NAME: _____

VCE® PHYSICS

UNITS 3 & 4 Practice Written Examination

Reading time: 15 minutes
Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOK

Structure of Book

Section	*Number of Questions*	*Number of questions to be answered*	*Number of marks*
A	**20**	**20**	**20**
B	**19**	**19**	**100**
			Total 120

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

Materials supplied

- Question and Answer Book of 39 pages.
- Formula and Data Sheet provided by your teacher.

Instructions

- Write your **student name** in the space provided above on this page and the multiple-choice answer sheet.
- 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 Questions

Instructions

Answer **all** questions in pencil on the Multiple-Choice Answer Sheet.

Choose the response that is **correct** or that **best answers** the question.

A correct answer scores 1; an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Take the value of *g* to be 9.8 m s^{-2}.

Question 1

A puck of mass 0.18 kg is sliding on ice with a constant velocity of 13 ms^{-1} to the left. An ice hockey stick exerts a force on the puck for a short period of time to the right. The momentum of the puck changes by 4.32 kg $ms^{-1}$to the right. Ignoring the effects of friction, what is the new velocity of the puck as it leaves the ice hockey stick?

A. $11ms^{-1}$ to the left

B. $11ms^{-1}$ to the right

C. $24ms^{-1}$ to the left

D. $24ms^{-1}$ to the right

Question 2

Figure 1 below shows a small ball of mass 0.6 kg swinging in a circular path on the end of a 1 m long string. It travels in a horizontal circle at an angle of 15 degrees to the verical at a constant speed of $0.83\,m\,s^{-1}$.

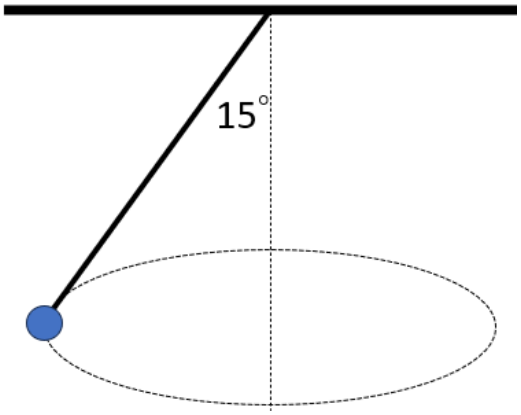


Figure 1

The net acceleration of the ball is closest to

A. 0.3 m s^{-2}

B. 0.9 m s^{-2}

C. 1.4 m s^{-2}

D. 2.7 m s^{-2}

The following information applies to Questions 3 and 4.

Figure 2 below shows a block of wood of mass 250 g on a smooth slope.

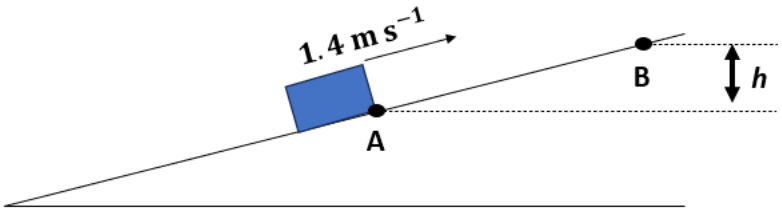


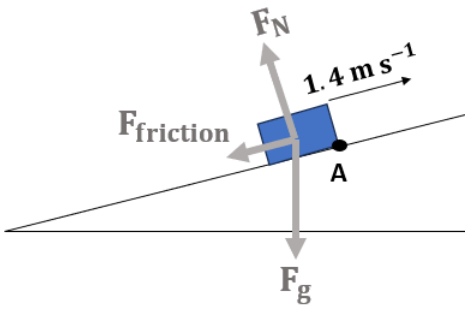
Figure 2

At time $t = 0\ s$, the block is a point A and has a velocity of 1.4 $m\,s^{-1}$ up the slope. The block decelerates at a rate of 1.8 $m\,s^{-2}$before momentarily coming to rest at point B. It then slides back down the slope.

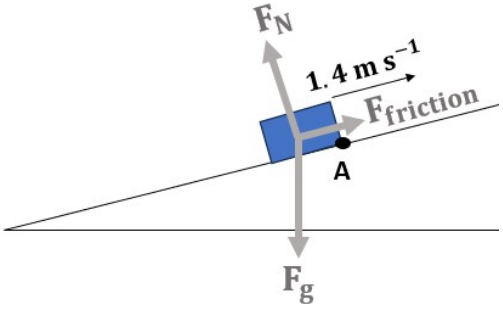
Question 3

Which diagram below correctly shows the forces acting on the mass at point A?

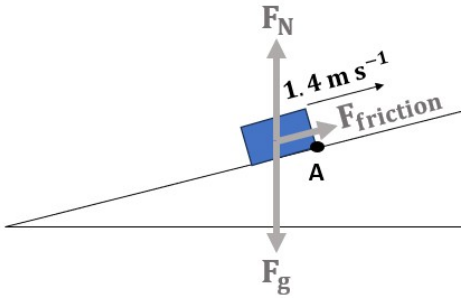
A.



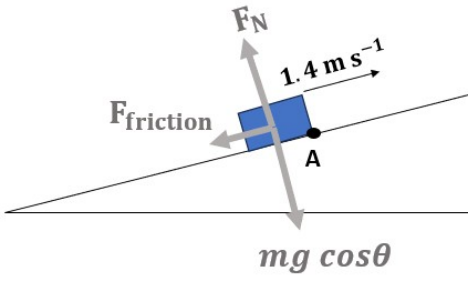
B.



C.



D.



Question 4

The time taken to travel from point A to B is closest to

A. 0.24 s

B. 0.78 s

C. 1.30 s

D. 2.45 s

Question 5

Two charged plates placed 10 cm apart produce an electric field of strength 350 $V\,m^{-1}$.

The work done to move an electron from the negative to the positive plate is closest to

A. $5.6 \times 10^{-18}\,J$

B. $7.2 \times 10^{-18}\,J$

C. $3.7 \times 10^{-19}\,J$

D. $1.6 \times 10^{-19}\,J$

The following information refers to Questions 6 and 7.

A point charge 'A' of magnitude $2.8 \times 10^{-6} C$ is shown in Figure 4 below.

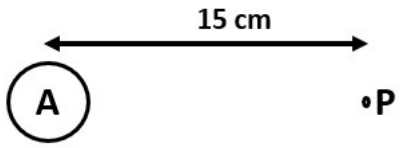


Figure 4

Question 6

The electric field strength at point 'P' which is 15 cm away is closest to

A. $1.2 \times 10^{3} N C^{-1}$

B. $4.2 \times 10^{3} N C^{-1}$

C. $1.1 \times 10^{6} N C^{-1}$

D. $7.5 \times 10^{6} N C^{-1}$

Question 7

The force on a 3.00×10^{-6} C charge placed at point P would be closest to

A. 0.025 N

B. 0.087 N

C. 1.26 N

D. 3.36 N

Question 8

What is the main function of an inverter in a photovoltaic power system?

A. To store excess electricity

B. To convert AC to DC power

C. To regulate voltage output

D. To convert DC to AC power

Question 9

How is DC voltage produced in DC generators?

A. By using slip rings

B. By using split ring commutators

C. By using transformers

D. By employing semiconductors

Question 10

An ideal transformer contains 8 turns in the primary coil and 40 turns in the secondary coil.

If 1.4 A of current runs through the primary coil, what is the current through the secondary coil?

A. 0.14 A

B. 0.28 A

C. 1.4 A

D. 2.6 A

Question 11

A proton and an electron travel at the same speed. Which statement correctly explains the difference between their de Broglie wavelengths?

A. The proton has a longer wavelength because its mass is greater.

B. The proton has a shorter wavelength because its mass is smaller.

C. The electron has a shorter wavelength because its mass is greater.

D. The electron has a longer wavelength because its mass is smaller.

Question 12

Figure 5 shows three energy levels of an electron within a gas atom.

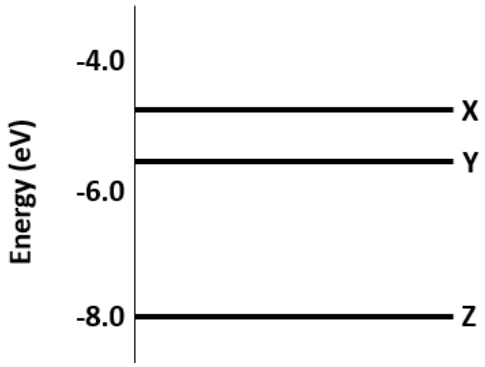


Figure 5

Which transition occurs when the electron absorbs a photon with the shortest wavelength?

A. X to Y

B. Y to X

C. Z to Y

D. Z to X

Question 13

Students conduct Young's double slit experiment with laser lights. Their second trial results in light bands that are closer together.

Which change could have been made to produce these new results?

A. Increase the distance from the slits to the screen.

B. Increase wavelength.

C. Increase the distance between slits.

D. Increase intensity of the light.

The following information relates to Questions 14 and 15.

In one of Einstein's famous thought experiments, a passenger travels on a train that passes through a station at 65% of the speed of light ($\gamma = 1.3$¿. According to the passenger, the length of the train carriage is 25 m from front to rear.

Question 14

A light in the train carriage is switched on. Compared to the passenger on the train, a rail worker standing on the station platform would see the velocity of the light beam as

A. the same velocity as the passengers on the train.

B. greater than the velocity as the passengers on the train.

C. less than the velocity as the passengers on the train.

D. greater than a comparable non-inertial frame of reference.

Question 15

The length of the carriage as observed by the rail worker on the station platform would be closest to

A. 1.5 m

B. 19.2 m

C. 32.5 m

D. 150 m

Question 16

Electrons produce a diffraction pattern when passed through a crystalline lattice. This provides evidence for electrons'

A. ability to form standing waves.

B. exhibiting wave like properties.

C. exhibiting particle like properties.

D. showing relativistic effects.

The following information relates to Questions 17 and 18.

Students conduct a Young's double slit experiment in class. They measure the fringe separation with a ruler that has 1 cm markings. They use a ruler that is quite thick and read the distance at an angle to the side as the equipment is in the way.

Question 17

The resolution of this ruler would be closest to

A. 0.005 m

B. 0.001 m

C. 0.01 m

D. 0.05 m

Question 18

The way in which the students measure the distance off the ruler creates and error in their results. What type of error would this be considered?

A. Standard error

B. Systematic error

C. Random error

D. Human error

Use the following information to answer Questions 19 and 20.

Students collect the following data when attempting to measure the acceleration due to gravity.

Julius

$g\ (m\ s^{-2})$			
Trial 1	**Trial 2**	**Trial 3**	**Average**
9.1	10.4	9.6	9.7

Maximus

$g\ (m\ s^{-2})$			
Trial 1	**Trial 2**	**Trial 3**	**Average**
9.8	9.4	9.3	9.5

Question 19

Which set of data could be considered the most accurate?

A. Julius

B. Maximus

C. They both have the same level of accuracy

D. Neither results would be considered accurate

Question 20

Which set of data could be considered the most precise?

A. Julius

B. Maximus

C. They both have the same level of precision

D. Neither results would be considered precise

END OF SECTION A

Section B Short Answer Questions

Instructions

Answer **all** questions in the space provided.

Write your responses in English.

Where an answer box is provided, write your final answer in the box.

In questions where more than one mark is available, appropriate working **must** be shown.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (3 marks)

An archer pulls back 0.75 m horizontally on a bow which has a stiffness of 200 $N\,m^{-1}$. The arrow weighs 50 g.

a. Show that the energy stored in the bow is 56 J. 1 mark

b. Calculate the velocity of the arrow immediately after release. 2 marks

$m\,s^{-1}$

Question 2 (6 marks)

A car (of mass 1.5×10^3 kg) is moving around a horizontal circular track. Initially the car travels on path A (radius of 80 m) shown in Figure 6.

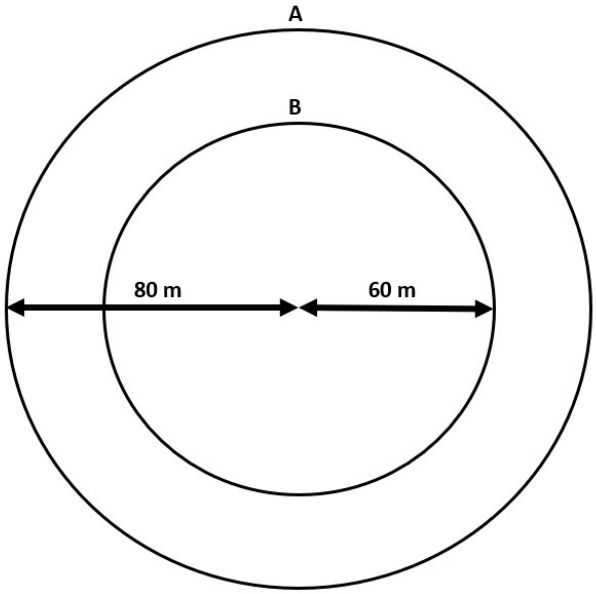


Figure 6

The maximum speed the car can move around path A without sliding is 18 m s^{-1}.

a. Calculate the centripetal force acting on the car moving around path A at maximum speed. 2 marks

_____

_____

_____

_____

N

b. The car now moves to path B, travelling at the same speed as it did on path A. Compare the new values for centripetal force and period, giving reasons for each choice. 4 marks

Centripetal force: ……. *Greater than A* *…….Less than A* *……. The same as A*

Period: ……*Greater than A* *…….Less than A* *……. The same as A*

Question 3 (3 marks)

An unpowered car moves at a constant speed along a horizontal frictionless track. It then enters a vertical loop as shown in Figure 7.

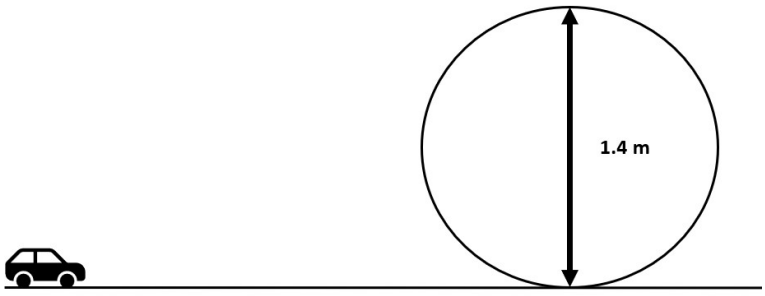


Figure 7

Explain why the car needs to be travelling at a speed of 5.8 $\mathrm{m\ s^{-1}}$ when moving along the horizontal section of the track, to maintain contact with the track at the top of the loop. Use calculations to support your answer.

Question 4 (6 marks)

An astronaut on a new planet throws a stone from the top of a cliff at a speed of 14 ms^{-1} at an angle of 25 degrees above the horizontal, as shown in Figure 8. The stone hits the ground 7.4 s later.

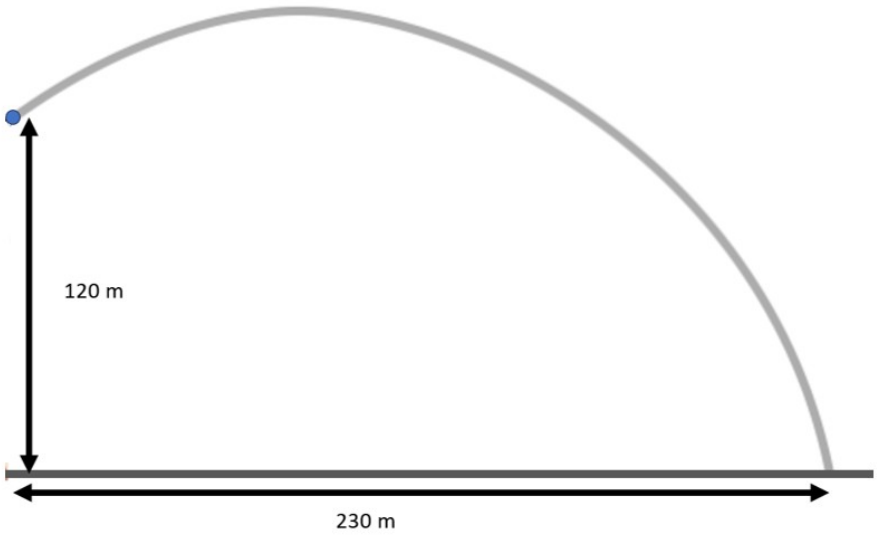


Figure 8

a. Show that the initial vertical velocity is 5.9 $\mathrm{m\ s^{-1}}$. 1 mark

b. Calculate the acceleration due to gravity on this unknown planet. 2 marks

ms^{-1}

c. If the planet has a radius of 2500 km, calculate the mass of the planet. 3 marks

kg

Question 5 (7 marks)

A 2000 kg car moving at 18 ms^{-1} East and a 10 000 kg truck moving at 14 ms^{-1}West are involved in a head-on collision. After the collision, the two vehicles move off as one.

a. Calculate the combined momentum of the car and truck before the collision. Include a direction. 3 marks

$kg\ ms^{-1}$ | *Direction*:

b. Calculate the velocity of the car and truck after the collision. 2 marks

ms^{-1}

c. Compare and contrast the forces acting on the car and the force on the truck, referring to appropriate physics principles in your response. 2 marks

Question 6 (6 marks)

A current carrying conductor connected to a battery is shown in Figure 9 below.

Figure 9

a. Label the direction of the magnetic field around the wire on Figure 9 above. Use the following symbols:

Into the page **X** Out of the page ● To the left ← To the right → Up ↑ Down ↓

1 mark

b. Which of the following word(s) could be used to describe the magnetic field around the wire? Circle all those that are appropriate. 1 mark

Static **Changing** **Uniform** **Non-uniform**

c. The wire is then placed inside an external magnetic field as shown in Figure 10. A current of 0.85 A passes through the wire. 15 cm of the wire is located inside the magnetic field of strength 62 mT.

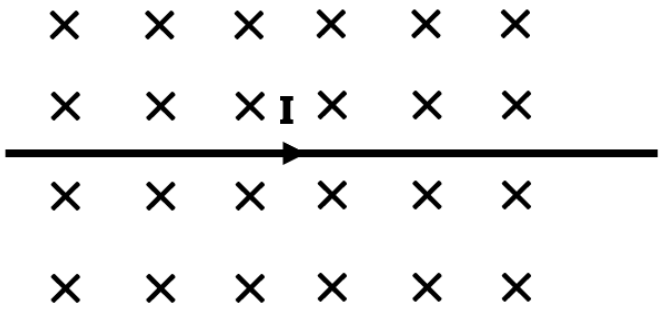


Figure 10

i. Identify the direction of the force on the wire from the magnetic field. Circle your choice below. 1 mark

Into the page **Out of the page** **To the left** **To the right** **Up** **Down**

ii. Calculate the magnitude of the force on the wire. Give your answer to **two** significant figures. 3 marks

_____

_____

_____

_____

N

Question 7 (3 marks)

For each description listed below, tick the appropriate column to identify if the statement applies to point masses only, point charges only, or both point masses and point charges.

	Point Mass only	**Point Charge only**	**Both Point Charge and Point Mass**
Creates a gravitational field			
Field around it can attract only			
Creates an electric field			
Creates a radial non- uniform field			
Strength weakens as per the inverse square law the further you get away			
Field around it can attract or repel			

Question 8 (4 marks)

Figure 11 below shows the shape of the gravitational field around two stars A and B.

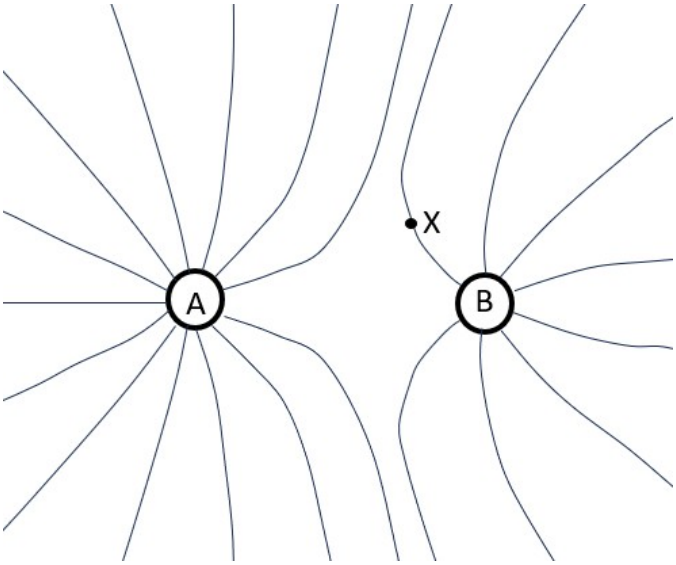


Figure 11

a. Compare the masses of A and B. Justify your response. 2 marks

b. Annotate Figure 11 to show the direction of the field at point labelled X. 2 marks

Question 9 (3 marks)

Engineers want to put a satellite into orbit that has a period of 1.00 hour.

a. Calculate the orbital radius for an Earth satellite having a period of 1.00 hour. 2 marks

m

b. Give a reason why this result could be considered unreasonable. 1 mark

Question 10 (3 marks)

Figure 12 below shows two insulated copper coils A and B, wrapped around the same iron rod.

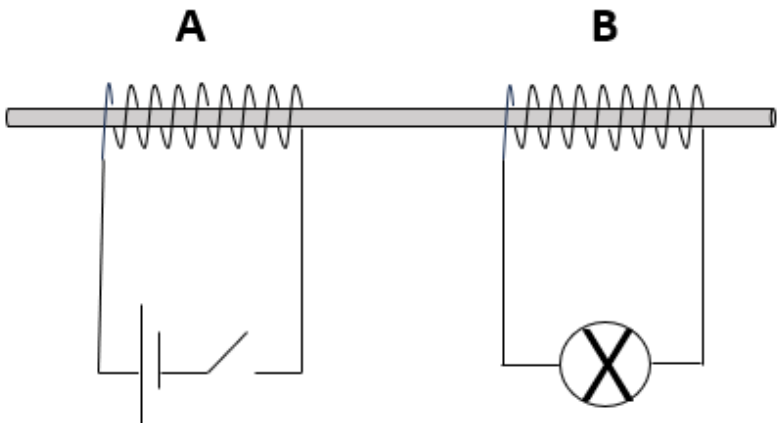


Figure 12

Coil A is connected to a battery. Coil B is connected to a filament lamp.

The switch is initially open, and the lamp is off. The switch is then closed. The lamp flashes for a brief period of time and then remains off.

Explain these observations.

Question 11 (9 marks)

A single coil of wire (radius 8 cm) moves from point A (just outside a magnetic field) to position B (just inside a magnetic field) at a speed of 4 $cm\,s^{-1}$. The magnetic field has a strength of 300 mT.

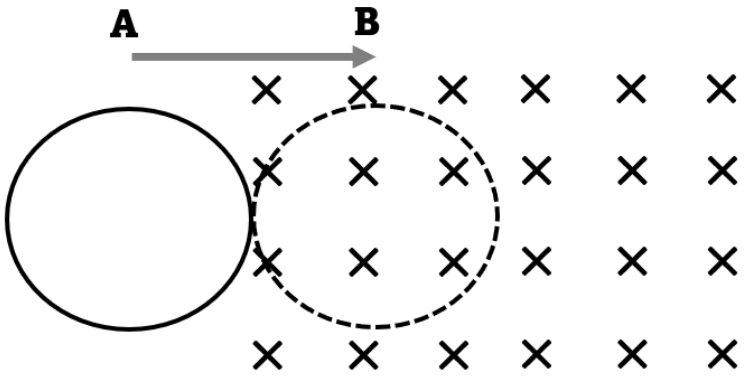


Figure 13

a. Calculate the maximum flux through the coil. Include an appropriate unit.

3 marks

	Unit:

b. Calculate the induced emf as the coil moves from point A to point B. 3 marks

V

c. Determine and label the direction of the current through the coil as it enters the field. Explain how you determined this direction, including appropriate laws of physics. 3 marks

Question 12 (3 marks)

With the aid of a diagram, describe how a photovoltaic cell produces electricity.

Question 13 (4 marks)

20 MW of electricity produced in a small regional town (Town 1) is transmitted to the town next to it (Town 2).

The electricity is transmitted through wires that have a total resistance of 80 Ω with a current of 300 A.

a. Calculate the power that reaches Town 2 as a percentage of the original power produced. 2 marks

%

b. Explain how transformers could be used to increase the power supplied to Town 2. 2 marks

Question 14 (8 marks)

Young's double slit experiment was set up as shown in Figure 14 below. The distance from the double slit screen to the optical screen is 0.8 m. The slit separation is 2.5 mm.

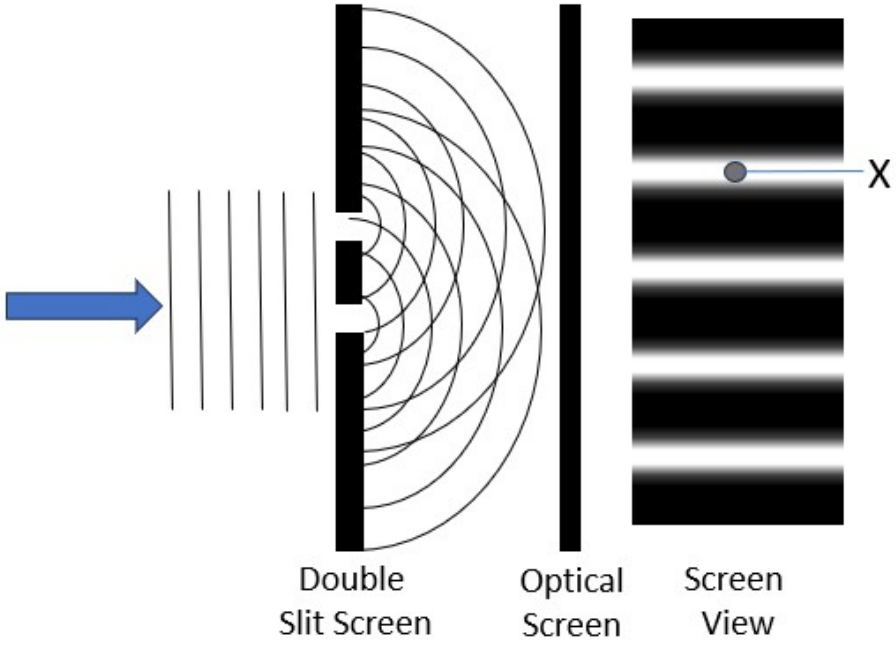


Figure 14

a. Calculate the wavelength of light used to produce a fringe separation of 0.14 mm. Give your answer in nm. 3 marks

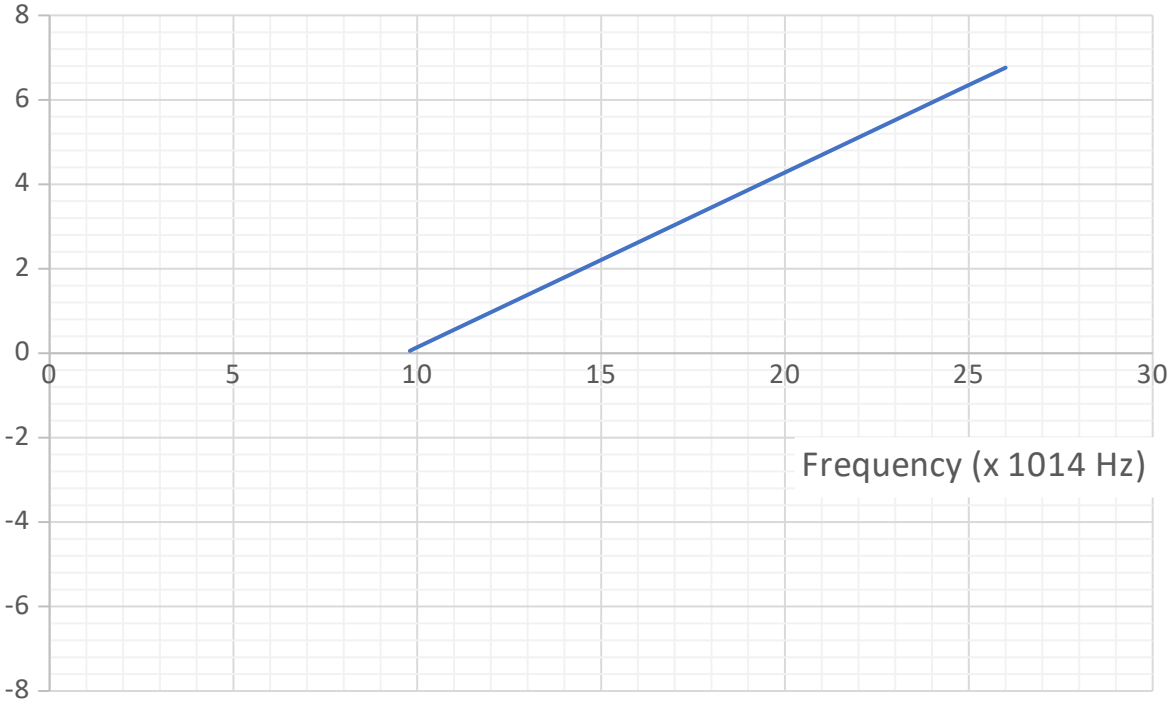
nm

b. Explain why there is a light band rather than a dark band at point **X** labelled on Figure 14. 2 marks

c. At the time at which Young's double slit experiment was conducted, there were two competing models of the nature of light. Explain how Young's experiment supported one of these models. 3 marks

Question 15 (8 marks)

The graph below shows the stopping voltage of electrons emitted from a zirconium surface at different frequencies of light.



a. Use the graph to determine the work function for Zirconium.
Include an appropriate unit. 2 marks

	Unit:

b. Explain why the stopping voltage increases as the frequency increases.

3 marks

c. Light of wavelength 290 nm is incident on zirconium in a vacuum. Electrons are emitted. Calculate the shortest de Broglie wavelength of the emitted electrons.

3 marks

m

Question 16 (3 marks)

Michelson Morley experiment was conducted in 1887 to measure the change in the speed of light as Earth travels through the ether, as a way of measuring the motion of the Earth relative to the ether. Describe how the experiment was conducted and the overall result of the Michelson Morley experiment.

Question 17 (5 marks)

A proton of mass $1.67 \times 10^{-27} kg$ is accelerated in a particle accelerator and reaches a speed of $2.75 \times 10^{8} m s^{-1}$.

a. Calculate the relativistic kinetic energy of the proton. 3 marks

J

b. Explain how a proton colliding with another proton in a particle accelerator can produce a particle with a mass much greater than that of two protons.

2 marks

Question 18 (11 marks)

An alpha particle (charge $3.2 \times 10^{-19} C$) enters a magnetic field of strength $3\,mT$. The mass of an alpha particle is approximately $6.64 \times 10^{-27} kg$.

The velocity at which the alpha particle enters the field is varied and the radius of the path is measured. The results are collected in the table on the following page.

a. Write a hypothesis for this experiment. Include a reason for your prediction.
3 marks

b. Complete the table to identify the independent variable, the dependent variable and **two** controlled variables for this experiment. 4 marks

Independent Variable	Dependent Variable	Controlled Variables

c. Students collect the following data:

Velocity ($\times 10^6 m s^{-1}$)	**Radius (m)**
5.00	34.6
5.25	36.3
5.50	38.1
5.75	39.8
6.00	41.5
6.25	43.3

Graph the data. Include a straight line of best fit. 4 marks

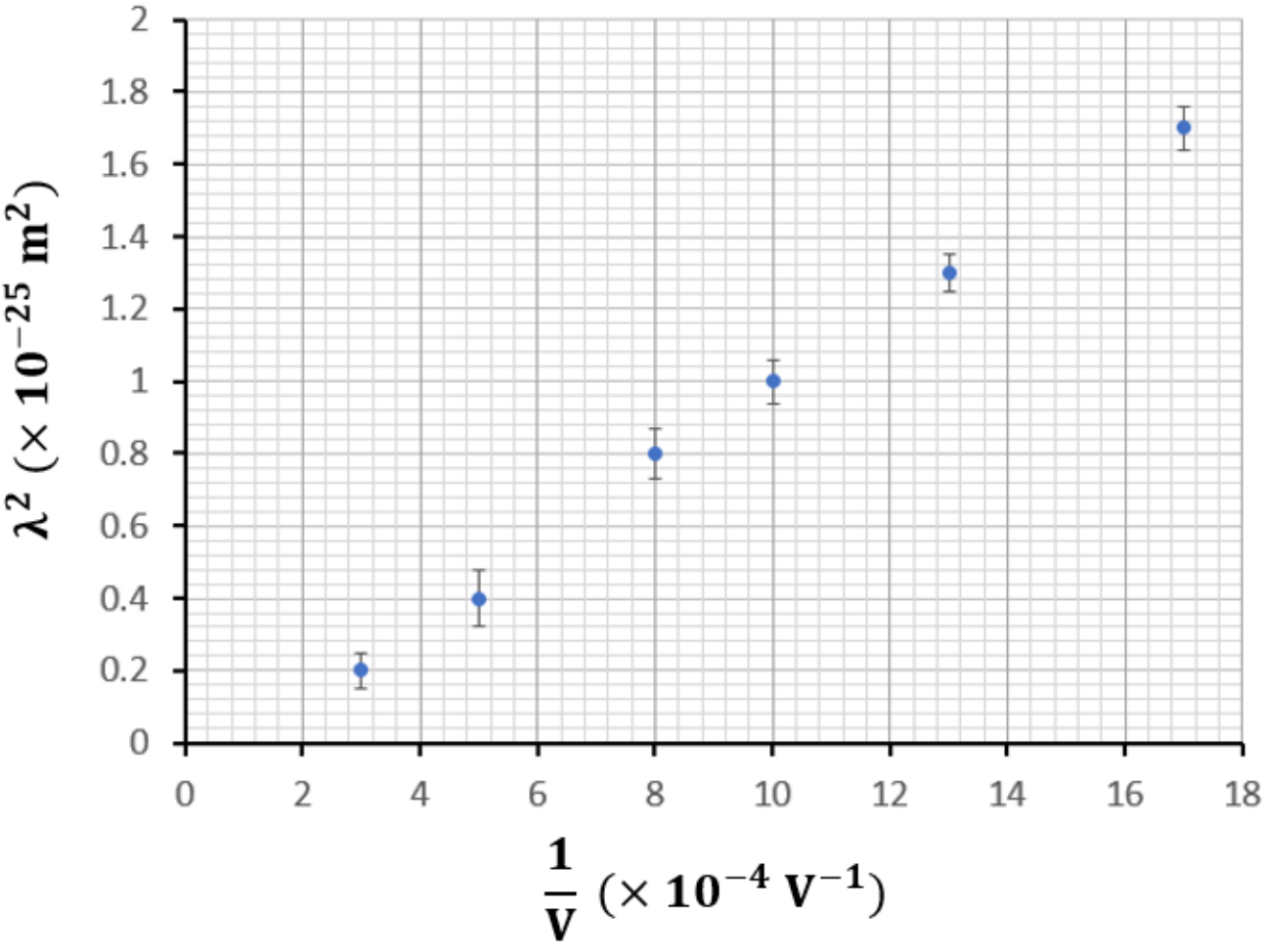
Question 19 (5 marks)

A researcher is investigating the de Broglie wavelength of charged particles. The charged particles are accelerated through a potential difference V. The de Broglie wavelength (λ¿of these particles is then determined by the researcher. Each particle has a mass (m) and charge (q).

The equations $\lambda = \frac{h}{p} = \frac{h}{mv}$ and $\frac{1}{2}mv^2 = qV$ can be combined to give an alternate equation for the de Broglie wavelength of a charged particle accelerated through a specific potential difference. *You do not need to derive this equation.*

$$\lambda^2 = \frac{h^2}{2mq} \times \frac{1}{V}$$

The researcher plots data points on a λ^2 against $\frac{1}{V}$ grid as shown below:



a. Draw a straight line of best fit through the graph on the previous page. 1 mark

b. Calculate the gradient of the line of best fit. Show your working. 2 marks

m^2V

c. The charge on the particle is 2e (where e is the elementary charge).
Use your gradient of your line of best fit to calculate the mass of the particle.
2 marks

END OF SECTION B

END OF EXAMINATION

VCE PHYSICS Unit 3 and 4 Multiple-Choice Answer Sheet

NAME: _____

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