PENRITH HIGH SCHOOL

2021 Trial HSC Exam

SCIENCE HSC PHYSICS

Task Weighting: 30 %

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, formulae sheet and Periodic Table are provided at the back of this paper
- Write your student number at the bottom of every answer page
- There is supplementary writing paper at the back of this booklet. Students using this supplementary space should indicate this at the relevant question

Total Marks: 100

Section I

Pages 11

20 marks

- Multiple Choice
- Attempt Questions 1–20
- Allow about 35 minutes for this part

Section II

Pages 1 – 18

80 marks

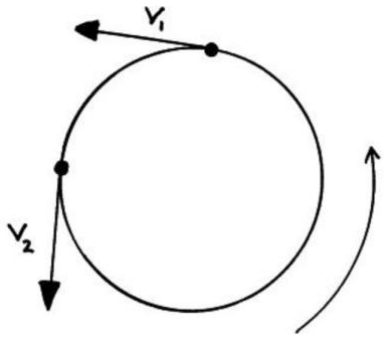
- Extended Answer
- Attempt Questions 21–32
- Allow about 2 hours and 25 minutes for this part

Total pages this exam: 18
M/C answer sheet: 1

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 following image shows an object undergoing uniform circular motion.



At the position where the object has a velocity of V_1, the direction of its net force is closest to:

A. None
B. Left
C. Upwards
D. Downwards

2. A transformer has a primary coil with 12 000 turns and a secondary coil with 2400 turns. If the primary voltage to the transformer is 240 V, determine the type of transformer and its secondary voltage.

	Type of transformer	Secondary Voltage (V)
A.	Step-up	48
B.	Step-up	12 000
C.	Step-down	48
D.	Step-down	12 000

3. A light with a wavelength of 400 nm is shone onto a metal surface with a threshold frequency of 2×10^7 Hz. What is the maximum kinetic energy of the photoelectrons liberated from the metal of the surface?

A. 0 J
B. 4.97×10^{-19} J
C. 1.32×10^{-26} J
D. -1.32×10^{-26} J

4. A car of mass 1.3 tonnes is travelling around a flat circular track at a speed of 40 km/h.

   Determine what would happen to the centripetal force if the same car travelled at the same speed around a banked track inclined at 15° to the horizontal.

   A. No change
   B. Increase in centripetal force
   C. Decrease in centripetal force
   D. The centripetal force would increase, then decrease.

5. Which of the following is NOT evidence for Einstein's special theory of relativity?

   A. Observation of cosmic-muons in the Earth's upper atmosphere
   B. The desynchronisation of atomic clocks on different moving objects
   C. Observations of momentum dilation from particle accelerator experiments
   D. No change in the velocity of light rays moving in perpendicular directions

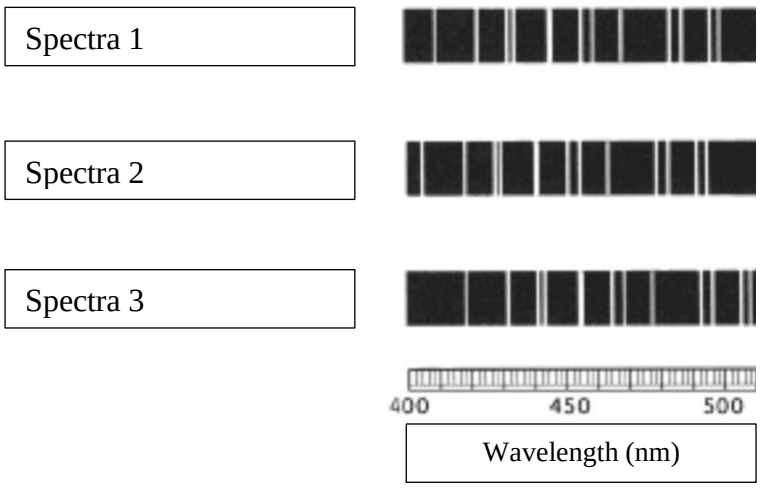
6. A low earth orbit satellite experiences orbital decay due to its interaction with the atmosphere. Which of the following correctly describes the effect on its kinetic energy and gravitational potential energy as it descends?

	Kinetic Energy	Gravitational Potential Energy
A.	Decreases	Decreases
B.	Increases	Decreases
C.	Decreases	Increases
D.	Decreases	Decreases

7. Determine the distance between the central maxima and the second order diffraction of a 800 nm wavelength laser which is shone through a double slit with a slit separation of 20 μm if the distance from the laser to the screen is 8.2 m.

   A. 6.56×10^{-1} m
   B. 6.56×10^{-2} m
   C. 6.56×10^{-3} m
   D. 6.56×10^{-4} m

8. The following diagram depicts the spectra of the same type of star as observed from different positions in the universe.



Which of the following best describes the motion of the star?

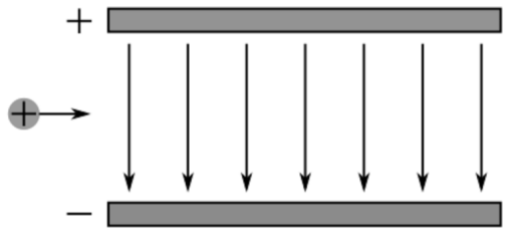
	Spectra 1	Spectra 2	Spectra 3
A.	Moving away	Stationary	Moving closer
B.	Stationary	Moving away	Moving Closer
C.	Stationary	Moving closer	Moving away
D.	Moving closer	Moving away	Stationary

9. An electron is fired at a velocity of 2.2×10^6 m/s into a magnetic field that is directed into the page.

What is the force it experiences if the magnetic field has a strength of 1.5 T?

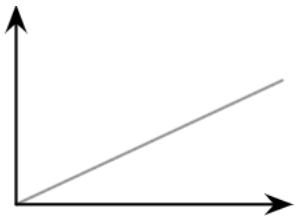
	Magnitude of force (N)	Direction
A.	3.3×10^7	Up
B.	5.29×10^{-6}	Up
C.	3.3×10^7	Down
D.	5.29×10^{-6}	Down

10. A particle travelling at constant velocity enters an electric field.

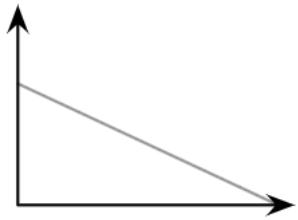


Which of the following displacement-time graphs best represents the particle's horizontal motion?

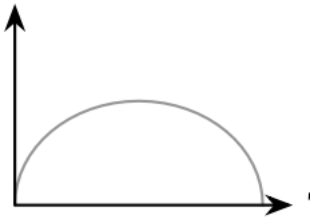
A.



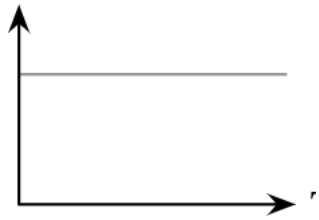
B.



C.



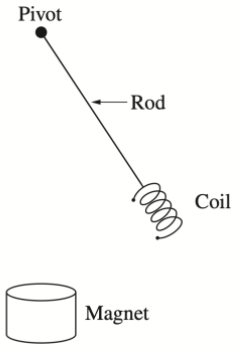
D.



11. Which of the following is NOT a contribution of Maxwell to the classical theory of electromagnetism?

A. The prediction of the speed of electromagnetic waves.
B. The measurement of the speed of light.
C. Unification of the theory of electricity and magnetism.
D. The prediction of electromagnetic waves which did not exist at the time.

12. A rod is swinging left and right from a fixed pivot. A coil of insulated copper wire is fixed at the other end. The result is a pendulum which is free to swing back and forth. A magnet is placed underneath this pendulum where the north pole of the magnet is facing upwards.



Which of the following best describes what will happen as the coil is allowed to swing over the magnet?

A. The coil pendulum will come to a stop in more time than if there was no magnet present.

B. The coil pendulum will come to a stop in the same time as if there was no magnet present.

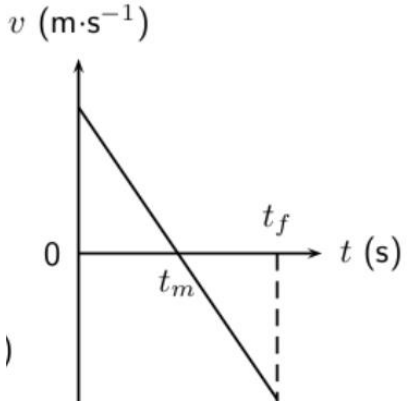
C. The coil pendulum will come to a stop in less time than if there was no magnet present and south pole will form at the bottom of the coil.

D. The coil pendulum will come to a stop in less time than if there was no magnet present and an alternating magnetic field will form at the bottom of the coil.

13. Determine the angular velocity of a 20 g bob that was swung around a string with a length of 20 cm that is moving at a constant velocity of 3 m/s.

A. 1.26 rad/s
B. 22 rad/s
C. 0.14 rad/s
D. 49 rad/s

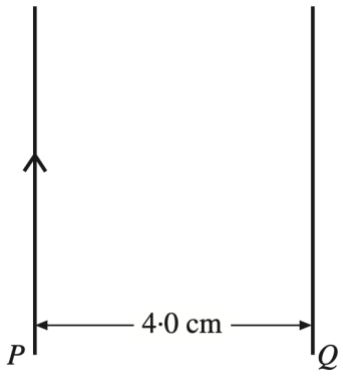
14. The following is a vertical velocity time graph of an object undergoing projectile motion. The projectile finishes moving immediately after the time, t_f.



Which of the following descriptions best describes the motion of the object:

A. A ball rolled off the edge of a table.
B. A ball that is thrown to the ground which then bounces back up.
C. A projectile launched from a cliff that drops to sea level.
D. A projectile launched from ground level that is returning to ground level

15. Two parallel conductors P and Q are separated by 4.0 cm. It is measured that an attractive force of 2.5 x 10-5 N/m acts between the conductors. A current of 2.0 A if flowing through P.



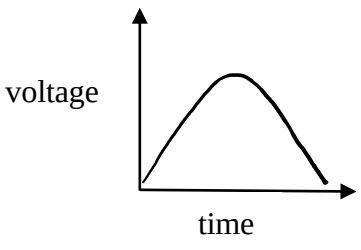
Determine the current through wire Q.

	Magnitude of current, (A)	Direction of current in wire Q
A.	2.5	Up
B.	250	Down
C.	2.5	Up
D.	250	Down

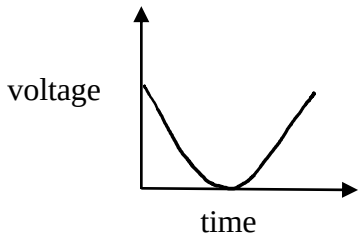
16. A basic DC motor is initially stationary. It is connected to a power source and the motor begins to turn until it reaches and maintains its maximum speed. The motor is forced to stop by an external braking force applied to the coil of the motor.

A voltmeter is connected across the terminals of the motor. Which of the following best represents how the voltage across the motor would change over a period of time.

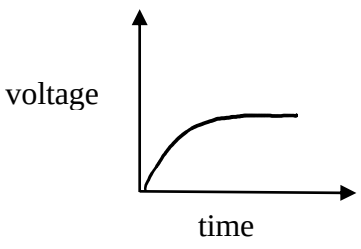
A.



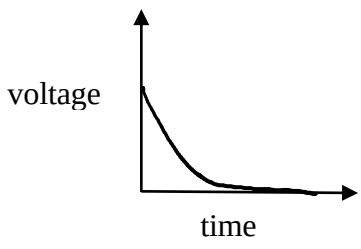
B.



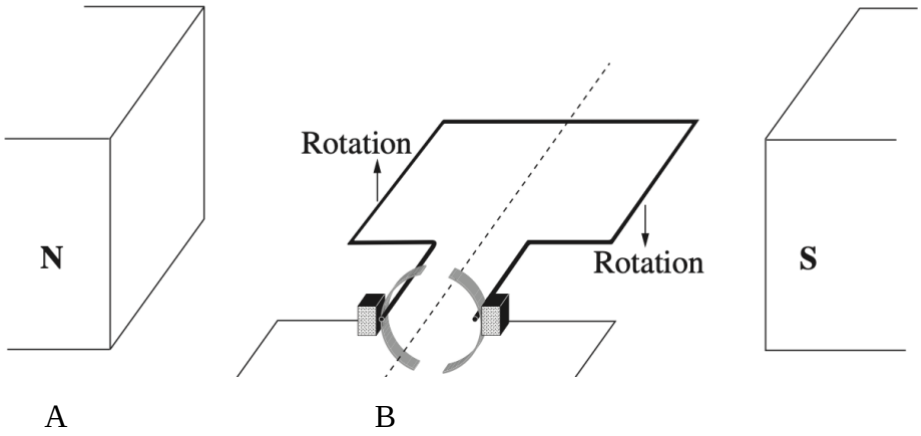
C.



D.



17. A coil is forced to rotate in a clockwise direction. The ends of a coil are connected to points A and B through a commutator which do not form a complete circuit.



Which of the following best describes what would happen to the positive charges when the coil is in the position as shown in the diagram?

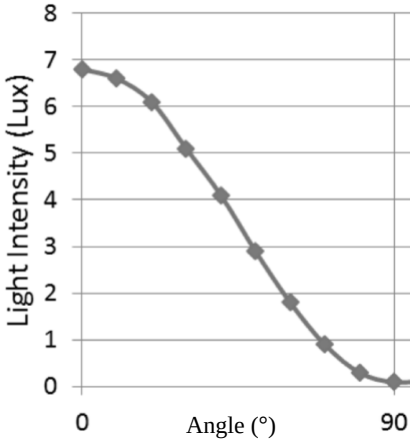
A. The positive charges would accumulate at point A.

B. The positive charges would accumulate at point B.

C. The positive charges would alternate back and forth.

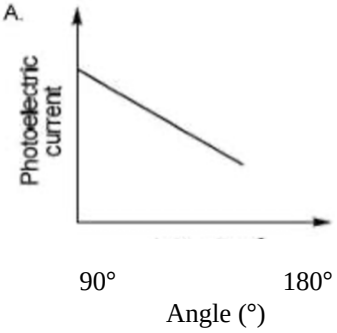
D. The positive charges would not move as there is no external circuit.

18. The following is a graph that represents how the light intensity changes as the angle of a polariser is rotated clockwise from 0° to 90°.

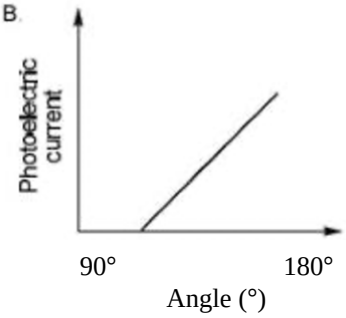


The light emitting from the polariser is shone onto a metal surface and the liberation of electrons is observed. If the polariser was rotated from an angle of 90° to 180°, which graph would best represent the photocurrent?

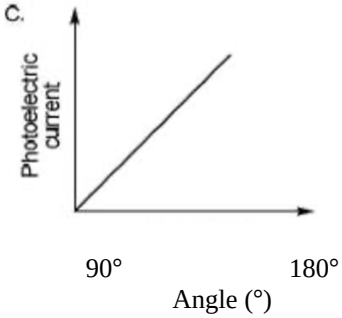
A.



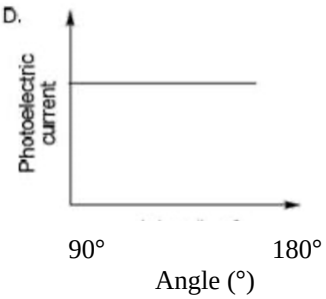
B.



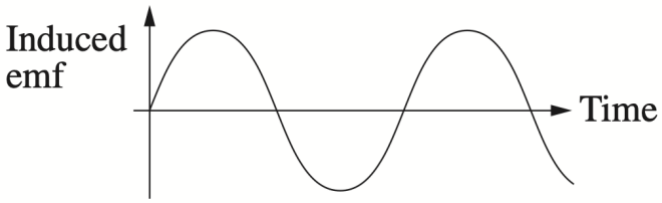
C.



D.

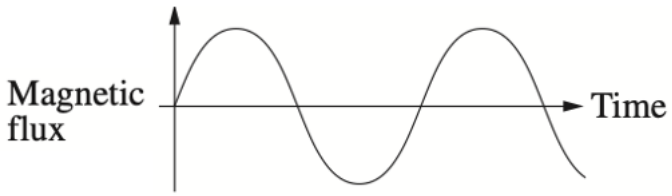


19. The following graph shows the induced EMF in a coil that is rotating in a magnetic field.

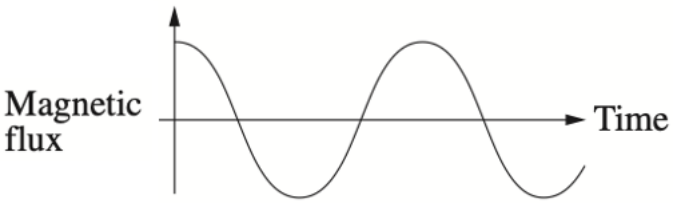


Which of the following graphs would represent the magnetic flux through the coil as it is rotated?

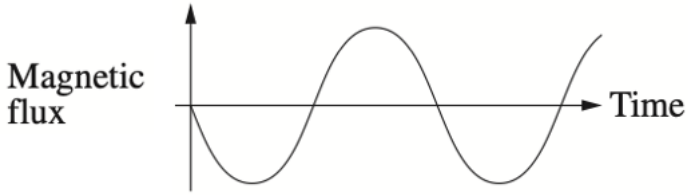
A.



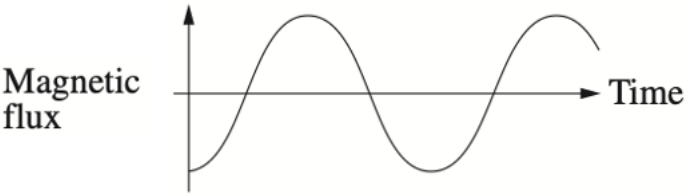
B.



C.



D.



20. An observer that is stationary on Earth looks up and observes a spaceship flying past with a constant velocity of 0.5 c with a length of 12.5 m. After it passes the observer, it accelerates for 30 seconds and then maintains its final velocity. A second observer measures the final velocity of the spaceship to be 11.0 m.

What is the distance between the two observers as measured on Earth?

A. 14.4 m

B. 1.00×10^{10} m

C. 2.00×10^{10} m

D. 3.00×10^{10} m

END OF MULTIPLE CHOICE

Student Number

Physics
Section II Answer Booklet

80 marks
Attempt Questions 21 – 32
Allow about 2 hours and 25 minutes for this section

Instructions

- Write your Centre Number and Student Number at the top of this page
- Answer the questions in the spaces provided.
- 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.

Question 21 (6 marks)

Each of the following formulae can be used to calculate the gravitational potential energy (E_p) of an object due to the gravitational field of a planet:

(1) $E_p = mgh$ and (2) $E_p = -GMm/r$

a. List the circumstances under which (1) is an acceptable formula to use.

[2]

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b. Define gravitational potential energy as indicated by (2)

[2]

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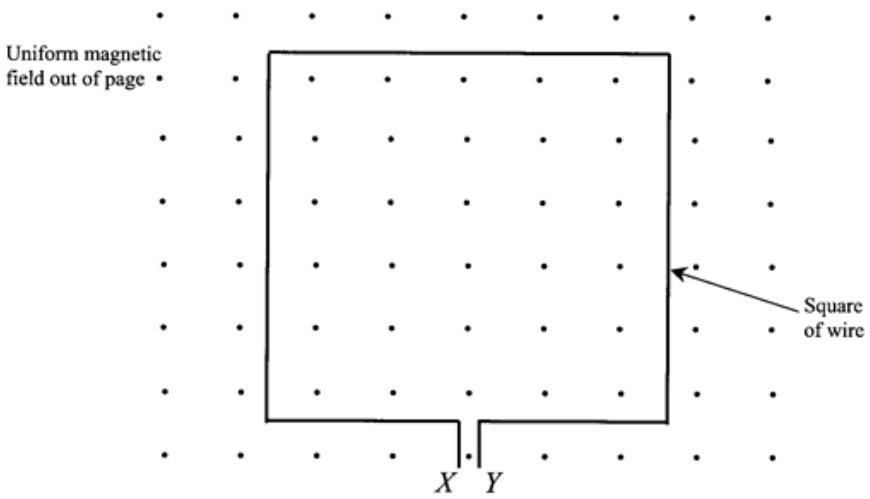
c. Explain the ***maximum*** value of gravitational potential energy allowed by (2)?

[2]

Question 22 (5 marks)

A uniform magnetic field, of strength 20 T, acts vertically out of the page.
A single length of wire, X-Y, forms a square loop of wire, of side length 0.480 m, as shown in the diagram.



a. Calculate the magnetic flux is passing through the square of wire?

[2]

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b. The magnetic field is reduced at a uniform rate to zero, over a time of 50 milliseconds. Calculate the average induced voltage between X and Y.

[3]

Question 23 (4 marks)

A school prefect on a bike is travelling along a straight road at a constant speed of 5 ms^{-1} in an Easterly direction away from school. His friend, who is not a prefect, is also travelling on a straight road, his constant velocity is 6 ms^{-1} away from school in a Northerly direction.

a. Determine the relative velocity of the prefect to his friend.

[2]

The two friends become astronauts in adulthood. On their journeys to Mars, their motion replicates that from their school days. This time the speed of the old prefect is 0.6c toward Mars and his friend travels at 0.5c away from Mars in the direction of Earth. Both friends have well-lit space craft headlights.

b. At what speed will the old prefect observe the speed of light from the headlights of his friend's spacecraft?

[1]

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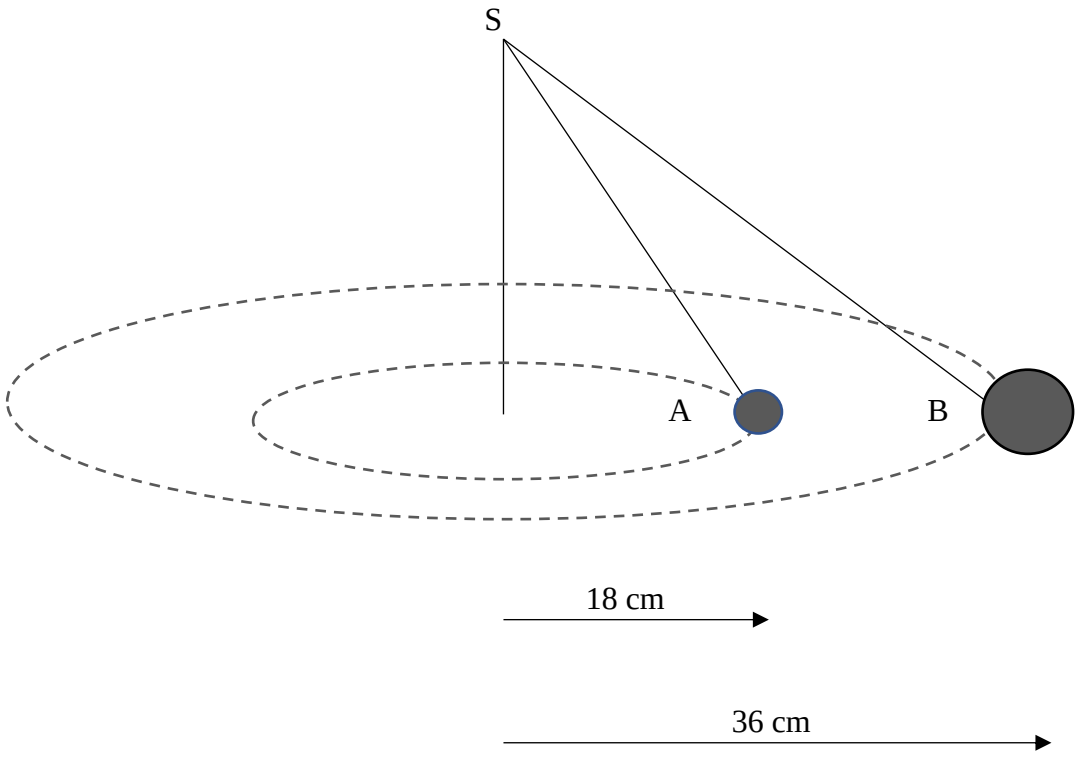
c. Identify Maxwell's contribution to your answer for B.

[1]

Question 24 (4 marks)

Two masses A and B are attached to the ends of light, inextensible strings SA and SB. They are swung in horizontal circles as shown in the diagram below. The time for one complete revolution is the same for both A and B. The radius of A's path is 18 cm, and the radius of B's path is 36 cm.



a. Determine the value of the ratio:

$$\frac{Speed\ of\ Mass\ A}{Speed\ of\ Mass\ B}$$

[2]

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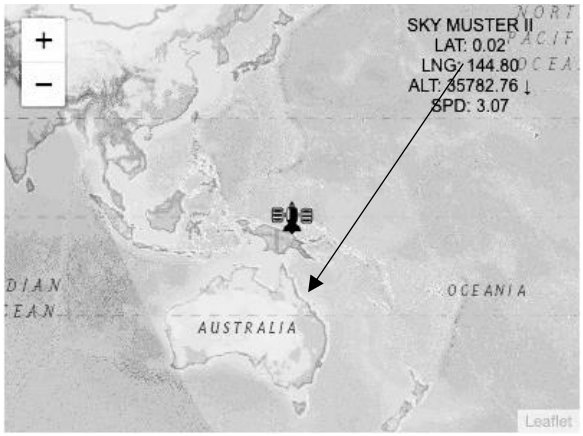
b. If the mass of B is 3 times greater than mass B. Determine the value of:

$$\frac{Centripetal\ force\ on\ Mass\ A}{Centripetal\ force\ on\ Mass\ B}$$

[2]

Question 25 (8 marks)

The Skymuster II satellite, is an Australian, communications satellite. It is in a geosynchronous orbit directly above one position on the Earth's equator. This satellite is an important component of the Australian National Broadband Network infrastructure.



The Moon is a natural satellite of the Earth. It has Mass = 7.34×10^{22} Kg, Radius = 1.74×10^{6} m, Mean radius of orbit = 3.84×10^{8} m and Period of revolution = 2.36×10^{6} s.

a. What is the period of revolution of Skymuster II?

[1]

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b. The Skymuster II is an Australian communications satellite, yet the map shows that it is positioned closer to Indonesia. Explain why Skymuster II is not positioned directly above the Australian land mass.

[2]

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c. Use data about the Moon's orbit to determine the orbital radius of Skymuster II.

[3]

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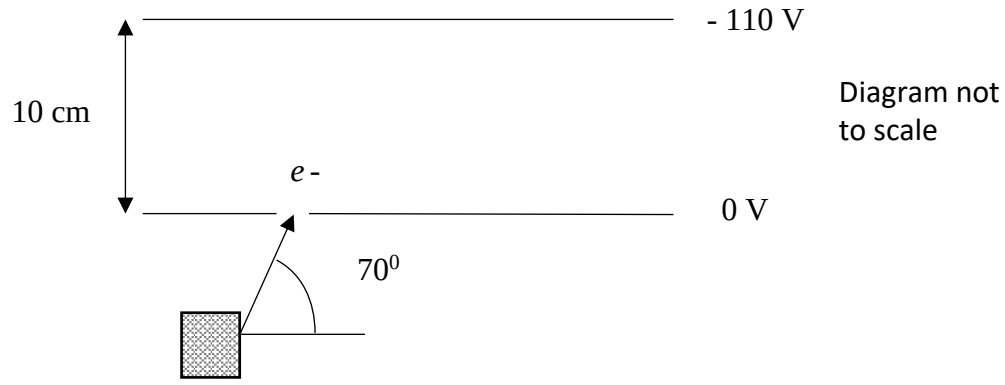
d. Calculate the total energy of the Skymuster II in its orbit.

[2]

Question 26 (6 marks)

An electron is emitted from a sample. It travels through an aperture allowing it to move into the space between two parallel charged plates. The electron is emitted at a speed of 4.5×10^6 ms^{-1} and the apparatus is set up as shown in the diagram below:



a. Sketch the predicted path the electron would take on the diagram above.

[1]

b. Determine the acceleration of electron.

[2]

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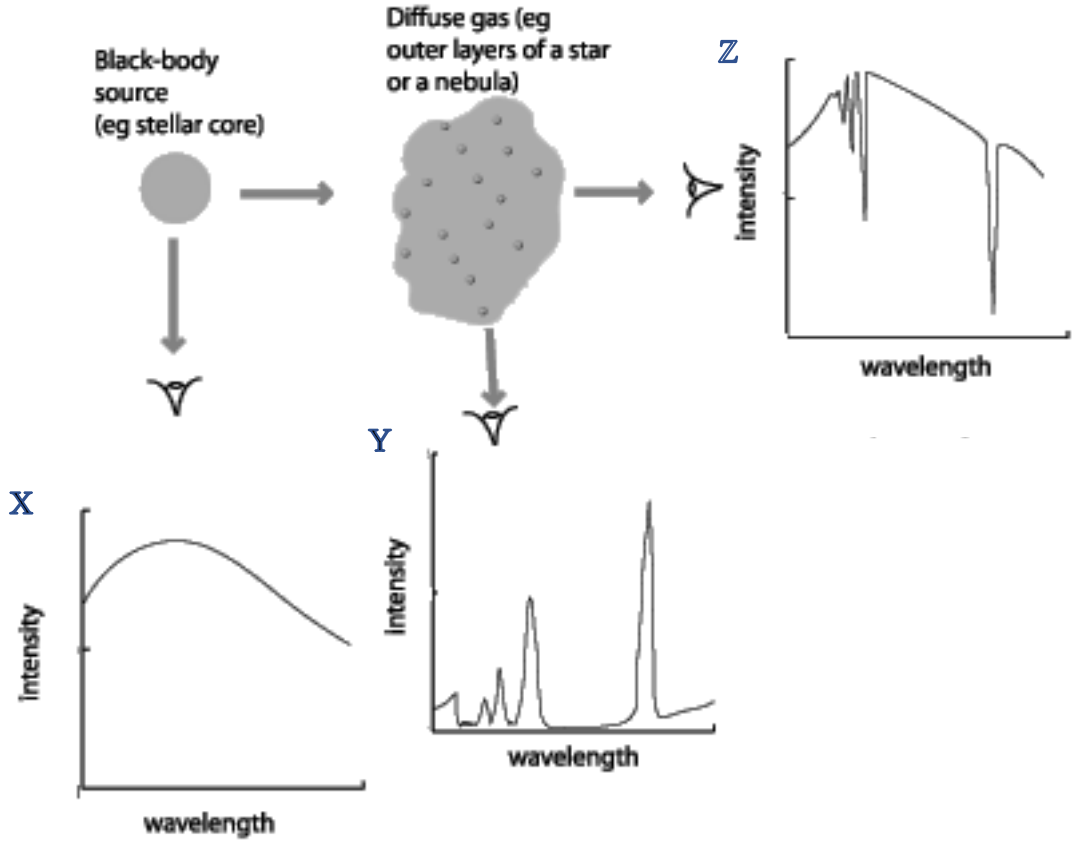
c. Predict where a detector would need to be placed to observe the final position by collision with the electron.

[3]

Question 27 (10 marks)

Consider diagram shown below.



a. Describe the production of each of the graphs X, Y and Z.

[3]

Question 27 continued

Consider the diagram below that shows the spectrum produced by a star.

Sample stellar spectrum

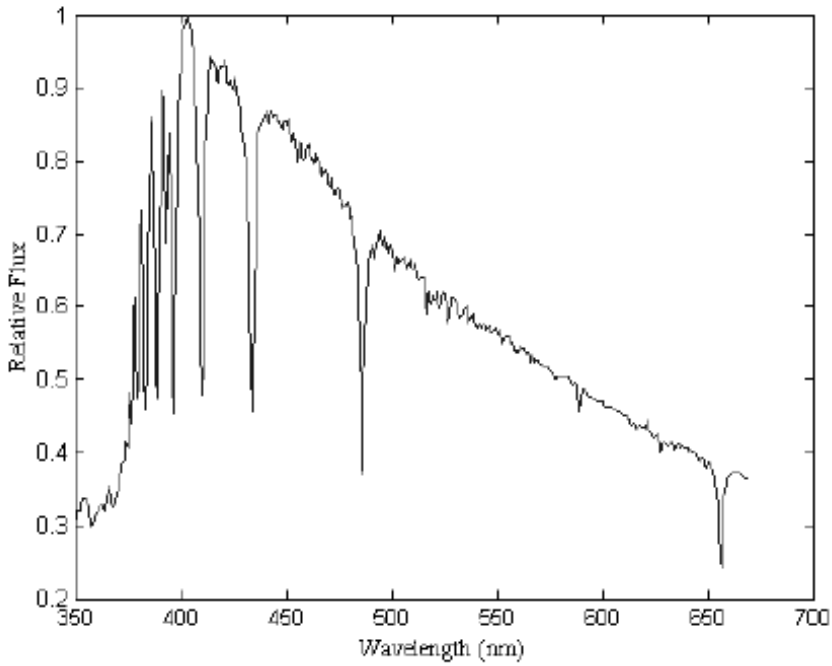


Image reference: SPECTRAL ANALYSIS USING EVOLUTION STRATEGIES - Scientific Figure on ResearchGate. Available from: https://www.researchgate.net/figure/Sample-stellar-spectrum_fig1_254719006 [accessed 3 Jul, 2021]

b. Use this information to calculate the approximate temperature of the star.

[3]

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c. Describe how this diagram might appear different if it was for a star

i. of the same temperature but moving away from the observer

[2]

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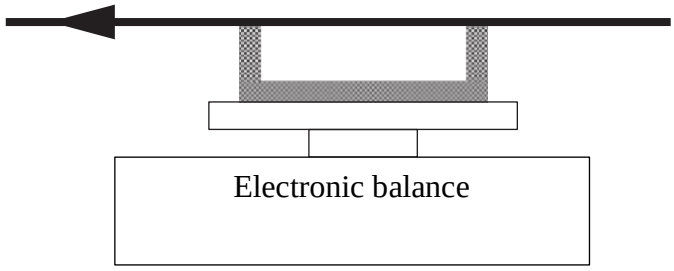
ii. a higher density and temperature star

[2]

Question 28 (9 marks)

In an experiment to explore the force on a current-carrying conductor, a 2.2 m long fine aluminium bar was placed in an external magnetic field. The bar was connected in series to a power supply. The following results were recorded.

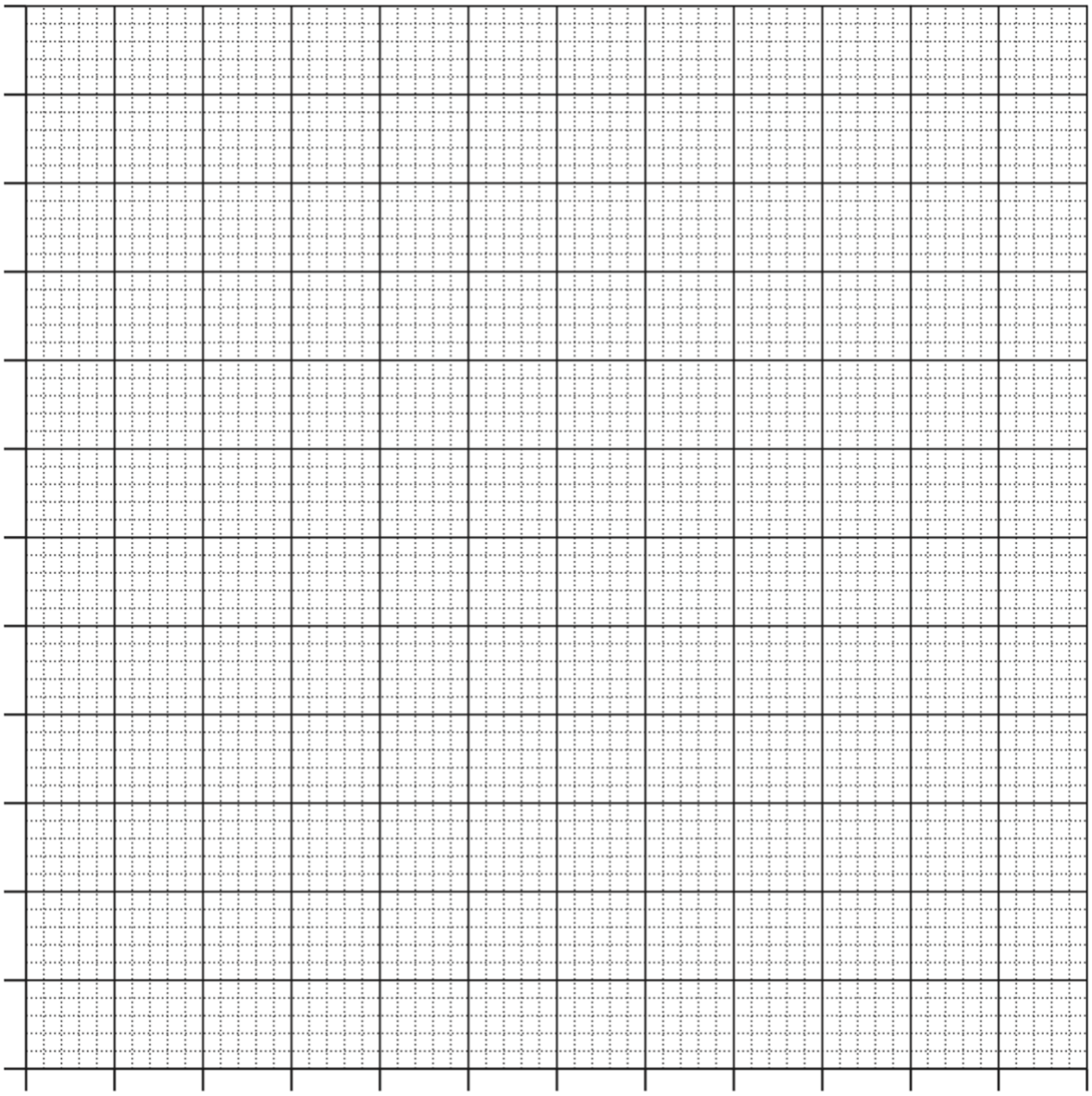
The apparatus was set up as shown below:



Current (A)	0	1.0	2.0	3.0	4.0	5.0
Reading on balance (N)	0.30	1.2	2.0	3.1	4.2	5.4

a. Graph these results on the grid paper provided over page.

[3]



b. Describe the features of this graph that agree with expectation and disagree with expectations.

[3]

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c. Use your graph to find the size of the external magnetic field.

[3]

Question 29 (4 marks)

Ryan has two *synchronised* alarm clocks which are set to go off in 1 hour.
Clock A remains with Ryan while clock B is set in motion with Leah at a velocity 0.98 times the speed of light (0.98 c) relative to Ryan.

a. Calculate how much time passes for Ryan (as measured by him on clock A) before he concludes that Leah's clock alarm (clock B) has sounded

[2]

---

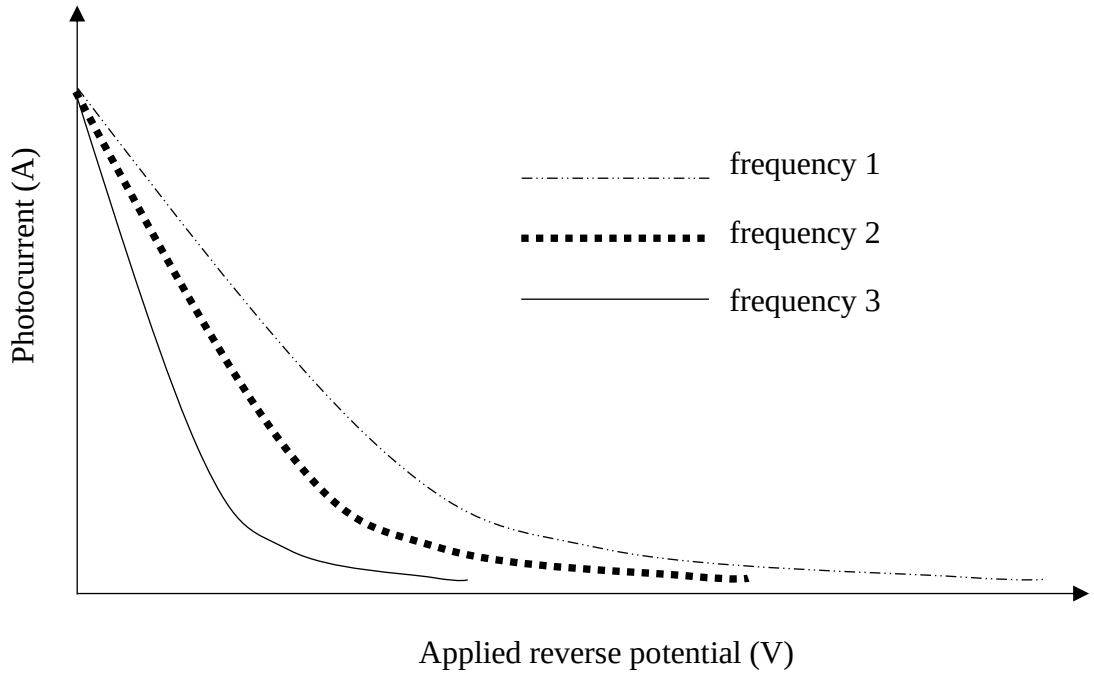
b. Explain how much time elapses on Leah's clock *according to her* before its alarm sounds?

[2]

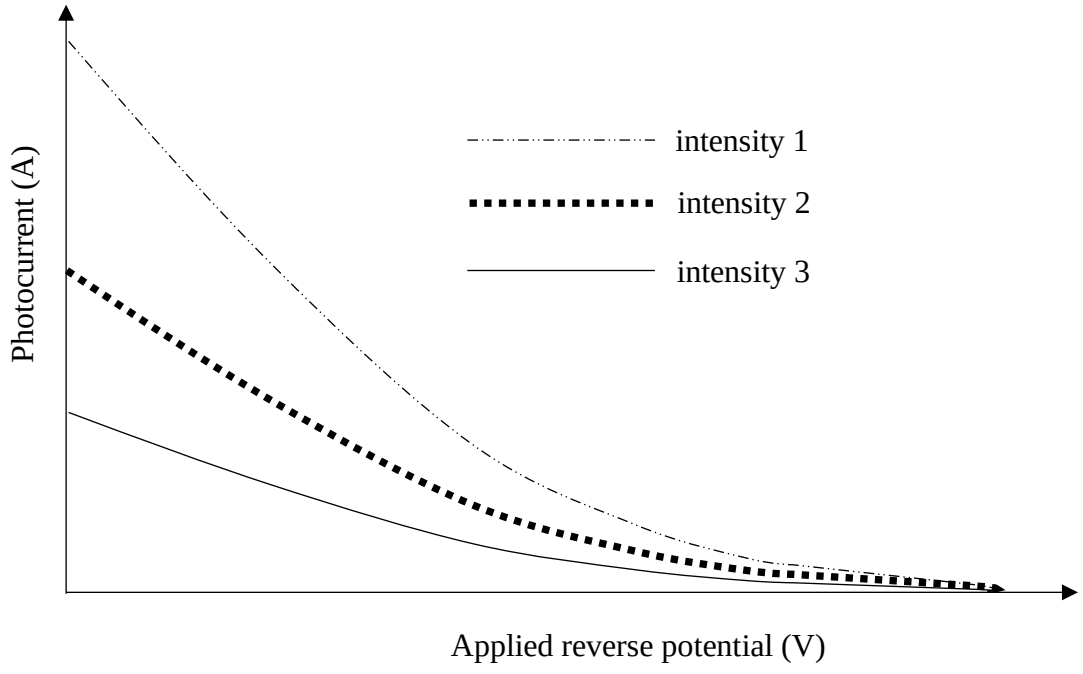
Question 30 (6 marks)

Students experimentally investigating the photoelectric effect gathered the data below.
Analyse the graphs to explain how data from the photoelectric effect was inconsistent with the wave model for light.

Graph of results produced with constant light intensity and three different frequencies of light

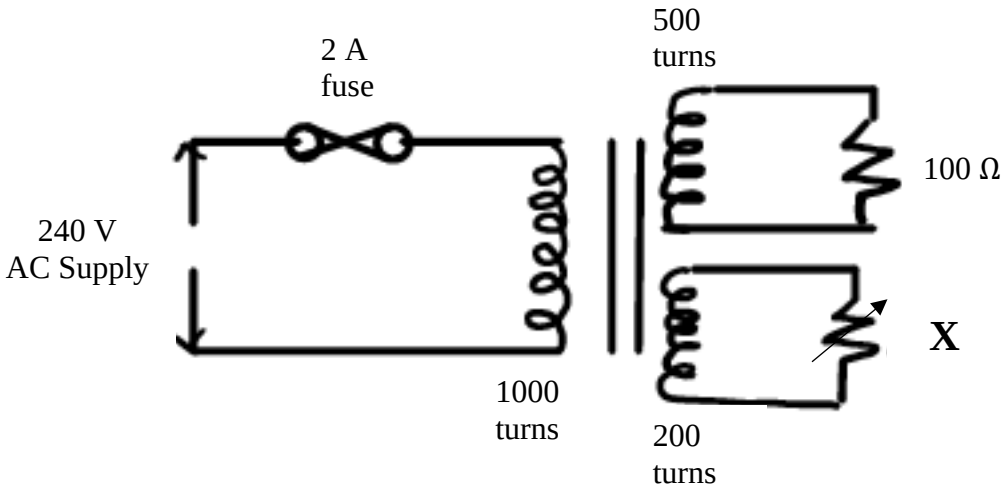


Graph of results produced with constant frequency and three different intensities of light



Question 30 (7 marks)

A dual output transformer is used to provide two output voltages from a single input. It obeys the same rules for power input and output as a single output transformer.
An ideal dual output transformer is used to power an electric heater and light. The circuit is shown below:



a. This diagram shows that the transformer is set up differently to a single primary coil and single secondary coil transformer. Name the Physics law will determine the ratios of input voltage and current to output current and voltage?

[1]

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b. Write an expression to relate the input and output voltages and currents.

[1]

---

c. What is the maximum power the heater, X, can draw so that no more that 2 A will flow in the primary circuit?

[3]

---

d. What current would the heater draw when it was operating at the maximum power from A?

[2]

Question 31 (6 marks)

An electrically charged sphere the size of a tennis ball is supported by an insulating stand on the front bench of a school physics laboratory. A student has an electrometer which is an instrument that can detect and measure ***electric*** fields. She also has a magnetometer which is an instrument that can detect and measure ***magnetic*** fields.

The student places the electrometer at a distance of 1 m from the charged sphere and notes that it gives an obvious reading. She places the magnetometer at the same distance.

a. What reading is expected to show on the magnetometer?

[1]

---

b. Explain what would happen to the reading on the electrometer as the student moves it slowly away from the charged sphere?

[2]

---

c. The student now moves the magnetometer quickly towards the charged sphere and then brings it to *rest* close to sphere. Describe and explain the response of the magnetometer throughout this process.

[3]

Question 32 (5 marks)

Identify three historical experiments that were used to provide evidence for a classical model of the atom. Explain how the observations from one of these experiments were used to provide further detail to the model of the atom.

End of Paper

Section II extra writing paper.

If you use this paper, clearly indicate which question you are answering and also indicate that you have used this paper at the question.