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‘2017 Examination Package’ -
Trial Examination 1 of 9

STUDENT NUMBER

Figures									
Words									

Letter

PHYSICS

Units 3&4 – Written examination
*(*TSSM’s 2008 trial exam updated for the current study design*)*

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	17	17	110
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, and rulers, up to 2 pages of pre written notes and an approved **scientific calculator**.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape, graphics calculators

Materials supplied
- Question and answer book of 31 pages (including a multiple choice answer sheet for **Section B)**.
- Formula 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 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 ms^{-2}

Question 1
What is true about the field lines of all electric, magnetic, and gravitational fields? They

A. Form loop
B. Radiate from charges or masses
C. Show the path that a particle will follow
D. Never cross

Question 2
The direction of the force on a current carrying wire placed in a magnetic field depends on

A. The direction of current
B. The direction of the field
C. The direction of the current as well as the field
D. Neither the direction of the current or the field

Question 3
Which of the following best matches the voltage required to accelerate an electron to 6% of the speed of light? Ignore any relativistic effects.

A. 921 V
B. $1.02\times10^{-14}V$
C. 256 kV
D. $2.46\times10^{-15}V$

Question 4
Sara is operating a small scale experiment, deflecting an electron beam with magnets. She accelerates the beam to 1% of the speed of light. The magnetic field can be assumed to be perpendicular to the path of the electrons.
Which of the following best describes the field strength required to generate a radius of 2.1mm?

A. $2.7\times10^{-11}T$
B. $8.1\times10^{-3}T$
C. 8.1 T
D. 0.81 T

SECTION A – continued
TURN OVER

Question 5
Which of the following best estimates the magnitude of the force on a single electron in the beam?

A. 3.9×10^{-15} N
B. 2.44 N
C. 3.9×10^{-13} N
D. None of the above

Question 6
The gravitational field strengths at the surfaces of the Earth and the Moon are 9.8 N kg^{-1} and 1.7 N kg^{-1} respectively. If the mass of the Earth is 81 times the mass of the Moon, what is the ratio of the radius of the Earth to the radius of the Moon?

A. 3.7
B. 5.8
C. 14
D. 22

Question 7
A 1.2-kg object moving with a speed of 8.0 ms^{-1} collides perpendicularly with a wall and emerges with a speed of 6.0 ms^{-1} in the opposite direction. If the object is in contact with the wall for 2.0 ms, what is the magnitude of the average force on the object by the wall?

A. 9.8 kN
B. 8.4 kN
C. 7.7 kN
D. 9.1 kN

Question 8
A block of mass 4m can move without friction on a horizontal table as shown in Figure 1. This block is attached to another block of mass m by a string that passes over a frictionless pulley. If the masses of the string and the pulley are negligible, what is the magnitude of the acceleration of the descending block?

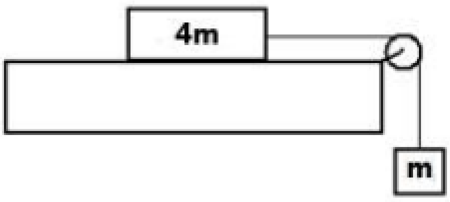

Figure 1

A. g/5
B. g/4
C. g/3
D. g

SECTION A – continued
TURN OVER

Question 9
The Michelson-Morley experiment was designed to:

A. Measure the speed the Earth moves through the aether
B. Accurately measure the speed of light
C. Test Einstein's theory of relativity
D. Show it is impossible to travel faster than light

Question 10
Terry wishes to build an electronic circuit to enable him to run a DC radio from mains supply. The mains supply is providing 240 V RMS AC. The turns ratio of the transformer is $N_P : N_S = 20 : 1$
The value of the AC voltage after it is transformed is:

A. 6 V
B. 12 V
C. 18 V
D. 24 V

Question 11
Because of the Doppler Effect, sound coming from a moving source

A. Seems louder than if the source was not moving.
B. Are of higher frequency if the sound source is moving away from the observer.
C. Have a lower frequency if the sound source is moving toward the observer.
D. Have a higher frequency is the sound source is moving toward the observer.

Question 12
An electromagnetic wave is generated by

A. any moving charge
B. any accelerating charge
C. only a charge with changing acceleration
D. only a charge moving in a circle

Question 13
The index of refraction of benzene is 1.80. The critical angle for total internal reflection, at a benzene-air interface, is about:

A. 56°
B. 47°
C. 34°
D. 22°

SECTION A – continued

Question 14
The frequency of an electromagnetic wave with a wavelength of 2.75×10^{-8}m is

A. 1.10 Hz
B. 1.09×10^{16}Hz
C. 9.17×10^{15}Hz
D. 9.17×10^{16}Hz

Question 15
An electron can circle a nucleus only in orbits that contain a whole number of wavelengths. This statement

A. Has a few exceptions, but they are not important at a quantum level.
B. Implies that the quantum number, n, is the sum of all the orbits minus the length of the de Broglie wavelength
C. Combines both the particle and wave characteristics of the electron into a single statement
D. Suggests the uncertainty principle is not correct after all.

Question 16
An important implication of the uncertainty principle discovered by Werner Heisenberg is:

A. Very small particles moving a slow speeds contains vast quantities of energy.
B. If we can gather enough data, then it may be possible to predict the future based on present conditions
C. Above a certain particle size the de Broglie waves are so insignificant that they drop to zero.
D. We can never predict the future with absolute certainty because it is impossible to know the present with certainty.

Question 17
Which of the following properties is a characteristic of the light from a laser?

A. The waves all have the same frequency
B. The waves are all in phase with each other
C. The waves form a narrow beam
D. All of the above

Question 18
Which of the following effects could not be observed for sound waves in air?

A. Interference
B. Refraction
C. Polarisation
D. Diffraction

SECTION A – continued
TURN OVER

Question 19
Systematic errors are:

A. Instrumental errors
B. Environmental errors
C. Random errors
D. Both A and B

Question 20
In an experiment, the one variable that is changed is called the

A. Dependent
B. Independent
C. Controlled
D. Experimental

END OF SECTION A
TURN OVER

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 ms^{-2}

Question 1(3 marks)
Two point charges Q1 = 5 nC and Q2 = -8 nC are placed in a vacuum. Point P is 0.5 m from the first charge and 120 cm from the second one as shown in Figure 1

Figure 1

State the field strength at Point P. 3 marks

N C^{-1}

Question 2 (6 marks)
A uniform electric field between two parallel plates 20 cm apart has the value of 400 N C^{-1}.

a. Find the voltage between the plates 2 marks

V

SECTION B – Question 1 - continued
TURN OVER

b. What force would be acting on a charge of -2 nC placed in the field 2 marks

N

c. What would be the electric field strength when the distance between the plates changes to 30 cm? 2 marks

$N\ C^{-1}$

Question 3 (4 marks)

a. Sketch field lines around the two bar magnets shown in Figure 2a

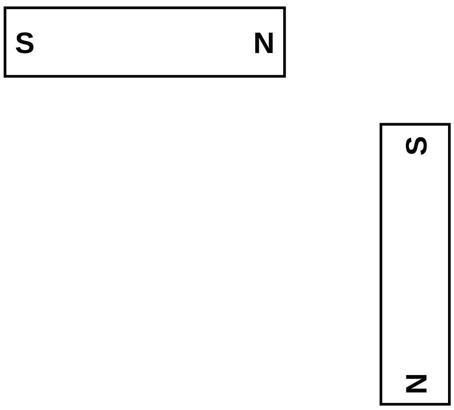

Figure 2a

SECTION B – Question 3 - continued

b. Which of the following best describes the direction of the magnetic field at **A** due to the current carrying wire shown in Figure 2b? 2 marks

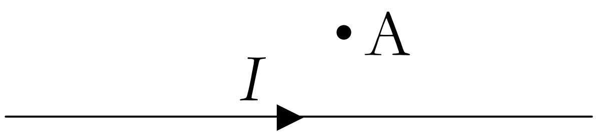

Figure 2b

A	B	C	D	E
$\rightarrow$	$\leftarrow$	Into page	Out of page	Up

Question 4 (9 marks)
Mars has a mass of $6.42\times10^{23}kg$ and radius of 3400 km and orbits the sun every 16500 hours at a distance of $2.28\times10^{8}km$. A day on Mars is 24 hours and 39 minutes long.

a. Calculate the acceleration due to gravity at the surface of Mars. 2 marks

ms^{-2}

b. Calculate the period of revolution of Mars about the Sun in seconds. 1 mark

s

SECTION B – Question 4 - continued
TURN OVER

c. Calculate the mass of the Sun. 3 marks

kg

Steve wishes to launch a geostationary satellite above the surface of Mars.

d. Calculate the distance above the surface of Mars of the satellite. 3 marks

m

SECTION B – continued

Question 5 (8 marks)
Gavin is at the golf driving range. He selects a club that will launch the ball at an angle of 60° to the horizontal. Gavin strikes the ball with a launch speed of 50 ms^{-1}. The ball lands at the same elevation that it leaves the ground
The effects of air resistance on the ball can be ignored for **a, b and c**.

a. Calculate the total time of flight of the ball. 3 marks

s

b. Calculate the horizontal range of the ball. 2 marks

m

c. Calculate the acceleration of the golf ball at the top of its flight. 2 marks

ms^{-2}

SECTION B – Question 5 - continued
TURN OVER

d. If the effects of air resistance are significant what would happen to the horizontal range of the ball? 1 mark

Question 6 (9 marks)
A red ball of mass 30 g and travelling at speed of 3 ms^{-1} East strikes a stationary blue ball of mass 80 g. After the collision the red ball rebounds off the blue ball towards the West. The velocity of the blue ball after the collision is 1.5 ms^{-1} East. The time of the collision is 0.15 s. Assume the collision can be considered isolated.

a. Calculate the velocity of the red ball after the collision. 3 marks

ms^{-1}

b. Calculate the average force exerted by the red ball on the blue ball during the collision. 3 marks

N

SECTION B – Question 6 - continued

c. Is this an elastic or inelastic collision? Justify your answer with an appropriate calculation. 3 marks

Question 7 (3 marks)
A car drives around a roundabout at a constant speed of 20 kmh^{-1}. The roundabout has a radius of 3.5 m and the car a mass of 1 200 kg.

a. Calculate the speed of the car in ms^{-1}. 1 mark

ms^{-1}

b. Calculate the magnitude and direction of the net force acting on the car. 2 marks

N

SECTION B – Question 7 - continued
TURN OVER

Question 8 (4 marks)
Three books, book A (0.6 kg), book B (1.0 kg) and book C (1.2 kg), are sitting on a table as shown in Figure 3.

Figure 3

a. What is the force by book C on book B?
Explain your answer in terms of Newton's Laws. 2 marks

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N

b. The table is now removed and the books free fall.
Calculate the force by book B on book C. Ignore air resistance and explain your answer. 2 marks

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N

SECTION B – continued

Question 9 (7 marks)
Donald has built a super fast space ship that can travel at 30% of the speed of light.
He sets out from Earth for the planet Pluto which is $5.9 \times 10^{9}\,km$ away from the Earth. Daisy is on Earth and is observing Donald's journey. Daisy and Donald synchronise their watches so that both watches read 12:00 noon when Donald takes off.

a. What time does Daisy's watch read at the instant Donald arrives at Pluto? 2 marks

b. What time does Donald's watch read at the instant Donald arrives at Pluto? 3 marks

Donald's spacecraft is 7 m in length. Calculate the length of Donald's spacecraft as measured by Daisy. 2 marks

m

SECTION B – continued
TURN OVER

Question 10 (5 marks)
Figure 4 shows a basic DC motor.

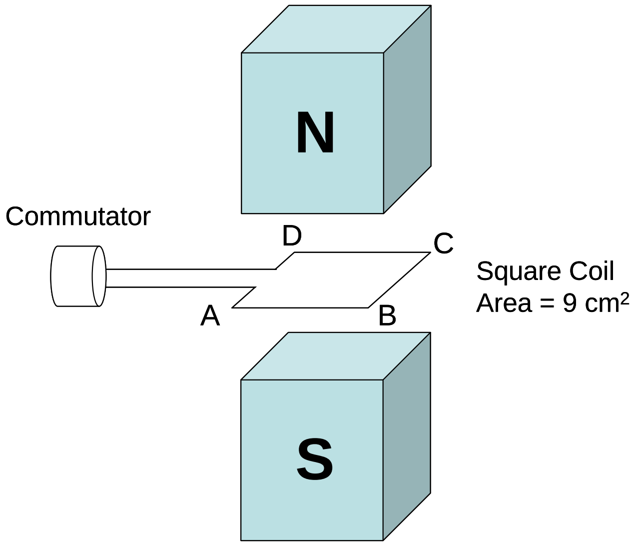

Figure 4

In the position shown, a force of $8.1\times10^{-2}\,N$ acts on side **AB**. The field strength due to the uniform field created by the magnets is 0.3 T and the current is 100 mA.

a. Determine the number of loops that must be in the coil of the DC motor shown in **Figure 4.** 2 marks

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____

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turns

SECTION B – Question 10 - continued

b. Complete **Table 1** by inserting the option which correctly describes the **changes in magnitude** of the forces and current that act on the coil when it is rotated 90^{o} from horizontal (as in **Figure 12**) to a vertical position. 3 marks
(Use terminology: INCREASED / DECREASED / NO CHANGE)

Changes to the coil as it rotates from horizontal to vertical

FORCE on SIDE AB	FORCE on SIDE BC	CURRENT in SIDE AB

Table 1

Question 11 (6 marks)
Brian has been given a rechargeable torch, which uses electromagnetic induction to charge a small capacitor and power an LED. A simplified sketch of the casing, coil and magnet is shown in Figure 5

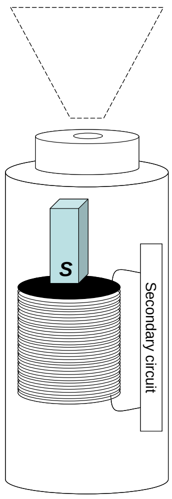
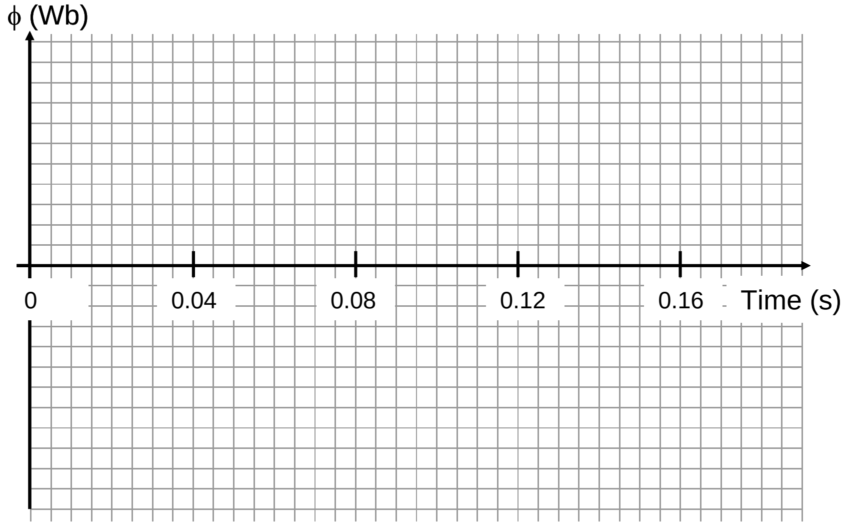


Figure 5

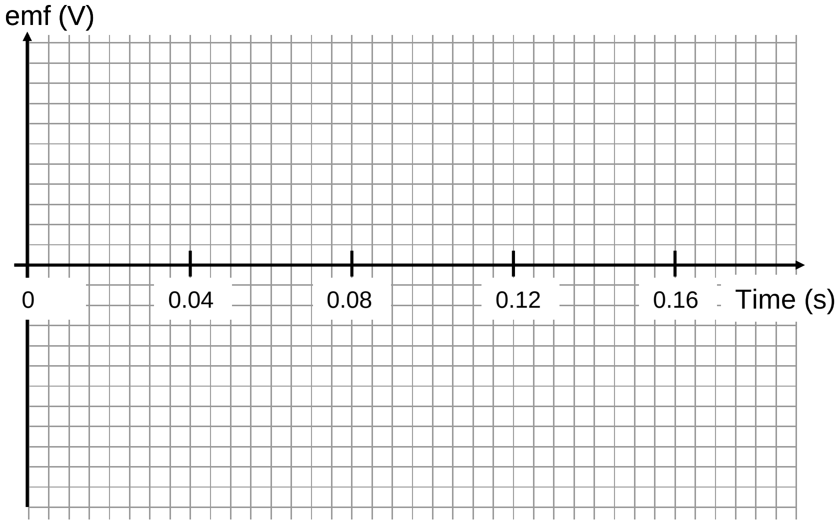
- A small, but strong magnet (B = 0.4 T) is shaken up and down within a circular coil (diameter = 3 cm) which is connected to a secondary circuit.
- You may assume the magnet takes 0.04 s to enter the coil and moves at a constant speed.
- After 0.16 sec, the magnet has fully exited the coil.
- Flux is zero at either end (i.e. magnet clear of the coil)

SECTION B – Question 11 - continued
TURN OVER

a. Using the axes provided below, sketch a graph of flux over time as the magnet moves from the **top to the bottom** of the torch. Specify a vertical scale. 2 marks



b. For the same movement from top to bottom of the coil, sketch a graph of induced voltage (emf) over time. No vertical scale is required. 2 marks



SECTION B – continued

As the magnet first enters the coil, the average emf over the 0.04 sec interval is 0.353 V.

c. Which of the following options best approximates the number of loops in the coil?

2 marks

A. 2
B. 20
C. 50
D. 250

SECTION B – continued
TURN OVER

Question 12 (10 marks)
A wind turbine is modelled as a coil rotating within a magnetic field, as shown in Figure 6. Assume an observer is positioned at **P** and current is flowing from **A** to **B** as shown.
(NOTE: For reference purposes, a faint line indicates what the coil would look like in a vertical position)

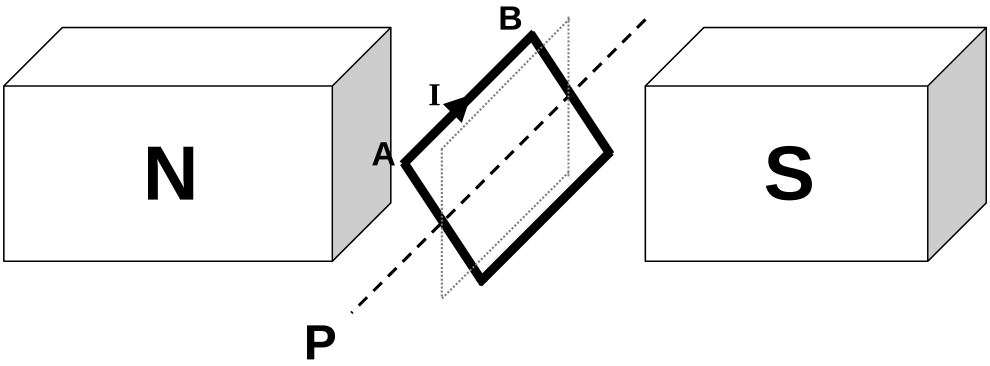


Figure 6

a. Is the turbine spinning **clockwise** or **anticlockwise**? Justify your answer with reference to the principle of electromagnetic induction. 3 marks

SECTION B – Question 12 - continued

The turbine's coil is connected to an output circuit via **slip rings**.

b. Explain the purpose of **slip rings** in such a circuit. 2 marks

c. Is this setup an **alternator** or **generator**? Explain your answer and be sure to distinguish between these two terms. 3 marks

SECTION B – Question 12 - continued
TURN OVER

d. The output circuit from the turbine leads to a step down transformer. Explain, in terms of induction, why **alternating current** is preferable to **direct current** in this situation.
2 marks

Question 13 (9 marks)
At one point, the turbine produces 2.5 kW at 400 V AC RMS. It is connected, via transmission cables ($R = 4\ \Omega$) and a step down transformer, to a small shack located 5 km away. Figure 7 shows a basic outline of the setup.

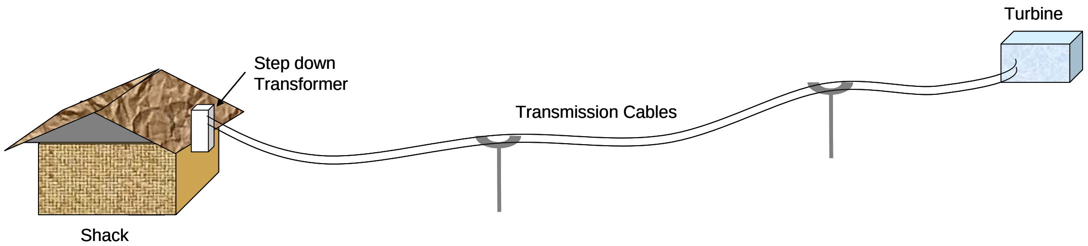


Figure 7

a. Determine the value of V_{peak} at the turbine. 2 marks

V

SECTION B – Question 13 - continued

b. Determine the value of $I_{peak\text{-}peak}$ at the turbine. 2 marks

A

c. Determine the voltage drop in the cables. 2 marks

V

The owner of the shack is disappointed to find that, when several large appliances are operating and the current in the shack is increased, the voltage falls below 110 V. Assume an ideal transformer is being used.

d. Explain why the voltage drops below 110 V, despite the use of an ideal transformer.
3 marks

SECTION B – continued
TURN OVER

Question 14 (4 marks)

Choose the correct descriptors to complete Table 2. 4 marks

Source of Light	**Spectrum (Continuous/Discrete)**	**Nature of Phase (Coherent/Incoherent)**	**Electron behaviour (Thermal motion / Quantised energy level)**
LASER			
Candle			
Metal Vapour Lamp			
Incandescent Globe			

Table 2

Question 15 (13 marks)
Students as part of their extended practical investigation are investigating the interference of light via Young's Double Slit experiment.
They start using a laser with red light of frequency 4.14×10^{14}Hz

a. Calculate the wavelength of the laser. 2 marks

m

The students use the laser to obtain the interference pattern shown in Figure 8 and find the path difference to Point X, the 2nd bright band from the centre.

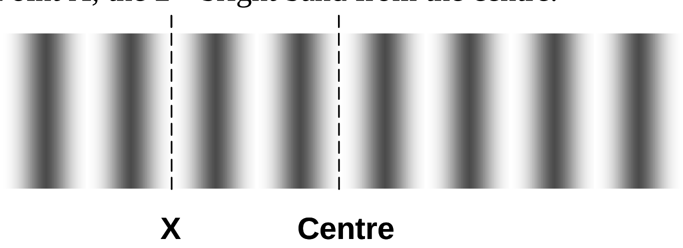


Figure 8

SECTION B – Question 15 - continued

b. Identify the independent and dependent variables within this experiment. 2 marks

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c. Outline a suitable method they may use to achieve the interference pattern. 2 marks

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d. Calculate the path difference in nanometres 2 marks

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	nm

e. List two possible errors within the experiment and identify them as systematic or random errors. 2 marks

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f. The students replace the red laser with another laser of unknown frequency. The point that was the 2^{nd} bright band in the original experiment is now the first dark band. Find the frequency of this new laser. 3 marks

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	Hz

SECTION B – continued
TURN OVER

Question 16 (6 marks)
Brian supervises a basic experiment to investigate the photoelectric effect. A violet light source (λ = 380 nm) illuminates a metal surface and photocurrent is generated. Brian records a stopping voltage of 1.3 V.

a. Determine the momentum of a photon of the violet light 2 marks

kg ms^{-1}

b. Determine the momentum of the most energetic electron ejected from the metal. 2 marks

$kgms^{-1}$

c. Determine the threshold frequency for the metal surface in hertz. 2 marks

Hz

SECTION B – continued

Question 17 (4 marks)
Figure 9 is a simplified depiction of the energy levels for mercury. High voltage is applied across mercury vapour, causing its electrons to become excited.

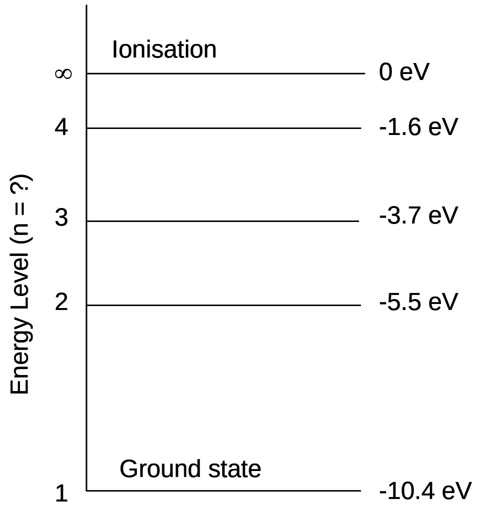

Figure 9

a. Which **one or more of** the following wavelengths may be observed within the emission spectrum for the mercury? 2 marks

A. 776 nm
B. 591 nm
C. 185 nm
D. 226 nm

b. Explain, with reference to **standing waves**, why there is no energy level at -4.5 eV. 2 marks

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 : $\varepsilon = -N\dfrac{\Delta\phi}{\Delta t}$ 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	$p = \dfrac{h}{\lambda}$
25	de Broglie wavelength	$\lambda = \dfrac{h}{p}$
26	Planck's constant	$h = 6.63 \times 10^{-34}$ J s $h = 4.14 \times 10^{-15}$ 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 x 10^{24} kg
29	Radius of Earth	R_E = 6.37 x 10^6 m
30	Mass of the electron	m_e = 9.1 x 10^{-31} kg
31	Charge on the electron	q = -1.6 x 10^{-19} C
32	Speed of light	c = 3.0 x 10^8 ms^{-1}
33	energy transformations for electrons in an electron gun (<100 keV)	$\frac{1}{2}mv^2 = eV$
34	radius of electron beam	$r = \dfrac{p}{qB}$
35	force applied to an electron beam	$F = qvB$
36	electric field between charged plates	$E = \dfrac{V}{d}$

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