THE SCHOOL FOR EXCELLENCE (TSFX)

VCE PHYSICS UNIT 3 & 4

WRITTEN EXAMINATION 2018

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

QUESTION AND ANSWER BOOK

Student Number: | | | | | | | | | | **Letter** |

Structure of Book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	23	23	110
			Total 130

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers pre-written notes (one 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 correction fluid/tape.

Materials Supplied

- Question and answer book of 32 pages
- Formula sheet
- Answer sheet for multiple choice questions

Instructions

- Write your **student number** in the space provided above on this page.
- All written responses must be in English.

At the End of the Examination

Place the answer sheet for multiple-choice questions inside the front cover of this book.

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

VIC: Level 3, 99 William Street, Melbourne VIC 3000
Phone: (03) 9663 3311 Fax: (03) 9663 3939

www.tsfx.com.au
admin@tsfx.com.au

NSW: PO Box r1407, Royal Exchange, Sydney NSW 1225
Phone: 1300 364 173 Fax: 1300 364 065

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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** 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 $9.8\,ms^{-2}$.

QUESTION 1
A planet has twice the mass of Earth and half the radius. Find the acceleration at the surface of the planet.

A. 39.2 ms^{-2}
B. 78.4 ms^{-2}
C. 4.9 ms^{-2}
D. 9.8 ms^{-2}

QUESTION 2
Two students are conducting an experiment to determine the relationship between horizontal launch speed and range. They are rolling three different balls off a table at speeds they judge to be slow, medium and fast. Which of the following statements is the best way to improve their experiment?

A. Only use one ball instead of three types.

B. Use a machine to control the launch speed because slow, medium and fast are not acceptable.

C. Only use one ball instead of three types and use a machine to control the launch speed because slow, medium and fast are not acceptable.

D. Use more than three different balls because you cannot get a good graph from three points.

QUESTION 3
The force of repulsion between two electric charges of 2.3 x 10^{-3} C that are 45 cm apart is:

A. 25.6 N
B. 1.07 X 10^{6} N
C. 2.6 X 10^{-3} N
D. 11.52 N

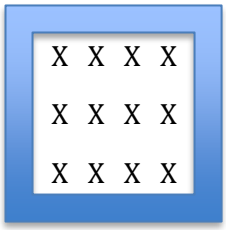
QUESTION 4
An electron is accelerated from rest across a potential difference of 1200 Volts. Find the kinetic energy of the electron when it finishes accelerating.

A. 1.2 J
B. 1.92×10^{-17} J
C. 1200 J
D. 1.92×10^{-16} J

QUESTION 5
In a DC motor, the role of the split-ring commutator is:

A. To reverse the current every half-turn so that the motor keeps turning.
B. To enable the generated current to flow in the same direction.
C. To stay connected to one side of the coil.
D. To reverse the current every quarter turn to keep the motor turning.

QUESTION 6
A magnetic field is straight into the page through a square coil of wire. The magnetic field is increased in strength. Find the direction of any induced current while the magnetic field strength is increasing.



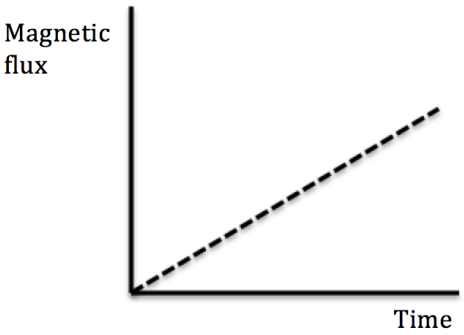
A. Clockwise according to the right hand screw rule. Increasing primary flux is into the page.

B. Clockwise according to Faraday's Law of induced currents.

C. Anti-clockwise according to the right hand screw rule and Lenz's Law. The induced flux is out of the page to oppose the increased primary flux into the page.

D. Anti-clockwise according to the right hand screw rule and Lenz's Law. The induced current opposes the magnetic field.

QUESTION 7
This is a graph of the changing flux through a metal ring. Which statement best describes the change in induced voltage in the ring?



A. The voltage has increasing positive levels as it matches the change in flux.
B. The voltage has a constant negative value.
C. The voltage has a constant positive value.
D. The voltage has an increasing negative value to oppose the change in flux.

QUESTION 8
A transformer has 120 primary turns and 480 secondary turns. If the primary voltage is 18V RMS, find the secondary voltage.

A. 4.5 V
B. 101.8 V
C. 25.5 V
D. 72.0 V

QUESTION 9
A rock is dropped from the top of a vertical cliff 120 m high. Find the speed of the rock after 3 seconds.

A. 29.4 ms^{-1}
B. -29.4ms^{-1}
C. 30 ms^{-1}
D. 30 ms^{-1} down

QUESTION 10
A 3.5 kg box is accelerated from rest by a horizontal force of 24 N. There is a frictional force of 5.5 N. Find the work done on the box in the first 2 m.

A. 48 J
B. 59 J
C. 11 J
D. 39 J

QUESTION 11
A car drives over the top a curved part of a road without losing contact with the road. At the top of the curve the road has a circular shape. The reaction between the car and the road can be found by:

A. Adding the weight of the car to the circular force (resultant).
B. Subtracting the circular force (resultant) from the weight of the car.
C. Adding the mass of the car to the circular force (resultant).
D. Subtracting the circular force (resultant) from the mass of the car.

QUESTION 12
A 300 gm ball rolls into a wall at right angles with a speed of 15 ms^{-1} and bounces straight back with a speed of 9 ms^{-1}. Find the magnitude of the change of momentum of the ball.

A. 2.7 $kgms^{-1}$
B. 7.2 $kgms^{-1}$
C. 1.8 $kgms^{-1}$
D. 7200 $kgms^{-1}$

QUESTION 13
Bill and Ben are discussing length contraction. Bill claims that only distances can display length contraction. Ben thinks that objects can also display length contraction. Who is correct and why?

A. Bill because length contraction only applies to distances travelled by very fast particles.

B. Ben because very fast particles only display time dilation.

C. Ben because both distance and objects can display length contraction. It depends on the relative velocity of the moving and inertial frame of reference.

D. Bill because length contraction only applies for particles if an observer is in an inertial frame of reference.

QUESTION 14
Five waves pass an observer every 3 seconds. Find the period of the waves.

A. 0.6 s
B. 1.66 s
C. 15 s
D. 0.6 Hz

QUESTION 15
Light passes from plastic with a refractive index of 1.65 to glass with a refractive index of 1.44. Which of the following is true?

A. There is no critical angle for this situation, as passage to air must be involved.
B. There is a critical angle as the light is passing to a less dense medium.
C. There is no critical angle because light needs to pass into a more dense medium.
D. There is no critical angle as this is a reflection situation only.

QUESTION 16
In an experiment, which of the following best describes an independent variable?

A. A variable that is kept constant during the entire experiment.
B. A variable that depends on what happens during the experiment**.**
C. A variable used to describe the main sources of error during the experiment.
D. A variable that is controlled and varied by the experimenter during the experiment.

QUESTION 17
Arrange the following Electromagnetic Waves in order of wavelength from smallest to largest.

Ultra Violet, Radio, Infra-red, Blue Light, Micro

A. Ultra Violet, Radio, Infra-red, Blue Light, Micro
B. Radio, Ultra Violet, Blue Light, Micro, Infra-red
C. Radio, Micro, Infra-red, Blue Light, Ultra Violet
D. Ultra Violet, Blue Light, Infra-red, Micro, Radio

QUESTION 18
Heisenberg's Uncertainty principle talks about the relationship between position and momentum and is mathematically stated as: $\Delta x \Delta p \geq \frac{h}{2\pi}$.

Which of the following is the most correct about applying this principle?

A. It only is significant for very small masses.
B. It is significant for all masses but we generally ignore it.
C. It applies to light waves some of the time.
D. It is only a theoretical concept and is not applicable to Physics.

QUESTION 19
Which of the following best describes the term Work Function in the Photoelectic Effect?

A. It is the work done on any electron able to escape the metal surface.
B. It is the same for all metals.
C. It is the maximum energy required to eject an electron from a particular metal.
D. It is the minimum energy required to eject an electron from a particular metal.

QUESTION 20
Which of these instruments/experiments is the best demonstration of the wave nature of electrons?

A. Electron microscope.
B. Photoelectric effect.
C. Electrons being accelerated across a potential difference.
D. Refraction of light as it changes from one medium to another.

SECTION B – SHORT ANSWER QUESTIONS

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 final answer in the box.

If an answer box has a unit printed in it, give your answer in that unit.

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.

Take the value of g to be $9.8\,ms^{-2}$.

QUESTION 1 (2 marks)
A student sends a current of 5.0 A through a wire perpendicular to a magnetic field with strength of 0.25 T. There is 20 cm of the wire in the field.

Calculate the force on the wire with the measurements above. 2 marks

N

QUESTION 2 (6 marks)
Two horizontal parallel metal plates are 5 cm apart and have a potential difference of 800 Volts.

a. Find the electric field strength between the plates. Include the correct unit. 2 marks

_____

_____

_____

_____

Vm^{-1}

b. A small dust particle with two excess electrons is held at rest between the plates by the electric field. Find the mass of the dust particle. 2 marks

_____

_____

_____

_____

kg

c. Which metal plate (top or bottom) is positive and why? 2 marks

_____

_____

_____

_____

_____

QUESTION 3 (4 marks)
A small planetoid has a mass of 5.8×10^{21} kg and a radius of 3.1×10^{5} m.

a. Find the gravitational field strength on the surface of the planetoid. 2 marks

Nkg^{-1} or ms^{-2}

b. A natural satellite travels in a circular orbit around the planetoid with a period of exactly 8 Earth days.

Find the radius of the orbit of the satellite. 2 marks

m

QUESTION 4 (16 marks)
Alpha decides to build his own power system but the generator is 200 m from his house.

a. His first attempt just has power lines with a resistance of 8 **Ω.** The generator has an output of 4000 W at 250 V RMS AC.

Generator House

(i) Find the current in the lines. 2 marks

A

(ii) Calculate the voltage available at the house. 2 marks

V

b. Alpha decides that the voltage loss is not acceptable and consults two friends Beta and Gamma. Beta tells him to use a step down transformer near the generator. Gamma suggests two transformers are best. He would use a step up transformer near the generator and a step down transformer near the house.
Who is correct and why? 3 marks

c. Alpha builds the system suggested by Gamma.

The lines still have a resistance of 8 **Ω.** Transformer 1 (T1) has N1 = 100 and N_2 = 800.

(i) Find the power output of T1. 1 mark

W

(ii) Find the voltage output of T1. 2 marks

V

(iii) Find the power loss in the lines. 2 marks

W

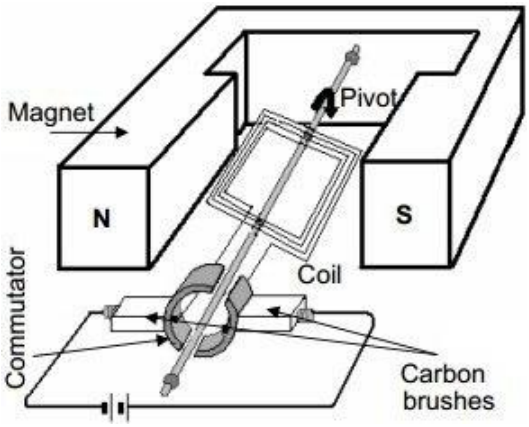
(iv) Find the voltage available at the house. T2 has $N_1 = 800$ and $N_2 = 100$. 2 marks

V

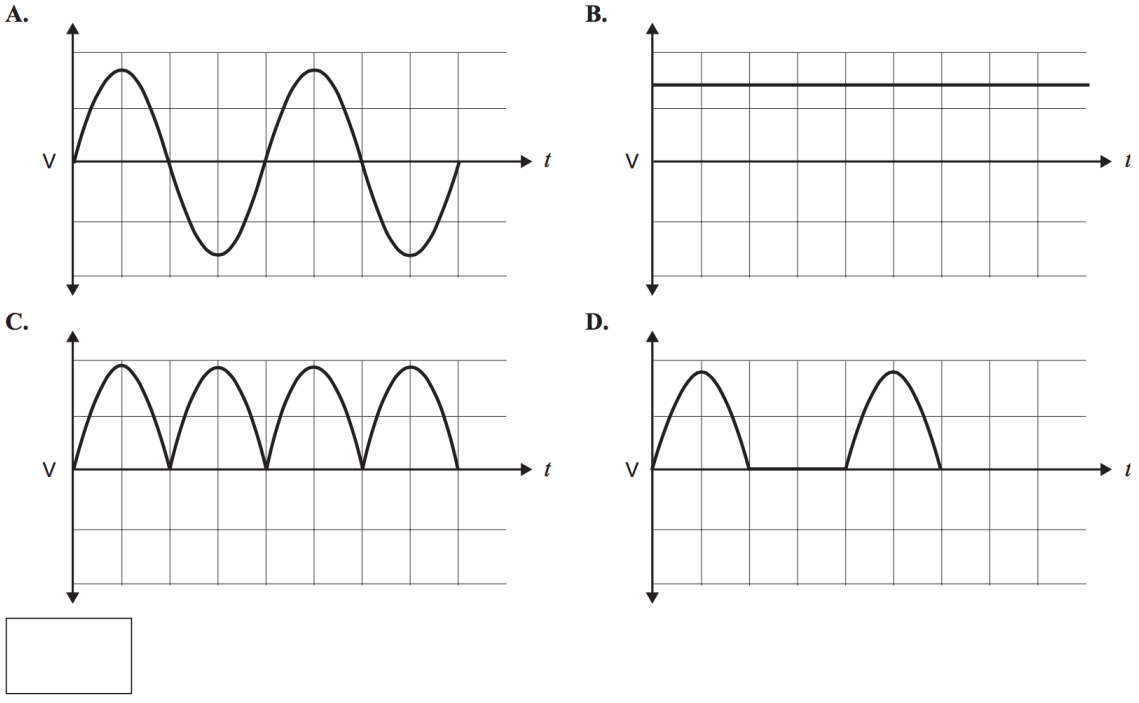
d. Alpha also gets advice from Delta who told him that his whole system would work better if the AC generator was replaced with a DC generator just before T1. Explain why Delta's ideas are not going to help. 2 marks

QUESTION 5 (5 marks)

a. Explain the role of the split-ring commutator in the following generator. 2 marks



b. Which of the following graphs would show the Voltage – time graph for this generator? 1 mark



c. The generator has a frequency of 100 Hz. The magnetic field has a strength of 0.6 T. The rectangular coil has 8 turns and an area of 20 cm^2. Find the average voltage generated in one quarter of a turn. 2 marks

_____

_____

_____

_____

V

QUESTION 6 (4 marks)

a. A car accelerates from 6 ms^{-1} to 64 ms^{-1} over a distance of 120 m.
Find the acceleration. 2 marks

ms^{-2}

b. How long did it take the car to travel the 120 m? 2 marks

s

QUESTION 7 (4 marks)
A tractor is towing a trailer of hay. The tractor has a mass of 1200 kg and the loaded trailer is 800 kg. The frictional forces on the tractor are 120 N and the trailer experiences frictional forces of 90 N.

a. Starting from rest the tractor and trailer accelerate at 1.2 ms^{-2}. Find the driving force being applied by the tractor. 2 marks

N

b. Find the tension in the tow bar between the tractor and the trailer. 2 marks

N

QUESTION 8 (7 marks)
A canon fires a 5 kg cannon ball with an initial speed of 113.16 ms^{-1} at 60^0 above the horizontal.

a. Find the maximum height reached by the cannon ball. 2 marks

m

b. Find the horizontal distance travelled by the cannon ball. 2 marks

m

c. A second identical canon ball is fired but hits a vertical cliff at a horizontal distance of 800 m. Find the height above the ground that the canon ball hits the cliff. 2 marks

m

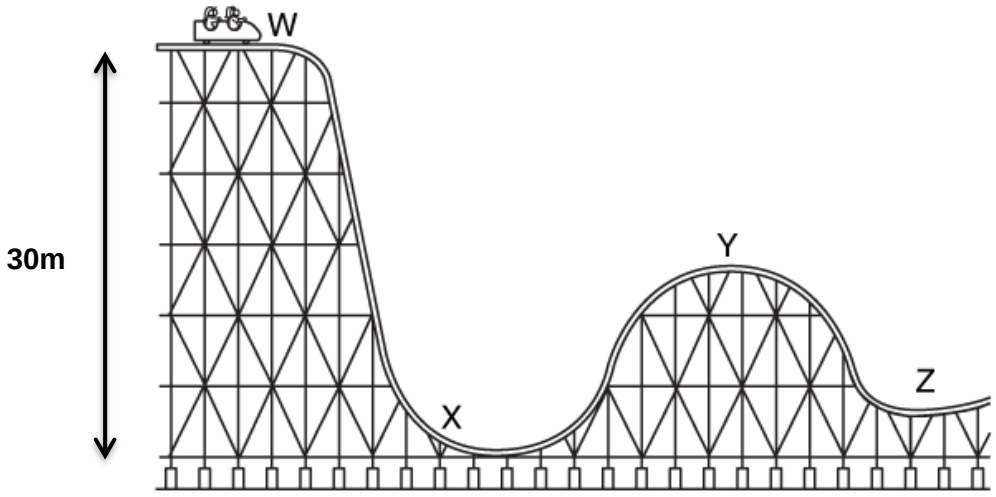
QUESTION 9 (4 marks)
A 130 gm arrow has a speed of 40 ms^{-1} when it collides with a stationary 400 gm apple. The apple and arrow continue together.

a. Find the speed of the apple and arrow after the collision. 2 marks

ms^{-1}

b. Is the collision elastic? Justify your answer with calculations. 2 marks

QUESTION 10 (7 marks)



A 320 kg roller coaster cart is on a track with no friction. At point W it has a speed of 12 ms^{-1}.

a. Find the speed of the cart at point X at the bottom of the curve. Point X is 30 m below point W. 3 marks

_____

_____

_____

_____

_____

	ms^{-1}

b. Explain how you found the answer to part a. 2 marks

_____

_____

_____

_____

_____

c. The track at point Y is circular with a radius of 15 m. If the cart has a speed of 10 ms^{-1} at Y find the reaction between the cart and the track. 2 marks

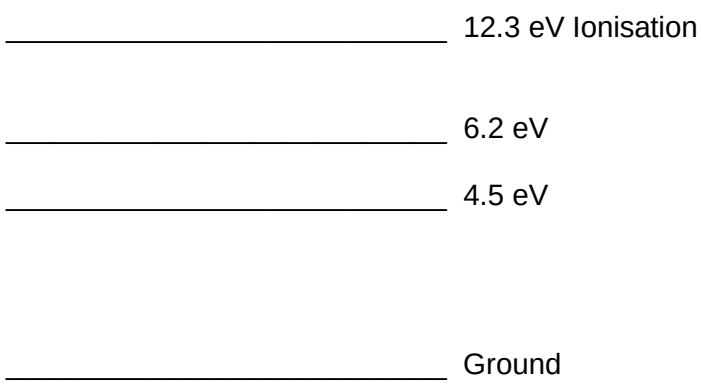
N

QUESTION 11 (2 marks)
An observer on a stationary asteroid watches a very fast space ship race past at 0.92 c. When the ship was at rest it was measured to be 64m long. What length does the observer measure for the ship? 2 marks

m

QUESTION 12 (2 marks)
An X-ray stream and an electron stream produce similar diffraction patterns. What do the two streams have in common? 2 marks

QUESTION 13 (4 marks)
An atom has the possible energy levels shown in the diagram.

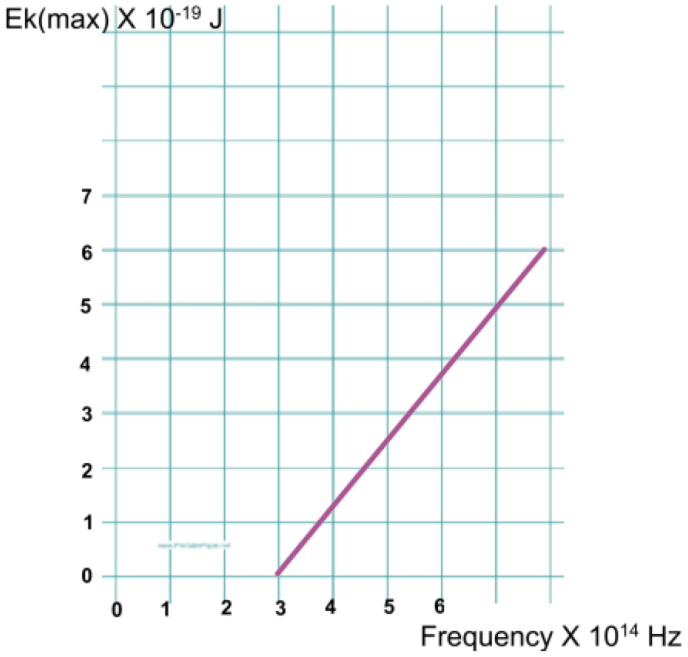


a. What is the lowest frequency photon that could be emitted from this atom? 2 marks

Hz

b. How does the wave nature of electrons explain the possible energy levels of an atom? 2 marks

QUESTION 14 (7 marks)
This graph shows the results of a photoelectric experiment.



a. Find the threshold frequency from the graph. 1 mark

Hz

b. Find the Work Function for this metal. Describe how you found the answer. 3 marks

J

c. Add a line to the graph that shows a different metal with a lower work function.
Explain your reasoning to draw the correct line. 3 marks

QUESTION 15 (13 marks)
Some students have completed a practical investigation to measure the range of a projectile. Their question was "Is there an ideal angle for maximum range of a projectile?" For each test the projectile has the same launch speed but a different angle of projection. The same projectile was used for all tests.

a. For this experiment, identify the following variables. 3 marks

Controlled variable _____

Independent variable _____

Dependent variable _____

b. On the day of the experiment the students could only find a tape measure marked in 5 cm divisions. Their results are in the table below. 8 marks

Angle above horizontal (^{0})	10	20	30	40	45	50	60	70	80
Measured range (cm)	14	26	35	40	41	40	35	26	14

On the grid on the next page, complete the following:

- Appropriate scales and units
- Plot the data from the grid
- Appropriate uncertainty bars
- A smooth curve of best fit

c. Write an appropriate conclusion from the results. 2 marks

_____

_____

_____

_____

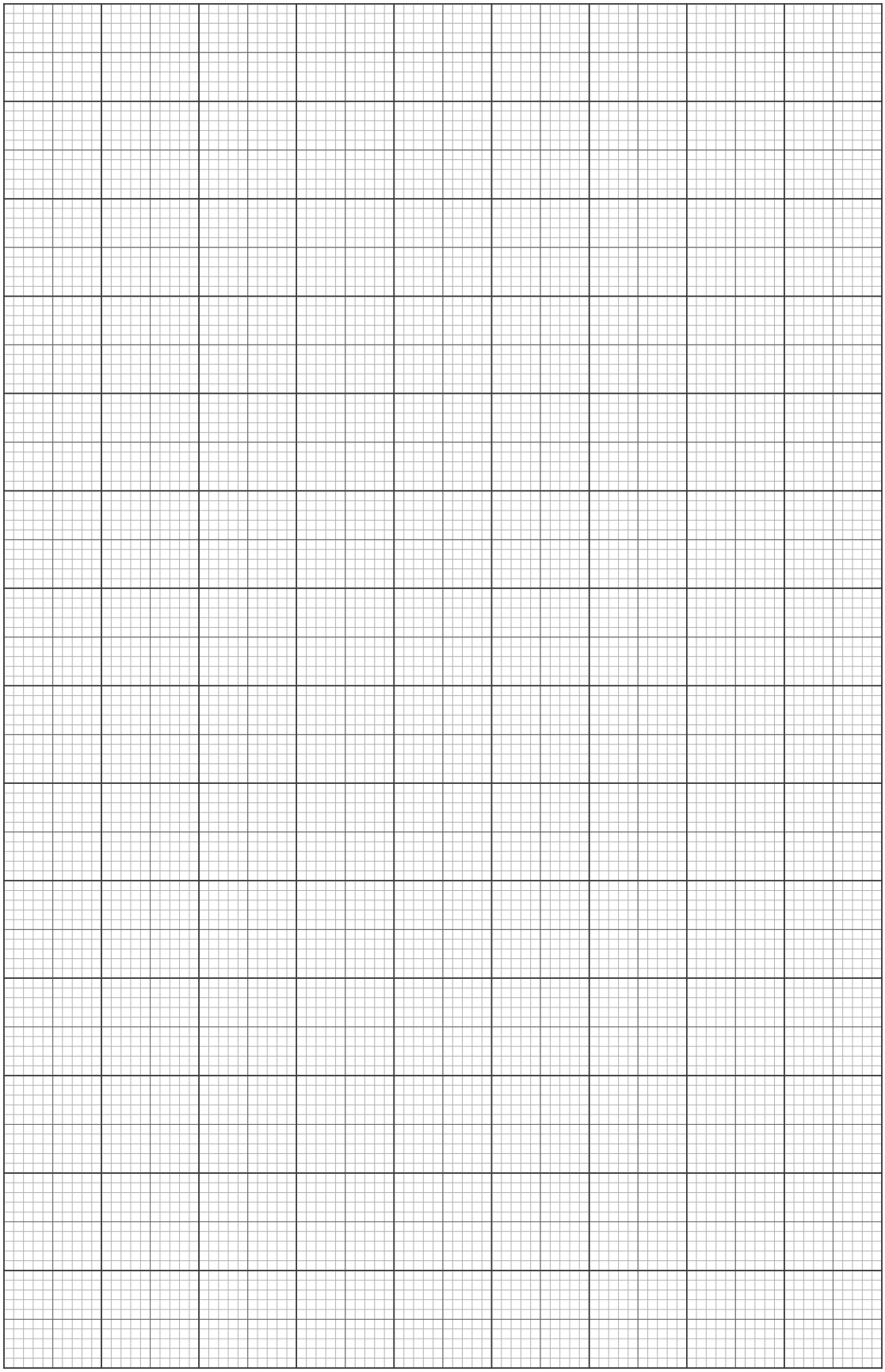
_____

_____

_____

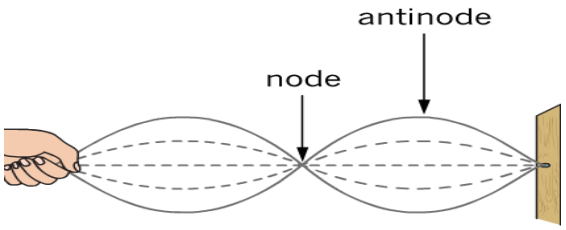
_____

Range



Angle

QUESTION 16 (3 marks)
The following diagram shows a standing wave on a string fixed at both ends.



Which harmonic is shown and how do you know? 3 marks

QUESTION 17 (4 marks)
A ray of light travels from air to high density plastic with a refractive index of 1.6. The angle of incidence is 45^0.

a. Draw a labelled diagram. 2 marks

b. Calculate the angle of refraction. 2 marks

0

QUESTION 18 (2 marks)
Light passes from glass (n = 1.4) to air. Find the critical angle.

0

QUESTION 19 (2 marks)
In Young's interference experiment explain why there are nodal points and how they occur.

QUESTION 20 (2 marks)
An interference pattern is observed with yellow light. Describe the change to the pattern due to each of the following:

a. Change to blue light. 1 mark

_____

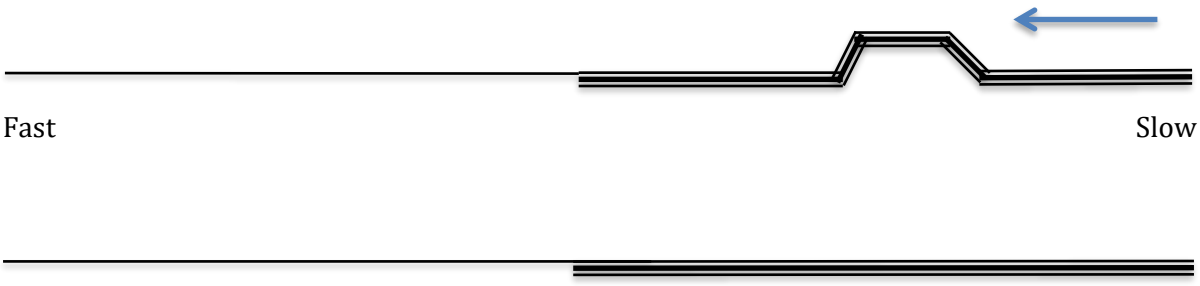
_____

b. A decrease in the separation of the slit centres. 1 mark

_____

_____

QUESTION 21 (3 marks)
A wave pulse travels from a slow spring to a fast spring. Sketch what happens shortly after the pulse has passed to the fast spring. 3 marks



QUESTION 22 (5 marks)
Microwaves have a frequency of 2.5 X 10^9 Hz.

a. Find the wavelength of the microwaves. 2 marks

_____

_____

_____

m

b. The microwaves are directed through a hole with a diameter of 8 cm. Will significant diffraction occur? 1 mark

_____

_____

c. Explain your answer to part b. 2 marks

_____

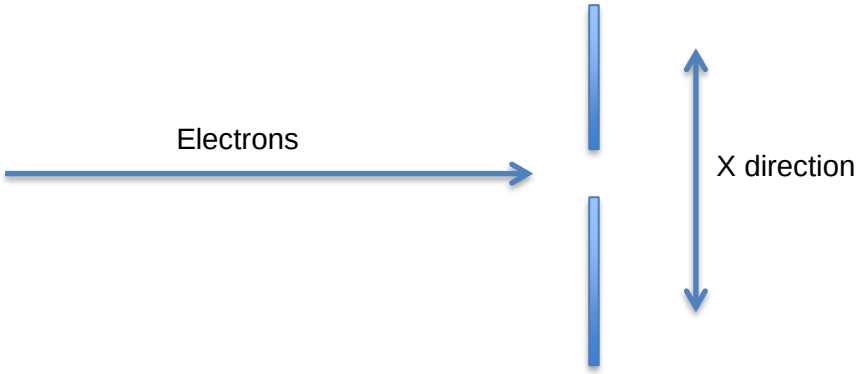
_____

_____

_____

_____

QUESTION 23 (2 marks)
A stream of electrons is directed at a narrow slit as shown. Describe what happens to the uncertainty of the momentum of the electrons in the X direction as the width of the slit is reduced.



End of Paper