TSSM
Creating VCE Success

2022 Trial Examination

THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

STUDENT NUMBER | | | | | | | | | Letter

PHYSICS

Units 3 & 4 – Written examination

Reading time: 15 minutes
Writing time: 2 hour and 30 minutes

Question & 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 white out liquid/tape.

Materials supplied

- Question and answer book of 44 pages (including formula sheet)Answer sheet for multiple-choice questions

Instructions

- Print your name in the space provided on the top of this page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication 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

A teenager of mass 40 kg runs towards a stationary skateboard of mass 2.0 kg and jumps on as shown in Figure 1 below. The teenager was running at a speed of 6.0 m s^{-1}.

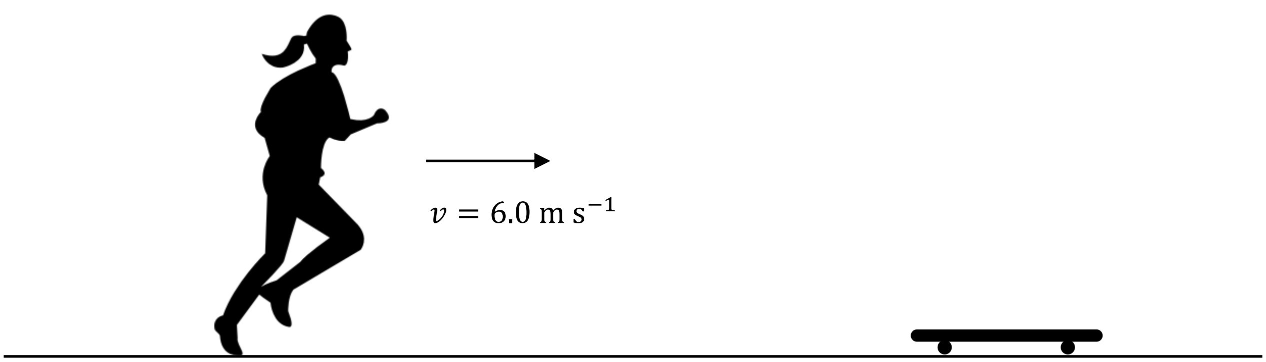


Figure 1.

The final speed of the teenager and skateboard is closest to:

A. 5.7 m s^{-1}
B. 6.3 m s^{-1}
C. 6.0 m s^{-1}
D. 0.29 m s^{-1}

Question 2

An alternator rated 24 V RMS has a peak-to-peak voltage of:

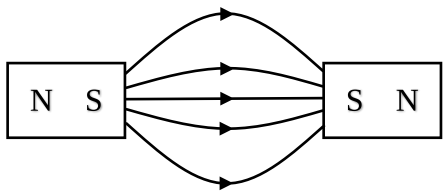
A. 34 V
B. 64 V
C. 48 V
D. 68 V

SECTION A – continued

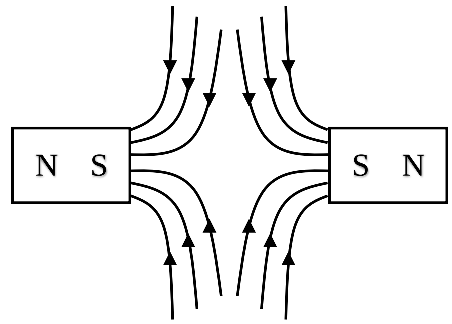
Question 3

Which of the following diagrams shows the magnetic field lines between two South pole ends of two magnets with equal strength?

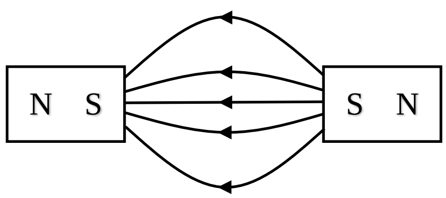
A.



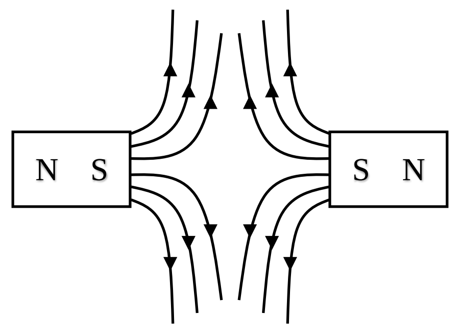
C.



B.



D.



Question 4

A particle has a charge of -4.8×10^{-8} C. The electric field strength due to the particle at a distance of 3.0 m is closest to

A. 48 N C^{-1}

B. 48 V m

C. 144 N C^{-1}

D. 144 V m

Question 5

A photon of yellow light has a frequency of 5.16×10^{14} Hz. The momentum of the photon is closest to:

A. 1.03×10^{-10} kg m s^{-1}

B. 1.14×10^{-27} kg m s^{-1}

C. 7.12×10^{-9} kg m s^{-1}

D. 2.59×10^{39} kg m s^{-1}

Use the following information to answer Questions 6 and 7.

A 0.45 kg ball that is suspended by a string from the top of a pole is hit in a game of tetherball and follows the path as shown in Figure 2 below. The length of the string is 1.8 m and the radius of the circular path is 0.34 m.

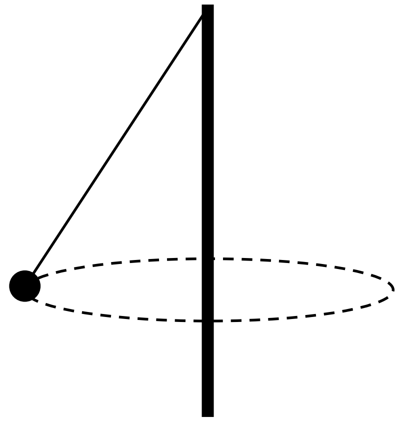


Figure 2.

Question 6

The magnitude of the net force on the tetherball is

A. 4.3 N

B. 0.85 N

C. 0.82 N

D. 0.44 N

Question 7

The tension in the string is

A. 4.3 N

B. 2.3 N

C. 4.5 N

D. 2.7 N

Question 8

A 624 g basketball is dropped from a height of 0.80 m above the ground. Immediately after the ball strikes the ground, it rebounded at a speed of 3.2 m s^{-1}. How much energy is converted to heat or sound as the ball falls from rest to the ground?

A. 1.7 J

B. 3.2 J

C. 4.9 J

D. 8.1 J

SECTION A – continued

Question 9

Which of the following statements is **false**?

A. The first postulate of special relativity states that the laws of physics are the same in all inertial frames of reference.

B. The second postulate of special relativity states that the speed of light has a constant value regardless of the motion of the observer or the source.

C. Less muons are detected at the surface of the Earth than predicted by classical physics which provides evidence for special relativity.

D. Muons formed in the atmosphere being able to reach the surface of the Earth provides evidence for special relativity.

Question 10

A spring is used inside a foam dart gun to launch the foam projectile. The foam dart gun is loaded and aimed directly upwards. The spring is compressed, and the trigger is pulled to launch the projectile as shown in the Figure 3 below.

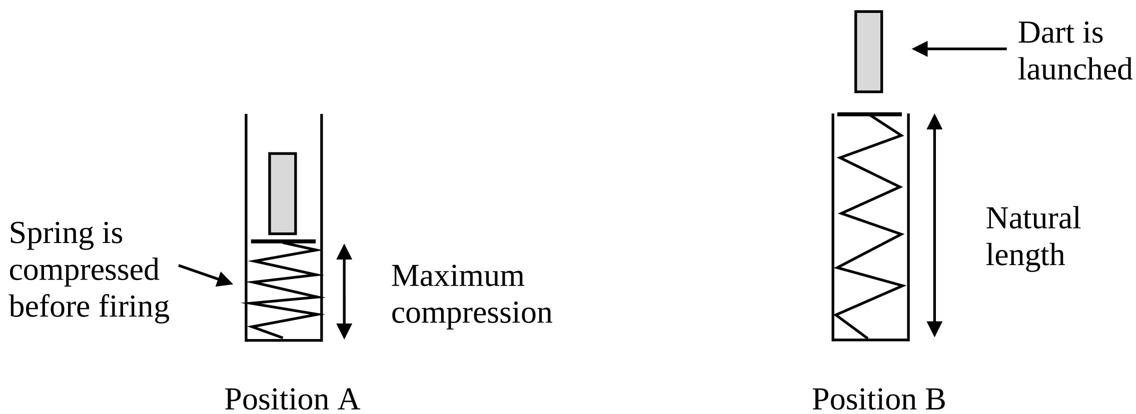


Figure 3.

Which of the following best describes the energy forms of the dart-spring system at positions A and B.?

	Position	Kinetic Energy of the Dart	Spring Potential Energy
A.	**A** **B**	Maximum Zero	Maximum Maximum
B.	**A** **B**	Zero Maximum	Zero Maximum
C.	**A** **B**	Zero Maximum	Maximum Zero
D.	**A** **B**	Maximum Zero	Maximum Zero

SECTION A – continued
TURN OVER

Use the following information to answer Questions 11 and 12.

Pluto has five natural satellites. The largest of these moons is known as Charon. Data for Pluto's moon, Charon is provided in Table 1 below:

Table 1.

Orbital period	153 hours
Orbital radius	1.89×10^{7} m
Mass	7.5×10^{15} kg

Question 11

The speed of Charon's orbit is closest to

A. 0.183 m s^{-1}

B. 1.29×10^{4} m s^{-1}

C. 7.76×10^{5} m s^{-1}

D. 216 m s^{-1}

Question 12

The mass of Pluto is closest to

A. 1.23×10^{22} kg

B. 1.32×10^{22} kg

C. 3.21×10^{22} kg

D. 3.12×10^{22} kg

Question 13

A magnetic field causes an electron to follow a circular path of radius 2.0 m at a speed of 3.0×10^{5} m s^{-1}. The strength of the magnetic field is closest to:

A. 8.5×10^{-7} T

B. 8.5×10^{17} T

C. 3×10^{-6} T

D. 1.2×10^{6} T

Question 14

Which of the following will **decrease** the rotational speed of a coil in a DC motor?

A. Increasing the number of loops in the coil

B. Increasing the magnetic field strength

C. Using a slip ring instead of the split ring commutator

D. Increasing the resistance of the wire used in the coil

SECTION A – continued

Question 15

A young child passes a phone from a higher platform by dropping it down to their older brother below as shown in Figure 4. As the phone is released, an incoming phone call is received.

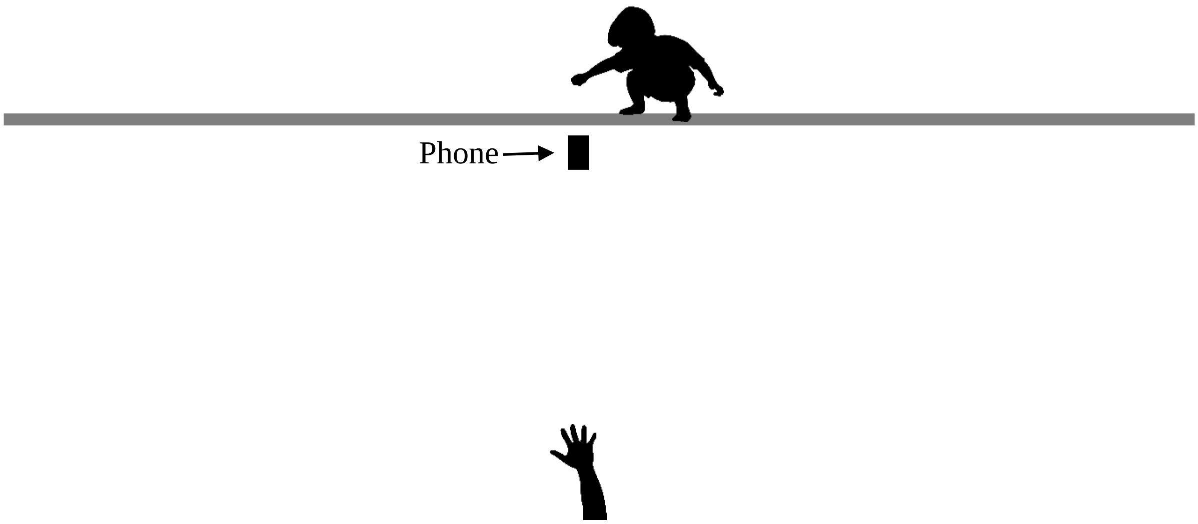


Figure 4.

Which of the following statements is **correct**?

A. The ringtone sounds the exact same for both brothers as it falls.

B. The ringtone sounds at a higher pitch to the older brother as it falls.

C. The ringtone sounds at a lower pitch to the older brother as it falls.

D. The ringtone sounds at a higher pitch to the younger brother as it falls.

Question 16

Which of the following phenomena **do not** relate to longitudinal waves?

A. Polarisation

B. Reflection

C. Diffraction

D. Harmonics

SECTION A – continued
TURN OVER

Question 17

A corridor in a house has two thin vertical windows. A cut-out view from the top is illustrated in Figure 5 below. An interference pattern was observed on the wall of the corridor during the day.

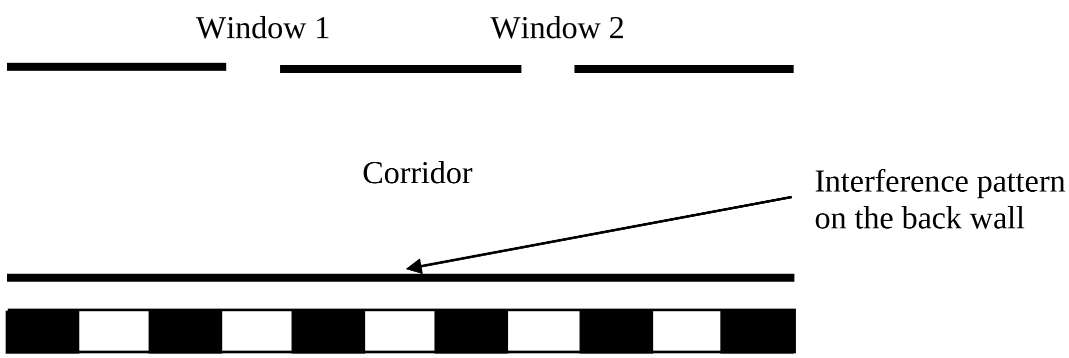


Figure 5.

Renovation plans were made to increase the distance between the windows. Which of the following best describes what will occur as a result?

A. There will be more bands visible on the back wall.

B. There will be no bands visible on the back wall.

C. The bands will become less in number

D. The bands will spread further apart

Question 18

A student is studying the photoelectric effect on an unknown metal. A light is set up which can transfer an energy of 3.2 eV to each of the electrons on the metal surface. The maximum kinetic energy of the ejected electrons was measured to be 0.80 eV. The work function of the metal is closest to

A. 4.0 eV

B. 2.4 eV

C. -2.4 eV

D. 1.3×10^{-14} eV

SECTION A – continued

Use the following information to answer Questions 19 and 20.

A student is using an oscilloscope with a microphone probe to measure the frequency of sound generated by a string under different tension as shown in Figure 6 below.

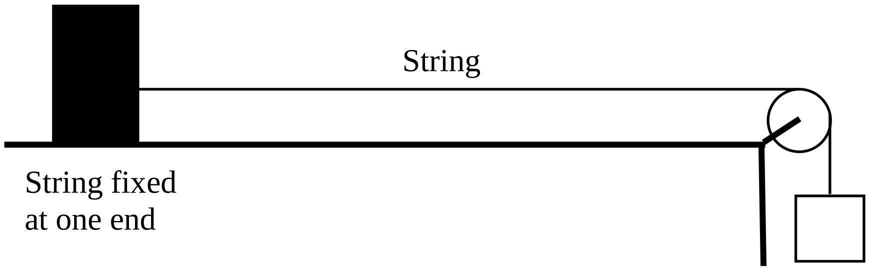


Figure 6.

Data collected from the experiment is shown in Table *2* below.

Table 2.

Tension (N)	**Average Frequency (Hz)**
1.96	120
3.92	142
5.88	157
7.84	178
9.80	203

Question 19

The mass was adjusted using 200g weights, which were verified using a scale that measured to the nearest 0.1 kg. The uncertainty in the tension is equal to:

A. $\pm$ 0.10 N

B. $\pm$ 0.05 N

C. $\pm$ 0.98 N

D. $\pm$ 0.49 N

Question 20

The string was plucked 5 times to determine the average frequency (Hz). The purpose of this is to:

A. Reduce the effect of random error

B. Improve the accuracy

C. Reduce the precision

D. Improve the validity

END OF SECTION A
TURN OVER

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.
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)

Cathode Ray Tube (CRT) televisions were an earlier technology used to display pictures. It consisted of manipulating and focusing an electron source onto a surface.

Electrons were emitted from the cathode (negative terminal) as shown in Figure 7 below. The electrons are accelerated from rest between the two plates using a potential difference of 25 kV at a distance of 35 cm.

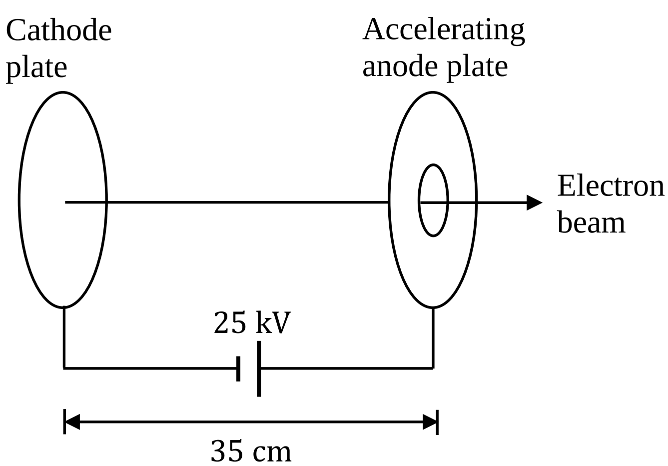


Figure 7.

a. Calculate the electric field strength between the two plates.

V m^{-1}

2 marks

SECTION B – continued

b. Calculate the speed of the electron as it exits the electric field generated by the two plates.

m s^{-1}

2 marks

A snapshot of time shows two electrons in space as shown in Figure 8 below.

c. Sketch the shape and direction of **at least four** electric field lines between the two charged particles within the dashed border shown in Figure 8 below.

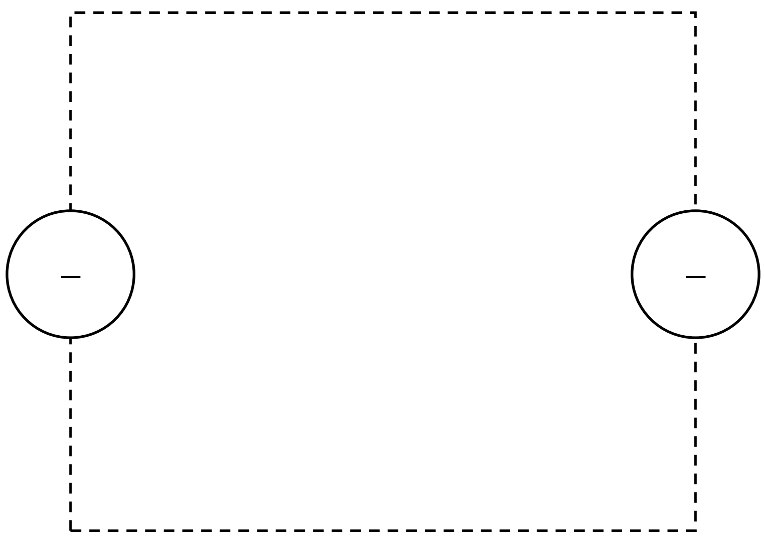


Figure 8.

2 marks

SECTION B – continued
TURN OVER

As the electrons exit the field of the accelerating plates, magnetic coils around the CRT redirect the beam to different positions on a phosphor screen as shown in Figure 9 below.

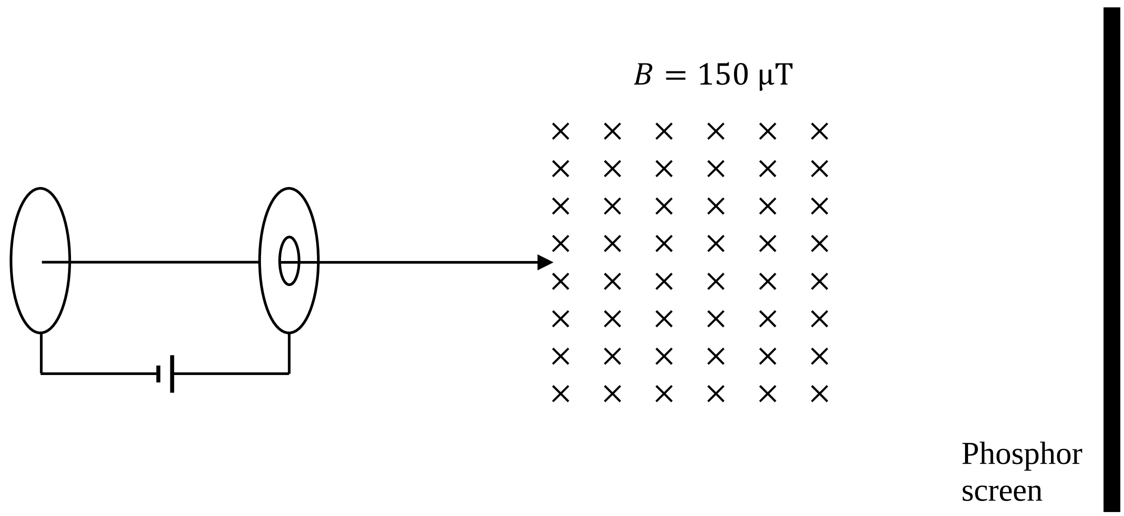


Figure 9.

d. Calculate magnitude and direction of the force on the electron as it enters the magnetic field.

N

3 marks

SECTION B– continued

e. Calculate the radius of the path that the electron follows whilst it is in the magnetic field.

m

2 marks

When electrons are incident on a phosphor screen, photons are emitted in the visible light spectrum.

f. Describe how this relates to the photoelectric effect.

2 marks

SECTION B - continued
TURN OVER

Question 2 (6 marks)

Elom Husk's company SpaceZ has recently launched a 4500 kg satellite into orbit around Earth at an altitude of 750 km to spy on his competitor at Green Origin.

a. Calculate how long it takes for Elom Husk's satellite to orbit the Earth once.

s

2 marks

b. Calculate the orbital speed of Elom Husk's satellite.

$m\ s^{-1}$

2 marks

SECTION B– continued

c. Describe what would occur if the satellite was moving at a speed **less than** the orbital speed.

2 marks

Question 3 (6 marks)

A simple DC motor is constructed using 50 turns of wire in a single rectangular shaped coil, ABCD, as shown in Figure 10 below, with dimensions 20 cm × 10 cm. It is rotated in the field of a uniform permanent magnet of field strength 2.5×10^{-2} T. A current of 1.5 A flows through the coil.

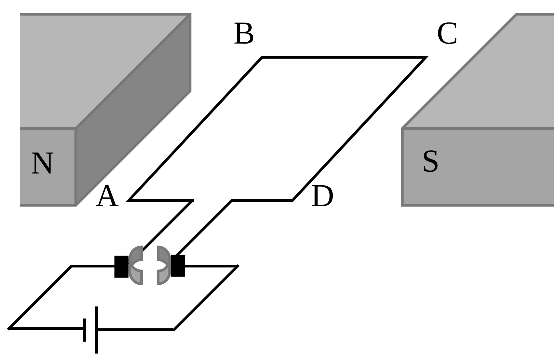


Figure 10.

a. Calculate the magnitude and direction of the force on side AB.

N

3 marks

SECTION B– continued

TURN OVER

b. Describe which orientations of side BC would result in a force on the side BC being zero.

2 marks

c. State one modification that can increase the speed of the DC motor.

1 mark

SECTION B – continued

Question 4 (6 marks)

A bar magnet is threaded through a coil with 4 turns at a constant speed as shown in Figure 11.

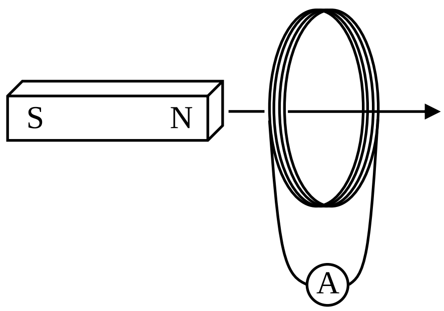


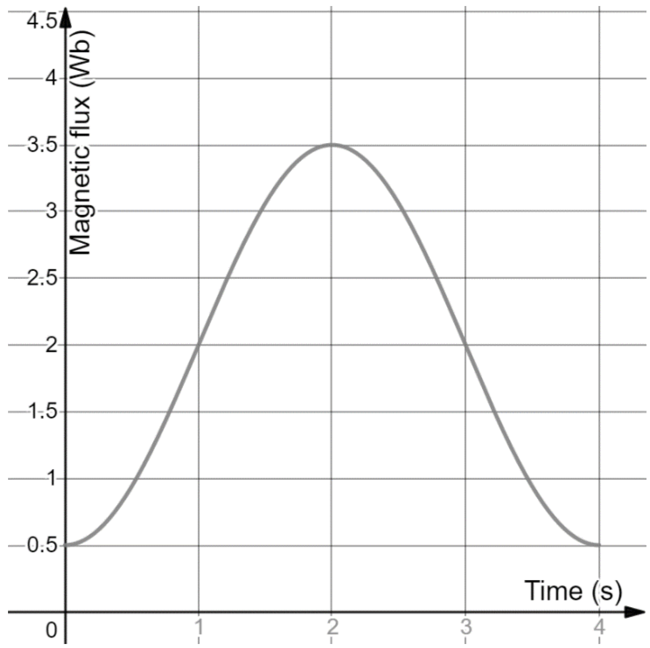
Figure 11

a. On the axes below, sketch a graph of the current against time. Exact values are not required, only relative magnitudes.

2 marks

SECTION – continued
TURN OVER

A bar magnet oscillates in and out of a coil. The magnetic flux can be modelled by the graph below.



b. Calculate the magnitude of the average EMF between 0.0 s and 2.0 s.

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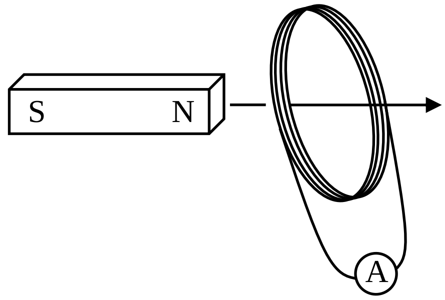
V

2 marks

SECTION B – continued

c. If the coil was tilted on an angle as shown in below. Outline what would happen to the magnetic flux.



2 marks

Question 5 (7 marks)

A microwave uses a transformer circuit to achieve a power of 1000 W. The mains power is 230 V_{RMS} and the microwave operates at 2.3 kV_{RMS}. The primary coil is attached to the mains supply and is stepped up using a secondary coil which is attached via a transformer core.

Assume that the transformer is ideal.

a. Calculate the current in the secondary coil.

A

2 marks

SECTION B– continued
TURN OVER

b. Calculate the peak voltage of the secondary coil.

V

2 marks

c. Calculate the ratio of the number of turns $\frac{N_s}{N_p}$.

2 marks

d. Outline why AC power is required rather than DC for the microwave.

1 mark

SECTION B – continued

Question 6 (15 marks)

A 70 g yo-yo is swung in a vertical circular path as shown by Figure 12 below. The radius of the circular path is 70 cm.

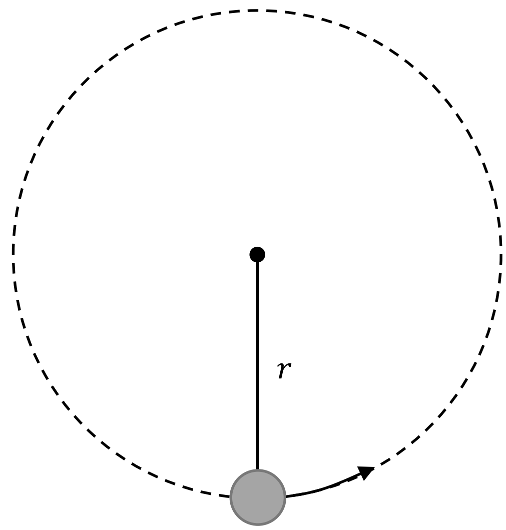


Figure 12.

a. Draw and label the forces on the yo-yo on the diagram above.

2 marks

b. If the yo-yo is being swung at a velocity of 8.0 m s^{-1}.

i. Calculate the tension force in the rope at the bottom of the circular path (position as shown in Figure 12 above).

N

2 marks

SECTION B – continued
TURN OVER

ii. Calculate the tension force in the rope at the top of the circular path as shown in Figure 13 below.

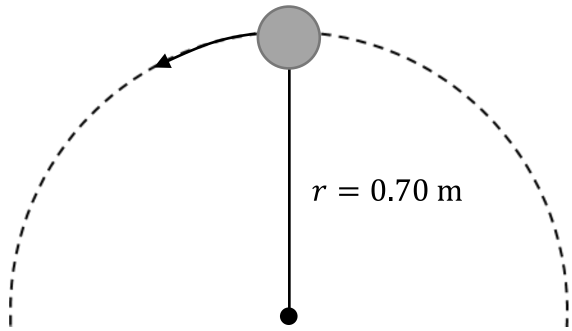


Figure 13.

N

2 marks

At an angle of 45° to the horizontal, as shown in Figure 14 below, the yo-yo rope suddenly breaks, sending the yo-yo flying.

c. Draw an arrow to represent the direction that the yo-yo flies at the moment the rope breaks on Figure 14. below.

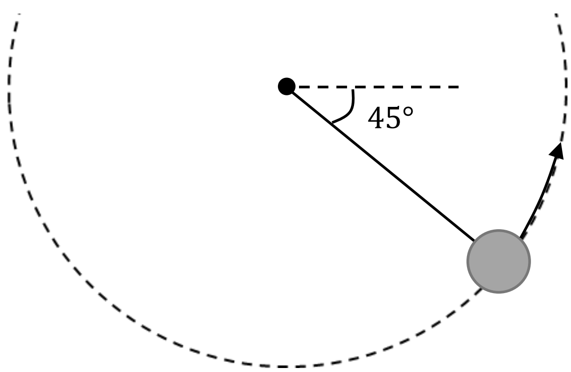


Figure 14.

1 mark

SECTION B– continued

d. The yo-yo was at a height of 1.0 m from the ground when the rope broke and flew off at a speed of 4.0 m s^{-1}. Assume that the effects of air resistance are negligible.

i. Calculate the time taken for the yo-yo to reach the peak height of its flight.

s

2 marks

ii. Calculate total flight time of the yo-yo.

s

4 marks

SECTION B– continued
TURN OVER

iii. Calculate the horizontal distance the yo-yo travelled in the air.

m

2 marks

Question 7 (5 marks)

A new particle is created which is shot out of Earth's atmosphere. It has a Lorentz factor of 3. It was observed from Earth to travel to the moon before decaying. Take the distance to the moon from Earth to be 3.8×10^5 m from the observer's perspective.

a. Calculate the speed, in terms of c, in which the particle is travelling at.

c

2 marks

SECTION B – continued

b. How long will it take for the particle to decay according to the particle's frame of reference?

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s

3 marks

Question 8 (5 marks)
A mass is vertically suspended by a spring as shown in Figure 15.

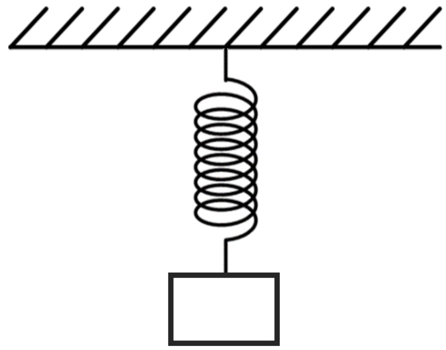
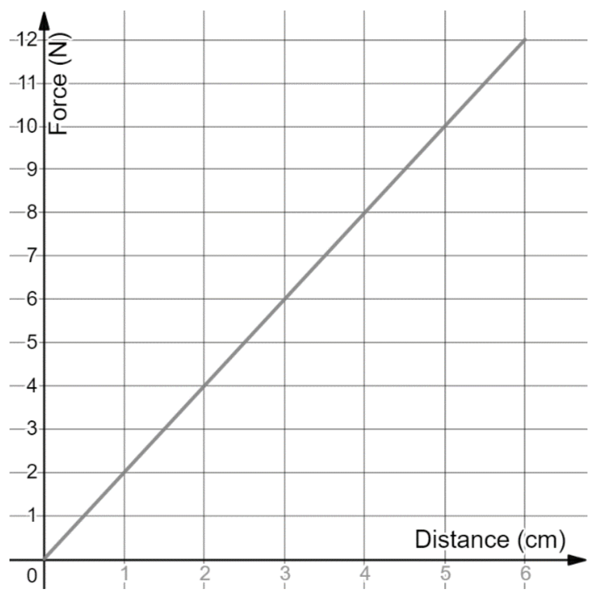


Figure 15.

A force is applied upwards, to compress the spring 6 cm according to the graph below.



a. Calculate the work done on the spring.

J

2 marks

SECTION B – continued

As the spring is released from its compressed position, the spring and mass changes energy in the three stages (Left – maximum compression, middle – equilibrium, right – maximum extension) shown in Figure 16 below.

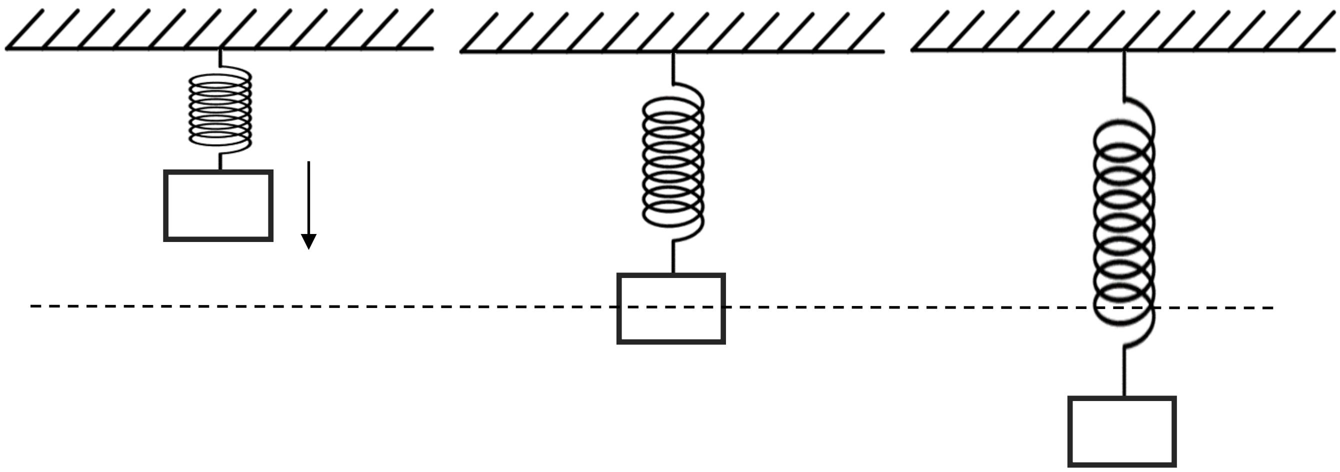


Figure 16.

b. Describe the energy (in terms of kinetic energy (E_k), gravitational potential energy (U_g), and spring potential energy (U_s)) available to the spring-mass system in each of the three stages.

3 marks

SECTION B – continued
TURN OVER

Question 9 (8 marks)

A particle with a mass of 3.24×10^{-27} kg was calculated to have 1.98×10^{-10} J of kinetic energy.

a. Calculate the speed of the particle using classical physics in terms of c.

c

3 marks

b. Calculate the speed of the particle using relativistic physics in terms of c.

c

3 marks

c. Explain which calculation is more accurate and why.

2 marks

SECTION B – continued

Question 10 (10 marks)

A student is studying the effects of waves in a swimming pool. A pebble is dropped into the pool and the waves generated were recorded using a camera.

A side profile of some of the waves formed on the surface can be shown in Figure 17 below.

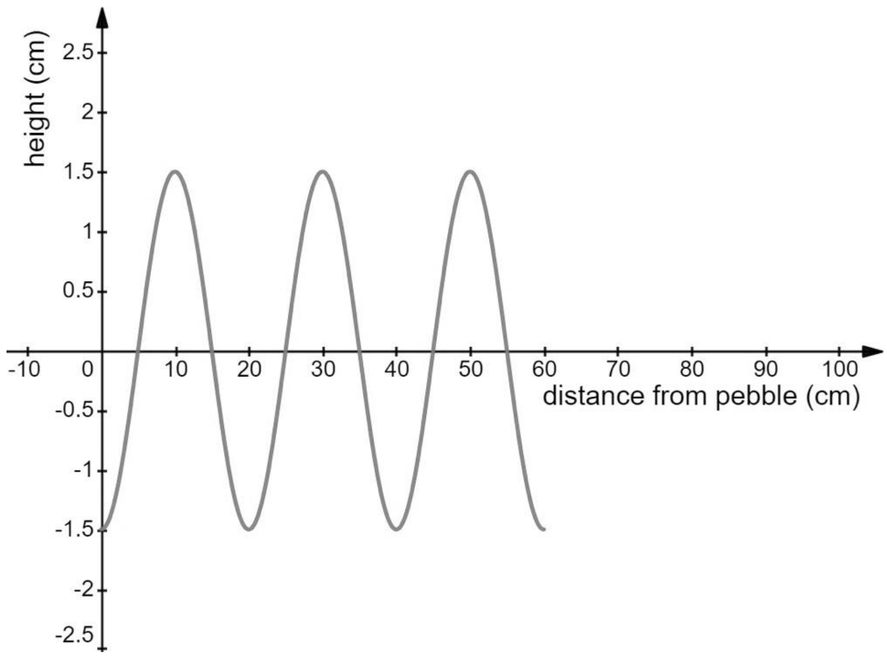


Figure 17.

a. Determine the wavelength.

m

1 mark

The waves were measured to travel at a speed of 0.4 m s^{-1}.

b. Calculate the frequency of the wave.

Hz

2 marks

SECTION B – continued

TURN OVER

The student dropped two pebbles which were identical to the single pebble drop to investigate constructive and destructive interference as shown in Figure 18 below. The solid lines represent the crests of the waves, and the dotted lines represent the troughs.

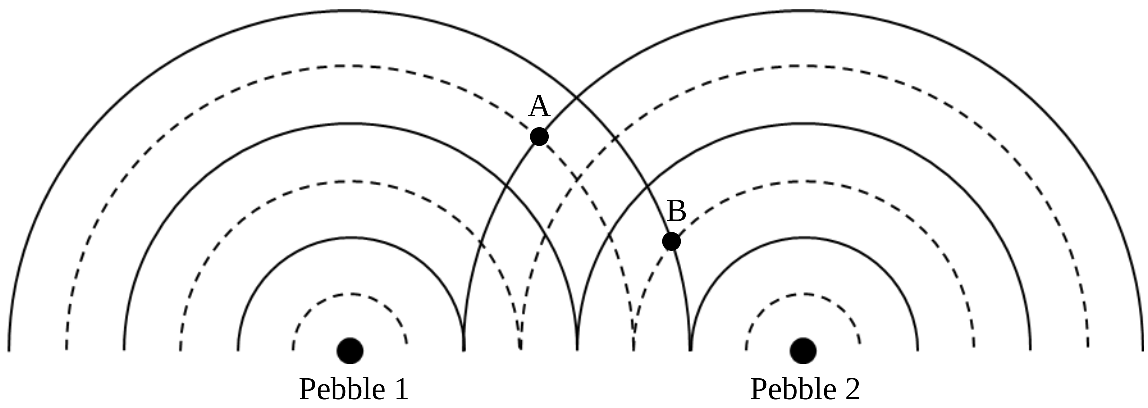


Figure 18.

c. Outline whether point A is a node or an antinode.

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1 mark

d. Calculate the path difference to point B.

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____

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m

2 marks

SECTION B – continued

A point on the edge of the pool is 2.2 m from Pebble 1, and 3.1 m from Pebble 2.

e. Determine what type of interference is occurring at that point.

2 marks

The student wore polarised glasses during this experiment as the ripples were initially hard to see because of the glare on the surface of the water.

f. Describe how this helped to reduce the glare.

2 mark

SECTION B – continued
TURN OVER

Question 11 (5 marks)

A student is conducting a double-slit experiment using a red laser ($\lambda = 638$ nm). The laser is incident on two slits that are 3.80×10^{-4} m apart, and produce an interference pattern on a screen 1.60 m behind the slits.

a. Calculate the distance between the centre of adjacent dark bands produced on the screen.

m

2 marks

Another student in the class is using a blue laser ($\lambda = 458$ nm) using the same set up as the first student and determines their bands to be 1.93×10^{-3} m apart.

b. The student wishes to make their interference pattern the exact same by moving the screen back further. How much further back should the second student move the screen?

m

2 marks

c. What is one other way, other than moving the screen back, the second student could do to replicate the first student's interference pattern?

1 mark

SECTION B – continued

Question 12 (7 marks)

A teacher conducts an experiment to demonstrate the photoelectric effect to a class by shining different progressively decreasing wavelengths of light monochromatic onto a particular metal as shown in Figure 19. Electrons were first detected when light with a wavelength of 790 nm was used.

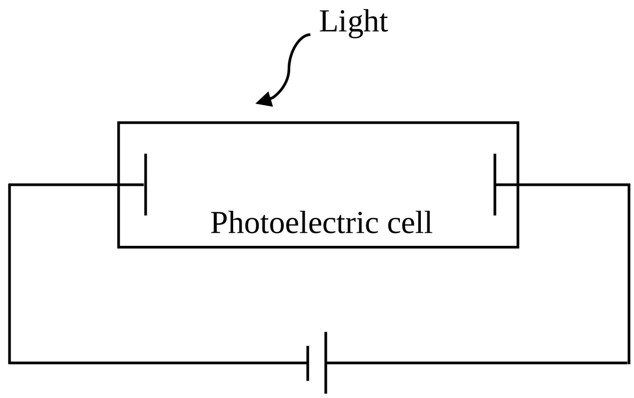


Figure 19.

a. Determine the work function of the metal. Show calculations.

eV

3 marks

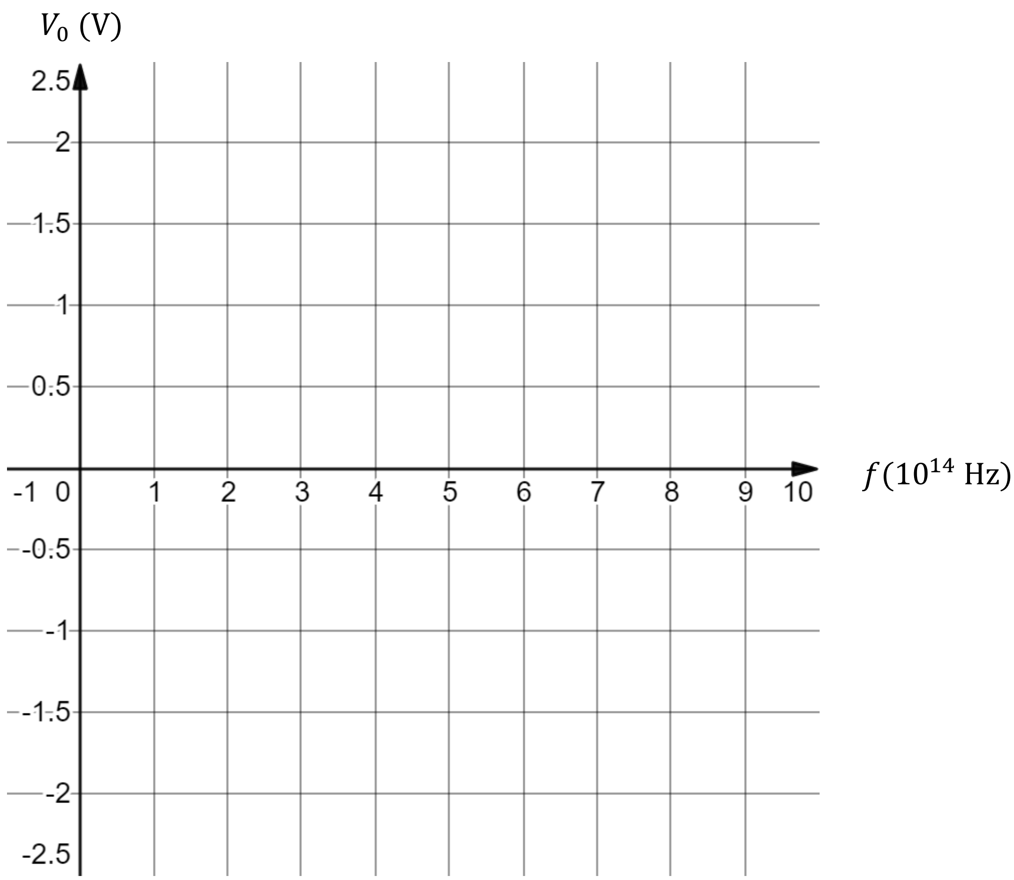
SECTION B – continued
TURN OVER

b. Explain how changing the wavelength provides evidence for the particle-like nature of light.

2 marks

As the teacher continued to decrease the wavelength of light, the stopping voltage increased.

c. Plot the graph of the stopping voltage versus the frequency that the teacher recorded on the axes provided below. Label the relevant intercepts.



2 marks

SECTION B – continued

Question 13 (3 marks)

A beam of electrons is travelling at a speed of 2.36×10^4 m s^{-1} and is fired at leaf of gold to create a diffraction pattern as shown in Figure 20 below.

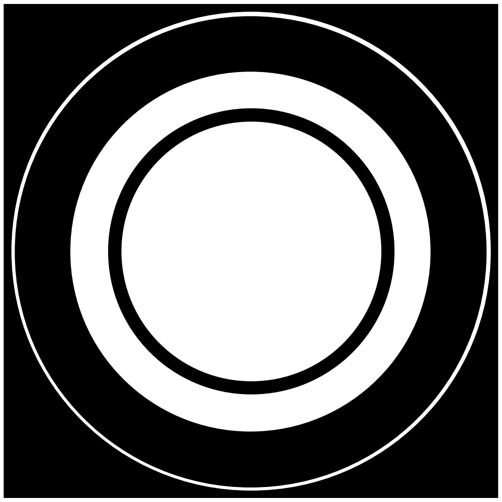


Figure 20.

a. Calculate the wavelength of the electrons.

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nm

2 marks

SECTION B – continued
TURN OVER

b. If the speed of the electron was accelerated significantly, draw a possible diffraction pattern in the square provided below.

1 mark

SECTION B – continued

Question 14 (6 marks)

An unknown element has the energy levels shown in Figure 21 below.

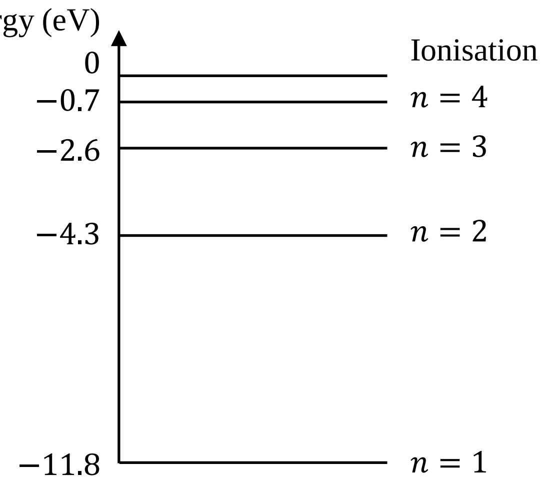


Figure 21.

a. How many bands would you expect to see produced in the emission spectrum of this element from an electron that returns to the ground state from $n = 4$.

1 mark

b. What wavelength of light will be emitted from an electron which moves from $n = 3$ to the ground state? Show calculations.

nm

3 marks

SECTION B – continued

TURN OVER

c. Describe how electrons can only exist in these energy levels. Refer to standing waves in your response.

2 marks

Question 15 (8 marks)

A student is exploring how the angle of attack (θ) of an aerofoil can affect lift force generated. The student uses a fan blowing air at a constant velocity through a makeshift wind tunnel as shown in Figure 22 below. A spring balance is attached to a rod which is connected to the base of the aerofoil. The rod is kept vertical by two pegs through the centre which will allow the upwards motion.

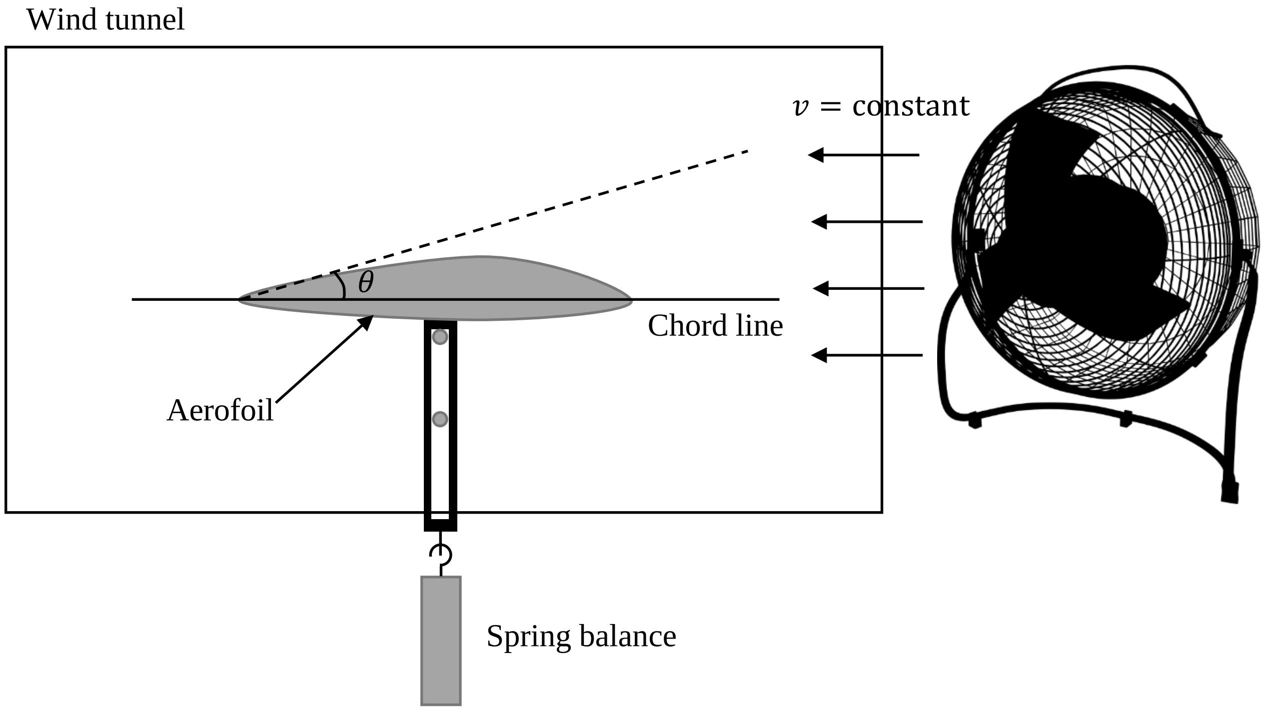


Figure 22.

a. Identify two control variables.

2 marks

The student recorded their data collected in Table 3 below.

Table 3.

Angle of attack (°)	Force (N)
0	0.7
4	1.3
8	1.7
12	2.5
16	2.7

SECTION B – continued
TURN OVER

b. The spring balance has measurements printed on it in increments of 0.1 N.

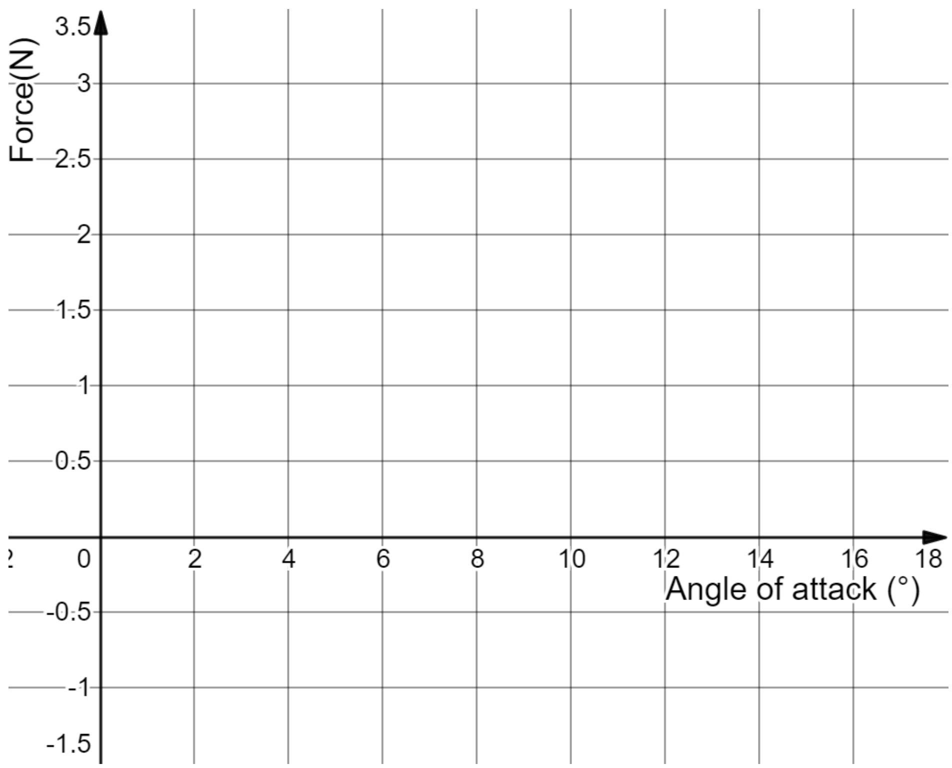
i. Determine the uncertainty from the spring balance.

1 mark

ii. Describe whether this uncertainty would be represented as error bars in the x or y direction on the graph.

1 mark

c. Plot a graph of the angle of attack against the force on the axes provided below. Draw a straight line of best fit through the plotted points.



2 marks

SECTION B – continued

d. Justify whether or not the line of best fit drawn in **part c.** is a good fit for the data.

2 marks

END OF QUESTION AND ANSWER BOOK

Formula Sheet

Motion and related energy transformations

velocity; acceleration	$v = \frac{\Delta s}{\Delta t}$; $a = \frac{\Delta v}{\Delta t}$
equations for constant acceleration	$v = u + at$ $s = ut + \frac{1}{2}at^2$ $s = vt - \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $s = \frac{1}{2}(v + u)t$
Newton's second law	$\Sigma F = ma$
circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
Hooke's law	$F = -k\Delta x$
elastic potential energy	$\frac{1}{2}k(\Delta x)^2$
gravitational potential energy near the surface of Earth	$mg\Delta h$
kinetic energy	$\frac{1}{2}mv^2$
Newton's law of universal gravitation	$F = G\frac{M_1 M_2}{r^2}$
gravitational field	$g = G\frac{M}{r^2}$
impulse	$F\Delta t$
momentum	mv
Lorentz factor	$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
time dilation	$t = t_o\gamma$
length contraction	$L = \frac{L_o}{\gamma}$
rest energy	$E_{rest} = mc^2$
relativistic total energy	$E_{total} = \gamma mc^2$
relativistic kinetic energy	$E_k = (\gamma - 1)mc^2$

Fields and application of field concepts

electric field between charged plates	$E = \frac{V}{d}$
energy transformations of charges in an electric field	$\frac{1}{2}mv^2 = qV$
field of a point charge	$E = \frac{kq}{r^2}$
force on an electric charge	$F = qE$
Coulomb's law	$F = \frac{kq_1q_2}{r^2}$
magnetic force on a moving charge	$F = qvB$
magnetic force on a current carrying conductor	$F = nIlB$
radius of a charged particle in a magnetic field	$r = \frac{mv}{qB}$

Generation and transmission of electricity

voltage; power	$V = RI$; $P = VI = I^2R$
resistors in series	$R_T = R_1 + R_2$
resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
ideal transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2} = \frac{I_2}{I_1}$
AC voltage and current	$V_{RMS} = \frac{1}{\sqrt{2}}V_{peak}$ $I_{RMS} = \frac{1}{\sqrt{2}}I_{peak}$
electromagnetic induction	EMF: $\varepsilon = -N\frac{\Delta \Phi_B}{\Delta t}$ flux: $\Phi_B = B_\perp A$
transmission losses	$V_{drop} = I_{line} R_{line}$ $P_{loss} = I^2_{line} R_{line}$

Wave concepts

wave equation	$v = f\lambda$
constructive interference	path difference = $n\lambda$
destructive interference	path difference = $\left(n - \frac{1}{2}\right)\lambda$
fringe spacing	$\Delta x = \frac{\lambda L}{d}$
Snell's law	$n_1 \sin\theta_1 = n_2 \sin\theta_2$
refractive index and wave speed	$n_1 v_1 = n_2 v_2$

The nature of light and matter

photoelectric effect	$E_{k\max} = hf - \phi$
photon energy	$E = hf$
photon momentum	$p = \frac{h}{\lambda}$
de Broglie wavelength	$\lambda = \frac{h}{p}$

Data

acceleration due to gravity at Earth's surface	$g = 9.8\ \text{m s}^{-2}$
mass of the electron	$m_e = 9.1 \times 10^{-31}\ \text{kg}$
magnitude of the charge of the electron	$e = 1.6 \times 10^{-19}\ \text{C}$
Planck's constant	$h = 6.63 \times 10^{-34}\ \text{J s}$ $h = 4.14 \times 10^{-15}\ \text{eV s}$
speed of light in a vacuum	$c = 3.0 \times 10^{8}\ \text{m s}^{-1}$
gravitational constant	$G = 6.67 \times 10^{-11}\ \text{N m}^2\ \text{kg}^{-2}$
mass of Earth	$M_E = 5.98 \times 10^{24}\ \text{kg}$
radius of Earth	$R_E = 6.37 \times 10^{6}\ \text{m}$
Coulomb constant	$k = 8.99 \times 10^{9}\ \text{N m}^2\ \text{C}^{-2}$

Prefixes/Units

p = pico = 10^{-12}	n = nano = 10^{-9}	μ = micro = 10^{-6}	m = milli = 10^{-3}
k = kilo = 10^{3}	M = mega = 10^{6}	G = giga = 10^{9}	t = tonne = 10^{3} kg