Quality Assessment Tasks

NAME: ____________________________

VCE®Physics

UNITS 3 & 4 Practice Written Examination

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 36 pages.
- Formula sheet PROVIDED BY YOUR TEACHER.
- Answer sheet for multiple-choice questions.

Instructions

- Write your **student name** in the space provided above on this page and on the multiple choice answer sheet.
- 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 around the outside of this book.
- You may keep the formula sheet.

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

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SECTION A – Multiple-choice questions

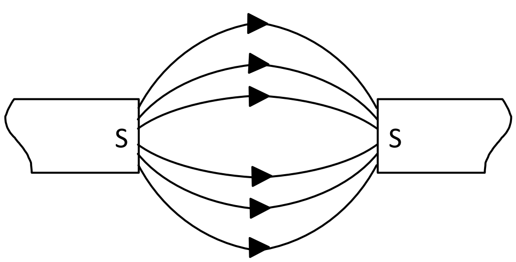
Instructions for Section A

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}.

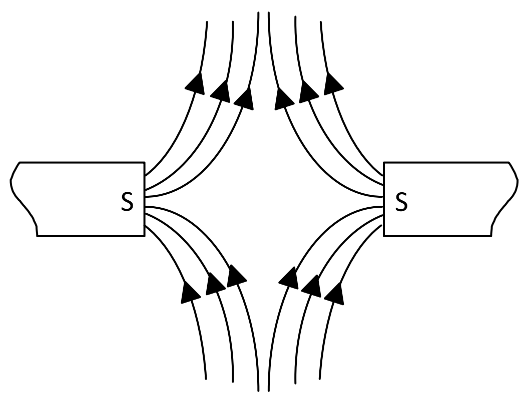
Question 1

Which one of the following diagrams shows the magnetic field pattern surrounding two horizontally aligned, equal strength, south poles of different magnets?

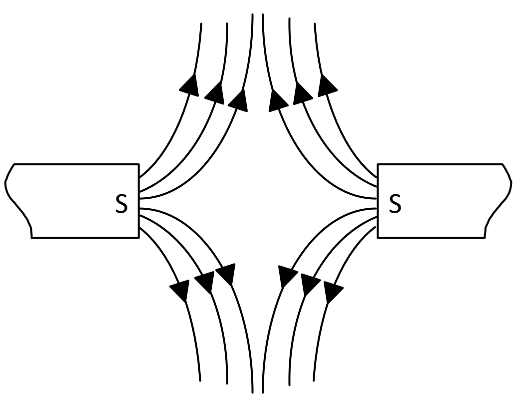
A.



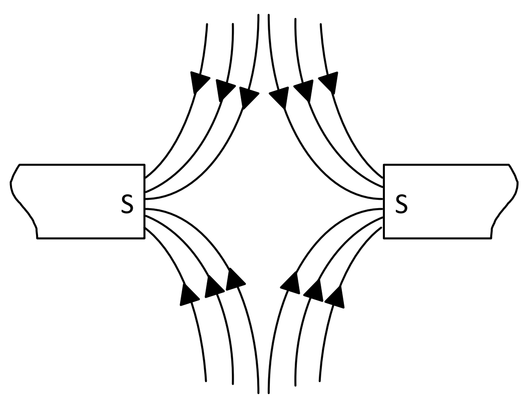
B.



C.



D.



Question 2

Which one of the following statements is correct?

A. Gravitational Fields have monopoles, Electric fields have dipoles, Magnetic fields can have both.

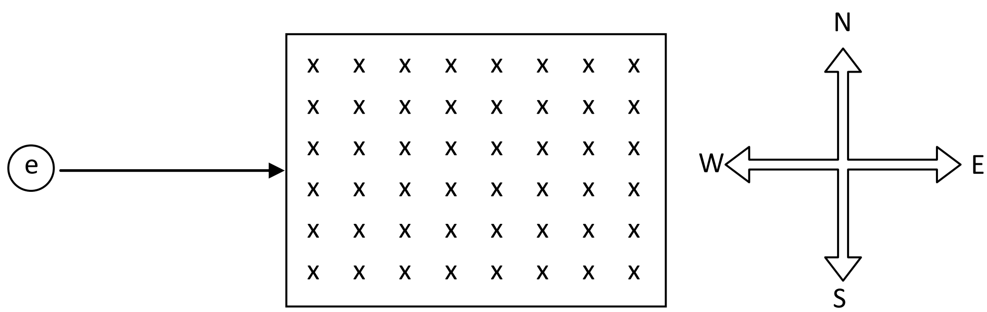
B. Gravitational Fields have monopoles, Magnetic fields have dipoles, Electric fields can have both.

C. Gravitational, Magnetic and Electric fields can have each have both monopoles or dipoles.

D. Gravitational, Magnetic and Electric fields can have each only have either monopoles or dipoles.

Question 3

An electron is moving to East through a magnetic field directed downwards (in to the page) as shown in the diagram below:



Which of the following describes the direction of the force of the magnetic field shown on the electron?

A. North

B. East

C. South

D. West

Question 4

A charged particle has a mass of 1 x10^{-32} kg, a velocity of 2 x10^{7} m s^{-1}, and, a charge of 1 x10^{-16} C and is travelling through a perpendicular magnetic field with a strength of 1 T.

Which one of the following gives the best estimate of the radius of the charged particle in a magnetic field?

A. 2 x10^{-41} m

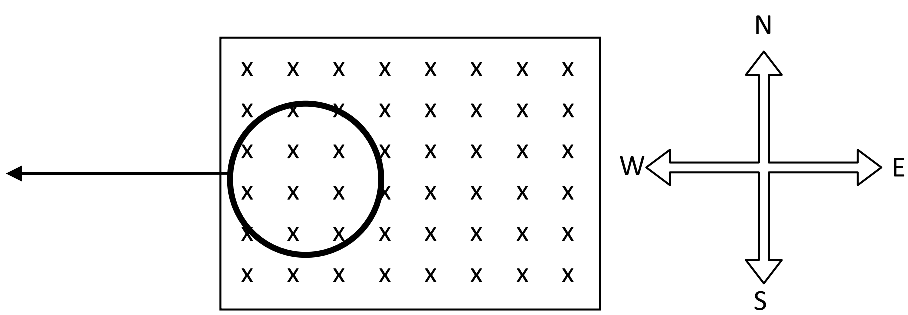
B. 2 x10^{-9} m

C. 2 x10^{-23} m

D. 2 x10^{-8} m

Question 5

A circular loop of wire is pulled toward the West and out of a magnetic field directed downward (in to the page) as shown in the diagram below:



Which of the following describes the direction of the current through the circular loop of wire?

A. Clockwise.

B. Anticlockwise.

C. First one direction and then the other.

D. There is no current in the loop.

Question 6

Which one of the following statements is correct?

A. An AC generator can be converted from a simple DC motor by replacing the split-ring commutator with slip-rings and connecting the terminals to a source.

B. An AC generator can be converted from a simple DC motor by replacing the split-ring commutator with slip-rings and connecting the terminals to a load.

C. An DC generator can be converted from a simple DC motor by replacing the slip-ring commutator with split-rings and connecting the terminals to a load.

D. An AC generator can be converted from a simple DC motor by replacing the split-ring commutator with slip-rings and connecting the terminals to a load.

Question 7

Which of the following describes the main advantage of the use of AC power, rather than DC power, for domestic power supply in large-scale transmission systems?

A. The AC voltage can be more easily stepped-up, for transmission with lower power loss, and then stepped-down, for safe use in domestic settings, using transformers, than DC voltage.

B. The AC voltage can be more easily stepped-down, for transmission with lower power loss, and then stepped-up, for safe use in domestic settings, using transformers, than DC voltage.

C. The AC current can be more easily stepped-up, for transmission with lower power loss, and then stepped-down, for safe use in domestic settings, using transformers, than DC current.

D. The AC voltage can be more easily stepped-up, for safer transmission, and then stepped-down, for lower power loss in domestic settings, using transformers, than DC voltage.

Question 8

Which of the following is the most accurate description of the law of conservation of momentum?

A. When two or more objects interact or collide, the total initial momentum will be equal to the total final momentum of the objects.

B. When two or more objects interact or collide in an isolated system, the total initial momentum will be equal to the total final momentum of the objects.

C. When two or more objects interact or collide in an isolated system, the total initial momentum & kinetic energy will be equal to the total final momentum and kinetic energy of the objects.

D. When two or more objects interact or collide, the total initial momentum & kinetic energy will be equal to the total final momentum and kinetic energy of the objects.

Question 9

Which of the following gives the best description of how the detection of muons at the surface of Earth provides evidence for Einstein's theory of special relativity?

A. The proportion of muons that reach the Earth's surface is much less than is expected given their very short half-life. This is due to time dilation.

B. The proportion of muons that reach the Earth's surface is much greater than is expected given their very long half-life. This is due to length contraction.

C. The proportion of muons that reach the Earth's surface is much less than is expected given their very short half-life. This is due to length contraction.

D. The proportion of muons that reach the Earth's surface is much greater than is expected given their very short half-life. This is due to time dilation.

Question 10

What is the primary distinction between elastic and inelastic collisions?

A. In an elastic collision, the total kinetic energy of the objects is the same before and after the collision. In an inelastic collision, the total kinetic energy after the collision is less than the total kinetic energy before the collision.

B. In an inelastic collision, the total kinetic energy of the objects is the same before and after the collision. In an elastic collision, the total kinetic energy after the collision is less than the total kinetic energy before the collision.

C. In an elastic collision, the total kinetic energy of the objects is the same before and after the collision. In an inelastic collision, the total kinetic energy after the collision is more than the total kinetic energy before the collision.

D. In an inelastic collision, the total kinetic energy of the objects is the same before and after the collision. In an elastic collision, the total kinetic energy after the collision is more than the total kinetic energy before the collision.

Question 11

In a fusion reaction in the Sun, 25 MeV of energy is released. What is the mass defect for this reaction?

A. 2.8×10^{-10} kg

B. 4.4×10^{-35} kg

C. 4.4×10^{-29} kg

D. 1.3×10^{-20} kg

Question 12

Which of the following statements is FALSE?

A. In transverse waves, the particles in the medium vibrate perpendicular to the direction of wave propagation.

B. Mechanical waves are the propagation of energy through a medium.

C. In longitudinal waves, the particles in the medium vibrate perpendicular to the direction of wave propagation.

D. Mechanical waves require a medium.

Question 13

Which of the following statements best explains standing waves in strings?

A. Standing waves form when two waves of equal amplitude interfere with one another while travelling in opposite directions along the same string.

B. Standing waves form when two waves of equal amplitude interfere with one another while travelling in the same direction along the same string.

C. Standing waves form when two waves of equal amplitude and frequency interfere with one another while travelling in the same direction along the same string.

D. Standing waves form when two waves of equal amplitude and frequency interfere with one another while travelling in opposite directions along the same string.

Question 14

Which of the following is not evidence observed from Young's Double Slit experiment that supports a wave nature of light?

A. In order for light to be polarised it must have a transverse wave nature.

B. In order for the pattern of bright and dark fringes to form on the screen, there must be diffraction of light through the slits.

C. In order for the pattern of bright and dark fringes to form on the screen, there must be interference of the two wave trains of light coming from each slit.

D. If light behaved purely as a particle then it would be expected to see only two bight bands on the screen.

Question 15

Which of the following is **not** a result of the photoelectric effect, which is wrongly-predicted by the wave-model of light?

- **A.** Increasing the intensity of light incident on a photocell increases the maximum photocurrent.
- **B.** Increasing the intensity of light incident on a photocell increases the stopping voltage.
- **C.** Increasing the frequency of light incident on a photocell increases the stopping voltage.
- **D.** Increasing the duration of light incident on a photocell has no effect of the stopping voltage.

Question 16

Which of the following best describes the quantised states of the atom as evidence for the dual nature of matter?

- **A.** Orbital electrons can only maintain a steady energy level if they established a circular standing wave with a circumference equal to the exact value of their de Broglie wavelengths to avoid destructive interference with itself.
- **B.** Orbital electrons can only emit an quantised energy levels if they established a circular standing wave with a circumference equal to the exact value of their de Broglie wavelengths to avoid destructive interference with itself.
- **C.** Orbital electrons can only maintain a steady energy level if they established a circular standing wave with a circumference equal to a whole-number multiple of their de Broglie wavelengths to avoid constructive interference with itself.
- **D.** Orbital electrons can only maintain a steady energy level if they established a circular standing wave with a circumference equal to a whole-number multiple of their de Broglie wavelengths to avoid destructive interference with itself.

Question 17

Which of the following describes how diffraction from a single slit experiment can be used to illustrate Heisenberg's uncertainty principle?

A. Increasing the slit-width, decreases the positional uncertainty, which decreases the uncertainty of the momentum of the particles passing through the slit, causing a increase in the extent of diffraction on the screen.

B. Increasing the slit-width, increases the uncertainty of the momentum of the particles passing through the slit, which decreases the positional uncertainty, causing a increase in the extent of diffraction on the screen.

C. Increasing the slit-width, increases the positional uncertainty, which decreases the uncertainty of the momentum of the particles passing through the slit, causing a decrease in the extent of diffraction on the screen.

D. Increasing the slit-width, increases the uncertainty of the momentum of the particles passing through the slit, which decreases the positional uncertainty, causing a decrease in the extent of diffraction on the screen.

Question 18

In an experiment, what is the variable that is being measured referred to as?

A. Control variable

B. Dependent variable

C. Independent variable

D. Measurement variable

Questions 19 and 20 relate to the following information.

Two students took measurements of diffraction patterns formed with a double-slit slide in a version of Young's double slit experiment. This was used to calculate the slit separation of the slide, which was known to be 0.130 mm. The results of their trials are shown below:

Trial	Slit separation
1	0.121
2	0.120
3	0.122
4	0.120
5	0.122

Question 19

Which of the following best describes the data set shown above?

A. Precise and accurate

B. Imprecise and accurate

C. Imprecise and inaccurate

D. Precise and inaccurate

Question 20

If the systematic errors in the experiment outlined above are negligible, the measurement uncertainty of the results is approximately

A. 0.001 mm

B. 0.121 mm

C. 0.009 mm

D. 0.002 mm

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 (10 marks)

A satellite of mass 1.50 x10^3 kg is orbiting the Earth (which has a mass, m_E= 5.98 × 10^{24} kg, and a radius, r_E= 6.37 × 10^6 m) at a distance of 400 km above the Earth's surface.

a. Calculate the magnitude of the gravitational field strength at this altitude. 2 marks

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N kg^{-1}

b. Calculate the magnitude of the force on the satellite due to the Earth's gravitational field acting on it at this altitude. 2 marks

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N

c. Calculate the period of orbit of this satellite at this altitude. 3 marks

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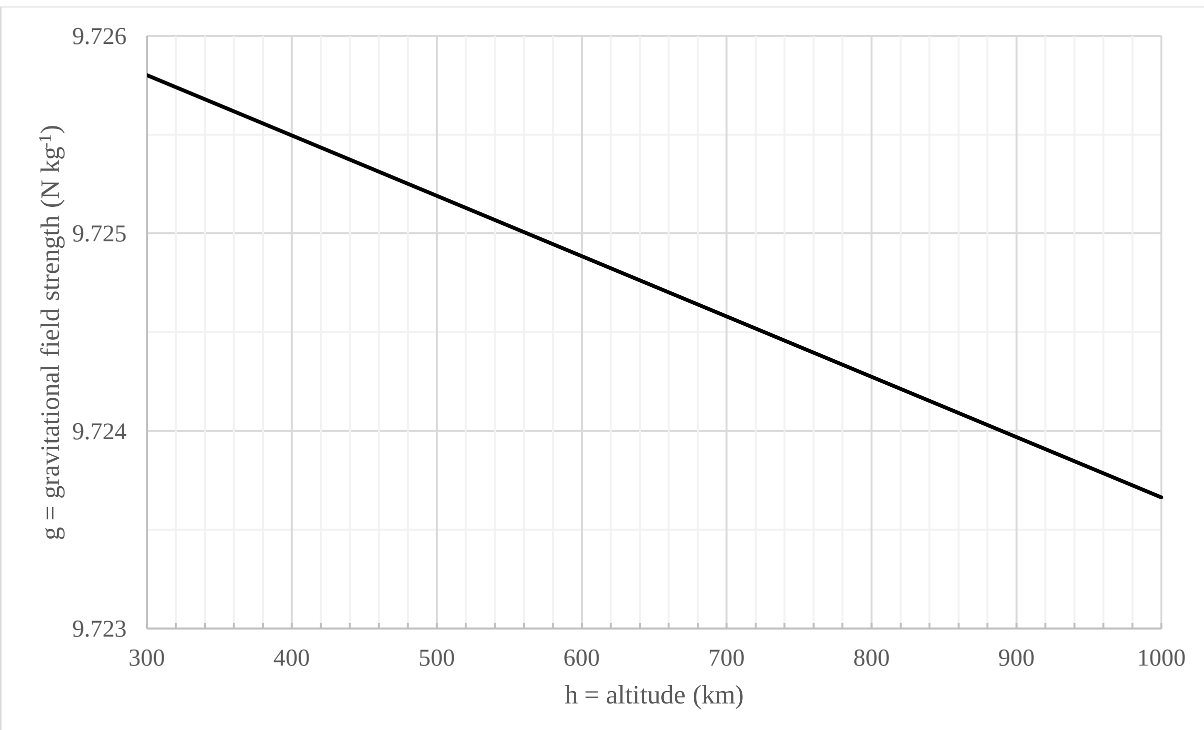
s

d. The satellite uses its thrusters to extend its orbital radius by an additional 500 km. A graph of the gravitational field strength as a function of altitude is presented below:



Calculate the minimum work required to achieve this change in gravitational potential energy. 3 marks

J

Question 2 (3 marks)

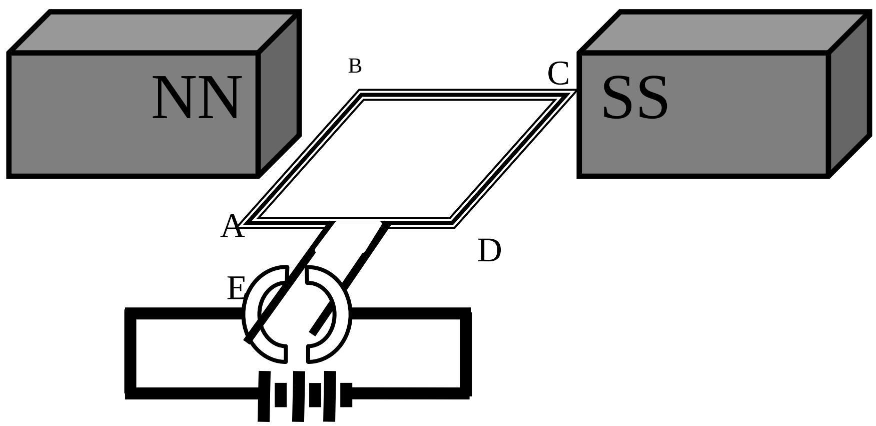
Two charged parallel plates are placed 5.0 mm apart and a potential difference of 6.0 V is applied across them.

Calculate the force of the electric field of these two plates on a free electron accelerated from the negative plate to the positive plate. 3 marks

N

Question 3 (8 marks)

Below is a simplified diagram of a model DC motor: The coil of the motor has 300 turns of wire with each of the sides (AB, BC & CD) having a length of 1.5 cm. The coil is housed within a uniform magnetic field of 0.080 T between the magnets and a current of 40 mA can be made to pass through the wires when the circuit with the voltage source is complete.



a. Calculate the magnitude of force on the side AB when the loop is in the position shown above.

2 marks

N

b. Is the magnitude and/or direction of the force on the side BC different to that for the side AB when the loop is in the position shown above? **Explain your Answer.**

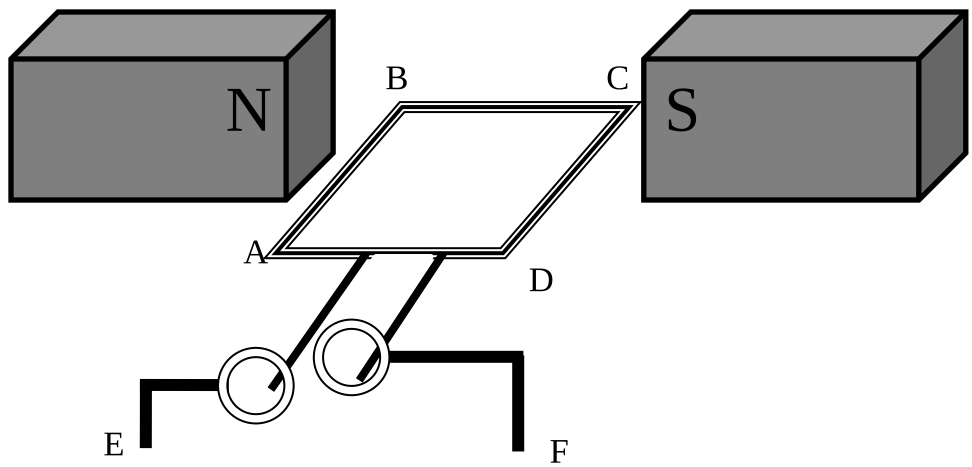
2 marks

c. Is the magnitude and/or direction of the force on the side CD different to that for the side AB when the loop is in the position shown above? **Explain your answer.** 2 marks

d. Is the magnitude and/or direction of the force on the side AB different to that for when the loop has rotated by 10^{O} compared to the position shown above? **Explain your answer.** 2 marks

Question 4 (8 marks)

A generator is constructed using a square coil with 200 turns of wire with each of the sides (AB, BC & CD) having a length of 0.05 m which are connected through slip-rings to the terminals at E and F. The coil is housed within a uniform magnetic field of 0.50 T. The coil is rotated at a rate of 2.50 Hz.



a. Calculate the magnitude of the change in flux through the coil that occurs in the first quarter turn as it is rotated clockwise. 3 marks

Wb

b. Calculate the magnitude of the average voltage of the EMF generated by the generator. 3 marks

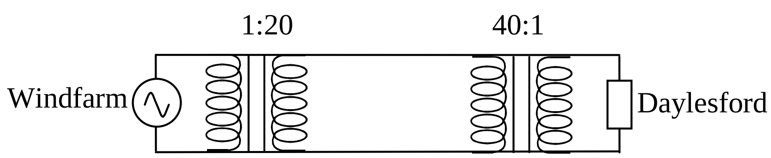
V

c. If the peak voltage from this generator were 3.93 V, calculate the associated RMS voltage. 2 marks

V

Question 5 (10 marks)

A community owned wind farm located 10.0 km from the Victorian town of Daylesford is capable of generating 4.1 MW of electrical power for the town with a peak voltage of 600 V. The transmission lines between the windfarm and the town have a total resistance of 45.0 Ω. To address potential transmission losses, the community have added a 1:20 step-up transformer and a 40:1 step-down transformer to the circuit above, at the windfarm and nearby the town of Daylesford, respectively. For each of these transformers, assume the power loss of transformation is negligible.



a. Calculate the current that would flow through the transmission lines when these transformers are used to connect the windfarm to Daylesford in the way shown in the diagram above. 3 marks

A

b. Calculate the voltage that would be available to Daylesford, taking into account transmission losses with the transformer now in place. 4 marks

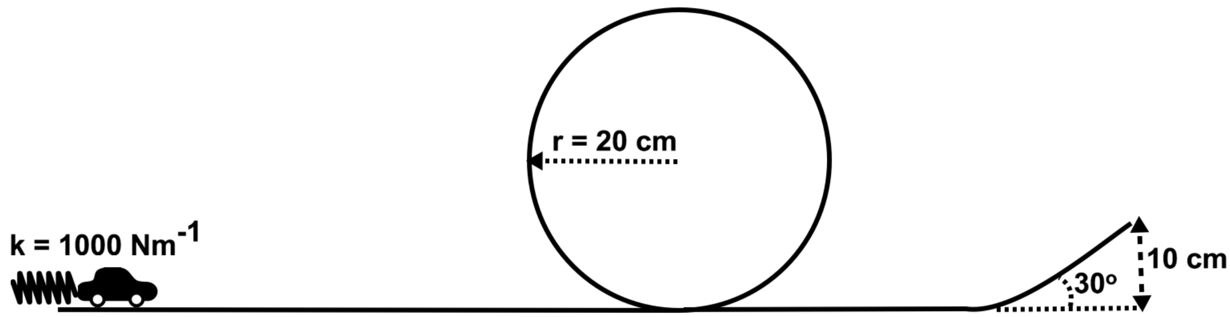
V

c. Calculate the power 'lost' in the transmission lines now that the transformers are being used. 3 marks

W

Question 6 (13 marks)

Ellen is carrying out an experiment with a toy car that is launched by a spring, travels through a vertical loop, and then off a jump. The setup is shown below.



The spring constant for the launching spring is 1000 Nm^{-1}, the vertical loop has a radius of 20cm, and the jump is on an angle of 30^{o}, with a height of 10 cm. The toy car has a mass of 50 grams.

a. If the spring is compressed by 3.0 cm and then released in order to accelerate the toy car, calculate the magnitude of the velocity of the car just before it enters the vertical loop. Ignore friction and air resistance. 2 marks

ms^{-1}

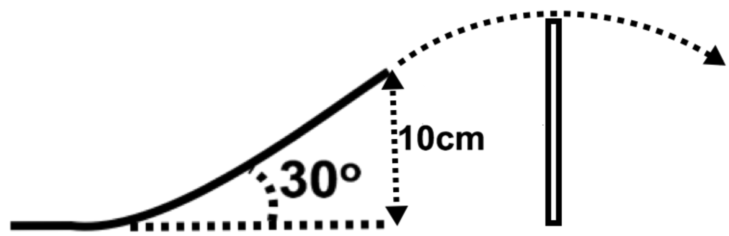
b. Calculate the normal reaction force acting on the toy car at the top of the vertical loop. Ignore friction and air resistance. 4 marks

N

c. Calculate the horizontal and vertical components of the toy car's velocity just before it leaves the jump. 3 marks

Horizontal: ms^{-1} Vertical: ms^{-1}

d. Ellen wants to determine the maximum height a wall can be so that the car can just jump over it. She also needs to determine how far from the jump the wall needs to be placed to coincide with the maximum height reached in the car's projectile motion, as shown in the diagram below.



Calculate both the maximum height of the wall and how far she should place it from the jump in order for the toy car to just make it over. 4 marks

Maximum Height: m

Distance from jump: m

Question 7 (10 marks)

A truck of mass 6000 kg is travelling west at a speed of 25 m s^{-1} when it collides with a car of mass 1200kg travelling east at a speed of 20 m s^{-1}. The vehicles become locked together during the collision. The collision took 0.90 s.

a. Calculate the magnitude and direction of the velocity of the joined vehicles immediately after the collision? Assume it is an isolated collision. 3 marks

Magnitude: ____ ms^{-1} Direction: ____

b. Calculate the magnitude and direction of the change of momentum of the car. 2 marks

Magnitude: ____ $kgms^{-1}$ Direction: ____

c. Calculate the magnitude and direction of the average force that the car exerts on the truck during the collision. 2 marks

Magnitude: N Direction:

d. Was the collision elastic or inelastic? Support your answer with calculations. 3 marks

Circle correct response: ELASTIC / INELASTIC

Question 8 (4 marks)

Andrew is playing darts on his spaceship making its way out into the solar system. He is standing 3 m from the dartboard, and from Andrew's perspective, the darts take 0.2 seconds to reach the board. The darts are being thrown parallel to the direction of the spaceship's motion. Andrew and his spaceship fly past Asoka who is orbiting Earth at a relative speed of 1.2×10^8 ms^{-1}.

a. Calculate the distance from Andrew to the dartboard from Asoka's measurements. 2 marks

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m

b. Calculate the flight time of the darts from Asoka's measurements. 2 marks

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s

Question 9 (6 marks)

A metal bar is repeatedly lowered and raised into the surface of water at one end of a 1.25 meter wave tank at a rate of 20 times every minute. It takes 2.50 seconds for each resulting wave to travel the length of the tank before reflecting back towards the bar. The bar moves a total of 4.00 cm from its highest to its lowest point of each oscillation as it displaces the surface of the water by an equal amount above and below its resting level.

Determine the following values for the wave described above;

a. Amplitude 1 mark

m

b. Period 1 mark

s

c. Frequency 1 mark

Hz

d. Speed 1 mark

s

e. Wavelength 2 marks

m

Question 10 (5 marks)

A narrow beam of monochromatic light is passed through two narrow slits 0.005 m apart. A diffraction pattern appears on a screen 2.0 m away and the 3rd bright band from the centre is found to be 0.03 m from the centre of the diffraction pattern.

a. Find the path difference of the two wave trains arriving at the 3rd bright band in terms of the number of wavelengths of that light. 1 mark

wavelengths

b. Calculate the wavelength of the monochromatic light used to produce the diffraction pattern. 2 marks

m

c. Calculate the path difference of the two wave trains arriving at the 3rd dark band measured in meters. 2 marks

m

Question 11 (11 marks)

A group of 10 students are each asked to measure the fringe separation in a double slit diffraction pattern on a screen 3 metres from a double slit slide. Each student is assigned a different inter-slit width, and they are using a laser with a wavelength of 650nm. Each student measures three different inter-fringe widths and takes the average value. The averaged results of all ten students are shown below:

Student	Inter-slit width (mm)	Inter-fringe spacing (mm)
1	0.050	40
2	0.075	25
3	0.100	20
4	0.125	16
5	0.150	13
6	0.175	11
7	0.200	10
8	0.225	9
9	0.250	8
10	0.275	7

a. In this particular data collection, state which is the independent variable and which is the dependent variable. 1 mark

Independent Variable:

Dependent Variable:

b. Plot the data on the following grid with the independent variable on the horizontal axis. Include axis labels and units and draw a line of best fit. 4 marks

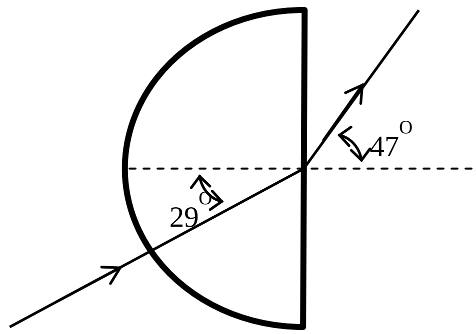
c. How could the students best describe the type of relationship that exists between the two variables?
2 marks

d. List the control variables in this experiment. 2 marks

e. Outline one source of error in the experiment carried out by the students, and one safety concern that would need to be addressed. 2 marks

Question 12 (4 marks)

A beam of light travelling through air (n = 1.00) is incident on a semicircular prism. The beam passes through the prism and is incident on the centre of the straight edge at an angle of 26^{O}, as shown below, and then exits at an angle of 47^{O} back into the air.



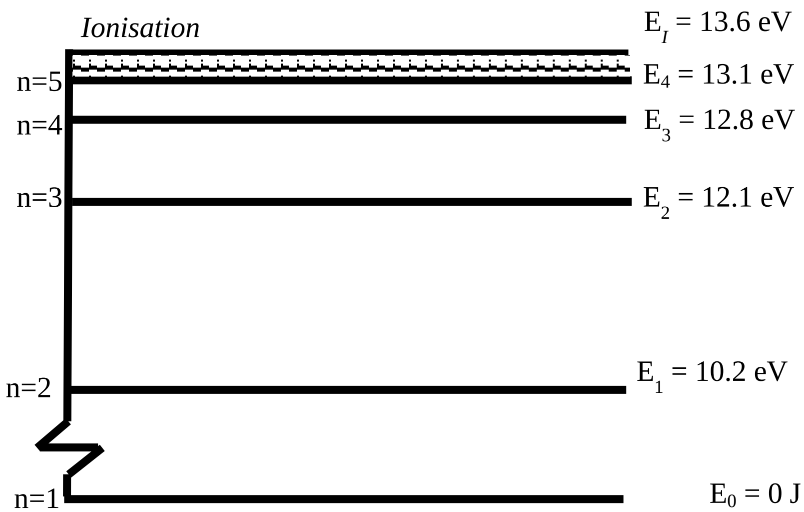
a. Determine the refractive index for the semicircular prism shown above. 2 marks

b. Determine the critical angle for the situation shown above with the semicircular prism. 2 marks

o

Question 13 (6 marks)

The following diagram shows the associated Energy Level diagram for a hydrogen atom with excitation energy of electrons in a hydrogen atom for the ground state and the first four excited states:



a. For an electron in the second excited state, what are the highest frequencies of light that could be emitted from this hydrogen atom? 3 marks

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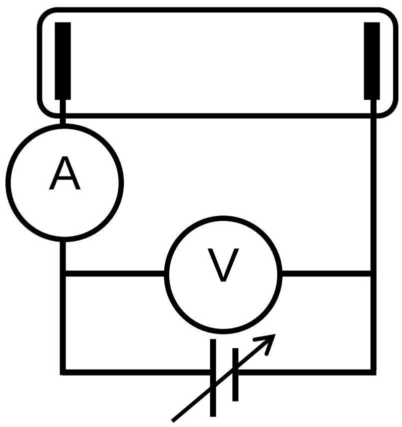
Hz

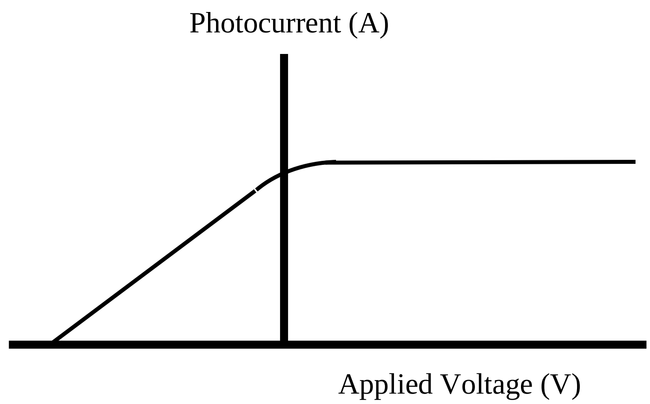
b. If a photon with a wavelength 1.77 μm of were absorbed by this hydrogen atom, what would the principal quantum number of the final state of this hydrogen atom be? 3 marks

n=

Question 14 (9 marks)

For the diagram below, the graph on the right was plotted from data obtained by varying the applied voltage across the photocell (the Voltmeter) and measuring the value of the photocurrent (the Ammeter). In one experiment, light with a frequency of 6.90×10^{14} Hz was used and a stopping voltage of 1.31 V and maximum photocurrent of 0.5 μA were recorded.





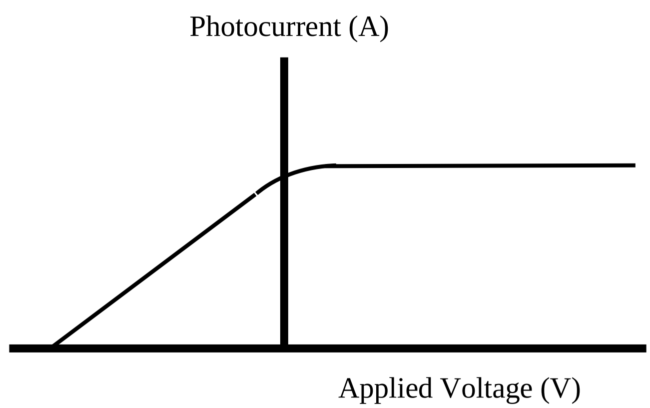
a. Based on these results, calculate the value of the work function (φ) of the metal used in the photocell in joules (J). 3 marks

J

b. Based on these results, calculate the value of the threshold frequency (the minimum frequency required to generate a photocurrent). 3 marks

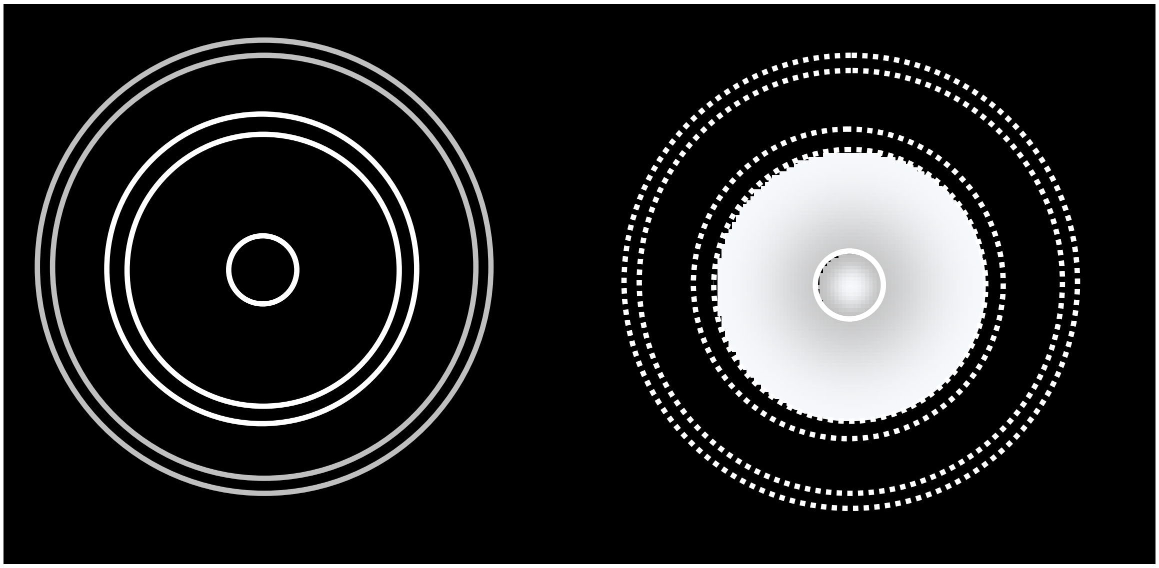
Hz

c. Draw a new line on the graph below to show the effect of increasing the intensity of light on the photocurrent and explain why this provides evidence against the wave-like nature of light. 3 marks



Question 15 (3 marks)

The diagram bellow shows circular diffraction patterns for X-rays (*left*) and electrons with a speed of 2.35 $\times 10^{6}$ m s^{-1} (*right*) passing through Aluminium foil.



Calculate the wavelength of the X-rays that were used to produce the image on the left.

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____

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____

____

nm

VCE Chemistry **NAME:** ____________________

Section A: Multiple Choice Answer Sheet

For each multiple choice question, shade letter of your choice.

Question				
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D

Solution Pathway

NOTE: This task is sold on condition that it is NOT placed on any school network or social media site (such as Facebook, Wikispaces etc.) at any time.

NOT FOR PRIVATE TUTOR USE.

FORMULA & DATA SHEET

This is available from the site below and must be provided to students.

http://www.vcaa.vic.edu.au/Documents/exams/physics/physics-formula-w.pdf

Below are sample answers. Please consider the merit of alternative responses.

SECTION A: Multiple Choice

Question	Answer	Explanation (if required)
Question 1	**D**	Field direction N->S, Don't cross, Density ~ Strength
Question 2	**B**	
Question 3	**C**	Right Hand Slap: e ~ -I
Question 4	**B**	$r = mv/qB$
Question 5	**A**	Right Hand Grip: $\Delta\Phi = \Phi f - \Phi i = 0 - in$ $\therefore$ induced current $\Phi = in$
Question 6	**B**	
Question 7	**A**	
Question 8	**B**	
Question 9	**D**	
Question 10	**A**	
Question 11	**C**	$\Delta E = \Delta mc^2$, $\Delta m = \Delta E/c^2 = (25\times 10^6 \times 1.6\times 10^{-19})/(3\times 10^8)^2$
Question 12	**C**	
Question 13	**D**	
Question 14	**A**	
Question 15	**B**	
Question 16	**D**	
Question 17	**C**	

Question 18 **B**

Question 19 **D**

Question 20 **A** Mean = 0.121, Max. variation from the mean is 0.001 mm

SECTION B

Question 1 (10 marks)

a. 2 marks

$g = GM/r^2 = (6.67\times10^{-11} \times 5.98\times10^{24}) / (6.37\times10^6 + 0.40\times10^6)^2$ [1 mark]

$g =$ $\underline{\mathbf{8.70\ N\ kg^{-1}}}$ [1 mark]

b. 2 marks

$F_G = mg = 1.50 \times10^3 \times 8.70$ [1 mark]

$= 13{,}053 =$ $\underline{\mathbf{1.31\times10^4\ N}}$ [1 mark]

c. 3 marks

$4\pi^2 r/T^2 = g$ [1 mark]

$\therefore T = \sqrt{(4\pi^2 r/g)}$ [1 mark]

$= \sqrt{(4\pi^2(6.37\times10^6 + 0.40\times10^6) / 8.7)} =$ $\underline{\mathbf{5.54\times10^3\ s}}$ [1 mark]

OR:

$r^3/T^2 = GM/4\pi^2$ [1 mark]

$\therefore T = \sqrt{(r^3 4\pi^2/GM)}$ [1 mark]

$=$ $\underline{\mathbf{5.54\times10^3\ s}}$ [1 mark]

d. 3 marks

W = *Area under g-h graph* x *mass* $= mA_{trapezium}$ [1 mark]

$= m \times ½(a+b)h = 1.50\times10^3\ ½(9.7255+9.7240)500\times10^3$ [1 mark]

$= 750\times10^6 \times 19.4495/2 =$ $\underline{\mathbf{7.29\times10^9\ J}}$ [1 mark]

Question 2 (3 marks)

a. 3 marks

$Fd = qV$ [1 mark]

$\therefore F = qV/d = (1.6\times10^{-19} \times 6.0\ ) / 5.0 \times10^{-3}$ [1 mark]

$= \underline{\mathbf{1.92 \times10^{-16}\ N}}$ [1 mark]

Question 3 (8 marks)

a. 2 marks

$F = nB_{\perp}Il$ [1 mark]

$= 300 \times 80\times10^{-3} \times 40\times10^{-3} \times 0.015 = \underline{\mathbf{1.44\times10^{-2}\ N}}$ [1 mark]

b. 2 marks

[1 mark]: *Yes, the* ***magnitude*** *is different.*

[1 mark]: *The force on side BC is 0 as the field is parallel (whereas it is perpendicular for side AB).*

c. 2 marks

[1 mark]: *Yes, the* ***direction*** *is different (although the magnitude is the same).*
[1 mark]: *The force on side CD is opposite to side AB as the current is travelling in the opposite direction (may refer to the Right Hand Slap Rule).*

d. 2 marks

[1 mark]: *No, it is the same.*
[1 mark]: *Neither the magnitude nor the direction of the field have changed relative to the current.*

Question 4 (8 marks)

a. 3 marks

$\Delta\Phi = \Phi_f - \Phi_i$ [1 mark]
$= B_{\perp}A - 0$ [1 mark]
$= 0.50 \times (50\times10^{-3})^2 = 0.50 \times 2500\times10^{-6} = \underline{\mathbf{1.25\ mWb}}$ [1 mark]

b. 3 marks

$\Delta t = \frac{1}{4}T = \frac{1}{4}(1/f) = 1/(4 \times 2.5) = 1/10 = 0.1\ s$ [1 mark]

$\varepsilon = -n\Delta\Phi/\Delta t$ [1 mark]

$= (-300 \times 2.50\times10^{-3})/0.1 =$ ***3.75 V*** [1 mark]

c. 2 marks

$V_{RMS} = V_{peak}/\sqrt{2}$ [1 mark]

$= 3.93 / 1.41 =$ **2.78 V** [1 mark]

Question 5 (10 marks)

a. 3 marks

$V_{RMS} = V_{peak}/\sqrt{2} = 600 / 1.41 = 424.26\ V$ [1 mark]

$P = IV \therefore I = P/V = (4.1\times10^3)/424 = 9.67\ A$ [1 mark]

$I_2/I_1 = N_1/N_2 = \therefore I_2 = I_1N_1/N_2 = 9.67/20 =$ ***0.483 A*** [1 mark]

b. 4 marks

$V_2/V_1 = N_2/N_1 = \therefore V_2 = V_1N_2/N_1 = 424.26 \times 20 = 8485\ V$ [1 mark]

$V_{load} = V_{supply} - V_{loss}$ [1 mark]

$= 8485 - IR = 8485 - 0.483\times45.0 = 8463V$ [1 mark]

$V_2/V_1 = N_2/N_1 = \therefore V_2 = V_1N_2/N_1 = 8463 / 20 =$ ***423 V*** [1 mark]

c. 3 marks

$P_{loss} = I^2R$ [1 mark]

$= 0.483^2\times45.0$ [1 mark]

$=$ ***10.5 W*** [1 mark]

Question 6 (13 marks)

a. 2 marks

$E_{EP} = ½\ kx^2 = ½×1000×0.030^2 = 0.45\ J$ [1 mark]

$v = \sqrt{(2E_K/m)} = \sqrt{(2×0.45/0.050)} = \underline{\mathbf{4.2\ ms^{-1}}}$ [1 mark]

b. 4 marks

E_K *at top of loop* $= 0.45 – mgh = 2 – (0.050×9.8×0.40) = 0.25\ J$ [1 mark]

Velocity at top of loop $= v = \sqrt{(2E_K/m)} = \sqrt{(2×0.25/0.050)} = 3.2\ ms^{-1}$ [1 mark]

$F_{NET} = F_C$ *at top* $= mv^2/r = 0.05×(\sqrt{10})^2/0.2 = 2.5\ N$ [1 mark]

F_N *at top* $= F_C - F_W = 2.5 – (0.050×9.8) = \underline{\mathbf{2.0\ N}}$ [1 mark]

Note: If students use their rounded value for *v*, of 3.2 ms^{-1}, they will get a slightly different answer.

c. 3 marks

E_K *at top of jump* $= 0.45 – (mgh) = 0.45 – (0.050×9.8×0.10) = 0.40\ J$ [1 mark]

Velocity at top of jump $= v = \sqrt{(2E_K/m)} = \sqrt{(2×0.40/0.050)} = 4.0\ ms^{-1}$ [1 mark]

$V_{HORIZONTAL} = 4×\cos(30) = 3.5\ ms^{-1}$, $V_{VERTICAL} = 4×\sin(30) = 2.0\ ms^{-1}$ [1 mark]

d. 4 marks

<u>Vertical (UP) motion:</u>
$u = 2.0\ ms^{-1}$
$a = -9.8\ ms^{-2}$
$v = 0\ ms^{-1}$
$s = v^2-u^2/2a = (0^2-2^2)/(2×-9.8) =$ ***<u>0.20 m = Maximum wall height</u>*** [1 mark]
$t = v-u/a = (0 – 2.0)/(-9.8) = 0.20\ s$ [1 mark]

<u>Horizontal motion:</u>
$u = 3.5\ ms^{-1}$
$a = 0\ ms^{-2}$
$t = 0.20\ s$ [1 mark]
$s = ut = 3.5×0.20 =$ ***<u>0.70 m = Distance of wall from jump</u>*** [1 mark]

Question 7 (10 marks)

a. 3 marks

$m_A = 6.0 \times 10^3$ kg, $m_B = 1.2 \times 10^3$ kg, $u_A = 25$ ms^{-1}, $u_B = -20$ ms^{-1} [1 mark]
$m_A u_A + m_B u_B = m_A v_A + m_B v_B$
$m_A u_A + m_B u_B = v_{A\&B}(m_A + m_B)$
$v_{A\&B} = (m_A u_A + m_B u_B)/(m_A + m_B)$ [1 mark]
$v_{A\&B} = (6.0\times10^3 \times 25 + 1.2\times10^3 \times -20)/(6.0\times10^3 + 1.2\times10^3)$
$v_{A\&B} = (150\times10^3 - 24\times\square\square^{\square})/(7.2\times10^3) = (126\times10^3)/(7.2\times10^3) =$ <u>**17.5 ms^{-1} West**</u> [1 mark]

b. 2 marks

$\Delta p = p_f - p_i = mv - mu = m(v - u)$ [1 mark]
$\Delta p = 1.2\times10^3\times(17.5 - -20) = 1.2\times10^3\times37.5 =$ <u>**4.5×10^4 kgms^{-1} West**</u> [1 mark]

c. 2 marks /

$\Sigma F\Delta t = \Delta p,\ \Delta p_{C\text{-}T} = -\Delta p_{T\text{-}C},\ \Delta t = 0.90$ s [1 mark]
$\therefore \Sigma F = \Delta p/\Delta t = -45\times10^3/0.90 =$ <u>**5.0×10^4 N East**</u> [1 mark]

d. 3 marks

If elastic: $\Sigma E_{Kf} = \Sigma E_{Ki}$ [1 mark]

$½m_A v_A^2 + ½m_B v_B^2 =?= ½m_A u_A^2 + ½m_B u_B^2$

$½(6.0\times10^3\times25^2) + ½(1.2\times10^3\times-20^2) = ? = ½(6.0\times10^3\times17.5^2) + ½(1.2\times10^3\times17.5^2)$

$1{,}875\times10^3 + 240\times10^3 =?= 918.75\times10^3 + 183.75\times10^3$ [1 mark]

$2{,}115\times10^3 \neq 1102.5\times10^3$

$\therefore$ <u>***Inelastic***</u> [1 mark]

Question 8 (4 marks)

a. 2 marks

$L = L_o / \gamma$

$\gamma 1 / \sqrt{(1-(v^2/c^2))} = 1 / \sqrt{(1-(1.2^2/3^2))} = 1.09$ [1 mark]

L = 3 / 1.09 = <u>**2.75 m**</u> [1 mark]

b. 2 marks

$t = t_o \cdot \gamma$

$\gamma = 1.09$ [1 mark]

t = 0.2 × 1.09 = **0.218 s** [1 mark]

Question 9 (6 marks)

a. Amplitude 1 mark

Half the total vertical displacement of the bar = 4.00 cm / 2 =2.00 cm = ***0.0200 m***

b. Period 1 mark

The amount of time for one complete cycle = time / cycles = 60 s / 20 = ***3.00 s***

c. Frequency 1 mark

f = 1/T = 1/3.00 s = ***0.33 Hz***

d. Speed 1 mark

v = d / t = 1.25 / 2.50 = $\mathbf{0.50\ m\ s^{-1}}$

e. Wavelength 2 marks

$v = \lambda f \quad \therefore \lambda = v / f$ [1 mark]

$\therefore \lambda = 0.50 / (1/3) =$ **1.50 m** [1 mark]

Question 10 (5 marks)

a. 1 mark

n = 3 , therefore pd = $\mathbf{3\lambda}$

b. 2 marks

$\lambda = \Delta x.d/L$ [1 mark]

$= 0.01 \times 0.005 / 2 =$ $\mathbf{2.5\times10^{-5}\ m}$ [1 mark]

c. 2 marks

$pd = (n - 1/2)\lambda$ [1 mark]

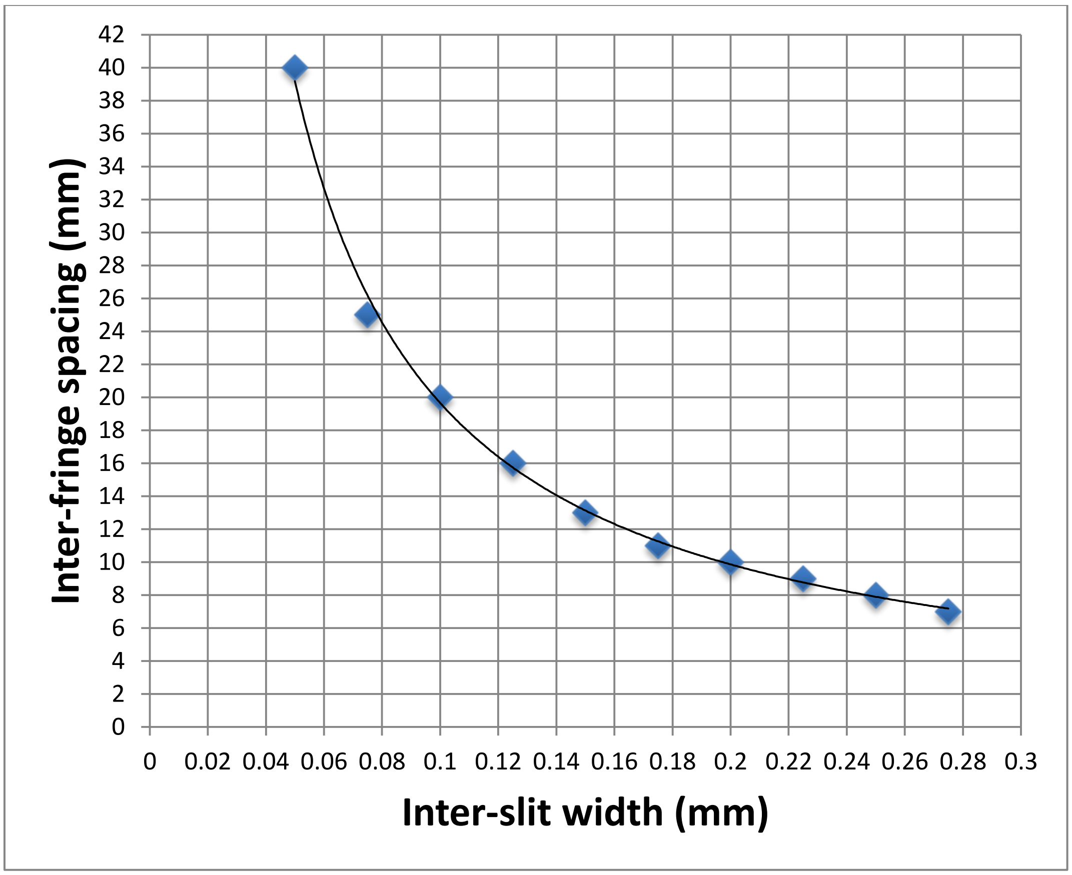
$= 2.5 \times 2.5 \times 10^{-5} = \underline{\mathbf{6.25 \times 10^{-5}\ m}}$ [1 mark]

Question 11 (11 marks)

a. 1 mark

Independent Variable: ***Inter-slit width***
Dependent Variable: ***Inter-fringe spacing***

b. 4 marks



[1 mark] for correct variables on axis
[1 mark] for correct labels and units
[1 mark] for correctly plotted points
[1 mark] for appropriate line of best fit.

c. 2 marks

- *Inverse/reciprocal relationship.* [1 mark]
- *Inter-fringe spacing is inversely related to inter-slit width.* [1 mark]

d. 2 marks

Slit-screen distance [1 mark]
Wavelength of light [1 mark]

e. 2 marks

Possible sources of error: [1 mark for any one stated]

- *Slit-screen distance accuracy*
- *Measurement of inter-fringe spacing*
- *Accuracy of the manufacturer's stated inter-slit width*
- *Accuracy of the manufacturer's stated laser wavelength.*

Possible safety concerns: [1 mark for any one stated]

- *Laser light entering eyes*

Question 12 (4 marks)

a. 2 marks

$n_1 \sin \theta_1 = n_2 \sin \theta_2$

$\therefore n_1 = n_2 \sin \theta_2 / \sin \theta_1$ [1 mark]

$= 1.00 \sin(47^O) / \sin(29^O) = \underline{\mathbf{1.51}}$ [1 mark]

b. 2 marks

$n_1 \sin \theta_1 = n_2 \sin \theta_2$ AND $\theta_2 = 90^O$, when $\theta_1 = \theta_C$ [1 mark]

$\therefore \theta_C = \sin^{-1}[n_2 \sin \theta_2 / n_2] = \sin^{-1}[1.00 \sin(90^O) / 1.51] = \sin^{-1}[1 / 1.51] = \underline{\mathbf{41.5^O}}$ [1 mark]

Question 13 (6 marks)

a. 3 marks

$\Delta E = hf \;\therefore f = \Delta E/h$ [1 mark]

$= (E_f - E_i)/h$ [1 mark]

$= (0 - 12.1)/4.14\times10^{-15} = \underline{\mathbf{2.92\times10^{15}\ Hz}}$ [1 mark]

b. 3 marks

$\Delta E = hc/\lambda = (4.14\times10^{-15} \times 3.0\times10^{8})/(1.77\times10^{-6}) = 0.70\ eV$ [1 mark]

$\Delta E = E_f - E_i = 12.8 - 12.1 = 0.70,$ [1 mark]

n=3 to n=4 is the only transition that matches the energy $\therefore n =$ ***4*** [1 mark]

Question 14 (9 marks)

a. 3 marks

$E_{Kmax} = hf - W = eV_0$ [1 mark]

$\therefore W = hf - eV_0$ [1 mark]

$= 6.63\times10^{-34} \times 6.90\times10^{14} - 1.6\times10^{-19} \times 1.31 = \mathbf{2.48\times10^{-19}\ J}$ [1 mark]

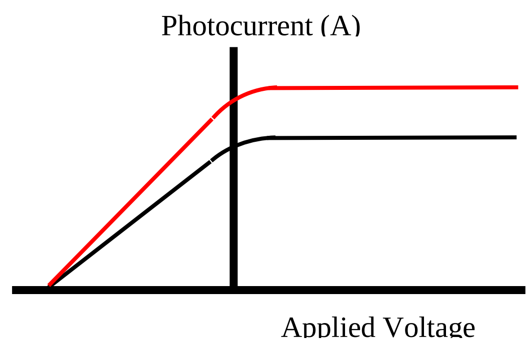
b. 3 marks

$E_{Kmax} = hf - W$ [1 mark]

$\therefore f = (E_{Kmax} + W)/h,\ \&,\ f_0 = (0+W)/h = W/h$ [1 mark]

$f_0 = 2.48\times10^{-19}/6.63\times10^{-34} = \mathbf{3.74\times10^{14}\ Hz}$ [1 mark]

c. 3 marks



[1 mark]: (line shown above) *All photocurrent values multiplied by a common factor greater than 1. NOTE: x-intercept (V_0) unchanged.*

[1 mark]: *According to wave-model; intensity is proportional to the amplitude and energy of the wave which should increase the stopping voltage (x-intercept: V_0): this is not the case.*

[1 mark]: *According to particle-model; intensity is proportional to number of photons/particles (not energy per photon/particle) which only increases the photocurrent (number of liberated electrons) and not the stopping voltage (x-intercept: V_0): this is in fact the case.*

Question 15 (3 marks)

$\lambda = h/p = h/mv$ [1 mark]

$= 6.63\times10^{-34} /(2.35\times10^{6} \times 9.1\times10^{-31})$ [1 mark]

$= 3.1\times10^{-10}$ = ***0.31 nm*** [1 mark]

