TSSM™
Creating VCE Success

'2017 Examination Package' -
Trial Examination 8 of 9

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

PHYSICS

Units 3 & 4 – Written examination

(*TSSM's *2015 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			110
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers, one folded A3 sheet or two A4 sheets of notes and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 40 pages.
- A formula sheet.
- Answer sheet for multiple-choice questions.

Instructions

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

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

SECTION A – Multiple Choice

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

Spacing between electric field lines shows:

A. Their direction.
B. Their position.
C. Their strength.
D. Both A and B.

Question 2

Electrical as well as gravitational effects can be thought to be caused by fields. Which of the following is true of an electric or gravitational field?

A. The field concept is often used to describe contact forces.
B. A gravitational or electric fields does not always exist in the space around an object.
C. Fields are useful for understanding forces acting through a distance.
D. There is no way to verify the existence of a force field since it is just a concept.

Question 3

Which of the following will not strengthen the magnetic field produced by a single straight current carrying wire?

A. Coiling the wire.
B. Increasing the current.
C. Coiling the wire around a piece of iron.
D. Increasing the thickness.

SECTION A – continued

Question 4

An astronaut is standing on Mars. The astronaut throws an object of mass 0.30 kg vertically upward at an initial speed of 9.0 m s^{-1}. It reaches a maximum height of 11 metres. What is the magnitude of the acceleration of the object?

A. 1.4 m s^{-2}
B. 3.7 m s^{-2}
C. 9.0 m s^{-2}
D. 9.8 m s^{-2}

Question 5

Figure 1 shows four positions of a car on a roller coaster ride.

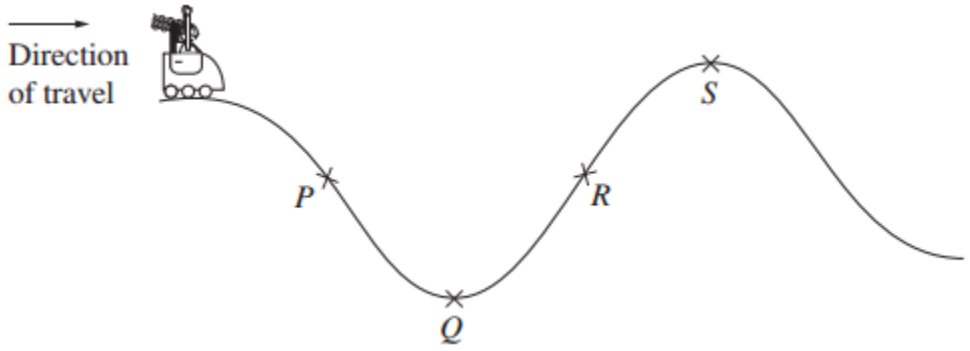


Figure 1

At which point during this ride would the occupant experience maximum 'g force'?

A. P
B. Q
C. R
D. S

Question 6

A clock is in a moving reference frame with respect to an observer. To the observer, the time on the clock appears to:

A. Be the same.
B. Run fast.
C. Run slow.
D. None of the above.

SECTION A – continued
TURN OVER

Question 7

Ashley and Emily are twin sisters. Emily makes a trip through space at close to the speed of light. Emily's age on her arrival will be:

A. Less than Ashley on Earth.

B. More than Ashley on Earth.

C. Same as Ashley.

D. Emily will be 3×10^8 s younger than her sister.

Question 8

Figure 2 shows a DC generator connected to a cathode ray oscilloscope (CRO).

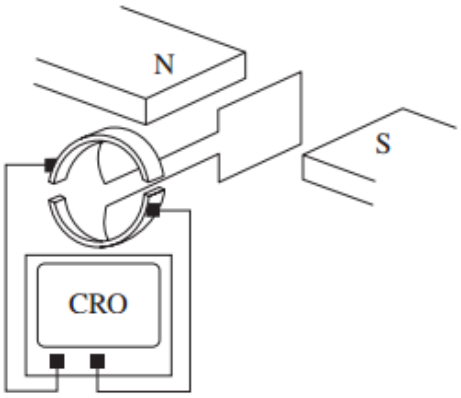
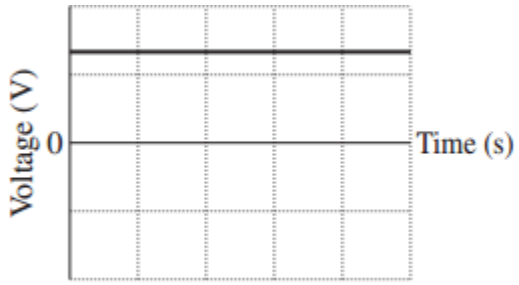


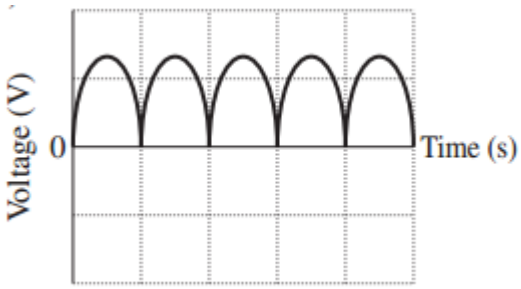
Figure 2

What output voltage would be observed for this generator on the CRO?

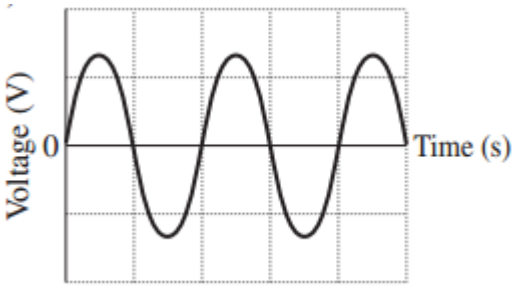
A



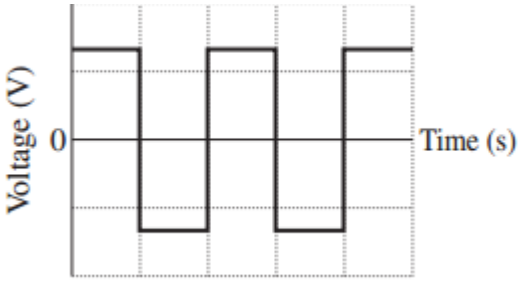
B



C



D



SECTION A – continued

This information applies to Question 9 and Question 10.

A current of 4.0 A flows in the primary coil of an ideal transformer when it is connected to 240 V, AC. The number of turns on the secondary coil is 6 times the primary coil.

Question 9

What is the voltage across the secondary coil?

A. 1020 V

B. 1440 V

C. 2010 V

D. 2040 V

Question 10

What current flows through the secondary coil?

A. 1.5 A

B. 0.44 A

C. 0.55 A

D. 0.67 A

Question 11

The polarisation of light shows that light is made of

A. Waves

B. Longitudinal waves

C. Transverse waves

D. Electromagnetic radiation

Question 12

Light refracts when it goes from air to water. This is because which of the following decreases?

A. wavelength, speed

B. wavelength, frequency

C. speed, frequency

D. wavelength, speed & frequency

Question 13

The index of refraction for a certain type of glass is 1.640 for blue light and 1.605 for red light. When a beam of white light enters a plate of this glass at an incidence angle of 40°, what is the angle in the glass between blue and red parts of the refracted beams?

A. 0.53°
B. 23.075°
C. 23.619°
D. 46.685°

Question 14

Isaac Newton sent a narrow bean of white light though a prism. As a result, Newton observed the white light dispersing into:

A. The electromagnetic spectrum.
B. The visible light spectrum of colours.
C. The primary colours.
D. The ultraviolet and infrared colours.

Question 15

In an open pipe, third harmonic is 450 Hz. Calculate the frequency of the 7^{th} harmonic? Velocity of sound is 340 m s^{-1}

A. 350 Hz
B. 750 Hz
C. 1050 Hz
D. 1200 Hz

Question 16

In a Young's double-slit experiment the centre of a bright fringe occurs wherever waves from the slits differ in the distance they travel, by a multiple of:

A. A fourth of a wavelength.
B. A half a wavelength.
C. A wavelength.
D. Three-quarters of a wavelength.

SECTION A – continued

Question 17

A student carried out an experiment during which light of different frequencies was shone onto a metal surface to produce photoelectrons. The student measured the maximum kinetic energy of the emitted photoelectrons as the frequency of light was altered. The relationship between the maximum kinetic energy of the photoelectrons and the frequency of the light incident on the metal surface is given by:

$$E_k(max) = hf - W$$

where

$E_k(max)$ = maximum kinetic energy of the photoelectrons

f = frequency of light used

h = Planck's constant

W = The work function of the metal

How could the student best analyse the data to determine a value for Planck's constant?

A. Plot $E_k(max)$ against f and find the gradient of the line of best fit.

B. Plot $E_k(max)$ against W and find the gradient of the line of best fit.

C. Plot $E_k(max)$ against f and find the intercept of the line of best fit.

D. Plot $E_k(max)$ against W and find the intercept of the line of best fit.

This information applies to Question 18 to Question 20.

The energy levels of the Helium-Neon laser is shown in Figure 3

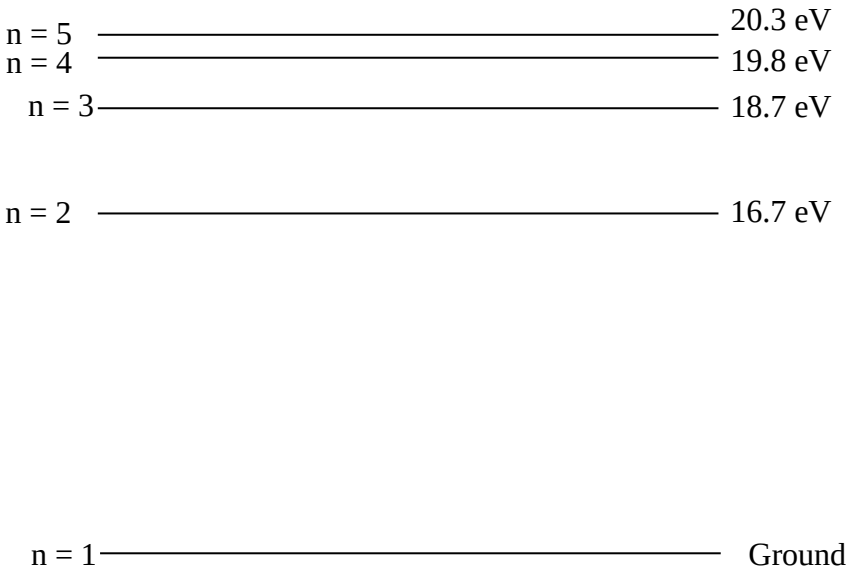


Figure 3

SECTION A – continued
TURN OVER

Question 18

Energy required to move an electron from n = 2 to n = 5 is approximately equal to:

A. 3.1 eV

B. 3.6 eV

C. 4.2 eV

D. 5.3 eV

Question 19

Energy required to move an electron from n = 2 to n = 5 is approximately equal to:

A. 5.76×10^{-19} J

B. 6.75×10^{-19} J

C. 7.78×10^{-19} J

D. 8.69×10^{-19} J

Question 20

How many different transitions are possible, when the electron is returning to n = 5 to n = 2?

A. 10

B. 7

C. 6

D. 2

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 (4 marks)

An electron gun consists of two metal plates, 5mm apart and connected to a high voltage supply of 2000 V. Electrons get accelerated to the positive plate as shown in Figure 1.

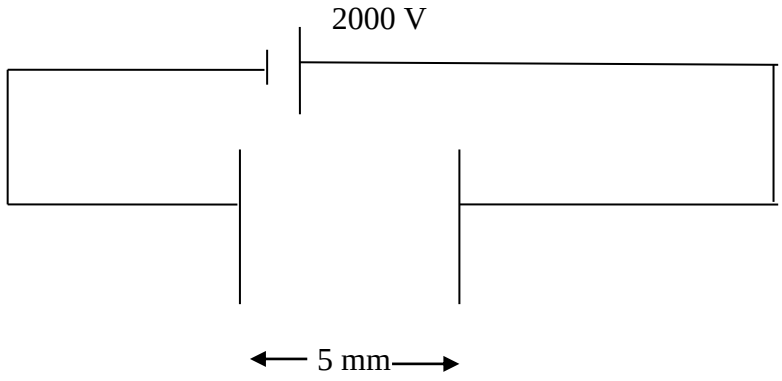


Figure 1

a. Calculate the strength of the electric field 2 marks

V m^{-1}

SECTION B – Question 1 - continued
TURN OVER

b. The force experienced by an electron is: 2 marks

_____

_____

_____

N

Question 2 (6 marks)

Vendor, a geostationary satellite was found to orbit around the planet Zapol at the distance of 9×10^5 m from the surface of the Zapol. The mass of the planet is 8.0×10^{20} kg. It takes 20 hours for Vendor to complete one revolution around the planet Zapol.

Universal Gravitational Constant = 6.67×10^{-11} N m^2 kg^{-2}

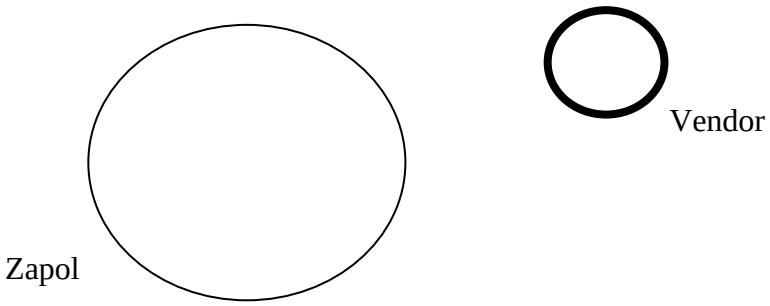


Figure 2

a. Calculate the period of rotation in seconds of the planet Zapol about its own axis.

1 mark

_____

_____

_____

SECTION B – Question 2 - continued

b. Calculate the radius of planet Zapol. 3 marks

m

c. Calculate the speed at which Vendor is orbiting around the planet Zapol. 2 marks

m s^{-1}

SECTION B – continued
TURN OVER

Question 3 (4 marks)

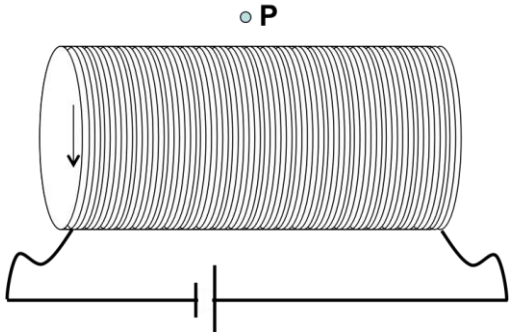


Figure 3

Figure 1 shows a solenoid connected to a DC power supply. Current flows in the solenoid as shown by the arrow in Figure 3. The magnetic field induced by this current has a strength of 0.13 T at **P**. A linear wire (effective length 4 cm) is positioned at **P** and runs perpendicular to the solenoid. Initially, there is no current in the linear wire.

Where required, adopt the direction convention: **(Left / Right / Up / Down / Into Page / Out of Page)**

a. State the direction of the magnetic field at **P**. 1 mark

A student now wants to induce an upwards force on the linear wire at **P** of 0.02 N.

b. Calculate the size and direction of the required current in the linear wire. 3 marks

_____

_____

_____

Size:

A

Direction:

SECTION B – continued

Question 4 (6 marks)

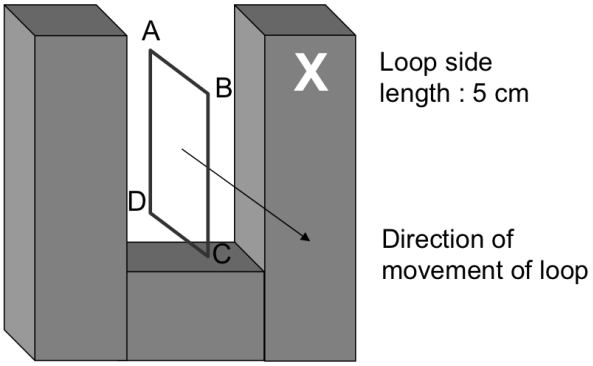


Figure 4

A square copper loop with resistance 0.3 Ω is initially immersed within a magnetic field as shown in Figure 2.
The loop is removed from the field in the direction shown, taking 80 ms to do so.
Current of 40 mA flows in the direction ABCD in the loop as it is removed.

a. Calculate the size of the magnetic field. 3 marks

_____

_____

T

b. Circle the polarity of X and explain how you reached your answer. 3 marks

North / South

_____

_____

_____

SECTION B – continued
TURN OVER

Question 5 (7 marks)
A basic DC motor is shown in Figure 5. The magnetic field provided by the bar magnets is 0.08 T and there are 30 turns in the coil. The coil has side length of 16 cm.

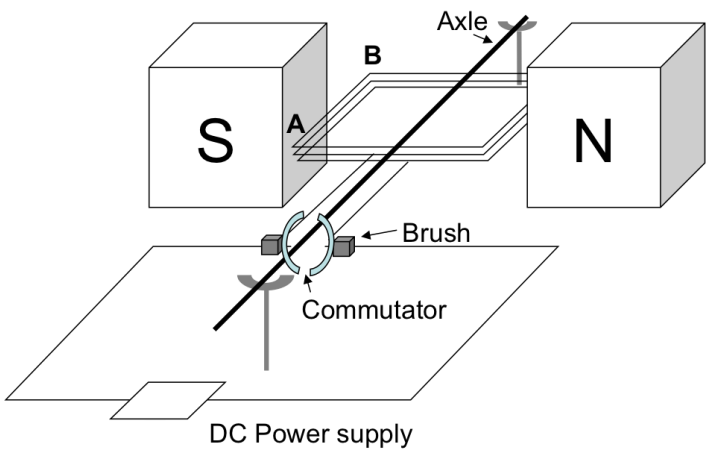


Figure 5

The size of the force on side AB is measured at 0.23 N upwards.

a. Calculate the size and direction of the current in the coil. 4 marks

_____

_____

_____

	A

Direction:

b. Explain how the commutator ensures continuous rotation of the coil. 3 marks

_____

_____

_____

SECTION B – continued

Question 6 (7 marks)

A student constructs a basic generator as shown in Figure 6a and connects it to a CRO (cathode ray oscilloscope), whose output is shown in Figure 6b. A black box deliberately obscures a key component of the generator.

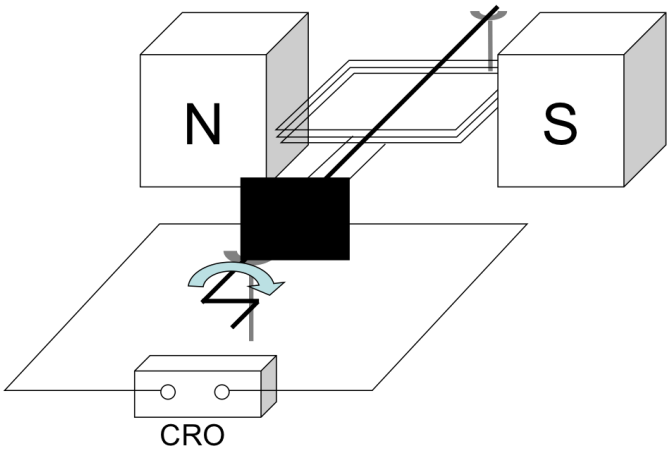


Figure 6a

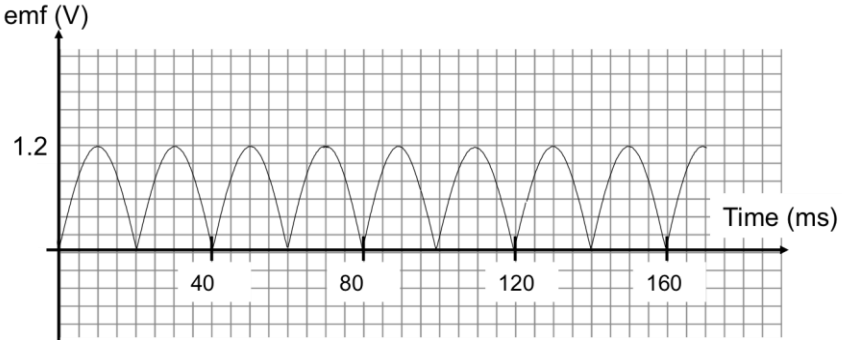


Figure 6b

a. Determine the frequency of rotation of the coil. 2 marks

Hz

b. Are slip-rings or a split-ring commutator used in the setup? Explain your answer. 3 marks

_____

_____

_____

The speed of rotation of the coil is now halved. 2 marks

c. Referring to Figure 6b, determine the voltage measured by the CRO at T = 20 ms.

_____

_____

_____

V

Question 7 (6 marks)

Year 12 students set up a ramp which is 40^o to the horizontal as shown in Figure 1. They use two blocks A and B, each of mass 15 kg. Block B is placed on a frictionless ramp. They connect the masses using a light and frictionless pulley. The frictional force between A and the horizontal surface is 10 N.

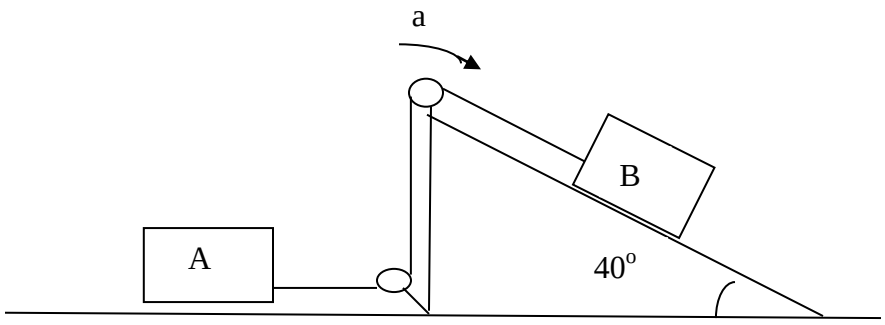


Figure 7

a. Calculate the acceleration of the system. 2 marks

_____

_____

_____

m s^{-2}

b. Work out the Tension force in the string. 2 marks

_____

_____

_____

N

SECTION B – Question 7 - continued
TURN OVER

c. Calculate the time taken by block B to move 40 cm down the ramp starting from rest.

2 marks

_____

_____

_____

s

SECTION B – continued

Question 8 (7 marks)

Cathy watches a collision between two carts in a Physics lab, approaching each other from opposite directions. Cart A has a mass of 550g and is travelling with a velocity of 20cm/s, hit Cart B that has a mass of 720g and is travelling with a velocity of 15cm/s, shown in figure 8a. After the collision, Cart A locked onto Cart B as shown in figure 8b.

Before collision

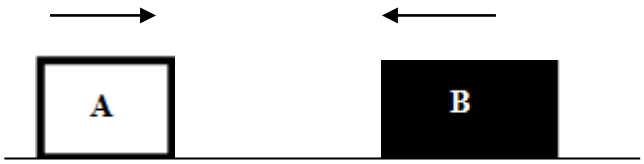


Figure 8a

After collision

Figure 8b

a. At what speed and direction, cart B will move after the collision? 2 marks

_____

_____

_____

$m\ s^{-1}$	Direction:

b. Is the collision elastic or inelastic? 1 mark

SECTION B – Question 8 - continued
TURN OVER

c. Justify your answer in part b, using appropriate calculations. 2 marks

_____

_____

_____

_____

_____

_____

d. If the collision lasts for 0.40 s, what is the size of the force applied by Cart A on Cart B? 2 marks

_____

_____

_____

_____

N

SECTION B – continued

Question 9 (6 marks)

Betty went to Luna Park with her friends. Betty's height from the ground to her shoulders is 1.8m , as shown in figure 9. She tried throwing a ball in the hoop to win. She aimed the ball at an angle of 70^{o} to the horizontal from her shoulders with a velocity of 7.5 m s^{-1}.

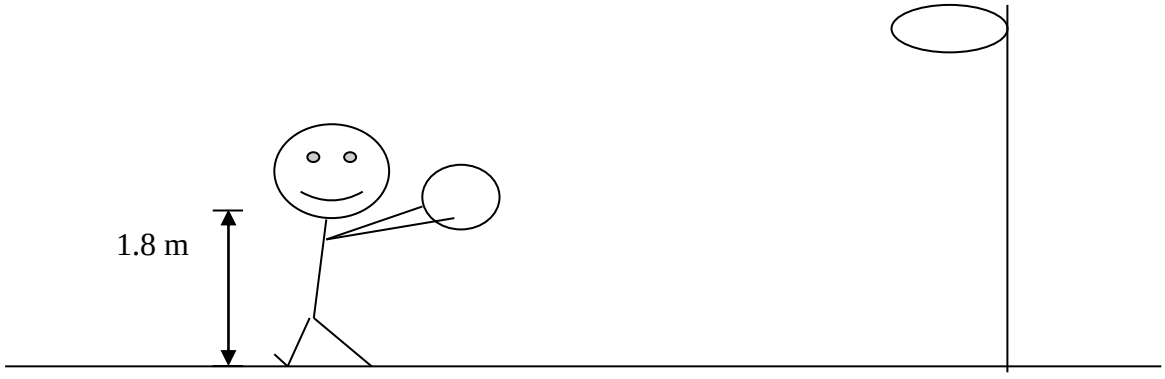


Figure 9

a. Calculate the horizontal component of its initial velocity. 1 mark

_____

_____

m s^{-1}

b. Calculate the vertical height that the ball reaches from the ground. 2 marks

_____

_____

_____

_____

m

SECTION B – Question 9 - continued
TURN OVER

c. Calculate the time the ball spent in air. 2 marks

_____

_____

_____

_____

s

d. If the ball gets in the hoop at highest point how far should Betty stand from the hoop? 1 mark

_____

_____

_____

m

SECTION A - continued

Question 10 (7 marks)

Travis went for a bike ride at the base of a circular track with a radius of 25 m. The maximum centripetal force between the bike tires and the track is 200 N. Travis and his bike weigh a total of 90 kg.

Figure 10

a. State what is meant by "centripetal force". 1 mark

_____

_____

_____

b. Calculate the maximum speed at which Travis can travel safely on his bike, as he approaches the circular part of the flat track. 2 marks

_____

_____

_____

m s^{-1}

SECTION B – Question 10 - continued
TURN OVER

After 10 rounds, Travis moves to an banked track of radius 30 m at an angle of 20^{o}.

c. Calculate the design speed at which he should travel safely with the same track conditions.

2 marks

_____

_____

_____

m s^{-1}

d. Explain what would happen to Travis if he rides at a speed higher than that as calculated in part c. 2 marks

_____

_____

_____

_____

SECTION B – continued

Question 11 (5 marks)

Jesse goes to a circus and enjoys a Ferris wheel ride as shown in figure 8. Jesse's mass is 50 kg and whenever the Ferris wheel reaches position A, she feels a little heavier.

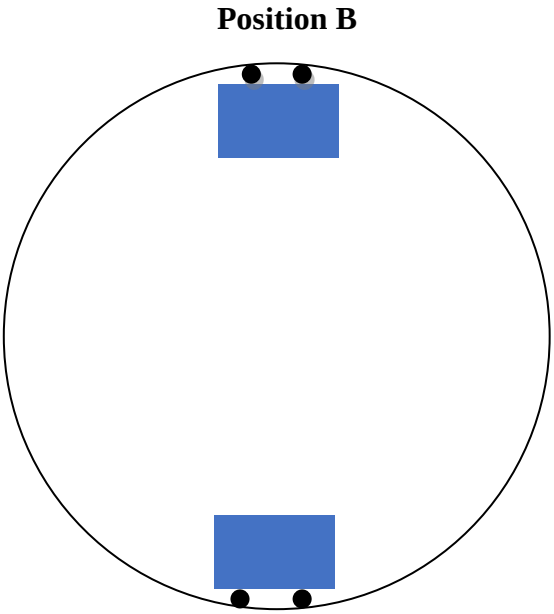


Figure 11

a. Label all the forces acting on Jesse at position A. 1 mark

b. Explain why Jesse feels a little heavier by using the forces you have labelled in part a, when she is at the bottom of the ride. 2 marks

_____

_____

_____

_____

_____

SECTION B – Question 11 - continued
TURN OVER

c. Compare Jesse's apparent weight as she reaches the top of the ride, at Position B with respect to Position A. 2 marks

_____

_____

_____

_____

Question 12 (3 marks)
A spring is compressed to 4.0 cm by a 250 g block. When the spring is released, the block acquires 4.0 J of Kinetic energy.

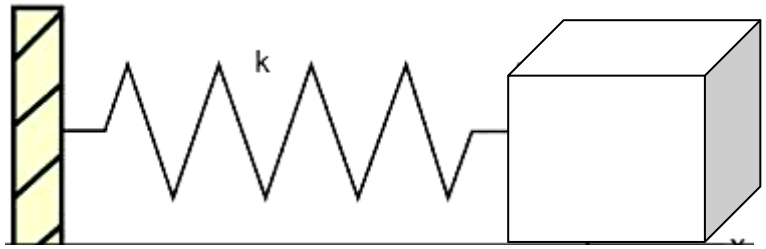


Figure 12

a. Calculate the block's speed after the spring is released. 1 mark

_____

_____

_____

_____

m s^{-1}

SECTION B – Question 12 - continued

b. Calculate the spring constant of the spring. 2 marks

N m^{-1}

Question 13 (2 marks)

An electron has a mass 9.1×10^{-31} kg and is moving with a velocity of 0.6×10^{8} m s^{-1}. Calculate the relativistic mass of the electron.

kg

SECTION B – continued
TURN OVER

Question 14 (5 marks)

A generator operating at 2.5 kW, 200 V AC RMS is connected to a transformer which steps up the voltage to allow for more efficient transmission.
The RMS current in the transmission lines is recorded at 2.5 A as shown in Figure 13.
Assume the transformer is ideal.

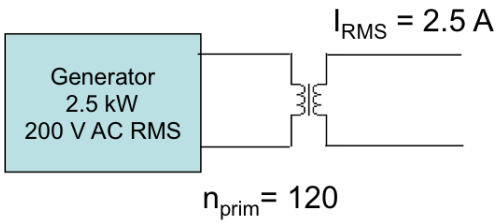


Figure 13

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

A

b. Calculate the RMS voltage on the secondary side of the transformer. 2 marks

V

There are 120 turns on the primary side of the transformer.

c. Determine the number of turns on the secondary side of the transformer. 2 marks

turns

SECTION B – continued

Question 15 (9 marks)

A new generator is connected in a transmission system, providing power to a distant shop. At one point, the generator operates at 4.0 kW, 1200 V AC RMS.
3 km transmission lines with a total resistance of 12 Ω connect the generator to a step-down transformer with turns ratio of 400:100.
A shop is adjacent to the transformer and acts as the operating load for the system.
Figure 14 shows a basic schematic of the setup.

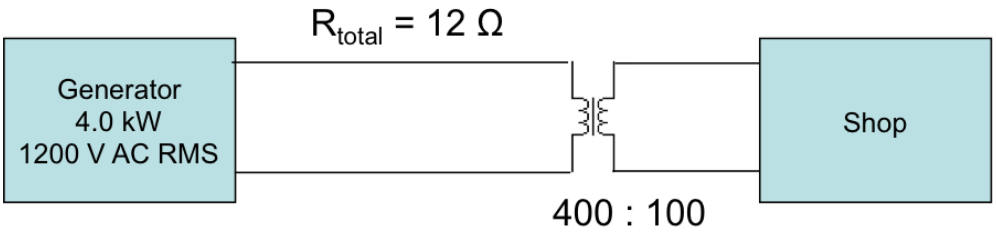


Figure 14

a. Calculate the voltage drop across the transmission lines. 2 marks

_____

_____

V

b. Calculate the efficiency of the system, using the equation: $\eta = \frac{P_{input} - P_{loss}}{P_{input}} \times 100\%$. 2 marks

_____

_____

%

SECTION B – Question 15 - continued
TURN OVER

c. Calculate the voltage available at the shop. 2 marks

_____

_____

V

The effective resistance of the shop is now reduced as a result of the owner switching on more equipment in parallel with the initial load.

d. Describe and explain the effect on the voltage at the shop. 3 marks

_____

_____

_____

_____

SECTION B – continued

Question 16 (7 marks)

Students are investigating Young's Double Slit experiment with a laser source as part of their Extended Practical Investigation. The setup and pattern resulting from the interference is shown in Figure 15a and 15b.
C is the centre of the pattern. The path difference $S_1Y - S_2Y = 1$ μm.

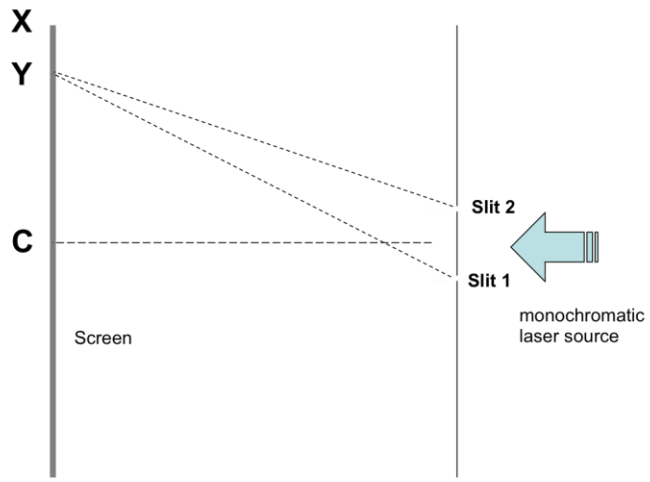


Figure 15a

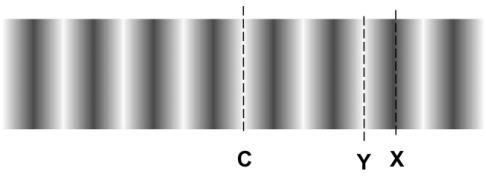


Figure 15b

a. Develop a suitable hypothesis for this experiment. 2 marks

_____

_____

_____

_____

b. Determine the wavelength of the laser source. 2 marks

_____

_____

nm

SECTION B – Question 16 - continued
TURN OVER

c. Explain the process that allows for a dark band at X to be formed. 2 marks

_____

_____

_____

_____

d. If the distance between Slit 1 and Slit 2 is reduced, state the effect on the pattern. 1 mark

_____

_____

SECTION B – continued

Question 17 (7 marks)

The energy vs. frequency plot for a photoelectric effect experiment is shown in Figure 8.

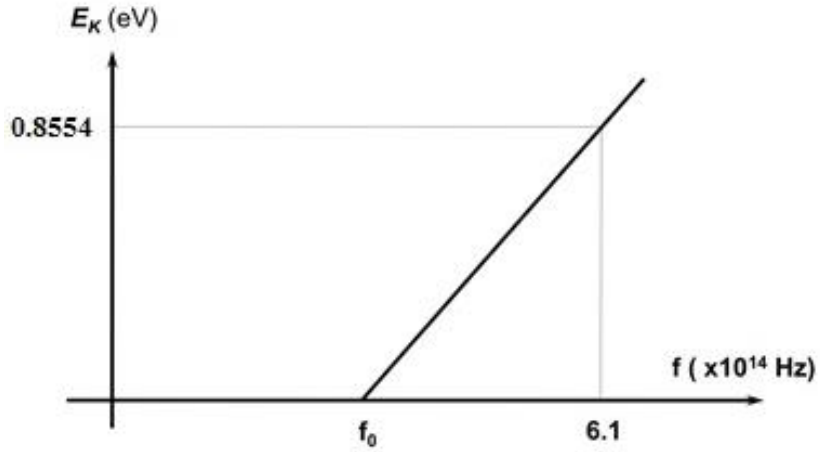


Figure 16

a. Determine the work function for the metal used in the experiment. 2 marks

_____

_____

eV

b. Determine the threshold frequency, f_0. 2 mark

_____

_____

Hz

SECTION B – Question 17 - continued
TURN OVER

e. Explain how the existence of a threshold frequency supports the particle model for light and not the wave model. 3 marks

_____

_____

_____

_____

Question 18 (5 marks)
X-rays of wavelength 0.08 nm undergo diffraction through a circular aperture, as shown in Figure 17.

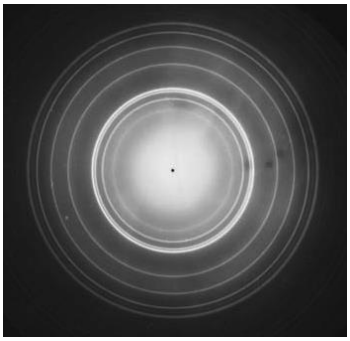


Figure 17

a. Calculate the momentum of a single x-ray photon. 2 marks

_____

_____

N s

b. Explain why electrons of the same energy as the original x-rays would not have the same pattern spacing as shown in Figure 17. 3 marks

_____

_____

_____

_____

Question 19 (5 marks)

A simplified energy level diagram for a hydrogen atom is shown in Figure 18.

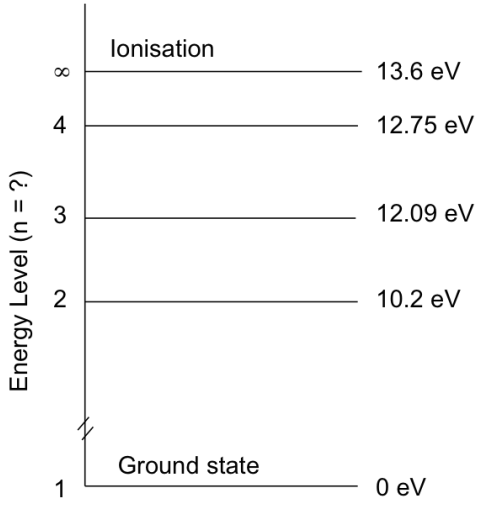


Figure 18

a. Calculate the wavelength of a photon emitted as an electron transitions from n = 4 to n = 2. 2 marks

_____

_____

nm

SECTION B – Question 19 - continued
TURN OVER

b. Explain why .an electron can exist (briefly) at level 12.75 eV, but not in the region between 0 and 10.2 eV 3 marks

_____

_____

_____

_____

Question 20 (2 marks)

Calculate the de Broglie wavelength for an electron accelerated by a voltage of 400 V. 2 marks

_____

_____

m

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	$G = 6.67 \times 10^{-11}$ 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 20 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