TSSM
Creating VCE Success

'2017 Examination Package' -
Trial Examination 9 of 9

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

PHYSICS

Units 3 & 4 – Written examination

(*TSSM's *2016 trial exam updated for the current study design)

QUESTION & ANSWER BOOK

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	17	17	110
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is permitted in this examination.

Materials supplied

- Question and answer book of 34 pages (including a multiple choice answer sheet).

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

Instructions for Section A

Answer **all** questions in pencil on the answer sheet provided for multiple choice questions.
Choose the response that is **correct** and that **best answers** the question.
A correct answer **scores** 1; an incorrect answer scores 0.
Marks will not be deducted for incorrect answers.
Unless 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

An electron is accelerated by a potential between two plates, experiencing a force of 5.76×10^{-14} N.

Determine the size of the electric field experienced by the electron.

A. 5.76×10^{5} N m^{-1}
B. 3.6×10^{5} N m^{-1}
C. 1.6×10^{5} N m^{-1}
D. 1.6×10^{-19} N m^{-1}

The following information applies to Questions 2 and 3

Another electron is accelerated by a potential between two plates, reaching a speed of 1.9×10^{8} m s^{-1}.

The electron now enters a magnetic field of strength 0.4 T as shown in Figure 1.

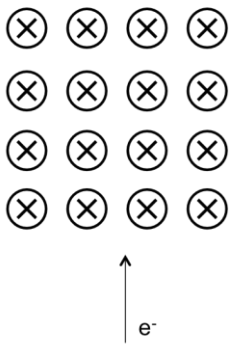


Figure 1

Question 2

Which of the following describes the direction that the electron will initially be deflected?

A. Right
B. Left
C. Into the page
D. Out of the page

SECTION A – continued

Question 3
Which of the following is the best estimate for the radius of curvature of the electron's path?

A. 2.7 mm
B. 2.7 m
C. 1.1 mm
D. 2.7×10^{-11}m

The following information applies to Questions 4 and 5.

A transformer is required to convert 240 V AC RMS to 12 V AC RMS. It has 4500 turns in its primary coil and carries 10 A AC RMS current in its primary coil

Question 4
Assuming an ideal transformer, which of the following is the correct number of turns required for the secondary coil?

A. 9×10^4
B. 225
C. 24
D. 20

Question 5
Which of the following is the best estimate for the peak current in the secondary coil?

A. 28 A
B. 200 A
C. 14 A
D. 283 A

Question 6
A ball with a mass of 0.5 kg is thrown vertically upward with a speed of 15 m s^{-1}. What are its speed and direction two seconds later?

A. 15 m s^{-1} upward
B. 4.6 m s^{-1} upward
C. zero
D. 4.6 m s^{-1} downward

SECTION A – continued
TURN OVER

Question 7

Terry and Chris pull hand-over-hand on opposite ends of a rope while standing on a frictionless frozen pond. Terry's mass is 25 kg and Chris's mass is 75 kg. If Terry's acceleration is 12 ms^{-2}, what is Chris's acceleration?

A. 36 m s^{-2}
B. 12 m s^{-2}
C. 6 m s^{-2}
D. 4 m s^{-2}

Question 8

Which of the following best describes an inertial frame of reference?

A. It is detectable because objects require a net force to maintain position within it.
B. It is accelerating at a rate of $\boldsymbol{g}$.
C. It is only located at rest on Earth.
D. There is no way to detect motion within it except by observing motion relative to other frames of reference.

Question 9

James is observing a pulsing light source on a vertical pole (h = 3.0 m) aboard his spacecraft whilst the craft is stationary in the inertial reference frame of our galaxy. He then observes an identical light source that is moving away from the craft at constant velocity of 0.4c (γ = 1.09)

Which of the following best describes the period of the moving pulse source from James' perspective?

A. It would appear to be pulsing faster than the one on board James' craft.
B. It would appear to be pulsing slower than the one on board James' craft.
C. It would appear to be pulsing at the same rate than the one on board James' craft.
D. It would be static (i.e. not pulsing at all).

SECTION A – continued

The following information applies to Questions 10 and 11

Table 1 details a range of characteristics for light sources.

Option	Range of wavelengths (nm)	Stimulated (ST) or spontaneous (SP) emission	Type Coherent (C) Incoherent (I)	In phase?
A	3	ST	C	Yes
B	3	SP	I	No
C	35	SP	I	No
D	35	ST	C	No

Table 1

Question 10

Which of the above options represents an LED source?

Question 11

Which of the above options represents an LASER source?

Question 12

A speaker broadcasts an audio source with a wavelength of 1.2 m. The sound travels at 330 m s^{-1} in the surrounding air.

Which of the following is the best estimate for the frequency of the source?

A. 330 Hz
B. 0.8 Hz
C. 275 Hz
D. 396 Hz

SECTION A – continued
TURN OVER

Question 13

Which of the following best explains the direction of oscillation of dust particles immediately adjacent to the speaker? Refer to Figure 2 for the direction.

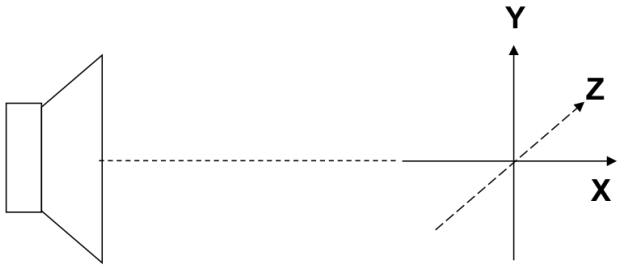


Figure 2

A. Oscillating about its rest position in a direction parallel to the x-axis.
B. Oscillating about its rest position in a direction parallel to the y-axis.
C. Oscillating about its rest position in a direction parallel to the z-axis.
D. Moving away from the speaker at 330 m s^{-1}.

Question 14

In an electromagnetic wave, the direction of the magnetic field

A. Will be parallel to the direction of the electric field.
B. Will be perpendicular to the direction of the electric field.
C. Will be parallel to the direction of travel of the wave.
D. Will be randomly oriented with respect to the direction of the electric field.

Question 15

What is the critical angle for light traveling from crown glass (n = 1.52) into water (n = 1.33)?

A. 42°
B. 53°
C. 57°
D. 61°

Question 16

Figure 3 below shows a wave. The arrow is showing the distance from the top of the wave to the bottom of the wave.

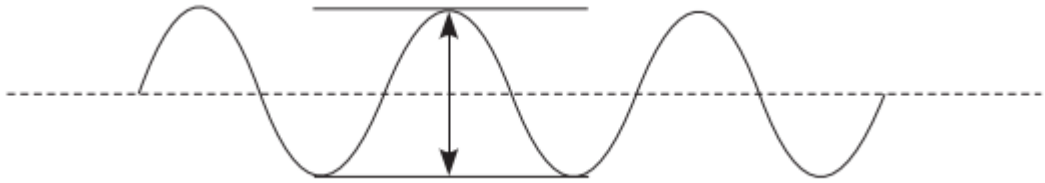


Figure 3

This arrow represents

A. the amplitude

B. twice the amplitude

C. the wavelength

D. twice the wavelength

The following information applies to Questions 17 to 19.

A hollow circular tube is closed at one end and induced into a series of resonant frequencies by an external source. The tube is 0.4 m long and sound travels at 330 m s^{-1} in the tube.

Question 17

Which of the following is the best estimate for the fundamental resonant frequency of the tube?

A. 103 Hz
B. 206 Hz
C. 309 Hz
D. 412 Hz

The source is now increased in frequency until the tube reaches the *next* resonant frequency.

Question18

Which of the following is now the best estimate for distance from the open end to the first antinode?

A. 0.133 m
B. 0.267 m
C. 0.1 m
D. 0.2 m

SECTION A – continued
TURN OVER

The tube is now opened at both ends.

Question 19

Which of the following best explains the effect on the magnitude of the fundamental resonant frequency?

A. The fundamental frequency will increase.
B. The fundamental frequency will decrease.
C. The fundamental frequency will remain the same.
D. The tube will no longer resonate, so there is no fundamental frequency.

Question 20

An observer standing in a room near a speaker records the intensity level of a variable-frequency source, as shown in Figure 3. Non-reflective materials on the walls reduce the reflection of the sound. The source is gradually reduced from 1200 Hz to 120 Hz.

Figure 3

Which of following best describes the comparative changes at X as the frequency decreases?

A. The sound intensity at X will decrease as the diffraction increases.
B. The sound intensity at X will decrease due to reflections.
C. The sound intensity at X will increase as the diffraction increases.
D. The sound intensity at X will decrease as the diffraction decreases.

END OF SECTION A

SECTION B – Short answer

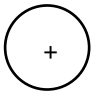
Instructions for Section B

Answer **all** questions in the spaces provided. Write using blue or black pen.
Where an answer box is provided, write your full answer in the box.
If an answer box has a unit provided in it, give your answer in that unit.
In questions where more than one mark is available, appropriate working **must** be shown.
Unless 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 (3 marks)

a. Draw the magnetic field around a wire carrying a current out of the page. 1 mark

b. Draw the electric field around two positive point charges. 2 marks



SECTION B - continued
TURN OVER

Question 2 (4 marks)

A charged body of mass 0.100 kg and charge +5.00 μC is placed in an electric field of intensity 5×10^5 NC^{-1} caused by another positive charge.

a. What is the force acting on the charge? 2 marks

N

b. Find the acceleration experienced by the charged body. 2 marks

m s^{-2}

Question 3 (4 marks)

Astronomers are looking for a potential Earth-like planet orbiting around a distant start with a mass twice that of our Sun ($m_{sun} = 2.0 \times 10^{30}$ kg). They find a potential object with an orbital period of 398 Earth days.

a. Calculate the radius of orbit of the object in kilometres. 2 marks

km

SECTION B – Question 3 - continued

b. Determine the orbital speed of the object. 2 marks

m s^{-1}

Question 4 (4 marks)

A solenoid is shown in Figure 1.

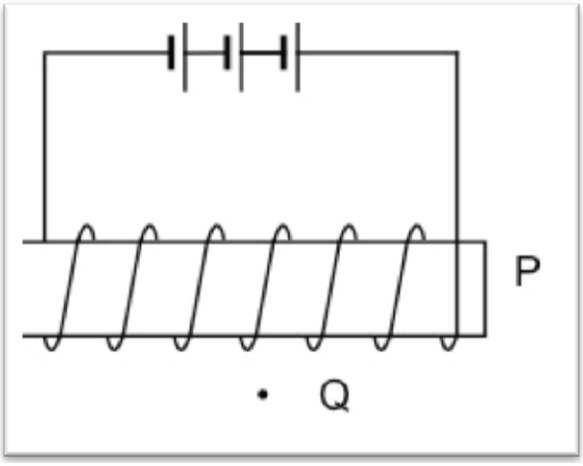


Figure 1

a. Referring to the convention shown in Figure 1, state the direction of the field at Point P. 1 mark

Direction:

SECTION B – Question 4 - continued
TURN OVER

A 6 cm piece of wire is positioned at point Q and carries a current of 1.3 A perpendicular to the page. This leads to a force of 0.02 N directed upwards on the wire.

b. Calculate the size of the magnetic field at Q and state the direction of the current in the wire at Q.

3 marks

Field strength:	T

Direction of current:

Question 5 (8 marks)

A basic DC motor is shown below in Figure 2.

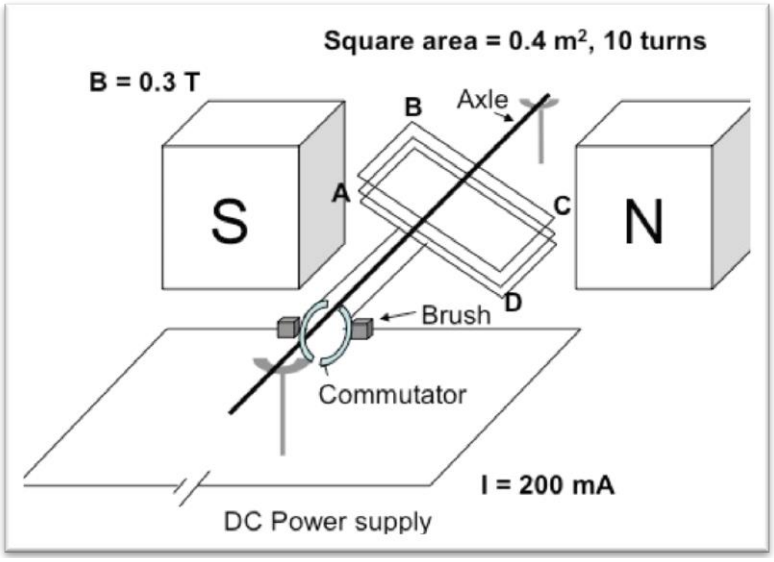


Figure 2

a. Calculate the size of force on side AB. 2 marks

	N

SECTION B – Question 5 - continued

b. Determine the direction of rotation of the coil. 2 marks

Starting from horizontal, the coil now rotates 45^{o}.

c. Which of the following statements is correct about the size of the force on side AB?

A. Increased
B. Decreased by 30%
C. Unchanged
D. Halved

2 marks

d. Explain the role of a split-ring commutator in a DC motor.

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2 marks

SECTION B - continued
TURN OVER

Question 6 (6 marks)

Consider the experiment shown below in Figure 3. As a circular coil of 10 loops enters a 0.15 T field over an interval of 0.2 s, the average *emf* generated is 85 mV.

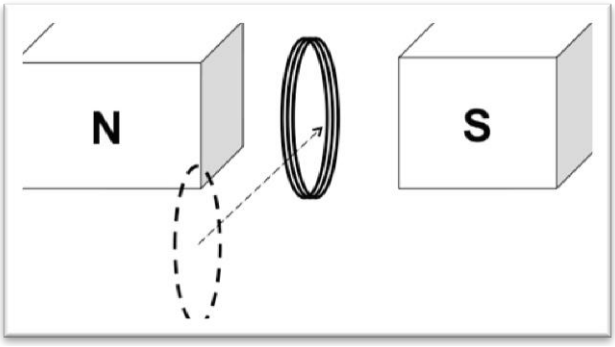

Figure 3

a. Determine the radius of the coil (to the nearest centimetre). 3 marks

cm

b. Determine the direction of the current when viewed from the south pole of the magnet. Explain your answer. 3 marks

Direction:

SECTION B - continued

Question 7 (7 marks)

A basic generator is shown in Figure 4. The generator operates at 5 Hz, with a coil area of 0.15 m^2 in a magnetic field of 0.2 T. There are 25 turns in the coil.

The coil initially rotates 90^o clockwise from horizontal to vertical.

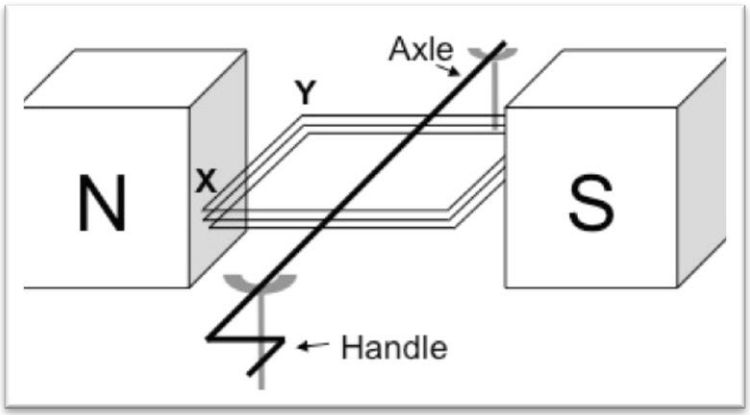

Figure 4

a. Determine the magnitude of the average voltage induced in the coil over the 90^o rotation. 2 marks

V

b. Determine the direction of current in the coil. Show reasoning. 3 marks

The rate of rotation of the coil is now increased to 15 Hz. 2 marks

c. Explain the effect on the induced voltage.

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Question 8 (9 marks)

As shown in Figure 5, a 400 V generator provides power to a remote house, linked by transmission lines of total resistance 3 Ω. A pair of transformers with turns ratio 1:5 are included in the system to improve the efficiency of the system. Initially, the current at the house is 30 A.

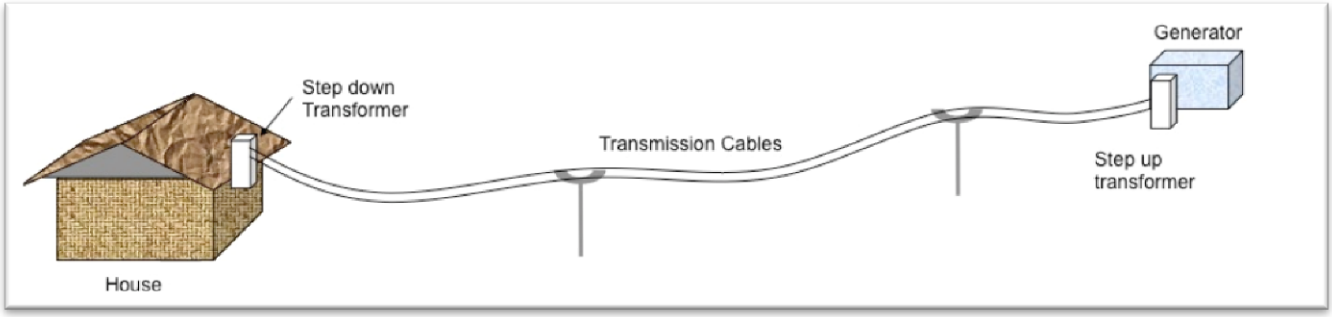

Figure 5

a. Calculate the current in the transmission lines. 1 mark

A

SECTION B – Question 8 - continued

b. Determine the voltage drop across the transmission lines. 2 marks

V

c. Determine the power lost in the system as a percentage of the power produced by the generator.

3 marks

%

d. Calculate the voltage supplied on the secondary side of the transformer at the house.

3 marks

V

SECTION B - continued
TURN OVER

Question 9 (11 marks)

A 5 kg toy truck pulls a 2 kg trailer up a 10^{o} inclined plane as shown in Figure 6. The truck wheels generate a driving force of 60 N up the plane. Rolling friction of 15 N acts on the truck and 3 N on the trailer.

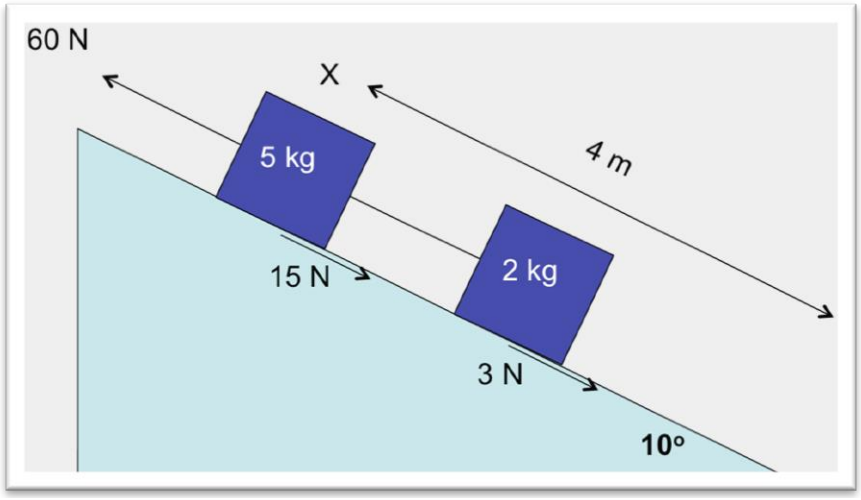

Figure 6

a. Determine the overall acceleration of the truck and trailer. 2 marks

m s^{-2}

b. Determine the tension in the coupling between the truck and the trailer. 2 marks

N

SECTION B – Question 9 - continued

When the cart reaches Point X, the system is brought to rest and the trailer is released to roll 4 m freely down the plane (subject to rolling friction of 3 N).

c. Show that the speed of the trailer will be approximately 1.3 m s^{-1} when it reaches the base of the ramp.

3 marks

Reaching a smooth, horizontal frictionless surface, the trailer collides with another stationary cart (mass = 3.5 kg) at the bottom of the ramp. The trailer and cart stick together.

d. Determine the final velocity of the pair. 2 marks

m s^{-1}

e. With the aid of calculations, determine whether the collision is elastic or inelastic.

2 marks

SECTION B - continued
TURN OVER

Question 10 (8 marks)

A 2.4 kg mass is attached to a spring with natural length 4 m. The mass is raised to a height of 10 m as shown in Figure 7. The mass is then released to fall and extend the spring. The spring has a constant (k) equal to 30 N m^{-1}.

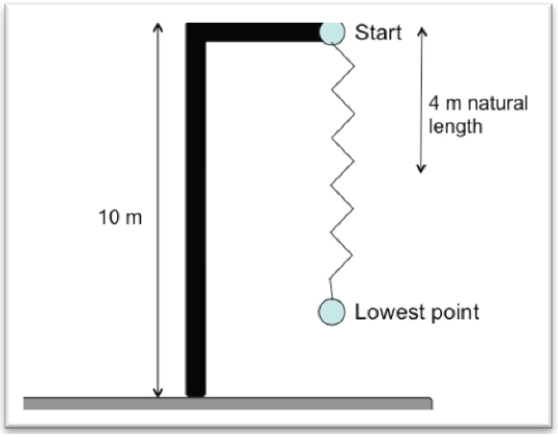

Figure 7

a. Determine the maximum extension of the spring when the mass is at its lowest point.

3 marks

m

b. Determine the *final* resting height of the mass (above the ground level) once the mass has stopped bouncing. 2 marks

m

SECTION B – Question 10 - continued

c. Determine the velocity of the mass when the acceleration of the spring is zero.

3 marks

m s^{-1}

Question 11 (5 marks)

A 30 kg projectile is launched from ground level with a velocity of 35 m s^{-1} an angle of 25^{o} to the horizontal axis. The projectile is aimed at a target wall at a distance of 75 m, as shown in Figure 8.

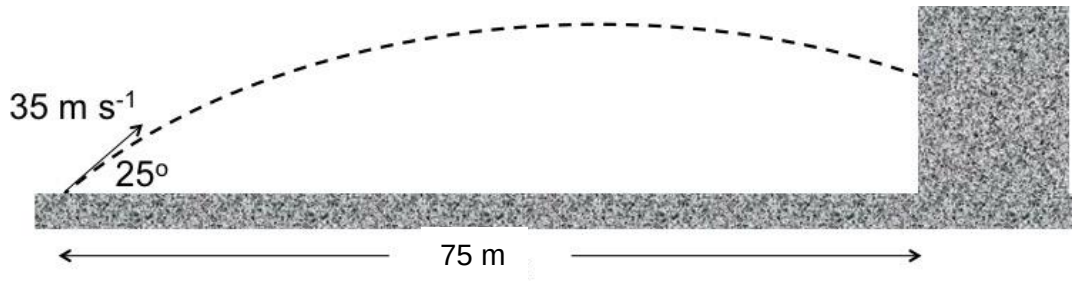

Figure 8

a. Determine the time taken for the projectile to reach the target. 2 marks

s

SECTION B – Question 11 - continued
TURN OVER

b. Determine the height that the projectile strikes the wall. 3 marks

m

Question 12 (5 marks)

Jo is travelling in his car as it travels through lowest point of a vertical circle in the road, with a radius of 100 m as shown in Figure 9. At the point shown, the car is moving at 15 m s^{-1}.

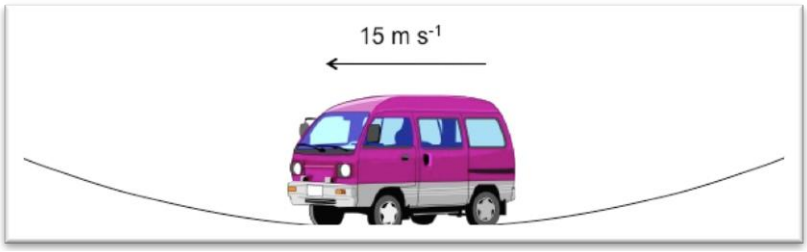

Figure 9

a. Calculate the acceleration of the car when it has a speed of 15 m s^{-1}. 2 marks

m s^{-2}

SECTION B – Question 12 - continued

Jo then travels back over the same stretch of road, but this time aims to feel twice as heavy as when he is stationary. Jo's mass is 75 kg.

b. Calculate the speed required for Jo to feel twice as heavy and explain your solution.

3 marks

m s^{-1}

Question 13 (6 marks)

A particle has a rest mass of 1.30×10^{-28} kg.

a. Determine the total energy of the particle 2 marks

J

b. Calculate the work done on the particle to achieve a Lorentz factor of $\gamma = 4.0$.

2 marks

J

c. Calculate the relativistic speed of the particle 2 marks

m s^{-1}

SECTION B - continued
TURN OVER

Question 14 (4 marks)
A 8.25 Hz water wave travels from deep water, where its speed is 42.0 cm s^{-1}, to shallow water where its speed is 31.5 cm s^{-1}. The angle of incidence is 30.0°.

a. Determine the wavelengths of the waves in the two media. 2 marks

	cm
	cm

b. Find the angle of refraction in the shallow water 2 marks

	°

SECTION B - continued

Question 15 (4 marks)

A laser of unknown wavelength is directed through a pair of narrow slits, forming an interference pattern as shown in Figure 10. Point C is located at the centre of the pattern.

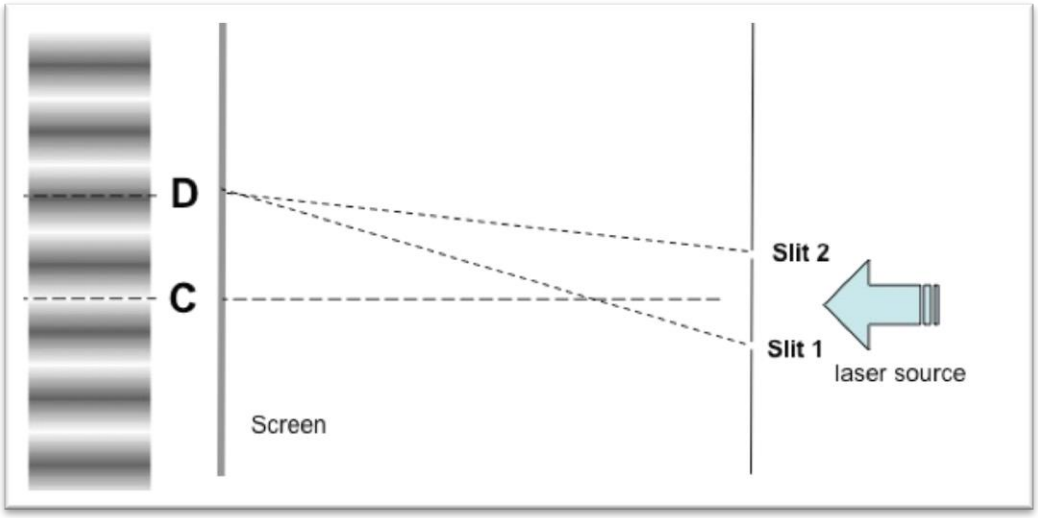

Figure 10

The path difference between the slits at Point D is known to be 825 nm.

a. Determine the wavelength of the laser source in metres. 2 marks

m

b. Explain how the dark bands on the pattern can be produced. 2 marks

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SECTION B - continued
TURN OVER

Question 16 (10 marks)

Students are performing an experiment where light of various frequencies is directed onto a metal plate in order to demonstrate the photoelectric effect. Based on the data, students construct a graph as shown in Figure 11.

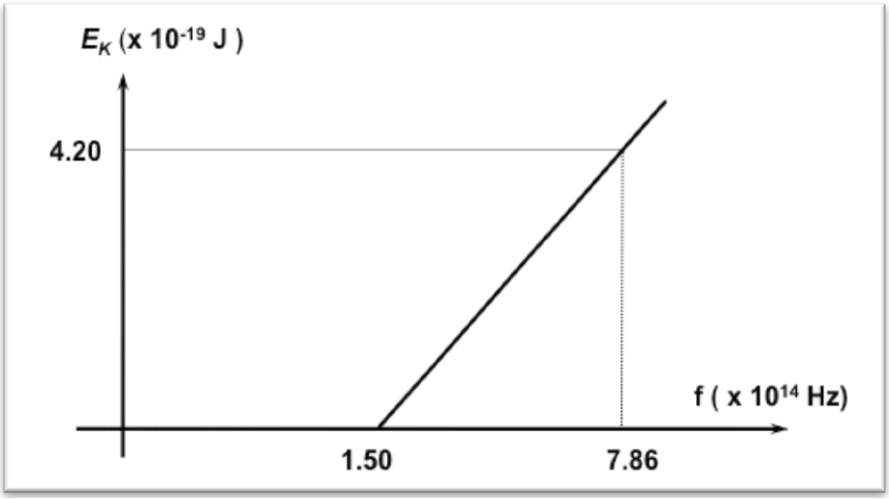

Figure 11

a. Identify the variable they consider to be their independent variable. 1 mark

b. Identify and explain the significance of the threshold frequency. 2 marks

Hz

c. Using the student's value for Planck's Constant, determine the stopping voltage for light with a wavelength of 400 nm.

3 marks

_____

_____

V

The experiment is repeated with the wavelength held at 400 nm but with greater brightness.

d. Explain the effect on stopping voltage as determined in part **c**. 2 marks

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e. Outline any errors they may have encountered within this experiment and classify them as either systematic or random. 2 marks

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SECTION B - continued
TURN OVER

Question 17 (5 marks)
Students with access to some handy equipment demonstrate diffraction through foil using both X-rays and high-speed electrons that have been accelerated by a potential of 250 V. The patterns are shown below in Figure 12a and 12b.

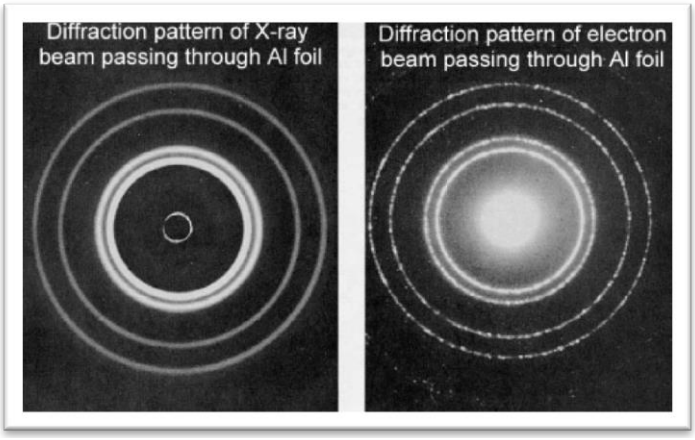

Figure 12a – X-ray **Figure 12b – electrons**

a. Determine the wavelength of the electrons. 2 marks

m

b. Determine the momenta of the x-ray photons needed to match the diffraction of the electrons. 1 mark

N s

SECTION B – Question 17 - continued

The voltage used to accelerate the electrons is now increased.

c. Describe and explain the effect on the pattern shown in Figure 12b. 2 marks

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Question 18 (7 marks)
The energy level diagram for an unknown element is shown in Figure 13.

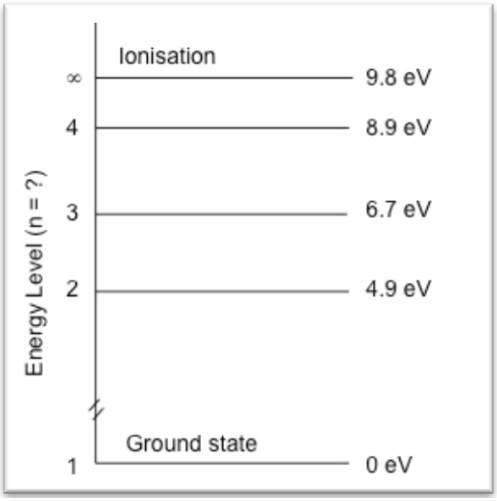

Figure 13

a. Determine the shortest wavelength photon that could be emitted from the transition of an electron from its third excited state. 2 marks

nm

SECTION B – Question 18 - continued
TURN OVER

b. Explain why discrete energy levels lend support to the wave model for electrons in the atom. 3 marks

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c. Explain the difference between and absorption and emission spectrum. 2 marks

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END OF QUESTION AND ANSWER BOOK

Data Sheet

1	Velocity, acceleration	$v = \frac{\Delta x}{\Delta t}\ a = \frac{\Delta v}{\Delta t}$
2	Equations for constant acceleration	$v = u + at$ $x = ut + \frac{1}{2}at^2$ $v^2 = u^2 + 2as$ $x = \frac{1}{2}(u + v)t$
3	Newton's second law	$F = ma$
4	Circular motion	$a = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$
5	Hooke's law	$F = -kx$
6	Elastic potential energy	$\frac{1}{2}kx^2$
7	Gravitational potential energy near the surface of the earth	mgh
8	Kinetic energy	$\frac{1}{2}mv^2$
9	Lorentz factor	$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$
10	Time dilation	$t = t_0\gamma$
11	Length contraction	$L = L_0 / \gamma$
12	Relativistic mass	$m = m_0\gamma$
13	Newton's law of universal gravitation	$F = \frac{GM_1M_2}{r^2}$
14	Gravitational field	$g = \frac{GM}{r^2}$
15	Transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
16	AC voltage and current	$V_{\text{RMS}} = \frac{1}{\sqrt{2}}V_{\text{peak}}$ $\quad$ $I_{\text{RMS}} = \frac{1}{\sqrt{2}}I_{\text{peak}}$
17	Voltage, power	$V = IR\ ,\ \ P = VI$
18	magnetic force	$F = IlB$

19	electromagnetic induction	emf : $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ flux : $\phi = BA$
20	transmission losses	$V_{\text{drop}} = I_{\text{line}}R_{\text{line}}$ $P_{\text{loss}} = I_{\text{line}}^2 R_{\text{line}}$
21	Snell's Law	$n_1 \sin i = n_2 \sin r$
22	photoelectric effect	$E_{\text{k max}} = hf - W$
23	photon energy	$E = hf$
24	photon momentum	$p = \frac{h}{\lambda}$
25	de Broglie wavelength	$\lambda = \frac{h}{p}$
26	Planck's constant	$h = 6.63\times10^{-34}$ J s $h = 4.14\times10^{-15}$ eV s
27	Universal gravitational constant	G = 6.67 x 10^{-11} N m^2 kg^{-2}
28	Mass of Earth	$M_E = 5.98 \times 10^{24}$ kg
29	Radius of Earth	$R_E = 6.37 \times 10^6$ m
30	Mass of the electron	$m_e = 9.1 \times 10^{-31}$ kg
31	Charge on the electron	$q = -1.6 \times 10^{-19}$ C
32	Speed of light	$c = 3.0 \times 10^8$ m s^{-1}
33	energy transformations for electrons in an electron gun (<100 keV)	$\frac{1}{2}mv^2 = eV$
34	radius of electron beam	$r = \frac{p}{qB}$
35	force applied to an electron beam	$F = qvB$
36	electric field between charged plates	$E = \frac{V}{d}$

Prefix/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

SECTION A MULTIPLE CHOICE ANSWER SHEET

Answers – Circle ONE of A-D for each of the 11 multiple choice questions.

Question	Answer			
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