CENTRE FOR STRATEGIC EDUCATION

Leading educational thinking and practice

IARTV

STUDENT:	TEACHER:

YEAR 12
CSE TEST: OCTOBER 2010
PHYSICS
Written test 2

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

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions To be answered*	*Number of marks*
A – Core – Areas of study			
1. Electric power	18	18	35
2. Interactions of light and matter	14	14	29
B – Detailed studies			
1. Synchrotron and its applications	13	13	26
OR			
2. Photonics	13	13	26
OR			
3. Sound	13	13	26
			Total 90

- Students are permitted to bring into the examination room: 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 into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 37 pages. The question and answer book has a detachable formula sheet and answer sheet for Section B multiple-choice questions as centrefolds.

Instructions
- Detach the multiple-choice answer sheet and then the formula sheet from the centre of this book during reading time.
- Write your **name** and **teacher's name** in the spaces provided above on this page.
- Write your name in the space on your answer sheet for multiple-choice questions.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for the 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.

SECTION A – Areas of study

Instructions for Section A

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

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

You should take the value of *g* to be 10 N kg^{-1}.

Where answer boxes are provided write your final answer in the box.

In questions worth more than one mark, appropriate working should be shown.

Area of study 1 – Electric power

The following information relates to Questions 1 and 2.

Maria performs an experiment to demonstrate the magnetic force acting on a bar magnet positioned near a solenoid. The magnet experiences a force to the left when it is positioned near the end of the solenoid, as shown in Figure 1.

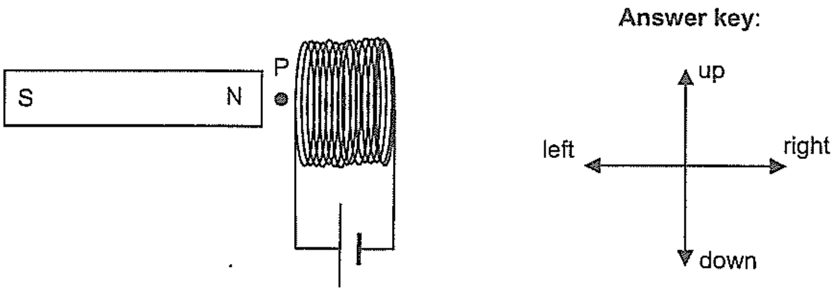


Figure 1

Question 1

Using the Answer key in Figure 1, what is the direction of the magnetic field of the solenoid at the point P?

1 mark

In a different demonstration, Maria places a compass at a point Q inside the solenoid shown end-on in Figure 2. The compass points in a direction into the page due to the magnetic field of the solenoid at the point Q.

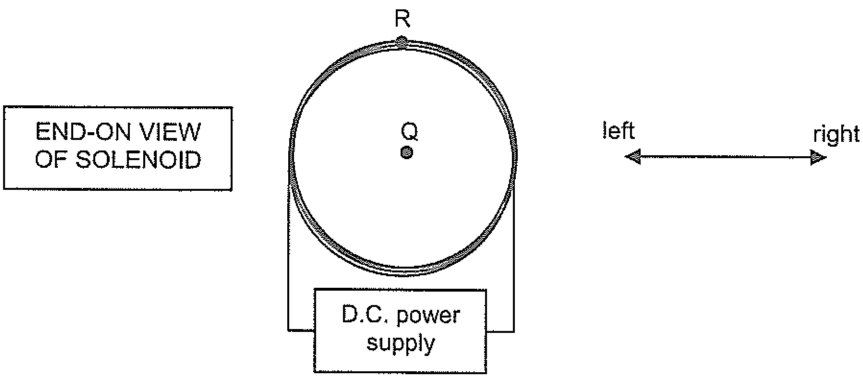


Figure 2

Question 2

What is the direction of the current in the solenoid at the point R (**left** or **right**)?

1 mark

The following information relates to Questions 3–5.

Terri designs a see-saw arrangement where a large magnet generates a magnetic force on a wire carrying an electric current. Her design is shown in Figure 3 where the heavy line shows the electric circuit.

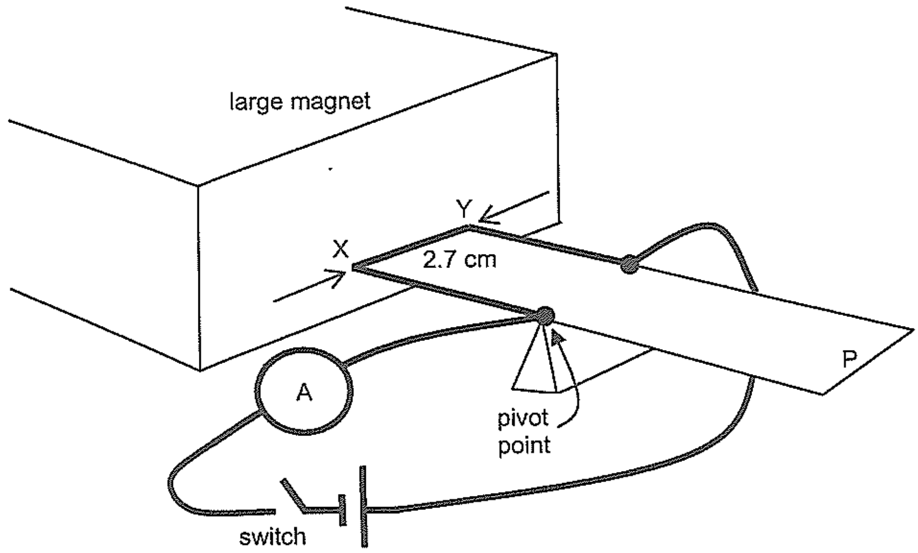


Figure 3

At the left end of the see-saw is a conducting wire XY of length 2.7 cm. At the other end weights are placed at P to balance the see-saw and make it horizontal.
The pivot is positioned in the middle of the see-saw which is balanced when the switch is open and with no weights positioned at P.
With the switch closed, the ammeter registers a current of 3.8 A and the left end of the see-saw moves down due to a magnetic force acting on XY.

Question 3
What is the polarity (**North** or **South**) of the end of the large magnet near XY? Explain how you determined your answer.

3 marks

With the switch still closed, Terri balances the see-saw by placing an object of weight 0.045 N at P.

Question 4
Calculate the magnitude of the magnetic field of the magnet at the left end of the see-saw.

T

2 marks

Terri reverses the terminals of the battery. With the switch again closed, the left end of the see-saw now moves up.

Question 5
State how Terri could modify this arrangement so that the left end of the see-saw would move down and resume its former balance position (apart from reversing the battery terminals).

1 mark

The following information relates to Questions 6–11.

Brendan and Chris are building a DC motor. The arrangement is shown in Figure 4. It consists of a circuit containing a battery, a square coil and a split-ring commutator. The coil has 20 turns and sides of length 2.5 cm. The current is 3.2 A. The magnetic field between the magnetic poles is uniform and has strength 0.17 T.

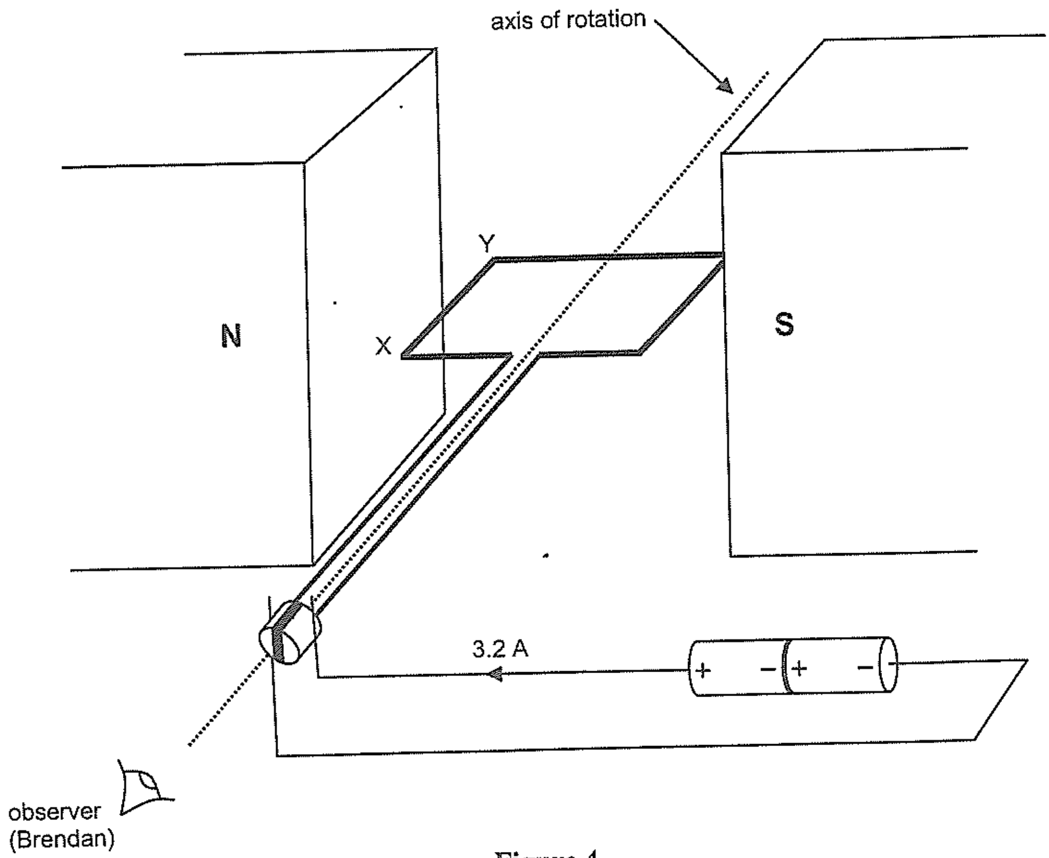


Figure 4

Question 6

With the coil shown horizontal in Figure 4, calculate the size of the force acting on the side XY.

N

2 marks

A short time later Brendan observes that the coil has rotated 45° clockwise from the position shown in Figure 4.

Question 7
Calculate the size of the force now acting on the side XY.

N

1 mark

Question 8
Explain why a split-ring commutator is required.

____

____

____

____

2 marks

Chris recalls that he can use a motor as a generator by simply rotating the coil and causing a change in magnetic flux through the coil to occur. The coil consisting of 20 loops is now positioned vertically as shown in Figure 5.

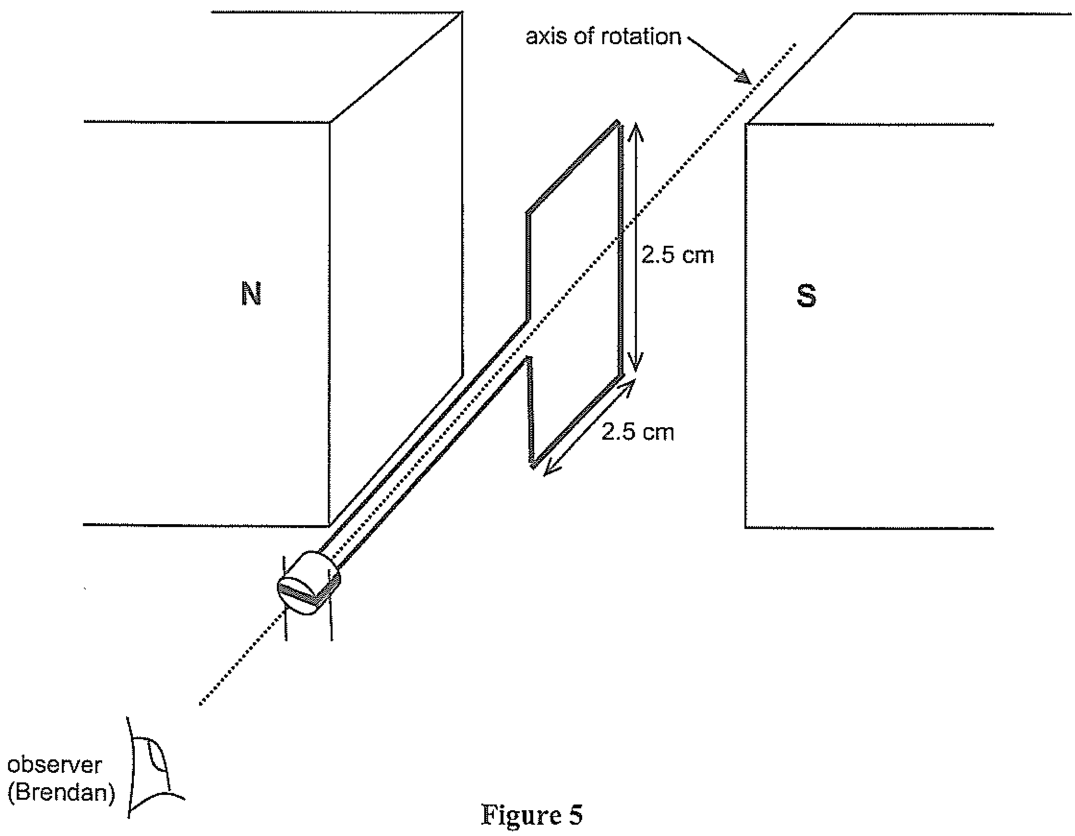


Figure 5

Question 9
Calculate the magnetic flux through the coil as positioned in Figure 5.

Wb

2 marks

From the position shown in Figure 5, Chris rotates the coil clockwise through 180° at a steady rate for 0.50 s.

Question 10
Calculate the magnitude of the average voltage induced between the ends of the coil during that 0.50 s.

V

3 marks

Chris continues to rotate the coil at a steady rate. Figure 6 shows a graph of magnetic flux through the coil against time.

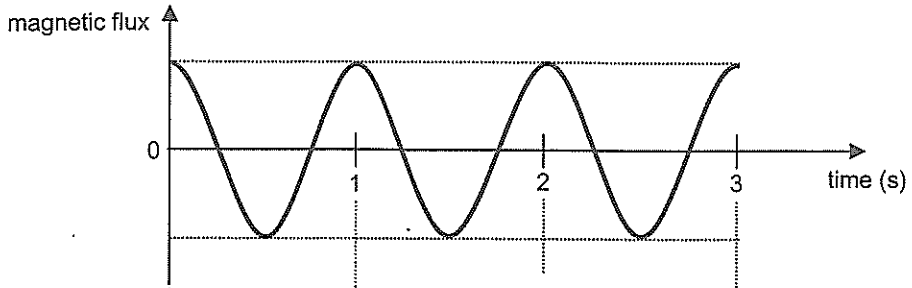


Figure 6

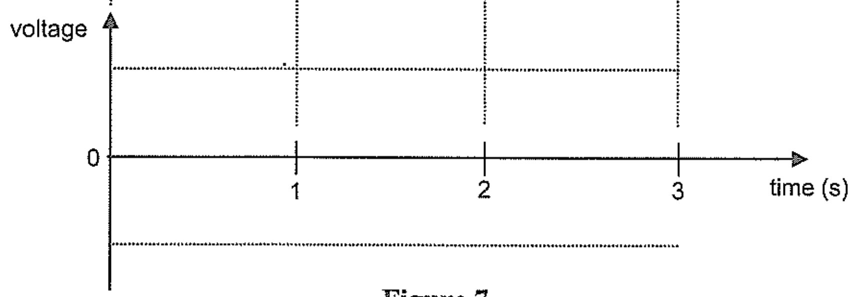


Figure 7

Question 11
On Figure 7 above, sketch a graph of the corresponding output voltage of the motor when used as a generator. The arrangement still has a split-ring commutator.

2 marks

Patricia and James are investigating induced electric currents when magnets are moved near a conducting loop. Their arrangement is shown in Figure 8 and consists of a loop and sensitive ammeter used to measure both the direction and size of small electric currents. Point O is at the centre of the loop.

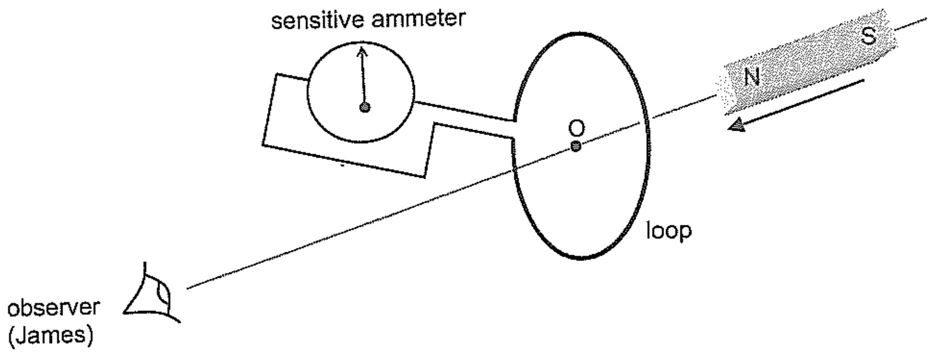


Figure 8

Patricia moves the magnet toward the loop as shown in Figure 8.

Question 12
Explain, using Lenz's law, how you would predict the direction (either **clockwise** or **anticlockwise** as viewed by James) of conventional current in the loop while Patricia moves the magnet?

3 marks

The following information relates to Questions 13 and 14.

The voltage **output** of a transformer is displayed on a CRO and shown in Figure 9. The vertical scale is set to 5.0 V cm^{-1}.

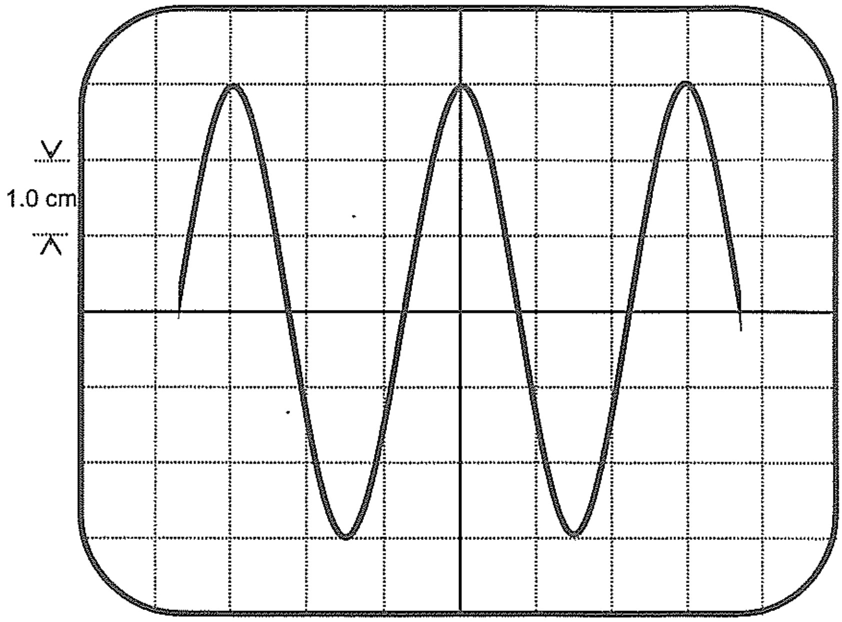


Figure 9

Question 13

Calculate the RMS **output** voltage from the transformer.

V

2 marks

The transformer has a turns ratio:

$$\frac{N_s}{N_p} = 0.23$$

Question 14

Calculate the RMS **input** voltage to the transformer.

V

1 mark

The following information relates to Questions 15–18.

Mario and Samos construct a simple model of a transmission system wired to minimise power loss. The system consists of an AC power supply with RMS voltage 6.0 V, two ideal transformers X and Y, each with 12 times as many turns on one coil as the other and a light globe G. The circuit is shown in Figure 10.

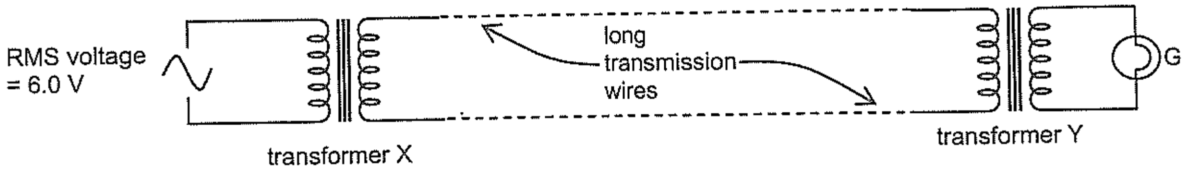


Figure 10

Question 15
Which statement represents the correct use of the two transformers?

A. Transformer X is a step-down and transformer Y is a step-down.

B. Transformer X is a step-up and transformer Y is a step-down.

C. Transformer X is a step-down and transformer Y is a step-up.

D. Transformer X is a step-up and transformer Y is a step-up.

1 mark

The RMS current in the globe G is measured by Mario to be 2.4 A.

Question 16
Calculate the RMS current in the transmission wire.

A

2 marks

Samos measures the RMS voltage across the input of transformer Y and finds it is 70 V.

Question 17
Determine the **total** resistance of the transmission wires.

Ω

3 marks

A second identical globe is connected in series with globe G. The **total** voltage across the two transmission wires is measured by Samos.

Question 18
State whether the **total** voltage across the two long transmission wires measured by Samos is now **smaller**, the **same** or **larger** than the total voltage across the transmission wires prior to the second globe being connected into the circuit.
Give a detailed explanation for your choice.

3 marks

Area of study 2 – Interactions of light and matter

The following information relates to Questions 1 and 2.

In 1801 Thomas Young directed a beam of light at two thin parallel slits and observed an interference pattern. This demonstration can be repeated in the classroom with a laser, as illustrated in Figure 1. Five of the resulting adjacent bright bars observed on the screen are labelled A to E with C being the central maximum and the brightest bar.

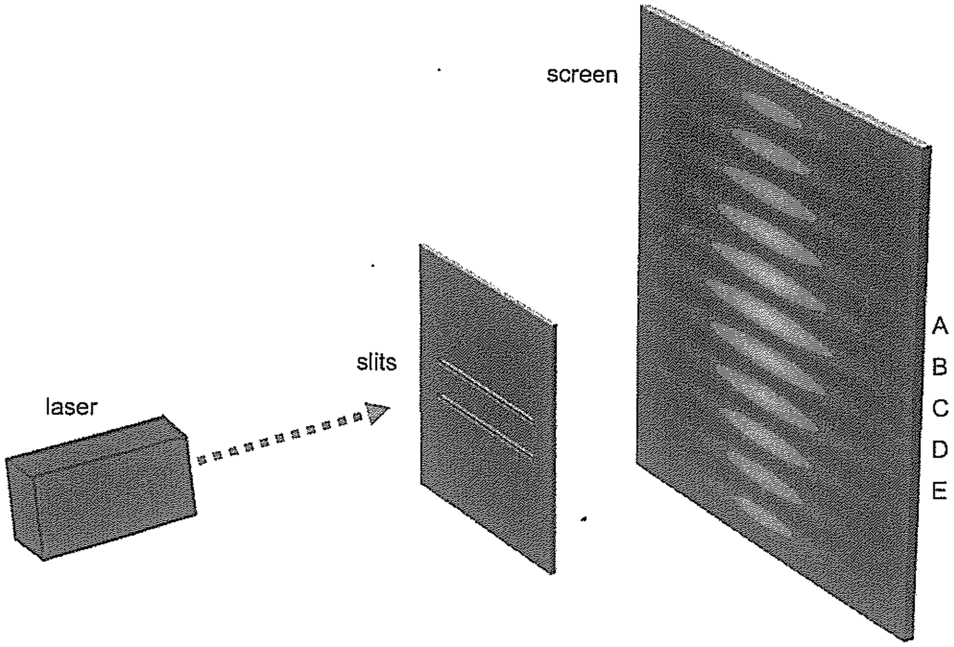


Figure 1

Question 1

Explain why a bright bar is formed at position E?

____

____

____

2 marks

Question 2

The interference pattern illustrated in Figure 1 was produced using a green laser light.
Which of the following changes would reduce the spacing between the bright bars?

A. Moving the screen further from the slits

B. Using new slits which are further apart

C. Using red laser light

D. Using orange laser light

2 marks

This question concerns the photoelectric effect.
Figure 2 shows graphs labelled A to D.

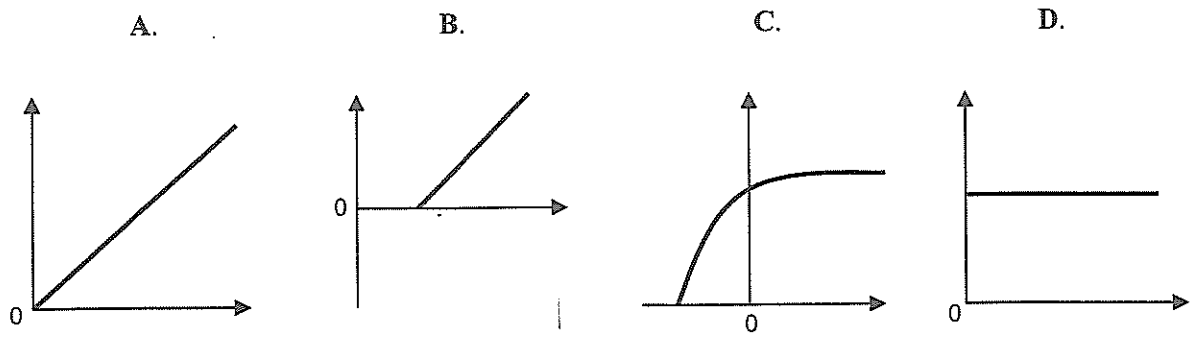


Figure 2

Question 3
Complete the table by filling in the letter of the graph that best represents results from the photoelectric effect experiment for each of the listed pair of variables.
In each case assume all other variables are kept constant.

Vertical Axis	Horizontal Axis	Graph
Maximum kinetic energy of photoelectrons	Frequency of incident light	
Stopping voltage	Intensity of incident light	
Photoelectron current	Voltage across photocell	

3 marks

The following information relates to Questions 4–6.

When completing a photoelectric effect experiment, Ryan finds that incident light of wavelength 428 nm results in a stopping voltage of 1.19 V being required to reduce the photocurrent to zero.

Question 4

What is the maximum kinetic energy of the ejected photoelectrons? Give your answer in joule.

J

2 marks

Question 5

Calculate the work function for the target surface. Give your answer in electron volt.

eV

2 marks

Question 6

What stopping voltage will be required when the same target surface is used but the incident light is changed to a wavelength of 590 nm?

V

2 marks

The following information relates to Questions 7–10.

In 1929 Sir George Thomson fired a beam of electrons through a thin metal foil and observed the similarities with the diffraction pattern produced by 10.4 keV X-rays incident on the same foil. The two diffraction patterns are represented in Figure 3.

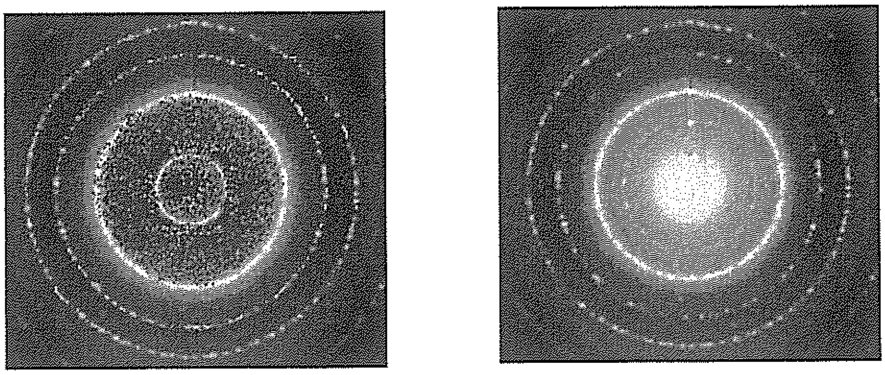


Figure 3

Question 7

What is the significance of the discovery that electrons can form a diffraction pattern?

____

____

____

____

2 marks

Question 8

Determine the momentum of a 10.4 keV X-ray photon.

kg m s^{-1}

2 marks

Question 9
Calculate the wavelength of a 10.4 keV X-ray photon.

m

2 marks

Question 10
Compare and comment on the momentum of an electron in this beam with the momentum of the 10.4 keV X-ray photon.

2 marks

The following information relates to Questions 11–13.

Figure 4 shows part of the emission spectrum for mercury from a mercury vapour lamp. The positions of some of the emission lines are indicated by the letters P to T.
The lower atomic energy levels of mercury are shown in Figure 5.

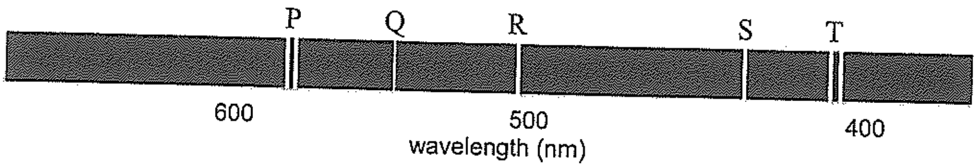


Figure 4

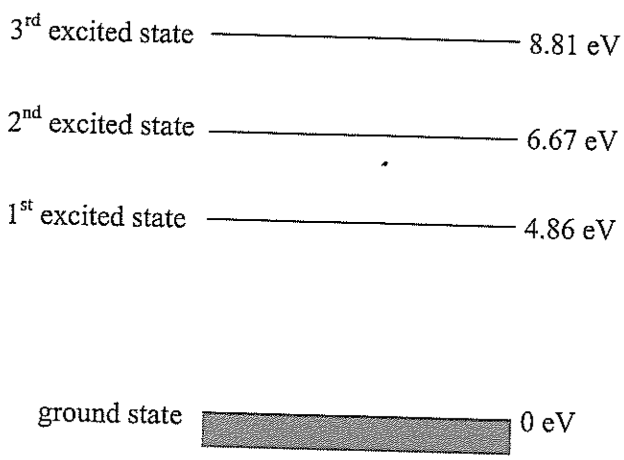


Figure 5

A photon collides with a mercury atom, causing its energy level to rise from the ground state to the first excited state.

Question 11

Which of the following represents the energy of the photon?

A. Exactly 3.95 eV

B. Exactly 4.86 eV

C. Any energy greater than 4.86 eV

D. Any energy greater than 8.81 eV

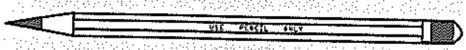
2 marks

CSE TEST: OCTOBER 2010
PHYSICS
Written Test 2

ANSWER SHEET

STUDENT NAME:

INSTRUCTIONS:



Use a **PENCIL** for **ALL** entries. For each question, shade the box which indicates your answer.
All answers must be completed like **THIS** example: [A] ■ [C] [D]
Marks will **NOT** be deducted for incorrect answers.
NO MARK will be given if more than **ONE** answer is completed for any question.
If you make a mistake, **ERASE** the incorrect answer. **DO NOT** cross it out.

SECTION B

Show the Detailed Study answered by shading one box.

Detailed Study:

- ☐ **Detailed Study 1: Synchrotron and its applications**
- ☐ **Detailed Study 2: Photonics**
- ☐ **Detailed Study 3: Sound**

Please write the Detailed Study name in the box below to confirm your chosen Detailed Study.

Detailed Study:

ONE ANSWER PER LINE				
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

ONE ANSWER PER LINE				
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

Please DO NOT fold, bend or staple this form.

CENTRE FOR STRATEGIC EDUCATION

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IARTV

YEAR 12

CSE TEST: OCTOBER 2010

PHYSICS

Written test 2

FORMULA SHEET

Directions to students

Detach this formula sheet before commencing the examination.

This formula sheet is provided for your reference.

1	photoelectric effect	$E_{k\,max} = hf - W$
2	photon energy	$E = hf$
3	photon momentum	$p = \frac{h}{\lambda}$
4	de Broglie wavelength	$\lambda = \frac{h}{p}$
5	resistors in series	$R_T = R_1 + R_2$
6	resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
7	magnetic force	$F = IlB$
8	electromagnetic induction	emf : $\varepsilon = -N\frac{\Delta\phi}{\Delta t}$ flux : $\phi = BA$
9	transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
10	AC voltage and current	$V_{RMS} = \frac{1}{\sqrt{2}}V_{peak}$ $I_{RMS} = \frac{1}{\sqrt{2}}I_{peak}$
11	voltage; power	$V = RI$ $P = VI$
12	transmission losses	$V_{drop} = I_{line}R_{line}$ $P_{loss} = I_{line}^2 R_{line}$
13	mass of the electron	$m_e = 9.1 \times 10^{-31}$ kg
14	charge on the electron	$e = -1.6 \times 10^{-19}$ C
15	Planck's constant	$h = 6.63 \times 10^{-34}$ J s $h = 4.14 \times 10^{-15}$ eV s
16	speed of light	$c = 3.0 \times 10^8$ m s^{-1}

Detailed study 3.1 - Synchrotron and its applications

17	energy transformations for electrons in an electron gun (<100 keV)	$\frac{1}{2}mv^2 = eV$
18	radius of electron beam	$r = mv/eB$
19	force on an electron	$F = evB$
20	Bragg's law	$n\lambda = 2d\sin\theta$
21	electric field between charged plates	$E = \frac{V}{d}$

Detailed study 3.2 - Photonics

22	band gap energy	$E = \frac{hc}{\lambda}$
23	Snell's Law	$n_1 \sin i = n_2 \sin r$

Detailed study 3.3 - Sound

24	speed, frequency and wavelength	$v = f\lambda$
25	intensity and levels	sound intensity level (in dB) $= 10\log_{10}\left(\frac{I}{I_0}\right)$ where $I_0 = 1.0 \times 10^{-12}$ W m^{-2}

Prefixes/Units

p = pico = 10^{-12}

n = nano = 10^{-9}

μ = micro = 10^{-6}

m = milli = 10^{-3}

k = kilo = 10^{3}

M = mega = 10^{6}

G = giga = 10^{9}

t = tonne = 10^{3} kg

END OF FORMULA SHEET

Question 12

Which one of the emission lines (**P** to **T** in Figure 4) most likely results from an atom of mercury undergoing a transition from the 3rd excited state to the 2nd excited state?

2 marks

Question 13

Determine the frequency of the light emitted when atoms of mercury return to the ground state from the first excited state?

Hz

2 marks

A standing wave pattern for an orbiting electron in a hydrogen atom is illustrated in Figure 6.

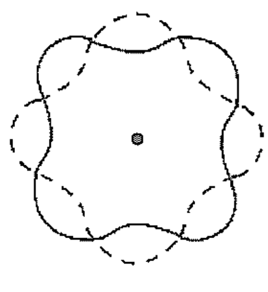

Figure 6

Question 14

Which of the following statements is correct for this electron?

A. It is in its 4th excited state and exists as a standing wave.

B. It is in its 4th excited state but does not exist as a standing wave.

C. It has formed a standing wave with the circumference of its motion equal to 4 wavelengths.

D. It has formed a standing wave with the circumference of its motion equal to 8 wavelengths.

2 marks

END OF SECTION A

TURN OVER

SECTION B – Detailed studies

Instructions for Section B

Select **one** Detailed study.

Answer **all** questions from the Detailed study, in pencil, on the answer sheet provided for multiple-choice questions.

Write the name of your chosen Detailed study on the multiple-choice answer sheet **and** shade the matching box.

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

A correct answer scores 2, 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.

You should take the value of g to be 10 N kg^{-1}.

Detailed study 1 – Synchrotron and its applications

The following information relates to Questions 1–4.

Figure 1 shows a schematic diagram of an electron gun which accelerates electrons towards and through a hole in a positive plate. The positive and negative plates are 25 cm apart and there is a 90 kV potential difference between them.

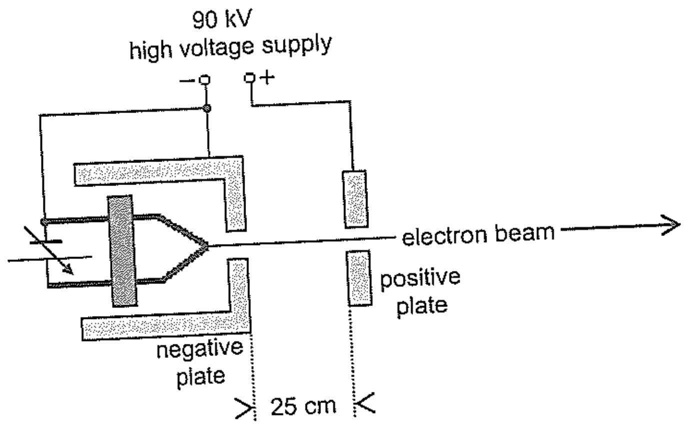

Figure 1

Question 1
How are the electrons produced?

A. By radioactive emission from a heated metal anode.
B. By radioactive emission from a heated metal cathode.
C. By thermionic emission from a heated metal anode.
D. By thermionic emission from a heated metal cathode.

Question 2

What will be the magnitude of the electric field between the plates?

A. 3.60 V m^{-1}

B. 2.25 kV m^{-1}

C. 360 kV m^{-1}

D. 2.25 MV m^{-1}

Question 3

If the magnitude of the electric field between the plates (the answer to Question 2) is represented by E, which of the following represents the magnitude of the acceleration of an electron as it travels between the plates?

A. $1.6 \times 10^{-19} E$

B. $5.69 \times 10^{-12} E$

C. $1.75 \times 10^{11} E$

D. $\frac{E}{9.1\times10^{-31}}$

Question 4

What will be the increase in kinetic energy of an electron as it passes from the negative plate to the positive plate?

A. 1.44×10^{-14} J

B. 2.88×10^{-14} J

C. 4.32×10^{-14} J

D. 5.76×10^{-14} J

The following information relates to Questions 5–7.

Figure 2 shows part of a **modelled** synchrotron storage ring. The arrow shows the direction of electron movement due to the magnetic field of dipole magnets.

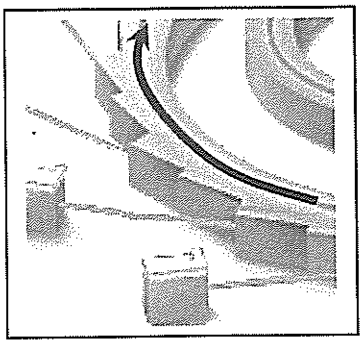

Figure 2

Question 5
In this section of the storage ring what is the direction of the magnetic field of the dipole magnets?

A. Vertically upwards
B. Vertically downwards
C. Horizontally inwards
D. Horizontally outwards

Questions 6 and 7 refer to dipole magnets acting on electrons in the storage ring. Relativistic effects are to be ignored.

Question 6
What is the magnitude of the magnetic force on an electron if a magnetic field of 1.2×10^{-4} T is directed at right angles to the direction of the electron which is travelling at 5.0×10^{6} m s^{-1}?

A. Zero
B. 9.6×10^{-17} N
C. 6.0×10^{2} N
D. 4.2×10^{10} N

Question 7
What would be the radius of curvature of the path of the electron described in Question 6?

A. 0.24 m
B. 0.38 m
C. 0.48 m
D. 0.54 m

Synchrotron radiation, as it leaves the storage ring, has several properties which give it an advantage over other forms of electromagnetic radiation such as laser light, X-rays from an X-ray tube, etc.

Question 8
Which of the following is one of these properties?

A. It has low levels of brightness and intensity.
B. It is monochromatic.
C. It is able to be tuned from a small range of available wavelengths.
D. It has a low level of divergence.

Synchrotron X-rays with a wavelength of 0.12 nm are directed at the surface of a graphite sample, initially with a very small grazing (or Bragg) angle θ as shown in Figure 3. The first-order Bragg diffraction occurs at a grazing angle of 10.32°.

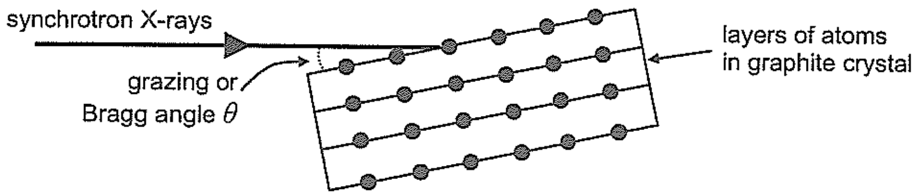

Figure 3

Question 9
What is the spacing between adjacent layers of graphite atoms as found from this data?

A. 0.335 nm
B. 0.670 nm
C. 0.335 μm
D. 0.670 μm

Question 10
Including this first intensity peak at 10.32°, what number of intensity peaks will be observed as the graphite crystal is rotated between grazing angles of 0° and 30°?

A. 1
B. 2
C. 3
D. 4

Question 11
Which of the following types of scattering is used to explain Bragg diffraction?

A. Compton scattering
B. inelastic scattering
C. Thompson scattering
D. photoelectric effect scattering

Question 12

Which of the following devices may be found on a storage ring rather than on the beamline?

A. an attenuator

B. a collimator

C. mirrors

D. a wiggler

Question 13

Which of the following optical devices may be found on a beamline?

A. a double crystal monochromator

B. an insertion device

C. an undulator

D. a wiggler

END OF DETAILED STUDY 1

Detailed study 2 – Photonics

The following information relates to Questions 1–3.

Nathan is building a tail light for his bike using twelve WL84C LEDs arranged as in the circuit diagram in Figure 1. The NiMH battery has an emf of 13.2 V. The LEDs emit light of wavelength 625 nm.

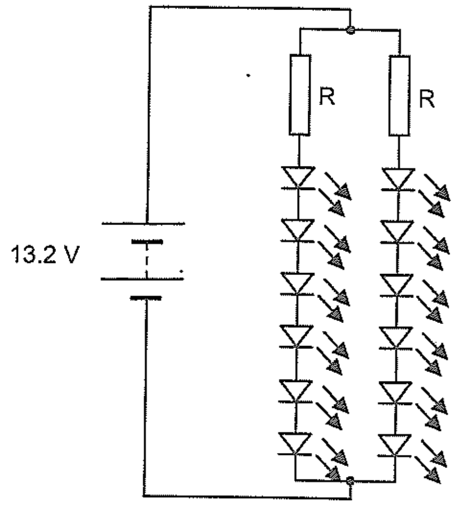

Figure 1

Question 1

What causes light to be generated in each LED?

A. Random motion of the valence electrons

B. Energy loss by atoms after colliding with other atoms

C. Electrons moving from the conduction band to the valence band of a semiconductor

D. Electrons moving from the valence band to the conduction band of a semiconductor

Question 2

Determine the band gap energy of this LED.

A. 2.0 eV

B. 3.2×10^{-19} eV

C. 1.1×10^{-21} eV

D. 8.6×10^{-30} eV

Question 3

If the 13.2 V battery in Figure 1 was replaced by a 12 V battery, what change would result?

A. The colour of the light emitted would change from red to orange.

B. More photons of lower energy would be emitted per second.

C. Fewer photons of the same energy would be emitted per second.

D. The light emitted would be of the same colour but brighter.

The following information relates to Questions 4 and 5.

Ms Johnston is using a laser pointer to direct her students' attention to various parts of a PowerPoint presentation on a screen.

Question 4

The light from the laser is generated by

A. the deceleration of electrons as they make random thermal collisions with one another.

B. excited atoms releasing energy equal to that of passing photons with which the atoms interact.

C. the transition of valence electrons to lower energy states.

D. electrons emitting energy as they change from a conduction band to a valence band.

Question 5

Which of the following best describes the light in the laser beam?

A. It is coherent, i.e. all the photons travel down the laser side by side.

B. Only the most energetic photons pass through the partially reflective mirror at one end.

C. It all has the same frequency, wavelength and speed.

D. It all has the same frequency, wavelength, phase and speed.

The following information relates to Questions 6–9.

Janine and Ishita have access to three demonstration models of a fibre optic wave guide.

A cross-section of **Model 1** is shown in Figure 2. The 'core' material is crown glass of refractive index 1.61, while the 'cladding' is borosilicate of refractive index 1.47.

Using a HeNe laser directed at the centre P of the end of the 'fibre', they vary the angle of incidence at P until the light in the core just fails to pass into the cladding, as shown in Figure 2, which shows the path of the light that is transmitted into the core.

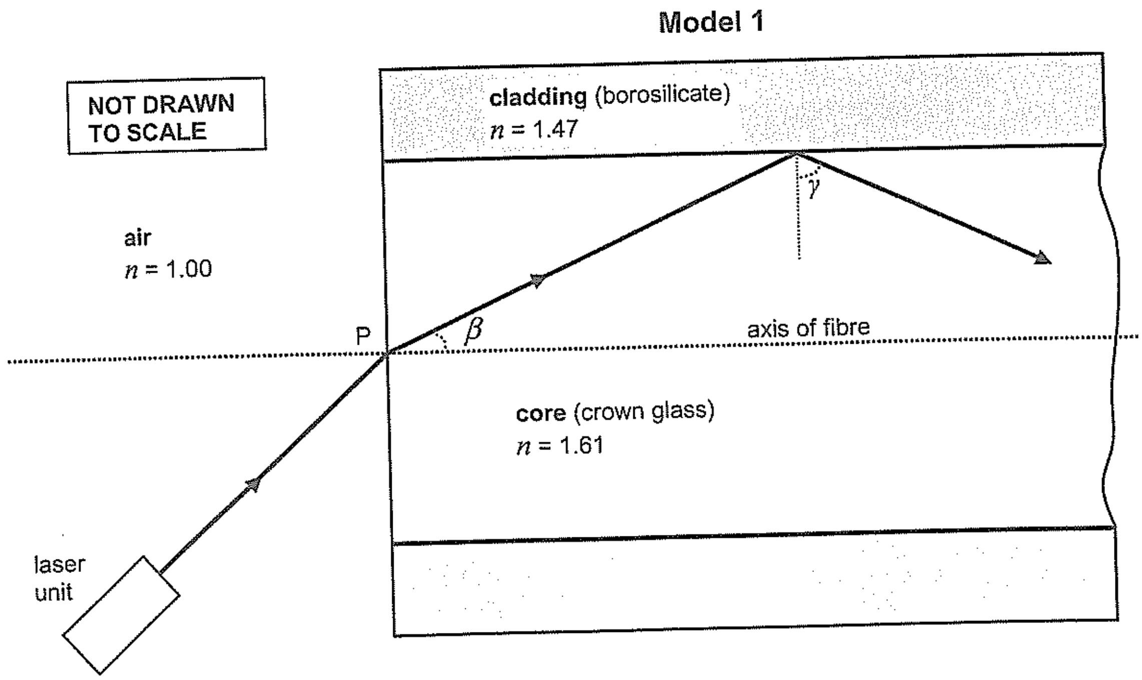

Figure 2

Question 6

Determine the size of the angle γ in Figure 2 for **Model 1**.

A. 66°
B. 43°
C. 38°
D. 24°

Janine and Ishita now set up **Model 2**, which is identical to Model 1 except that the cladding material is different.

They find that the new value of angle β (refer to Figure 2) is 30°.

Question 7

What would be the value of the acceptance angle for Model 2?

A. 36°
B. 47°
C. 54°
D. 107°

They now use the third model where **the cladding material is different again**, and this time they find the acceptance angle is 40°.

Question 8

What would be the resulting path (or paths) of a laser beam if it directed towards point P (Figure 2) with an angle of incidence of 45°?

A. All the light would be totally reflected at P.
B. Some of the light would be reflected at P and some transmitted into the core and then at the core-to-cladding interface this would be totally reflected.
C. Some of the light would be reflected at P and some transmitted into the core and then at the core-to-cladding interface this would be transmitted into the cladding.
D. Some of the light would be reflected at P and some transmitted into the core and then at the core-to-cladding interface this would be partially transmitted into the cladding and partially reflected.

Question 9

Which of the following statements best describes the fibre optic wave guide shown in Figure 2?

A. It is a single-mode, step-index wave guide
B. It is a multimode, step-index wave guide.
C. It is a single-mode, graded-index wave guide.
D. It is a multimode, graded-index wave guide.

Question 10

Which of the following statements best describes dispersion of signals along an optic wave guide?

A. Modal dispersion is reduced by using multimode fibres with the lowest refractive index at the centre and gradually increasing as we move outwards.
B. Modal dispersion is minimised by using a very thin core in a step-index fibre.
C. Material dispersion is reduced by using light from an LED rather than from a laser.
D. Material dispersion will be reduced by using a light source with a broad range of wavelengths.

Figure 3 shows a graph of the **attenuation** (or signal loss per kilometre) occurring along an optical fibre against the **wavelength** of the light used.

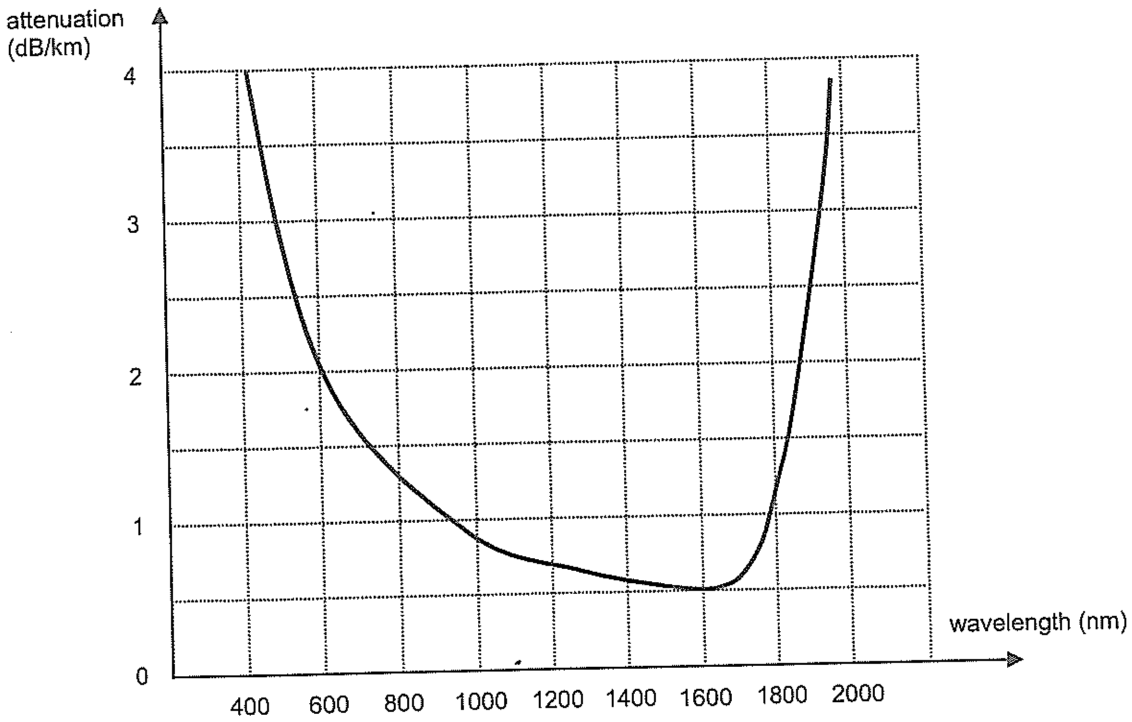

Figure 3

Two students make comments about this attenuation:

Peta: The loss in the region with wavelengths above about 1600 nm is due to energy absorbed by silicon dioxide molecules which vibrate readily at frequencies equivalent to these wavelengths.

Quentin: The loss in the region with shorter wavelengths is due to Rayleigh scattering which increases with the frequency of light.

Question 11

Which one of the following indicates whose statement/s is/are correct?

	Peta	**Quentin**
A.	Correct	Incorrect
B.	Incorrect	Correct
C.	Incorrect	Incorrect
D.	Correct	Correct

Different types of optic fibres are used for short and long distance communication.

Question 12

Which of the following statements is correct?

A. Multimode fibres can be used for short distance communication where modal dispersion is insufficient to cause overlapping of pulses.

B. Light from LEDs rather than lasers is more appropriate for long distance communication.

C. In long distance optic fibres, modal dispersion is a greater problem than material dispersion.

D. The core diameter is usually smaller in short distance fibres than in long distance fibres.

Optic fibres can be used in bundles for a variety of purposes. They can be classified as coherent or non-coherent bundles. See Figure 4.

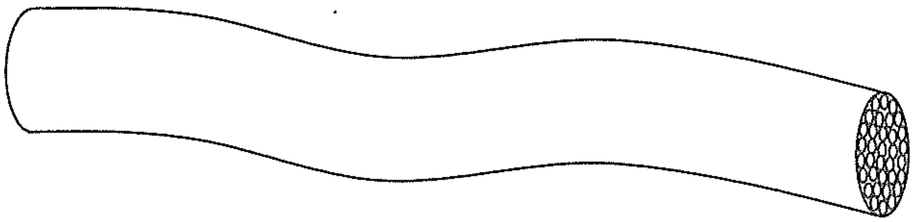

Figure 4

Question 13

Which of the following statements about fibre bundles is correct?

A. Bundles which carry light from coherent sources such as a laser are referred to as coherent bundles.

B. During a medical procedure, only coherent bundles are used to illuminate areas difficult to see, such as inside a patient's lungs.

C. To provide medical images inside a patient's stomach both ends must have the fibres in the same relative position to all other fibres in the bundle.

D. Non-coherent bundles are used to provide clear images from inside a patient's lungs.

Detailed study 3 – Sound

The following information relates to Questions 1–9.

In testing his new speaker during a physics investigation Haran connects it to a signal generator as shown in Figure 1. He sends a sinusoidal signal of constant frequency 500 Hz to the speaker.
Take the speed of sound in air as 340 m s^{-1}.

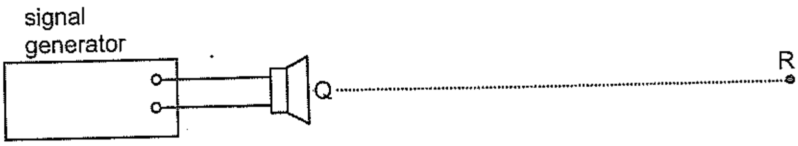

Figure 1

Figure 2 shows the variation of air pressure P with distance x along the line QR, at a particular time.

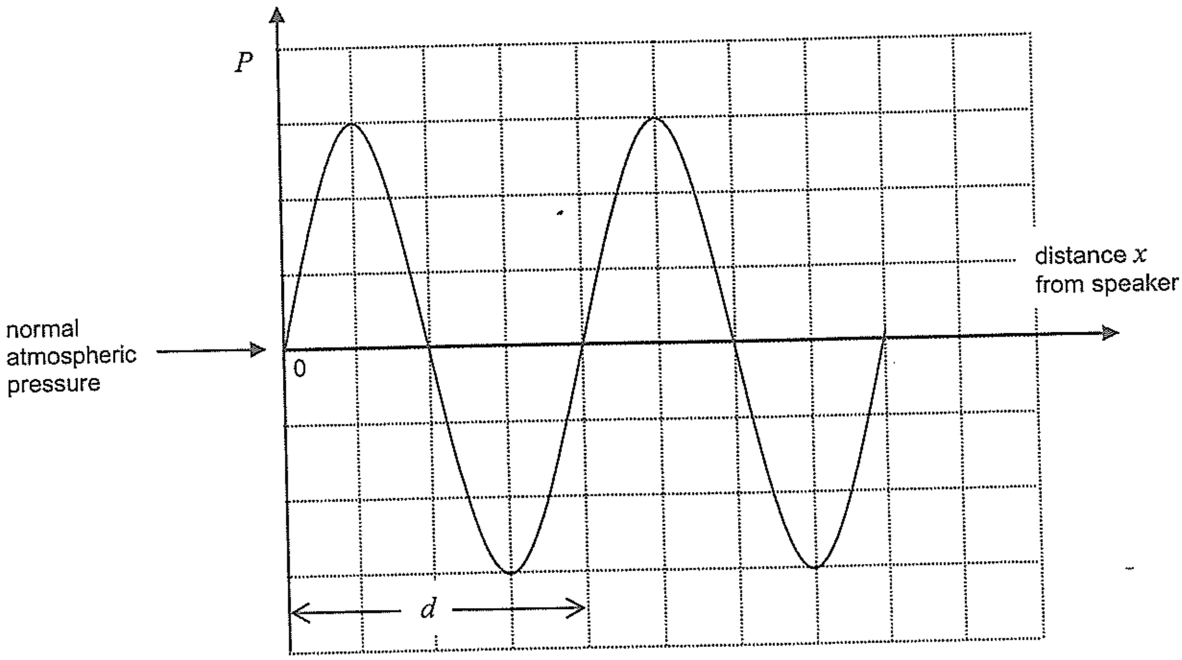

Figure 2

Question 1
Determine the distance d marked on Figure 2.

A. 0.002 m
B. 0.68 m
C. 1.47 m
D. 340 m

Question 2
In terms of d in Figure 2 what is the distance between adjacent compressions?

A. $2d$
B. $5d/4$
C. d
D. $d/2$

Question 3
Figure 2 shows the graph of P against x at a particular instant of time. What would be the appearance of the graph a very short time later?

A. Exactly as in Figure 2
B. Exactly as in Figure 2, but with smaller amplitude
C. Exactly as in Figure 2, but moved slightly to the left
D. Exactly as in Figure 2, but moved slightly to the right

Haran's friend, Callum, places a sound level meter at the point R (Figure 1) and it reads 60 dB.

Question 4
What is the sound intensity at R?

A. 1.0×10^{-18} W m^{-2}
B. 6.0×10^{-12} W m^{-2}
C. 1.0×10^{-6} W m^{-2}
D. 60 W m^{-2}

Haran now places a vertical board at R at right angles to the direction from Q to R as shown in Figure 3.

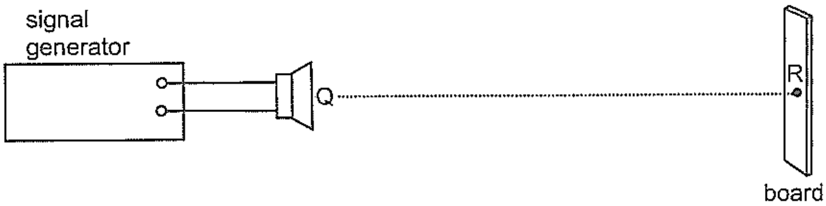

Figure 3

When Callum moves the sound level meter from Q towards the board along the line QR, he notices that the sound level goes up then down, up then down, and so on.

Question 5
What causes this variation in sound level?

A. diffraction
B. compressions and rarefactions
C. inverse square law
D. interference

Question 6
What would be the distance between adjacent points along QR where the sound intensity level readings would have been a maximum? Determine your answer in terms of d in Figure 2.

A. $d/4$
B. $d/2$
C. d
D. $2d$

Recall that Callum had found that the sound intensity level at R was 60 dB using a frequency of 500 Hz. Callum now removed the board at R and took three further sound level readings at points U and V, shown in Figure 4:

(1) At U, using the frequency of 500 Hz
(2) At V, with a frequency of 500 Hz (Distances QR and QV are equal.)
(3) At V, with a frequency of 200 Hz

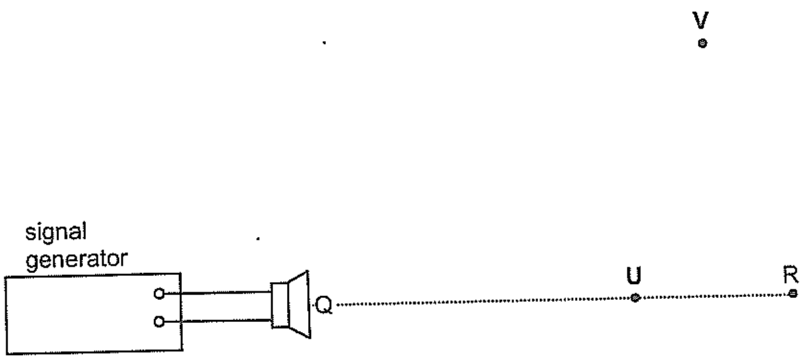

Figure 4

Question 7
Which of the following sets of readings are the most likely to have been obtained?

	Sound intensity level readings (dB)		
	(1) At U (500 Hz)	**(2) At V (500 Hz)**	**(3) At V (200 Hz)**
A.	64	50	54
B.	64	64	54
C.	60	60	54
D.	60	50	50

They then decide to investigate the frequency response of the speaker using the setup shown in Figure 5. Haran varies the frequency of the signal generator while Callum records readings on the nearby sound level meter.

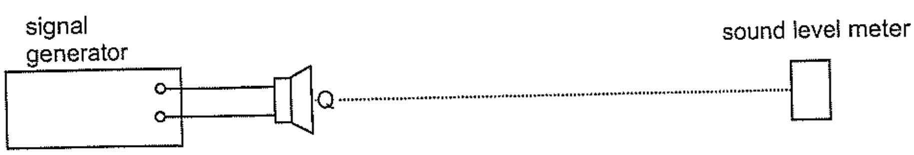

Figure 5

Figure 6 shows the frequency response curve they produce.

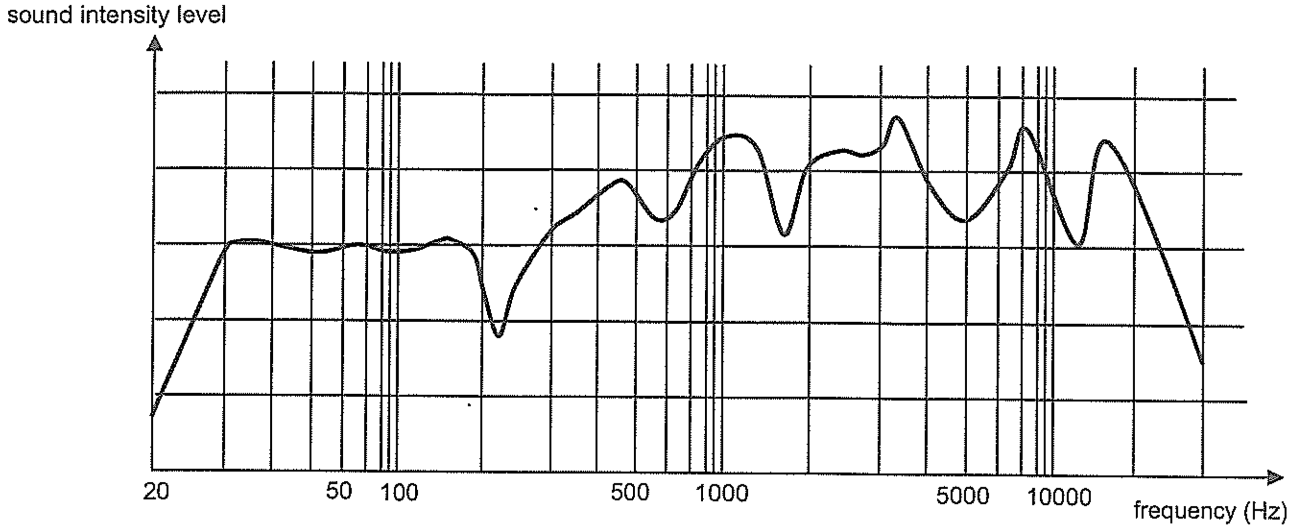

Figure 6

Question 8

Which of the following conclusions by Haran and Callum is correct?

A. The quietest sound they detect is at a frequency of about 220 Hz.

B. The loudest sound would have been heard at a frequency of about 1100 Hz.

C. This speaker would be useful as a woofer.

D. The speaker shows the best fidelity for frequencies between about 500 and 20,000 Hz.

Figure 7 shows a cross-section of part of Haran's speaker.

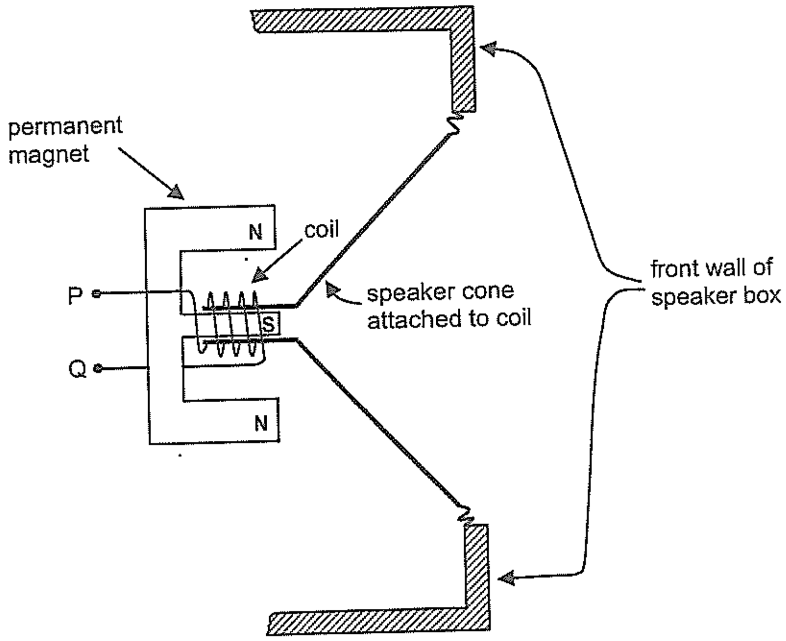

Figure 7

Their speaker is housed in a wooden speaker box.

Question 9
What is the main purpose of the front wall of the speaker box?

A. To hold the speaker in a convenient vertical position
B. To increase the amount of vibrating surface
C. To avoid constructive interference between pressure waves generated by the two sides of the cone
D. To avoid destructive interference between pressure waves generated by the two sides of the cone

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The following information relates to Questions 10–13.

Anna and Shivaun are investigating the sounds produced by a didgeridoo.
Anna generates notes corresponding to the **three lowest frequencies** that the didgeridoo can produce.
Shivaun sets up a microphone connected to a CRO to monitor the sound produced as shown in Figure 8.
In these questions model the didgeridoo as an air column closed at one end and open at the other.

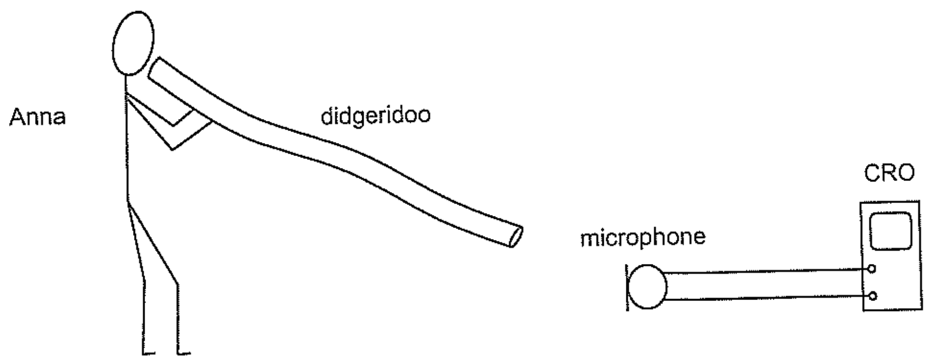
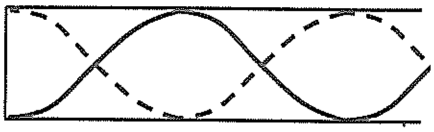


Figure 8

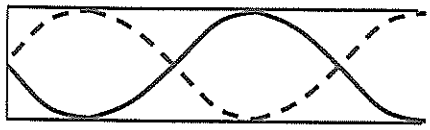
Question 10

Which of the drawings best represents the standing air pressure waves in the didgeridoo when Anna generates the highest frequency of the three notes?

A.

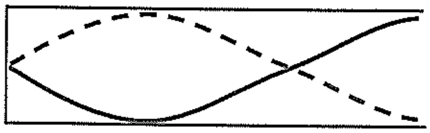


B.



C.

D.



Question 11

If the didgeridoo is 1.4 m long, which of the following is closest to the frequency of the fundamental note? Take the speed of sound in air as 350 m s^{-1}.

A. 62.5 Hz

B. 125 Hz

C. 250 Hz

D. 313 Hz

Question 12

Of the three notes Anna generates, which harmonic is the highest she produces?

A. Second

B. Third

C. Fourth

D. Fifth

The microphone Shivaun used was new. It came with an explanatory leaflet, which stated:

> "This microphone contains a coil mounted over the inside pole of a circular magnet. This coil is attached to a diaphragm which oscillates as sound waves meet it. ..."

Question 13

What type of microphone was it?

A. Electret-condenser

B. Dynamic

C. Crystal

D. Velocity

END OF QUESTION AND ANSWER BOOK