



Access Education

NAME:

PHYSICS

Unit 3 & 4

Trial examination 2017

Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

<i>Section</i>	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
A	20	20	20
B	15	15	110
<i>Total</i>			130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, pre-written notes (one folded A3 sheet or two A4 sheets bound together by tape) and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

- Question and answer book of **29** pages
- Formula sheet
- Answer sheet for multiple-choice questions

Instructions

- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the formula sheet.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions. Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2} .

Question 1

The Heisenberg Uncertainty Principle means that for sub atomic particles:

- A. If the position is not known then the momentum must be known.
- B. We cannot be certain of the momentum unless we know the position of the particle.
- C. The momentum must be known if we want to find the position.
- D. Measuring the particles position will change the particles momentum in some way.

Question 2

Jamila is swinging a bucket of water in a vertical circle in a way that none of the water falls out of the bucket at the top of the swing. This is due to:

- A. The tension in Jamila's arm being greater than the weight of the water.
- B. The water being apparently weightless at this point.
- C. The water having no inertia at this point.
- D. Jamila swinging her arm in the same direction as the Earth's rotation.

Question 3

Which of the following will **not** effect the diffraction pattern produced when electrons are fired at a salt crystal?

- A. Changing the speed of the electrons.
- B. Altering the de Broglie wavelength of the electrons.
- C. Changing the type of salt crystal used as the target.
- D. Increasing the intensity of the electron beam.

PHYSICS TRIAL EXAMINATION

The following information applies to Questions 4 to 7

A set of $50.0 (\pm 0.5)$ g masses is used to determine the spring constant of a nylon spring. The length of the spring is measured using a 30 cm ruler with 1 mm graduations. The results are in the table below.

Number of masses added	0	1	2	3	4	5
Spring length (cm)	14.0	17.3	20.1	22.9	25.8	28.9

Question 4

The total mass added to the spring is:

- A. 250 ± 0.5 g
- B. 250 ± 2.5 g
- C. 250 ± 3.0 g
- D. 250 ± 0.0 g

Question 5

The ruler used is accurate to:

- A. ± 1 mm
- B. ± 0.1 cm
- C. ± 0.5 cm
- D. ± 0.05 cm

Question 6

The uncertainty in the value of the spring constant calculated from this data is referred to as uncertainty:

- A. systematic
- B. relative
- C. random
- D. human

Question 7

The calculated value of the spring constant from this data is:

- A. 16.44 ± 0.22 N m⁻¹
- B. 16.4 ± 0.2 N m⁻¹
- C. 16.5 ± 0.2 N m⁻¹
- D. 16.0 ± 0.2 N m⁻¹

Question 8

Figure 1 shows a beam white light polarised at an angle of 30° to the horizontal being directed towards a bracket which can hold a polarising filter.

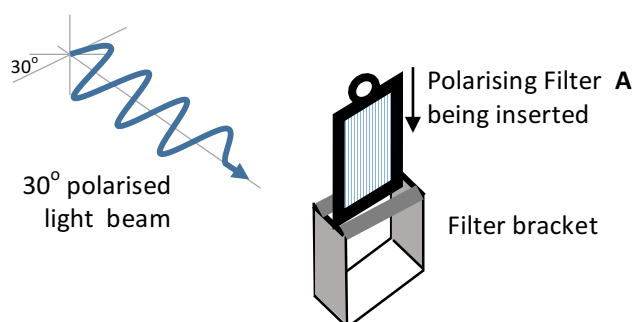
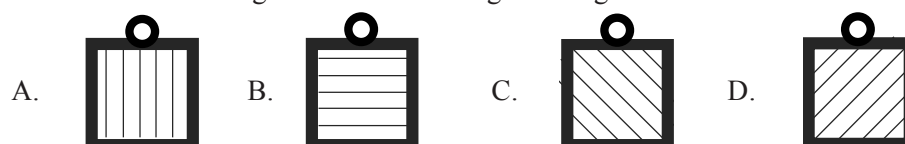


Figure 1

The filter that will allow the greatest amount of light through is:



Question 9

Students use a compass to trace the field lines around a black box. The field lines traced are shown in Figure 2.

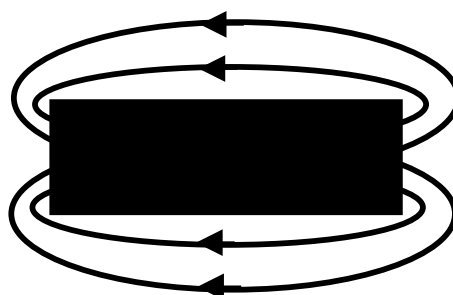


Figure 2

Inside the black box could be:

- A. A magnet with its north pole to the left.
- B. A magnet with its north pole to the right.
- C. A coil with an AC current flowing clockwise.
- D. A coil with an AC current flowing anticlockwise.

Question 10

A 4 kg cannon ball is fired into the air from ground level with an initial velocity of 22 m s^{-1} at an angle of 40° to the horizontal. Ignoring the effects of air resistance, at its highest point it's kinetic energy is:

- A. 568 J
- B. 400 J
- C. 284 J
- D. 0 J

Question 11

A spaceship travelling at 80% the speed of light is measured to have a length of 308 m.

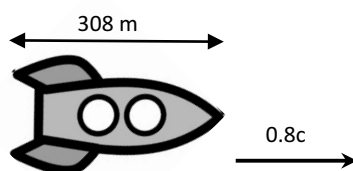


Figure 3

At rest the spaceship would measure closest to:

- A. 185 m
- B. 308 m
- C. 385 m
- D. 513 m

Question 12

An electron is located $4 \times 10^{-3} \text{ m}$ from an oxygen ion (O^{2-}). The force the electron exerts on the oxygen ion is:

- A. $2.9 \times 10^{-23} \text{ N}$
- B. $2.7 \times 10^{-4} \text{ N}$
- C. $1.8 \times 10^{-4} \text{ N}$
- D. $9.0 \times 10^{-5} \text{ N}$

PHYSICS TRIAL EXAMINATION

Question 13

The results of Young's double slit experiment were considered irrefutable proof that light:

- A. was a particle.
- B. was a wave.
- C. was a wave with particle properties.
- D. was both a wave and a particle.

Question 14

Incandescent light is produced by:

- A. an LED
- B. a laser
- C. the Sun
- D. a synchrotron

Question 15

Potassium has a work function of 2.30 eV. When photons of frequency 6×10^{15} Hz strike potassium the maximum kinetic energy of photoelectrons would be closest to:

- A. 2.25 eV
- B. 2.30 eV
- C. 22.5 eV
- D. 225 eV

Question 16

The phenomenon of total internal reflection occurs when light travels:

- A. between any two optical media
- B. between optical media with a difference in refractive indices of more than 0.4
- C. from a medium of higher refractive index to one of lower refractive index
- D. from a medium of lower refractive index to one of higher refractive index

PHYSICS TRIAL EXAMINATION

Question 17

When a fire engine approaches you with its siren and lights flashing, the doppler effect occurs:

- A. Only with the sound waves.
- B. Only with the light waves.
- C. With both the sound and light waves.
- D. Only after the ambulance has passed you.

Question 18

An electron and then a proton were fired into a uniform magnetic field. The electron travelled along path X, which path was the proton expected to take?

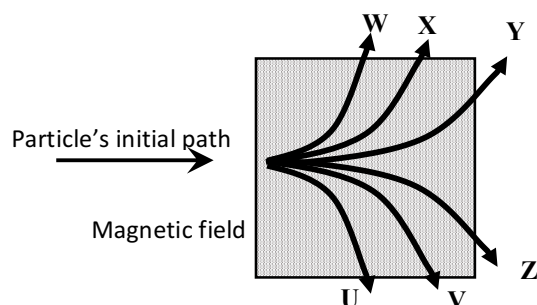


Figure 4

- A. V
- B. Z
- C. X
- D. U

Question 19

Bella and Jin are investigating the relationship between temperature and volume of a gas. They inflate 4 balloons to the same size and then place one in a refrigerator at 4°C , one in a freezer at -7°C , one in an incubator at 60°C and leave the last one in a room thermostatically controlled to remain at 24°C . After 6 hours they measure the size of the balloons.

The independent variable in this experiment is the:

- A. Size of the balloon.
- B. temperature of the rooms.
- C. gas used to fill the balloons.
- D. Type of balloon used.

Question 20

A standing wave can be described as:

- A. A wave that does not move through a medium.
- B. A wave that is resonating.
- C. A wave that only constructively interferes with itself.
- D. A wave that only destructively interferes with itself.

End of Section A

SECTION B**Instructions for Section B**

Answer **all** questions in the spaces provided. Write using blue or black pen.

Where an answer box is provided, write your final answer in the box.

If an answer box has a unit printed in it, give your answer in that unit.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of g to be 9.8 m s^{-2} .

Question 1 (13 marks)

A 2 kg pendulum is released from a height of 40 cm. It swings freely until it reaches its lowest point where it collides with a 3.2 kg cart. The cart is on a track assumed to be frictionless. The track is horizontal for 1.5 m then slopes upward at 30° to the horizontal as shown in Figure 1.

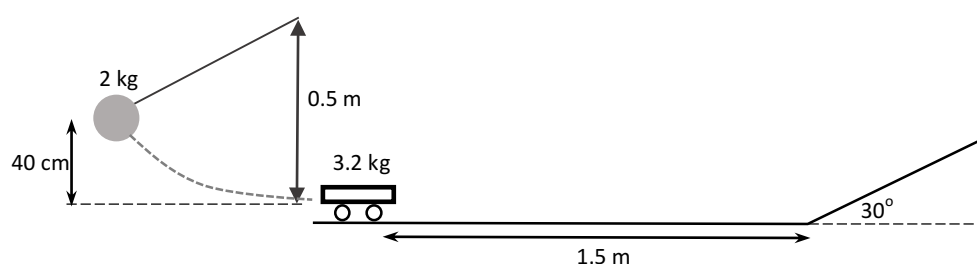


Figure 1

- a. Prove that the speed of the pendulum just before it strikes the cart is 2.8 m s^{-1} .
2 marks

PHYSICS TRIAL EXAMINATION

- b.** Calculate the tension in the pendulum cable when it is at its lowest point, just before it hits the cart. 2 marks

	N
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The pendulum comes to a complete stop when it strikes the cart.

- c.** Find the initial speed of the cart. 2 marks

	m s^{-1}
--	-------------------

- d.** Use calculations to determine if the collision between the pendulum and cart is elastic. 3 marks

PHYSICS TRIAL EXAMINATION

- e. Show that the cart's centre of mass should reach a height of 15.6 cm above the horizontal track section before rolling back down. 2 marks

When tested the cart travels only 1.40 m along the track before stopping.

- f. Determine the frictional force that the track applies to the cart. 2 marks



Question 2 (7 marks)

Figure 2 below shows a 0.050 kg tennis ball which is bounced from a chair into a cup on a table 0.30 m higher than the chair. Assume both surfaces are horizontal and air resistance is negligible. The ball is in the air for 1.2 s between leaving the chair and landing in the cup. It travels a horizontal distance 0.80 m during this time.

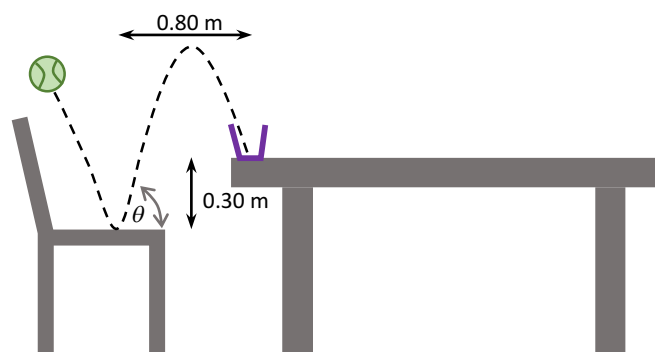


Figure 2

- a. Prove that the angle θ at which the ball left the chair was 83.8° to the horizontal. 4 marks

- b. Find the maximum height the ball rises above the table. 3 marks

	m
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Question 3 (8 marks)

A simple DC motor is constructed as shown in Figure 3. The rectangular loop is free to rotate about the axis XY. The magnets generate a uniform 0.02 T magnetic field between them. The 2×4 cm loop has 20 turns.

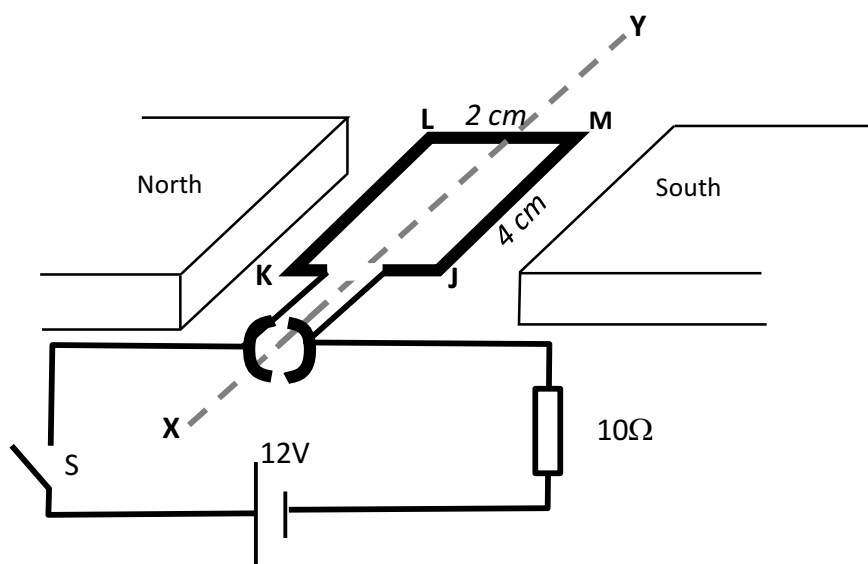


Figure 3

The switch (s) is closed with the loop in the position shown.

- a. Determine the magnitude of the force on side KL. 2 marks

N

- b. Circle your answer
As viewed from point X, the initial rotation of the loop would be:

clockwise
anticlockwise
zero
1 mark

PHYSICS TRIAL EXAMINATION

- c.** An essential component of a DC motors is the commutator.
Explain how the commutator operates in this motor. 3 marks

- d.** Which of the following changes would result in an increased rotation rate? 2 marks

- (i) Increase the area of the loop to $4 \times 4 \text{ cm}$
- (ii) Increase the supply voltage
- (iii) Double the magnetic field strength whilst halving the resistance
- (iv) Halving the number of turns and doubling the supply voltage

Question 4 (9 marks)

An electron gun is designed to fire horizontal electrons at a speed of $4.6 \times 10^6 \text{ m s}^{-1}$.

- a. What must be the potential difference across the electric field of the electron gun? 2 marks

- b. If the electrons are to continue to travel horizontally after leaving the electron gun determine the magnitude and direction a magnetic field that would achieve this outcome. 3 marks

- c. The beam of electrons are now directed at a crystal and produce a diffraction pattern. Calculate the wavelength of light that would produce an identical pattern? State your answer in nanometres. 3 marks

- d. Circle the region of the electromagnetic spectrum this light is from? 1 mark

Radiowaves – microwaves – infrared – visible – ultraviolet - X-rays - Gamma rays

Question 5 (2 marks)

A proton enters a region of space where it passes through a magnetic field and then an electric field (see Figure 4).

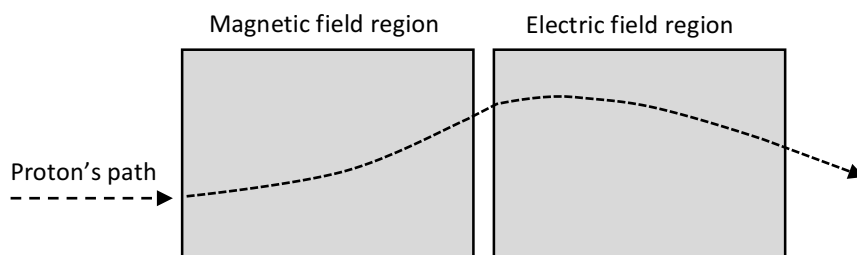


Figure 4

In Figure 4 above draw the direction of the field lines in each box that caused the proton to follow the path shown. 2 marks

Question 6 (10 marks)

Wendy and Linda are investigating electric circuits. They connect the circuit shown in Figure 5 and record the ammeter reading at 1.0 A. they notice that the 6 W globe does not shine as brightly as expected.

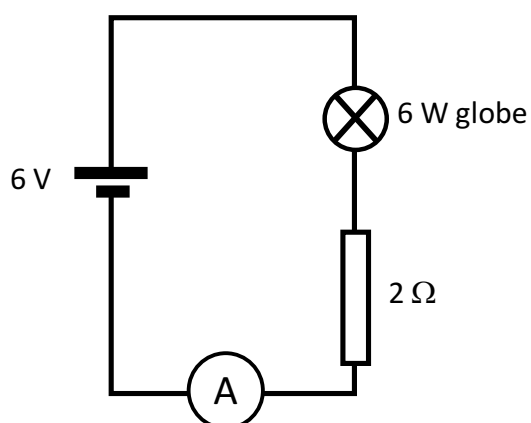


Figure 5

- a. Explain why the globe does not shine as brightly as expected. 2 marks

They now replace the 6 V battery with a 6 V_{rms} AC supply, but the globes brightness does not change. Wendy suggests they use transformers in their circuit and create a new circuit as shown in Figure 6.

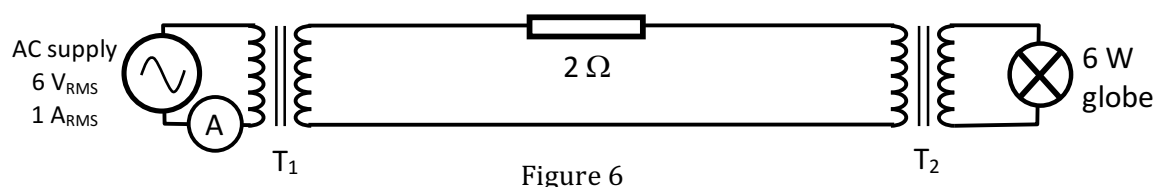


Figure 6

- b. Complete the table of results for the following combinations of transformers by stating if the globe will now shine brighter, duller or equal compared to that in Figure 5. 2 marks

Transformer T ₁ N _p : N _s	Transformer T ₂ N _p : N _s	Globe brightness compared to Figure 5 circuit
20 : 200	200 : 20	
200 : 20	20 : 200	

PHYSICS TRIAL EXAMINATION

Assume that the transformers are identical and ideal.

- c. Calculate the minimum power loss in the Figure 6 circuit now. 3 marks

W

- d. Determine V_{peak} across the globe in Figure 6 to 2 decimal places. 3 marks

V

Question 7 (6 marks)

A generator is rotating at 50 Hz. Its 100 turn loop has an area of 0.04 m^2 and is immersed in a uniform 0.5 T magnetic field.

- a. How long does the loop take to complete one complete revolution? 1 mark

s

- b. Find the average EMF generated by the generator. 3 marks

V

The rate of rotation is now altered so that output voltage in Figure 7 is produced.

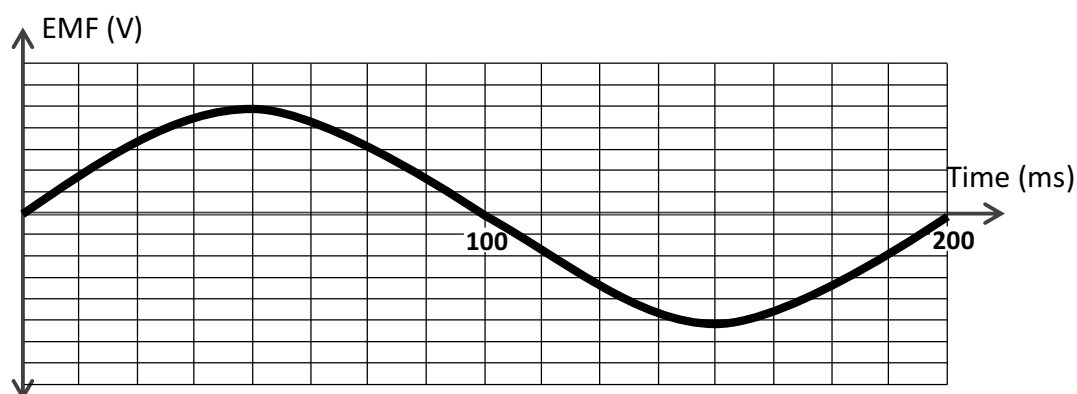


Figure 7

- c. On Figure 8 below sketch the magnetic flux that induces this EMF. 2 marks

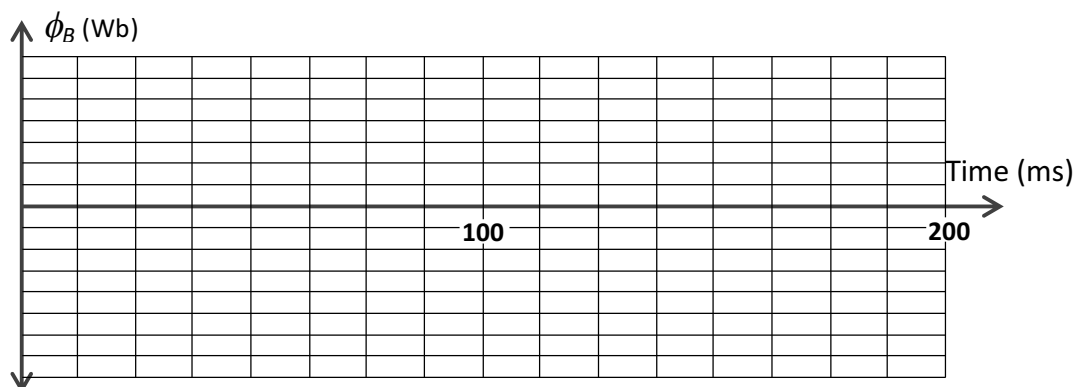


Figure 8

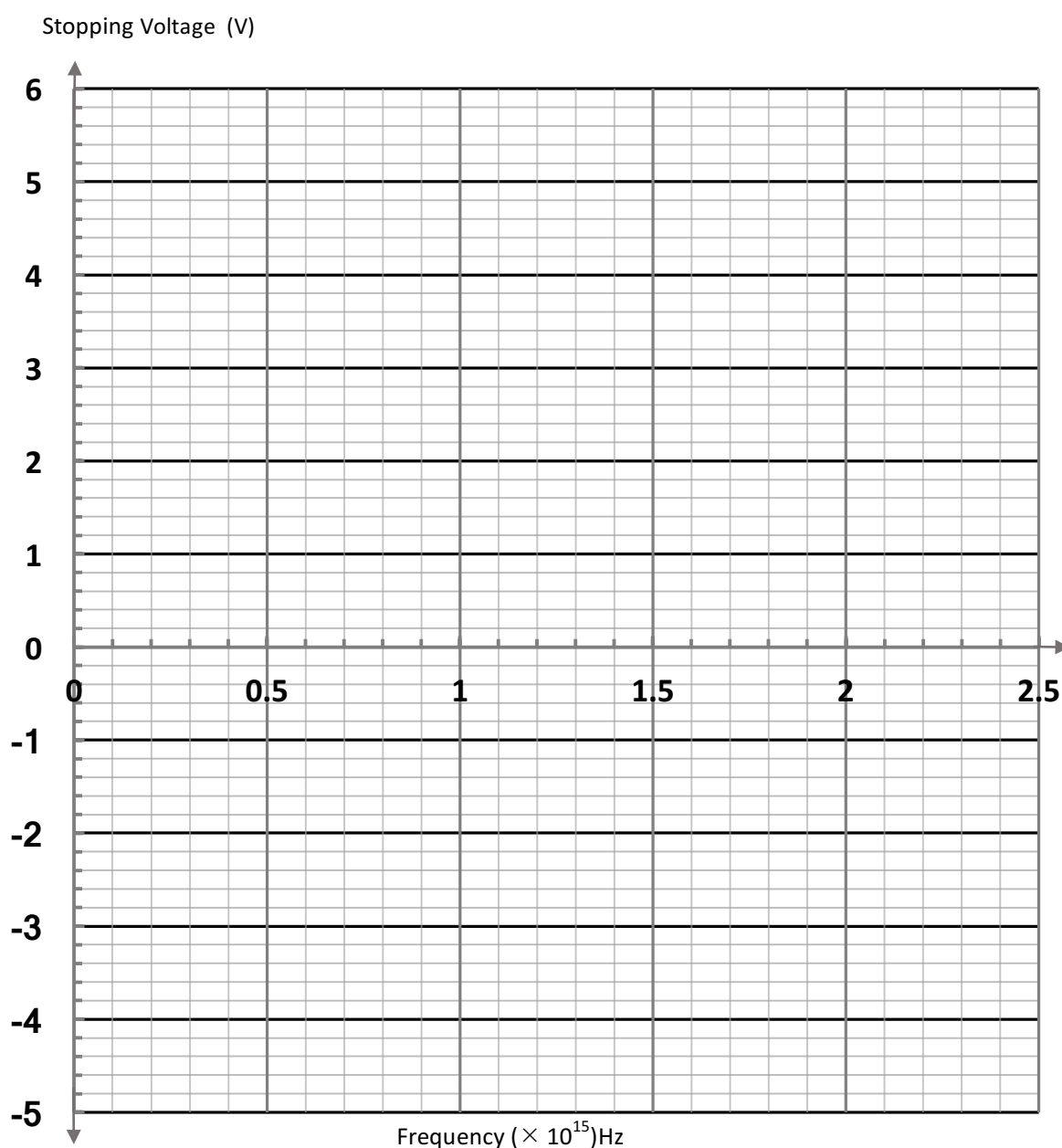
Question 8 (8 marks)

Kelly and Matt are investigating the photoelectric effect using aluminium as their metal cathode. They have tabulated their results including their precision below.

Stopping Voltage ± 0.1 volts	Frequency ($\times 10^{15}$) ± 0.1 ($\times 10^{15}$) Hz
0.2	1.0
2.5	1.6
4.4	2.0
5.7	2.4

- a. Plot the data on the axes provided. Include error bars.

2 marks



- b.** Calculate the value of Planck's constant that this data provides and determine the precision of your answer. 3 marks

$\pm$	eVs
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- c.** Give evidence that the photoelectric effect supports a particle model for light and not a wave model. 3 marks

Question 9 (9 marks)

The energy levels of a mercury atom are shown in Figure 9.

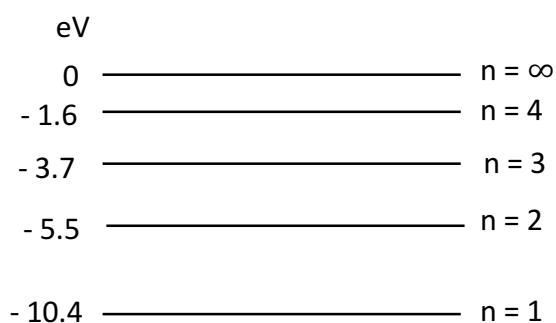


Figure 9

- a. What is the shortest wavelength of light emitted when an electron de-excites from $n = 3$ to $n = 1$? 2 marks

nm

- b. How many different energy photons are possible if an excited electron drops back to the ground state from $n = 4$? 1 mark

- c. Explain what occurs in a mercury atom if a ground state electron absorbs a photon possessing 1.68×10^{-18} J energy. 3 marks

- d.** Use wave particle duality to justify the existence of discrete electron energy levels found in atoms. 3 marks

Question 10 (5 marks)

Two monochromatic lasers one red ($\lambda = 650 \text{ nm}$) and one green ($\lambda = 510 \text{ nm}$) direct parallel beams of light toward a horizontal line marked on a thick rectangular prism of perspex ($n_{\text{red}} = 1.50$, $n_{\text{green}} = 1.58$) at an angle of 60° as shown in Figure 10. ($n_{\text{air}} = 1.00$)

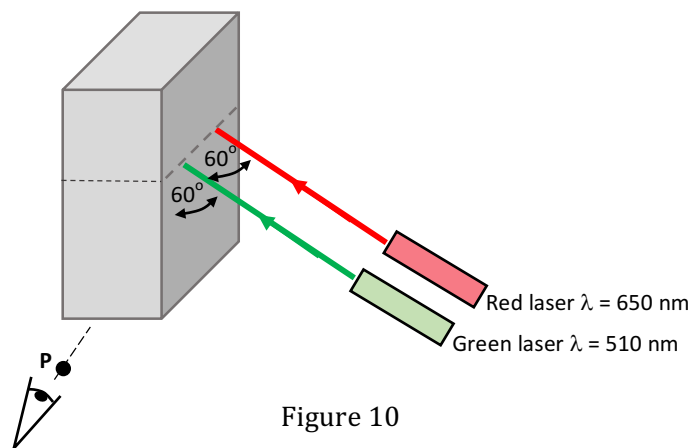


Figure 10

- a. Determine the angle between the red and green light beams as they exit the perspex. 2 marks

°

- b. On Figure 11 below, sketch the path of both light rays as they travel **through** the perspex as viewed from point P in Figure 10. Calculate the angle of refraction for each light beam. It is not necessary to draw the beams exiting the Perspex. 3 marks

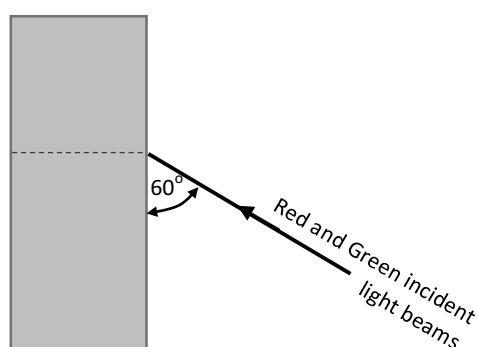


Figure 11

$\theta_{r_{\text{Red}}} =$ °

$\theta_{r_{\text{Green}}} =$ °

Question 11 (7 marks)

A laser ($\lambda = 620 \text{ nm}$) is directed at two parallel slits separated by 0.40 mm . the resultant pattern is displayed on a screen located 0.80 m behind the slits.

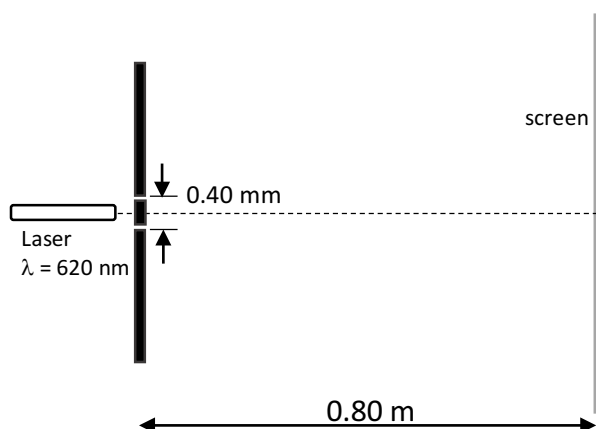


Figure 12

- a. Calculate the distance from the middle of the central maxima to the middle of the 3rd dark band on the screen. 3 marks

mm

The laser is replaced with a beam of 2 keV electrons and the screen replaced with a detector array.

- b. Describe the pattern produced by the electrons. Use calculations to support your answer. 4 marks

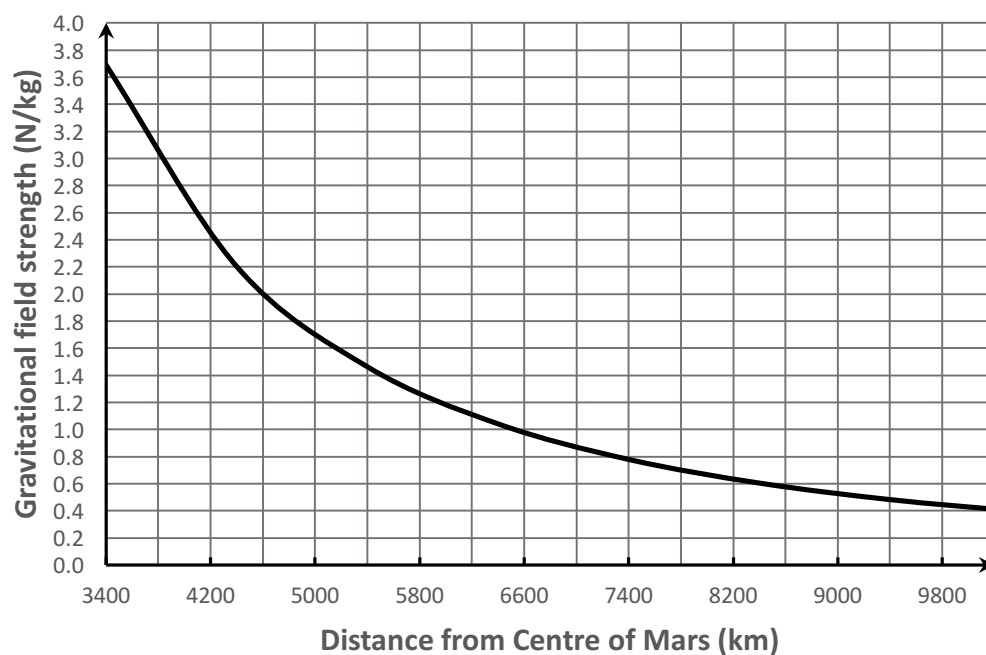
Question 12 (5 marks)

Phobos is one of Mars' many moons. It orbits Mars at a radius of 9400 km.

- a.** Show that the gravitational field strength due to Mars at a radius of 9400 km is close to 0.5 N kg^{-1} . 2 marks

($m_{\text{Mars}} = 6.4 \times 10^{23} \text{ kg}$, $m_{\text{Phobos}} = 1.07 \times 10^{16} \text{ kg}$, $R_{\text{Mars}} = 3400 \text{ km}$)

The graph below shows the variation in gravitation field strength with distance from the centre of Mars.



- b.** At what speed would a 2 kg meteor collide with the surface of Mars if it was travelling directly towards Mars at a speed of 3 m s^{-1} when it crossed the orbit of Phobos? 3 marks

m s^{-1}

Question 13 (8 marks)

A 60 kg cyclist rides at a constant speed of 72 km h^{-1} around a velodrome. The bends are circular with a radius of 20 m and slope at θ° to the horizontal. Figure 13 shows the cyclist when she is half way around the bend.

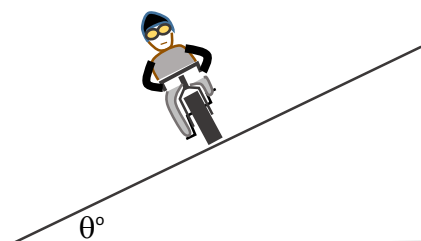


Figure 13

- a. Find the magnitude of net force acting on the cyclist when she is half way around the bend. 3marks

- b. On Figure 13 draw in and label all the forces acting on the cyclist at this time. 2 marks

- c. Calculate the angle of the track θ to one decimal place. 3 marks

Question 14 (7 marks)

Figure 14 shows a solenoid attached to a 12 V battery. The solenoid produces a 1.00 mT magnetic field at point **P**. Near the solenoid is a bar magnet that produces a 1.73 mT magnetic field at point **P**.

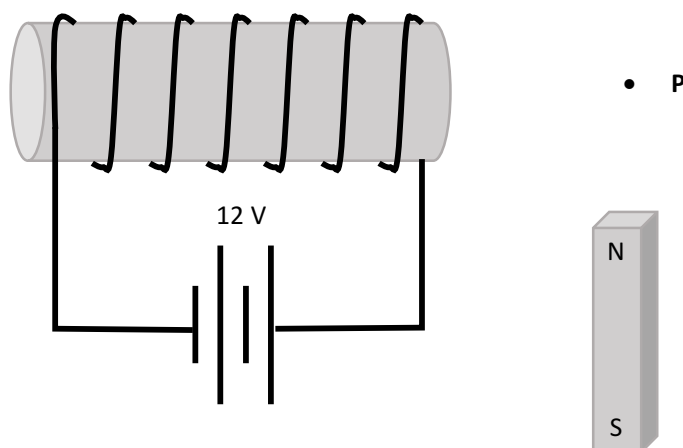


Figure 14

- a. On Figure 14 draw four magnetic field lines about the solenoid. 2 marks
- b. Calculate the strength of the magnetic at point **P** to 2 decimal places. 2 marks

	mT
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- c. Determine the direction of the magnetic field at point **P**. 2 marks
- d. Draw an arrow through **P** on Figure 14 to show the direction of the magnetic field at this point. 1 mark

Question 15 (6 marks)

An electron travelling at $0.9c$ is approaching a target crystal located 2.400 m away when a timer starts recording.

- a. What distance is the target from the electron at this time in the electron's frame of reference? Give your answer to 3 decimal places. 2marks

 m

- b. How much time in nanoseconds will elapse according to the timer? 2 marks

 ns

- c. How much kinetic energy does the electron possess just before it reaches the crystal? Give your answer to 2 decimal places. 2 marks

 J