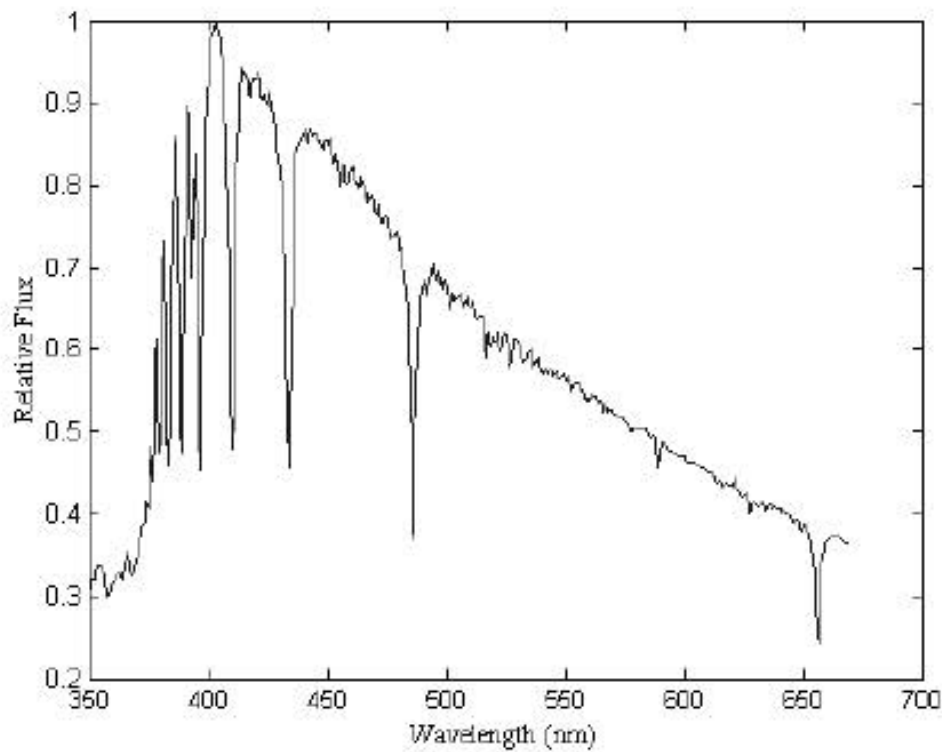
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**Question 23** (5 marks)

Below is an image of the spectrum of a star.

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Identify the factor(s) that affect the above spectrum and the effect that they have.

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**Question 24** (4 marks)

Two satellites I and II are orbiting the Earth in the same circular orbit. The mass of satellite II is twice that of satellite I. Use Physics principles to compare the force, energy and motion of two satellites.

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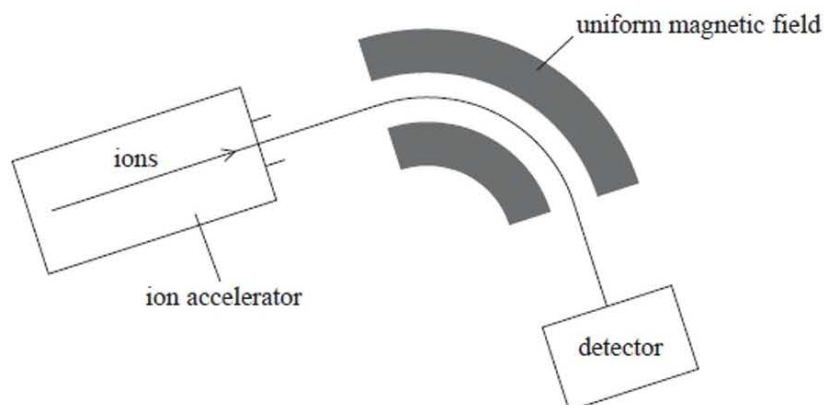
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**Question 25** (5 marks)

Mass spectrometry (diagram below) is a technique used to separate ions based on their charge to mass ratio. The atoms in a sample are ionised and then accelerated and passed into a region of uniform magnetic field and the ions are deflected by different amounts according to their mass.



Analysis of mass spectrometer data shows that bromine exists in nature as two isotopes, Br-79 (78.904 amu) and Bromine-81 (80.9163 amu). After passing through the velocity selector, both the isotope beams enter a region of uniform magnetic flux density 0.55 T with a velocity of  $4.31 \times 10^5 \text{ ms}^{-1}$ .

- (a) Calculate the ratio of the radii of the two isotopes given they have the same, non-zero, charge. **3**

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- (b) Explain why the isotopes move in a circular path. **2**

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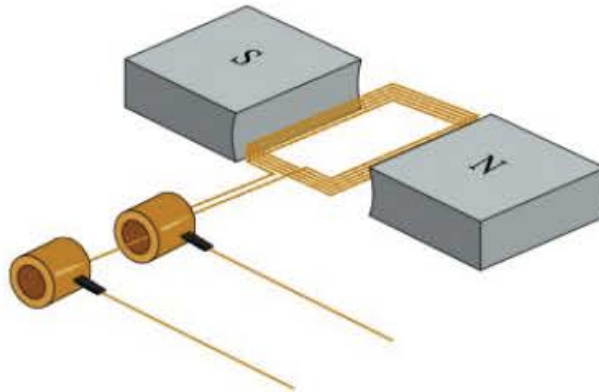
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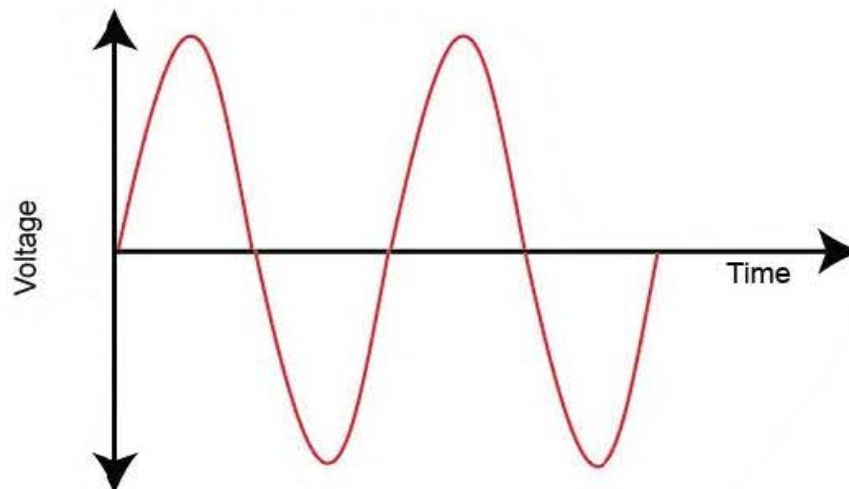
**Question 26 (5 marks)**

Below is an image of a simple AC generator:



- (a) A voltmeter is connected to the slip rings and the following graph of voltage vs time is produced. On the same graph below sketch the flux through the coil.

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- (b) Explain the link between generators and electromagnetic induction.

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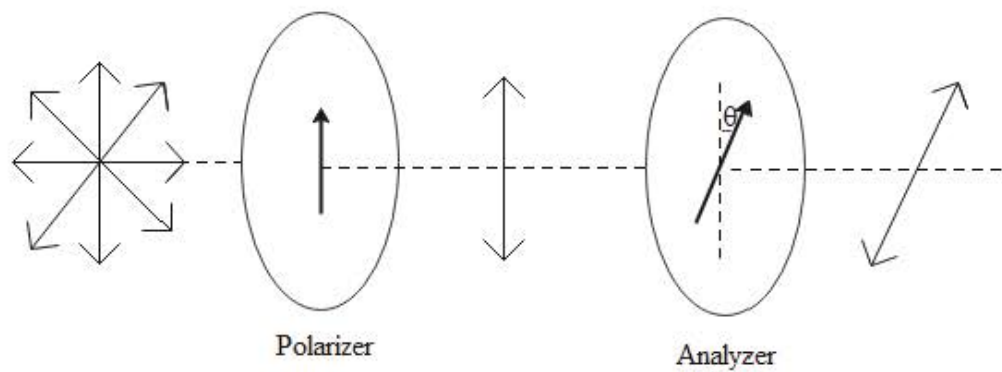
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Question 27 (4 marks)

A student is investigating the effect of polarizers on the intensity of light using the following setup.

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She recorded the following data:

| <i>Angle <math>\theta(^{\circ})</math></i> | <i>Intensity of light after the analyser (lux)</i> |
|--------------------------------------------|----------------------------------------------------|
| 20                                         | 88.3                                               |
| 40                                         | 58.7                                               |
| 60                                         | 25.0                                               |
| 80                                         | 3.0                                                |

Provide an explanation for these results.

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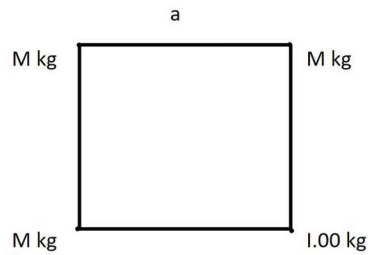
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**Question 28** (3 marks)

The diagram below shows three masses of magnitude ‘M’ placed at three corners of a square of side ‘a’.

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Calculate the force of gravitational attraction on the 1.00 kg mass.

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**Question 29** (4 marks)

A stationary observer sees a 3000 kg rocket’s momentum dilated to  $2.6 \times 10^{11}$  kg m/s. Calculate the height of the rocket if it is 42 m tall when at rest. Assume its velocity is parallel to its height axis.

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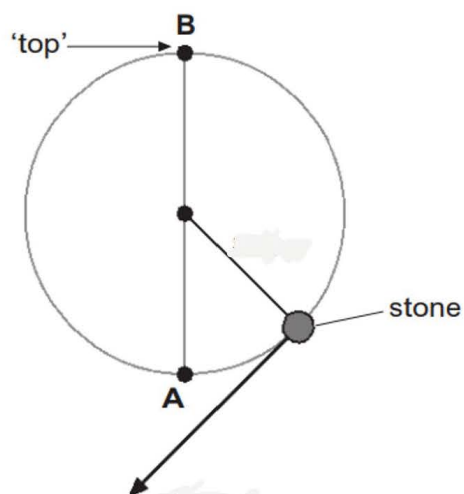
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**Question 30** (3 marks)

The diagram below shows a stone of 245 g attached to a light rigid rod and swung at a constant speed of  $4.00 \text{ ms}^{-1}$  in a vertical circle of radius 120 cm.

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Calculate the difference in values of the tension at point A to that at point B.

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**Question 31** (7 marks)

In an experiment, incident light is shone onto lithium (a photoelectric material with  $\phi = 2.3 \text{ eV}$ ).

- (a) The experimenter found the stopping voltage to be 3.4 V. Calculate the frequency of the incident light. **2**

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- (b) Explain the relationship between the work function and threshold frequency. **2**

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- (c) If the light source is now changed to a 133 nm source, calculate the maximum velocity of the photoelectrons. **3**

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**Question 32** (10 marks)

Below is an image of a flying chairs ride:



A prospective purchaser has recruited you to help answer some physics questions relating to its motor to help decide if it is worth upgrading.

Here is some information about the current motor:

- Requires 380 V input
- Uses 14.5 kW of power

- (a) What ratio of primary to secondary turns would a transformer need for this ride to be used with a 240 V power supply?

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**Question 32 continues on next page**

Question 32 (continued)

- (b) Residential power cables are suitable for up to about 20 A of current. Would it be appropriate to use this ride on a residential power supply? 3

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- (c) Given that the current cost of electricity is \$0.402/kWh, calculate the cost of electricity to operate the ride for 5 minutes. 2

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- (d) The purchaser has read that if he was to replace the motor with a simple DC motor, he would also need a variable resistor. Explain why this is necessary. 3

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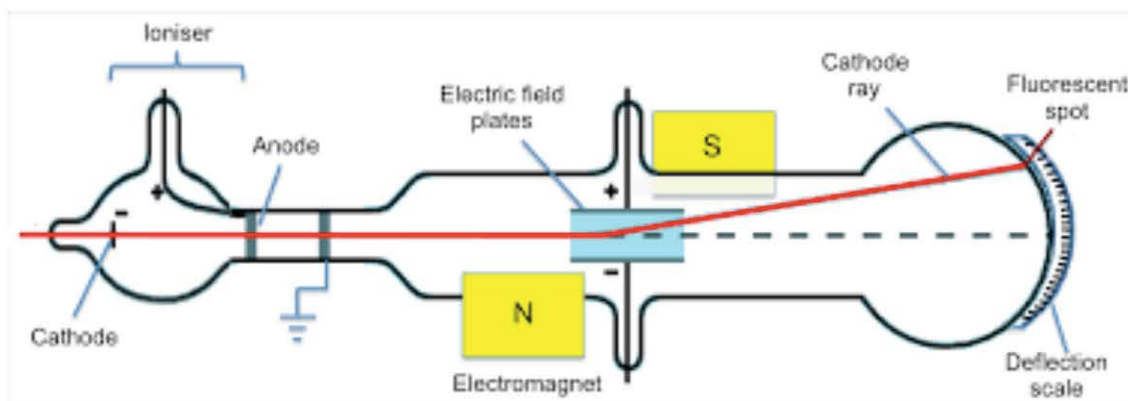
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**End of Question 32**

**Question 33** (7 marks)

Georgie is attempting to perform a modified version of Thomsons experiment. She was using an apparatus like the one below.

7



She found that electrons travelled in a straight line when the plates were supplied with 100 V, and the B field was set to  $4.8 \times 10^{-4}\text{T}$ . She then turned off the MAGNETIC FIELD and found that the electrons left the plates at an angle of  $30^\circ$  above the horizontal. The plates have a separation of 5.0 cm and a length of 2.8 cm. Calculate the charge to mass ratio of electrons based on the results of this experiment.

NOTE: since Georgie is attempting to verify the charge to mass ratio you should NOT use the known mass or charge of the electron in any of your calculations.

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**Question 34 (9 marks)**

Assess the contributions made by Rutherford, Bohr and Chadwick to our understanding of the atom.

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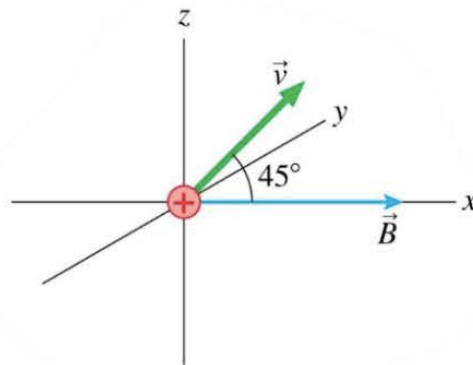
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**Question 35** (6 marks)

A positron enters a magnetic field at velocity  $v$  as shown below.

6



Given that:

- the positron's initial velocity is  $2.2 \times 10^4 \text{ m s}^{-1}$  at  $45^\circ$  from both the  $x$  and  $z$  axis and  $90^\circ$  from the  $y$  axis,
- the magnetic field has a strength of  $3.1 \mu\text{T}$  in the  $x$  direction, and
- the magnetic field is uniform throughout the entire region,

quantitatively describe the motion of the positron over the next 1.0 meter in the  $x$ -direction. Consider the  $x$ ,  $y$  and  $z$  labels to be at the positive end of the axis.

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**End of Task**

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Section II Extra writing space

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

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Student Number: .....

### Multiple-choice Answer Sheet (Questions 1-20)

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

**Sample:**  $2 + 4 =$  (A) 2 (B) 6 (C) 8 (D) 9

A ☐ B ☒ C ☐ D ☐

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☒ B ☒ C ☐ D ☐

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A ☒ B ☒ C ☐ D ☐  
correct

| Question |  | A                     | B                     | C                     | D                     |
|----------|--|-----------------------|-----------------------|-----------------------|-----------------------|
| 1        |  | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
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