

# ***INSIGHT***

## ***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**

| <i>Section</i>                      | <i>Number of questions</i> | <i>Number of questions to be answered</i> | <i>Number of marks</i> |
|-------------------------------------|----------------------------|-------------------------------------------|------------------------|
| <b>A – Core – Areas of study</b>    |                            |                                           |                        |
| 1. Electric power                   | 16                         | 16                                        | 42                     |
| 2. Interactions of light and matter | 10                         | 10                                        | 25                     |
| <b>B – Detailed studies</b>         |                            |                                           |                        |
| 1. Synchrotron and its applications | 11                         | 11                                        | 25                     |
| <b>OR</b>                           |                            |                                           |                        |
| 2. Photonics                        | 11                         | 11                                        | 25                     |
| <b>OR</b>                           |                            |                                           |                        |
| 3. Sound                            | 11                         | 11                                        | 25                     |
| <b>Total</b>                        |                            |                                           | <b>92</b>              |

- 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.**

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## 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.

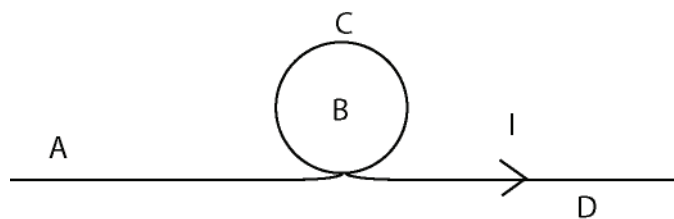


Figure 2

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.

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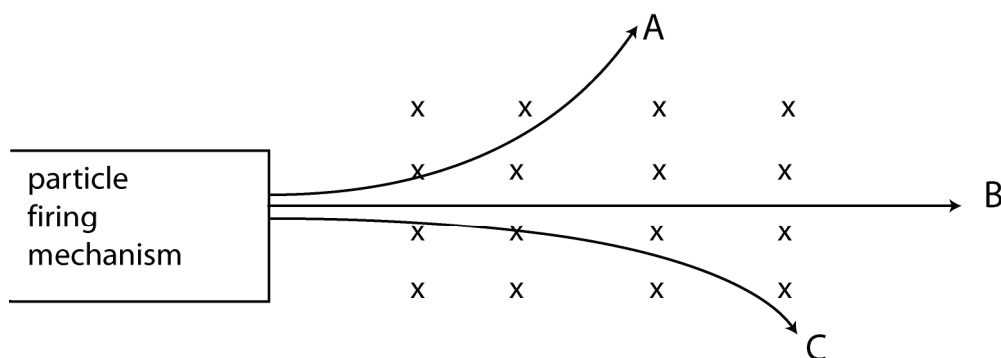
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2 marks

**SECTION A – AREA OF STUDY 1– continued**  
**TURN OVER**

### 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.



Note: magnetic field is **into** the page  
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  $4 \times 10^{-2}$  T provided by the magnets.

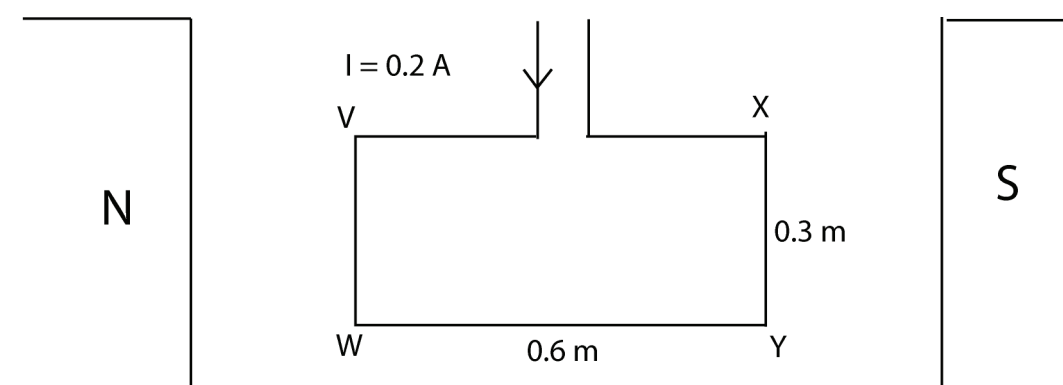


Figure 4

**Question 8**

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

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4 marks

**Question 9**

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

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2 marks

**Question 10**

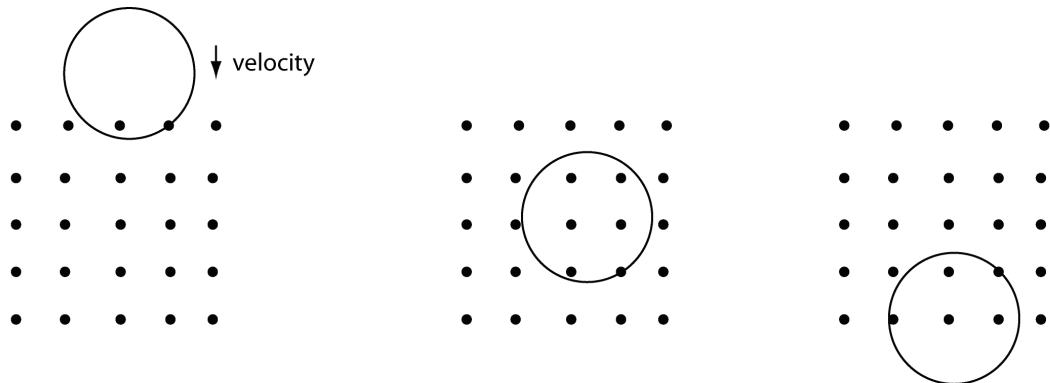
Which of the following would **not** increase the EMF (voltage) supplied by a generator?

- 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  $5 \times 10^{-3}$  Tesla, and is directed **out** of the page.



clockwise / anti-clockwise / none

clockwise / anti-clockwise / none

clockwise / anti-clockwise / none

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.**

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4 marks

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

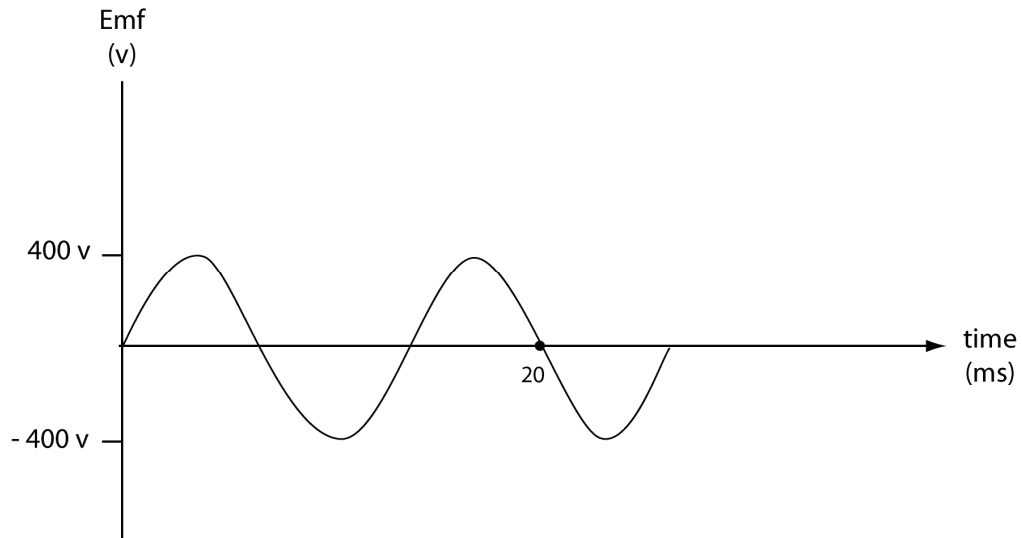


Figure 6

### Question 13

Find the following:

|                     |   |
|---------------------|---|
| $V_{\text{peak}} =$ | V |
|---------------------|---|

|                             |   |
|-----------------------------|---|
| $V_{\text{peak to peak}} =$ | V |
|-----------------------------|---|

|                    |   |
|--------------------|---|
| $V_{\text{RMS}} =$ | 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

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step-up

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2 marks

**Question 15**

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

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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.

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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.

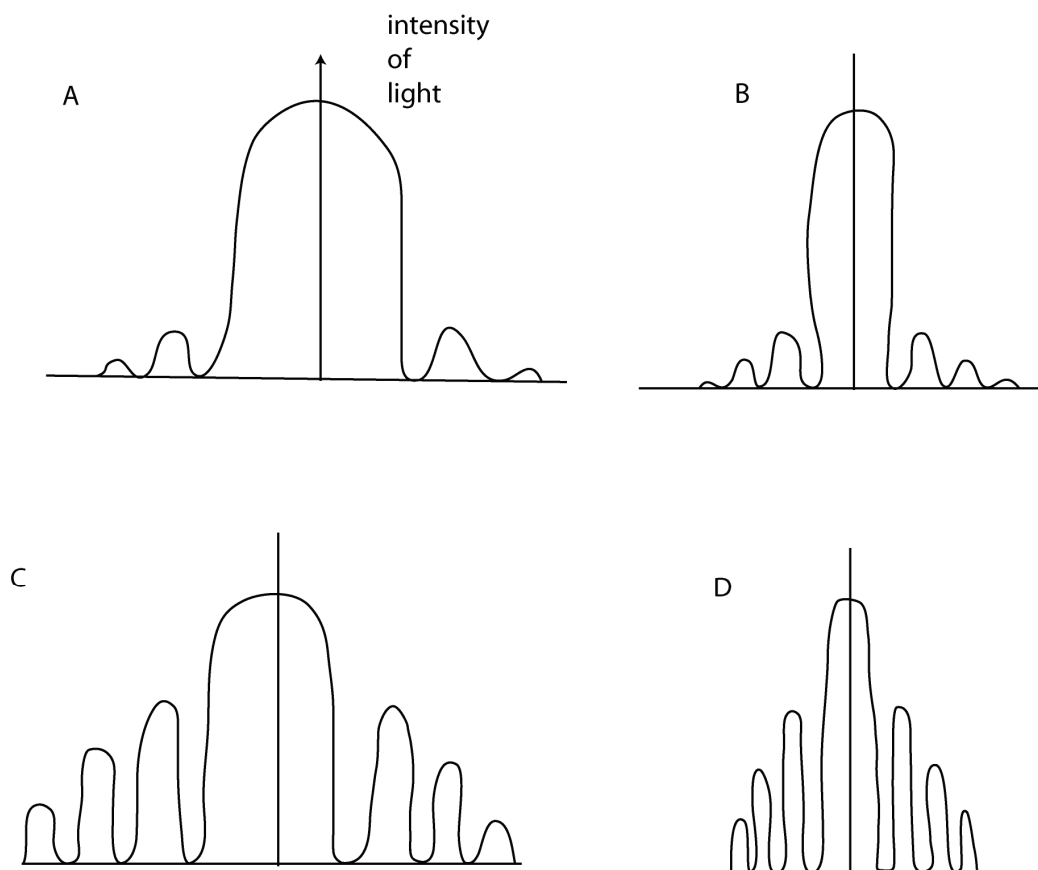


Figure 1

### 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  $5.6 \times 10^{14}$  Hz is incident on the photosensitive metal.

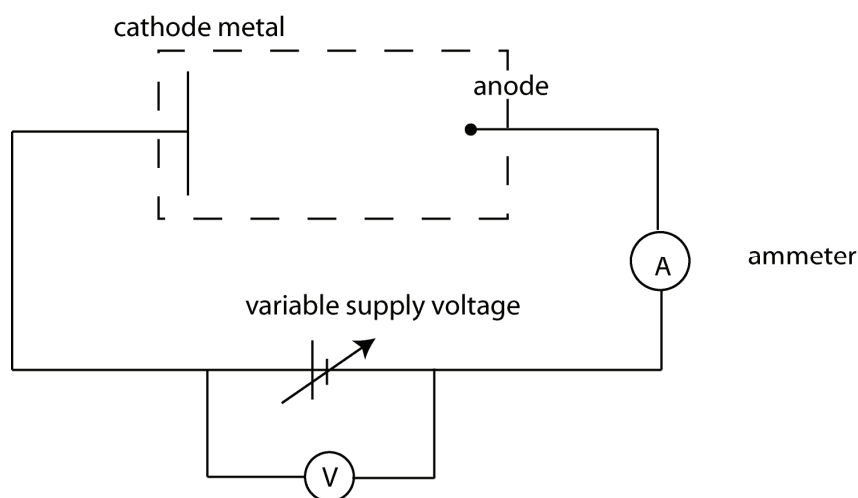


Figure 2

### Question 2

Calculate the wavelength of the green light being used.

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2 marks

### Question 3

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

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1 mark

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

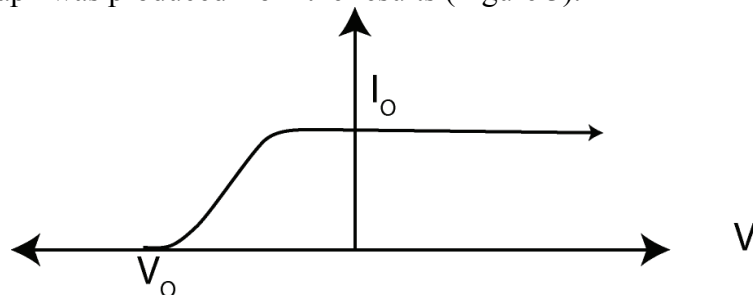
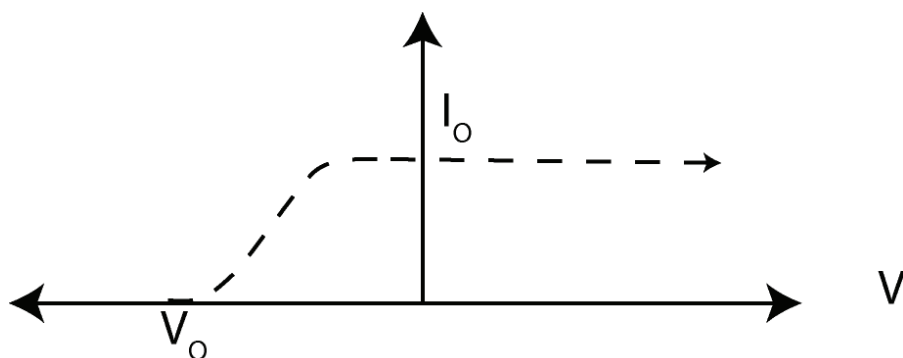


Figure 3

#### Question 4

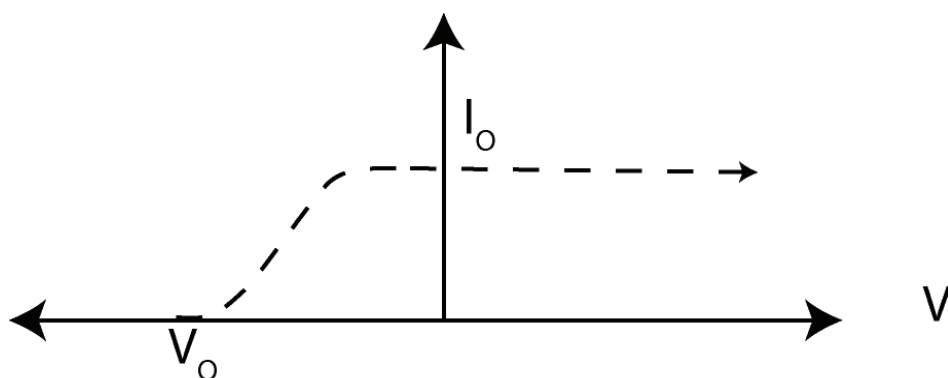
If the green light was replaced with a light of **higher frequency**, sketch a possible resulting graph on the axes provided.



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.

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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.

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4 marks

*The following information applies to Questions 8 and 9.*

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

**Question 8**

Calculate the de Broglie wavelength for the ball.

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3 marks

**Question 9**

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

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2 marks

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

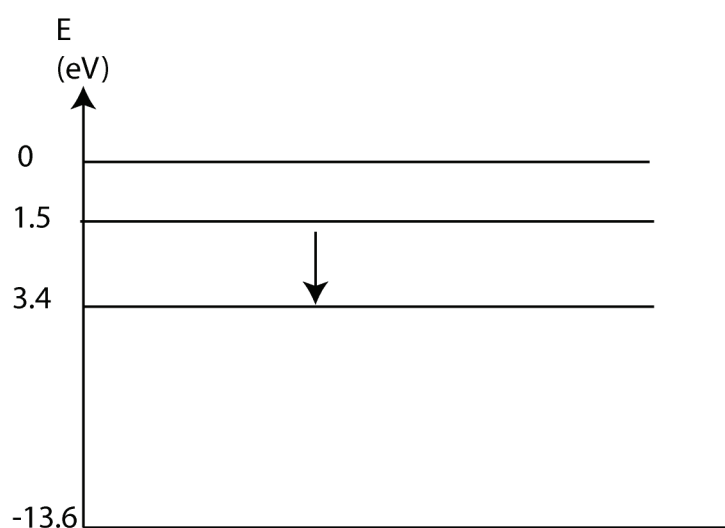


Figure 4

**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.

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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.

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2 marks

#### Question 3

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

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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.)

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2 marks

*The following information applies to Questions 5 and 6.*

An electron is fired into a magnetic field of strength  $3 \times 10^{-3}$  T, as shown in Figure 1. It is travelling at  $2 \times 10^8$  ms<sup>-1</sup>.

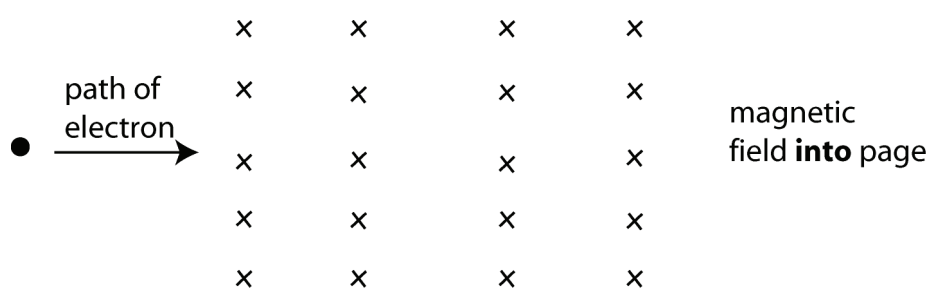


Figure 1

#### 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.

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3 marks

*The following information applies to Questions 7 and 8.*

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

### Question 7

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

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3 marks

### Question 8

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

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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?

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2 marks

### Question 3

Calculate the band gap for this LED, in eV.

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2 marks

**Question 4**

What is attenuation?

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Total 1 + 1 = 2 marks

**Question 5**

What is its unit?

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1 mark

*The following information applies to Questions 6–8.*

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

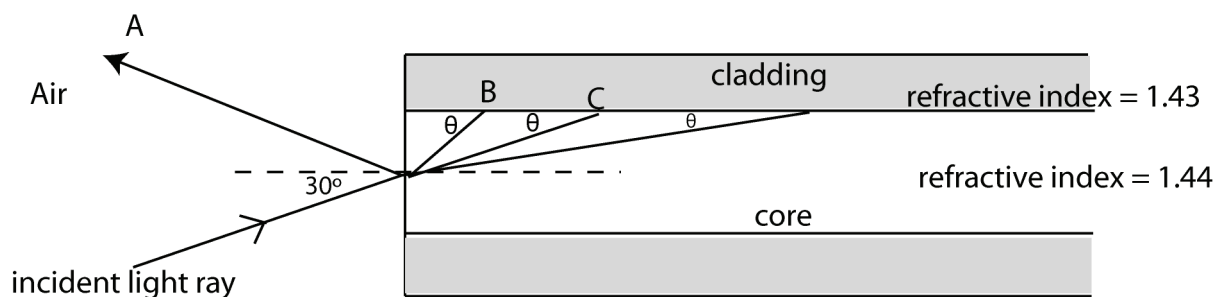


Figure 1

**Question 6**

Which path will the ray of light follow?

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2 marks

**Question 7**

Calculate the angle,  $\theta$ .

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2 marks

**Question 8**

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

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2 marks

**Question 9**

If the wavelength,  $\lambda$ , of the light was **increased**, then  $\theta$  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.

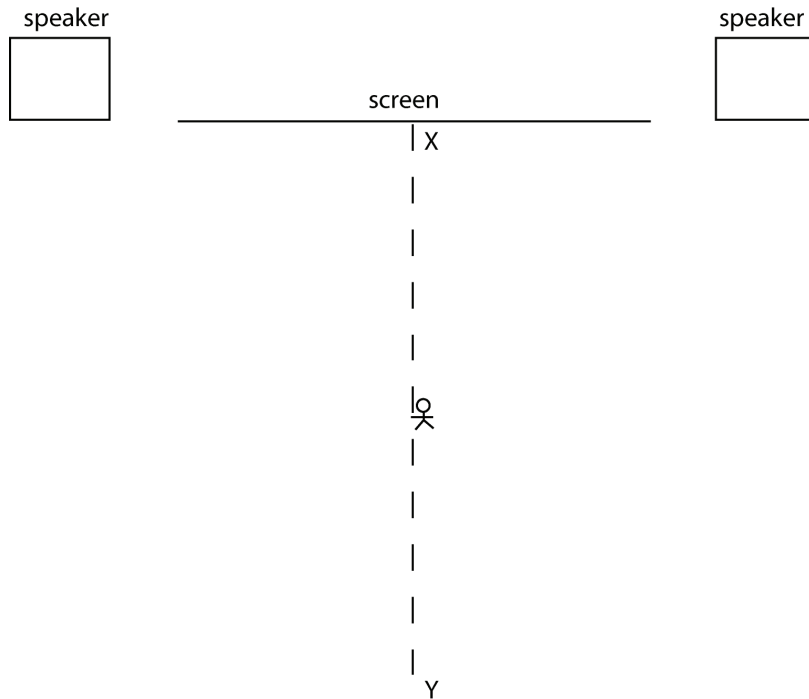


Figure 1

#### 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.

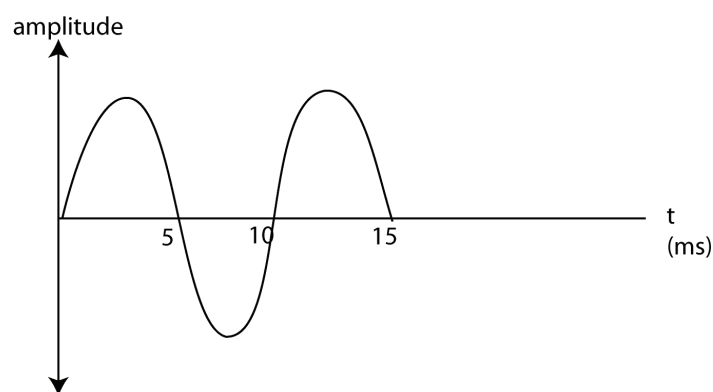


Figure 2

**Question 2**

What is the frequency of the wave?

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2 marks

**Question 3**

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

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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.

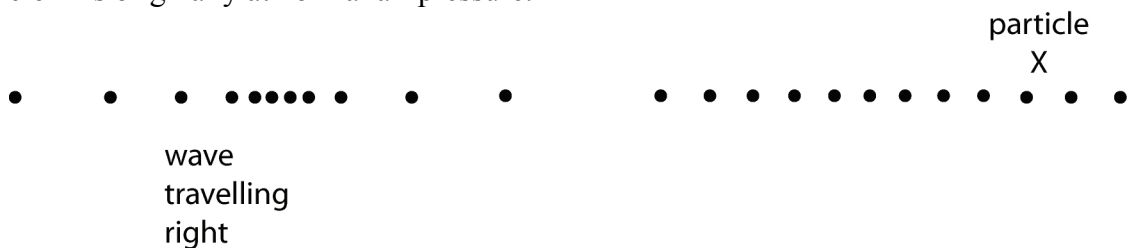


Figure 3

**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?

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2 marks

**Question 7**

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

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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).

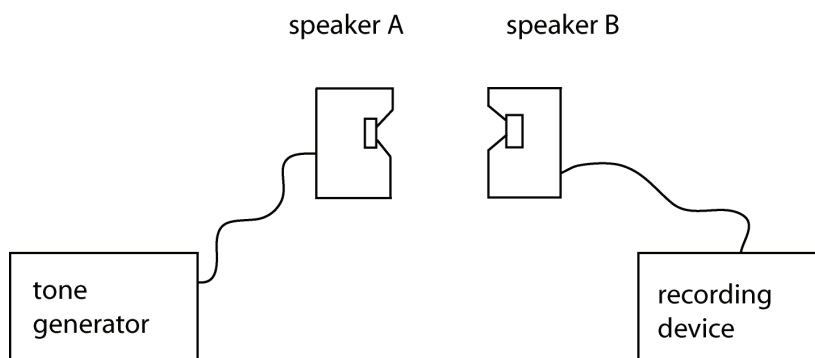


Figure 4

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?

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2 marks

### Question 9

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

Name of box:

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Purpose of box:

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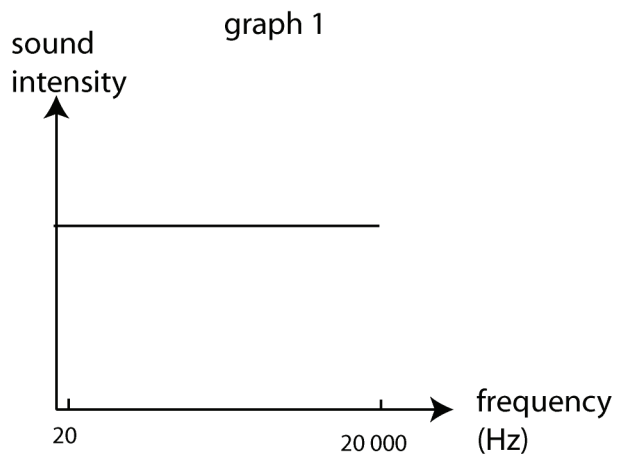


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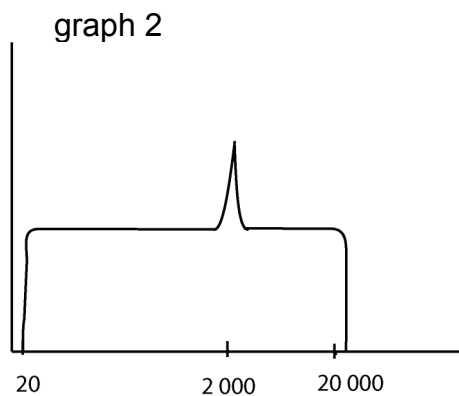
4 marks

**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?

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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**