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YEAR 12 *Trial Exam Paper*

2022

PHYSICS

Written examination

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	20	20	110
			Total 130

- Students are permitted to bring the following items into the examination: 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 sheets of blank paper or correction fluid/tape into the examination.

Materials provided

- Question and answer book of 47 pages
- Formula sheet
- Answer sheet for multiple-choice questions

Instructions

- Write your **name** in the space provided above on this page, and on the answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- You must answer all questions 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 unauthorised electronic device into the examination.

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.

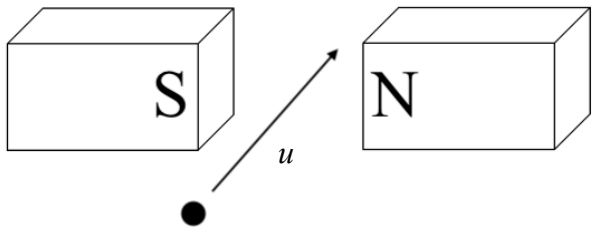
No marks will be given if more than one answer is completed for any question.

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

A positron travelling at a constant speed, u, enters a uniform magnetic field that is perpendicular to its direction of travel, as shown in the diagram below.



positron

Which one of the following options correctly describes the change in the positron's speed and direction as it enters the uniform magnetic field?

	Speed	Direction
A.	remains the same	remains the same
B.	increases	changes
C.	increases	remains the same
D.	remains the same	changes

Question 2

Alison and Virgil are measuring the period of a simple pendulum for five different pendulum lengths. They would like to improve their measurements by achieving:

I higher accuracy

II higher precision

III lower random error

For each pendulum length, they repeated their measurement twice using the same experimental set-up.

If Alison and Virgil repeated their measurements, which of these improvements could be achieved?

A. I only

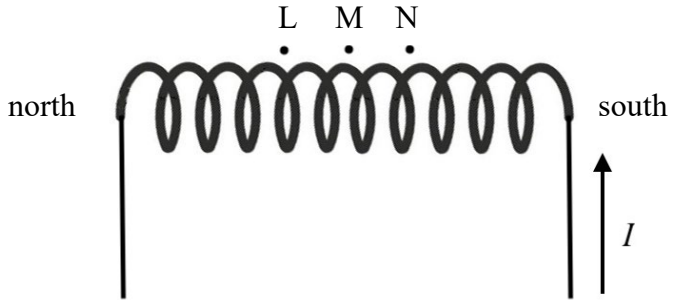
B. I and II only

C. I and III only

D. III only

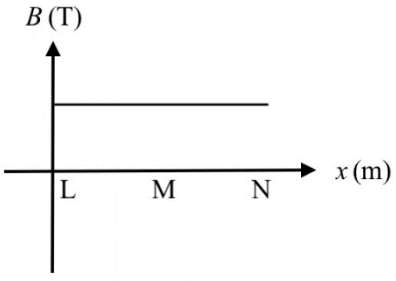
Question 3

The diagram below shows a solenoid with a constant current and with the north pole on the left. L, M and N represent different positions along the top of the solenoid, with M being the midpoint of the length of the solenoid.

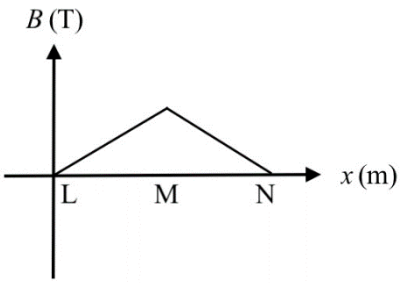


Which one of the following graphs best represents the magnetic field strength, B, of the solenoid versus the position, x, along the top of the solenoid?

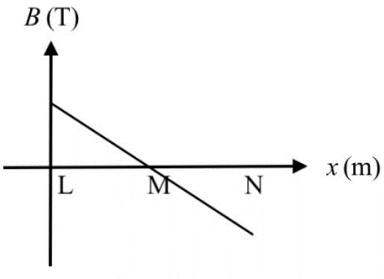
A.



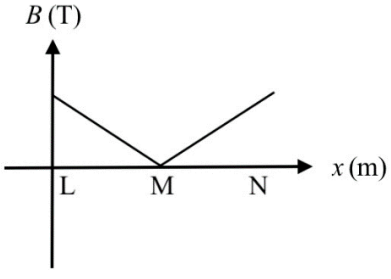
B.



C.



D.



Question 4

Acceleration due to gravity near the surface of Earth, at a distance of 6.37×10^{6} m from its centre, is 9.8 m s^{-2}.

Which one of the following is closest to the altitude at which the acceleration due to gravity is 4.9 m s^{-2}?

A. 2.6×10^{6} m

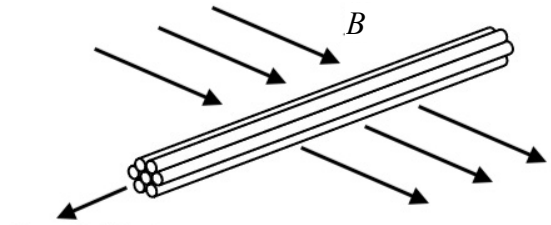
B. 9.0×10^{6} m

C. 1.3×10^{7} m

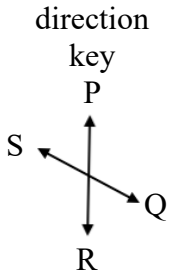
D. 8.1×10^{13} m

Use the following information to answer Questions 5 and 6.

A bundle of 7 straight conductors, each carrying a current of 0.50 A, is placed within a uniform magnetic field, *B*, such that the magnetic field is perpendicular to the direction of the current. The section of the bundle that is entirely within the magnetic field is 0.35 m long. The bundle of wires experiences a magnetic force of 7.3 mN.



l = 0.50 A
in each conductor



Question 5

What is the strength of the magnetic field?

A. 6.0 T

B. 6.0×10^{-3} T

C. 9.0 T

D. 9.0×10^{-3} T

Question 6

Using the direction key provided, what is the direction of the magnetic force on the bundle?

A. P

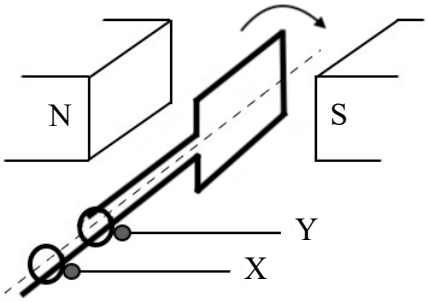
B. Q

C. R

D. S

Question 7

Fab and Ibou are experimenting with a model electric generator. The coil is rotating in the clockwise direction, represented by the arrow in the diagram. At the time shown, the coil is in the vertical position.



Which one of the following options correctly describes the magnitude of the magnetic flux and the rate of change through the loop when the loop is in the vertical position?

	Magnetic flux	Rate of change of magnetic flux
A.	minimum magnitude	minimum magnitude
B.	minimum magnitude	maximum magnitude
C.	maximum magnitude	maximum magnitude
D.	maximum magnitude	minimum magnitude

Question 8

A power tool battery charger is connected to a mains power outlet that supplies electricity at 230 V AC. The current drawn is 0.85 A. The charger uses a transformer to step down the voltage to 20 V. Assuming that there is no loss of power through the transformer, and that all values are RMS, what is the output current?

A. 4.3 A

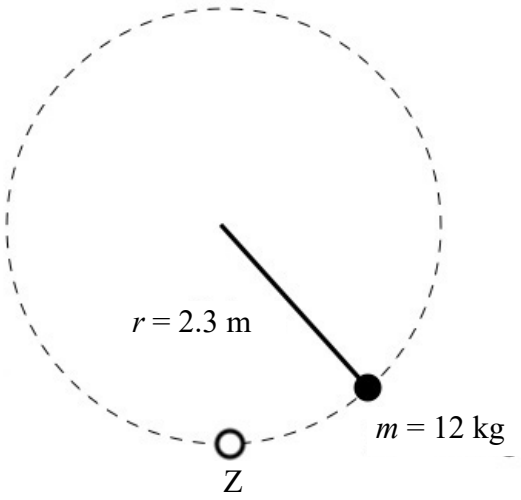
B. 9.8 A

C. 17 A

D. 20 A

Use the following information to answer Questions 9 and 10.

A 12 kg ball is attached to a length of rope. The ball is swung in a vertical circle with a radius of 2.3 m at a rate of 3 revolutions per second, as shown in the diagram below.



Question 9

At the lowest point of its circular path, indicated by Z, what is the tension in the rope?

A. 1.9 kN

B. 4.3 kN

C. 9.8 kN

D. 9.9 kN

Question 10

The rope will break if the tension in it increases.

Which one of the following actions will prevent the rope from breaking?

A. increasing the mass of the ball

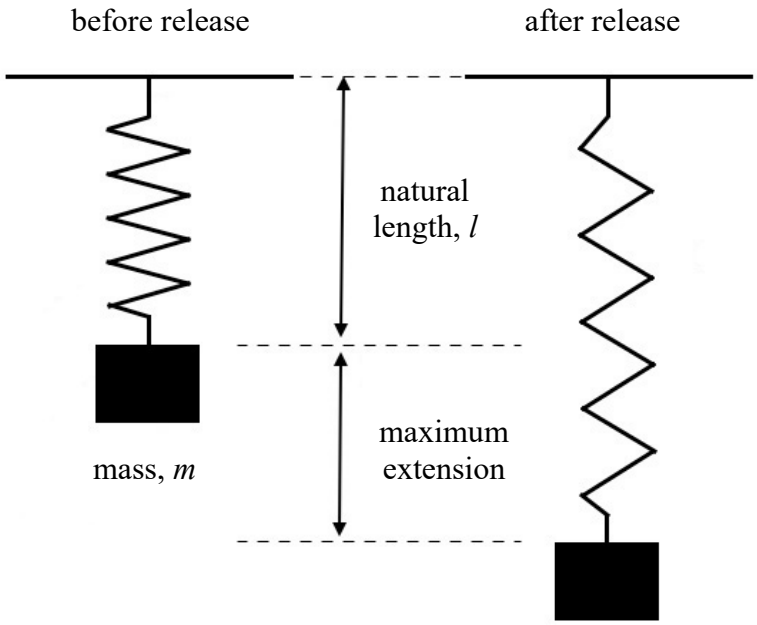
B. increasing the radius of the rotation (with the rate of rotation remaining the same)

C. decreasing the radius of the rotation (with the rate of rotation remaining the same)

D. increasing the rate of rotation

Question 11

A mass, m, is attached to a spring of natural length, l. The mass is initially supported so that the spring is not stretched. The mass is allowed to fall under gravity and the spring reaches its maximum extension, shown below, just before it moves up again.



Ignoring air resistance, which one of the following statements is correct?

A. The total mechanical energy of the mass remains the same.

B. The gravitational potential energy of the mass is maximum when the spring is at maximum extension.

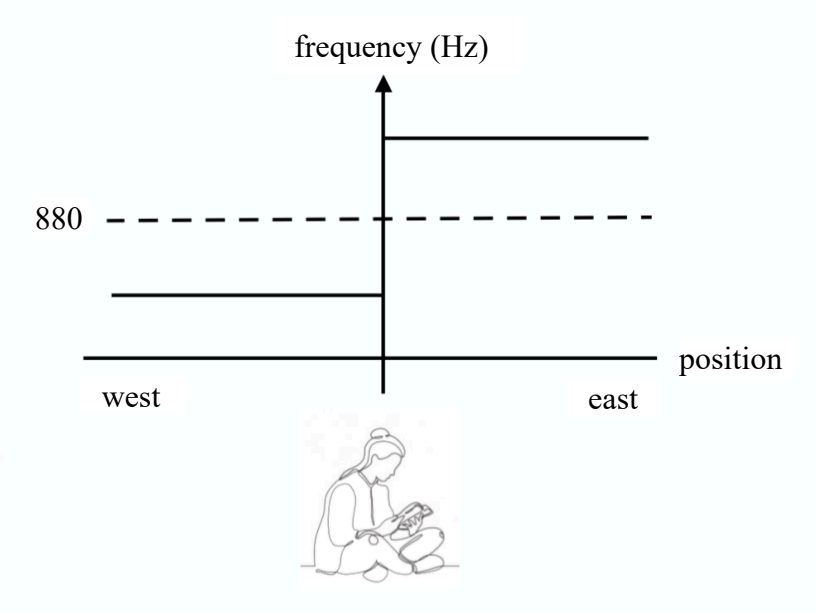
C. The elastic potential energy of the spring is maximum at the point of release.

D. The total mechanical energy of the system remains the same.

Question 12

Mina is reading her physics textbook in a park. An ambulance is passing by with its siren sounding. The frequency of the siren when stationary is 880 Hz.

The diagram below shows the frequency of the siren as heard by Mina as its position changes relative to Mina.



Based on the diagram above, what can be concluded about the motion of the ambulance?

A. It is travelling at a constant speed from west to east.

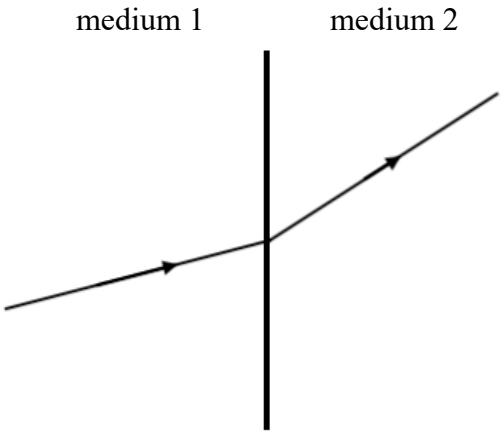
B. It is travelling at a constant speed from east to west.

C. It is accelerating from west to east.

D. It is accelerating from east to west.

Question 13

A laser beam is observed to refract as it passes from medium 1 into medium 2, as shown in the diagram below.

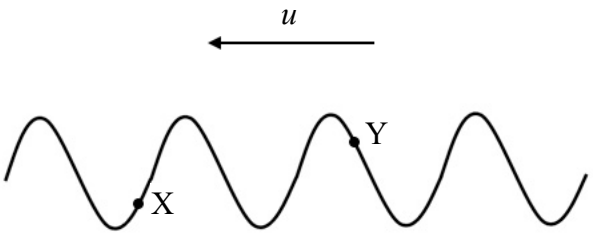


Which one of the following correctly describes the angle of refraction compared to the angle of incidence, and the change in the index of refraction between medium 1 and medium 2?

	Angle of refraction	Change in index of refraction
A.	greater	increase
B.	greater	decrease
C.	smaller	decrease
D.	smaller	increase

Question 14

A wave is travelling to the left at speed u, as shown in the diagram below.



Which one of the following best describes the motion of the points labelled X and Y on the wave?

A. both points are rising

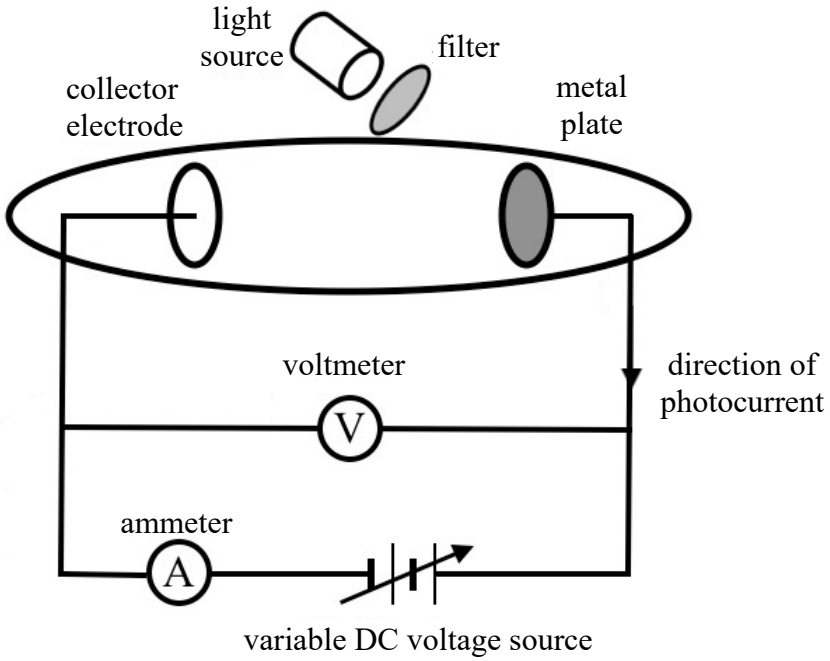
B. X is rising and Y is falling

C. both points are falling

D. X is falling and Y is rising

Use the following information to answer Questions 15 and 16.

The diagram below shows a set-up used to study the photoelectric effect. Light shining on the metal plate contributes to the kinetic energy of the electrons in the metal and produces a photocurrent that flows in the direction shown. An ammeter measures the photocurrent.



The variable DC voltage source is set so that the photocurrent reduces to zero. The stopping voltage, V_{stop}, is then read off the voltmeter.

Question 15

Which one of the following statements best explains why the photocurrent falls to zero at V_{stop}?

A. The intensity of the light source is too low, resulting in photoelectrons with less kinetic energy.

B. The DC voltage is increased until the work done on each photoelectron equals the maximum kinetic energy needed to reduce the photocurrent to zero

C. The DC voltage is reduced until the work done on each photoelectron equals the maximum kinetic energy needed to reduce the photocurrent to zero

D. The metal plate needs to be exposed to light for a longer time for the kinetic energy of the photoelectrons to be sufficient for them to be emitted again.

Question 16

Kellie and Hera carried out a series of measurements. For a certain frequency of light, they measured the threshold frequency to be 6.5×10^{14} Hz and the work function to be 3.4×10^{-19} J.

Using these measurements, what value would they calculate for Planck's constant?

A. 4.2×10^{-34} J s

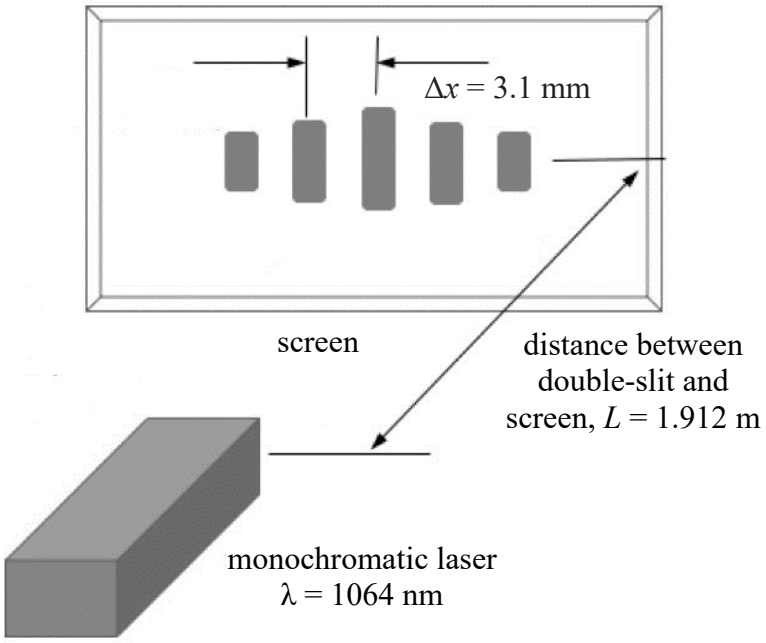
B. 5.2×10^{-34} J s

C. 6.2×10^{-34} J s

D. 6.6×10^{-34} J s

Use the following information to answer Questions 17 and 18.

Bobbi is carrying out a double-slit interference experiment using a monochromatic laser that has a wavelength of 1064 nm. She projects the interference pattern onto a screen. The distance from the slits to the screen is 1.912 m, and the distance between the central maximum and the first maximum is 3.1 mm. This is shown in the diagram below.



Question 17

Given the information provided, what is the slit separation, *d*?

A. 6.56 µm

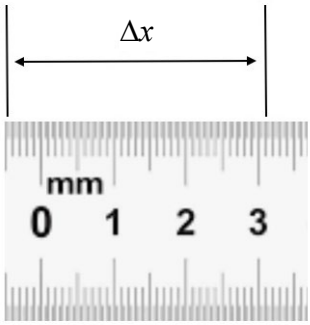
B. 65.6 µm

C. 656 µm

D. 6.56 mm

Question 18

Bobbi measures the fringe spacing, Δx, with a ruler and estimates Δx to be 3.1 mm, as shown in the diagram below.



Which one of the following options indicates the type of error, and the amount of error, in the measurement of Δx?

A. random error, overestimated by 0.5 mm

B. random error, underestimated by 0.5 mm

C. observer error, overestimated by 0.5 mm

D. observer error, underestimated by 0.5 mm

Question 19

A subatomic particle known as a kaon is travelling at a velocity of $0.697c$.

The Lorentz factor, correct to 3 significant figures, for this kaon is closest to

A. 1.39

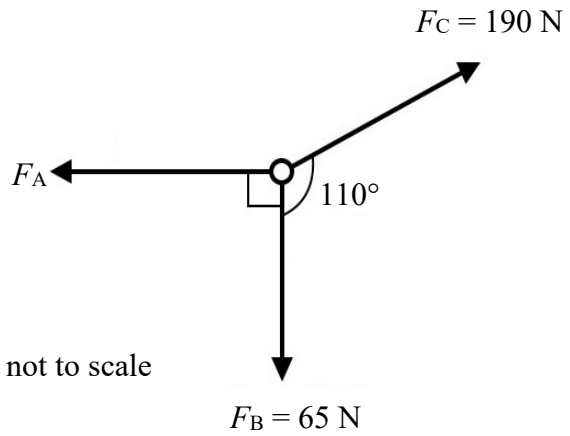
B. 1.390

C. 1.394

D. 1.40

Question 20

A circular ring is pulled by three forces: unknown force F_A horizontally to the west, F_B = 65 N to the south, and F_C = 190 N at an angle of 110° to F_B, as shown in the diagram below.



The net force on the ring is 0 N. The effects of the size of the ring and friction may be considered negligible.

What is the magnitude of the force, F_A?

A. 61 N

B. 69 N

C. 130 N

D. 179 N

END OF SECTION A

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.

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.

For 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 (5 marks)

Two point charges, q_1 and q_2, are placed 1 m apart, as shown in Figure 1. Both charges are positive, with q_1 = 2.5 mC and q_2 = 5.0 mC.

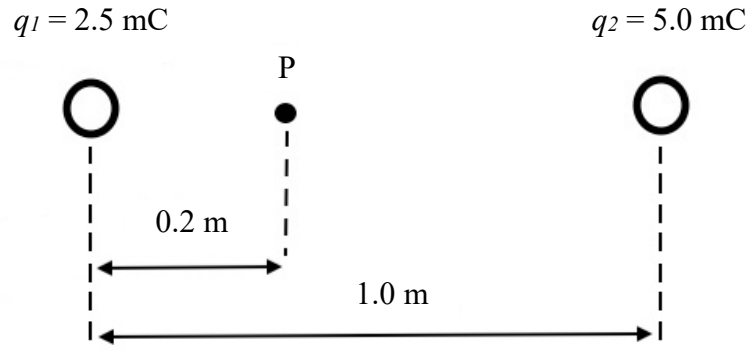


Figure 1

Point P is located 0.2 m to the right of q_1.

a. Calculate the electric field strength at point P due to q_1. Show your working.

2 marks

N C^{-1}

b. **i.** Calculate the magnitude of the force on q_1 due to q_2. Show your working.

2 marks

N

ii. Sketch an arrow on Figure 1 at q_1 to indicate the direction of the force.

1 mark

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Question 2 (3 marks)

A lunar orbiter maintains a position directly above a base located at the equator of the Moon. It orbits above the equator of the Moon, and its orbital period matches the period of the Moon's rotation on its axis.

The mass of the Moon is 7.35×10^{22} kg, and the period of its rotation on its axis is 2.36×10^{6} s.

Calculate the orbital radius of the lunar orbiter. Show your working.

3 marks

m

Question 3 (7 marks)

In a factory, a conveyor belt is used to transport boxes and deposit them into a chute. The entrance to the chute is a hole in the floor. As the boxes leave the end of the conveyor belt, they undergo projectile motion.

The mass of each box is 1.5 kg, and they travel at a constant speed, u, on the conveyor belt. The height of the conveyor belt from the floor is 1.4 m, and the horizontal distance between the end of the conveyor belt to the entrance of the chute is also 1.4 m. This is shown in Figure 2. Ignore air resistance.

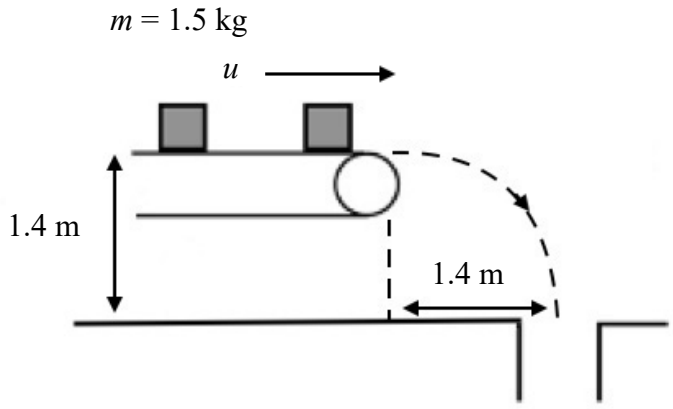


Figure 2

a. Show that the time taken for each box to reach the entrance of the chute from the end of the belt is 0.53 s. Show your working.

2 marks

b. Calculate the speed at which the boxes are travelling on the conveyor belt.

2 marks

m s^{-1}

c. The mass of each box is doubled to 3.0 kg.

i. How should the speed of the conveyor belt be altered so that the boxes follow the same trajectory and fall into the chute? Circle the correct answer.

1 mark

increase speed decrease speed keep speed the same

ii. Using physics principles, explain the reason for your choice.

2 marks

_____

_____

_____

_____

Question 4 (5 marks)

Jota and Keita are window washers working on tall city buildings in Melbourne. Their work platform is suspended by two cables from the top of the building they work on.

A bucket of cleaning detergent with a mass of 37.0 kg is placed on the platform while they are on it, as shown in Figure 3. The platform is initially stationary.

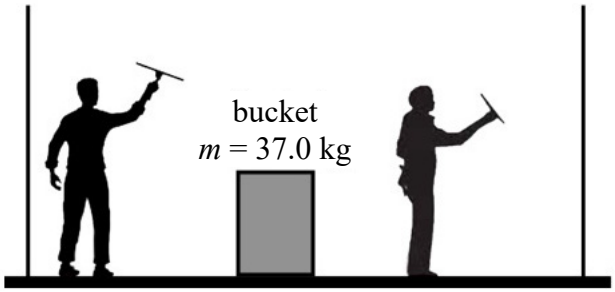


Figure 3

a. Calculate the magnitude of the force on the bucket by the platform, $F_{\text{on bucket by platform}}$.
Show your working. Give your answer correct to three significant figures.

2 marks

N

b. The platform, together with Jota, Keita and the bucket, is lowered down the side of the building. They initially accelerate downwards at 1.5 m s^{-2}.

i. What happens to the force on the bucket by the platform, $F_{\text{on bucket by platform}}$, during the acceleration? Circle the correct answer.

1 mark

force increases force decreases force stays the same

ii. Using physics principles, explain the reason for your choice. You may use a diagram in your answer.

2 marks

Question 5 (4 marks)

Nat and Phil are experimenting with a model electric motor in a physics laboratory. The model is made up of a rectangular coil of a conductor with 20 turns, which is placed entirely inside a magnetic field, as shown in Figure 4. The coil is connected to a DC power supply via a split-ring commutator. The DC power supply is initially off.

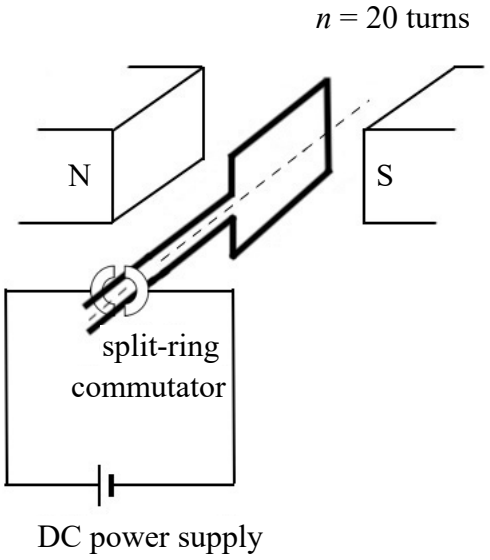


Figure 4

In an experiment, Nat and Phil position the coil vertically, as shown above. When they switch on the DC power supply, the coil does not turn. They switch off the power and reposition the coil horizontally. When they switch the power on again, the coil now turns as expected. This indicates that the electrical connections and the circuitry are not faulty.

a. Identify **two** possible reasons why the coil did not turn when it was in the vertical position when the power was switched on. You may use a diagram in your answer.

2 marks

In another experiment, Nat and Phil position the coil close to horizontally, as shown in Figure 5. The length of side PQ is 0.15 m. The DC power supply is switched on and the current flowing in the coil is 0.60 A. They measure the magnetic field strength to be uniformly 0.53 mT in the region of the coil.

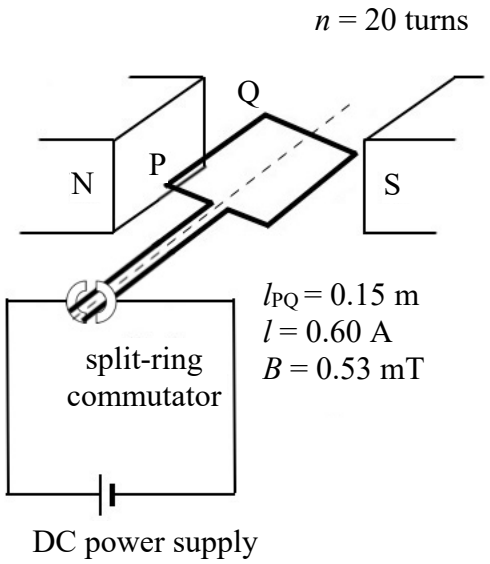


Figure 5

b. Determine the magnitude of the magnetic force on side PQ. Show your working.

2 marks

Question 6 (7 marks)

Trent and Roberta construct a small alternator, using a rectangular coil of wire placed entirely inside a uniform magnetic field, as shown in Figure 6.

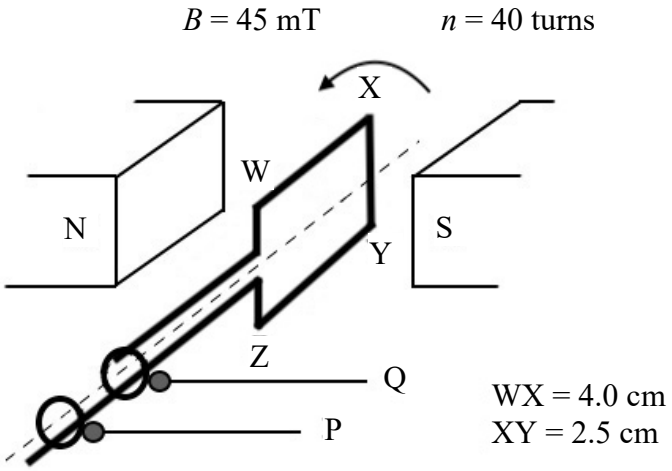


Figure 6

The magnetic field strength is 45 mT and the coil has 40 turns. The side labelled WX is 4.0 cm long and the side labelled XY is 2.5 cm long. The coil is connected to a pair of slip rings, which allow the electricity produced to flow through the terminals labelled P and Q.

Initially, the coil is stationary in the vertical position, as shown.

a. Calculate the initial magnetic flux through the coil. Show your working.

3 marks

Wb

Trent and Roberta rotate the coil in the anticlockwise direction, as indicated by the arrow in Figure 6. The frequency of rotation is 3 Hz.

b. Calculate the average EMF generated by each quarter turn of the coil. Show your working.

3 marks

_____

_____

_____

_____

_____

_____

	V

c. What is the direction of the current in the coil? Circle the correct answer.

1 mark

W to X X to W

Question 7 (8 marks)

A farmer in Nagambie has recently purchased a new farming property that has no electric power connected to it. She would like to connect the property to the grid power supply.

The grid power supply delivers 50 kW of power at a voltage of 11 kV AC. Assume that all readings are RMS.

The connection point at the boundary of the farm is 2 km from the buildings, and the total resistance of the transmission lines is 1.0 Ω.

The farming equipment and household appliances require 230 V AC.

The situation is shown in Figure 7a.

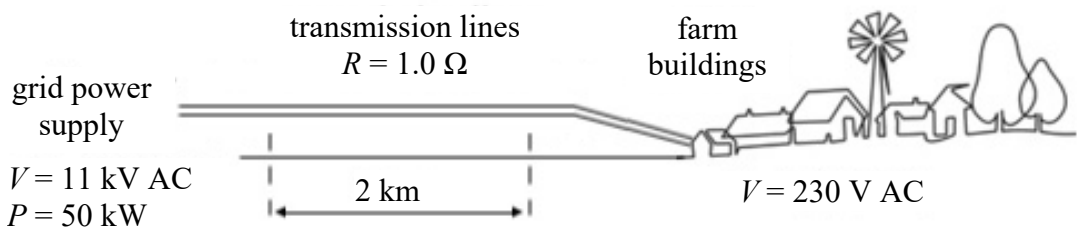


Figure 7a

a. What is the current of the grid power supply? Show your working.

2 marks

A

A transformer is required to reduce the voltage in the grid power supply from 11 kV AC to the required voltage of 230 V AC.

b. Calculate the ratio of the transformer windings, $N_{\text{primary}} : N_{\text{secondary}}$, to the nearest whole number ratio. Show your working.

2 marks

$N_{\text{primary}} : N_{\text{secondary}}$
:

There are two possible locations for the transformer: location A near the grid power supply and location B next to the farm buildings, as shown in Figure 7b. The location chosen must result in the least power loss.

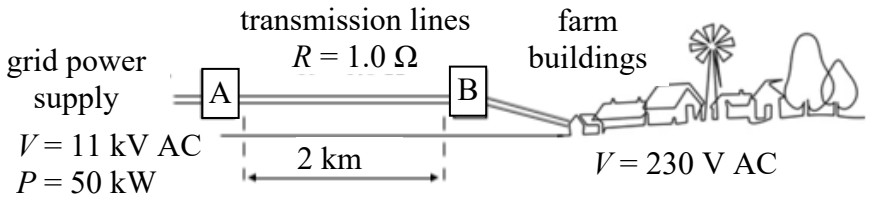


Figure 7b

c. At which location, A or B, should the transformer be positioned so as to result in the least power loss in the transmission lines? Use suitable calculations to support your answer.

4 marks

Question 8 (6 marks)

Roto-Launch is a company that aims to launch rockets into sub-orbital flights without using conventional rocket fuel.

The launch method places the rocket in uniform circular motion inside a vacuum chamber, so there is minimal air resistance, as shown in Figure 8. At the moment of launch, the rocket is released from the rotating arm and leaves the vacuum chamber vertically, punching through a cover.

The mass of the rocket is 295 kg. It will be rotated on an arm with a length of 24 m. The tangential speed of the rocket is 1.4 km s^{-1}.

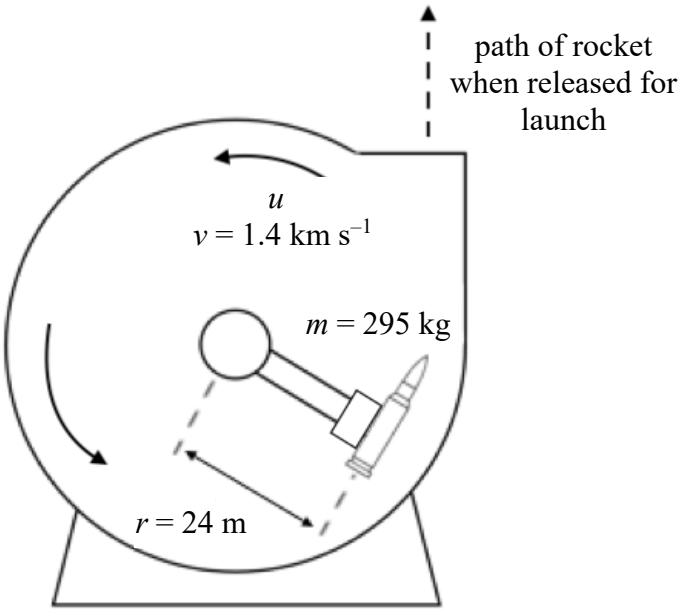


Figure 8

a. In order to reach the tangential speed of 1.4 km s^{-1}, determine the time taken to complete one revolution.

2 marks

s

b. Determine the frequency of the rocket in uniform circular motion, in revolutions per minute (RPM). Show your working.

2 marks

RPM

c. What is the centripetal force on the rocket just before it is released? Give your answer in MN.

2 marks

MN

Question 9 (9 marks)

A cricket ball with a mass of 0.16 kg is released from a height of 0.89 m above an uncompressed spring. At the lowest point of its fall, the ball compresses the spring by 0.17 m. This is shown in Figure 9 below. Ignore air resistance and friction.

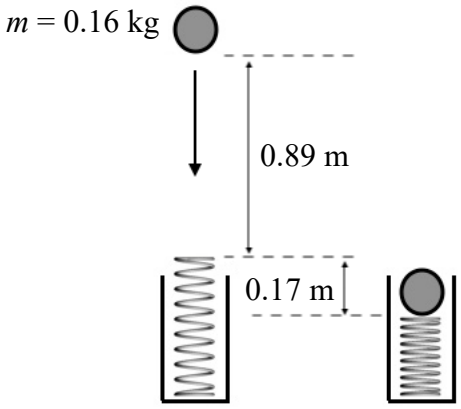


Figure 9

a. Show that the spring constant of the spring, k, is 115 N m^{-1}.

3 marks

b. Determine the magnitude of the net force on the cricket ball at its lowest point, that is, when the spring is compressed by 0.17 m. Show your working.

3 marks

N

The spring returns to its natural length as it pushes the cricket ball upwards. When the spring is at its natural length, the ball reaches a velocity of v, as shown in Figure 10.

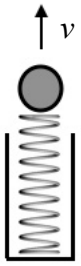


Figure 10

c. What is the kinetic energy of the cricket ball at this point?

3 marks

J

Question 10 (6 marks)

In deep space, a spaceship with a mass of 500 kg is initially stationary. It ejects a module with a mass of 50 kg away from the rear of the spaceship with a speed of 50 m s^{-1}. The spaceship moves forward at velocity v. The situation is shown in Figure 11.

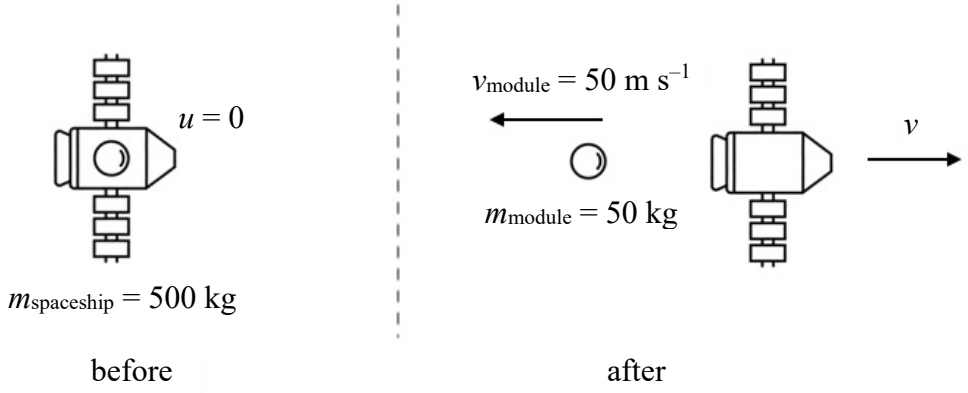


Figure 11

a. Determine the final velocity of the spaceship after the module is ejected. Show your working.

3 marks

m s^{-1}

b. Explain whether the interaction between the spaceship and the module is an elastic or inelastic interaction. You must use a calculation to justify your answer.

3 marks

Question 11 (5 marks)

Pions are particles that are produced in particle colliders and travel at relativistic speeds. Physicists have found that pions travel an average distance of 250 m before they decay. If relativistic effects are ignored, pions should only be able to travel 7.6 m.

a. By referring to the decay time of pions at rest, explain why pions travel further than classical physics predicts.

3 marks

b. Calculate the Lorentz factor for pions. Show your working.

2 marks

Question 12 (3 marks)

Millie and Jim construct a periscope using a pair of 45° triangular prisms. The two prisms are mounted inside a cardboard tube in the arrangement shown in Figure 12. Light rays enter the top opening of the tube and undergo total internal reflection inside the first triangular prism, travel vertically down, and undergo total internal reflection again inside the second triangular prism before exiting the bottom opening.

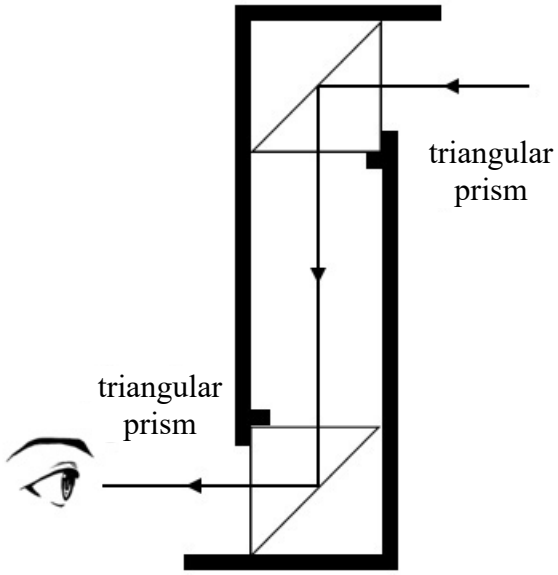
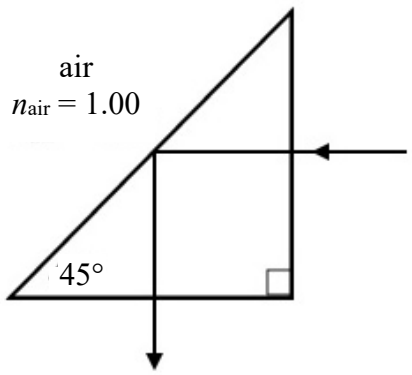


Figure 12

a. On the diagram below, draw the normal line to the surface of the prism at the point of incidence of the light ray.

1 mark



ray diagram

b. In order for total internal reflection to occur for horizontal rays of light entering the top prism, what is the minimum value of the index of refraction for the material of the triangular prism?

2 marks

$n_{\text{prism}} =$

Question 13 (4 marks)

Airliners frequently fly above the clouds. Sunlight reflecting off the top of clouds is glaring because sunlight is unpolarised. The instrument panels in airliners contain several liquid crystal displays (LCDs) which provide flight data to the pilots. The light output of these LCDs is polarised.

a. Explain the difference between unpolarised light and polarised light. You may use a diagram in your answer.

2 marks

b. To reduce sun glare from the tops of clouds, airline passengers can wear sunglasses with polarising filters. However, airline pilots do not wear sunglasses with polarising filters.

Explain why this might be the case. You may use a diagram in your answer.

2 marks

CONTINUES OVER PAGE

Question 14 (7 marks)

Earthquakes can generate transverse waves that travel vast distances. Geophysicists use computer simulations of earthquakes to study their effects. In one particular simulation, two earthquakes occurred simultaneously with the same frequency and wavelength. Figure 13 below shows the two epicentres, or sources, of the earthquake waves, labelled *E1* and *E2*. The earthquake waves form the interference pattern observed in the diagram. Two towns, Shaken and Stirred, are located not far from the two epicentres.

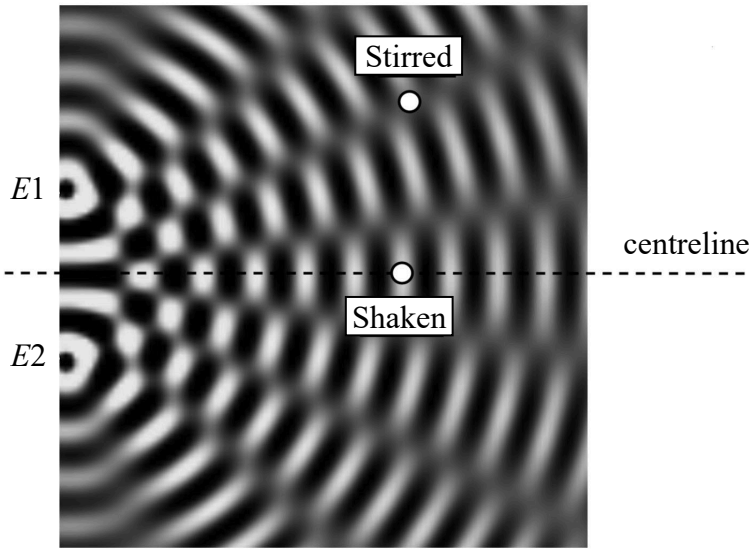


Figure 13

Shaken happens to be on the centreline between the two epicentres. Measurements taken at Shaken show that the magnitude of the waves resulting from the two earthquakes is greater than that resulting from one earthquake.

a. Using the concept of path difference, explain why the magnitude of the waves is greater in the case of two earthquakes.

2 marks

The measurements taken at Stirred show that the two earthquakes did not cause much shaking in this vicinity. The distance from Stirred to *E1* is 3.05 km, and from Stirred to *E2* is 3.83 km.

b. Calculate the wavelength, λ, of the earthquake waves. Show your working.

3 marks

km

The frequency of the earthquake waves was found to be 11 Hz.

c. What is the speed of the earthquake waves?

2 marks

km s^{-1}

Question 15 (5 marks)

A group of students conduct an experiment on the photoelectric effect and measure the following two data points. Their results are shown in Table 1 below.

Table 1

Frequency of light source ($\times 10^{14}$ Hz)	**Stopping voltage (V)**
6.25	1.17
5.15	0.52

a. Use the data above to obtain a value for Planck's constant.

2 marks

eV s

b. Using the value for Planck's constant obtained in **part a.**, explain why photoelectrons are not expected to be emitted when a light source with a frequency of 3.95×10^{14} Hz is used.

3 marks

Question 16 (5 marks)

In an X-ray diffraction experiment, Luisa and Diaz produced the pattern shown on the left-hand side of Figure 14. The X-ray wavelength used was 8.7×10^{-10} m. The diffraction grating used to produce this pattern had a spacing of 1.48×10^{-10} m.

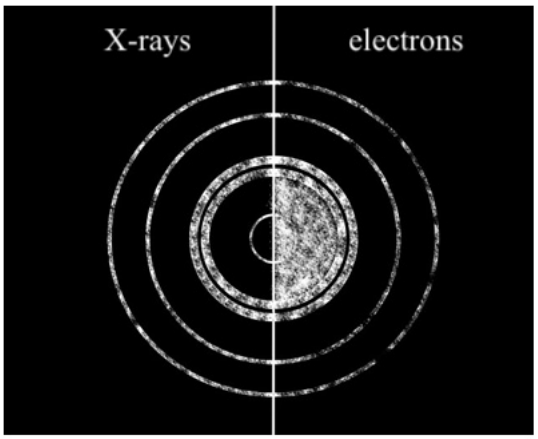


Figure 14

a. Show that the photon energy of the X-rays is 2.3×10^{-16} J correct to two significant figures.

1 mark

Luisa and Diaz decide to repeat the experiment, this time using electrons instead of X-rays. The only diffraction grating they could find that was suitable for electrons had a spacing of 9.1×10^{-11} m.

b. Determine the voltage required to accelerate electrons from rest to a speed such that electrons incident on the new grating could produce the pattern shown on the right-hand side of Figure 14. Show your working.

4 marks

V

Question 17 (6 marks)

The electron energy level diagram for an element is shown in Figure 15. Alcan and Tara wish to use this element to perform some absorption spectroscopy. They intend to use a light source to provide energy to excite the electrons of the element.

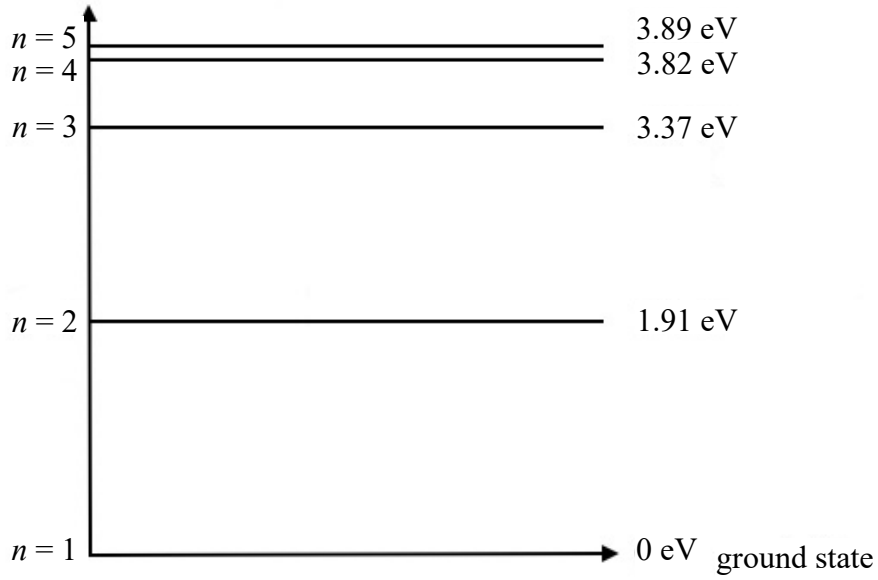


Figure 15

a. Explain why the light source cannot be an LED with a wavelength of 340 nm. Consider only the electrons at ground state. Support your answer with a calculation.

3 marks

Alcan and Tara decide to use a light source with a range of photon energies up to 3.89 eV to energise the electrons. They want to observe the element's absorption spectrum on a detector.

b. List all the possible transitions between energy levels and determine the number of lines that they should observe in the absorption spectrum.

3 marks

Question 18 (2 marks)

One method of producing energy without carbon emissions is nuclear fusion. The Laser Ignition Facility conducts experiments using lasers to compress and ignite isotopes of hydrogen, thereby fusing them into helium.

A recent experimental run produced 1.3 MJ of fusion energy.

Estimate the mass decrease resulting from this fusion reaction.

2 marks

kg

Question 19 (3 marks)

An electron source directs a beam of electrons through a single slit with width *d*. A screen behind the slit detects the electrons and the resulting intensity of electron collisions is then plotted. The set-up and intensity graph are shown in Figure 16.

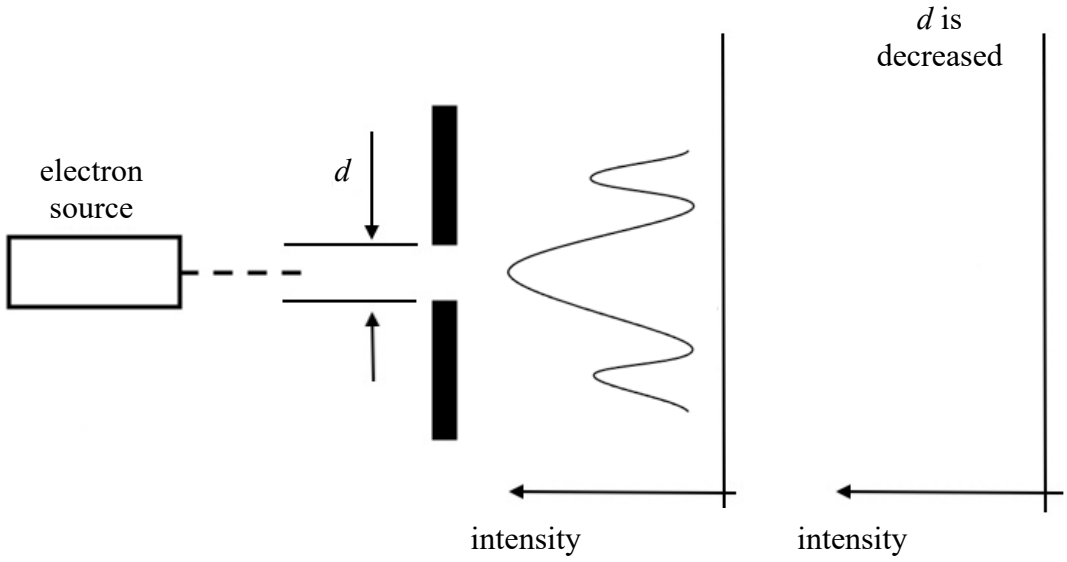


Figure 16

a. The slit width, *d*, is decreased.

Sketch the expected intensity graph of the electron collisions on the axes labelled '*d* is decreased'.

1 mark

b. Use Heisenberg's uncertainty principle to explain the differences, if any, between the original intensity graph in Figure 16 and the intensity graph you sketched in **part a.**

2 marks

Question 20 (10 marks)

A class of physics students is experimenting with the magnetic force on a current balance to measure the magnetic field strength inside a solenoid. The current balance is a rectangular piece of plastic with a U-loop of conductor attached, as shown at the left of Figure 17. The current balance beam is inserted into the solenoid and balanced like a seesaw on pivots attached to one end of the solenoid.

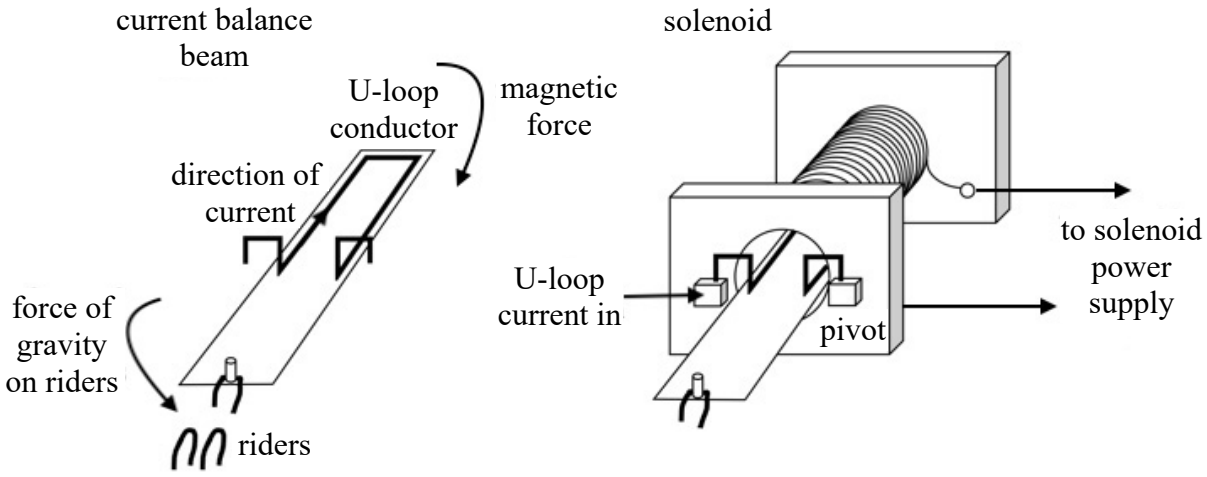


Figure 17

Riders are metal loops with a mass of 0.04 g each. The riders can be hooked around the end of the beam, and the force of gravity on the riders pulls that end of the beam downwards. That downward force can be opposed by the magnetic force of the solenoid when the current flows through the U-loop conductor, from left to right as shown.

With the current in the solenoid kept at a constant value, riders are added to the current balance beam one at a time. Each time a rider is added, the U-loop current is adjusted to balance the beam. Thus, the force of gravity on the riders, $F_{\text{g on riders}}$, is balanced by the magnetic force on the U-loop current, $I_{\text{U-loop}}$. The data obtained in the experiment is shown in Table 2 below.

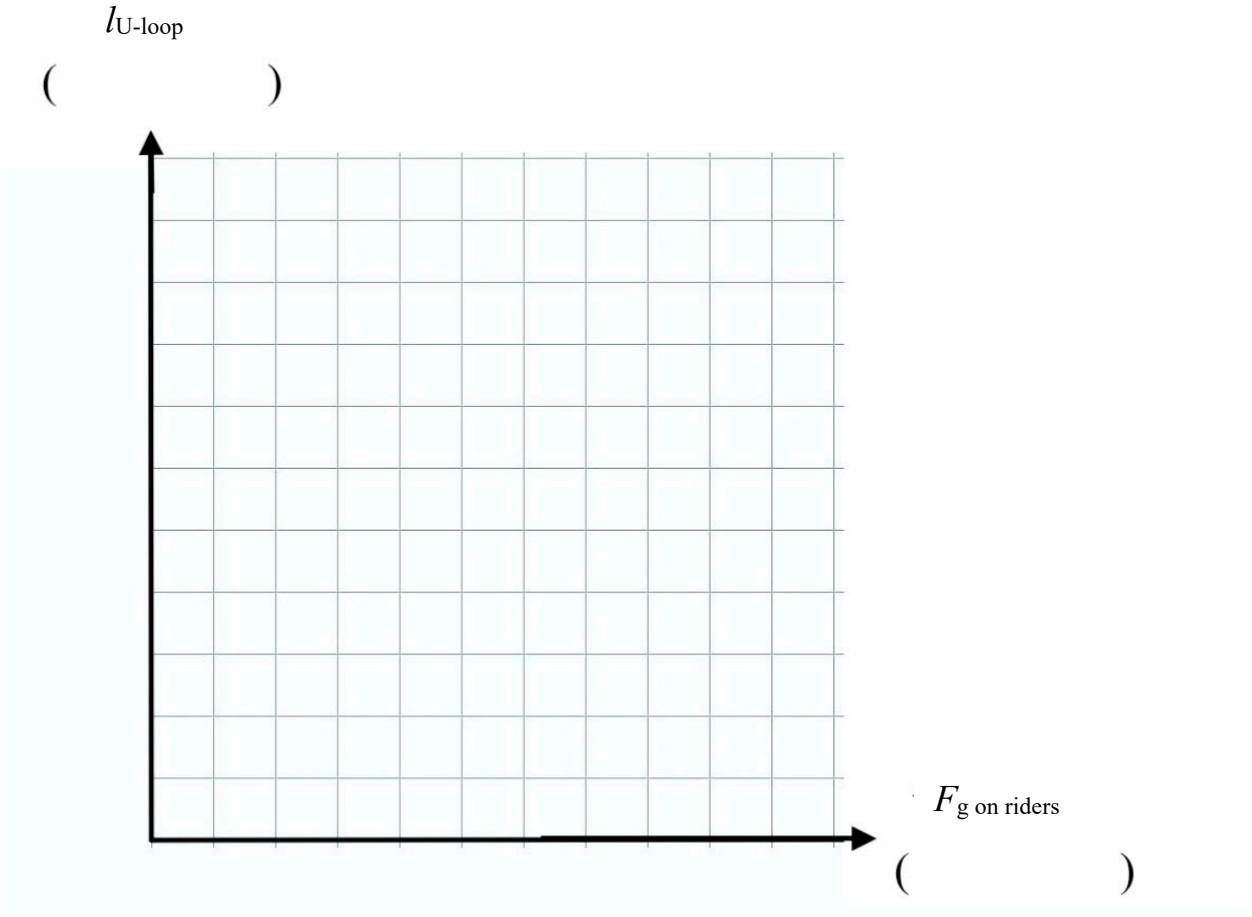
Table 2

I_{solenoid} (A)	Rider mass (g)	$F_{\text{g on riders}}$ ($\times 10^{-4}$ N)	$I_{\text{U-loop}}$ (A)
2.0	0.04	3.92	1.3
2.0	0.08	7.84	2.0
2.0	0.12	11.8	2.4
2.0	0.16	15.7	3.1
2.0	0.20	19.6	4.6

a. On the axes provided below:

- plot the graph of the data given in Table 2
- include appropriate units on each axis
- include scales on each axis
- draw a line of best fit.

5 marks



b. Calculate the gradient of the line of best fit drawn in **part a.** Show your working.

2 marks

A/N

The length of the conductor that is perpendicular to the magnetic field is 2.5 cm. The formula for the magnetic force on a length of conductor is $F = nIlB$.

c. Using the value of the gradient calculated in **part b.** and the formula given above, calculate the strength of the magnetic field, B, inside the solenoid. Show your working.

3 marks

T

END OF QUESTION AND ANSWER BOOK