ACCESS EDUCATION

Access Education

NAME:

PHYSICS
Unit 3 & 4
Trial examination 2017

Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	15	15	110
		Total	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 Uncertainity 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. Changingthe type of salt crystal used as the target.
D. Increasing the intensity of the electron beam.

The following information applies to Questions 4 to 7

A set of 50.0 (± 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.

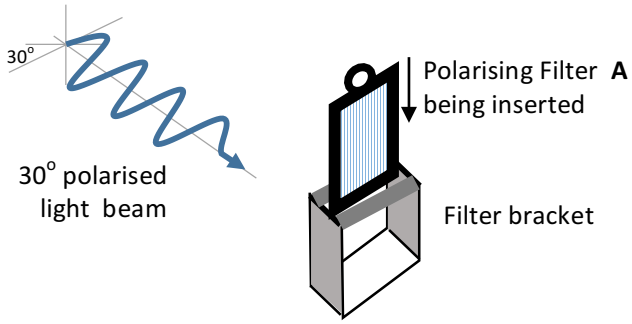
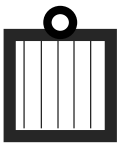
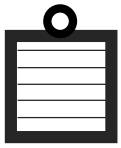
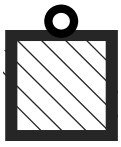
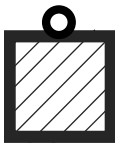


Figure 1

The filter that will allow the greatest amountof light through is:

A. 
B. 
C. 
D. 

Question 9

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

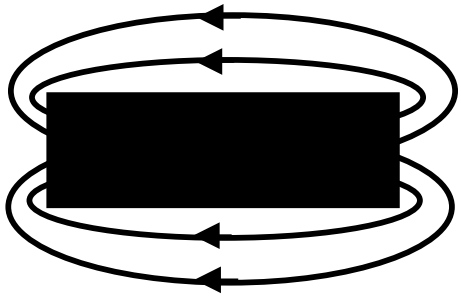


Figure 2

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^{o} 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.

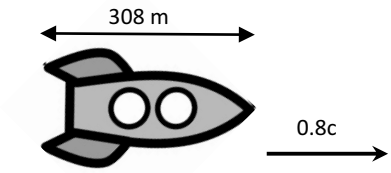


Figure 3

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 4×10^{-3} m from an oxygen ion (O^{2-}). The force the electron exerts on the oxygen ion is:

A. 2.9×10^{-23} N
B. 2.7×10^{-4} N
C. 1.8×10^{-4} N
D. 9.0×10^{-5} N

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 e V

Question 16

The phenomenom 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

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?

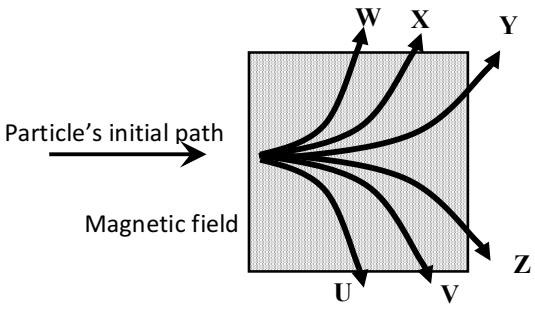


Figure 4

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^{o} C, one in a freezer at -7^{o} C, one in a incubator at 60^{o} C and leave the last one in a room thermostatically controlled to remain at 24^{o} C. After 6 hours they meaure 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 2kg 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 1.5m then slopes upward at 30° to the horizontal as shown in Figure 1.

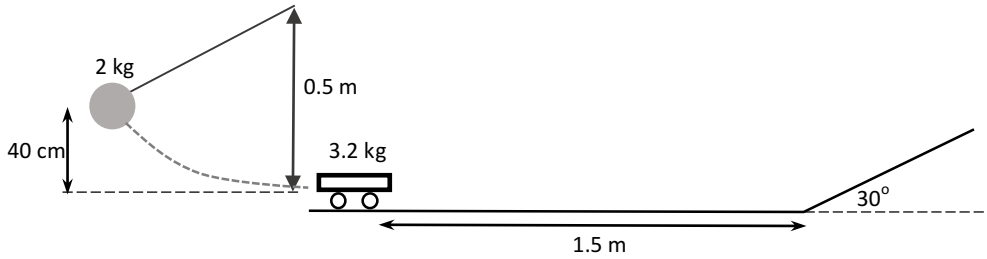


Figure 1

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

2 marks

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

N

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

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

N

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.

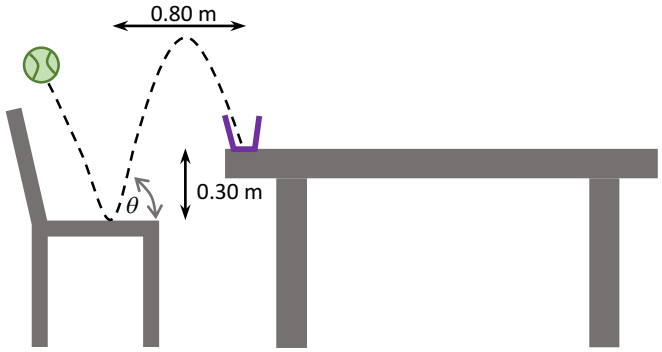


Figure 2

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

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.

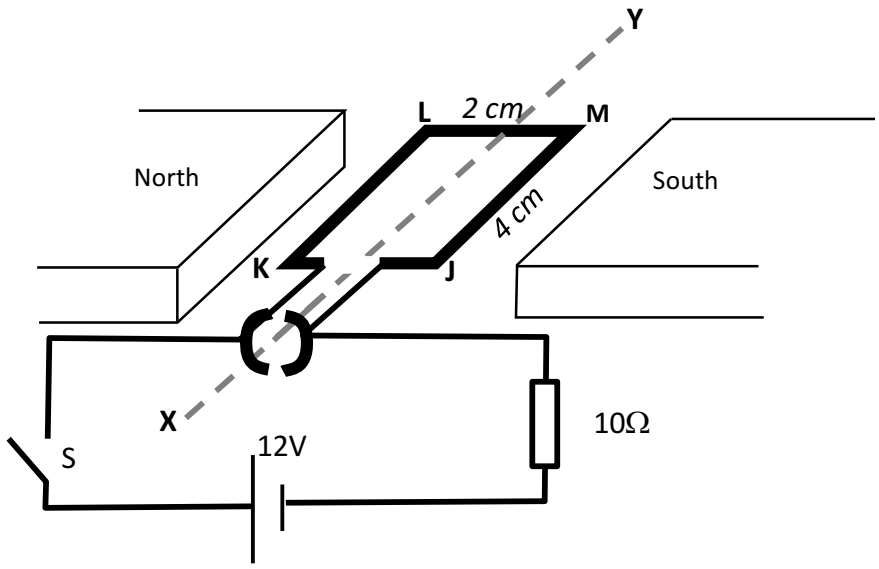


Figure 3

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

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 4×4 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 4.6×10^6 m s^{-1}.

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

V

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

T

Direction:

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

nm

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).

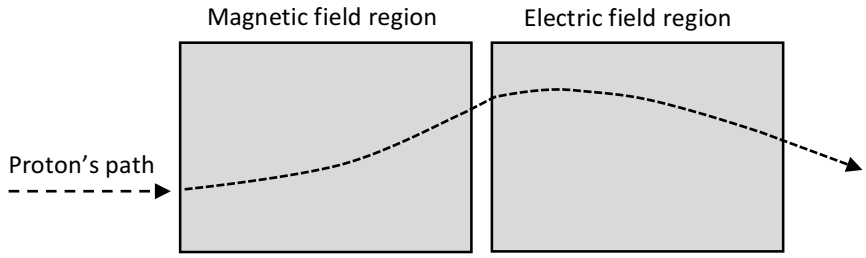


Figure 4

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.

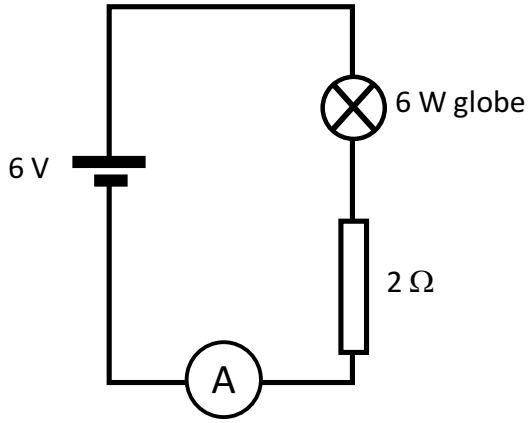


Figure 5

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.

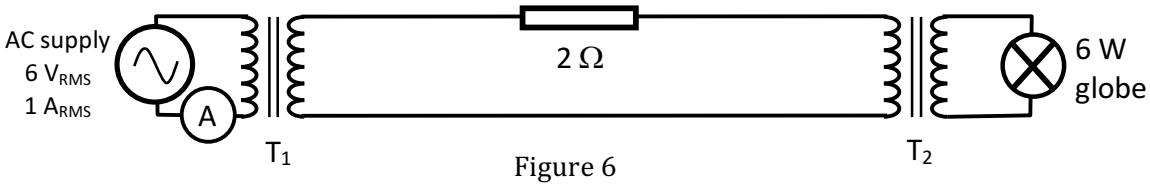


Figure 6

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	

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.

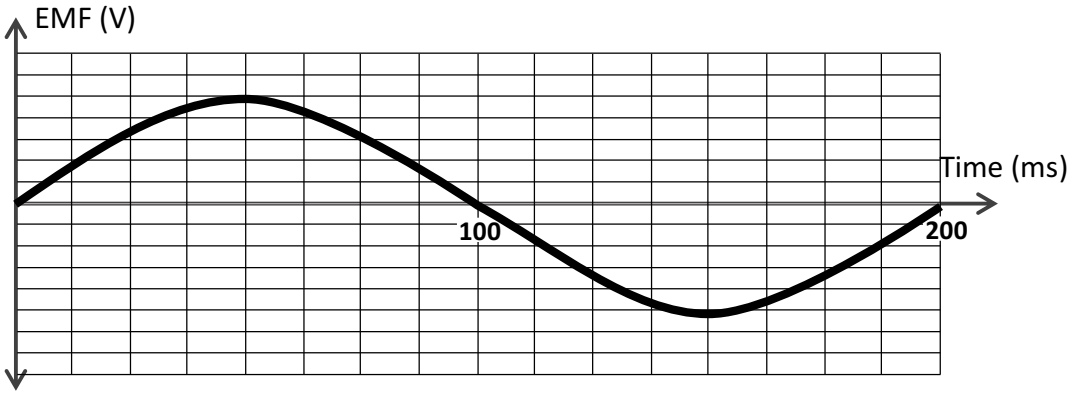


Figure 7

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

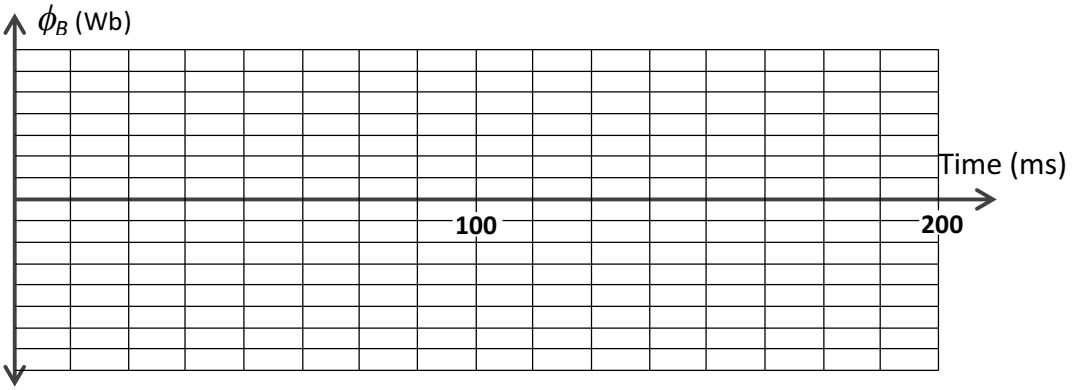


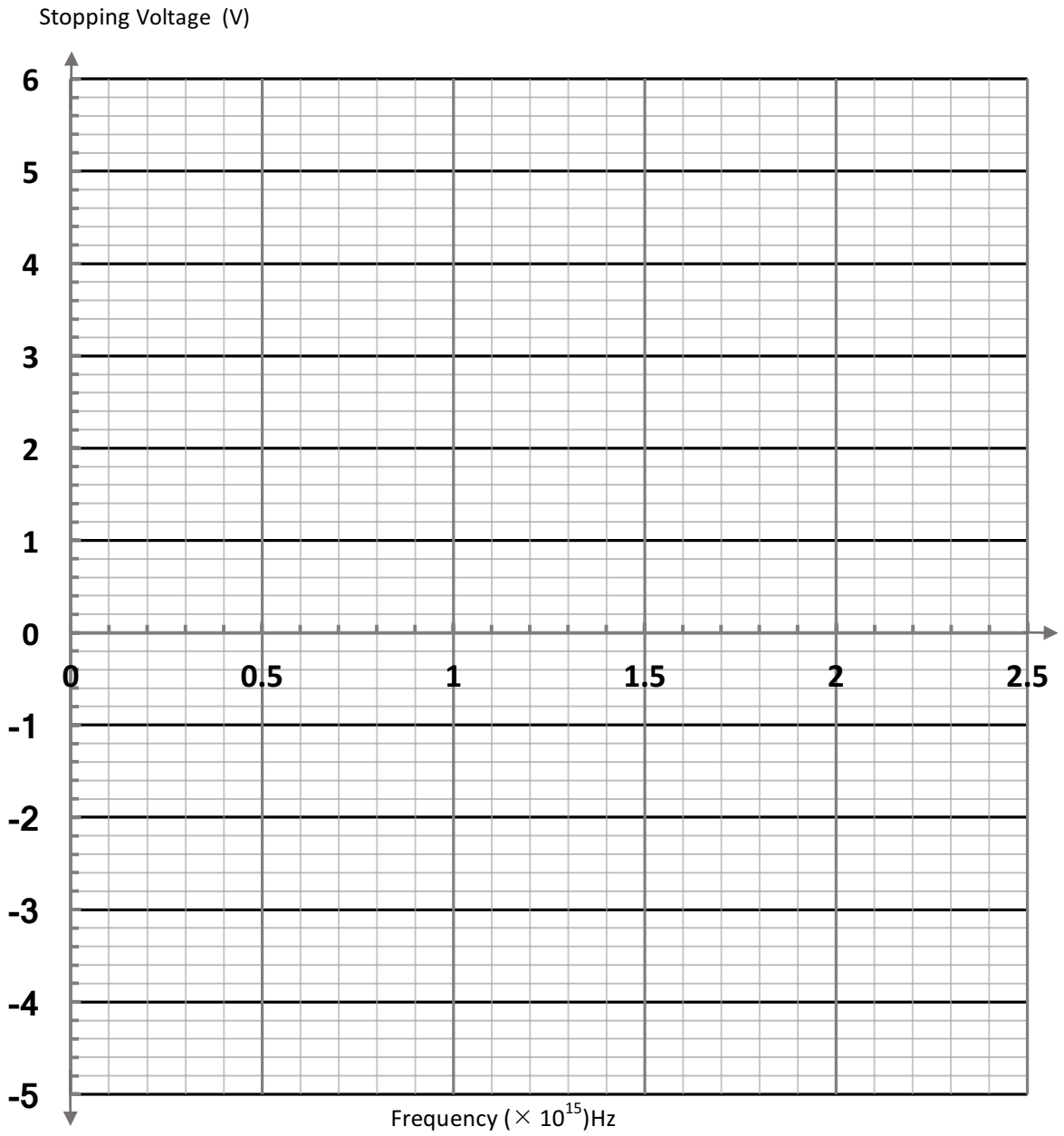
Figure 8

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

±	eVs

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.

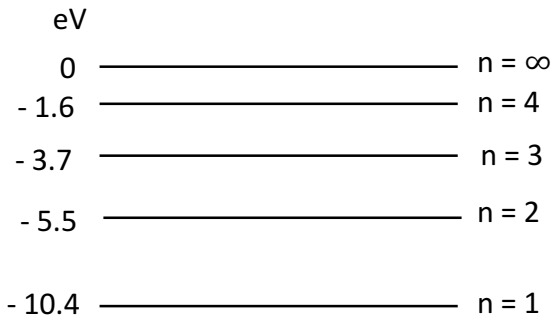


Figure 9

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

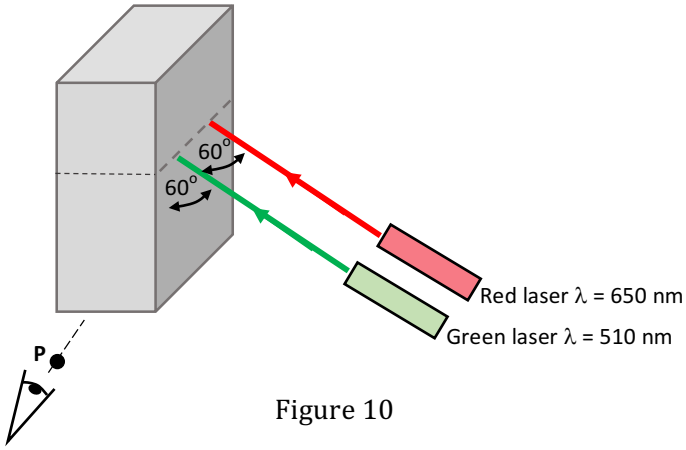


Figure 10

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

o

b. On Figure 11 below, sketch the path of both light rays as they travel **through** the perpex 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

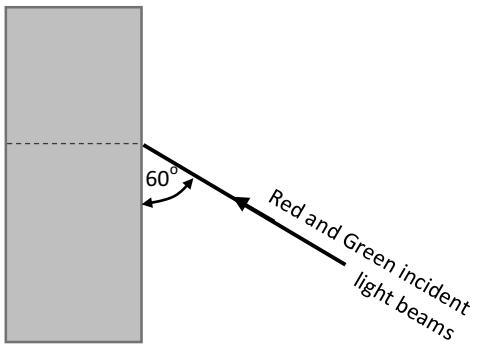


Figure 11

θr_{Red} = o

θr_{Green} = o

Question 11 (7 marks)

A laser (λ = 620 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.

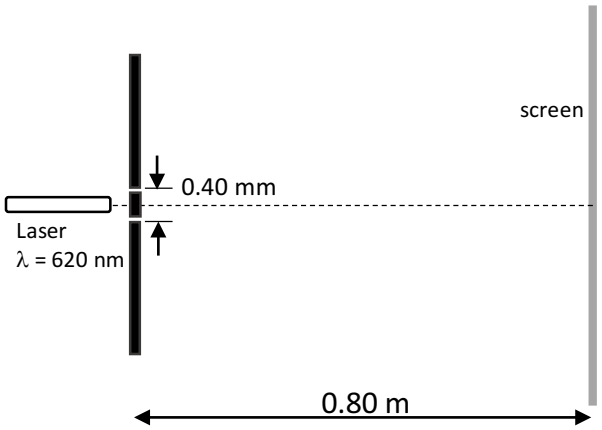


Figure 12

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

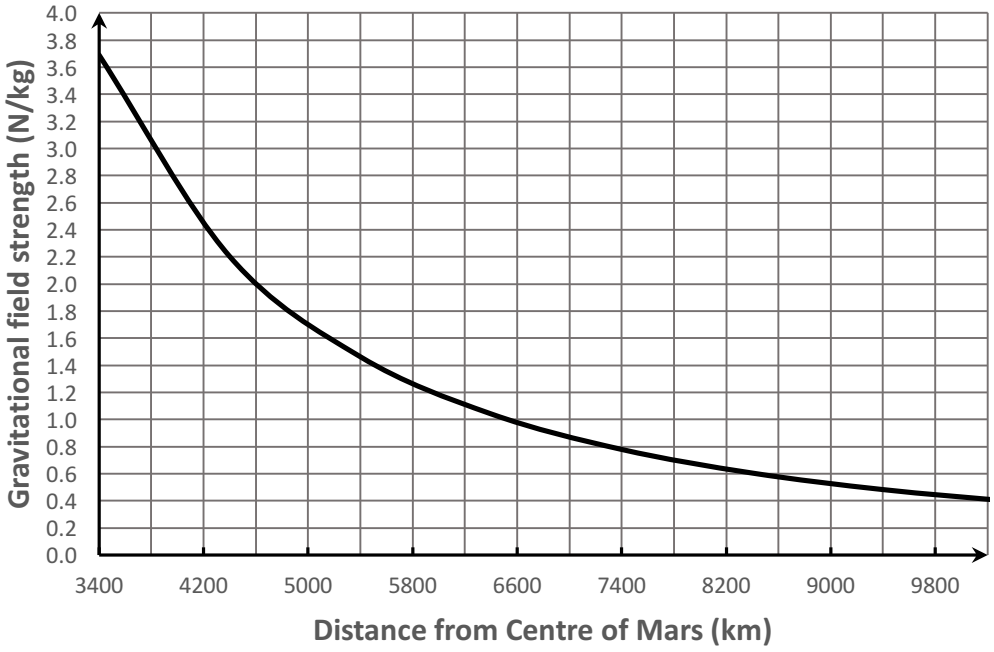
Question 12 (5 marks)

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

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

(m_{Mars} = 6.4 × 10^{23} kg, m_{Phobos} = 1.07 × 10^{16} kg, R_{Mars} = 3400 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^o to the horizontal. Figure 13 shows the cyclist when she is half way around the bend.

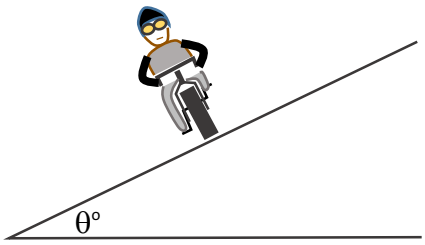


Figure 13

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

N

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**.

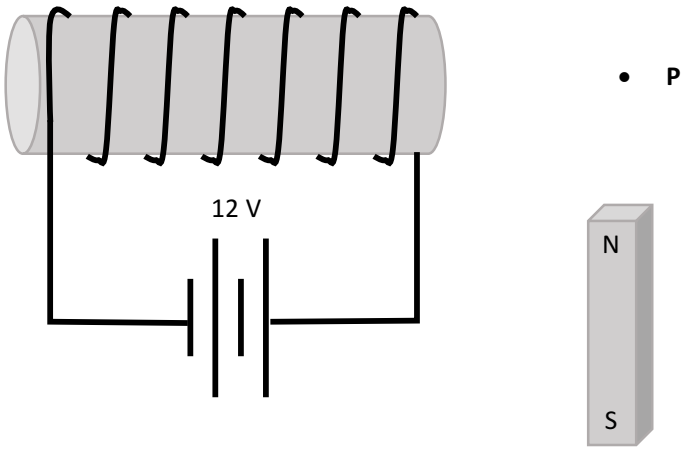


Figure 14

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

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