TSSM
Creating VCE Success

THIS BOX IS FOR ILLUSTRATIVE PURPOSES ONLY

'2017 Examination Package' -
Trial Examination 2 of 9

STUDENT NUMBER

									Letter
Figures									
Words									

PHYSICS

Units 3&4 – Written examination

*(*TSSM's *2009 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 41 pages (including a multiple choice answer sheet for **Section A)**.
- 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.

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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** 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

The electric field 2.0 m from a point charge has a magnitude of 8.0×10^4 NC^{-1}. What is the strength of the electric field at a distance of 4.0 m?

A. 2.0×10^4 N C^{-1}
B. 1.6×10^4 N C^{-1}
C. 4.0×10^4 N C^{-1}
D. 3.2×10^5 N C^{-1}

Question 2

Cable A is a current carrying cable hanging vertically as shown in Figure 1. The direction of current in cable A is upwards. Point **P** is a random point adjacent to Cable A.

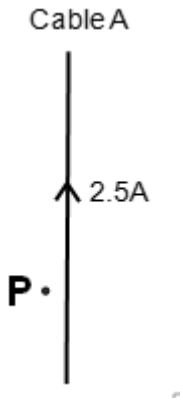


Figure 1

Which of the following best describes the direction of the magnetic field created by the current in Cable A at Point **P**?

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

SECTION A – continued

Question 3
Two protons are 1.0×10^{-14} m apart. Approximately how many times is the electrostatic force between them greater than the gravitational force between them?

A. 1.24×10^{23}
B. 1.24×10^{30}
C. 1.24×10^{36}
D. 1.24×10^{42}

Question 4
A planet has a radius half of the Earth's radius and a mass a quarter of the Earth's mass. What is the approximate gravitational field strength on the surface of the planet?

A. 1.6 N kg^{-1}
B. 4.9 N kg^{-1}
C. 9.8 N kg^{-1}
D. 19.6 N kg^{-1}

Question 5
At a particular moment, a positively charged particle is moving with velocity v in a magnetic field as shown in Figure 2

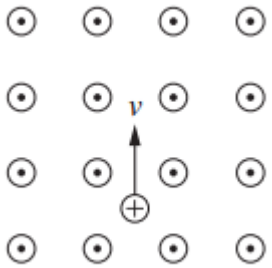


Figure 2

At this moment, what is the direction of the force on the positively charged particle?

A. To the right
B. To the left
C. Into the page
D. Out of the page

SECTION A – continued
TURN OVER

Question 6
Figure 3 shows a magnet moving upward into a coil.

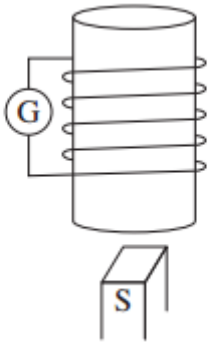


Figure 3

Which row of the table correctly identifies the direction of the induced current as viewed from the top, and the direction of the magnetic field inside the coil?

	Current Direction	*Magnetic field direction*
A.	Anticlockwise	Down
B.	Anticlockwise	Up
C.	Clockwise	Up
D.	Clockwise	Down

Question 7
A projectile was launched from the ground at 40 ms^{-1}. It had a range of 70 metres and was in the air for 3.5 seconds. At what angle to the horizontal was it launched?

A. 30°
B. 40°
C. 50°
D. 60°

Question 8
An object moves with a constant speed of 30 ms^{-1} on a circular track of radius 150 m. What is the acceleration of the object?

A. zero
B. 0.17 ms^{-2}
C. 5.0 ms^{-2}
D. 6.0 ms^{-2}

SECTION A – continued

Question 9
Figure 4 shows two 1.00 kg blocks connected by a rope. A second rope hangs beneath the lower block. Both ropes have a mass of 250 g. The entire assembly is accelerated upwards (near the surface of the Earth) by a force of magnitude 39.5 N.

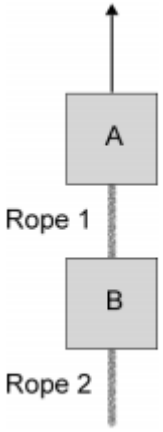


Figure 4

The tension, at the top end of Rope 1 is closest to:
A. 9.00 N
B. 15.8 N
C. 23.7 N
D. 39.5 N

Question 10
Scientific observations of short living muons travelling at 0.6c have shown that, over a distance of around 2000m, fewer decay than would be expected.

The best reason for this observation would be
A. The length perceived by the moving muons is considerably longer than for relatively stationary observers
B. The length perceived by the moving muons is considerably shorter than for relatively stationary observers
C. The muons mass would be much less as observed by the scientists, making them decay more slowly
D. Time travels faster for the muons from their reference point, so they decay more readily

Question 11
A neon sign requires a 6000 V supply for its operation. A transformer allows the neon sign to operate from a 240 V supply. What is the ratio of the number of secondary turns to the number of primary turns for the transformer?

A. 1 : 40
B. 1 : 25
C. 25 : 1
D. 40 : 1

SECTION A – continued
TURN OVER

Question 12
Which form of electromagnetic radiation has the longest wavelengths?
A. gamma rays
B. microwaves
C. radio waves
D. x-rays

Question 13
Which one of the following correctly describes the change, if any, in the speed, wavelength and frequency of a light wave as it passes from air into glass?

	Speed	**Wavelength**	**Frequency**
A.	Decreases	Increases	Unchanged
B.	Decreases	Unchanged	Decreases
C.	Unchanged	Increases	Decreases
D.	Increases	Decreases	Unchanged

Question 14
Which statement is true for standing (stationary) waves?

A. All points in the wave vibrate in phase.
B. There is no energy in a standing wave.
C. The wavelength of the wave is the distance between adjacent nodes.
D. Neighbouring points in the wave have different amplitudes of vibration.

Question 15
Two pipes P and Q are of the same length. Pipe P is closed at one end and pipe Q is open at both ends. The fundamental frequency of the closed pipe P is 220 Hz. Assuming speed of sound in air is 340 m s^{-1}, the best estimate for the fundamental frequency of the open pipe Q is

A. 880 Hz.
B. 440 Hz.
C. 110 Hz.
D. 55 Hz.

Question 16

Light from a double slit arrangement produces bright and dark fringes on a screen in the region near point P, as shown in Figure 5

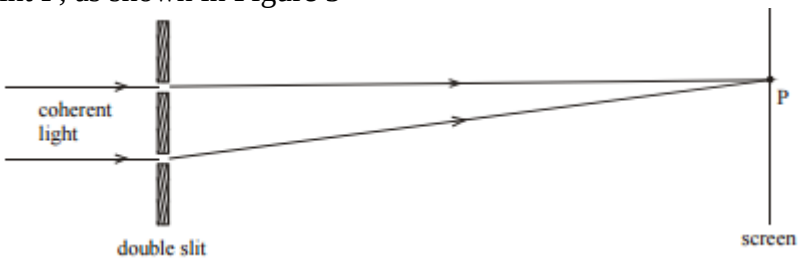


Figure 5

The light from the two slits has equal amplitudes on reaching point P. Which one of the following gives the change, if any, in the appearance of the bright and the dark fringes when the amplitude of the light wave from one slit is reduced?

	Bright Fringes	**Dark Fringes**
A.	Remains the same	Remains the same
B.	Becomes less bright	Remains the same
C.	Becomes less bright	Becomes more bright
D.	Remains the same	Becomes more bright

The following information refers to Questions 17 and 18

Figure 6 shows a simplified version of the energy level diagram of an atom.
An atom begins in the third excited state.

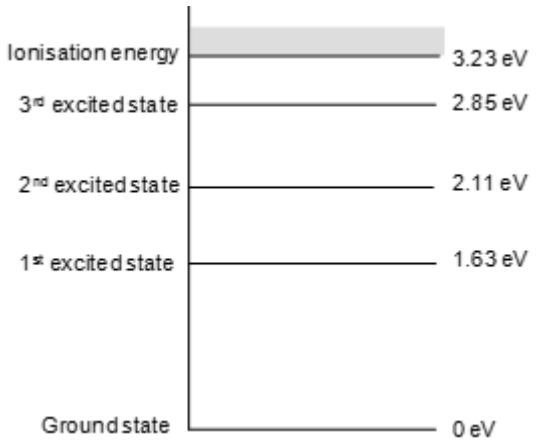


Figure 6

Question 17

Which of the following photons could NOT be emitted by the atom?

A. 0.38 eV
B. 0.48 eV
C. 0.74 eV
D. 2.11 eV

SECTION A – continued
TURN OVER

Question 18
Now in its ground state, the atom is exposed to photons of various energies.

Which photons with the wavelengths below could NOT be absorbed by the atom?

A. 762 nm
B. 510 nm
C. 436 nm
D. 325 nm

Question 19
Which of the following statements best describes the Heisenberg uncertainty principle?

A. The exact position of an electron is always uncertain.
B. The velocity of a particle can only be estimated.
C. It is impossible to accurately know both the exact location and momentum of a particle.
D. The location and momentum of a particle can be determined accurately, but not the identity of the particle.

Question 20
Systematic error occurred due to poor calibration of instrument that can be corrected by

A. Taking several readings
B. Replacing instrument
C. Taking mean of values
D. Taking median of values

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 ms^{-2}

Question 1 (8 marks)
A small object carrying a charge of -5×10^{-9} C experiences a downward force of 20×10^{-9}N when placed at a certain point in an electric field.

a. What is the electric field at the point? (Magnitude and direction) 3 marks

NC^{-1}	Direction

b. What would be the magnitude and direction of the force acting on an electron placed at the point? 3 marks

N	Direction

c. What is the acceleration of the electron? 2 marks

ms^{-2}

SECTION B – continued
TURN OVER

Question 2 (6 marks)

A rogue satellite is hurtling towards an asteroid deep in outer space.
The satellite has a mass of 650 kg and is presently located 400 km from the surface of the asteroid, moving at 450 m s^{-1}. The asteroid has no atmosphere.

- Figure 1 shows a diagram of the situation.
- Table 1 shows some key data about the asteroid.
- Graph 1 shows a plot of the gravitational field strength of the asteroid with respect to distance from its centre. Co-ordinates should be used in your calculations

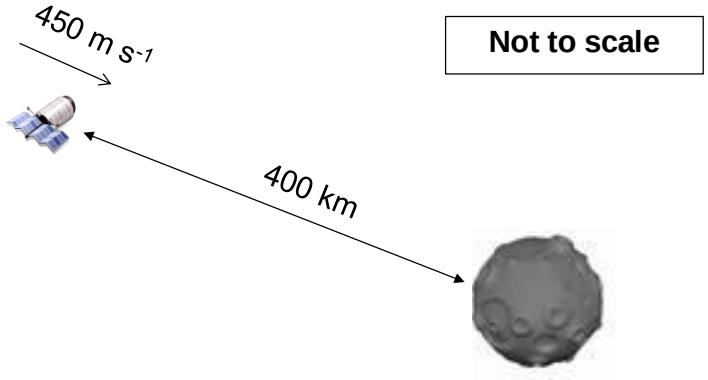
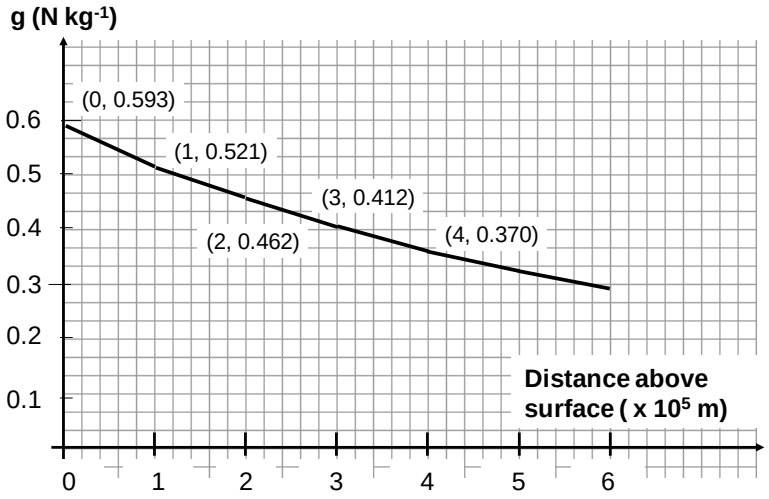


Figure 1

Table 1 – Asteroid Data

Mass	Radius of body	Radius of orbit	Period of revolution	Period of rotation
2 x 10^{22} kg	1.5 x 10^{6} m	5.9 x 10^{12} m	7.82 x 10^{9} s	2.1 x 10^{4} s



Graph 1

SECTION B – Question 2 - continued

a. Estimate the speed at which the satellite will hit the surface of the asteroid. You must show your working. 3 marks

m s^{-1}

In a mission to determine the fate of the first satellite, a research team led by Professor Marcus launches a second probe to enter into a geostationary orbit around the asteroid.

b. Determine the radius required for a geostationary orbit around the asteroid. You must show your working. 3 marks

m

SECTION B – continued
TURN OVER

Question 3 (5 marks)
Two current carrying cables hang vertically as shown in Figure 1. The direction of current in cable A is known, but the current direction in cable B is unknown.
Cable B is known to generate a magnetic field in the vicinity of Cable A. This leads to a force of 0.12 N acting on Cable A as shown in Figure 2.

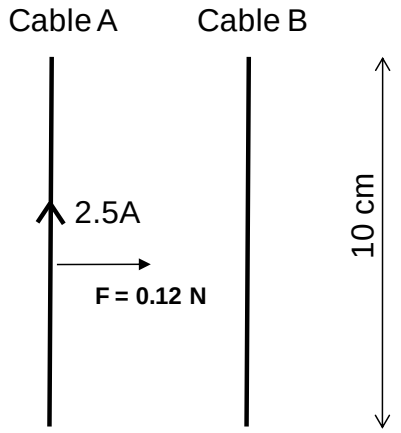


Figure 2

a. Determine the size and direction of the magnetic field acting on Cable A. You must show your working. 2 + 1 = 3 marks

Size: T	Direction:

b. Would Cable B be **attracted towards** or **repelled from** Cable A? Explain your answer. 2 marks

SECTION B – continued

Question 4 (6 marks)
A single square copper loop (side length 3 cm) is connected to a DC supply and placed between two magnets as shown in Figure 3. The magnetic field between the two poles is 0.2 T At time t = 0, the DC supply is connected and a current of 1.5 A flows through the loop.

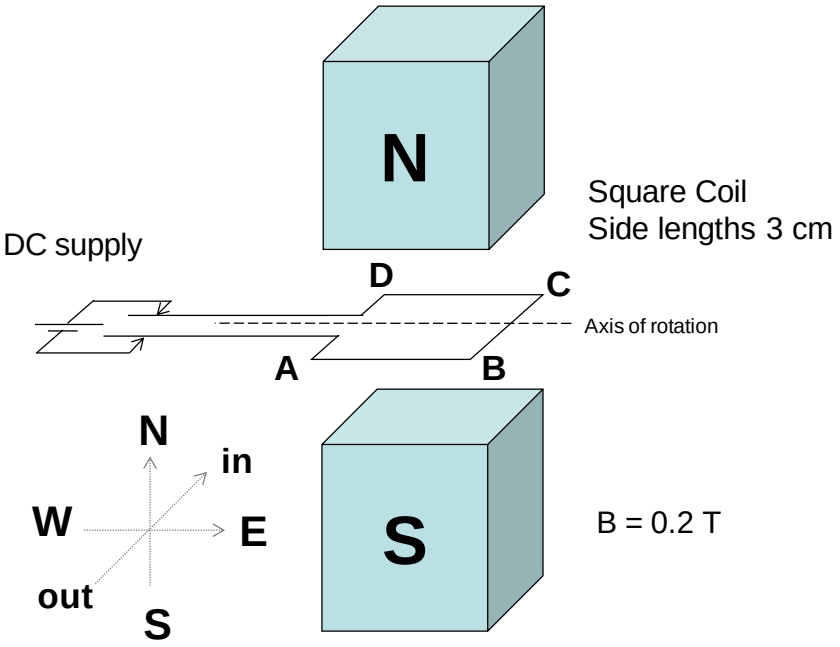


Figure 3

a. Determine the size and direction of the force on side BC, when the switch is initially closed. Refer your direction to the axes provided in Figure 3. You must show your working. 2 marks

Size: N	Direction:

SECTION B – Question 4 - continued
TURN OVER

The motion of the loop is now observed from its initial position at t = 0.

b. Which of the following best describes the magnetic force acting on side CD as the loop is rotated by 90 degrees to a vertical position. 2 marks

A. The force decreases in magnitude, but maintains the same direction.
B. The force decreases in magnitude and changes to the opposite direction.
C. The force increases in magnitude, but maintains the same direction.
D. The force maintains the same magnitude and direction.

In the vertical position the loop is set free.
After a few seconds, the loop comes to rest in a horizontal position.
Two students argue about how the device can be modified to ensure continuous rotation. One suggests adding a **commutator**, whilst the other suggests **slip-rings**.

c. Explain which choice would be most appropriate to ensure continuous rotation of the loop. Circle the preferred option below and refer to appropriate physics principles in your answer. 2 marks

Commutator / Slip-rings

SECTION B – continued

Question 5 (4 marks)
During the filming of a new action film, a stuntman hangs from a cable beneath a rising elevator, as depicted in Figure 4.
The elevator is accelerating upwards at a rate of 4 m s^{-2}.
The mass of the stuntman is 85 kg.

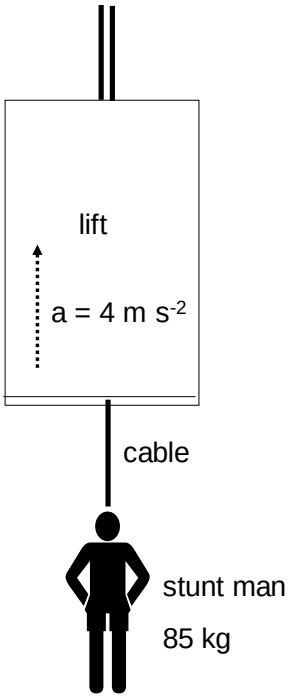


Figure 4

a. Determine the magnitude of the net force acting on the stunt man. You must show your working. 2 marks

_____

_____

_____

N

SECTION B – Question 5 - continued
TURN OVER

b. Determine the size of the tension in the cable that attaches the stuntman to the rising elevator. You must show your working. 2 marks

N

Question 6 (7 marks)
A student swings a ball (mass 0.1 kg) on a string in a clockwise vertical circle at a constant speed, as shown in Figure 5. At the instant shown, the ball is at the bottom of a revolution. Each revolution is known to take 0.8 sec and the string remains under tension at all times. The radius of revolution is 0.85 m.

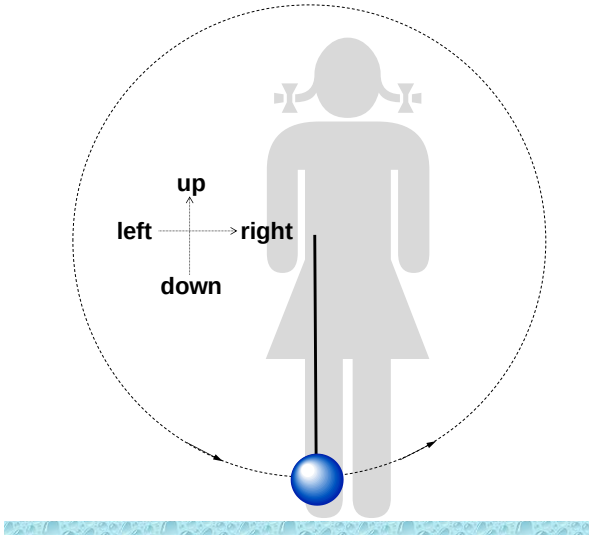


Figure 5

a. Carefully label Figure 5, showing the forces acting on the tennis ball. 2 marks

SECTION B – Question 6 - continued

b. In the box below, specify the direction of the net force acting on the ball. Use the key provided in Figure 5 to orient your answer. 2 marks

_____

_____

_____

c. Based on the information provided and for the position shown in Figure 5, determine the size of the tension force in the string. You must show your working. 3 marks

_____

_____

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N

SECTION B – continued
TURN OVER

Question 7 (7 marks)

A small rabbit is launched from a horizontal ledge to a shelf which is 2.7 m above. The rabbit reaches the shelf and lands such that it has no vertical velocity.
The rabbit starts 4 m horizontally from the vertical wall.
The path is depicted in Figure 6. Air resistance may be ignored.

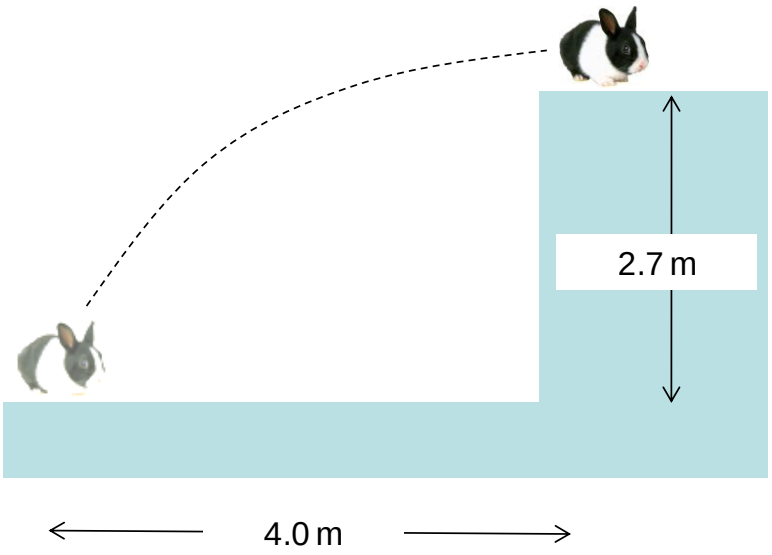

Figure 6

a. Determine the vertical component of the velocity required for the rabbit to complete the path described. You must show your working. 2 marks

m s^{-1}

SECTION B – Question 7 - continued

b. Determine the horizontal component of the velocity required by the rabbit. You must show your working. 2 marks

_____

_____

_____

	m s^{-1}

c. Calculate the launch angle required for the rabbit and the overall speed of launch. Show your working. 3 marks

_____

_____

_____

Angle:		Speed:	m s^{-1}

SECTION B – continued
TURN OVER

Question 8 (7 marks)

Initially travelling at 12 m s^{-1} west, a car collides with a solid granite wall. The car rebounds with a velocity of 3 m s^{-1} in an easterly direction. The collision takes place in 0.24 s.
The car has a mass of 1500 kg.
Figure 7 shows a simplified diagram of the collision.

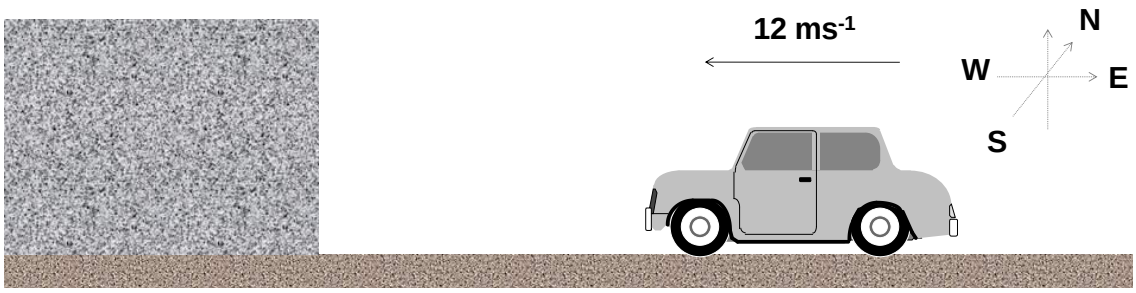

Figure 8

a. Determine the change in momentum of the car. Include a direction in your answer. You must show your working. 3 marks

kg m s^{-1}	Direction:

b. Determine the net force acting on the car. Include a direction in your answer and show your working. 2 marks

N	Direction:

SECTION B – Question 8 - continued

c. State whether the collision is isolated and justify your answer. 2 marks

Question 9 (7 marks)

Max has developed a new game, which involves throwing a 5 kg medicine ball over a high bar. He has placed a rubber mat on the other side of the bar for the ball to land on, as shown in Figure 8.

Max's best throw is launched at 7 m s^{-1} from ground level and clears the bar by a considerable margin.

The rubber mat is 0.5 m thick when at rest, but when the ball lands on it is compressed to a thickness of 0.2 m.

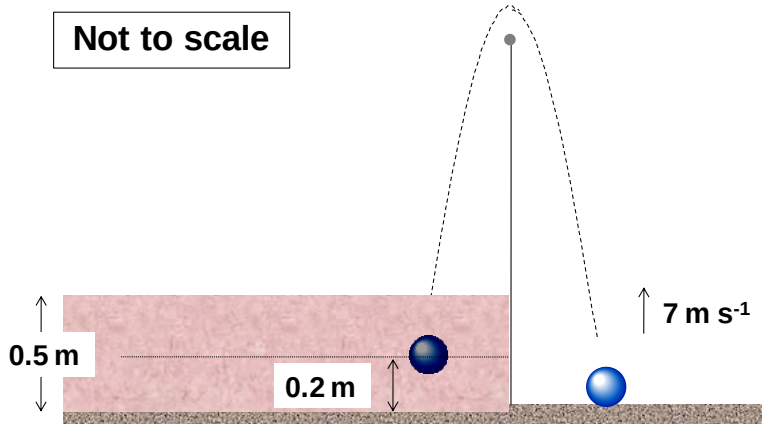

Figure 8

a. Determine the maximum height achieved by the ball. 2 marks

m

SECTION B – Question 9 - continued
TURN OVER

b. Determine the speed at which the ball is travelling when it reaches the mat (that is, at a height of 0.5 m). You must show your working. 2 marks

_____

_____

_____

m s^{-1}

c. Determine the spring coefficient of the mat required to bring the ball to rest at a height of 0.2 m. You must show your working. 3 marks

_____

_____

_____

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_____

N m^{-1}

SECTION B – continued

Question 10 (7 marks)
A spacecraft passes an observer on Earth at a relative speed of 0.85c. The captain of the craft measures its length to be 250 m.

a. The length of the spacecraft as measured by the observer on Earth would be? 3 marks

_____

_____

_____

m

b. According to the captain's clock, it takes 4 hours to reach his destination. How long would the Earth observer perceive the craft to take to reach its destination?
2 marks

_____

_____

_____

s

c. The spacecraft and its payload have a rest mass of 1.5×10^4 kg. Calculate the work that must be done to increase the craft from rest to 0.85c. 2 marks

_____

_____

_____

J

SECTION B – continued
TURN OVER

Question 11 (5 marks)
James is experimenting with a modified transformer, where he has replaced the AC supply with a DC supply and a switch, as shown in Figure 9.
The switch is initially open, so no current is flowing in the primary coil.
There is a secondary coil, load resistor which is linked to the primary coil by an iron core.
James then closes the switch, which completes the primary circuit in 0.05 s
You may assume that the only interaction between the coils is via the iron core.

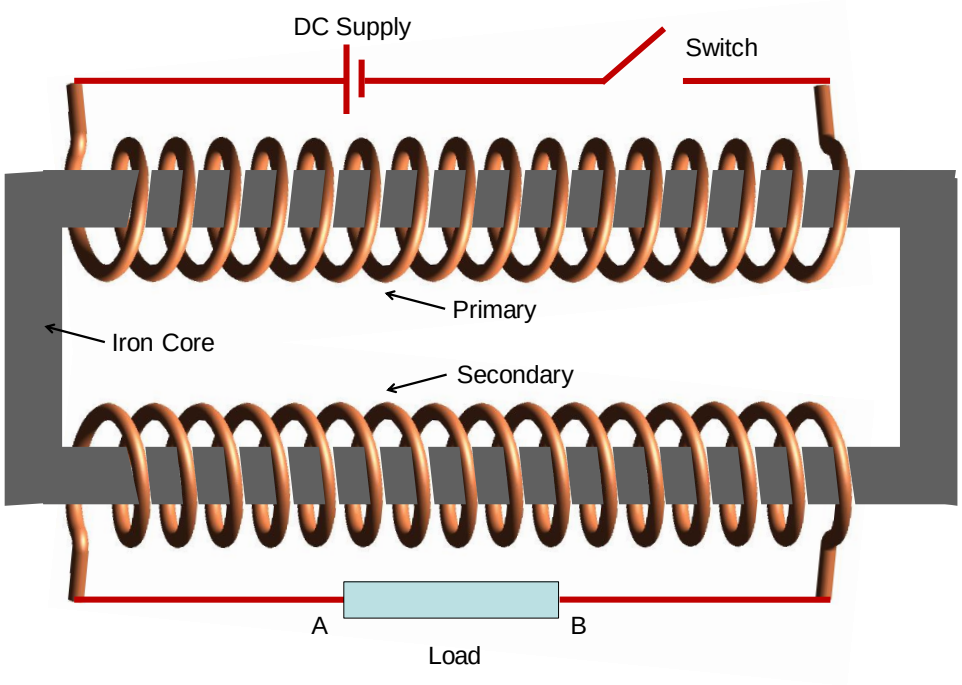


Figure 9

a. Which of the following best describes the observations that James would make of the load resistor? 2 marks

A. No current would flow at all in the secondary coil as the power source is DC in nature

B. Once the switch has been connected, continuous DC would flow from B to A across the load.

C. As the switch is connected, a short pulse of current would flow from A to B across the load

D. As the switch is connected, a short pulse of current would flow from B to A across the load

E. Once the switch has been connected, continuous AC would flow across the resistor

b. Explain your answer to Question 7, referring specifically to Lenz's Law. 3 marks

SECTION B – continued
TURN OVER

Question 12 (9 marks)

An engineer is modelling the electricity supply system for a remote factory, which received power from a small generator located some distance from the site. The simplified circuit diagram is shown in Figure 10.
Unfortunately, the engineer leaves some specifications and circuit parameters missing, so you have been asked to complete the analysis.

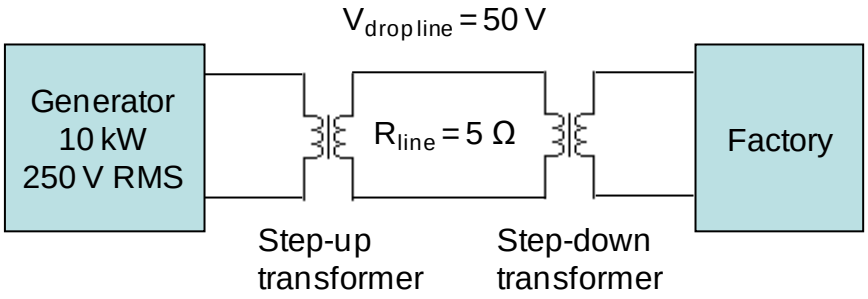


Figure 10

a. Use the information available to determine the current in the transmission lines. You must show your working. 2 marks

A

There are 1200 turns on the secondary side of the step-up transformer.

b. Determine the turns required on the primary side of the step-up transformer. You must show your working. 3 marks

turns

SECTION B – Question 12 - continued

c. Determine the voltage that would be available at the factory site, after the step-down transformer (ratio 4:1). You must show your working. 2 marks

_____

_____

_____

V

At one point during its operation, the generator is recorded as having an output of 10 kW at 250 V RMS

d. Determine the peak-to-peak voltage that would be observed. You must show your working. 2 marks

_____

_____

_____

V

Question 13 (5 marks)
A copper loop is positioned adjacent to a 0.4 T magnetic field directed into the page, as shown in Figure 11.
Starting a time t = 0, the loop is then pulled across the magnetic field at a constant speed until it reaches the position outlined in the figure.
The movement of the loop takes 0.4 sec.

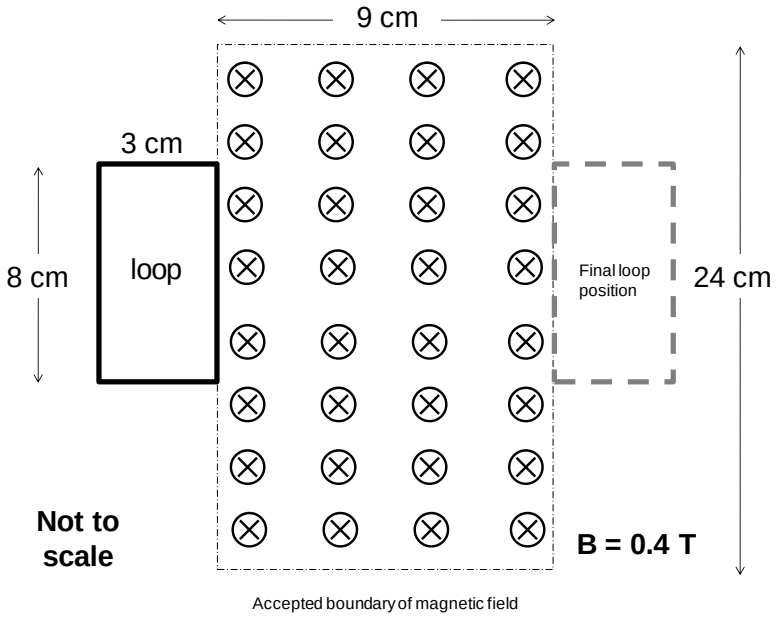
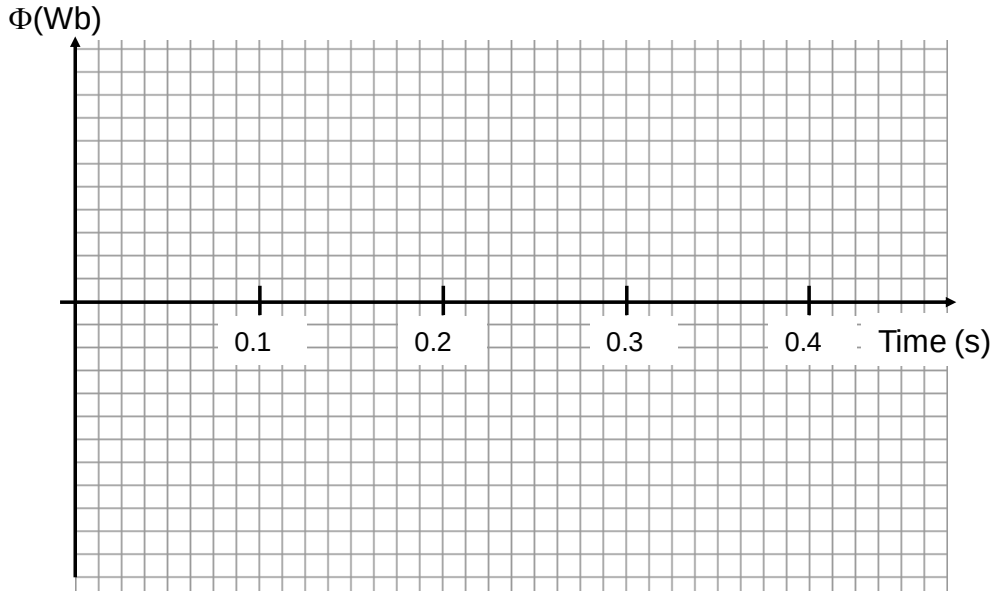


Figure 11

a. Using the axes provided, sketch a graph of the flux through the loop. Show a vertical scale. 3 marks
Note: Positive flux is defined as into the page.



SECTION B – Question 13 - continued

b. Determine the magnitude of the maximum emf generated in the loop. You must show your working. 2 marks

_____

_____

_____

V

SECTION B – continued
TURN OVER

Question 14 (13 marks)
A group of students were performing an experiment to verify the refractive index of Perspex to verify Snell's Law by measuring the angle of incidence and the angle of refraction. Their experimental set up is shown in Figure 12

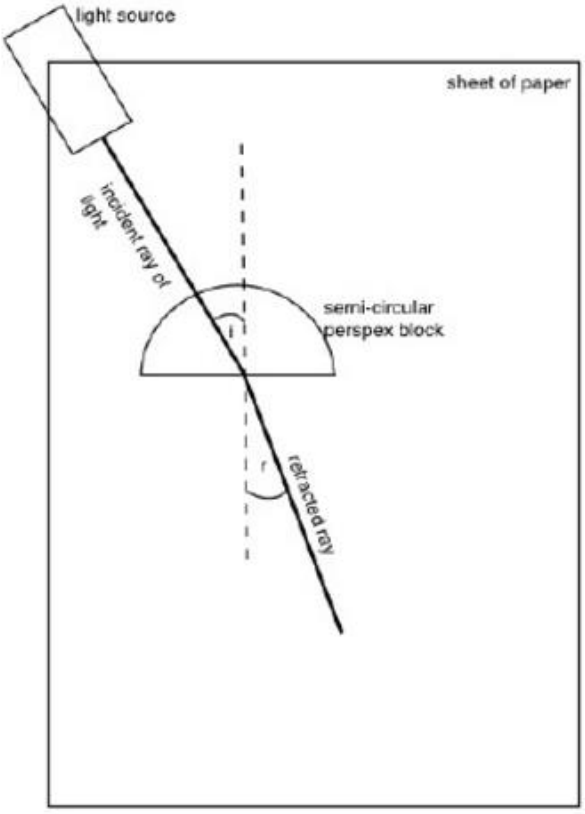


Figure 12

a. Write a suitable hypothesis. 2 marks

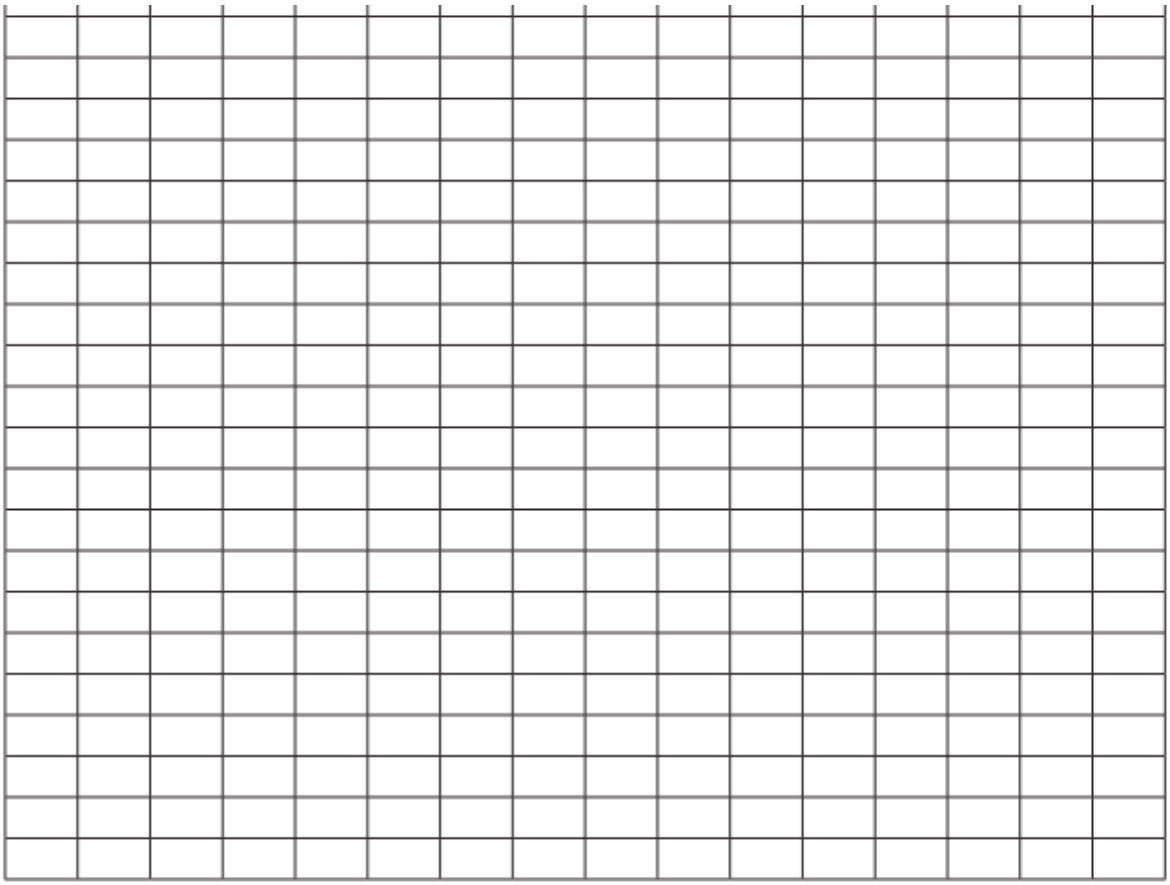
b. There were three main variables within the experiment. Identify the three under their correct categories. 3 marks

SECTION B – Question 14 - continued

The results the students obtained as displayed in Table 2

Angle of Incidence	Angle of Refraction
18^0	28^0
20^0	29^0
27^0	43^0
40^0	65^0
42.50^0	79^0

c. Using the recorded data draw a suitable graph and explain how your graph verifies Snell's law. 3 marks



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SECTION B – Question 14 - continued
TURN OVER

d. Find the refractive index of the Perspex. 2 marks

_____

_____

_____

V

e. If the theoretical value of Perspex is 1.5, find the percentage error and explain possible reasons for this error. 3 marks

_____

_____

_____

%

SECTION B – continued

Question 15 (4 marks)

A red laser of wavelength 625 nm is directed through a pair of narrow slits to generate a distinct pattern on a screen as depicted in Figure 13.
Point C is at the centre of the pattern and Point A is located 2.5 μm **further** from Slit 1 than Slit 2.

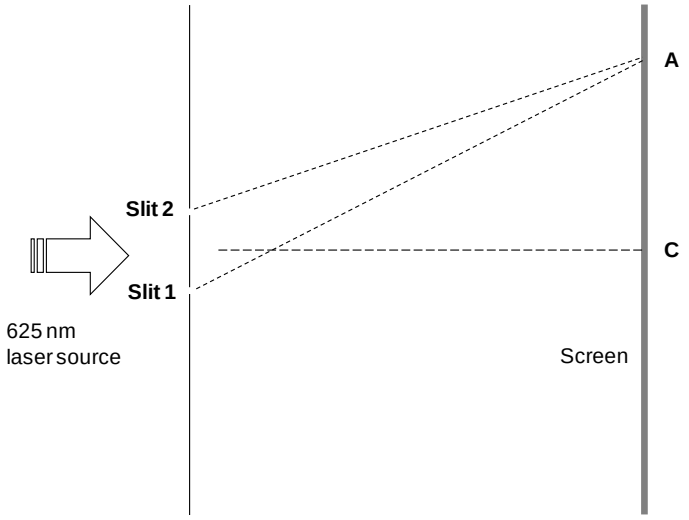

Figure 13

a. Starting from Point C and moving directly to Point A, how many dark bands would be crossed? You must show your working. 2 marks

_____

_____

_____

SECTION B – Question 15 - continued
TURN OVER

b. Use appropriate physics principles to explain the existence of the dark bands within the pattern. 2 marks

Question 16 (6 marks)
When directed through a polycrystalline metallic foil, both x-rays and electrons can exhibit similar diffraction patterns, as shown in Figure 14.

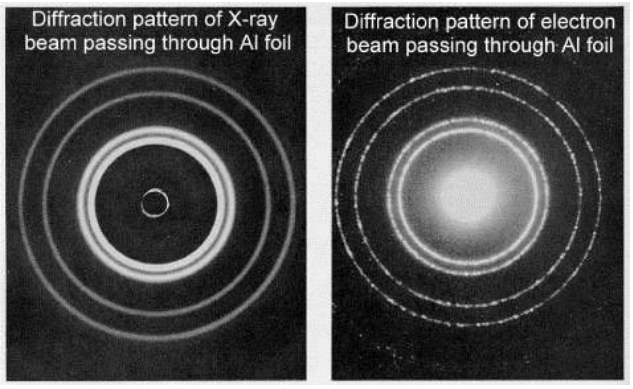

Figure 14

a. Explain why both electrons and x-rays could form a similar diffraction pattern, despite the obvious differences between them. 2 marks

SECTION B – Question 16 - continued

The electrons used in the diffraction experiment discussed above had been accelerated by a voltage of 600 V.

b. Determine the wavelength of the electrons. You must show your working. 2 marks

_____

_____

_____

m

c. Given the similar diffraction patterns in Figure 3, determine the energy of the x-rays used in the experiment. Give your answer in joules. You must show your working.
2 marks

_____

_____

_____

J

SECTION B –continued
TURN OVER

Question 17 (4 marks)
Figure 15 shows a circuit diagram for an experiment into the photoelectric effect.

For a light source of 500 nm, a stopping voltage of 1.7 V is just sufficient to ensure no current is recorded on the ammeter.

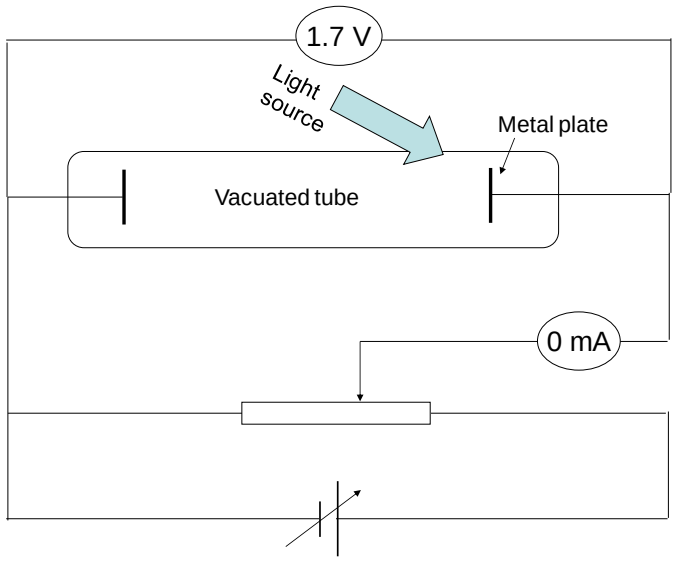

Figure 15

a. Determine the speed of the fastest electron as it is ejected from the metal surface. You must show your working. 2 marks

m s^{-1}

SECTION B – Question 17 - continued

b. Determine the threshold frequency for the experiment. You must show your working.

2 marks

_____

_____

_____

Hz

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 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	$r = \frac{p}{qB}$
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