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Student name

PHYSICS
Unit 4
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

	Number of Areas of study	Number of Areas of study to be answered	Number of marks
Section A – Areas of study	2	2	64
	Number of Detailed studies	**Number of Detailed studies to be answered**	**Number of marks**
Section B – Detailed studies	3	1	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, mobile phones and/or any other unauthorised electronic devices.

Materials supplied
- Question and answer book of 31 pages, with a detachable data sheet in the centrefold.
- Detachable answer sheet for mutiple choice questions.

Instructions
- Detach the data sheet from the centre of this book, and the answer sheet for multiple choice questions, during reading time.
- Write your **name** on the top of this page and on the 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 multiple choice answer sheet inside the front cover of this book.

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2008

PHYSICS

Unit 4 Trial Examination

MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries. For each question, **SHADE** the box which indicates your answer.
- 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		ONE ANSWER PER LINE
1	A B C D	8	A B C D
2	A B C D	9	A B C D
3	A B C D	10	A B C D
4	A B C D	11	A B C D
5	A B C D	12	A B C D
6	A B C D	13	A B C D
7	A B C D		

SECTION A

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.

Area of Study 1 – Electric power

Questions 1 to 3 relate to the following information.

In Victoria electricity is supplied at a nominal 240 V RMS at 50 Hz. In fact it can vary quite widely due to power losses in transmission lines. One household at the end of the distribution line actually receives 220 V RMS.

Question 1.

Convert 220 V RMS to a peak-to-peak voltage.
You must show your working.

V

[2 marks]

Question 2.

If the household is receiving only 220 V RMS what is the frequency of this reduced supply? Explain your answer.

____

____

Hz

[2 marks]

Question 3.

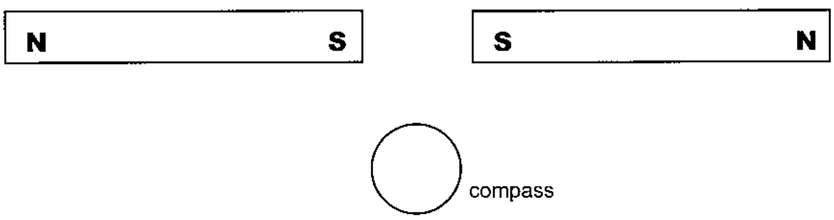
At 7:00 pm on one particular evening the household is being supplied at 220 V RMS and is consuming 6600 W. What is the RMS current being supplied to the household at this time? You must show your working.

A

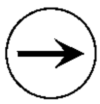
[2 marks]

Question 4.

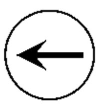
Two bar magnets are placed end to end near a small magnetic compass as shown in the diagram below.



The compass needle indicates the magnetic field direction. Which of the following best represents the expected direction of the compass needle when in the position in the diagram?

A 

B 

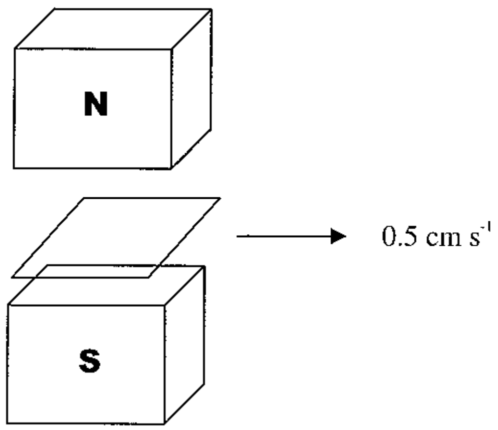
C 

D 

[2 marks]

Questions 5 to 8 relate to the following information.

A square loop of wire, 2.0 cm × 2.0 cm, is placed inside a uniform magnetic field of strength 0.05 T as shown in the diagram below. After 1.0 second the loop is withdrawn from the magnetic field at a steady speed of 0.5 cm s^{-1} into an area of negligible field.



Question 5.

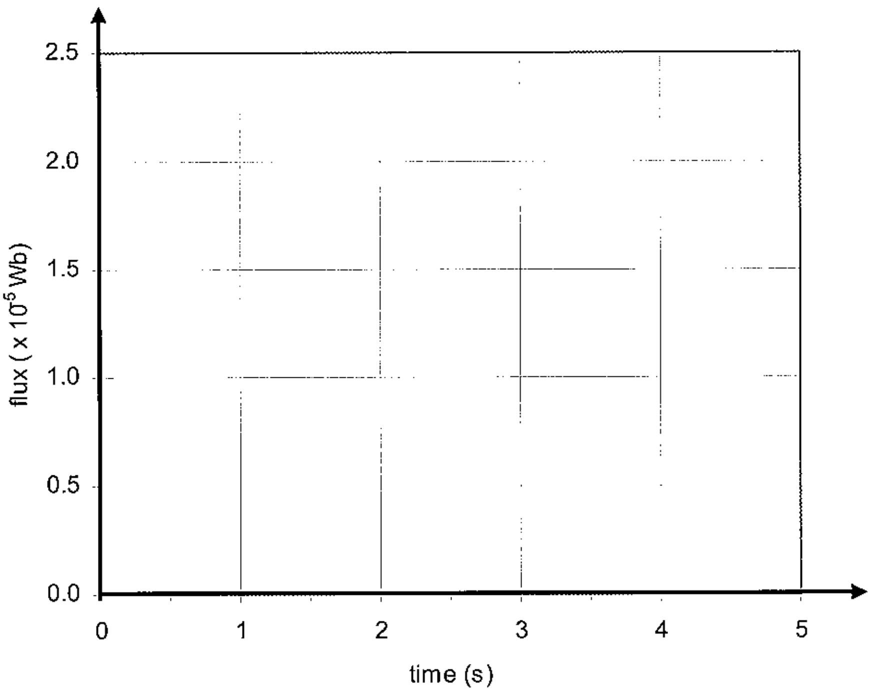
What was the magnitude of the flux inside the loop in the initial position when it was stationary inside the magnetic field? You must show your working.

Wb

[2 marks]

Question 6.

On the following axes draw the change in flux through the loop as it is being withdrawn from the magnetic field.



[2 marks]

Question 7.

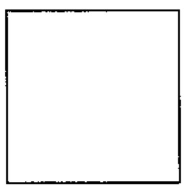
What is the average voltage induced in the loop as it is being withdrawn from the magnetic field? You must show your working.

V

[2 marks]

Question 8.

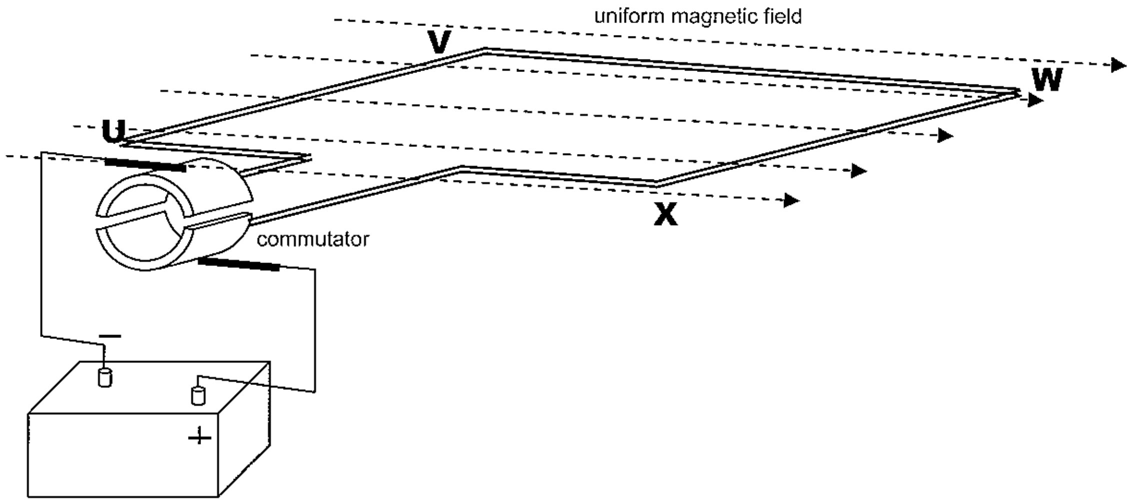
On the diagram below indicate the direction of the induced current in the loop as viewed from above, as the loop is being withdrawn from the magnetic field.



[2 marks]

Questions 9 to 11 relate to the following information

A small DC motor is dismantled to observe how it operates. A simplified diagram of the motor is shown below. In this model the single square loop is attached to a commutator and allowed to rotate freely in a uniform magnetic field of 0.50 T. The loop is a square of side length 3.0 cm.



Question 9.

What is the magnitude of the force on side **VW** when the loop is oriented as shown in the diagram?

N

[2 marks]

Question 10.

When viewed from the commutator what is the direction of rotation of the loop?

Clockwise **Anti-clockwise** ***(circle your choice)***

Explain your choice:

____

____

____

____

____

[3 marks]

Question 11.

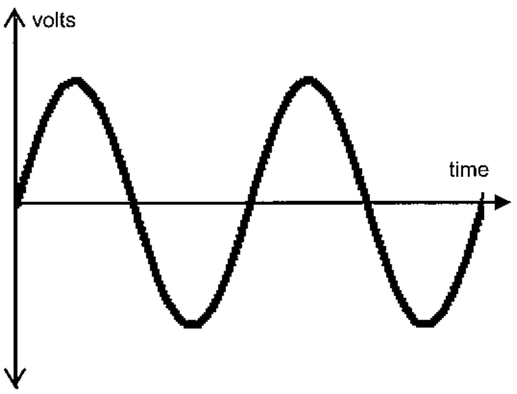
The single loop is replaced by an armature of multiple loops but of the same dimensions. A current of 1.5 ampere is then run through the coils and a force of 2.25 N is experienced by side **XW**.

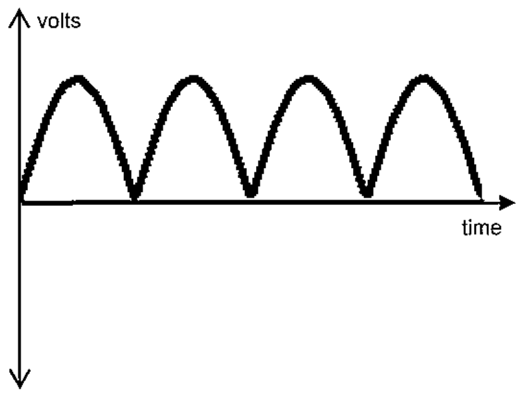
How many loops are there in this new armature? You must show your working.

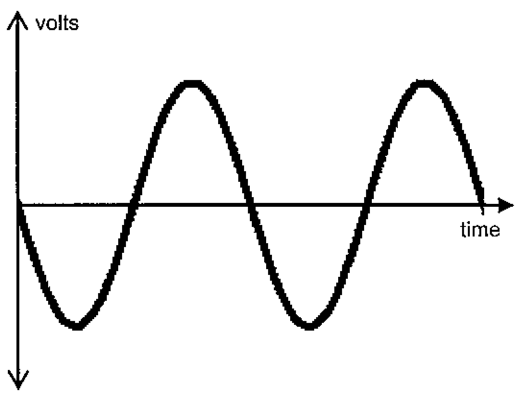
[2 marks]

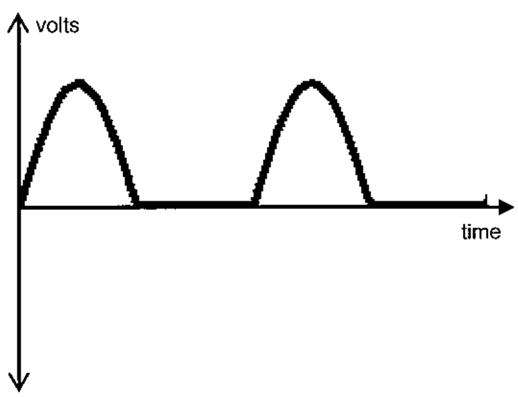
Question 12.

Which of the following output voltages best represents the possible output voltage of a generator using slip rings? (one or more answers)

A


B


C


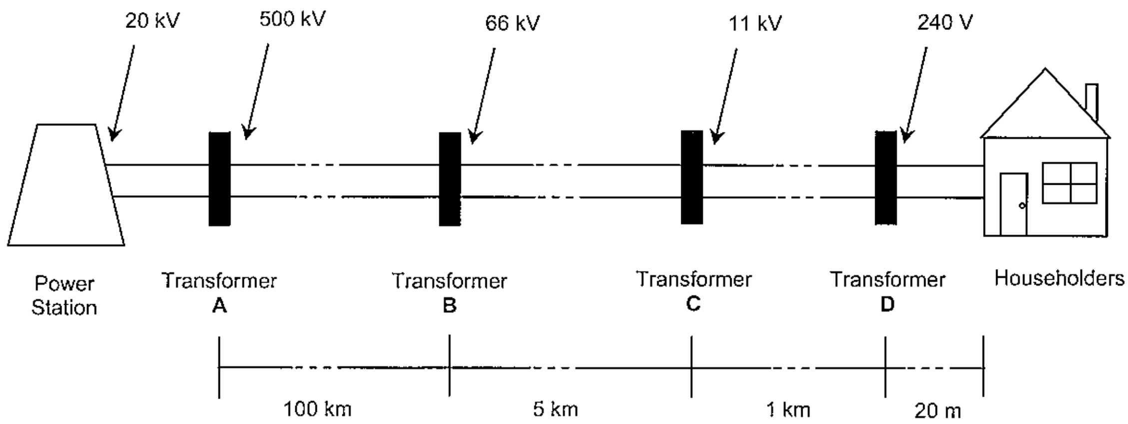
D


[2 marks]

Questions 13 to 18 relate to the following information

A power station delivers electricity to urban consumers using transformers at a number of different voltages. The generator produces electrical energy at an AC voltage of 20 kV RMS at 50 Hz. This voltage is immediately stepped up to 500 kV RMS before transmission to the urban distribution centre.

The figure below shows the output RMS voltages of the various transformers before the final delivery of 240 V RMS at 50 Hz to each individual urban user. The diagram also shows the lengths of the transmission lines between each transformer.



Question 13.

For Transformer **A**, which converts the generator supplied 20 kV RMS to 500 kV RMS, what is the value of:

$$\frac{\textbf{number of turns on seconday coil}}{\textbf{number of turns on primary coil}}$$

[2 marks]

Question 14.

Transformer **A** is delivering energy at a rate of 200 MW.

What is the RMS current flowing in the secondary coil of this transformer? You must show your working.

A

[2 marks]

Question 15.

By the time the 500 kV RMS voltage reaches Transformer **B** it has dropped to 495 kV RMS. What is the RMS current flowing in the primary coil of Transformer **B**?

A

[2 marks]

Question 16.

What is the power lost in the transmission lines between Transformer **A** and Transformer **B**? You must show your working.

W

[3 marks]

Question 17.

Give two modifications that could be made to the transmission system that could reduce this power loss.

One:

____

____

Two:

____

____

[2 marks]

Question 18.

What is the total resistance of the 100 km section of transmission lines between Transformer **A** and Transformer **B**? You must show your working.

Ω

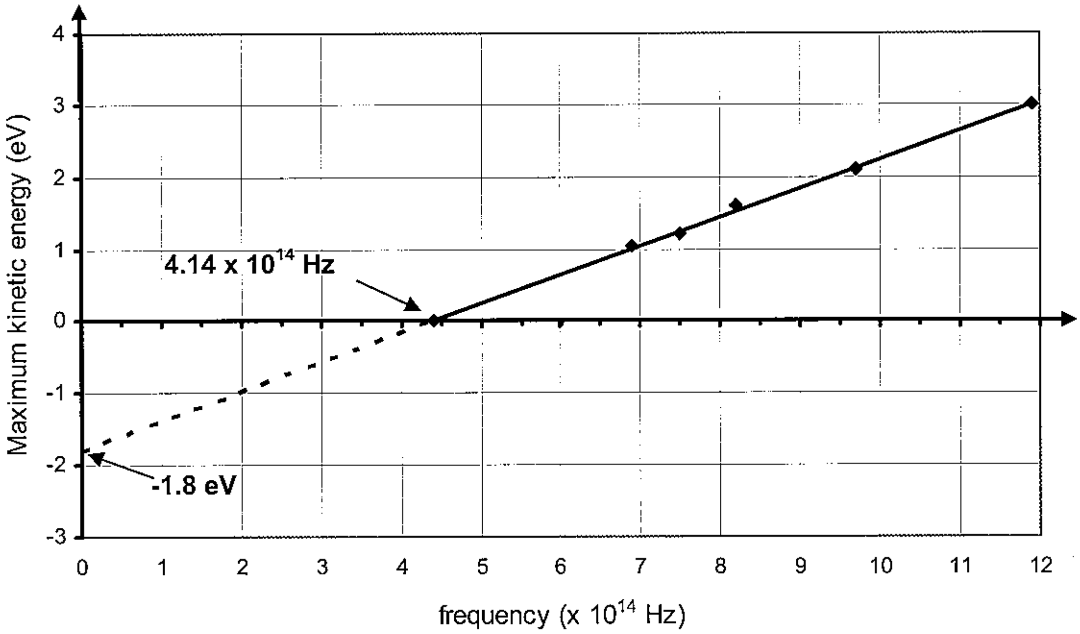
[2 marks]

End of Area of Study 1

Area of Study 2 – Interactions of light and matter

Questions 1 to 5 relate to the following information.

An early experiment to investigate the photoelectric effect was made with a beam of light of single frequency directed at a clean potassium surface. The maximum kinetic energy of the photo emitted electrons was measured. The experiment was repeated with a variety of light frequencies and the results are plotted below.



Question 1.

What is the wavelength of a photon of frequency 4.14×10^{14} Hz? You must show your working.

m

[2 marks]

Question 2.

What is the minimum energy of a photon that can eject an electron from potassium material? Give your answer in joules. You must show your working.

J

[2 marks]

Question 3.

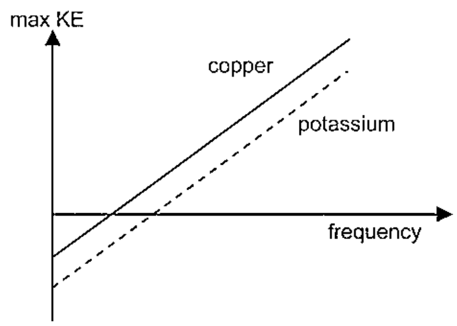
Explain why light of higher frequency ejects electrons with higher kinetic energy.

[2 marks]

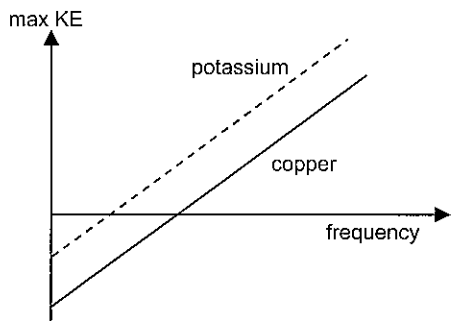
Question 4.

The minimum photon energy required to eject an electron from Copper is approximately twice that for Potassium. Which of the following graphs would best describe the results of the experiment with the Potassium replaced by Copper?

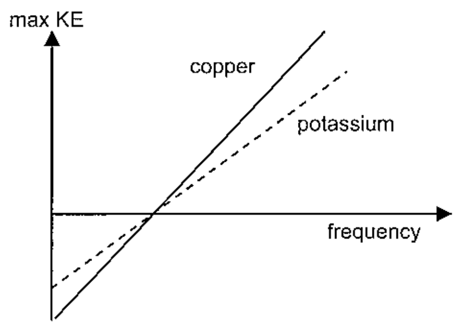
A



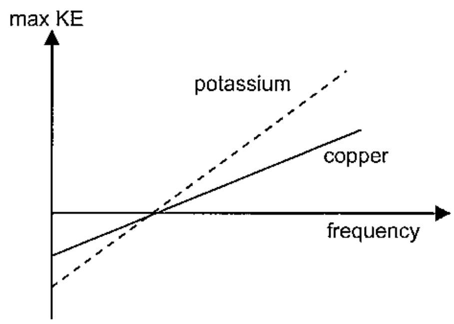
B



C



D



[2 marks]

Question 5.

The intensity of the source providing the photons of different frequencies in the experiment is reduced by 90%. The number of photoelectrons emitted from the surface of the metal will:

A be unchanged

B be reduced by 90%

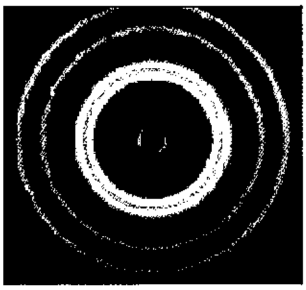
C be reduced by 10%

D not be able to be determined from the given data

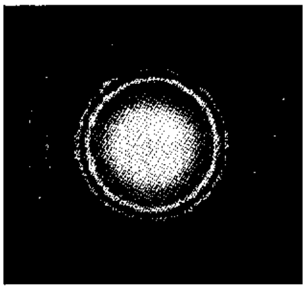
[2 marks]

Questions 6 to 11 relate to the following information.

An early experiment on the properties of X-rays involved the firing of monochromatic X-rays at a thin foil of Aluminium and observing the pattern created on a photographic film placed behind the aluminium foil. The pattern observed was a series of concentric light and dark rings.
In 1928 George Thomson repeated the experiment using electrons to create a very similar pattern.



X-rays



Electrons

The X-ray photons had an energy of 2.28×10^{-16} J and a momentum of 7.94×10^{-25} kg ms^{-1}.

Question 6.

What was the wavelength of the X-rays used in this experiment? You must show your working.

m

[2 marks]

Question 7.

What was the wavelength of the electrons used in this experiment?

m

[1 mark]

Question 8.

What is meant by the term monochromatic as used in this situation?

____

____

[1 mark]

Question 9.

The electron and X-ray diffraction patterns as shown in the previous diagram, have the same spacing between the rings. Did the X-rays have the same energy or momentum as the electrons?

Energy **Momentum** ***(circle your choice)***

Explain your choice.

____

____

____

____

____

[3 marks]

Question 10.

Does this experiment support the wave nature of matter? Explain your choice.

YES **NO** ***(circle your answer)***

____

____

____

[3 marks]

Question 11.

Which one of the following statements best explains why electrons and X-rays can produce similar patterns when fired through aluminium foil?

A Both X-rays and electrons exhibit particle-like properties when they pass through the foil.

B Both X-rays and electrons exhibit wave-like properties when they pass through the foil.

C X-rays are very fast electrons.

D The beams of X-rays and electrons both produce equal shadows because the crystal structure of the aluminium is very ordered.

[2 marks]

PHYSICS
Unit 4 Trial Examination

DATA SHEET

Directions to students

Detach this data sheet before commencing examination. This data sheet is provided for your reference.

1	photoelectric effect	$E_{k\,\max} \quad hf \quad W$
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	$F = I\,l\,B$
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	$V_{drop} = I_{line} R_{line}$ $P_{loss} = I^2_{line} R_{line}$
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	$r = p/eB$
19	force applied to an electron beam	$F = evB$
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	sound intensity and levels	sound intensity level (in dB) $= 10\log_{10}\left(\frac{I}{I_0}\right)$ where $I_0 = 1 \times 10^{-12}$ 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 DATA SHEET

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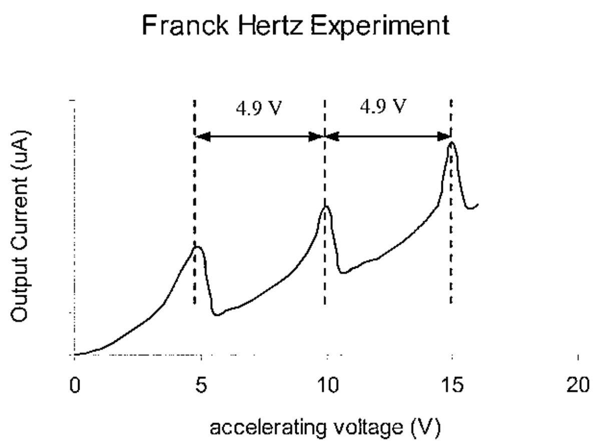
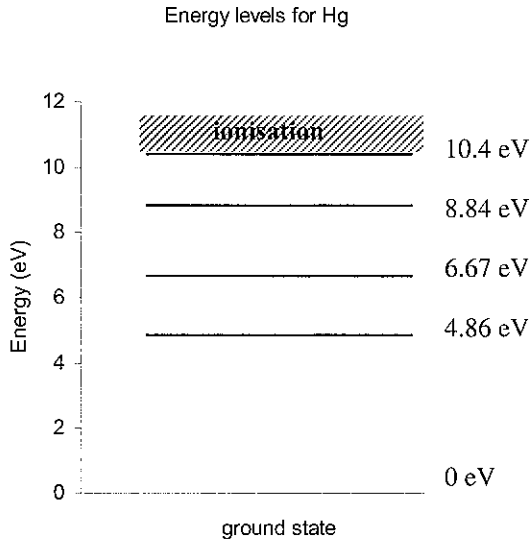
Question 12.

In 1914 two German physicists, James Franck and Gustav Hertz performed a very important experiment to support Bohr's ideas of quantum absorption and emission.

They fired electrons through a low-pressure mercury (Hg) vapour and measured variations in the electron current as the initial energy of the incident electrons was varied by the accelerating voltage.

The following graphical results were obtained.
The energy levels for Hg are also given.





This experiment verified that atoms contain discrete energy levels and cannot absorb random amounts of energy.

Explain why the mercury atoms cannot absorb random amounts of energy such as 6.0 eV.

____

____

____

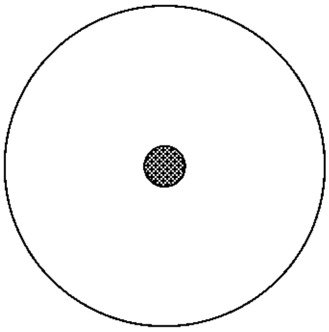
____

____

[2 marks]

Question 13.

Bohr's model of the atom used the idea of 'fitting' electrons into certain radius orbits around the nucleus according to their de Broglie wavelength.
For the n = 3 principal quantum number show how the de Broglie wavelengths can be represented on the following diagram.



[2 marks]

End of Area of Study 2

SECTION B – Detailed studies

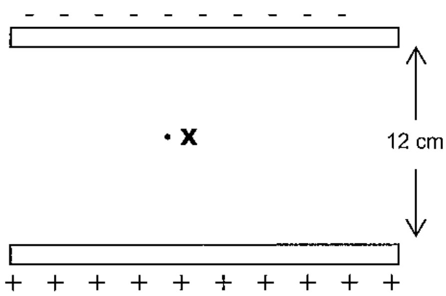
Instructions for Section B

Select **one** Detailed study.
Answer **all** questions from the Detailed study, in pencil, on the multiple choice answer sheet.
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** for the question.
A correct answer scores 2 marks, 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.

Detailed Study 1 – Synchrotron and its applications

Questions 1 to 4 relate to the following information.

A pair of parallel plates has a voltage of 720 V applied across them. The plates are separated by an air gap of 12 cm.



Question 1.

The direction of the electric field between the charged plates is:

A Vertically up the page
B Vertically down the page
C To the left of the page
D To the right of the page

Question 2.

The electric field strength between the charged plates is:

A 0.12 V m^{-1}
B 60 V m^{-1}
C 720 V m^{-1}
D 6000 V m^{-1}

Question 3.

An alpha particle (He^{2+}) is placed between the plates at the point **X**. What is the magnitude of the force acting on this alpha particle?

A 9.6×10^{-16} N **B** 1.92×10^{-15} N

C 60 N **D** 6000 N

Question 4.

The separation of the plates is increased to 15.0 cm. The force on the alpha particle:

A will be unchanged.

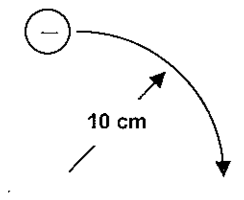
B will increase.

C will decrease.

D cannot be determined form the information given.

Questions 5 to 7 relate to the following information.

An electron is passed into a strong magnetic field at a velocity of 2.7×10^5 m s^{-1}. The electron proceeds on a circular path of radius 10 cm. This is shown in the diagram below.



Question 5.

The direction of the magnetic field in the region of the electron is:

A Vertically up the page

B Vertically down the page

C Into the page

D Out of the page

Question 6.

The size of the magnetic field acting on the electron is:

A 1.54×10^{-5} T

B 1.54×10^{-5} Wb

C 1.54×10^{-6} T

D 1.54×10^{-6} Wb

Question 7.

The direction of the net force acting on the electron is:

A Along the radius away from the centre of the circle

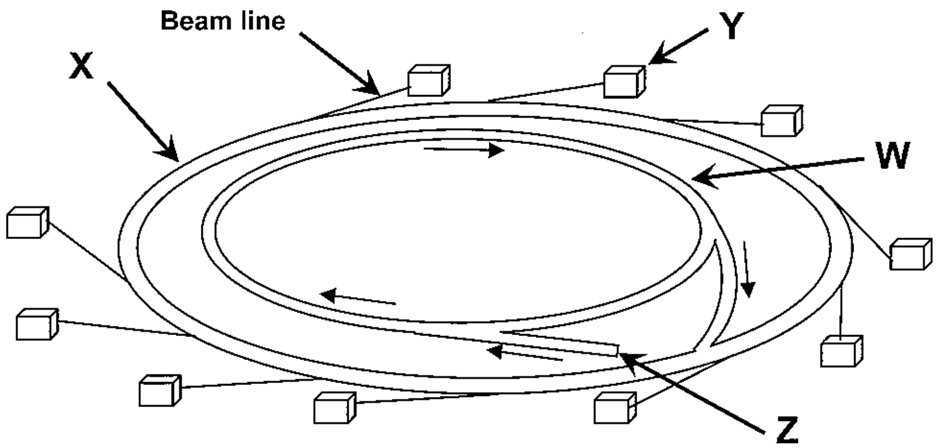
B Tangential to the circle

C Along the radius towards the centre of the circle

D Into the page at right angles to the velocity

Questions 8 & 9 relate to the following information.

The Australian Synchrotron has a number of important design features. Some of these are a LINAC (linear electron accelerator), a booster ring, a storage ring, beam lines and experiment stations. The following schematic shows a simplified diagram of the Australian Synchrotron.



Question 8.

Which of the following choices (A –D) correctly labels the components of the Australian Synchrotron as shown above?

	Storage Ring	LINAC	Experimental Station	Booster Ring
A	W	X	Y	Z
B	X	Y	W	Z
C	Z	W	X	Y
D	X	Z	Y	W

Question 9.

Which of the following is **NOT** a reason for choosing the Australian Synchrotron as a source for crystallography when compared to an X-ray source?

A Greater intensity or Brightness

B Low cost

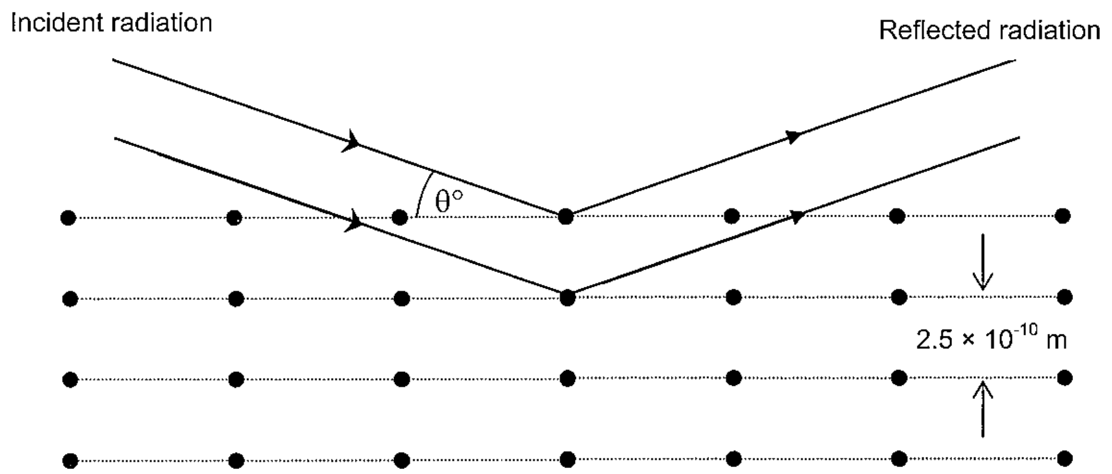
C A better focussing of the radiation beam

D A broad range of selectable wavelengths

Questions 10 to 13 relate to the following information.

One of the more basic uses for the Australian synchrotron is to investigate the internal structure of crystals. When a radiation beam of wavelength 1.50×10^{-10} m is shone onto a crystal surface the reflected radiation is observed to vary in intensity depending on the angle of incidence of the beam (θ°). This variation is attributed to the separation of the layers of atoms within the crystal. This particular crystal has layers separated by 2.5×10^{-10} m.

A simplified diagram of the experiment is given below.



Question 10.

The variation of the intensity of the reflected radiation is due to:

A Refraction

B Absorption

C Reflectivity

D Interference

Question 11.

The smallest value for θ that gives a maximum intensity of the reflected radiation is:

A 8.6° **B** 17.5° **C** 36.9° **D** 64.2°

Question 12.

What is the energy of one photon of incident radiation?

A	8.28 keV	**B**	9.95×10^{-44} J
C	6.21×10^{-25} eV	**D**	1.33×10^{-5} J

Question 13.

An alternative to changing the angle of the incident radiation is to fix the angle and then tune (change) the wavelength of the incident radiation until the maximum of the reflected radiation is found. If the incident angle is set to 20°, what is the wavelength that causes a maximum intensity of reflection?

A	8.55×10^{-11} m	**B**	1.71×10^{-10} m
C	3.52×10^{-10} m	**D**	4.56×10^{-10} m

End of Detailed Study 1

Detailed Study 2 – Photonics

Question 1.

LASER light can best be described as:

A monochromatic, coherent, unidirectional

B polychromatic, coherent, unidirectional

C monochromatic, incoherent, unidirectional

D polychromatic, coherent, multidirectional

Question 2.

Which of the following is **NOT** a true statement about LEDs?

A LEDs run on low voltage.

B LEDs are cheap to manufacture.

C LEDs are simple to use with heat sinks to reduce their thermal energy loss.

D LEDs produce a relatively narrow band of wavelengths.

Question 3.

Red, green and yellow LEDs are now being used in making traffic lights. Which of the following statements is NOT correct?

A The different colours are created by using different coloured plastic lenses.

B The different colours occur because of different band gap energies in the LEDs.

C The different LEDs produce light of different wavelength.

D The different LEDs produce light of different frequencies.

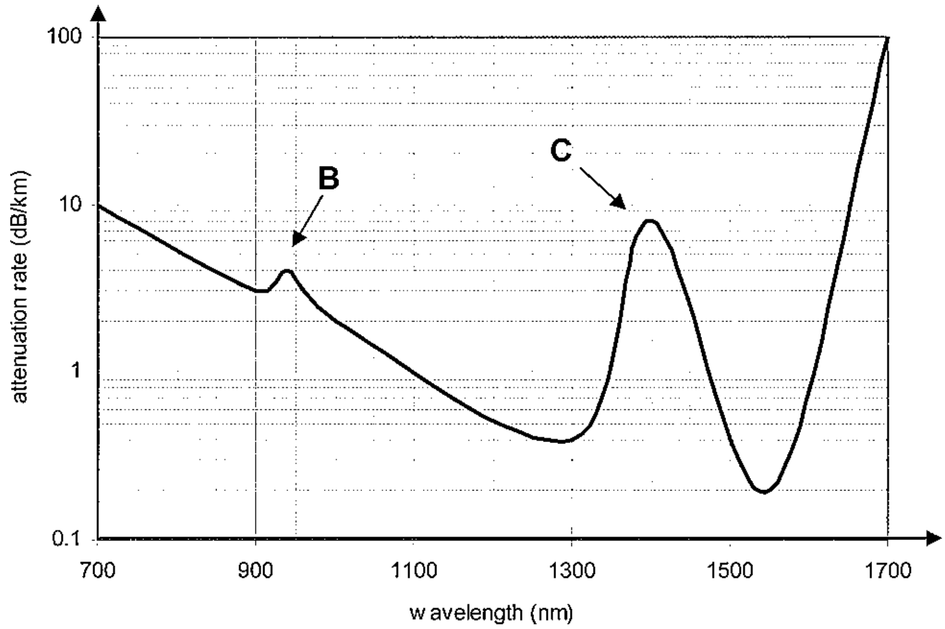
Question 4.

A yellow LED is producing light of wavelength 580 nm. The band gap energy of this LED is:

A	3.43×10^{-19} eV	**B**	3.43×10^{19} J
C	2.14 J	**D**	2.14 eV

Questions 5 to 9 relate to the following information.

As light travels along a fibre optic signal strength is lost due to a variety of reasons. This signal loss is dependent on the wavelength of the light source. This signal attenuation is shown in the following diagram for a particular silica-glass optic fibre.



Question 5.

The ability of fibre optic material to transmit light is based on:

A diffraction **B** refraction

C total internal reflection **D** attenuation

Question 6.

The minimum attenuation occurs at what wavelength and for what value of attenuation?

	wavelength	attenuation
A	1300 nm	80 dB km^{-1}
B	1300 nm	8 dB km^{-1}
C	1550 nm	0.12 dB km^{-1}
D	1550 nm	0.2 dB km^{-1}

Question 7.

The point **C** on the graph indicates the:

A UV absorption tail. **B** OH^- ion impurity absorption.

C IR absorption edge. **D** Raleigh scattering

Question 8.

The point **B** on the graph indicates the:

A UV absorption tail.

B OH^- ion impurity absorption.

C IR absorption edge.

D Raleigh scattering

Question 9.

To reduce the attenuation the wavelength of light used to transmit information through this fibre optic would best be:

A 950 nm

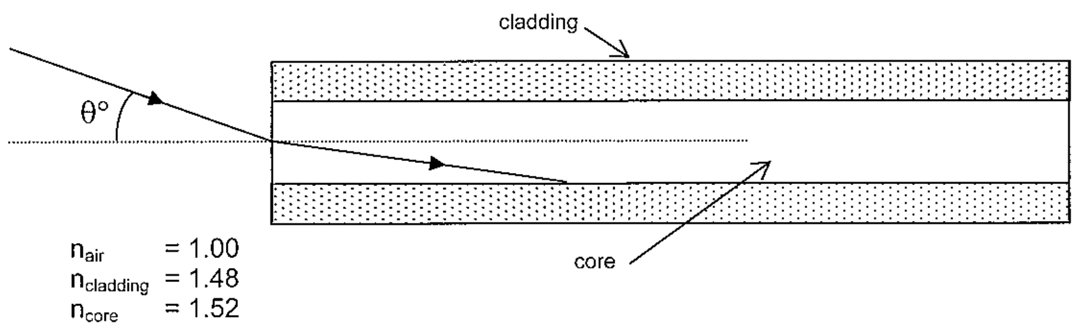
B 1300 nm

C 1400 nm

D 1550 nm

Questions 10 to 12 relate to the following information.

A section of fibre optic is shown below.



Question 10.

What is the critical angle for the core-cladding interface of this fibre optic?

A 13.2°

B 76.8°

C 42.5°

D 41.1°

Question 11.

What is the magnitude of the acceptance angle θ° ?

A 8.8°

B 9.4°

C 19.6°

D 20.3°

Question 12.

Two identical wavelength beams of light are sent down this fibre optic and it is found that the signals sent down these beams are slightly out of phase when received at the far end of the fibre optic line. This type of signal dispersion is best named:

A Raleigh Dispersion **B** Modal Dispersion

C Fresnel Dispersion **D** Material Dispersion

Question 13.

Which of the following best explains why fibre optics are used in modern communications?

A Fibre optic cables are easy to solder into electronic circuits.

B Fibre optic cables have virtually no resistance to electrical signals.

C Signals sent down fibre optic cables are not affected by either magnetic or electric fields.

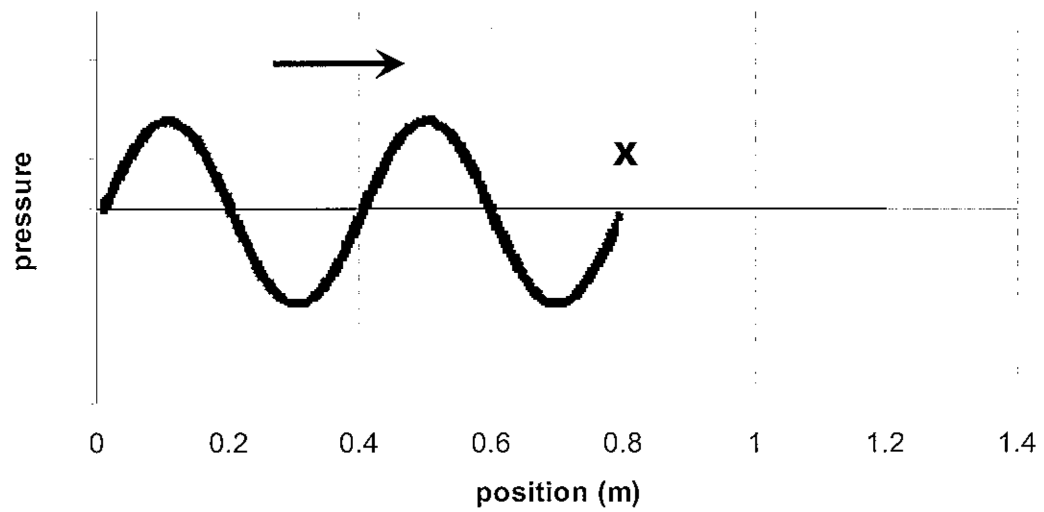
D Fibre optic cables are not affected by extremes of heat.

End of Detailed Study 2

Detailed Study 3 – Sound

Question 1.

The diagram below shows the pressure variation of a sound wave at a particular instant of time. The wave is travelling to the right and has reached the point X. A length scale is plotted below the graph. The speed of the wave is 340 m s^{-1}.



What is the frequency of the wave?

A 0.4 Hz **B** 425 Hz **C** 850 Hz **D** 1700 Hz

Question 2.

A cowboy actor on a movie set fires his pistol in a canyon. He hears the echo of the shot 1.5 seconds after he fires the pistol.

What is the **best** estimate of the distance to the reflecting canyon wall?

A 333 m **B** 267 m **C** 500 m **D** 666 m

Question 3.

In which of the following media does sound travel fastest?

A air **B** vacuum

C sea water **D** steel railway track

Questions 4 to 6 refer to the following information

A manufacturer uses sound to measure how full the machinery is filling glass containers with juice. Air is blown across the top of the container and the resultant resonant frequency is measured.

The glass container is 28 cm tall and when empty the fundamental frequency is found to be 300 Hz. When filled with fruit juice to the correct level the resonant frequency is now found to be 2700 Hz.

Ignore end effects with these questions.

Question 4.

What is the wavelength of the fundamental resonance when the container is empty?

A 0.112 m **B** 0.28 m **C** 0.56 m **D** 1.12 m

Question 5.

What is the speed of sound in the factory where the measurements are being taken?

A 324 m s^{-1} **B** 330 m s^{-1} **C** 336 m s^{-1} **D** 340 m s^{-1}

Question 6.

How far from the top of the container is the fruit juice when the glass jar is considered full?

A 0.12 m **B** 0.06 m **C** 0.03 m **D** 3.0 mm

Question 7.

A loudspeaker is measured to produce 93 dB of sound using a sound level meter. An identical second speaker producing an equal sound level is placed beside the first speaker and the combined sound level is now measured using the same sound level meter at the same position as the original measurement. The meter will now read:

A 87 dB **B** 93 dB **C** 96 dB **D** 99 dB

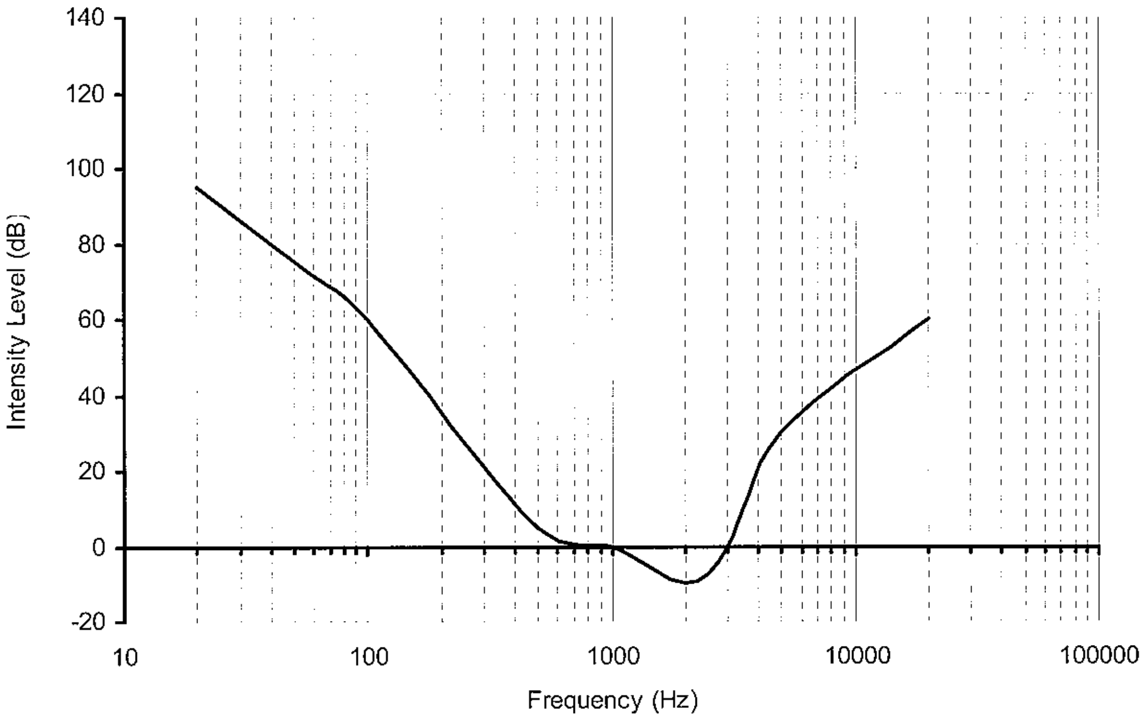
Question 8.

The amplitude of a sound wave, emitted from a source that is a fixed distance from the observer, determines the:

A The timbre or quality of the sound.
B The frequency of the sound.
C The volume or loudness of the sound.
D The velocity of the sound wave

Questions 9 & 10 refer to the following information

Students are using a signal generator, amplifier and loudspeaker to test the sensitivity of their hearing for a range of frequencies. The graph below is the result plotted for one student.



Question 9.

At what frequency is the student's hearing most sensitive?

A 1000 Hz **B** 2000 Hz **C** 2500 Hz **D** 3000 Hz

Question 10.

What is the intensity of the sound signal being heard by the student at a frequency of 100 Hz?

A	60 dB	**B**	1.0×10^{-6} W m^{-2}
C	1.0×10^{-6} dB	**D**	60 W m^{-2}

Question 11.

A student measures the sound level emitted from a loudspeaker as 88 dB when standing 2 metres from the loudspeaker. How far from the loudspeaker should she stand to reduce the sound level by 6 dB?

A	4 m	**B**	8 m
C	12 m	**D**	16 m

Question 12.

A microphone that relies on variations in capacitance to create an electrical signal variation due to sound pressure is called a(n):

A Electret microphone

B Moving Coil Microphone

C Dynamic Microphone

D Carbon Microphone

Question 13.

High quality loudspeakers are generally designed and manufactured with enclosures to improve the quality and clarity of the low frequency sound reproduced by the speaker.
The purpose of the enclosure is to:

A remove the sound that is 180° out of phase produced by the back of the speaker increasing the amount of sound produced by the front of the speaker.

B add in the sound that is 180° out of phase produced by the back of the speaker increasing the amount of sound produced by the front of the speaker.

C increase the path difference for the sound that is180° out of phase produced by the back of the speaker, so that it is back in phase and adds to the overall sound of the loudspeaker.

D seal inside the casing the sound that is 180° out of phase produced by the back of the speaker so that it cannot interfere with the sound projected from the front of the speaker.

End of Detailed Study 3

END OF EXAMINATION BOOK

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PHYSICS
Unit 4
Trial Examination

SOLUTIONS BOOK

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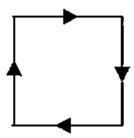
AREA 1 – ELECTRIC POWER

Q	Marks	Answer	Solution
1	2	**622 V**	$V_{peak} = \sqrt{2} \times V_{RMS} = \sqrt{2} \times 220 = 311$ $V_{peak\text{-}to\text{-}peak} = 2 \times V_{peak} = 2 \times 311 = 622$
2	2	**50 Hz**	Reductions to the supply change the size of the voltage, not the frequency.
3	2	**30 A**	$P = VI \rightarrow I = \frac{P}{V} = \frac{6600}{220} = 30$
4	2	**B**	The compass needle will point in the direction of the magnetic field, away from a north pole and towards a south pole. There is a component of the net field from each south pole of the bar magnets. When combined, the net field is up the page ∴ answer B.
5	2	**2×10^{-5} Wb**	$\phi = BA = 0.05 \times (0.02 \times 0.02) = 2 \times 10^{-5}$
6	2	At a speed of 0.5 cm s^{-1} the loop will take 4 seconds to be removed totally from the magnetic field. The flux will reduce to zero in this time at a steady rate. The correct graph will be a straight line starting at 2 on the y-axis and finishing at 4 on the x-axis. (In reality the field will extend beyond the edge of the magnets and the graph will not reach zero until some time after 4 seconds.)	
7	2	**5×10^{-6} V**	The flux reduces to zero in 4 seconds $emf = \frac{n\Delta\phi}{\Delta t} = \frac{1 \times 2 \times 10^{-6}}{4} = 5 \times 10^{-6}$ V
8	2		When the loop is in the magnetic field, the flux is down through the loop. As the loop is withdrawn, the flux through the loop reduces to zero. To oppose this, the current flow will increase the flux down through the loop. Using the right hand curl rule, a clockwise current will produce this effect.
9	2	**0 N**	Side VW is parallel to the magnetic field ∴ the force on it is zero.
10	3	**Clockwise**	In the position shown, current flows in the loop in the direction X → W → V → U. Using the right hand slap rule this gives the force on side XW as down and the force on side VU as up. Viewed from the commutator, this will produce clockwise rotation.
11	2	**100**	$F = nBIl \rightarrow n = \frac{F}{BIl} = \frac{2.25}{0.5 \times 1.5 \times 0.03} = 100$
12	2	**A, C**	A generator that uses slip rings will produce AC ∴ both of graphs A and C are correct.

Q	Marks	Answer	Solution
13	2	25	$\frac{N_S}{N_P} = \frac{V_S}{V_P} = \frac{500}{20} = 25$ Note: 500 and 20 are ok as both are in kV
14	2	400 A	P = V I → $I = \frac{P}{V} = \frac{200 \times 10^6}{500 \times 10^3} = 400$
15	2	400 A	Power and voltage are lost along transmission lines. Current is not lost ∴ it is still 400 A.
16	3	2×10^6 W	$P_{loss} = V_{loss} \times I = (500\text{ kV} - 495\text{ kV}) \times 400$ $= 5000 \times 400$ $= 2 \times 10^6$
17	2	Any two reasonable suggestions such as: • Use transmission lines of lower resistance • Reduce the length of the transmission lines • Step the voltage up more at transformer A (or have more secondary windings on transformer A)	
18	2	12.5 Ω	$V_{loss} = I R$ → $R = \frac{V}{I} = \frac{5000}{400} = 12.5$

AREA 2 – INTERACTIONS OF LIGHT AND MATTER

Q	Marks	Answer	Solution
1	2	7.25×10^{-7} m	$c = f\lambda \rightarrow \lambda = c / f = 3 \times 10^8 \div (4.14 \times 10^{14}) = 7.25 \times 10^{-7}$
2	2	2.74×10^{-19} J	from the graph, $f_0 = 4.14 \times 10^{14}$ Hz $E = h f_0 = 6.63 \times 10^{-34} \times 4.14 \times 10^{14} = 2.74 \times 10^{-19}$
3	2	Light of higher frequency has more energy. The energy in excess of 2.74×10^{-19} J appears as kinetic energy of the photoelectrons.	
4	2	B	The two lines on the graph must be parallel. If copper needs higher energy photons, they must have a higher threshold frequency since $E = h f \therefore$ graph B is correct.
5	2	B	Reducing the intensity by 90% means less photons by 90% and ∴ less photoelectrons are emitted by 90%.
6	2	8.72×10^{-10} m	$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E}$ $= 6.63 \times 10^{-34} \times 3 \times 10^8 \div (2.28 \times 10^{-16}) = 8.72 \times 10^{-10}$
7	1	8.72×10^{-10} m	Since the patterns are the same, the wavelength of the electrons must be the same as the wavelength of the X-rays.
8	1	Monochromatic means light of a single frequency (or wavelength).	
9	3	momentum	For electrons, their de Broglie $\lambda = h / p$ and since they have the same λ as the X-rays and h is a constant, they must have the same p or momentum.
10	3	Yes	This experiment shows that electrons can produce diffraction patterns and ∴ they can behave like waves even though they are particles.
11	2	B	The patterns are typical of diffraction patterns and diffraction is a wave property ∴ answer B.
12	2	The mercury atoms can only absorb exact (or discrete) amounts of energy to raise their electrons to their various energy levels. These amounts of energy are controlled by the energies of each level. For example, 6 eV is not an absorbable amount of energy but 4.86 eV and 6.67 eV are.	
13	2	n = 3 means that 3 wavelengths fit exactly into the circumference in the diagram. Divide this circumference into 3 equal parts (or into 6 is easier) and draw 3 complete wavelengths.	

Detailed study 1 – SYNCHROTRON AND ITS APPLICATIONS

Q	Marks	Answer	Reasoning
1	2	A	The electric field goes from the positive plate to the negative plate.
2	2	D	$E = \frac{V}{d} = 720 \div 0.12 = 6000 \text{ V m}^{-1}$
3	2	B	$F = E\,q = 6000 \times 2 \times 1.6 \times 10^{-19} = 1.92 \times 10^{-15}$ N
4	2	C	F = E q and $E = \frac{V}{d}$ so increasing d will decrease E and that will decrease F. OR $F = \frac{Vq}{d}$ and increasing d will decrease F.
5	2	C	Using the right hand slap rule, the thumb (current) points opposite to the electron's motion i.e. to the left, the palm (force) pushes the electron initially down the page and the fingers (B field) go into the page.
6	2	A	$r = \frac{mv}{Bq} \rightarrow B = \frac{mv}{rq} = \frac{9.1\times10^{-31}\times2.7\times10^{5}}{0.1\times1.6\times10^{-19}} = 1.54 \times 10^{-5}$ T
7	2	C	During circular motion the net force is always directed towards the centre of the circle.
8	2	D	W is the booster ring, X is the storage ring, Y is an experimental station and Z is the LINAC.
9	2	B	A, C & D are all advantages of the Australian Synchrotron.
10	2	D	Intensity peaks result from constructive interference when X-rays are scattered by successive atomic layers.
11	2	B	$n\lambda = d \sin\theta$ and n = 1 gives the smallest value of θ $\theta = \sin^{-1} \frac{\lambda}{2d} = \frac{1.5\times10^{-10}}{2\times2.5\times10^{-10}} = 17.46°$
12	2	A	$E = \frac{hc}{\lambda} = \frac{4.14\times10^{-15}\times3\times10^{8}}{1.5\times10^{-10}} = 8280$ eV = 8.28 keV
13	2	B	$\lambda = 2d\sin\theta = 2 \times 2.5 \times 10^{-10} \times \sin 20° = 1.71 \times 10^{-10}$ m

Detailed study 2 – PHOTONICS

Q	Marks	Answer	Reasoning
1	2	A	Answer A is the correct combination of features.
2	2	C	LEDs don't need heat sinks as they produce negligible heat energy.
3	2	A	Plastic lenses are not used.
4	2	D	$E_g = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{580 \times 10^{-9}} = 3.43 \times 10^{-19}$ J which is not there so convert to eV by $\div (1.6 \times 10^{-19})$ → 2.14 eV
5	2	C	Total internal reflection allows the light signal to travel along the fibre.
6	2	D	The minimum attenuation value is 0.2 dB km^{-1} and it occurs for a wavelength of 1550 nm.
7	2	B	Peaks B and C are both caused by OH^- impurity absorption.
8	2	B	Peaks B and C are both caused by OH^- impurity absorption.
9	2	D	The best wavelength is the one that has the lowest attenuation, i.e. 1550 nm.
10	2	B	$\theta_c = \sin^{-1} \frac{n_{cladding}}{n_{core}} = \frac{1.48}{1.52} = 76.8°$
11	2	D	$\theta = \sin^{-1} \sqrt{n_{core}^2 - n_{cladding}^2} = \sin^{-1} \sqrt{1.52^2 - 1.48^2} = 20.3°$
12	2	B	The beams have the same wavelength so they travel at the same speed along the fibre. Therefore they must be out of phase from taking different paths along the fibre. This is called modal dispersion.
13	2	C	Optical fibre cables are not very susceptible to interference unlike copper wiring.

Detailed study 3 – SOUND

Q	Marks	Answer	Reasoning
1	2	C	$v = f\lambda \rightarrow f = v / \lambda$ from the graph $\lambda = 0.4$ m $\therefore$ $f = 340 \div 0.4 = 850$ Hz
2	2	B	The sound travels to the canyon wall and back in 1.5 s. If the speed of sound is approx 340 m s^{-1}, $d = v \times t = 340 \times 1.5 = 510$ m to the wall and back, so the wall is 255 m away. Answer B is the closest to this value.
3	2	D	Sound travels fastest in solids. Answer D is the only solid.
4	2	D	The empty container acts like a pipe open at one end, hence its height is ¼ λ. Therefore $\lambda = 4\,L = 4 \times 0.28 = 1.12$ m.
5	2	C	$v = f\lambda = 300 \times 1.12 = 336$ m s^{-1}
6	2	C	$\lambda = v \div f = 336 \div 2700 = 0.124$ m $\lambda = 4\,L$ $\therefore$ $L = \lambda \div 4 = 0.124 \div 4 = 0.031$ m
7	2	C	Adding another speaker at the same intensity is a doubling of the intensity which corresponds to a 3 dB increase ∴ the meter will now read 96 dB.
8	2	C	Loudness is a subjective measurement of amplitude.
9	2	B	The minimum intensity level on graph occurs at a frequency of 2000 Hz.
10	2	B	From the graph, 100 Hz is at an intensity level of 60 dB $I = 1 \times 10^{(L/10 - 12)} = 1 \times 10^{-6}$ W m^{-2}
11	2	A	A 6 dB reduction is halving the intensity twice (as a 3 dB reduction is halving). Halving twice is the same as ¼ which occurs at twice the distance from the inverse square law.
12	2	A	An electret-condenser microphone uses capacitance to work.
13	2	D	The enclosure seals the rearward waves.