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Trial Exam Paper

2007

PHYSICS

Written examination 2

STUDENT NAME:

QUESTION AND ANSWER BOOK

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A – Core – Areas of study			
1. Electric power	16	16	42
2. Interactions of light and matter	10	10	25
B – Detailed studies			
1. Synchroton and its applications	11	11	25
OR			
2. Photonics	11	11	25
OR			
3. Sound	11	11	25
		Total	92

- Students are permitted to bring the following items into the examination: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator.
- Students are NOT permitted to bring sheets of paper or white out liquid/tape into the examination.

Materials provided

- The question and answer book of 27 pages with a separate data sheet.

Instructions

- Write your **name** in the box provided.
- Remove the data sheet during reading time.
- Answer all questions in the spaces provided.
- **Always** show your working where space is provided as marks may be awarded for this working.
- You must answer the questions in English and in the space provided.

Students are NOT permitted to bring mobile phones or any other electronic devices into the examination.

SECTION A – Core

Instructions for Section A

Answer **all** questions for **both** Areas of study in this section of the paper.

Area of study 1 – Electric power

Figure 1 shows a powerful magnet.

Question 1

Draw in the magnetic field lines, with direction included.

Figure 1

2 marks

The following information applies to Questions 2–4.

A current carrying wire is set up in a loop (Figure 2). Note the direction of the current.

Question 2

Complete Table 1, showing the **direction** of the magnetic field at A, B, C and D.

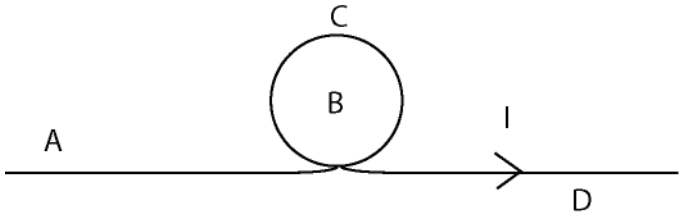


Figure 2

Choose the best answer from:

I. left
II. right
III. up
IV. down
V. into the page
VI. out of the page

Table 1

	Direction
A	
B	
C	
D	

4 marks

Question 3

Where would the magnetic field be the strongest? Choose from A, B, C or D.

2 marks

Question 4

To increase the *magnetic field strength* at B, which **one or more** could be used?

A. increase current
B. decrease current
C. increase radius of loop
D. decrease radius of loop

2 marks

The following information applies to Questions 5 and 6.

Anna and Jono are experimenting with two identical heating coils. They want the maximum amount of heat to radiate from the coils.

Jono suggests putting them in *series*, whereas Anna argues that they should be placed in *parallel*.

Question 5

Circle who is correct from the four options given in the box.

Jono	Anna	both	neither

2 marks

Question 6

Calculate the ratio for power loss in a series circuit : power loss in a parallel circuit.

2 marks

Question 7

An experiment was carried out by firing different charges through a magnetic field set at right angles to the velocity of the particles (Figure 3). Three distinct trajectories were observed, labelled A, B and C.

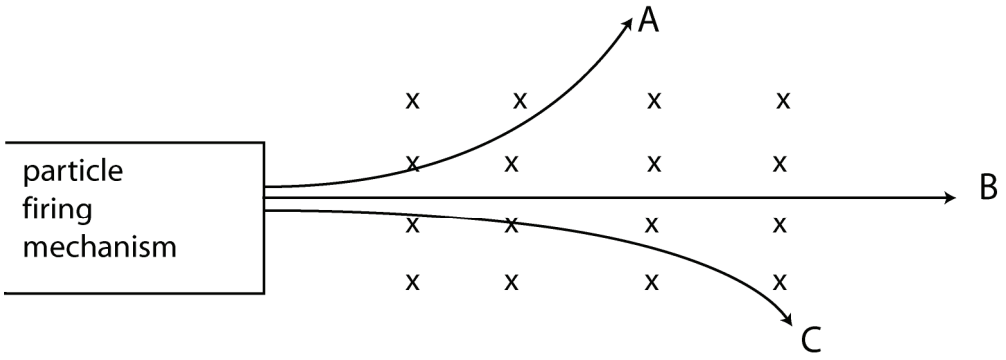


Figure 3

Complete the table by placing the correct trajectory next to the type of particle.

Charge on particle	Trajectory
neutral	
positive	
negative	

3 marks

A simple motor, with a single loop is set up (Figure 4). There is a current of 0.2 A flowing in the direction indicated, and a magnetic field strength of 4×10^{-2} T provided by the magnets.

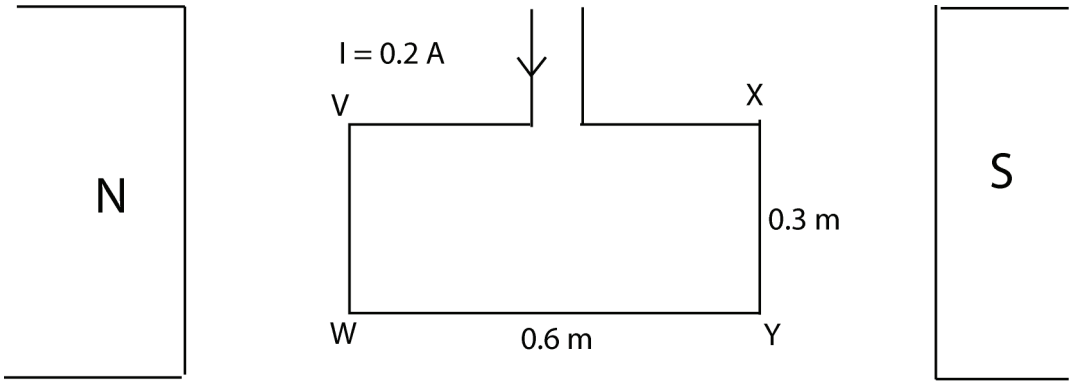


Figure 4

Question 8

What is the size, **and direction**, of the force acting on side X–Y?

4 marks

Question 9

DC motors have a part called a 'commutator'. What is the purpose of the commutator?

2 marks

Question 10

Which of the following would **not** increase the EMF (voltage) supplied by a generator?

A. Increase the area of the coil.
B. Increase the number of turns.
C. Increase magnetic field.
D. Increase the time period for 1 revolution.

2 marks

The following information applies to Questions 11 and 12.

A coil of copper wire, with a radius of 10 cm, falls through a magnetic field with a constant velocity (Figure 5). The strength of the magnetic field is 5×10^{-3} Tesla, and is directed **out** of the page.

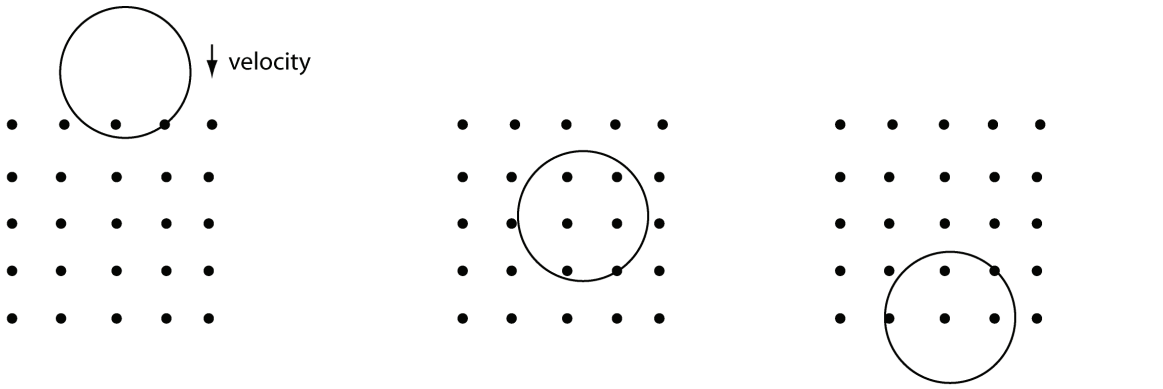


Figure 5

Question 11

Circle the correct answer that indicates the **direction** of the current induced in the coil in each of the scenarios.

First scenario: clockwise anti-clockwise no current

Second scenario: clockwise anti-clockwise no current

Third scenario: clockwise anti-clockwise no current

3 marks

Question 12

What is the maximum flux experienced by the coil? **Include units in your answer.**

_____

_____

_____

_____

_____

4 marks

In Jockaville, electricity is produced with the following characteristics, as shown in Figure 6.

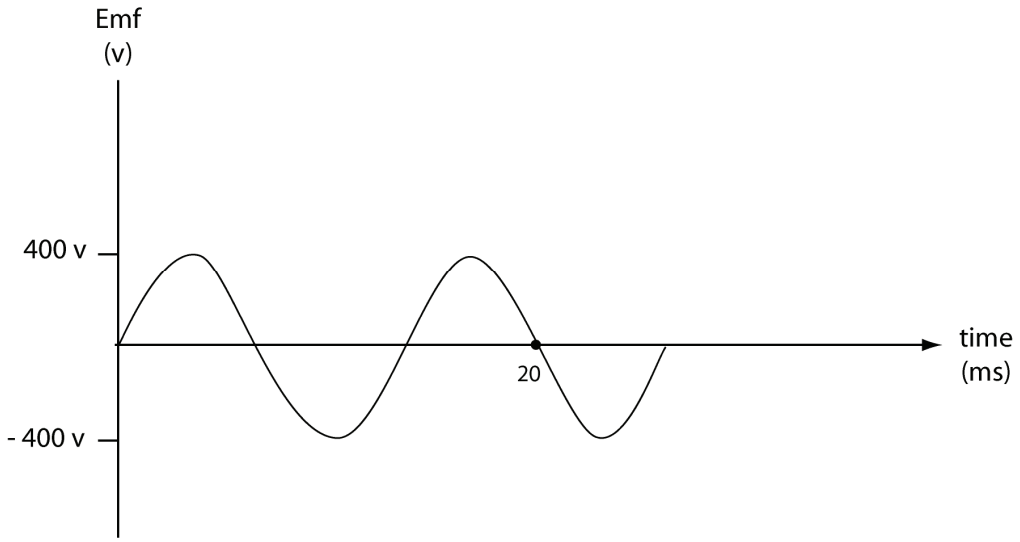


Figure 6

Question 13

Find the following:

V_{peak} = V

$V_{peak\ to\ peak}$ = V

V_{RMS} = V

Frequency = Hz

4 marks

The following information applies to Questions 14–16.

An ideal step-up transformer has primary windings of 30 turns, and secondary windings of 90 turns.

Question 14

What is meant by the terms 'ideal' and 'step-up' in this transformer?

ideal

step-up

2 marks

Question 15

240 V DC is introduced to the primary side of the transformer. Calculate the voltage coming from the secondary side.

2 marks

Question 16

If an RMS current of 1.5 A was introduced to the primary side of the transformer, calculate the RMS current in the secondary side.

2 marks

END OF AREA OF STUDY 1
SECTION A – continued

Area of study 2 – Interactions of Light and Matter

Some students have set up experiments to get some diffraction patterns from one slit, and to show Young's double slit experiment. They used both red light and blue light. The results are four patterns, as shown in Figure 1.

Unfortunately, somebody forgot to label the patterns.

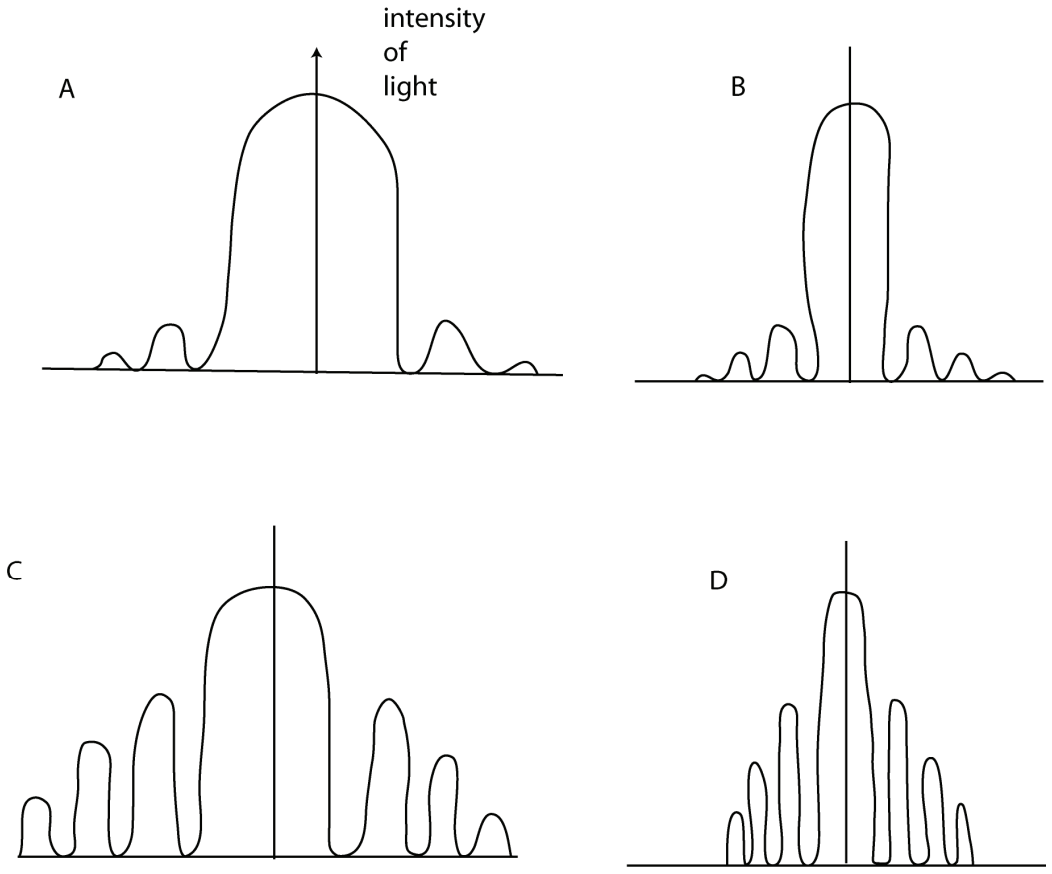


Figure 1

Question 1

Complete the table below to help the students out by placing the correct letter in the correct place.

Experiment	**Pattern**
single slit, red light	
double slit, blue light	
single slit, blue light	
double slit, red light	

4 marks

The following information applies to Questions 2–5.

Angus and Matilda set up a photoelectric effect experiment (Figure 2). Green light of frequency 5.6×10^{14} Hz is incident on the photosensitive metal.

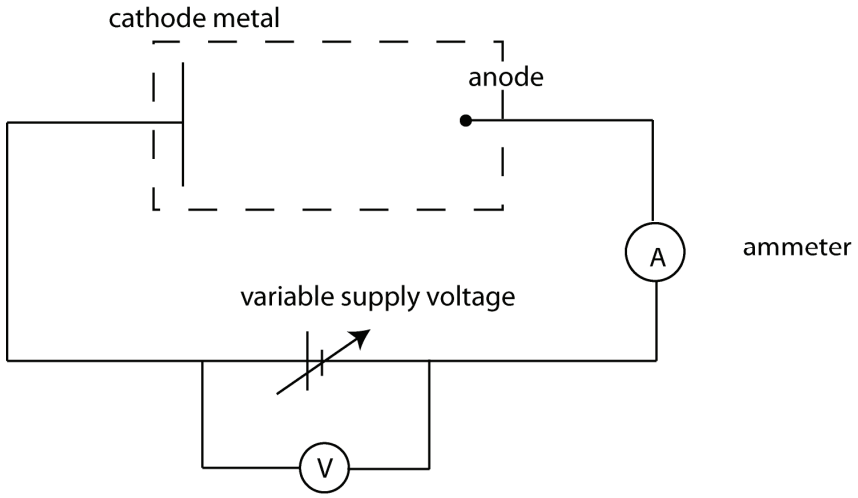


Figure 2

Question 2

Calculate the wavelength of the green light being used.

2 marks

Question 3

Calculate the energy contained in one photon of the green light.

1 mark

The following graph was produced from the results (Figure 3).

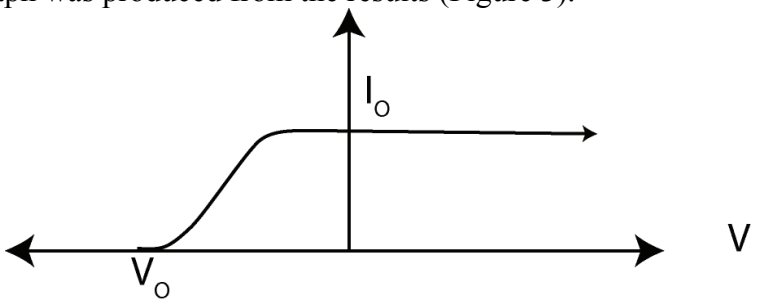
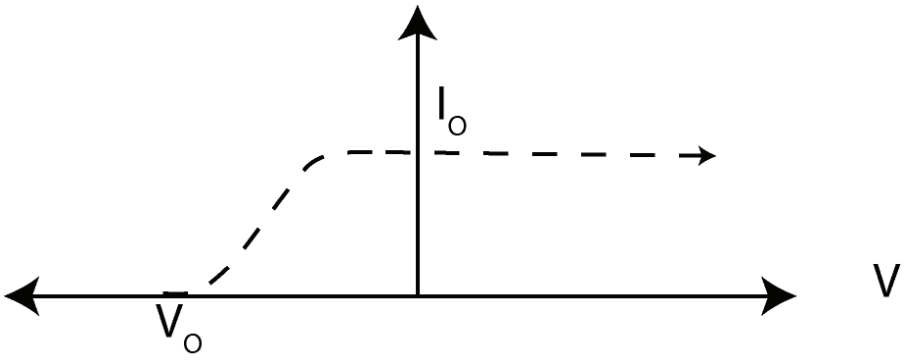


Figure 3

Question 4

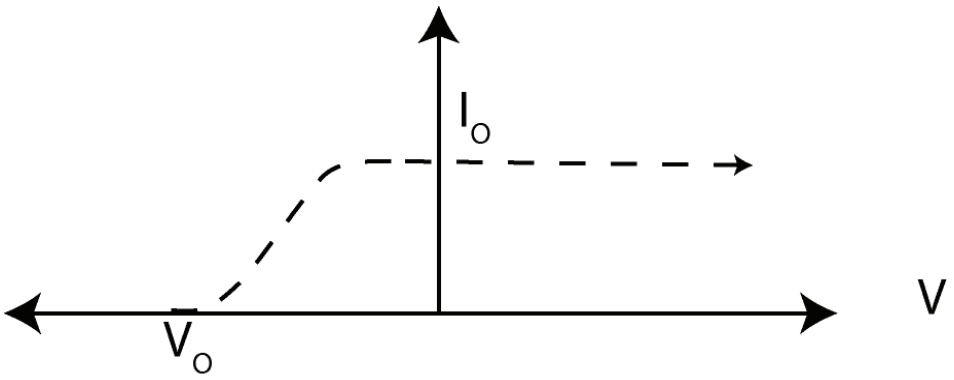
If the green light was replaced with a light of **higher frequency**, sketch a possible resulting graph on the axes provided.



2 marks

Question 5

If the original green light was used, but at a **higher intensity**, sketch a possible resulting graph on the axes provided.



2 marks

A certain metal is known to have a work function of 2.3 eV.

Question 6

Convert 2.3 eV to joules.

1 mark

A light of wavelength 550 nm is incident on the same metal.

Question 7

Will any photoelectrons be emitted? Support your answer with appropriate calculations.

4 marks

The following information applies to Questions 8 and 9.

Bryson throws a ball at 150 kmh^{-1}. The mass of the ball is 0.20 kg.

Question 8

Calculate the de Broglie wavelength for the ball.

3 marks

Question 9

Explain why it is impossible to detect diffraction of the ball.

2 marks

Hydrogen has an energy level diagram, as shown in Figure 4.

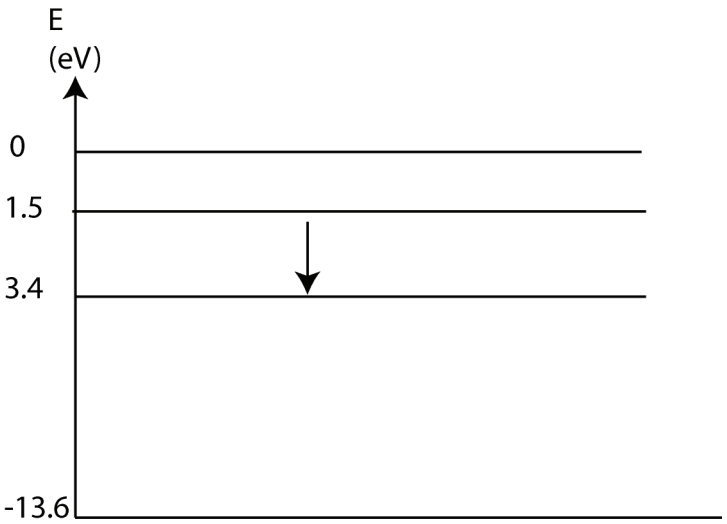


Figure 4

Question 10

If an electron falls from the 1.5 eV level to the 3.4 eV level, calculate the wavelength of the emitted light in nm.

4 marks

END OF SECTION A
TURN OVER

SECTION B – Detailed studies

Instructions for Section B

Choose **one** of the following **Detailed studies**. Answer all the questions on the Detailed study you have chosen.

Detailed study 1 – Synchrotron and its applications

Question 1

In the paragraph below, options to complete each sentence are given within the brackets. Circle the correct option in each case.

In a synchrotron, electrons are accelerated to near light speeds. They are focused by the **[booster rings / electron gun / beamlines]**. To increase the spectrum available to the scientists, the electrons are moved through **[bending magnets / storage rings / an electron gun].** The radiation is received at the experimental station via the **[beamlines / linac / electron gun]**.

3 marks

Question 2

Describe the **purpose** of the monochromator.

_____

_____

_____

_____

_____

2 marks

Question 3

In a synchrotron, electrons with momentum of 1.1×10^{-18} kgms^{-1} are bent by some magnetic fields. If the radius of the electron's path is 7.5 m, find the magnetic field strength.

_____

_____

_____

_____

_____

2 marks

During an experiment, a crystal structure is bombarded with X-rays with energy of 12 KeV.

Question 4

What is the wavelength of these X-rays? (Give your answer to 2 decimal places.)

2 marks

The following information applies to Questions 5 and 6.

An electron is fired into a magnetic field of strength 3×10^{-3} T, as shown in Figure 1. It is travelling at 2×10^{8} ms^{-1}.

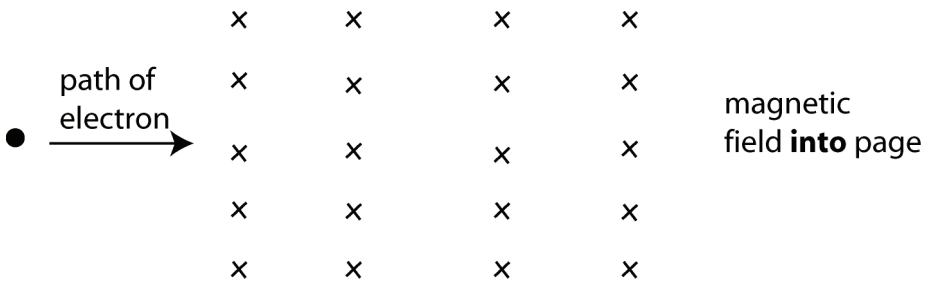


Figure 1

Question 5

In what direction will the electron accelerate? Choose the best answer.

A. up
B. down
C. into the page
D. out of the page

2 marks

Question 6

What is the value of this acceleration? Include a unit in your answer.

3 marks

The following information applies to Questions 7 and 8.

A monochromatic X-ray with wavelength 2×10^{-9} nm hits a crystal structure at an angle of 38°.

Question 7

If the detectors are recording a second-order maximum, what is the distance between the layers of the crystal?

3 marks

Question 8

What would be the next largest angle that would detect another maximum?

2 marks

Question 9

Synchrotron radiation is emitted because electrons:

A. have near light speed velocities
B. have constant velocities
C. change velocities
D. collide with particles in the air

2 marks

Question 10

For Thompson scattering, the best estimate for percentage energy **loss** is:

A. 0%
B. 5%
C. 50%
D. 100%

2 marks

Question 11

Which **one or more** can be investigated using the synchrotron?

A. protons
B. molecules
C. red blood cells
D. ants

2 marks

END OF DETAILED STUDY 1
SECTION B – continued
TURN OVER

Detailed study 2 – Photonics

Question 1

In the paragraph below, options to complete each sentence are given within the brackets. Circle the correct option in each case.

Step index fibres are common, but are not very good over longer distances because of **[modal dispersion / material dispersion / scattering]**. Graded index fibres are more desirable as they have a core whose refractive index **[increases / decreases]** from the centre of the core by **[increasing / decreasing]** the core's density.

3 marks

The following information applies to Questions 2 and 3.

A green LED emits a wavelength of 550 nm.

Question 2

What is the frequency of the green light?

_____

_____

_____

_____

_____

2 marks

Question 3

Calculate the band gap for this LED, in eV.

_____

_____

_____

_____

2 marks

Question 4

What is attenuation?

_____

_____

_____

_____

_____

_____

Total 1 + 1 = 2 marks

Question 5

What is its unit?

_____

1 mark

The following information applies to Questions 6–8.

A ray of light is entering an optical fibre, as shown in Figure 1.

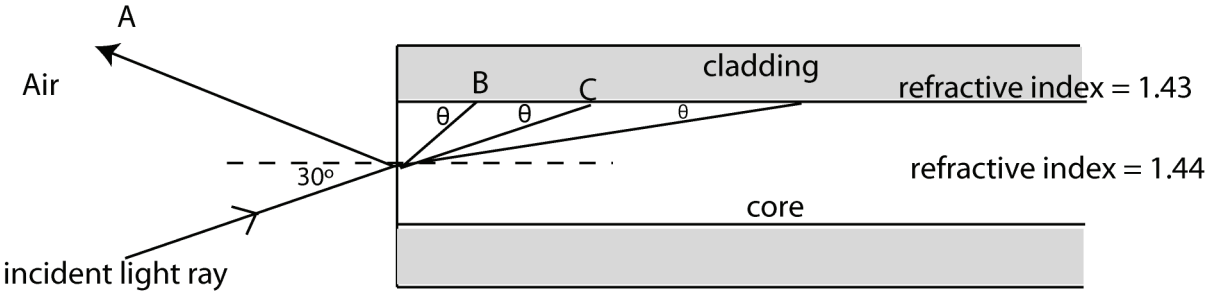


Figure 1

Question 6

Which path will the ray of light follow?

_____

_____

2 marks

Question 7

Calculate the angle, θ.

_____

_____

_____

_____

2 marks

Question 8

What is the critical angle for the boundary between the core and the cladding?

_____

_____

_____

_____

_____

2 marks

Question 9

If the wavelength, λ, of the light was **increased**, then θ from Figure 1 would be:

higher lower no different

(Circle the correct answer.)

2 marks

Question 10

Complete the table.

Type	**Caused by**	**Effect on signal**	**List one way to rectify**
Modal dispersion			
	Different wavelengths travel at different velocities		

6 marks

Question 11

When light is refracted through a triangular prism, which colour refracts the most?

A. red
B. yellow
C. green
D. blue

1 mark

END OF DETAILED STUDY 2
SECTION B – continued
TURN OVER

Detailed study 3 – Sound

Sandra is going to the movies. She decides to sit in front of the middle of the screen, not for the vision, but because of the audio opportunities.

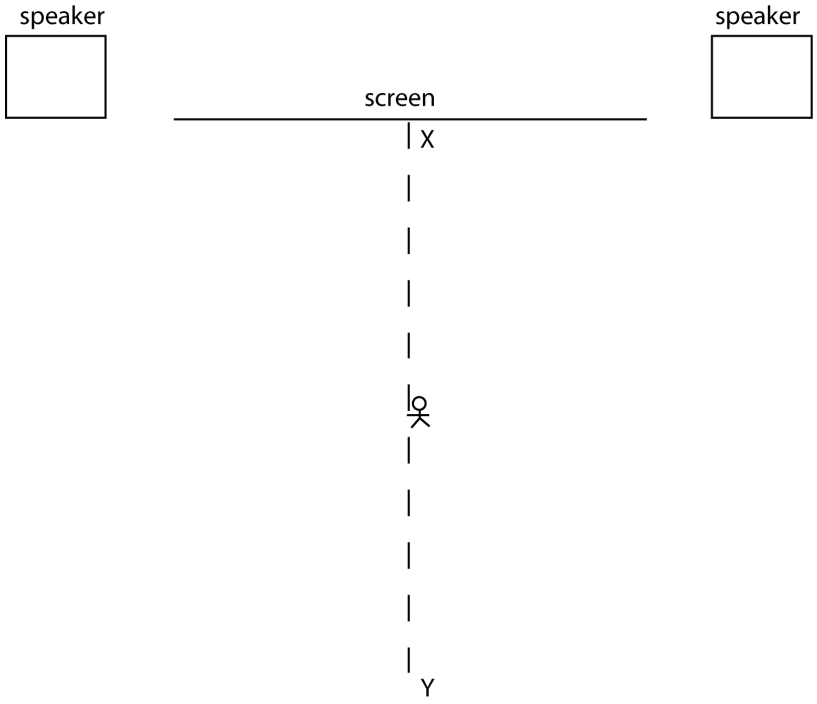


Figure 1

Question 1

In the paragraph below, options to complete each sentence are given within the brackets. Circle the correct option in each case.

It is advantageous to sit anywhere along the line X–Y because the sound will always be **[softer / louder / distorted]** due to **[destructive interference / constructive interference / diffraction]** of the sound from the speakers for **[high frequencies / low frequencies / all frequencies]**.

3 marks

Use the data in Figure 2 to answer Questions 2 and 3.

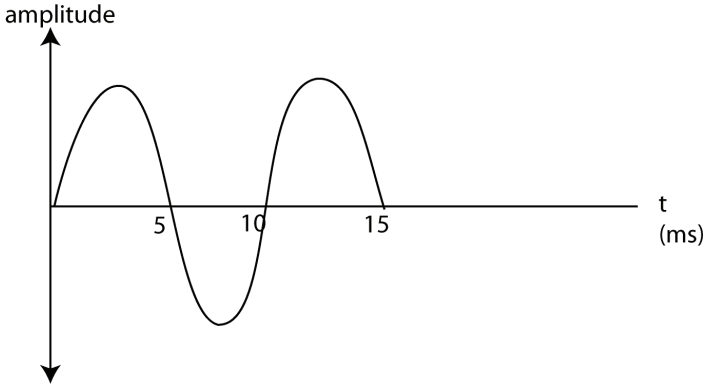


Figure 2

Question 2

What is the frequency of the wave?

_____

_____

_____

_____

2 marks

Question 3

If the speed of the wave is 340 ms^{-1}, find the wavelength.

_____

_____

_____

_____

_____

2 marks

Figure 3 is a representation of some air particles a sound wave is passing, towards the **right**. Particle X is originally at normal air pressure.

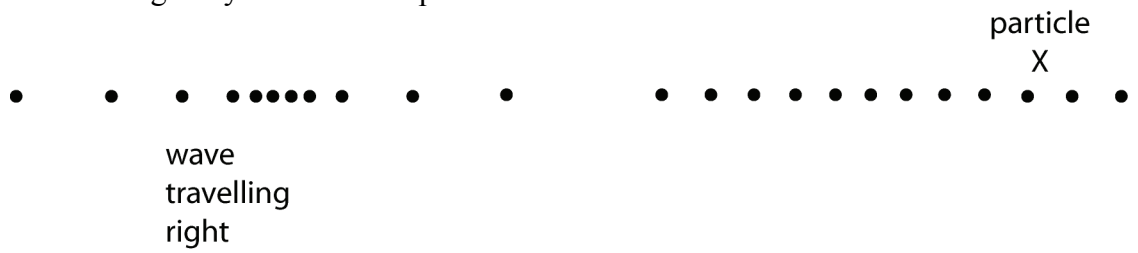


Figure 3

Question 4

In which direction will particle X first move?

A. left
B. right
C. up
D. down

2 marks

Question 5

After the wave has passed, the particle X will:

A. return to its original position
B. be above its original position
C. be left of its original position
D. be right of its original position

2 marks

Les is studying physics (of course) and loves listening to music while he does so. Edna, the cranky neighbour from next door asks for the music to be turned down. Les, being a physics super-genius, halves the power output of the speakers. Edna complains to the police that he hardly turned the music down at all. The case goes to court.

Question 6

For a 50% reduction in power output in Les's speakers, what is the reduction in dB?

2 marks

Question 7

If you were the judge in this case, would you say that Edna has a valid case? Explain your reasoning.

2 marks

The following information applies to Questions 8–10.

Melvin wants to find out if he can use a loudspeaker as a microphone, and sets up an experiment (Figure 4).

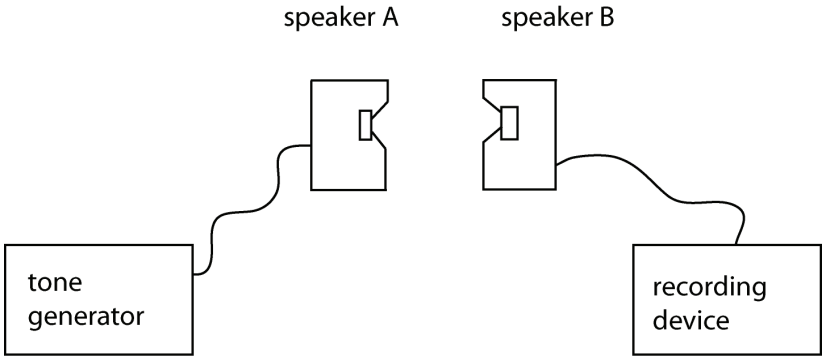


Figure 4

Speaker A is set up as a loudspeaker, and speaker B is set up as a microphone.

Question 8

Of the common types of microphone, what is the type of microphone that speaker B most closely resembles?

_____

_____

2 marks

Question 9

Speaker A has a box surrounding it. What is the name and purpose of this box?

Name of box:

_____

Purpose of box:

_____

_____

_____

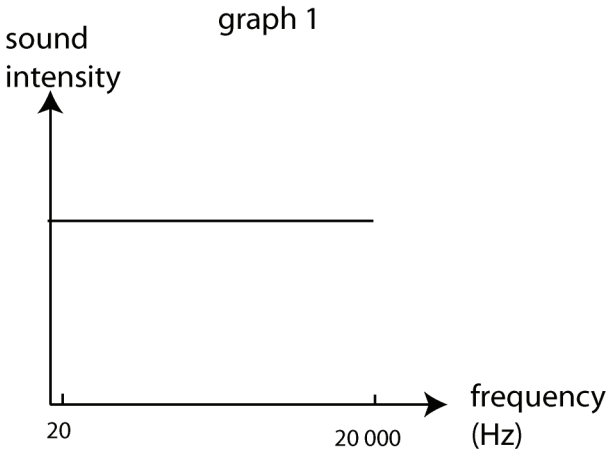
_____

_____

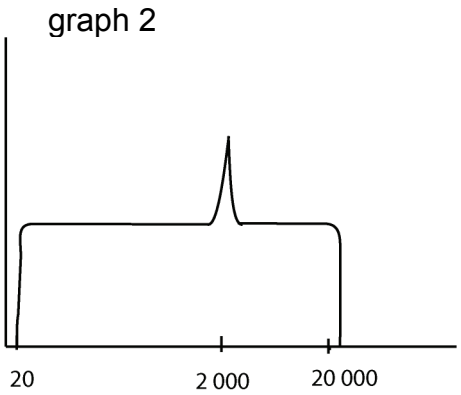
4 marks

Question 10

A tone of constant amplitude, but with varying frequency, is fed through speaker A, as shown in Graph 1.



Graph 2 was recorded through the microphone, speaker 2.



Notice the 'spike' at 2000 Hz. What is the cause of this spike?

_____

_____

_____

_____

2 marks

Question 11

Alva blows into the top of an empty bottle and notices that a frequency of 240 Hz is the most strongly produced frequency, as well as other 'harmonics'. Which of the following frequencies would also be produced?

A. 120 Hz
B. 360 Hz
C. 480 Hz
D. 720 Hz

2 marks

END OF QUESTION AND ANSWER BOOK