Insight Publications

INSIGHT

Trial Exam Paper

2007
PHYSICS
Written examination 2

Worked Solutions

This book presents:

- worked solutions, giving you a series of points to show you how to work through the questions
- mark allocation details.

SECTION A – Core

AREA OF STUDY 1 – Electric Power

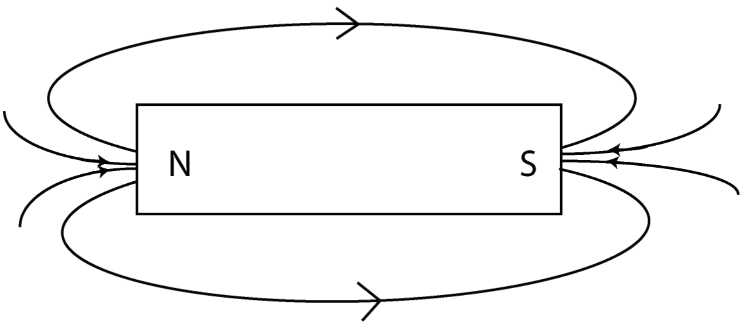
Figure 1 shows a powerful magnet.

Question 1

Draw in the magnetic field lines, with direction included.

Figure 1

Worked solution



2 marks

Mark allocation

- 1 mark for correct shape.
- 1 mark for marking direction correctly.

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.

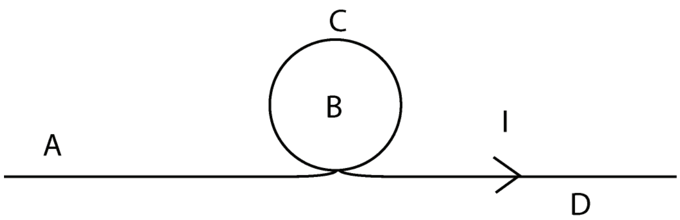


Figure 2

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	

Worked solution

	Direction
A	VI
B	VI
C	V
D	V

4 marks

Mark allocation

- 1 mark for each correct answer.

Tips

- *Use the right-hand rule at each location.*
- *Note that A and D are opposite, as are B and C, as expected because they are on opposite sides of the wire.*

Question 3

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

B

Worked solution

Answer is B.

B is the strongest as it has a cumulative effect from each part of the loop.

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

A and D

Worked solution

Correct answers are A and D.

Choices A and B: Increasing current increases magnetic field strength.

Choices C and D: Increasing radius decreases magnetic field strength. Not to be confused with *flux*.

2 marks

Mark allocation

- 1 mark for either correct answer and no wrong answers.
- 2 marks for both correct answer and no wrong answers.
- A wrong answer gets a mark deducted (i.e. reduced to 0 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

Answer

Anna is correct. (See worked solution to question 6 for an explanation.)

2 marks

Question 6

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

Worked solution

A parallel circuit will have 4 times less resistance than a series circuit.

Therefore, a parallel circuit will have 4 times more current (I) and thus 4 times the power (when considering $P = VI$).

$\therefore$ Ratio = 4 : 1 (or simply 4)

2 marks

Mark allocation

- 1 mark for stating that there is 4 times the current in parallel.
- 1 mark for correct answer.

Tip

- *Try substituting an arbitrary value for the resistance of each coil, say 1 Ω, and then calculate the power for each.*

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.

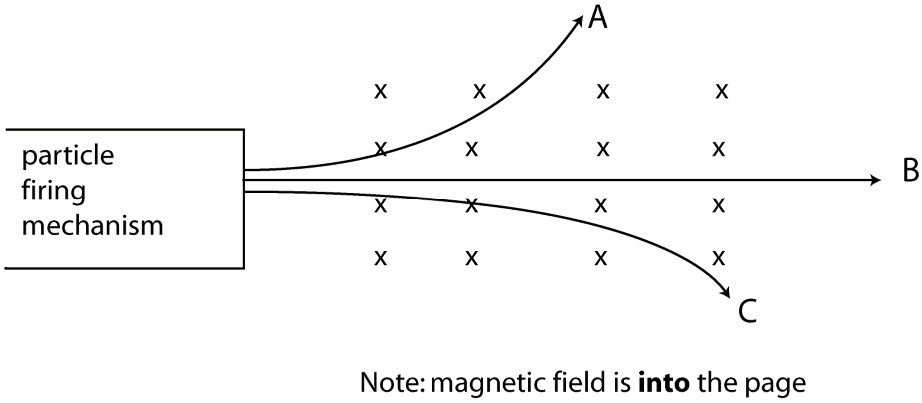


Figure 3

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

Worked solution

Charge on particle	Trajectory
neutral	B
positive	A
negative	C

Use $F = BIL$ and the right-hand rule.

B is neutral because there is no force on it, and it continues along a straight path.

A is positive because the current is going to the right of the page.

C is negative because the current is going to the left of the page.

3 marks

Mark allocation

- 1 mark for each correct answer.

Tip

- *Remember that electron flow and current flow is in opposite directions.*

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.

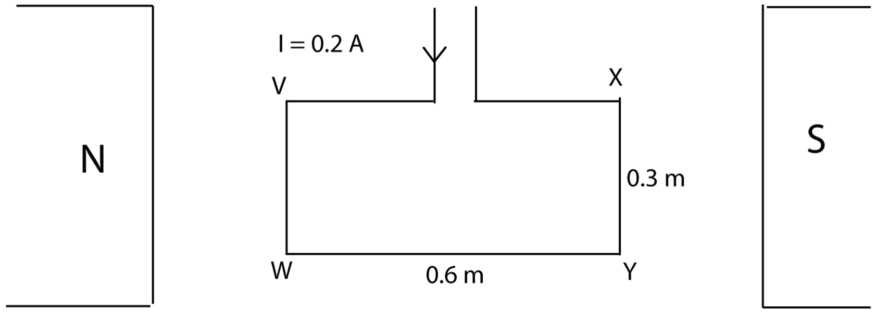


Figure 4

Question 8

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

Worked solution

Force $= BIL$

$= 4 \times 10^{-2} \times 0.2 \times 0.3$

$= 0.0024$

$= 2.4 \times 10^{-3}$ N

Using the right-hand rule:

Current going *up* the page (thumb).

Magnetic field is going to the *right* of the page (fingers).

Force is going *into* the page (palm).

∴ Direction = into the page.

4 marks

Mark allocation

- 1 mark for substituting correct values into the formula.
- 1 mark for correct answers.
- 2 marks for correct direction.

Question 9

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

Worked solution

The commutator switches (or reverses) the current in the motor every half turn.

This allows for continuous force (or torque), which continues to rotate the coil in the same direction.

Mark allocation

- 1 mark for each line.

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.

D

Worked solution

Answer is D.

Using the formula $\text{EMF} = \frac{N\Delta(AB)}{\Delta t}$, increasing the number of turns (N), the strength of the magnetic field (B) and the area of the coil (A) causes EMF (voltage) also to be increased. Increasing the time period for 1 revolution will **decrease** the EMF (voltage).

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.

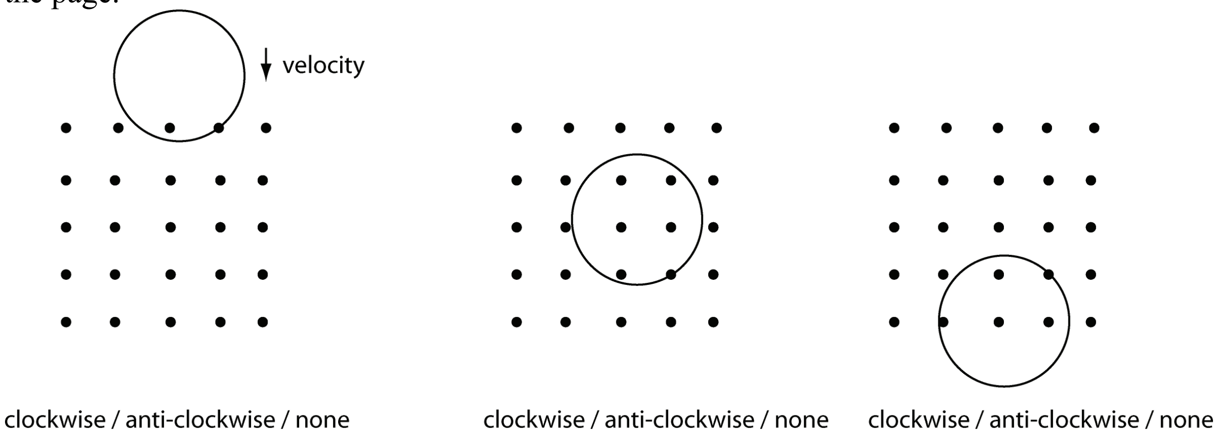


Figure 5

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

Worked solution

First scenario: clockwise

Second scenario: no current

Third scenario: anti-clockwise

In the first scenario as the coil starts to enter the magnetic field, Lenz's law states that the current induced will oppose the change in flux that produced it. This holds for the third scenario as well.

In the second scenario, there is no *change* in flux, and thus no induced current.

Mark allocation

- 1 mark for each answer.

3 marks

Question 12

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

Worked solution

$$\begin{aligned}\text{Flux} &= B \times A \\ &= 5 \times 10^{-3} \times (\pi r^2) \\ &= 5 \times 10^{-3} \times (\pi \times 0.1^2) \\ &= 0.000157 \\ &= 1.6 \times 10^{-4}\ \text{Tm}^2 \text{ or Wb}\end{aligned}$$

4 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.
- 2 marks for correct units.

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

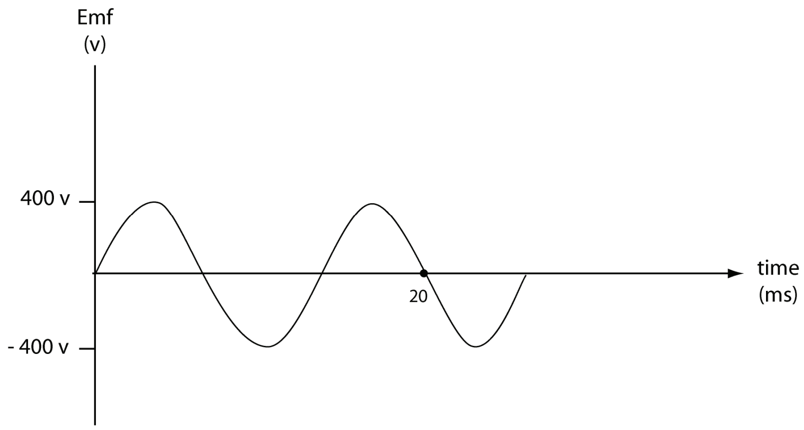


Figure 6

Question 13

Find the following:

Worked solution

$V_{peak} = 400$ V

$V_{peak\ to\ peak} = 800$ V

$V_{RMS} = 282.8$ V

Frequency = 75 Hz

$V_{peak} = 400$ V, and is the highest voltage on the graph.

$V_{peak\ to\ peak} = 800$ V is the range from –400 V to +400 V

$$V_{RMS} = V_{peak}/\sqrt{2}$$

$$= 400/\sqrt{2}$$

$$= 282.8\text{V}$$

Time period of 1.5 complete waves = 20×10^{-3}

$$T = \frac{20\times10^{-3}}{1.5}$$

= 0.0133 s

$$f = \frac{1}{T}$$

$$= \frac{1}{0.0133}$$

= 75 Hz

4 marks

Mark allocation

- 1 mark for each correct answer.

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?

Answer

An ideal transformer suffers no power loss.

Step-up means that the voltage increases.

2 marks

Mark allocation

- 1 mark for each correct answer.

Question 15

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

Answer

0 V

A transformer needs an alternating voltage to work, therefore no voltage on 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.

Worked solution

$$I_s = \frac{N_p \times I_p}{N_s}$$

$$= \frac{30 \times 1.5}{90}$$

$$= 0.5 \text{ A}$$

$\therefore$ RMS current = 0.5 A

2 marks

Mark allocation

- 1 mark for substituting correct values into correct formula.
- 1 mark for correct answer.

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.

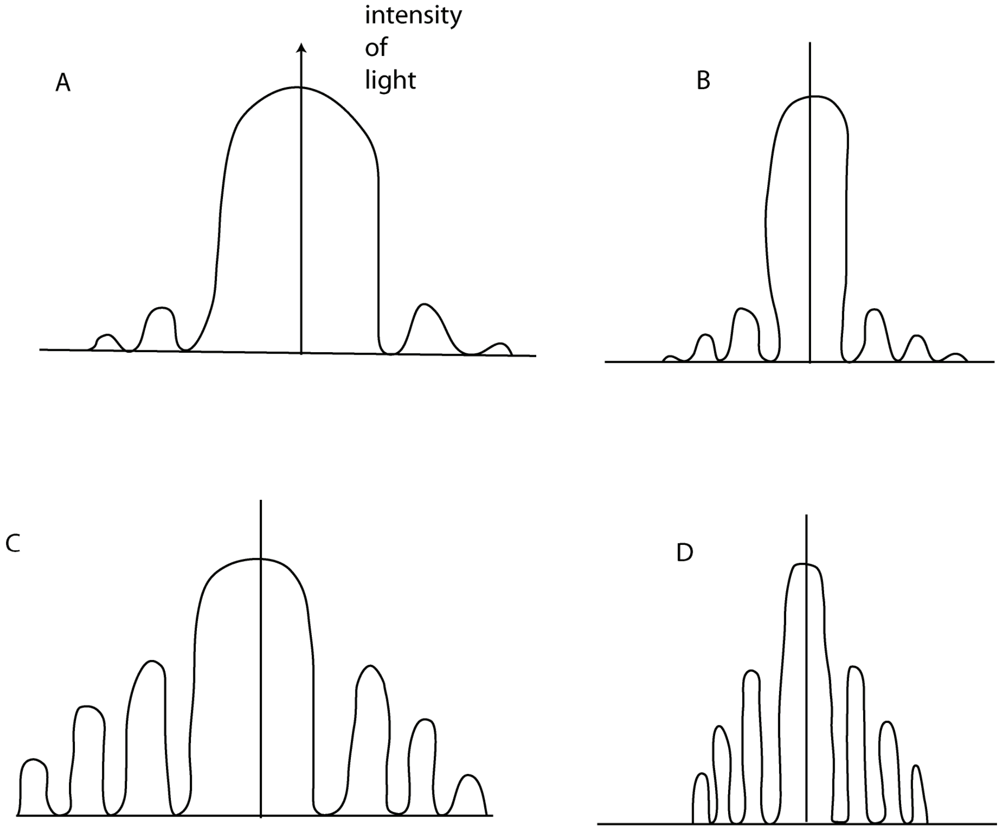


Figure 1

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	

Worked solution

Diagrams C and D are double slit because they have higher maximums off the central line. Diffraction from single slit falls away a lot quicker, as shown in diagrams A and B.

Red diffraction spreads a lot further than blue light, owing to its higher wavelength. Higher wavelengths diffract more.

Red interference from double slit has further spacing than blue (refer to formula $W = \lambda L/d$).

Experiment	Pattern
single slit, red light	A
double slit, blue light	D
single slit, blue light	B
double slit, red light	C

4 marks

Mark allocation

- 1 mark for each correct answer

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.

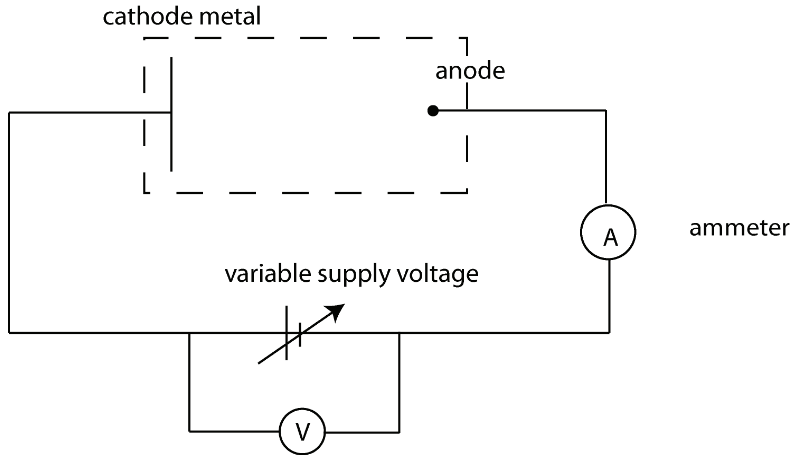


Figure 2

Question 2

Calculate the wavelength of the green light being used.

Worked solution

$$v = f\lambda$$

$$\lambda = \frac{v}{f}$$

$$= \frac{3\times10^{8}}{5.6\times10^{14}}$$

$$= 5.36 \times 10^{-6} \text{ m}$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 3

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

Worked solution

$E = hf$
$= 6.63 \times 10^{-34} \times 5.6 \times 10^{14}$
$= 3.7 \times 10^{-19}$ J

1 mark

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

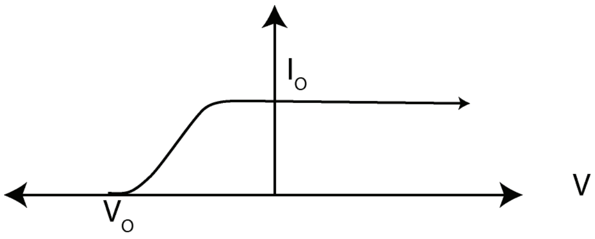
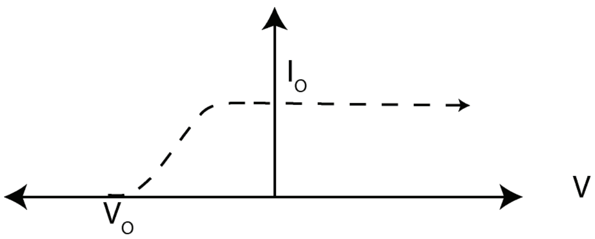


Figure 3

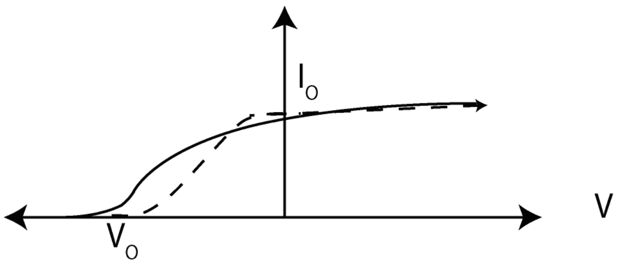
Question 4

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



Worked solution

The current would remain the same, but the stopping voltage would increase due to higher energy of the electrons emitted.



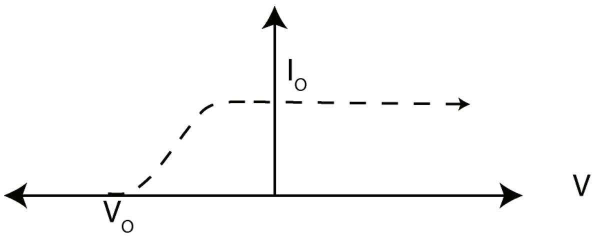
2 marks

Mark allocation

- 1 mark for calculating current correctly.
- 1 mark for calculating stopping voltage correctly.

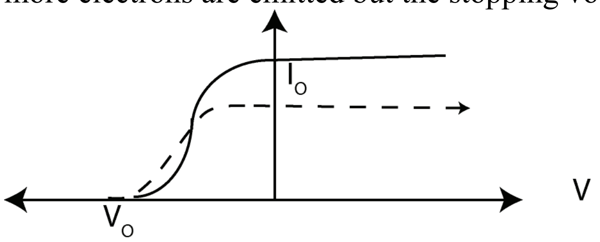
Question 5

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



Worked solution

The current would increase due to the increased number of photons striking the metal, thus more electrons are emitted but the stopping voltage remains the same.



2 marks

Mark allocation

- 1 mark for calculating current correctly.
- 1 mark for calculating stopping voltage correctly.

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

Question 6

Convert 2.3 eV to joules.

Worked solution

Energy in joules $= \text{energy in eV} \times 1.6 \times 10^{-19}$
$= 2.3 \times 1.6 \times 10^{-19}$
$= 3.68 \times 10^{-19}$ J

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.

Worked solution

$$\text{Energy of photon} = \frac{hf}{\lambda}$$
$$= \frac{hc}{f}$$
$$= \frac{6.63\times10^{-34}\times3\times10^{8}}{550\times10^{-9}}$$
$$= 3.62\times10^{-19}\ \text{J}$$
$$= \frac{3.62\times10^{-19}}{1.6\times10^{-19}}\ \text{eV}$$
$$= 2.26\ \text{eV}$$

Hence, there is not enough energy.

4 marks

Mark allocation

- 1 mark for substituting the correct numbers into the correct formula.
- 1 mark for correctly calculating energy in J.
- 1 mark for correctly calculating energy in eV.
- 1 mark for correct answer.

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.

Worked solution

150 kmh^{-1} = 41.7 ms^{-1}

$$\lambda = \frac{h}{p}$$
$$= \frac{h}{mv}$$
$$= \frac{6.63\times10^{-34}}{0.2\times41.7}$$
$$= 7.95\times10^{-35}\ \text{m}$$

3 marks

Mark allocation

- 1 mark for correctly converting 150 kmh^{-1} to 41.7 ms^{-1}.
- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 9

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

Worked solution

For diffraction, we need a slit size that approximates wavelength size. 1 mark

A slit that size will be too small to allow balls (or anything) through.

OR

Can't detect anything the size of 7.95×10^{-35} m. 1 mark

2 marks

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

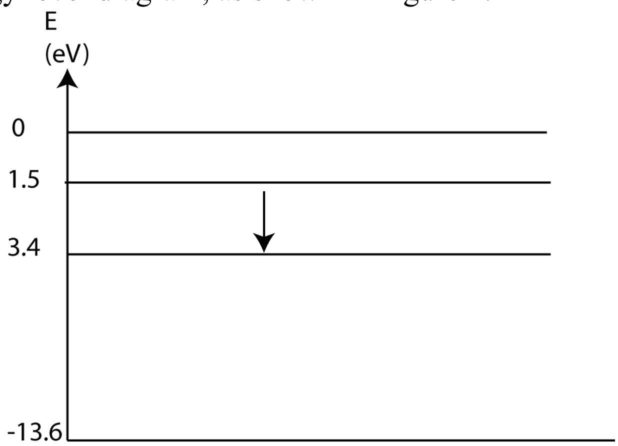


Figure 4

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.

Worked solution

Energy emitted, $E = 3.4 - 1.5$
$= 1.9$ eV
$= 1.6 \times 10^{-19} \times 1.9$
$= 3.4 \times 10^{-19}$

$$\lambda = \frac{hc}{E}$$

$$= \frac{6.63 \times 10^{-34} \times 3 \times 10^{8}}{3.04 \times 10^{-19}}$$

$= 6.54 \times 10^{-7}$ m
$= 654$ nm

4 marks

Mark allocation

- 1 mark for calculating energy emitted in eV.
- 1 mark for calculating energy emitted in J.
- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

END OF SECTION A

SECTION B – Detailed studies

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]**.

Worked solution

booster rings; storage rings; beamlines

3 marks

Mark allocation

- 1 mark for each correct answer.

Question 2

Describe the **purpose** of the monochromator.

Worked solution

The monochromator selects the single frequencies/wavelengths (1 mark) of the radiation needed to travel to the experimental stations (1 mark).

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.

Worked solution

$$B = \frac{p}{qr}$$

$$= \frac{1.1\times10^{-18}}{1.6\times10^{-19}\times7.5}$$

$$= 0.9167 \text{ T}$$

$$= 092 \text{ T}$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

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.)

Worked solution

$$\lambda = \frac{hc}{E}$$
$$= \frac{4.14\times10^{-15}\times3\times10^{8}}{12\times10^{3}}$$
$$= 1.035 \times 10^{-10}\ \text{m}$$
$$= 1.04\ \text{nm}$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

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}.

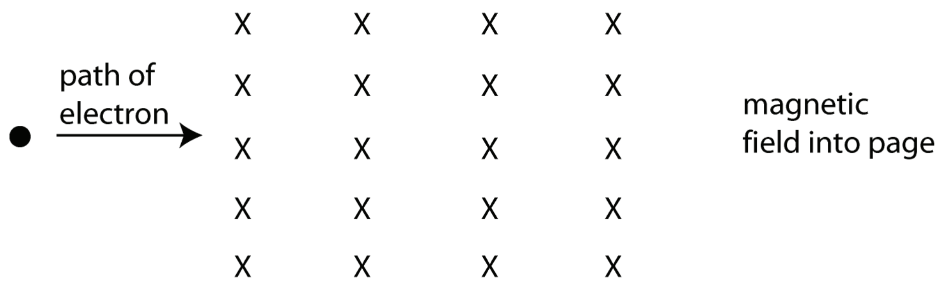


Figure 1

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

Worked solution

Answer is B.

Using the right hand (slap) rule, current (thumb) left, magnetic field into the page (fingers), leaving force (palm) up.

2 marks

Question 6

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

Worked solution

$$F = ma$$

$$a = \frac{F}{m}$$

$$= \frac{qvB}{m}$$

$$= \frac{1.6\times10^{-19}\times2\times10^{8}\times3\times10^{-3}}{1.9\times10^{-34}}$$

$$= 5.05\times10^{20}\,ms^{-1}$$

5.05×10^{20} ms^{-2} (or $CTms^{-1}kg^{-1}$)

3 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.
- 1 mark for correct units.

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?

Worked solution

$$2\,d \sin\theta = n\lambda$$

$$2 \times d \times \sin 38° = 2 \times 2 \times 10^{-9}$$

$$d = 3.25 \times 10^{-9}\text{ m}$$

3 marks

Mark allocation

- 1 mark for using $n = 2$ correctly.
- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 8

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

Worked solution

$$2\,d \sin\theta = n\lambda$$
$$2 \times 3.25 \times 10^{-9}\text{ m} \times \sin\theta = 3 \times 2 \times 10^{-9}$$
$$\theta = 67.38°$$
$$\theta = 67.4°$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

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

C

Worked solution

Answer is C. It is the *acceleration* of the electrons that cause radiation.

Options A and B are wrong because it doesn't matter how fast the electrons are travelling.

D is wrong because the electrons are in a vacuum.

2 marks

Question 10

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

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

A

Worked solution

Answer is A.

Thompson scattering is an **elastic** collision, so no energy is lost.

2 marks

Question 11

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

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

B and C

Worked solution

Synchrotron light is useful investigating objects ranging in size from 10^{-5} to 10^{-3} m, which includes atoms and cells.

Hence, correct answers are B and C.

2 marks

Mark allocation

- 1 mark for either correct answer, and no wrong answers.
- 2 marks for both correct answers and no wrong answers.
- A wrong answer gets a mark deducted (i.e. reduced to 0 marks).

END OF DETAILED STUDY 1

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

Answer

modal-dispersion; decreasedl; increasing

Mark allocation

- 1 mark for each correct answer.

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?

Worked solution

$$v = f\lambda$$

$$f = \frac{v}{\lambda}$$

$$= \frac{3 \times 10^8}{550 \times 10^{-9}}$$

$$= 5.45 \times 10^{14} \text{ Hz}$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 3

Calculate the band gap for this LED, in eV.

Worked solution

$$E = hf$$

$$= 4.14 \times 10^{-15} \times 5.45 \times 10^{14}$$

$$= 2.25 \text{ eV}$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 4

What is attenuation?

Answer

Attenuation is the loss of power/signal strength (1 mark) along a communicating channel/fibre (1 mark).

Total 1 + 1 = 2 marks

Question 5

What is its unit?

Answer

dB km^{-1}

1 mark

The following information applies to Questions 6–8.

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

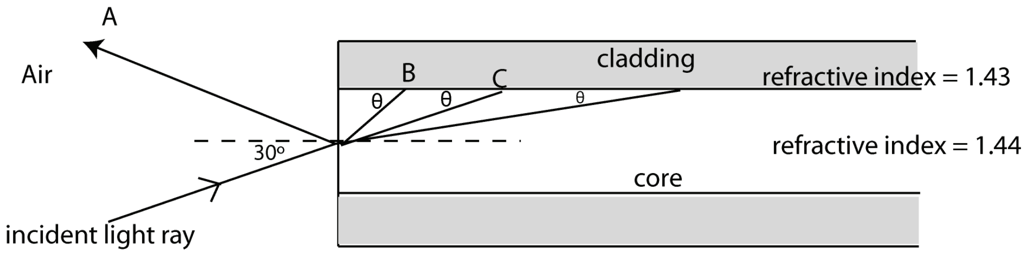


Figure 1

Question 6

Which path will the ray of light follow?

Worked solution

Answer is D.

The ray of light will bend *towards* the normal.

2 marks

Question 7

Calculate the angle, θ.

Worked solution

$n_1 \times \sin \theta_1 = n_2 \times \sin \theta$

$1 \times \sin \theta_1 = 1.44 \times \sin 30°$

$$\sin \theta = \frac{\sin 30°}{1.44}$$

$\theta = 20.3°$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

Question 8

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

Worked solution

$$\text{Critical angle} = \sin^{-1}\theta\frac{n_2}{n_1}$$

$$= \sin^{-1}\frac{1.43}{1.44}$$

$$\theta = 83.2°$$

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.
-

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.)

Worked solution

lower

If λ increases, then the refractive index of the material increases, and hence the angle θ decreases.

2 marks

Question 10

Complete the table.

Worked solution

Type	**Caused by**	**Effect on signal**	**List one way to rectify**
Modal dispersion	**Different modes (paths) from start to finish means different distances travelled.**	**Dispersed over time/distance**	**Smaller core diameter OR graded index fibres OR single mode fibres**
Material Dispersion	Different wavelengths travel at different velocities	**Dispersed over time/distance**	**Use only one λ, such as supplied by a laser**

6 marks

Mark allocation

- 1 mark for each correct answer.

SECTION B – DETAILED STUDY 2 – continued

Question 11

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

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

D

Worked solution

Answer is D; blue.

Red refracts the least.

B and C are incorrect because these colours are not at the end of the spectrum.

1 mark

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.

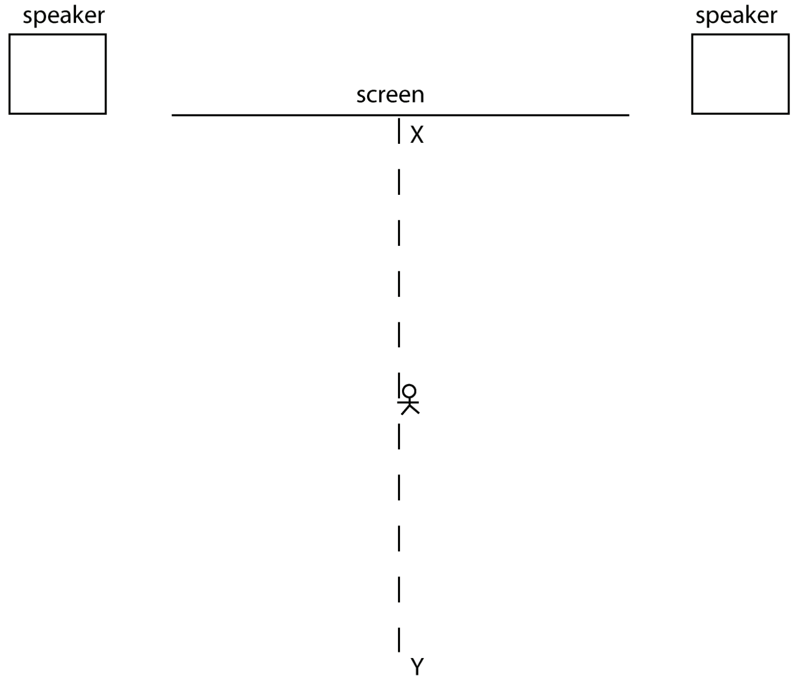


Figure 1

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]**.

Worked solution

louder; constructive interference; all frequencies

Anywhere along line X–Y is the same distance from both speakers, causing constructive interference and making the sound louder. This is independent of the frequency.

3 marks

Mark allocation

- 1 mark for each correct answer.

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

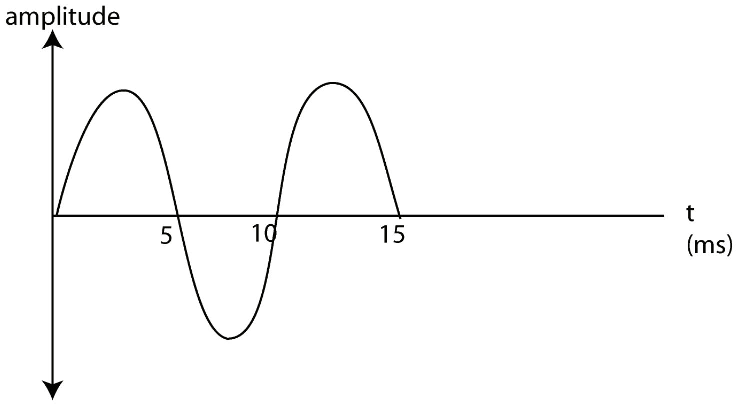


Figure 2

Question 2

What is the frequency of the wave?

Worked solution

$T = 10 \times 10^{-3}$

$f = \dfrac{1}{10 \times 10^{-3}}$

$= 100$ Hz

2 marks

Mark allocation

- 1 mark for putting correct numbers into correct formula
- 1 mark for correct answer

Question 3

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

Worked solution

$v = f\lambda$

$\lambda = \dfrac{v}{f}$

$= \dfrac{340}{100}$

$= 3.4$ m

2 marks

Mark allocation

- 1 mark for substituting correct values into the correct formula.
- 1 mark for correct answer.

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.

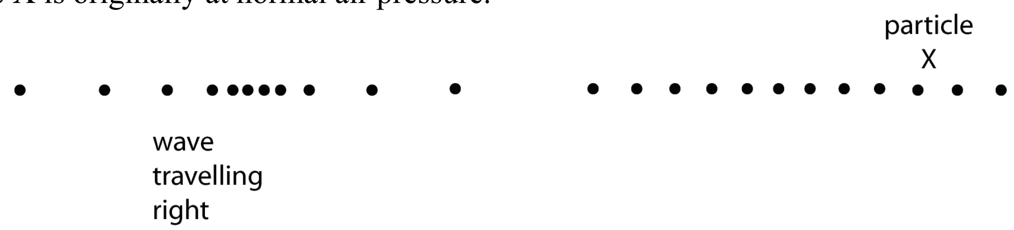


Figure 3

Question 4

In which direction will particle X first move?

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

A

Worked solution

Answer is A; the particle will move left.

B is wrong, although the sound wave is moving right, particles will move both left and right.

C and D are wrong, as the particles move on the same plane as the wave.

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

A

Answer

The answer is A.

All air particles move back to their 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?

Worked solution

$$= 10\log\left(\frac{I}{I_0}\right)$$

$$= 10\log\left(\frac{0.5}{1}\right)$$

$= -3$ dB

$\therefore$ A reduction of 3 dB.

2 marks

Mark allocation
All students should know that a 50% reduction in power output is a reduction of 3 dB.

Question 7

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

Worked solution

Yes. 1 mark

A 3 dB reduction is only *just* noticeable to the human ear. Edna would probably think that he didn't turn it down at all. (It is no wonder that Edna is upset.) 1 mark

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).

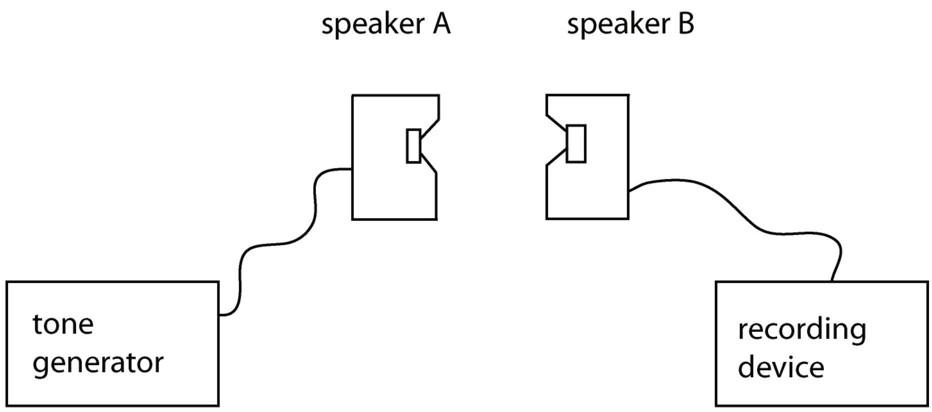


Figure 4

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?

Answer

dynamic microphone

2 marks

Question 9

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

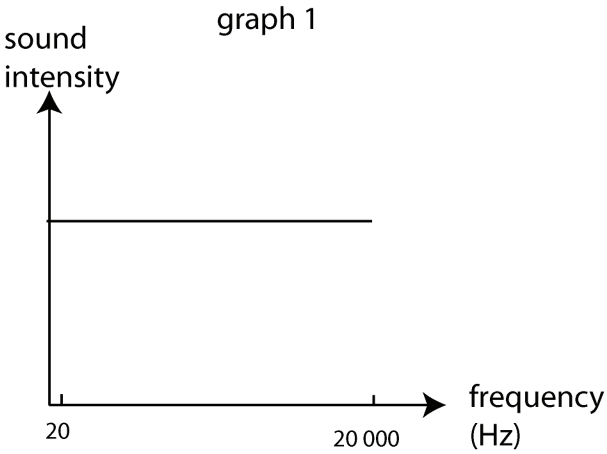
Answer

Name of the box: The box is called a baffle.2 marks

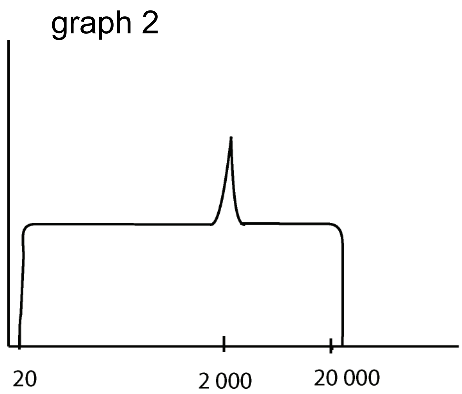
Purpose: Its purpose is to stop out-of-phase waves from the back of the speaker interfering with the waves coming from the front of the speaker. 2 marks

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?

Worked solution

This will be the 'natural resonance' of the speaker box (baffle).

As the speaker produces 2000 Hz, *the box will vibrate* at 2000 Hz, hence *adding* to the volume of the speaker.

Mark allocation

- 1 mark for each correct answer.

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

D

Worked solution

Answer is D.

For a closed air column, the frequency of the harmonics produced is *n* times an odd number of the fundamental frequency.

$f = nf_0$ where n is an odd integer (i.e. whole number).

2 marks

END OF WORKED SOLUTIONS