Neap:

Trial Examination 2009

VCE Physics Unit 4

Written Examination

Question and Answer Booklet

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

Student's Name: _____

Teacher's Name: _____

Structure of Booklet

Section	Number of questions	Number of questions to be answered	Number of marks
A Core – Areas of study			
1. Electric power	20	20	38
2. Interactions of light and matter	11	11	26
B Detailed studies			
1. Synchrotron and its applications	13	13	26
OR			
2. Photonics	13	13	26
OR			
3. Sound	13	13	26
			Total 90

Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, up to two pages (one A4 sheet) of pre-written notes (typed or handwritten) and one scientific calculator.

Students are NOT permitted to bring into the examination room: blank pieces of paper and/or white out liquid/tape.

Materials supplied

Question and answer booklet of 29 pages with a detachable data sheet in the centrefold.

Answer sheet for multiple choice questions.

Instructions

Detach the data sheet from the centre of this booklet during reading time.

Write your **name** and your **teacher's name** in the space provided on this page and on the answer sheet for multiple-choice questions.

Unless otherwise indicated, the diagrams in this booklet are **not** drawn to scale.

All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other electronic communication devices into the examination room.

Students are advised that this is a trial examination only and cannot in any way guarantee the content or the format of the 2009 VCE Physics Unit 4 Written Examination.

Area of study 1 – Electric power (38 marks)

Figure 1 shows a single coil of very low resistance wire connected to a 12 V battery and a variable resistor.

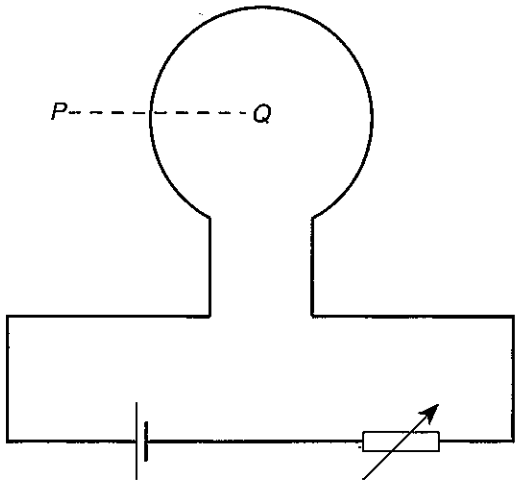


Figure 1

The variable resistor is adjusted to $R = 10\ \Omega$ so that current flows though the coil. Point Q is in the middle of the coil and points P and Q are equidistant from the wire along the line PQ.

Question 1

Calculate the magnitude of the current flowing though the coil.

	A

1 mark

Question 2

Which one of the following best represents the direction of the magnetic field produced by the current carrying coil at the position Q, as shown in Figure 1?

A. up
B. down
C. left
D. right
E. into the page
F. out of the page

2 marks

Question 3

Compared to the strength of the magnetic field at point Q, the strength of the magnetic field at point P will be

A. the same.
B. larger.
C. smaller.
D. cannot be determined from the information given

2 marks

The variable resistor is adjusted so that the new resistance is $R = 6\ \Omega$.

Question 4

Which one of the following is the ratio of the strength of the magnetic field produced by the coil at point Q when $R = 6\ \Omega$ compared to when $R = 10\ \Omega$?

A. 3 : 5
B. 1 : 1
C. 5 : 3
D. cannot be determined from the information given

2 marks

John is using a 240 V AC 2400 W iron to iron his clothes.

Question 5

Calculate the peak-to-peak voltage for the iron.

V

1 mark

Question 6

Calculate the RMS current being drawn by the iron.

A

2 marks

Figure 2 shows a simplified diagram of a small working model of a DC motor consisting of 50 coils of wire connected to a 12 V DC power supply. The total resistance of the coils of wire is 4.0 Ω. The length of side *AB* is 5.0 centimetres and the length of side *BC* is 2.5 centimetres. The strength of the magnetic field is 0.4 T. The design incorporates a split-ring commutator.

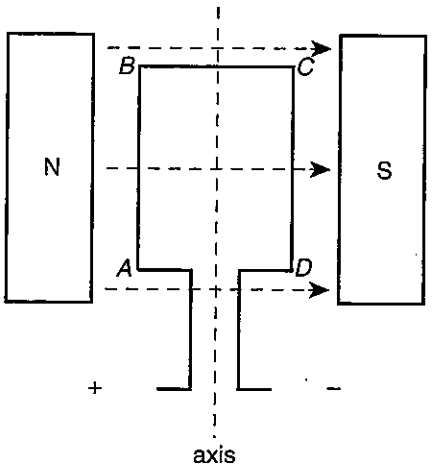


Figure 2

Question 7

Calculate the magnitude of the force acting on side *AB*.

N

2 marks

Question 8

Which one of the following best indicates the direction of the force acting on side *AB*?

A. up
B. down
C. left
D. right
E. into the page
F. out of the page
G. no force

2 marks

Question 9

Which one of the following best indicates the direction of the force acting on side *BC*?

A. up
B. down
C. left
D. right
E. into the page
F. out of the page
G. no force

2 marks

Question 10

Explain the purpose of the split-ring commutator in the DC motor.

2 marks

Figure 3 shows a schematic diagram of an AC generator. It is being rotated at 40 Hz. The strength of the magnetic field, B, is 0.5 T and the area of the coil is 0.2 m^2.

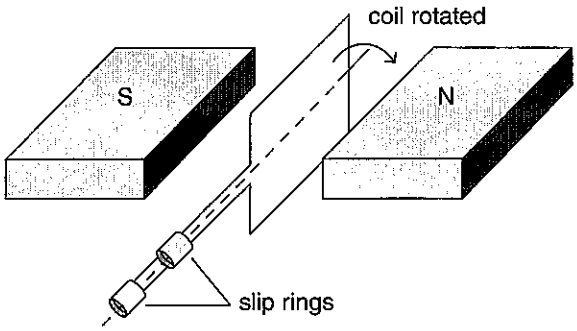


Figure 3

Question 11

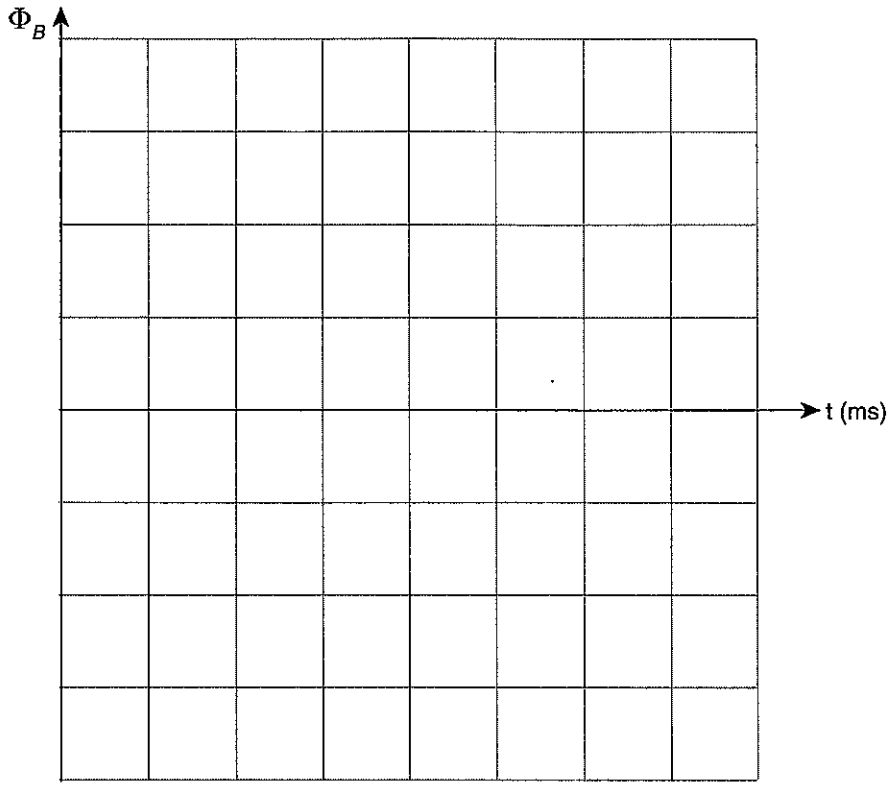
Calculate the magnetic flux Φ_B for the instant shown in Figure 3.

	Wb

2 marks

Question 12

On the axes below, draw the variation of magnetic flux as a function of time for one whole cycle starting at the instant shown in Figure 3. Put numerical values on the magnetic flux and time axes.



2 marks

Question 13

Explain the purpose of the slip rings in an AC generator as shown in Figure 3.

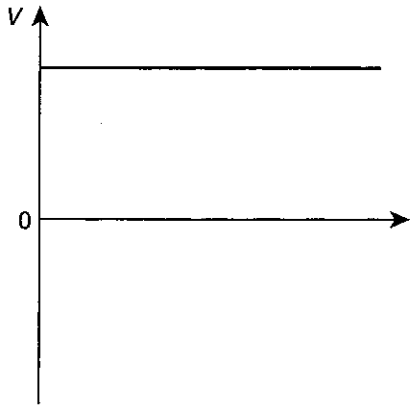
2 marks

A cathode-ray oscilloscope (CRO) is attached to the output of the slip rings.

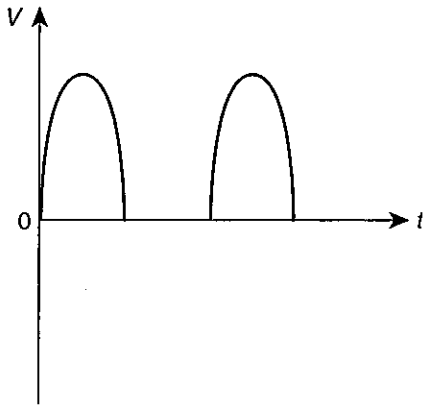
Question 14

Which of the following best shows the voltage variation of the generator that would be seen at the CRO?

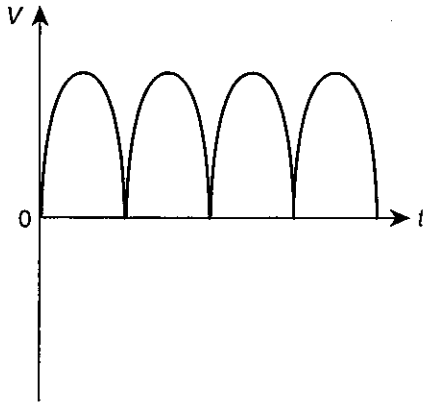
A.



B.



C.



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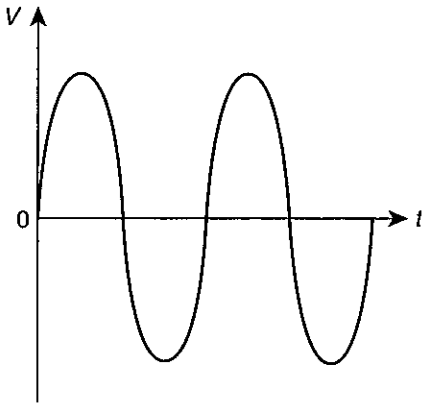


2 marks

Figure 4 shows the circuit diagram for a low voltage downlights system used in a kitchen.

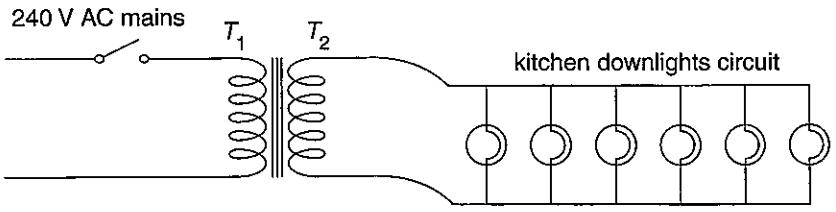


Figure 4

There are six downlights each rated at 30 W and 12 V AC. The circuit is connected via a transformer to the mains electricity. Assume the transformer is ideal.

Question 15

The 240 V mains section of the transformer (T_1) has 300 turns on it.

How many turns are there on the 12 V AC section of the transformer (T_2)?

2 marks

The switch is now closed and all of the downlights are on.

Question 16

Calculate the current flowing in one of the downlights.

A

2 marks

Question 17

Calculate the current flowing in the windings of the transformer T_1.

A

2 marks

One of the downlights malfunctions and burns out.

Question 18

Which of the following best explains what will happen to the kitchen downlights circuit?

A. All of the downlights stop working and the current going through the windings of transformer T_2 is zero.

B. The other five downlights keep working and the current going through the windings of transformer T_2 decreases.

C. The other five downlights keep working and the current going through the windings of transformer T_2 remains the same.

D. The other five downlights keep working and the current going through the windings of transformer T_2 increases.

2 marks

The Yallourn brown coal mine and power station is located in the Latrobe Valley, 150 km east of Melbourne. One generator generates 500 megawatts of electric power at 10 kV. This is then transformed to 500 kV for transmission to Melbourne. The total resistance of the transmission line used is 4 Ω.

Question 19

Calculate the amount of power lost in the transmission line.

W

2 marks

Question 20

Explain why the power is transmitted from Yallourn to Melbourne at 500 kV instead of 10 kV.

2 marks

END OF AREA OF STUDY 1

Area of study 2 – Interactions of light and matter (26 marks)

In an experiment to investigate the photoelectric effect, light of different frequencies was shone on an unknown metal. The voltage required to stop the most energetic ejected photoelectrons was recorded for the different frequencies of light.

It was found that no photoelectrons were ejected if the frequency of incident light was less than 5.6×10^{14} Hz, regardless of the intensity of the light.

The data collected was plotted on a graph as shown in Figure 5.

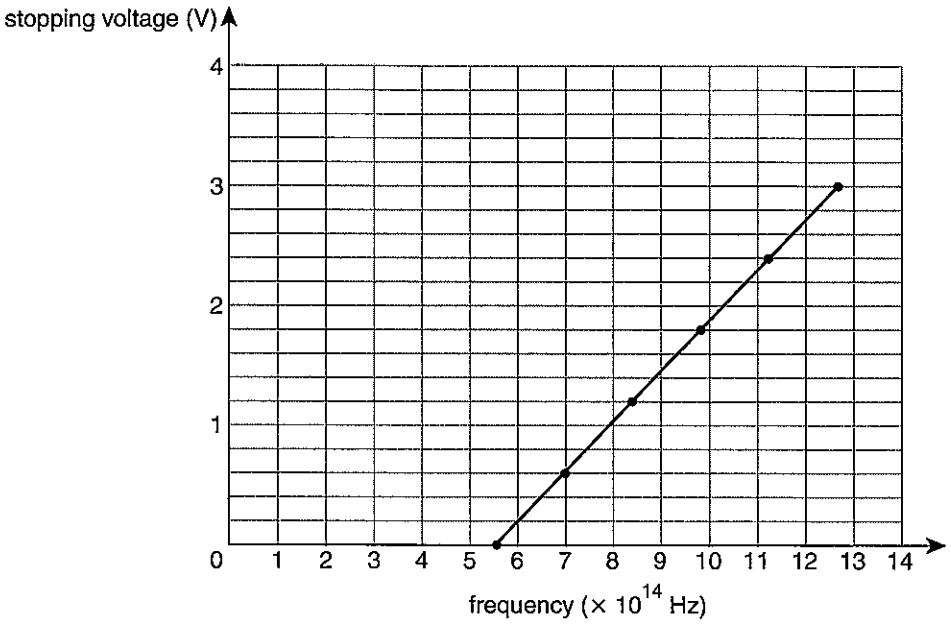


Figure 5

Question 1

Explain why the particle model provides a better explanation for the existence of a threshold frequency, regardless of light intensity, than the wave model.

3 marks

Question 2

Calculate the maximum kinetic energy of a photoelectron ejected when light of frequency 7.0×10^{14} Hz is incident on the metal surface. Include appropriate units in your answer.

2 marks

Question 3

Use the data provided in the graph to calculate the value of Planck's constant determined **in this experiment.**

eV s

2 marks

The following table of data provides the work functions for a number of different metals.

Table 1: Work function of different metals

Metal	Work function (eV)
caesium	1.9
potassium	2.3
magnesium	3.8
gold	5.1

Question 4

Which of the metals listed in Table 1 is most likely to be the unknown metal investigated? Use calculations to support your answer.

3 marks

In an experiment to demonstrate the wave-like nature of light, monochromatic green light is passed through double slits and an interference pattern detected on a screen, as shown in Figure 6.

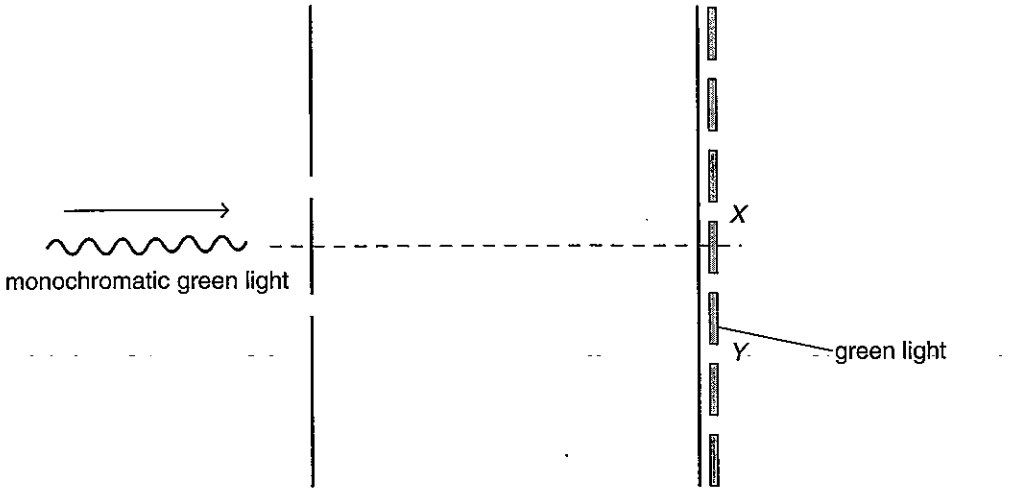


Figure 6

Points *X* and *Y* are two locations on the screen where no light is detected.

Question 5

The experimenters predict that at point *Y* the path difference is 765 nm.

Use this information to calculate the wavelength of the green light used to produce the pattern.

m

2 marks

Question 6

Calculate the momentum of a photon of the green light used in the experiment.

kg m s^{-1}

2 marks

Question 7

Which **one or more** of the following changes would result in an interference pattern where the dark and light bands were more closely spaced?

A. replacing the green light source with a red light source

B. increasing the distance between the two slits

C. increasing the distance between the screen and the slits

D. reducing the intensity of the green light source

2 marks

When X-rays of frequency 2.1×10^{18} Hz are fired at nickel crystals, a diffraction pattern can be detected. This pattern is shown in Figure 7a.

If electrons travelling at a particular speed are fired at the same crystals, a similar diffraction pattern can be produced. This is shown in Figure 7b.

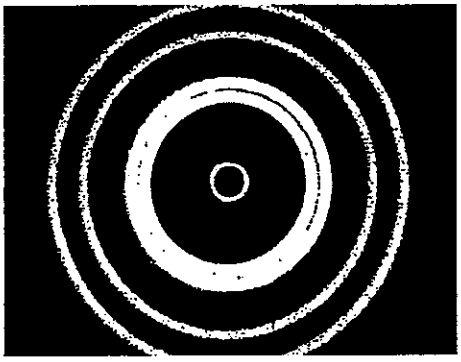


Figure 7a

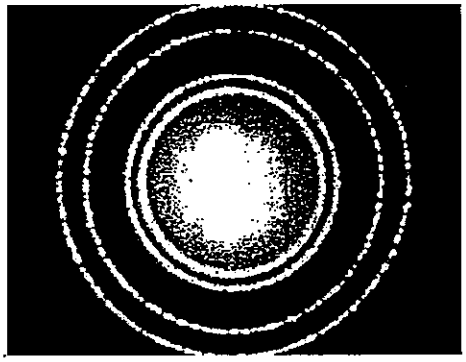


Figure 7b

Question 8

Calculate the speed at which the electrons must be travelling when they strike the nickel crystal in order to produce the diffraction pattern shown in Figure 7b.

m s^{-1}	3 marks

Question 9

If protons travelling at the speed calculated in Question 8 were incident on the nickel crystal, would they produce a diffraction pattern? Explain your answer.

3 marks

The energy levels for atomic sodium are shown in Figure 4.

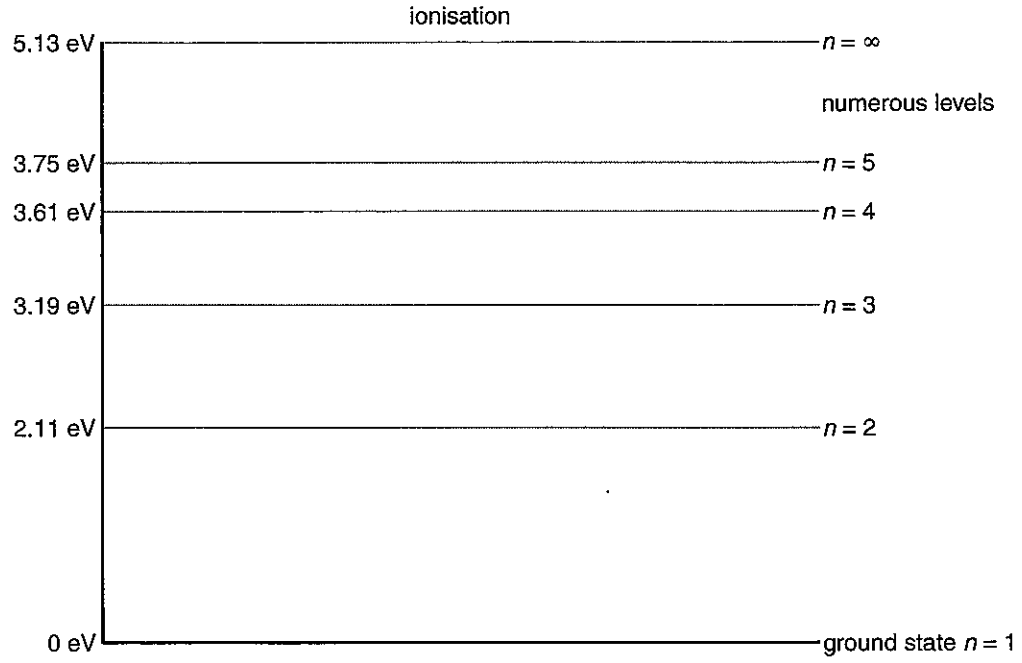


Figure 8

Question 10

A sodium atom is initially in its ground state ($n = 1$).

Which **one or more** of the following incident photons could be absorbed by the sodium atom?

A. 1.08 eV
B. 2.11 eV
C. 3.58 eV
D. 5.20 eV

2 marks

Question 11

A sodium atom is in an $n = 4$ excited state.

Calculate the highest frequency light that this atom could emit.

Hz

2 marks

END OF AREA OF STUDY 2

Detailed study 3 – Sound (26 marks)

A horn is used to signal the start of a yacht race. The frequency of the sound produced by the horn is 450 Hz and the speed of sound is 340 m s^{-1}.

Question 1

The wavelength of the sound produced by the horn is equal to

A. 0.76 m.
B. 1.32 m.
C. 110 m.
D. 790 m.

The intensity of the sound signal 2.0 m from the horn is measured to be 3×10^{-2} W m^{-2}.

Question 2

The sound level intensity (in dB) of the horn at this distance is equal to

A. 10.5 dB.
B. 15.2 dB.
C. 105 dB.
D. 300 dB.

Question 3

Jack is in his yacht 20.0 m from the horn when it signals the start of the race.

The intensity of sound at Jack's location is equal to

A. 7.5×10^{-6} W m^{-2}.
B. 3.0×10^{-4} W m^{-2}.
C. 1.5×10^{-3} W m^{-2}.
D. 3.0×10^{-3} W m^{-2}.

Some of the competitors complain after the race that they could not hear the start signal, so for the next race two horns, each identical to that used to start the first race, are sounded simultaneously.

Question 4

The overall effect of using two horns will be that

A. the sound intensity level of the start signal will increase by 2 dB.
B. the sound intensity level of the start signal will increase by 3 dB.
C. the sound intensity level of the start signal will double.
D. the sound intensity level of the start signal will increase by a factor of 4.

The graph shown in Figure 1 represents the sensitivity of the human ear to different frequencies. Each of the curves is known as an equal loudness curve.

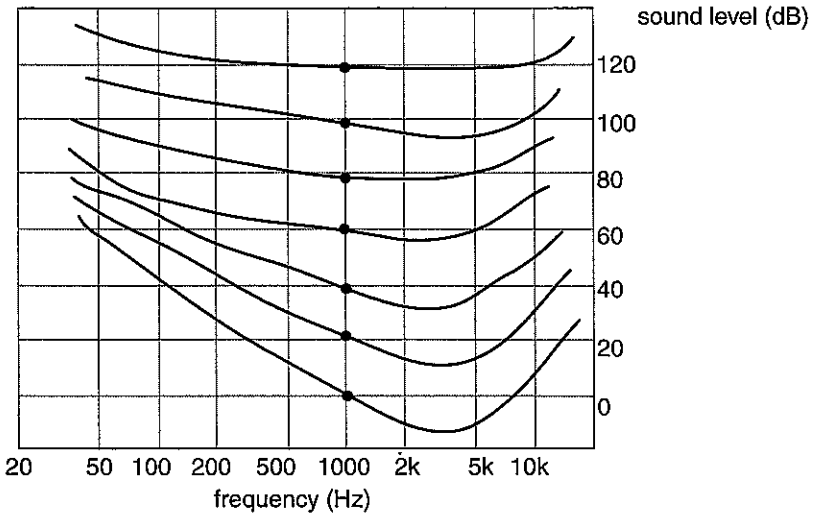


Figure 1

Question 5

According to the information provided in Figure 1, which of the following is correct?

A. A 40 Hz sound at 40 dB would be perceived to be equally as loud as an 80 Hz sound at 80 dB.

B. At 100 dB a 50 Hz sound will cause more damage to your ears than a 1000 Hz sound.

C. Our ears are most sensitive to frequencies less than 50 Hz.

D. A 5000 Hz sound at 60 dB would be perceived to be equally as loud as a 50 Hz sound at 80 dB.

Question 6

Which of the following statements about a standing wave produced in a spring and the travelling wave that produces the standing wave is **incorrect**?

A. The wavelength of the standing wave is equal to the wavelength of the travelling wave that produced it.

B. The frequency of the standing wave is double the frequency of the travelling wave that produced it.

C. The distance between nodes on a standing wave is equal to half of the wavelength of the travelling wave that produced it.

D. The amplitude of the antinodes on the standing wave is double the amplitude of the travelling wave that produced it.

The third harmonic is produced on a violin string of length 30 cm.

Question 7

If the speed of sound is 340 m s^{-1}, the frequency of the third harmonic is equal to

A. 850 Hz.

B. 1133 Hz.

C. 1700 Hz.

D. 5100 Hz.

Question 8

If the pipe in a pipe organ is closed at one end and open at the other, the length of pipe required for the organ to produce a third harmonic with the same frequency as the answer to Question 7 is equal to

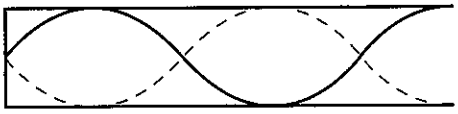
A. 15 cm.
B. 30 cm.
C. 60 cm.
D. 120 cm.

Question 9

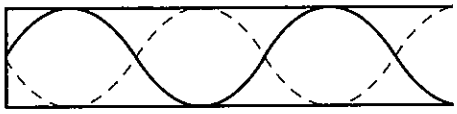
Which of the following diagrams correctly shows the pressure variation within the organ pipe when the third harmonic is produced?

A.

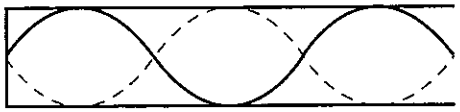
B.



C.



D.



Question 10

The two microphone types which **do not** utilise electromagnetic effects in their operation are

A. velocity and crystal microphones.
B. electret condenser and dynamic microphones.
C. velocity and dynamic microphones.
D. electret condenser and crystal microphones.

Question 11

A moving coil loudspeaker is most similar in construction to

A. an electret condenser microphone.
B. a dynamic microphone.
C. a velocity microphone.
D. a crystal microphone.

Question 12

The reason for placing a moving coil speaker in a large baffle is to

A. limit the vibration of the speaker coil so the sound is not distorted.
B. enable sound waves from the back of the speaker to be added to the sound waves from the front of the speaker so they interfere constructively.
C. reduce the effects of resonance from the speaker cone.
D. reduce the effects of destructive interference between the sound waves produced by the front and back of the speaker.

Kyle and Julie are investigating different musical instruments in their classroom. Julie plays a note of 1800 Hz on a flute, while Kyle produces a 320 Hz note on an oboe. Both sounds have equal perceived loudness at a distance of 1.0 m from the source.

Max is standing in the corridor outside the classroom, while Helen is standing just inside the door, 5.0 m away from Julie and Kyle. The location of the four students is shown in Figure 2.
The width of the doorway is 1.0 m.

Note: Figure 2 is not to scale.

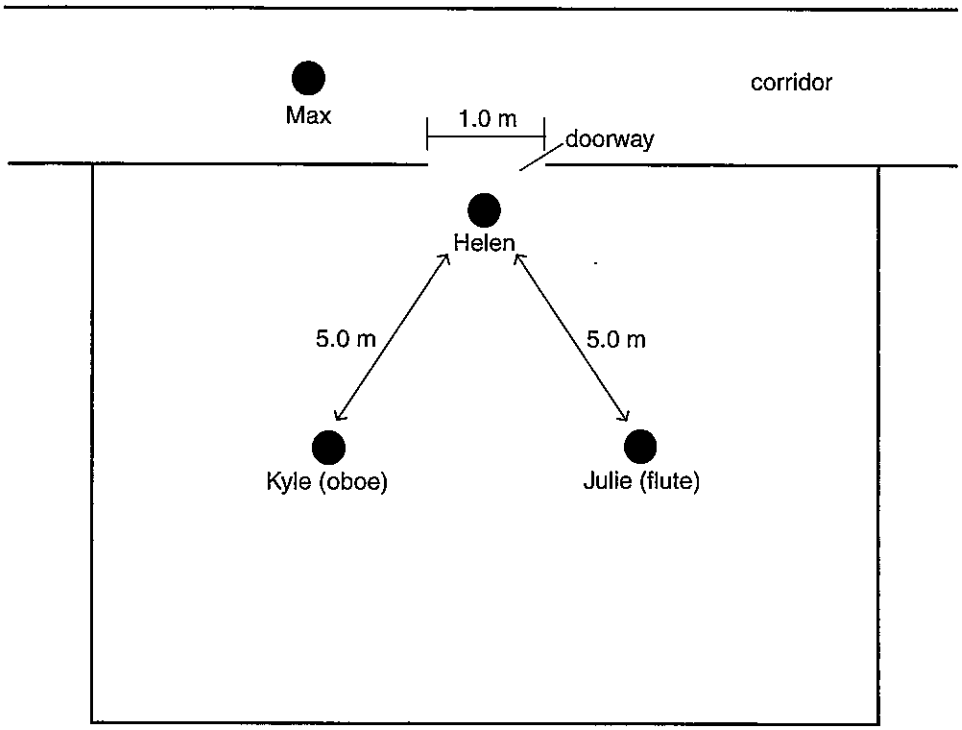


Figure 2

Question 13

Which of the following rows correctly describes the observations of Max and Helen?

	Max	Helen
A.	The oboe sounds louder than the flute.	The flute sounds louder than the oboe.
B.	The flute sounds louder than the oboe.	The oboe and the flute are equally as loud.
C.	The oboe and the flute sound equally as loud.	The oboe sounds louder than the flute.
D.	The oboe sounds louder than the flute.	The oboe and the flute sound equally as loud.

END OF QUESTION AND ANSWER BOOKLET