Insight Publications

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Trial Exam Paper

2008

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	40
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	90

- 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

The following information applies to Questions 1 and 2.

Figure 1 shows two current-carrying wires, A and B, both 2 m long. They each have the same current flowing through them.

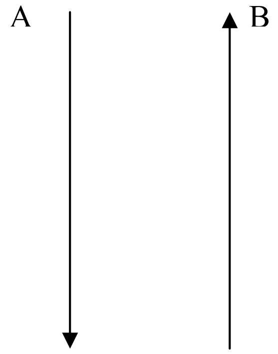


Figure 1

Question 1

The two wires would experience a force

A. both to the left
B. both to the right
C. towards each other
D. away from each other

2 marks

Question 2

What is the current flowing through wire A if it is in a magnetic field of 4×10^{-2} T and is experiencing a force of 8×10^{-3} N?

2 marks

The following information applies to Questions 3–7.

A coil, with 50 turns, is set up between two magnets, as shown in Figure 2. The maximum flux through the coil is 8×10^{-5} Wb. The distance of *AB* is 10 cm and *BC* is 20 cm.

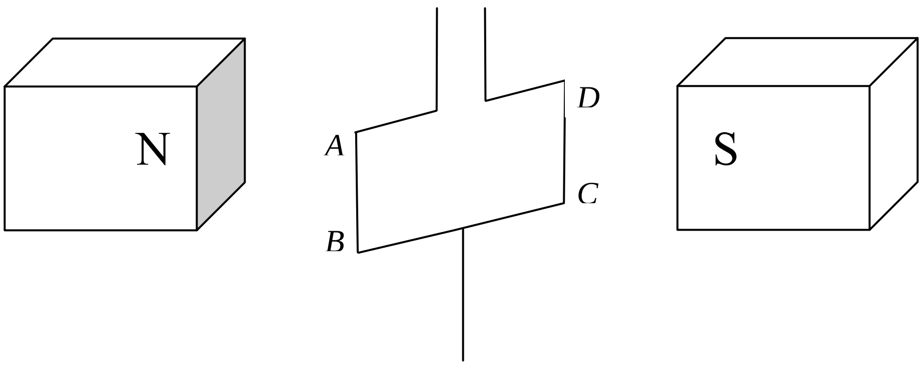


Figure 2

Question 3

What is the magnitude of the magnetic field through the coil? Include the unit in your answer.

Magnitude:

2 marks

Unit:

2 marks
Total: 2 + 2 = 4 marks

Question 4

Show that if the coil is rotated at 10 Hz, the average Emf generated is 1.6 V.

V

3 marks

Question 5

A battery of 3.2 V supplies a current of 0.2 A through the coil from *A* to *B*. What is the magnitude **and** direction of the force on side *AB*?

Magnitude: **N**

2 marks

Direction:

2 marks
Total: 2 + 2 = 4 marks

Question 6

Explain what would happen to the coil after the battery is connected.

____

____

____

____

2 marks

Question 7

Explain the operation of a split ring commutator in a DC motor.

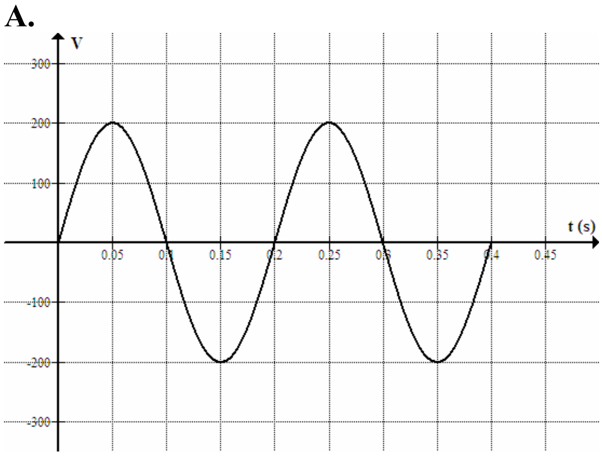
2 marks

The following information applies to Questions 8 and 9.

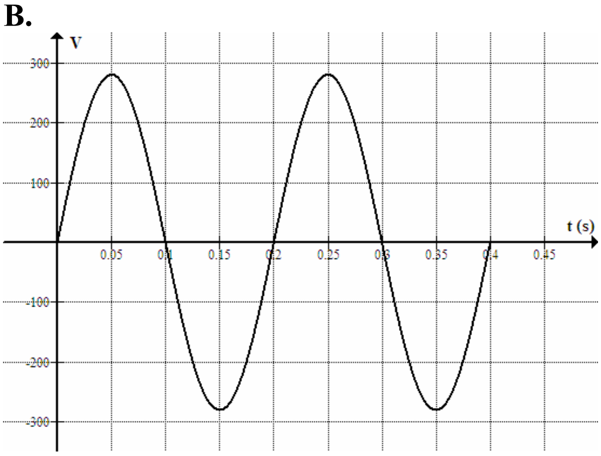
Question 8

A generator, rotating at 50 revolutions per second, has a RMS output of 200 V. Which of the following graphs represents this?

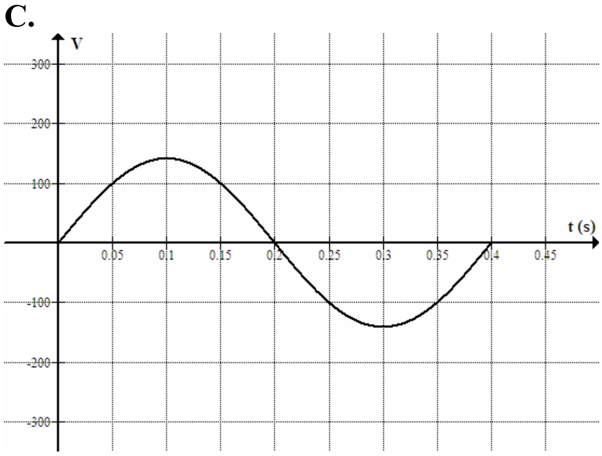
A.



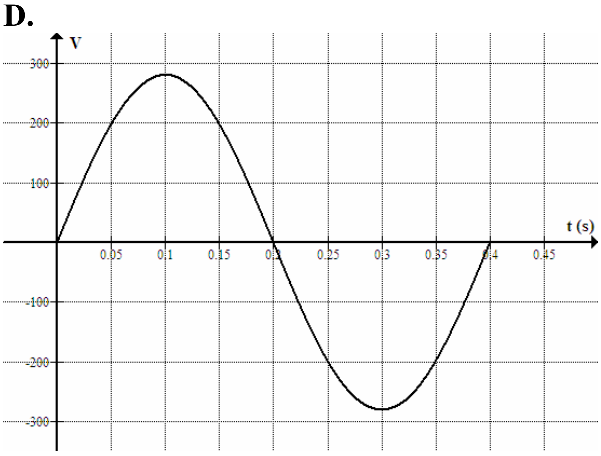
B.



C.



D.



2 marks

Question 9

The generator is slowed to 25 Hz. Which graph now best represents the output?

2 marks

The following information applies to Questions 10 –15.

David is trying out his new video game system. It draws 50 mA when connected to a 12 V AC power supply. Therefore, it needs a transformer so it can run from the 240 V mains electricity supply, as shown in Figure 3.

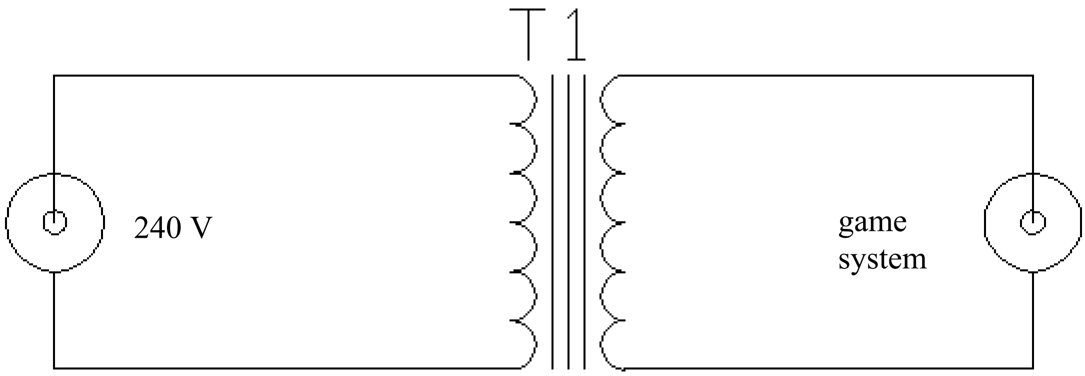


Figure 3

Question 10

What power is drawn from the primary side of the transformer?

W

2 marks

Question 11

What current is drawn in the primary side of the transformer?

mA

2 marks

Question 12

If the number of turns in the primary is 500, calculate the number of turns, N, in the secondary.

N_s =

2 marks

Question 13

Calculate the resistance of the game system.

Ω

2 marks

Question 14

What is the power loss in the system if the game system is connected to an extension cord with a total resistance of 20 Ω?

W

2 marks

Question 15

At what voltage would the game system operate at now?

V

2 marks

The following information applies to Questions 16 and 17.

A physics teacher drops her wedding ring next to a magnet during class. It falls between the teacher and the magnet, is perpendicular to the magnetic field, and does not spin. The ring has a radius of 0.5 cm, and the ring cuts into the magnetic field of 5×10^{-3} T in only 0.01 seconds.

Question 16

What is the Emf induced in the teacher's ring?

V

3 marks

Question 17

From the teacher's point of view, in which direction would the current flow in the ring?

(Circle the correct answer).

clockwise anti-clockwise

2 marks

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

Area of study 2 – Interactions of light and matter

Question 1

Explain the term **incandescent** in terms of the production of light.

2 marks

Question 2

Light **never** displays properties of

A. mass
B. momentum
C. acceleration
D. energy

2 marks

The following information applies to Questions 3–10.

Some Nobel Laureate prize winners set up the following experiment, as shown in Figure 1.

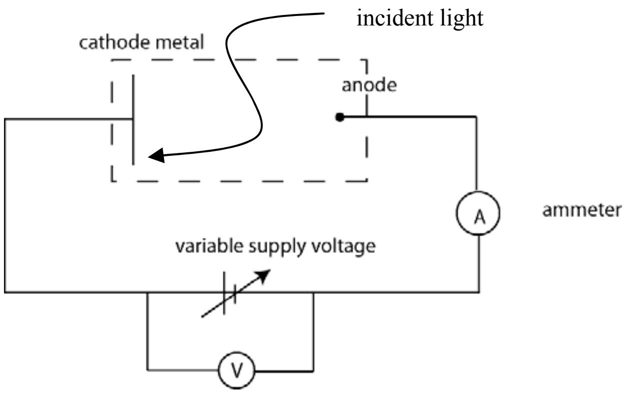


Figure 1

They find that the ammeter shows zero when the incident light frequency falls below 5×10^{14} Hz *no matter what the supply voltage*. They shine some red light of $f = 7.3 \times 10^{14}$ Hz onto the cathode metal.

Question 3

Calculate the wavelength, λ, of the incident light.

m

2 marks

Question 4

Find the energy of the incident photon in electron Volts.

eV

2 marks

Question 5

The ammeter is reading 2 mA. The decision is made to change the incident frequency to 9×10^{14} Hz. The reading on the ammeter would

A. remain the same

B. increase

C. decrease

D. increase, then decrease

1 mark

Question 6

Explain your answer to Question 5.

2 marks

Question 7

If the intensity of the incident light is increased, the reading on the ammeter would

A. remain the same
B. increase
C. decrease slightly
D. decrease to zero

2 marks

Question 8

Explain your answer to Question 7.

2 marks

Question 9

What is the work function of the metal in eV?

eV

2 marks

The intensity and frequency are changed back to their original levels.

Question 10

What voltage would be needed to stop the current flowing through the ammeter?

V

2 marks

Question 11

A laser hits a double slit, as shown in Figure 2. The pattern shows clearly on the screen. Explain why point *P*, which is equidistant from both slits, is a very bright band.

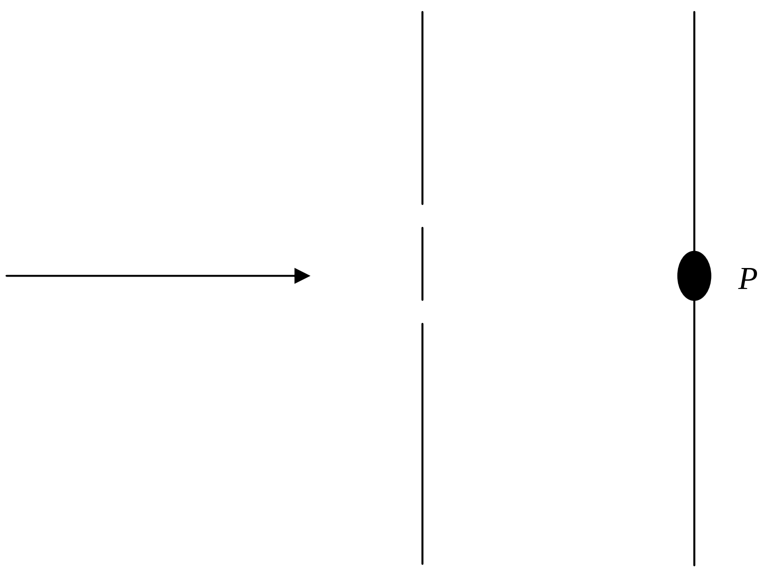


Figure 2

2 marks

Question 12

An electron gun shoots electrons (mass = 9.1×10^{-31} kg) with a velocity of 3×10^{7} ms^{-1}, as shown in figure 3.

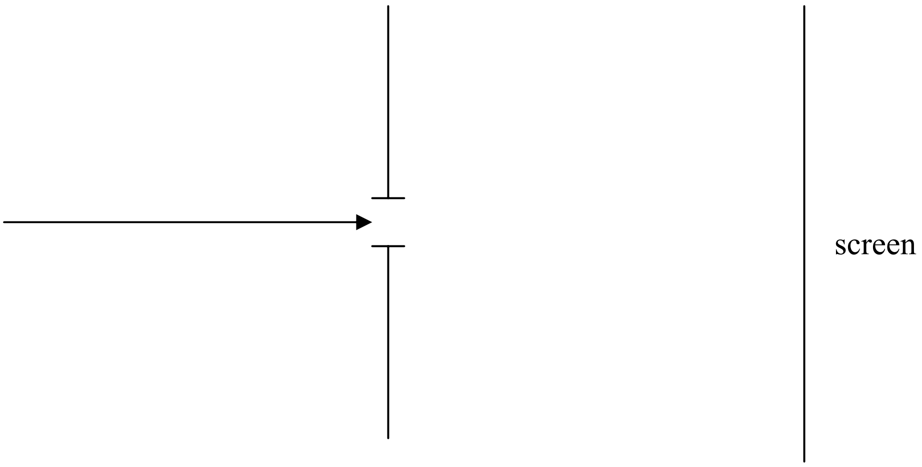


Figure 3

Determine the gap size needed in order to get a significant diffraction pattern on the screen.

m

2 marks

The following information applies to Question 13.

The energy level diagram for hydrogen is shown in Figure 4.

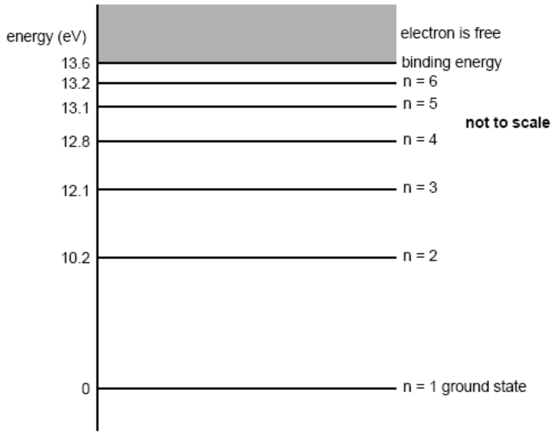


Figure 4

Question 13

If an electron falls from the 13.1 eV level (i.e. n = 5) to the 10.2 eV level (i.e. n = 2), calculate the frequency of the emitted light.

Hz

2 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

Describe the purpose of the booster ring in the synchrotron.

2 marks

The following information applies to Questions 2 and 3.

In the storage ring, electrons are found to have a momentum of 1.5×10^{-18} kg ms^{-1} and are being bent through an arc of radius 8.1 m, as shown in Figure 1.

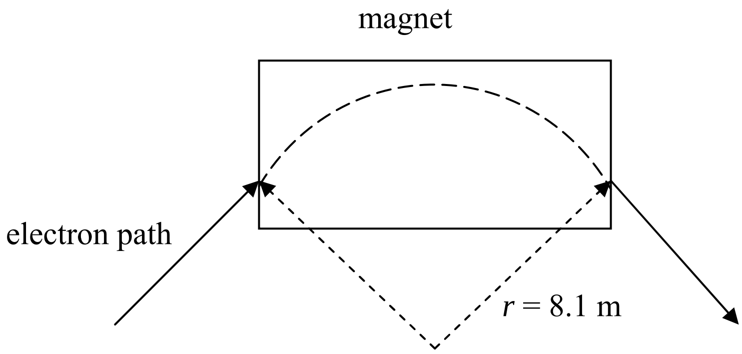


Figure 1

Question 2

Calculate the magnetic field required to keep the electrons on this arc. Include the unit in your answer.

Magnitude:

2 marks

Unit:

2 marks
Total: 2 + 2 = 4 marks

Question 3

From the following, what is the magnetic field direction in the ring?

into page
out of page
up
down
left
right

2 marks

Question 4

Electrons are fired from an electron gun and accelerated to a speed of 6×10^7 ms^{-1}. Calculate the kinetic energy of an electron in KeV.

KeV

3 marks

Susie is experimenting with a pair of charged parallel plates, which has some high voltage between them. The voltage difference between the plates is 10 000 V, and static electrons are introduced. It is found that the electrons have a kinetic energy of 1.5×10^{-15} joules. She then calculates the experimental value for the charge on the electrons.

Question 5

What is Susie's value for the charge on the electrons?

C

2 marks

Question 6

How can Bragg diffraction be differentiated from other types of diffraction?

____

____

____

2 marks

Question 7

Give **three** advantages that the synchrotron has over more traditional forms of radiation producers.

Advantage 1____

____

____

____

Advantage 2: ____

____

____

____

Advantage 3: ____

____

____

____

3 marks

Question 8

Circle True or False for each of the following.

(a)	The electrons are produced with an electron gun.	T	F
(b)	Electrons travel through the beam lines to the experimental stations.	T	F
(c)	Thomson scattering takes a small amount of energy from electrons.	T	F

3 marks

Question 9

Bragg diffraction is used to select desirable wavelengths from the synchrotron. Explain how this is done.

4 marks

END OF DETAILED STUDY 1

Detailed study 2 – Photonics

The following information applies to Questions 1 and 2.

A LED is connected correctly to a variable DC voltage supply. Current flows through the circuit, producing a bright steady light.

Question 1

The band gap of the LED is 2.4 eV. Calculate the wavelength (in nm) of the light produced.

nm

2 marks

Question 2

What is the colour of this light?

A. ultraviolet
B. infra-red
C. blue
D. red
E. green

2 marks

Question 3

Gertrude and Brenda are arguing about the benefits of laser light over LED light in an electro-photonic system. Gertrude has listed six reasons why she thinks that lasers are better than LEDs. From these, Brenda picks out the three correct responses easily. Can you? Circle the **three** most correct answers.

(a) brighter
(b) coherent
(c) cheaper
(d) more readily available
(e) less expensive to run
(f) monochromatic

3 marks

The following information applies to Questions 4–7.

Figure 1 shows a typical fibre optic cable.

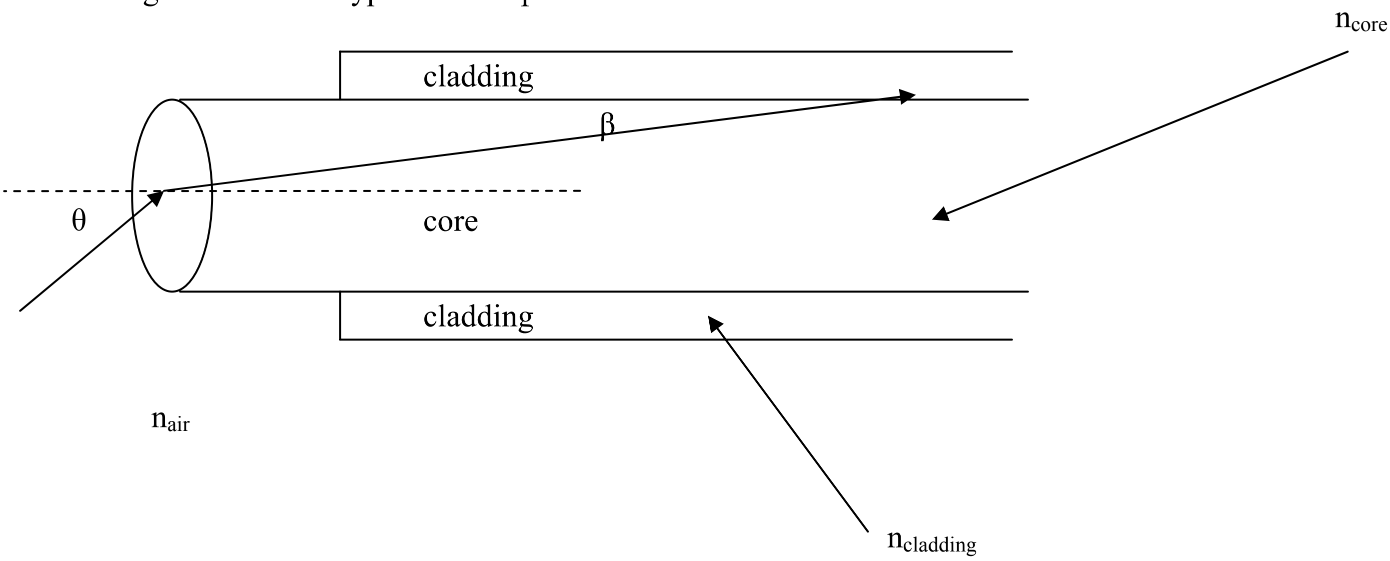


Figure 1

Question 4

Circle the correct answers within the following statement.

For the fibre optic to work correctly, $n_{core}/n_{cladding}/n_{air}$ needs to be the greatest, whereas $n_{core}/n_{cladding}/n_{air}$ needs to be the least.

2 marks

Question 5

If the n_{core} for the fibre optic cable is 1.5, what is the maximum angle θ that will allow light to enter the core?

°

1 mark

Question 6

What is the value of $n_{cladding}$ if the critical angle of the boundary is found to be 83.4°?

2 marks

Question 7

What is the angle θ, as shown on the diagram?

°

2 marks

The following information applies to Questions 8 – 12.

Question 8

Chelsea and Manu are having a healthy debate about modal dispersion, which they have encountered in their new fibre optic network. Chelsea states that a larger diameter fibre is needed, as this will allow more light in, giving more signal out, thus producing a better result for all. Manu suggests the exact opposite and wants a thinner fibre.

Whose advice should they follow and why?

3 marks

Question 9

What is material dispersion, and what is the best way to overcome it?

2 marks

Question 10

The phenomenon of refraction of light is due to the fact that

A. the speed of light is constant in all media
B. light exhibits both wave and particle behaviour
C. the speed of light is not constant in all media
D. photons have momentum

2 marks

Question 11

When transmitting signals through an optical fibre, those rays entering the fibre at angles of incidence outside the cone of acceptance will be transmitted

A. through the fibre with reduced amplitude
B. through the fibre with reduced frequency
C. through the fibre with reduced intensity
D. into the cladding and lost

2 marks

Question 12

Besides bandwidth, list **two** advantages that optical fibres have over copper wires.

2 marks

END OF DETAILED STUDY 2
SECTION B – continued
TURN OVER

Detailed study 3 – Sound

Take the speed of sound to be 340 ms^{-1} throughout this section.

The following information applies to Questions 1–4.

Corporal Agarn is blowing a trumpet with a fundamental frequency of 500 Hz.

Question 1

What is the wavelength of the produced sound?

m

2 marks

Question 2

Sergeant O'Rourke is standing 3 m in front of Agarn, and records the sound level at 65 dB.

What is 65 dB in sound intensity?

Wm^{-2}

3 marks

Question 3

Sergeant O'Rourke now moves so that she is 6 m from the trumpet. How will this affect the sound intensity, and what will be its new value?

Wm^{-2}

2 marks

Question 4

The trumpet can be modelled as a pipe with one closed end. Which other frequency will it produce?

A. 250 Hz
B. 750 Hz
C. 1000 Hz
D. 1500 Hz

2 marks

Question 5

How long is the trumpet?

m

2 marks

Question 6

Agarn tells O'Rourke that the trumpet is resonating. Briefly explain resonance in terms of the behaviour of the sound waves.

3 marks

The following information applies to Questions 7 – 9.

Shalderman is setting up his home theatre. Instructions state that all small speakers should be pointing directly at where the listener is sitting, with nothing in between. But the subwoofer, with its very low frequency output, is able to sit anywhere in the room, and does not have to be pointed directly at the listener.

Question 7

Why does the subwoofer get such special treatment?

2 marks

Question 8

The subwoofer is surrounded by a ‘box’. What is the name of this box and what is its purpose?

3 marks

Question 9

What is a drawback of this ‘box’ surrounding the speaker?

2 marks

Question 10

Explain the operation of an Electret-Condenser microphone.

2 marks

The following information applies to Question 11.

Grant Spatchcock, of Spatchcock Pizzas, is complaining about the phone ringing. He says it is very loud and is of a very annoying pitch. Gerard says that pitch and frequency are the same thing, and nothing can be done.

Question 11

With reference to pitch and frequency, explain why Grant is irritated with the pitch of the phone, but no one else is.

2 marks

END OF QUESTION AND ANSWER BOOK