STUDENT NAME

TEACHER

YEAR 12

Quality Assessment Task

VCE PHYSICS

Practice Written Examination 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	19	19	40
2. Interactions of light and matter	12	12	25
B – Detailed studies			
1. Synchrotron and its applications (page 16)	10	10	25
OR			
2. Photonics (page 20)	11	11	25
OR			
3. Sound (page 24)	11	11	25
			Total 90

- Students are permitted to use pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and an approved graphics calculator (memory cleared) and/or one scientific calculator.
- Students are NOT permitted to bring in blank sheets of paper and/or white out liquid/tape.

Materials supplied
- Question and answer book of 30 pages with a detachable data sheet.

Instructions
- Detach the data sheet during reading time.
- Write your **student name** in the space provided above on the page.
- Answer all questions in the spaces provided.
- **Always** show your working where space is provided and place your answer(s) to multiple choice questions in the box provided.
- Where an answer box has a unit printed in it, give your answer in that unit.
- All written responses should be in English.

Published by Warringal Publications and Barrile Consulting

SECTION A - Core

Instructions for Section A

Answer **all** questions **for both** Areas of study in this section of the paper

Area of study 1 – Electric power

A student investigates the factors affecting the size of the force exerted by a magnetic field on a current carrying wire.

To produce the magnetic field, the student uses a solenoid. See Figure 1.

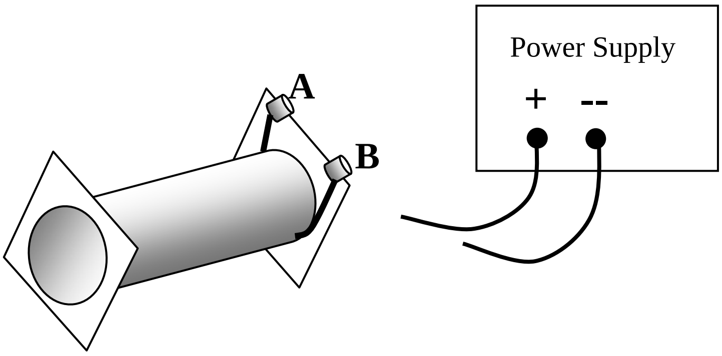


Figure 1

The student wants the magnetic field inside the solenoid to point to the right.

Question 1

Which connection, A or B, should be connected to the positive of the DC power supply?

2 marks

Question 2

Describe briefly how you determined your answer to question 1.

2 marks

SECTION A - AREA OF STUDY 1– continued

Published by Warringal Publications and Barrile Consulting

At the other end of the solenoid, two metal brackets are attached. They will support two metal point contacts across the middle of a plastic strip with a U shaped copper wire around one end. The strip can be balanced half in and half out of the solenoid. See Figure 2.

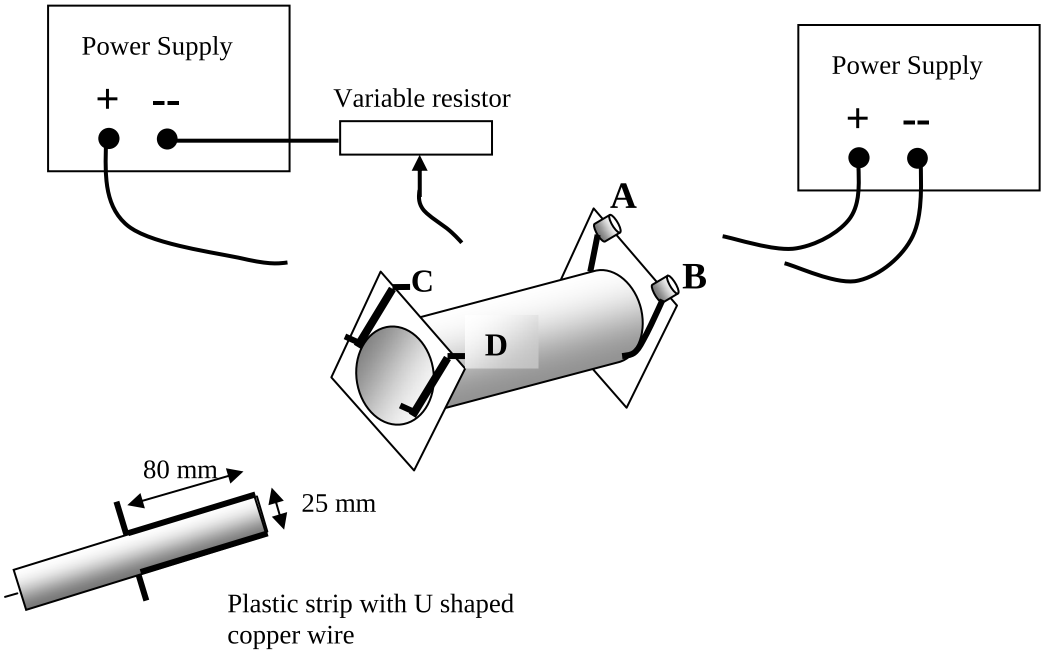


Figure 2

The plastic strip has a U-shaped copper wire running around the edge of one end. The wire is connected to the point contacts.

The strip is placed on the metal brackets. When the brackets are connected, a DC power supply current will flow through the U-shaped copper wire, down one side, across the end and back along the other side.

The DC power supply to the solenoid is tuned on. A magnetic field pointing to the right is set up inside the solenoid.

Question 3

Which connection, C or D, should be connected to the positive of the DC power supply to make the plastic strip tilt down **inside** the solenoid?

1 mark

Question 4

Describe briefly how you determined your answer to question 3. Refer to the direction of current in the copper wire.

2 marks

The equipment is now correctly wired. The power supplies are turned off and the plastic strip is adjusted to make it level. The power supplies are then turned on and the plastic strip tilts down inside the solenoid.

Three pieces of fine wire, cut to the same length, are added to the end of the plastic strip, an equal distance from the contact points as the copper wire at the other end. This means that when the strip is level the weight of the three pieces of wire equals the magnetic force on the current.

The current through the U-shaped copper is adjusted until the plastic strip is level. The following data was recorded.

Current through solenoid	4.5 A
Current through U-shaped copper	3.0 A
Mass of one piece of fine wire	0.15 gm
Number of pieces of fine wire	3
Length of copper wire: contact point to corner	80 mm
Length of copper wire: corner to corner	25 mm
Acceleration due to gravity	9.8 m/s^2

Question 5

Calculate the strength of the magnetic field inside the solenoid.

T

3 marks

Question 6

Is the copper wire from the contact point to the corner affected by the solenoid's magnetic field? Yes or No? Explain.

2 marks

Published by Warringal Publications and Barrile Consulting

Figure 3 shows a DC motor, viewed from side on looking along the axle, the shaded circle in the centre. The coil of wire goes into the page.

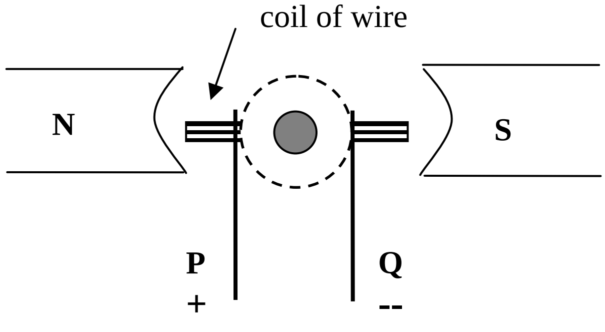


Figure 3

The commutator is the dashed circle with the two battery connections touching it. The commutator consists of two semi-circular pieces of metal separated by an insulating gap. If this DC motor is to spin continuously the insulating gap in the commutator must be positioned correctly.

Question 7

In Figure 3 draw on the dashed circle the positions of the two semi-circular pieces of metal also showing the insulating gap for the DC motor to spin continuously.

1 mark

Question 8

What is the function of the commutator? Refer to its design in explaining its function.

___

___

___

___

___

2 marks

Published by Warringal Publications and Barrile Consulting

If a DC motor is disconnected from its power supply and the shaft is made to spin, it will generate electricity.

The strength of the magnetic field in the DC motor is 35 mT, the dimensions of the coil are 25 mm by 20 mm, and it consists of 100 loops.

Question 9
Calculate change in magnetic flux through **one loop** as the coil moves **clockwise** through 90^0 from the position in Figure 3.

Wb

2 marks

Question 10
Calculate the average induced emf across PQ if the 90^0 turn took 0.25 seconds.

V

2 marks

Question 11
If a resistor was connected across PQ, which way would the current flow? P to Q or Q to P? Explain. Note: The coil is being spun clockwise.

____

____

____

____

____

3 marks

Published by Warringal Publications and Barrile Consulting

A length of string is wrapped around a spindle on the end of the axle of the DC motor. A mass is attached. The resistor across PQ is removed and replaced by a CRO. See Figure 4.

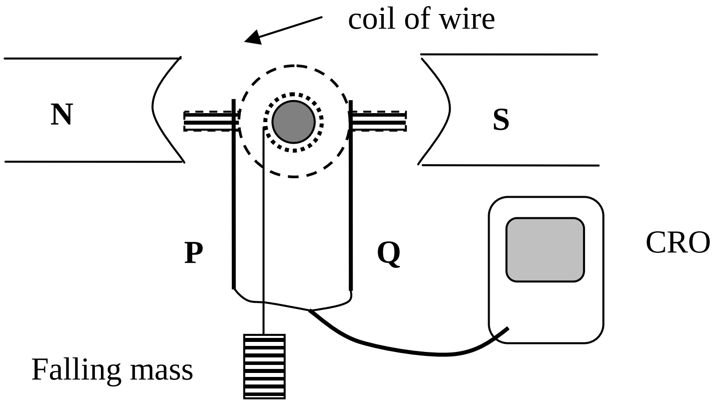
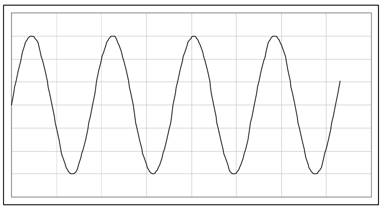


Figure 4

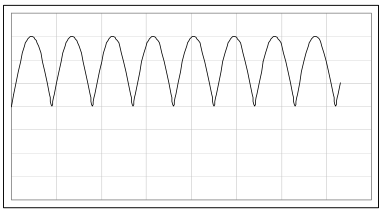
The mass is dropped. It accelerates under gravity. The coil spins faster.

Question 12

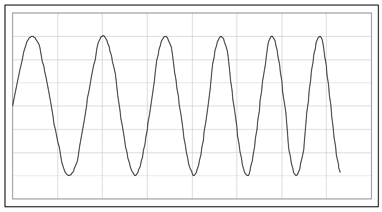
Which of the following graphs would you expect to see on the CRO?



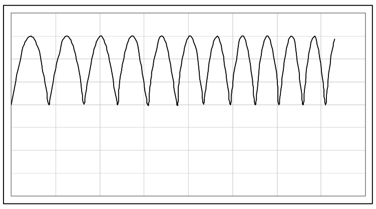
A



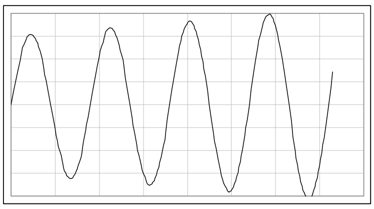
B



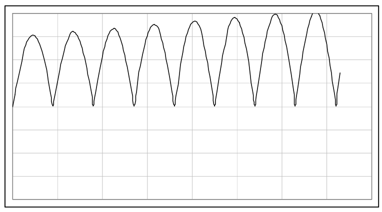
C



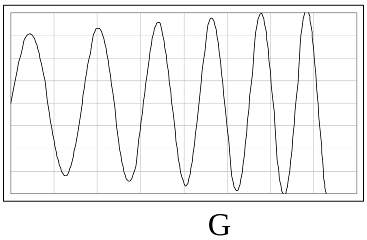
D



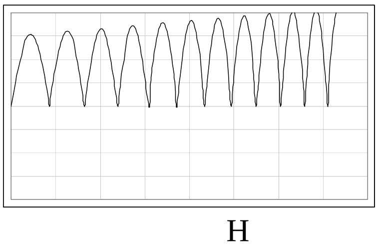
E



F



G



H

1 mark

Published by Warringal Publications and Barrile Consulting

Question 13
Explain your choice in Question 12.

3 marks

A remote community has an AC generator some distance away. The generator operates at a voltage of 240 V RMS, with a maximum power output of 100 kW.

The community uses two ideal transformers, a step up and a step down, each with the same turns ratio, to deliver power. The total resistance of the power lines between the transformers is 2.5 Ω.

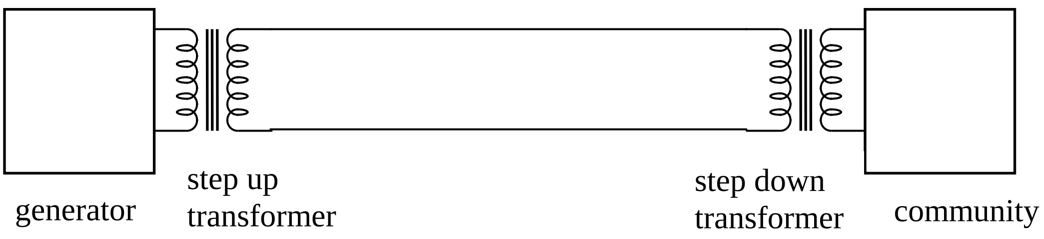


Figure 5

Question 14
What turns ratio for the step up transformer will produce an **RMS** voltage 3.0 kV?

2 marks

Question 15
What is value of the peak to peak voltage across the transmission lines at the step up transformer?

V

2 marks

Published by Warringal Publications and Barrile Consulting

For questions 16 – 18
The generator is operating at maximum power.

Question 16
Show that the power loss across the transmission lines is 2.8 kW.

3 marks

Question 17
Calculate the RMS voltage across the step down transformer at the ends of the transmission lines.

2 marks

Question 18
Show that the total current drawn by the community from the step down transformer is 420 A.

2 marks

Question 19
At night there is less current drawn by the community. Will the voltage at the step down transformer increase, decrease or stay the same? Explain your answer.

3 marks

SECTION A - AREA OF STUDY 1– end

Published by Warringal Publications and Barrile Consulting

Area of Study 2 – Ideas about light and matter

The sun is a wide spectrum light source.

Question 1
Explain the meaning of the phrase “wide spectrum”.

1 mark

The wide spectrum of light is produced by the motion of electrons in atoms on the surface of the sun.

Question 2
What is it about the motion of these electrons that makes the spectrum wide?

2 marks

When a laser beam passes through a double slit, it produces on a distant screen a pattern of equally spaced light and dark lines.

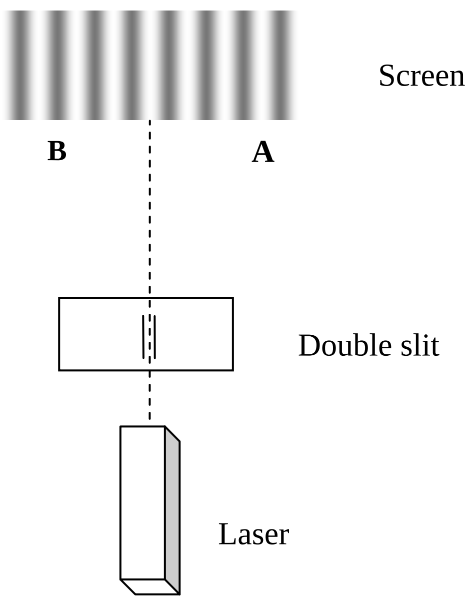


Figure 1 (Not to scale)

Published by Warringal Publications and Barrile Consulting

Question 3
Explain how the laser beam and the double slit produce the bright band at **A** in Figure 1.

___

___

___

2 marks

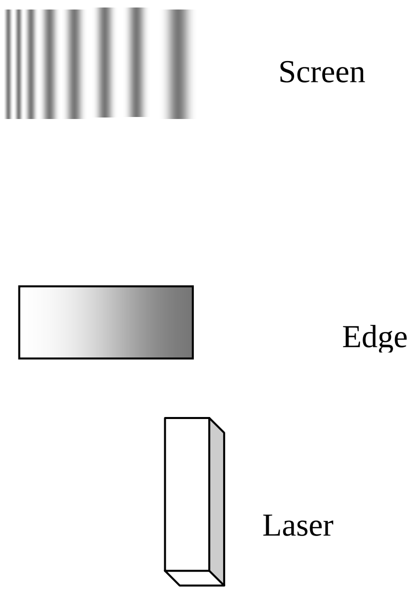
The wavelength of the light in Helium Neon laser beam is 1152 nm.

Question 4
Calculate the difference between the distance (in nm) travelled by the light to **point B** from the two slits.

nm

2 marks

The laser beam is now shone past a sharp edge on to a distant screen and produces the pattern on the screen.



Answer to Question 5

Figure 3

Question 5
Draw in the space above how the pattern on the screen would look if a ruby laser with a wavelength of 694 nm was used.

2 marks

Published by Warringal Publications and Barrile Consulting

An experiment is conducted to investigate the maximum kinetic energy of electrons ejected from Caesium when light is shone on the metal's surface. The light comes from a lamp and selective filters are used. The maximum kinetic energy is measured by the voltage required to stop the last electron.

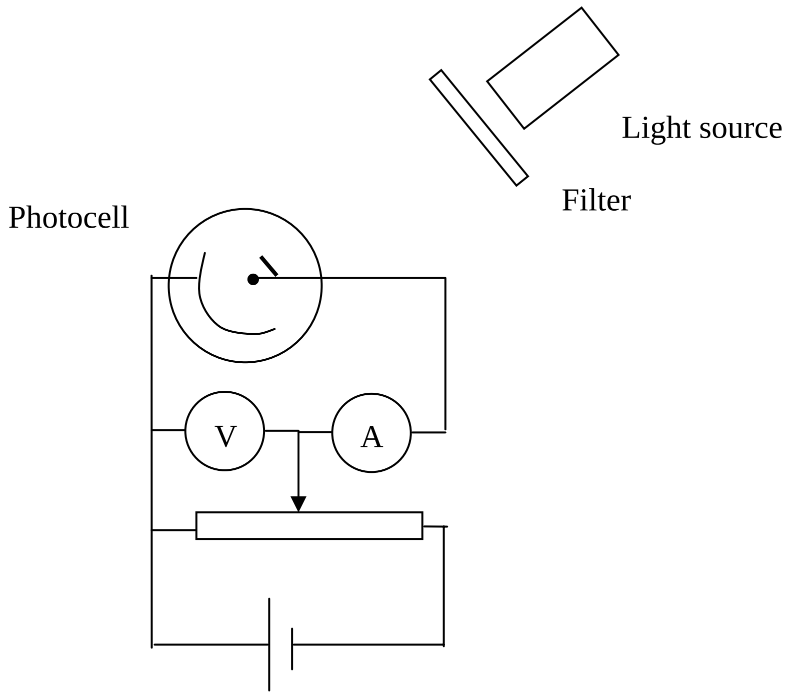


Figure 4

The following table of data is obtained.

Filter	Shortest Wavelength (nm)	Maximum Frequency (Hz)	Stopping voltage (V)
No filter	405	7.42×10^{14}	0.95
1	546		0.15
2	502.5	5.98×10^{14}	0.35
3	436	6.89×10^{14}	0.70

Question 6
Calculate the value of the missing frequency and enter it in the table.

1 mark

Question 7
On the grid opposite plot the maximum kinetic energy (in eV) against the frequency (in Hz). Axes can be drawn on the bottom and left edges of the grid.

3 marks

Published by Warringal Publications and Barrile Consulting

Question 8

Use your graph to determine the threshold frequency.

Hz

2 marks

SECTION A - AREA OF STUDY 2– continued

Published by Warringal Publications and Barrile Consulting

Question 9
Explain the significance of the threshold frequency.

2 marks

Question 10
A photon of frequency 6.2×10^{14} Hz is shone on another metal with a Work Function of 1.57 eV. Calculate the maximum kinetic energy of the ejected electron in eV and in Joules.

eV	J

2 marks

The energy level diagram for Hydrogen is in Figure 5. UV light of a single frequency is shone in to a chamber of the gas. The energy of each photon in the beam corresponds to the energy gap between one of the upper levels and the ground state (n = 1).

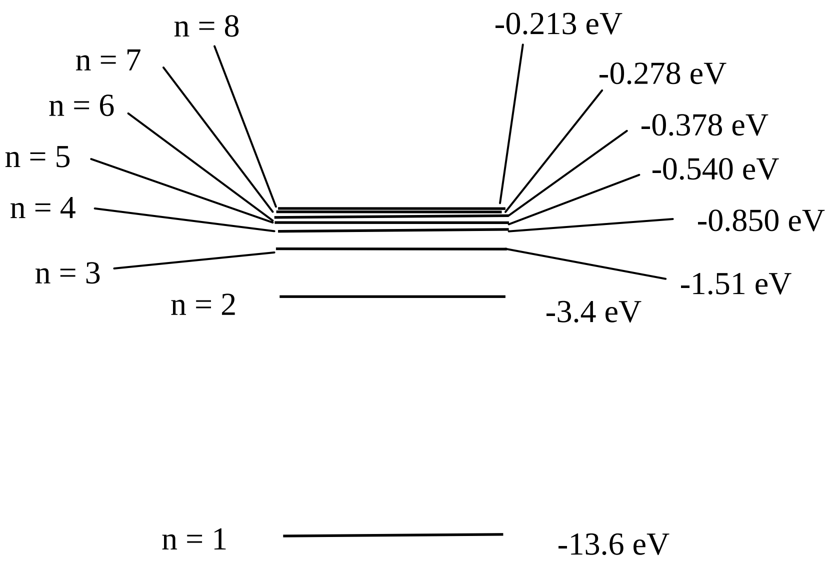


Figure 5

The part of the emission spectrum is observed in Figure 6.

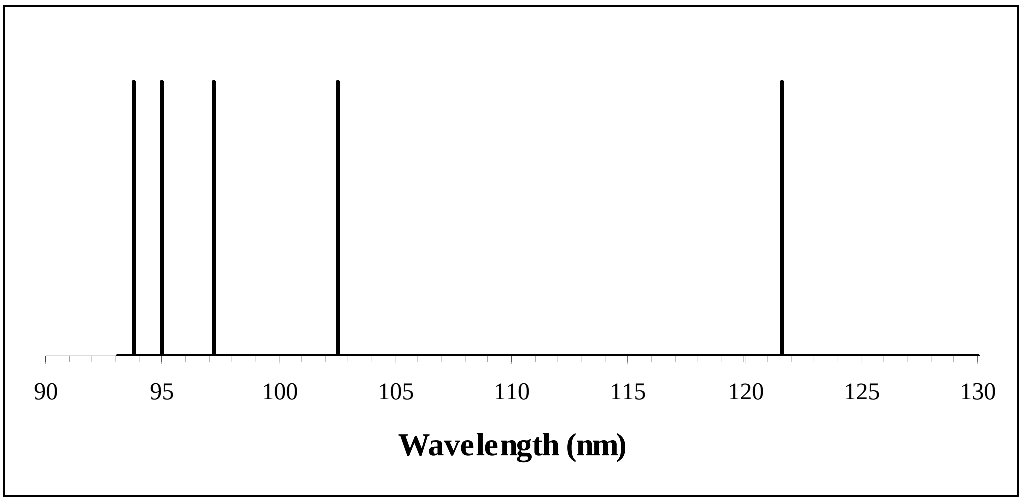


Figure 6

Question 11
To which energy level were the electrons raised to produce the emission pattern in Figure 6

n =

3 marks

A "slow moving" electron has a speed of 3.0 x 10^6 m/s, 1% of the speed of light. An X-ray photon has the same wavelength as this slow moving electron.

Question 12
What is the value of the ratio: Kinetic Energy of electron / Energy of photon? Show your working.

A: 200, B: 100, C: 20, D: 1, E: 1/20, F: 1/100, G: 1/200

3 marks

END OF SECTION A

Published by Warringal Publications and Barrile Consulting

SECTION B – Detailed Studies

Instructions for Section B
Choose **one** of the following **Detailed studies**. Answer **all** the questions on the **Detailed study** you have chosen.

Detailed study 1 – Synchrotron and its applications

An electron gun needs to accelerate an electron to a speed of 1.5×10^{7} m/s.

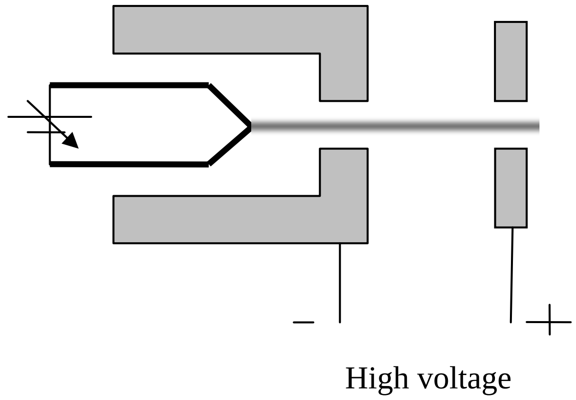


Figure 1

Question 1
What voltage should be applied across the electron gun?

V

2 marks

Question 2
The electron now enters a magnetic field of strength 500 mT. What is the radius of its trajectory?

m

2 marks

Published by Warringal Publications and Barrile Consulting

A Synchrotron consists of many components, each with a specific function.

Question 3
Draw a line from each component to its matching function.

A	Linac	X-rays are produced
B	Storage Ring	X-rays travel
C	Booster Ring	speed of electrons increases to 0.9999c
D	Beam Line	speed of electrons increases to 0.8c

4 marks

Question 4
Label Figure 2 using the letter beside each of the components listed in the previous question.

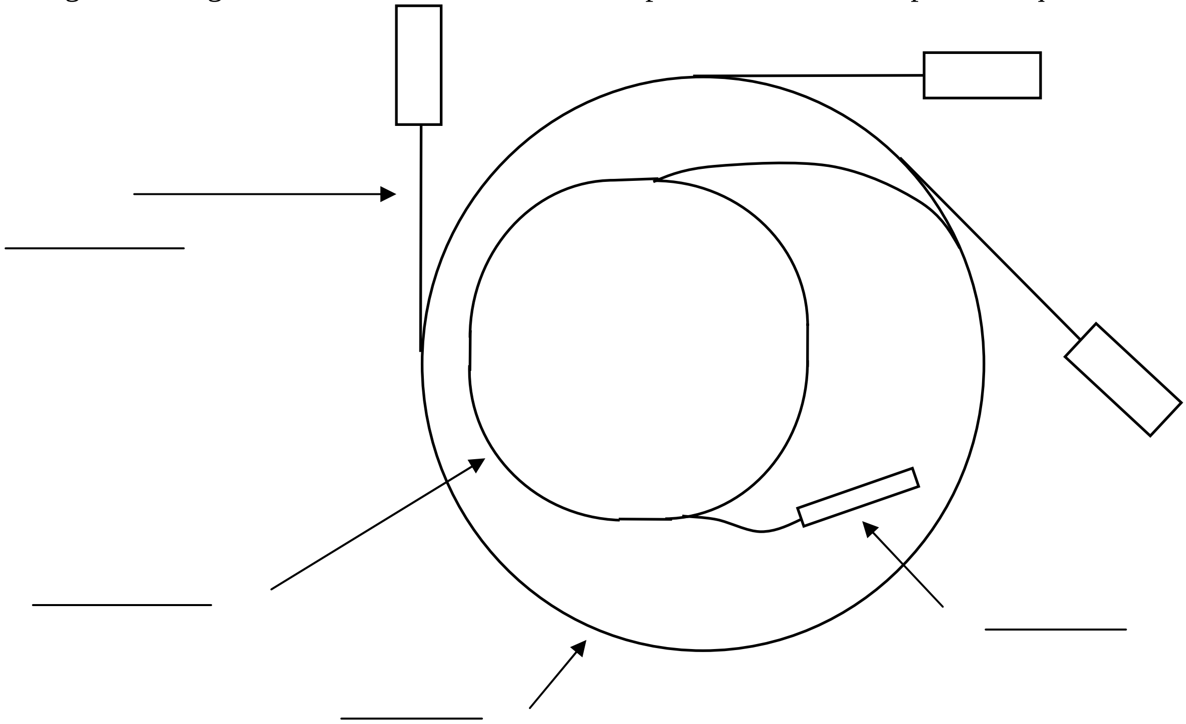


Figure 2

4 marks

Published by Warringal Publications and Barrile Consulting

Corundum is a mineral that is almost as hard as diamond. It has the chemical formula Al_2O_3. To determine its crystal structure, X-rays are fired at a small sample. The wavelength of the X-rays was 1.315×10^{-10} m.

Figure 3 is the Diffraction pattern produced, it shows the variation of the intensity of the reflected X-rays with angle. Note: This angle is labeled as "Two Theta" as this is the angle through which the incident X-ray beam has been deflected, and it is twice the angle between each of the incident and reflected x-ray beams and the face of the crystal.

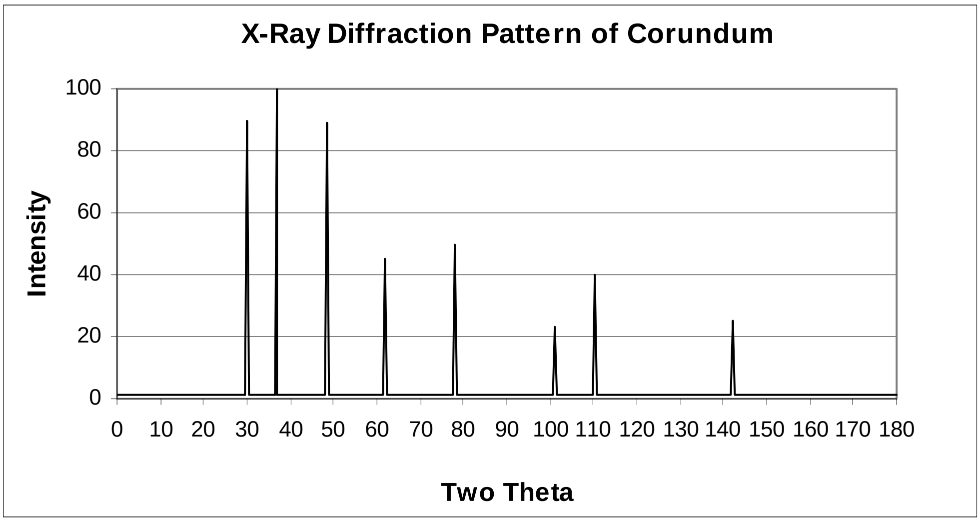


Figure 3

Question 5

Show that the crystal spacing corresponding to the peak on the left is 2.54×10^{-10} m.

3 marks

Question 6

For this crystal spacing, 2.54×10^{-10} m, circle the peak in Figure 2 that corresponds to the Bragg angle for n = 2. Show working.

3 marks

Published by Warringal Publications and Barrile Consulting

Question 7
Which of the following is X-ray Bragg Diffraction an example of:

A emission of photoelectrons
B elastic (Thomson) scattering
C inelastic Compton) scattering

Explain

____

____

3 marks

Synchrotron radiation consists of a range of frequencies. To investigate a sample a specific frequency needs to be selected, that is, the radiation needs to be "tuned". This tuning is done by a monochromator, which consists of a single silicon crystal.

Question 8
Explain, using Bragg's Law, how the monochromator is used to select a single frequency.

____

____

____

2 marks

Question 9
Compare the brightness of radiation from the following three sources: **synchrotron, laser** and **X-ray tube** by placing these three words in the correct order on the line below.

Low ____ High
Brightness Brightness

1 mark

Question 10
Compare the spectrum of radiation from the following three sources: **synchrotron, laser** and **X-ray tube** by placing these three words in the correct order on the line below.

Narrow ____ Broad
Spectrum Spectrum

1 mark

END OF DETAILED STUDY 1
SECTION B-continued

Published by Warringal Publications and Barrile Consulting

Detailed study 2 – Photonics

The Light Up The World Foundation, www.lutw.org, is an international humanitarian organisation dedicated to illuminating the lives of the world's poor. It uses ultra-efficient, durable and near permanent White Light Emitting Diodes to bring affordable, safe, healthy, efficient, and environmentally responsible lighting to people currently without access to proper lighting.

White LEDs are blue LEDs covered with a phosphor coating, as on the inside of a TV screen. The coating uses the blue light from the LED to produce a range of colours that appears white.

The wavelength of the blue light is 450 nm.

Question 1
What band gap energy (in eV) is needed in the LED to produce this blue light?

eV

2 marks

The word "laser" is an acronym for "**L**ight **A**mplification by the **S**timulated **E**mission of **R**adiation".

Question 2
How is "Light Amplified" in a laser? (A diagram may assist.)

2 marks

Question 3
Explain the significance of the word "Stimulated" in the above name.

2 marks

Published by Warringal Publications and Barrile Consulting

Question 4
Explain the meaning of the words "coherence", "wavelength" and "phase", showing the links between them.

3 marks

Material dispersion in an optical fibre limits the distance that digital signals can travel and still be decoded correctly.

Question 5
Why is the effect of material dispersion less significant for laser light compared to light from an LED?

2 marks

An optical fibre is constructed with the refractive index of the core = 1.48 and the refractive index of the cladding = 1.45.

Question 6
Show that the acceptance angle for the optical fibre is 17.2^o.

3 marks

Question 7
Why does the refractive index of the cladding need to be less than the refractive index of the core?

2 marks

Published by Warringal Publications and Barrile Consulting

Question 8
Explain modal dispersion with the aid of a diagram.

3 marks

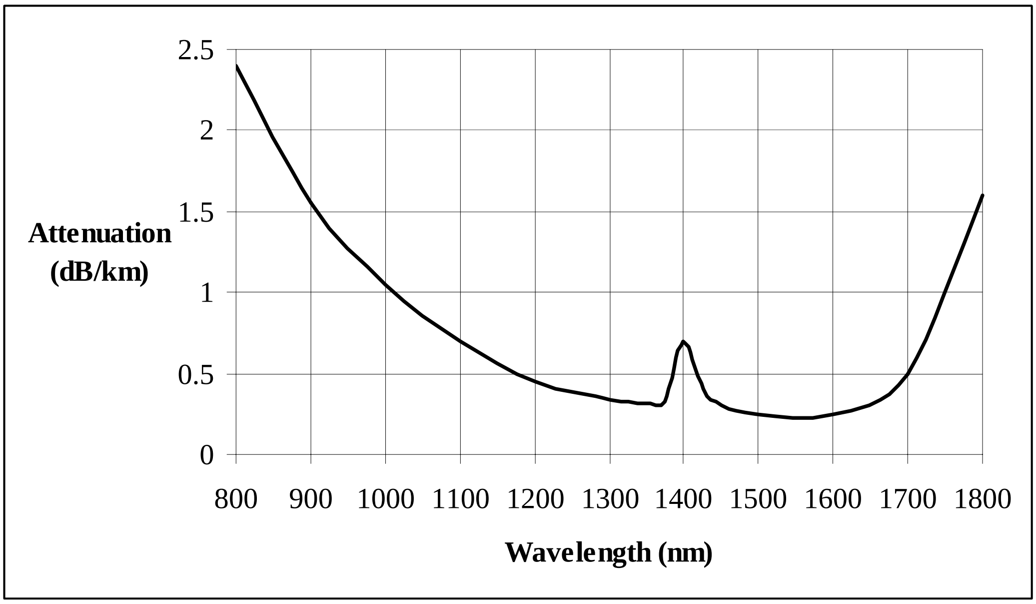


Figure 3

Figure 3 is a graph of attenuation against wavelength for an optical fibre. The attenuation is due to scattering and absorption.

Question 9
Which is scattered more, long or short wavelength?

2 marks

Question 10
Use Figure 3 to determine the wavelength that would ideal for long distance communication by optical fibre?

nm

2 marks

SECTION B – DETAILED STUDY 2 – continued

Published by Warringal Publications and Barrile Consulting

Optical fibres can be used as sensors. They are beginning to be used in a variety of areas, such as medical, aeronautical and nuclear applications as sensors to measure subtle changes in a variety of parameters. The advantage of the optical fibre sensors are that they are light, electrically isolated and immune from electromagnetic interference.

To work as a sensor, some property of the light needs to be affected in the application. One common property of light that is used in the sensors is its intensity.

Figure 4 shows an application that might be used in the joint of a bridge.

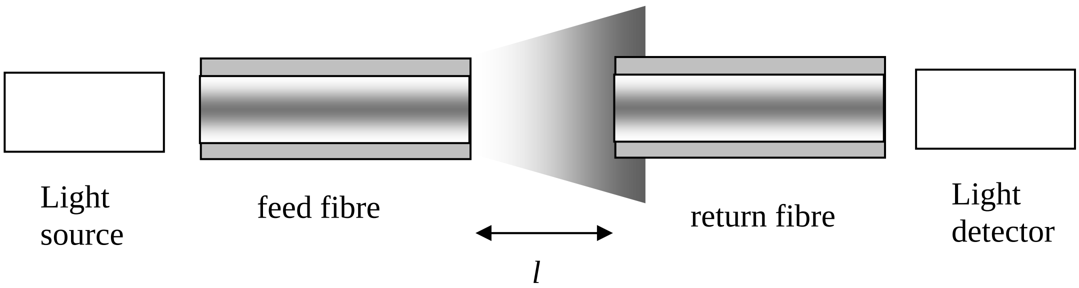


Figure 3. An intensity based fibre optic sensor measured the distance, *l*, across the joint

Question 11
Explain how this arrangement could be used to monitor the expansion and contraction of joints on the West Gate Bridge.

2 marks

END OF DETAILED STUDY 2
SECTION B – continued

Detailed study 3 – Sound

A small speaker produces a sound of frequency 100 Hz.
The speed of sound in the room is 340 m/s.

Question 1
On Figure 1 below draw a graph of the variation of pressure at a point in front of the speaker over a time interval of 40 ms. Include a scale on the time axis.

Figure 1

2 marks

Question 2
On Figure 2 below draw a graph of the variation of pressure at a point in front of the speaker over a distance of 10 m. Include a scale on the distance axis.

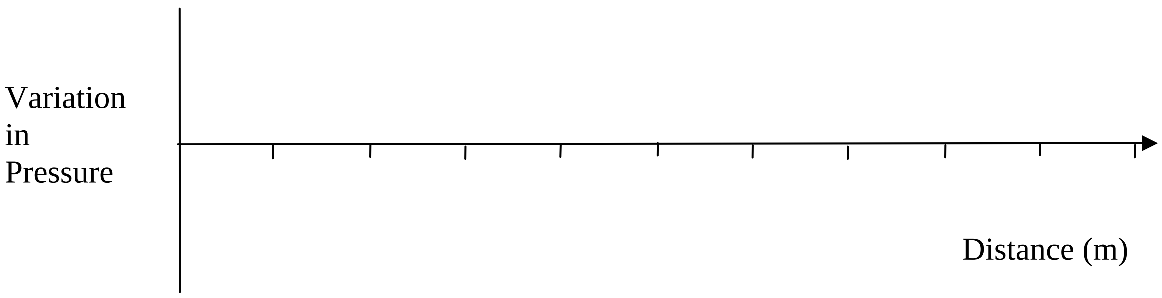


Figure 2

2 marks

At a distance of 3.0 metres from the speaker a decibel meter reads 83 dB.

Question 3
What is the value of the Intensity at this point in W/m^2?

2 marks

Published by Warringal Publications and Barrile Consulting

The signal into the speaker is adjusted to produce an intensity of 1.5 x 10^{-3} W/m^2 at this distance away of 3.0 metres. The decibel meter is now moved to a distance of 5.0 metres away.

Question 4
Treating the speaker as a point source, show that the intensity at 5.0 metres away should be 5.4 x 10^{-4} W/m^2.

2 marks

Question 5
What do you expect the decibel meter reading to be at this distance of 5.00 metres?

2 marks

Published by Warringal Publications and Barrile Consulting

In a demonstration of resonance a teacher places a long, large diameter plastic tube, open at both ends, above the flame from a Meeker burner and gently lowers it over the flame. When the flame is several centimetres into the tube a loud roar comes from the tube.

The teacher asks the students how can we tell whether the tube is acting as an air column open at both ends or one open at one end and fixed at the other. The students suggest using frequency analyser software to measure the roar's fundamental frequency.

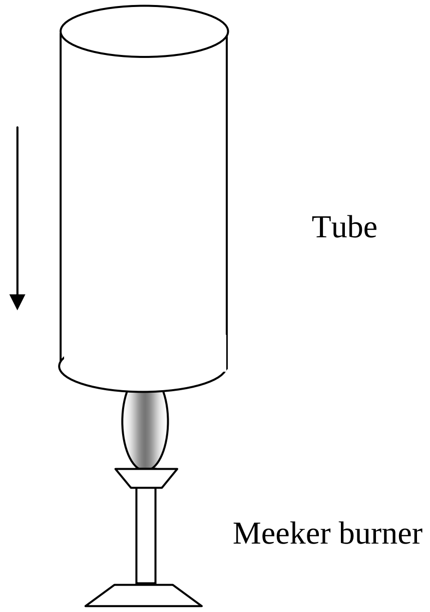


Figure 3

The length of the tube is 150 cm and its diameter is 10cm. The seat of the flame is 15 cm from the end of the tube. The fundamental frequency was measured to be 115 Hz. The speed of sound in the air column was assumed to be 350 m/s because the air was hotter.

Question 6
Is the tube acting as an air column open at both ends or as an air column open at one end and closed at the other? Explain with calculations.

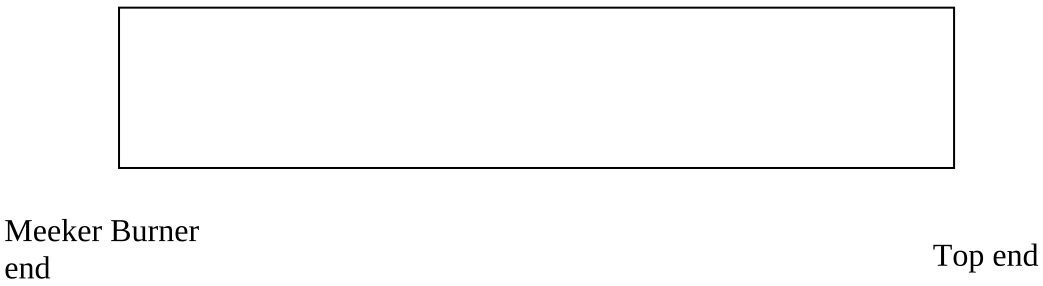
4 marks

Question 7
Based on your answer to the previous question which of the following additional frequencies do you expect to be present in the frequency analyser display (one or more answers).

A. 57.5 Hz B. 230 Hz C. 345 Hz D. 460 Hz E. 575 Hz

2 marks

Question 8
Draw the pressure pattern inside the tube for a resonant frequency of 345 Hz.



3 marks

Question 9
By referring to a musical instrument as a comparison, explain why no sound is heard until the flame is several centimetres inside the tube.

2 marks

Published by Warringal Publications and Barrile Consulting

Question 10
Which of the following microphones use a magnetic field (one or more answers)
A. Electret-condenser, B. Crystal, C. Dynamic D. Velocity

2 marks

The sound quality from a free standing speaker is poor. This problem can be overcome by the use of a baffle.

Question 11
Explain why the sound from a free standing speaker is poor and how a baffle overcomes the problem.

2 marks

END OF QUESTION AND ANSWER BOOKLET

Published by Warringal Publications and Barrile Consulting

YEAR 12

Quality Assessment Task

VCE PHYSICS

Practice Written Examination 2

DATA SHEET

Direction to students

Detach this data sheet before commencing the examination.

This data sheet is provided for your reference

Published by Warringal Publications and Barrile Consulting

1	resistors in series	$R_T = R_1 + R_2$
2	resistors in parallel	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2}$
3	magnetic force	$F = I\, l\, B$
4	electromagnetic induction	*emf:* $\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$ *flux:* $\Phi = BA$
5	Transformer action	$\frac{V_1}{V_2} = \frac{N_1}{N_2}$
6	AC voltage and current	$V_{RMS} = \frac{1}{\sqrt{2}} V_{peak},\ I_{RMS} = \frac{1}{\sqrt{2}} I_{peak}$
7	voltage; power	$V = RI$ $P = VI$
8	transmission line losses	$V_{drop} = I_{line} R_{line}$ $P_{loss} = I^2_{line} R_{line}$
9	photoelectric effect	$KE_{max} – hf - W$
10	photon energy	$E = hf$
11	photon momentum	$P = \frac{h}{\lambda}$
12	De Broglie wavelength	$\lambda = \frac{h}{p}$
13	mass of the electron	$m_e = 9.1 \times 10^{-31}$ kg
14	charge on the electron	$q = -1.6 \times 10^{-19}$ C
IS	Planck's constant	$h = 6.63 \times 10^{-34}$ Js $h = 4.14 \times 10^{-15}$ 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	$\frac{1}{2} mv^2 = e\,V$
18	Radius of electron beam	$r = p/qB$
19	Force applied to an electron beam	$F = qvB$
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	$n_1 \sin i = n_2 \sin r$
24	Acceptance angle	$\theta_A = \sin^{-1}\sqrt{(n_1^2 - n_2^2)}$

Detailed study 3.3 - Sound

25	Speed, frequency and wavelength	$v = f\lambda$
26	Intensity and levels	*Sound intensity level* (in dB) $= 10 \log_{10}\left(\frac{I}{I_0}\right)$ *where* $I_0 = 1.0 \times 10^{-12}\ Wm^{-2}$

Prefixes/Unit

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

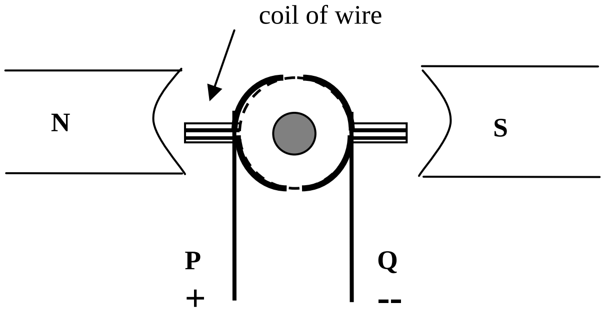
Published by Warringal Publications and Barrile Consulting

SOLUTIONS AND MARKING SCHEME

Marking scheme in italics.

Electric power

1. *(2)* B Use right hand grip rule.
2. *(2)* Imagine grabbing the wire from B in your right hand with the current down the front of the solenoid *(1)* , the fingers wrap around the wire in the direction of the magnetic field and inside the solenoid then the fingers point to the right. *(1)*
3. *(1)* D Use Fleming’s Left hand rule or Right hand slap rule.
4. *(2)* Magnetic field to the right, Force down, so current must be run from D to C *(1)*, so D is connected to positive. *(1)*
5. *(3)* 0.059 T Weight force mg = Magnetic force BI*l* *(1)*, B = mg / I*l* ,
   B = 3 x 0.15 x 10^{-3} x 9.8 / (3.0 x 25 x 10^{-3}) *(1)* = 0.059 T *(1)*
6. *(2)* No *(1)* The current is parallel to the field, copper is not attracted by a magnet. *(1)*
7. *(1)* The gaps are at the top and bottom.



8. *(2)* Reverse the current twice every cycle *(1)* when the coil is at right angles to the magnetic field. *(1)*
9. *(2)* 1.75 x 10^{-5} Wb Change in flux = flux after – flux before = BA – zero,
   Change in flux = 35 x 10^{-3} x 25 x 10^{-3} x 20 x 10^{-3} *(1)* = 1.75 x 10^{-5} Wb *(1)*
10. *(2)* 0.0070 volts Induced EMF = No of loops x Change in flux / Time taken *(1)*
    Induced EMF = 100 x 1.75 x 10^{-5} / 0.25 = 0.0070 volts *(1)*
    Conseq on Q’n 9
11. *(3)* Q to P *(1)* The right side of the coil is moving down, so the magnetic force on the positive charges in the right side of the coils will be out of the page towards Q *(1)*. Similarly the magnetic force on positive charges in the left side will be into the page, so the current flows from Q to P. *(1)*
    Alternatively, the magnetic flux to the right is increasing, so the induced magnetic field will be to the left *(1)*. To produce this field the current in the right side of the coil needs to go to Q and the current in the left side of the coil needs to go away from P .*(1)*
12. *(1)* H
13. *(3)* The commutator changes the AC to a fluctuating DC *(1)*, the increased speed of the falling mass increases both the frequency *(1)* and the peak voltage. *(1)*
14. *(2)* 12.5 Turns ratio = 3000 / 240 *(1)* = 12.5 *(1)*
15. *(2)* 8485 V V_{p-p} = 2 x 3000 x sqrt (2) *(1)* = 8485 V *(1)* accept 8490 V and 8480 V
16. *(3)* Current in transmission line = P/V = 100,000 / 3000 = 3.3 amp. *(1)* Power loss = I^2R = $(33)^2$ x 2.5 *(1)* = 2.8 kW *(1)*

Published by Warringal Publications and Barrile Consulting

17. *(2)* 2920 V Voltage drop = IR = 33 x 2.5 = 83 V. *(1)* Voltage across transformer = 3000 – 83 = 2917 V *(1)*

18. *(2)* Turns ratios are the same, and also apply to currents *(1)*, so the current to the community is the same as the current from the generator = 100,000 / 240 = 417 amp. *(1)*
Or Voltage to community = 2990 / 12.5 = 239.2 V *(1)*
Power to community = 10,000 – 28 = 9972 W, so current = 9972 / 239.2 = 42 Amp *(1)*

19. *(3)* Increase *(1)* Less power drawn by community means less current in T'n lines *(1)* and so less voltage drop across them and a greater voltage at the step down transformer. *(1)*

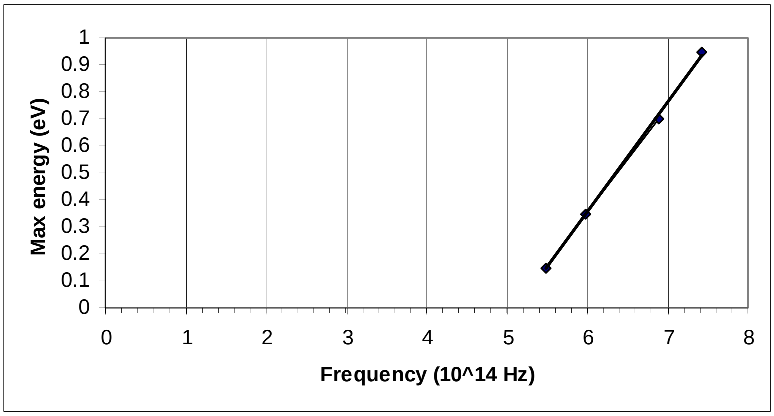
END OF DATA SHEET

Published by Warringal Publications and Barrile Consulting

Ideas about light and matter

1. *(1)* A large range of frequencies or wavelength.
2. *(2)* Radiation is produced by accelerating electrons *(1)*. The large range of electron speeds and accelerations produces are large range of frequencies in the radiation. *(1)*
3. *(2)* Constructive interference or reinforcement of the two diffracted beams coming from the two slits *(1)*: path differencc between A and the two slits equals an even number of half-wavelengths *(1)*. Crest meets crest.
4. *(2)* 2880 nm At B, the path difference is five half-wavelengths, *(1)* so the path difference= 5/2 x 1152 nm = 2880 nm *(1)*
5. *(2)* Lines closer together because the wavelength is shorter

6. *(1)* 5.49×10^{14} Hz Frequency = Speed / wavelength = $3.0 \times 10^{8} / 546 \times 10^{-9} = 5.49 \times 10^{14}$ Hz



7. *(3)*
(1) for correct labels and units, (2) for correct plotting,

8. *(2)* 5.13×10^{14} Hz Accept 5.1 to 5.3
9. *(2)* The threshold frequency is the frequency below which no electrons are emitted by the light *(1)* regardless of the intensity. *(1)*
10. *(2)* 1.0 eV Photon energy = hf = $4.14 \times 10^{-15} \times 6.2 \times 10^{14}$ = 2.57 eV *(1)*
1.6×10^{-19} J Electron energy = 1.0 eV, in joules = 1.6×10^{-19} J *(1)*
11. *(3)* n = 6 *(1)* The shortest wavelength corresponds to the highest frequency and energy and is the jump from the entry level down to the ground state n = 1. For wavelength = 93.8 nm,
energy = $4.14 \times 10^{-15} \times 3.0 \times 10^{8} / 93.8 \times 10^{-9}$ eV *(1)*
photon energy = 13.24 eV, 13.60 – 13.24 = 0.36 eV, *(1)*
which is close to 0.378 eV for n = 6
12. *(3)* G *(1)* Wavelengths are the same, so momenta the same *(1)*. For slow moving electrons KE = $p^2/2m$, while for photons E = hf = $(h/\lambda)c$ = pc. *(1)*
So ratio KE / E = $(p^2/2m) / (pc) = p/2mc$, but p = mv, so ratio = mv/2mc = v/2c
$v/2c = 3.0 \times 10^{6} / (2 \times 3.0 \times 10^{8}) = 1/200$.

Published by Warringal Publications and Barrile Consulting

Detailed studies
Synchrotron and its applications

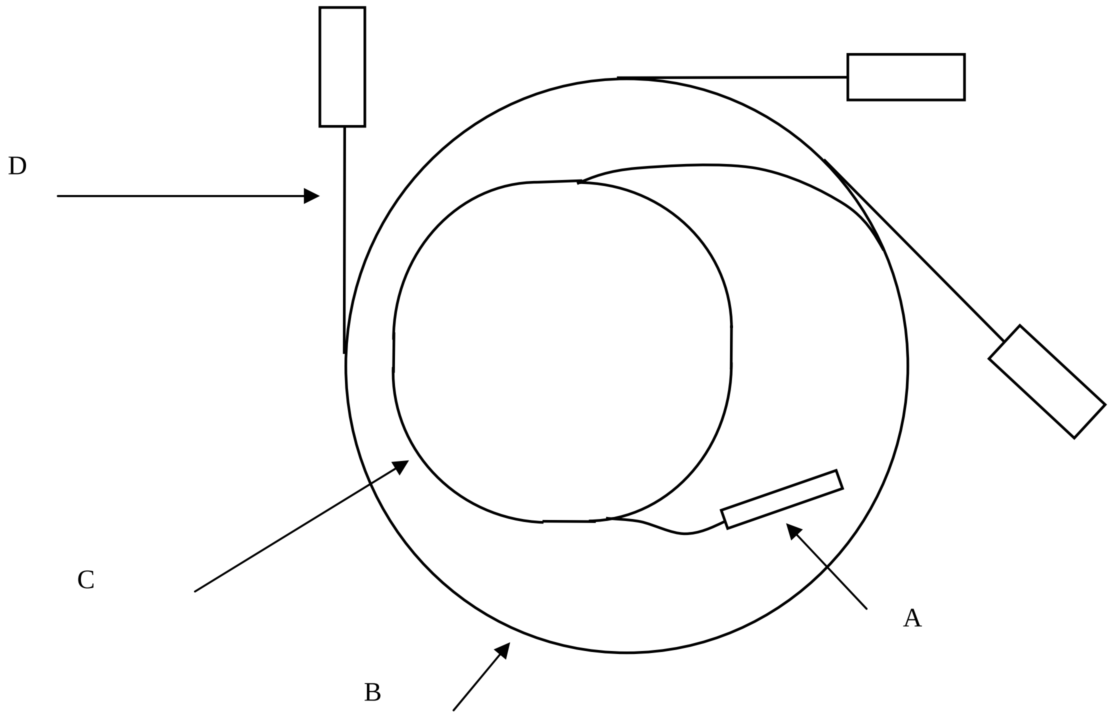
1. *(2)* 640 V $\frac{1}{2} mv^2 = Vq$. *(1)*
 $V = \frac{1}{2} \times 9.1 \times 10^{-31} \times (1.5 \times 10^7)^2 / (1.6 \times 10^{-19}) = 639.84$ V *(1)*

2. *(2)* 1.7×10^{-4} m $Bqv = mv^2/r$. $r = mv/Bq$ *(1)*
 $r = 9.1 \times 10^{-31} \times 1.5 \times 10^7 / (500 \times 10^{-3} \times 1.6 \times 10^{-19})$
 $r = 0.000170$ m *(1)*

3. *(4)*

A	Linac	X-rays are produced
B	Storage Ring	X-rays travel
C	Booster Ring	speed of electrons increases to 0.9999c
D	Beam Line	speed of electrons increases to 0.8c

4. *(2)*



5. *(3)* n = 1, so $\lambda = 2d\sin\theta$. From Figure 3, $2\theta = 30.0^0$, so $\theta = 15.0^0$, *(1)*
 $d = 1.315 \times 10^{-10} / (2 \times \sin 15^0)$ *(1)* $= 2.54 \times 10^{-10}$ m *(1)*

6. *(3)* 4th peak *(1)* from left For n = 2, $2 \times 1.315 \times 10^{-10} = 2 \times 2.54 \times 10^{-10} \sin\theta$. *(1)*
 $\sin\theta = 1.315 \times 10^{-10} / (2.54 \times 10^{-10}) = 0.5177$, $\theta = 31.2^0$,
 and $2\theta = 62.4^0$ *(1)*

7. *(3)* B *(1)* In Bragg diffraction the wavelength of the photon is unchanged *(1)*, so the frequency and energy are unchanged *(1)*. The interaction is therefore elastic.

8. *(2)* X-rays of different energies and frequencies will have different wavelengths *(1)*, so when they diffract off a crystal, the peaks due to constructive interference will occur at different angles *(1)*, enabling a particular frequency to be selected.

9. *(1)* Low Brightness ——— X-ray tube ——— Laser ——— Synchrotron ——— High Brightness

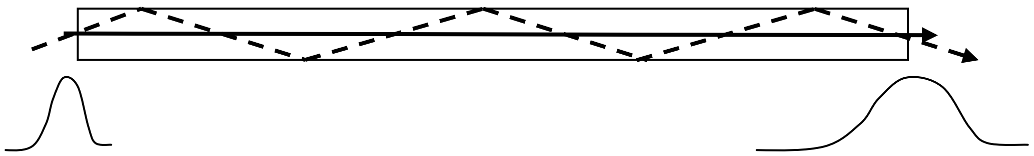
10. *(1)* Narrow Spectrum ——— Laser ——— X-ray tube ——— Synchrotron ——— Broad Spectrum

END OF DATA SHEET

Published by Warringal Publications and Barrile Consulting

Photonics

1. *(2)* 2.76 eV E = hf = hc/λ , E = 4.14 x 10^{-15} x 3.0 x 10^{8} / (450 x 10^{-9}) *(1)* = 2.76 eV *(1)*
2. *(2)* One photon enter the material, several come out. All the photons have the same frequency. Electrons in the material have been put into a higher energy state above the ground state. When another photon of energy equal to the difference in energy between the ground state and higher energy state *(1)*, all the photons simultaneously drop down to the ground state, each releasing a photon equal in energy to the incoming photon. *(1)*
3. *(2)* The electrons only drop down *(1)* when there is an incoming photon of energy equal to the energy gap. *(1)*
4. *(3)* Wavelength is the distance a wave takes to repeat itself. *(1)*
   Phase is where in the wavelength the wave is at a particular point in time or space. *(1)*
   Coherence is a fixed relationship between the phases of two points in time or space. *(1)*
5. *(2)* Material dispersion means that the material's refractive index varies with wavelength. *(1)* A laser beam has a narrower wavelength range than does an LED. *(1)*
6. *(3)* Sin (acceptance angle) = sqrt (1.48^2 – 1.45^2) = 0.2965 *(1)*, angle = 17.2^0 *(1)*
7. *(2)* The refractive index of the cladding needs to be less than that of the core so that the light will be totally internally reflected back into the core, *(1)* if light enters the core at less than the acceptance angle. *(1)*
8. *(3)* Light rays that experience more total internal reflections at the core boundary travel further than light rays that go down the middle of core *(1)*. This leads to spreading of the signal. *(1)*



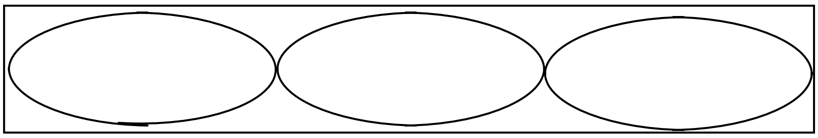
(1)

9. *(2)* Shorter
10. *(2)* 1500 – 1600 nm The smallest dB loss/km.
11. *(2)* The intensity of light coming from the end of the optical fibre will decrease with distance. *(1)* As the distance to the next optical fibre, *l*, increases the amount of light getting through will decrease. *(1)* This decrease can be measured and related to the distance *l*.

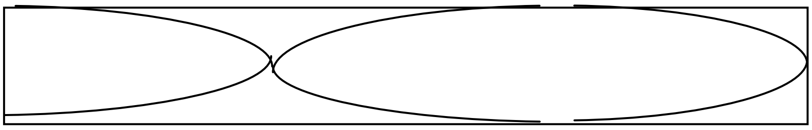
Published by Warringal Publications and Barrile Consulting

Sound

1. *(2)* A sine wave with a period of 10 ms *(1)* and four cycles over 40 ms. *(1)*
2. *(2)* A sine wave with a wavelength of 3.4 metres *(1)* and about three cycles in 10 m. *(1)*
3. *(2)* 2.0×10^{-4} W/m^2 $83 = 10 \log (I/I_0)$. $I = 10^{8.3} \times 10^{-12}$ *(1)* $= 10^{-3.7} = 1.995 \times 10^{-4}$ *(1)*
4. *(2)* Inverse square law: $I_1 r_1^2 = I_2 r_2^2$ *(1)*
   $I_2 = 1.5 \times 10^{-3} \times (3/5)^2 = 0.54 \times 10^{-3} = 5.4 \times 10^{-4}$ W/m^2 *(1)*
5. *(2)* 87.3 dB $L = 10 \log (5.4 \times 10^{-4} / 10^{-12})$ *(1)* $= 10 \log (5.4 \times 10^{8}) = 87.3$ dB *(1)*
6. *(2)* Open at both ends *(1)* The wavelength of the resonant frequency is 350 / 115 = 304 cm, which is twice the length of the tube *(1)*, which means that the tube must be open at both ends.
7. *(2)* If answer to Q'n 6 is Open at both ends: B, C, D, E all multiples
   If answer to Q'n 6 is Open at one end only: C, E odd multiples
8. *(3)*
   If answer to Q'n 6 is Open at both ends



If answer to Q'n 6 is Open at top end only.



9. *(2)* String instruments are played a short distance from a fixed end. In the case of the guitar, several cms from the bridge. In a flute the mouthpiece is about 5 cm from the end. Tympani (drums) are hit just off the edge. *(1)* The forced vibration has to be away from a node to excite vibration, but not on an antinode if a full range of frequencies is to be heard. *(1)*
10. *(2)* C, D
11. *(2)* For a free standing speaker, when a compression is created at the front, a rarefaction is created at the back when they met out to the side they can cancel *(1)*. A baffle is a means of preventing or increasing the path of the rarefaction from the back of the speaker getting to the front. *(1)*

END OF DATA SHEET

Published by Warringal Publications and Barrile Consulting