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PHYSICS

2007

Trial Examination 2

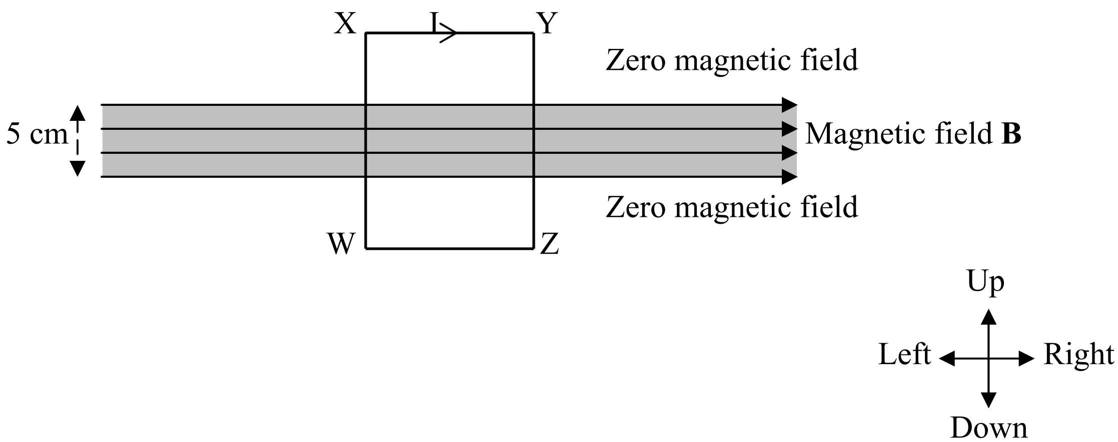
Electric power
Interactions of light and matter
Sound

SECTION A – Core

Instructions for Section A: Answer **all** questions for **both** Areas of study.

Area of study 1 – Electric power (40 marks)

A rectangular loop WXYZ of conducting wire is placed across a uniform magnetic field **B**. The wire carries an electric current I. WX = 15 cm, XY =10 cm.



Question 1 The net magnetic force on the loop is

A. to the left **B.** to the right **C.** upward **D.** downward **E.** into the page

F. out of the page **G.** zero

2 marks

Question 2 If the magnetic field **B**, the current I, the height WX and the width WZ are doubled, the magnetic force on the side WX will

A. be the same

B. double

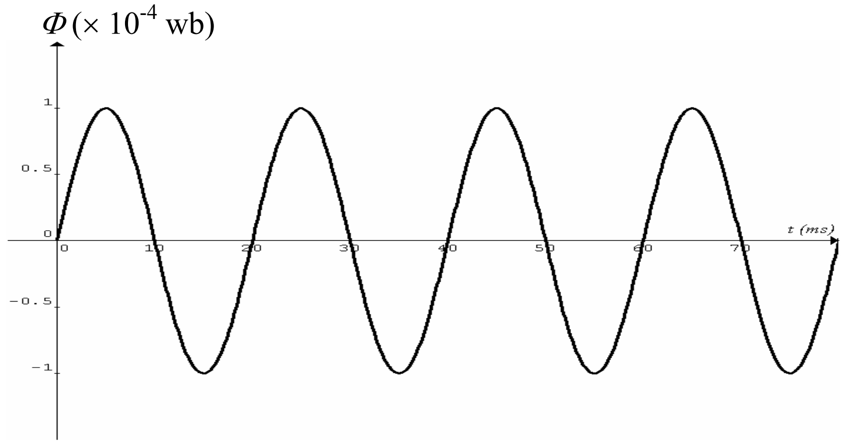
C. increase by a factor of 4

D. increase by a factor of 8

E. increase by a factor of 16

2 marks

A coil of insulated wire consisting of 50 closely wrapped loops is made to rotate in a uniform magnetic field. The magnetic flux Φ ($\times 10^{-4}$ wb) through each loop that changes with time t (ms) is shown in the graph below.



Question 3 Calculate the frequency of rotation of the coil.

2 marks

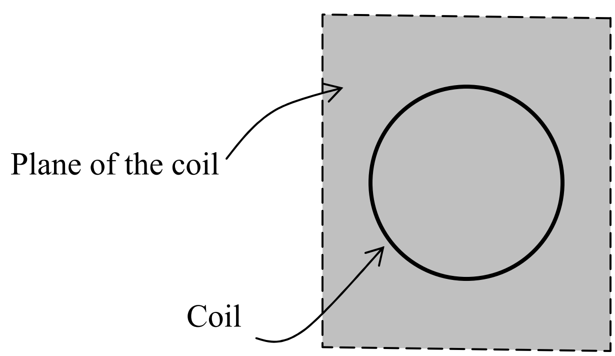
Question 4 At $t = 15$ ms, the magnetic field and the plane of the coil are

A. parallel

B. perpendicular

C. at 45°

D. at 315°



2 marks

Question 5 Calculate the average induced emf between $t = 0$ and $t = 5.0$ ms.

V

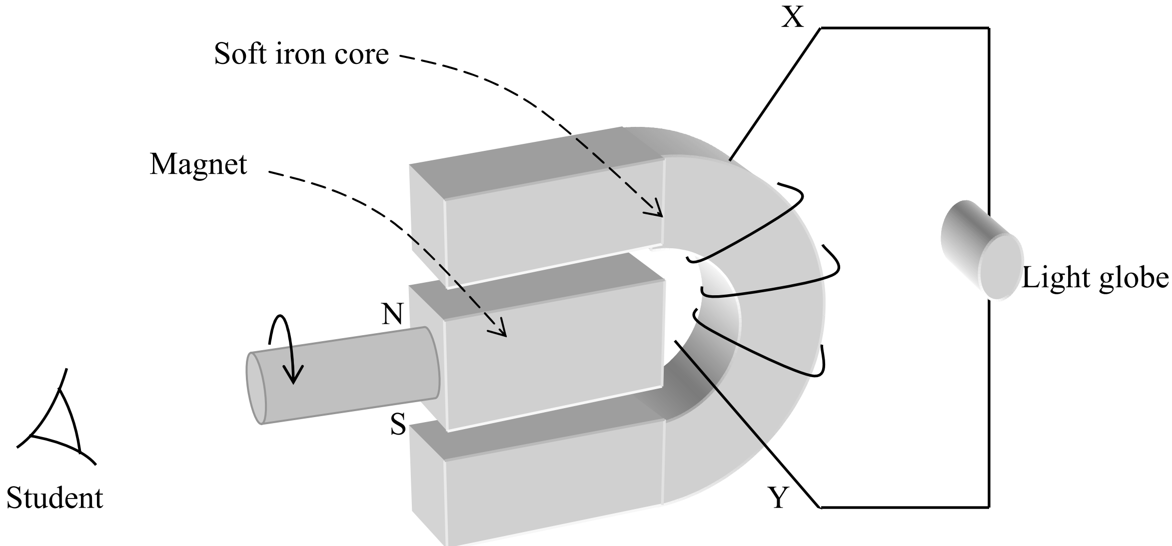
3 marks

Question 6 What is the induced emf at $t = 5.0$ ms?

V

2 marks

The following diagram shows the construction of a simple alternator.



The student rotates the magnet **clockwise** at a constant rate. The diagram shows the position of the magnet at a particular moment.

Question 7 What is the direction of the flow of current through the light globe just before that particular moment? From X to Y or from Y to X.

1 mark

Question 8 Explain your answer to **question 7** in terms of magnetic field, magnetic flux and Lenz's law.

3 marks

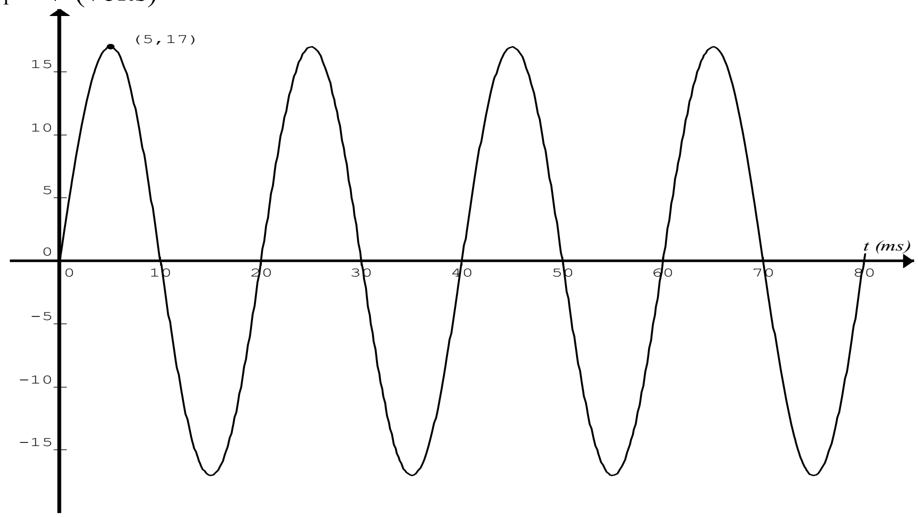
Question 9 What is the magnitude of the induced current at that particular moment?

A

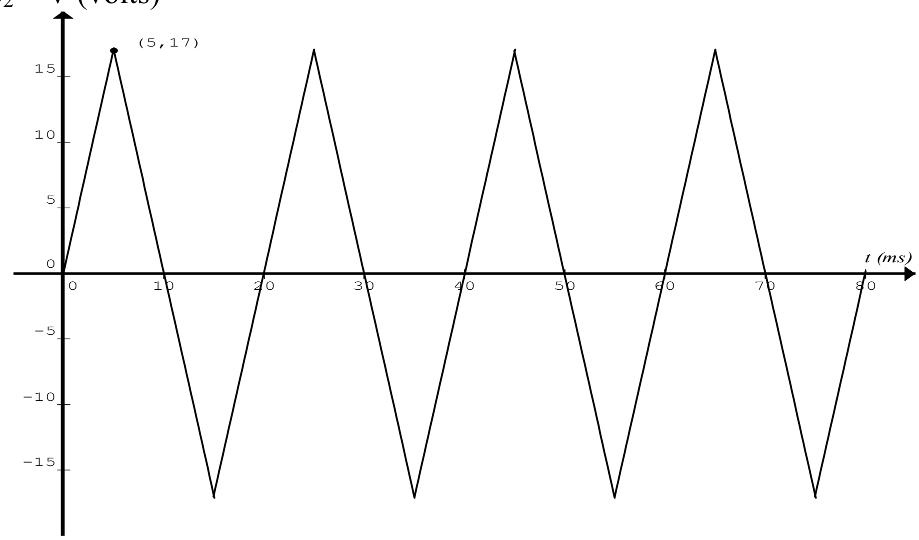
2 marks

Two sources of AC supply, S_1 and S_2 are shown below.

Source S_1 V (volts)



Source S_2 V (volts)



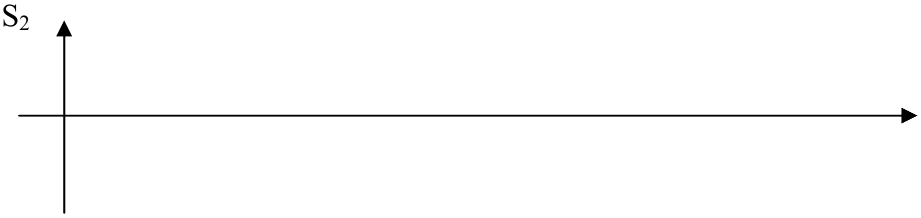
A light globe (assuming the resistance is constant 12 Ω) is connected to S_1 and then to S_2.

Question 10 In each case sketch I (A) versus t (ms) graph and indicate the magnitude of the peak current I_p.

3 marks

Source S_1

Source S_2



Question 11 The power of the light globe is 8.0 watts when it is connected to S_2.
What is the rms voltage of S_2?

volts

3 marks

A transformer (ideal) is used to lower the mains supply voltage to run a light globe that has a power rating of 25 watts at 12 volts.

Question 12 What is the value of the ratio

$$\frac{\text{number of turns in the secondary coil}}{\text{number of turns in the primary coil}}$$

of this transformer?

2 marks

Question 13 Calculate the current in the primary coil when the light globe is switch on.

A

2 marks

A short electrical cord connecting the transformer to the mains supply is rated 15 A and has negligible resistance.

Question 14 How many identical light globes rated 25 watts at 12 volts can be connected in parallel to the transformer safely without overloading the circuit?

3 marks

A long extension cord connecting the transformer to the mains supply is also rated 15 A and has total resistance of 0.50 Ω? You may assume that the cord is carrying the maximum allowable current.

Question 15 Determine the voltage input at the primary coil of the transformer.

volts

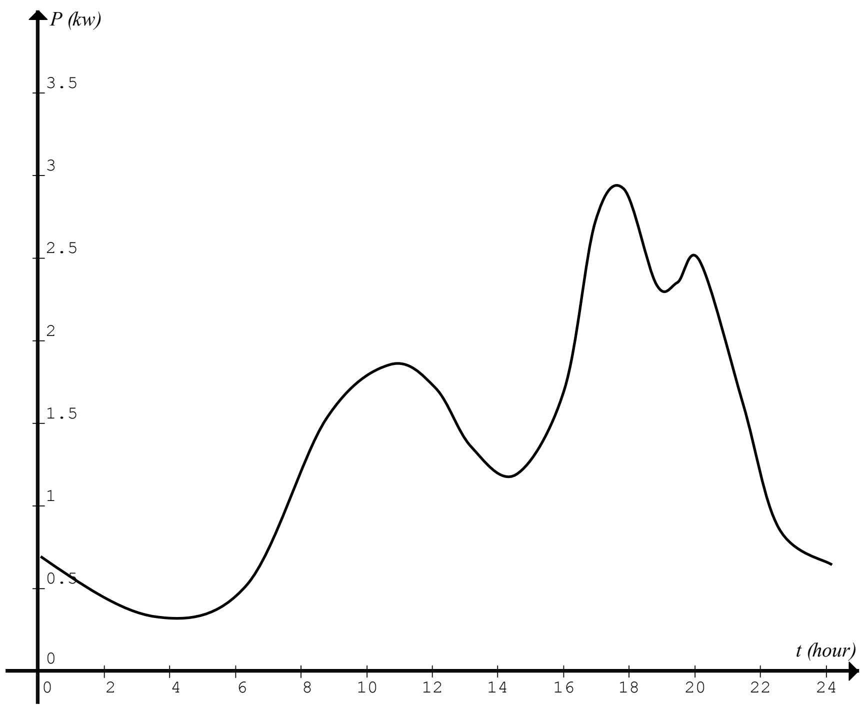
3 marks

Question 16 Determine the total power delivered to the light globes.

watts

2 marks

The electricity usage of a family on a particular day is shown in the following load curve.



Question 17 Estimate the cost of electricity used by the family in the 24-hour period at $0.13 per kilowatt-hour.

$

3 marks

Area of study 2 – Interactions of light and matter (25 marks)

Question 1 Light from an incandescent light globe is incoherent. Explain this statement in terms of the thermal motion of atoms in the filament.

2 marks

Question 2 A student failed to observe interference effects using two sources of light. Plausible reason for the failure is that

A. there was a random phase difference between the two sources.

B. there was a constant phase difference between the two sources.

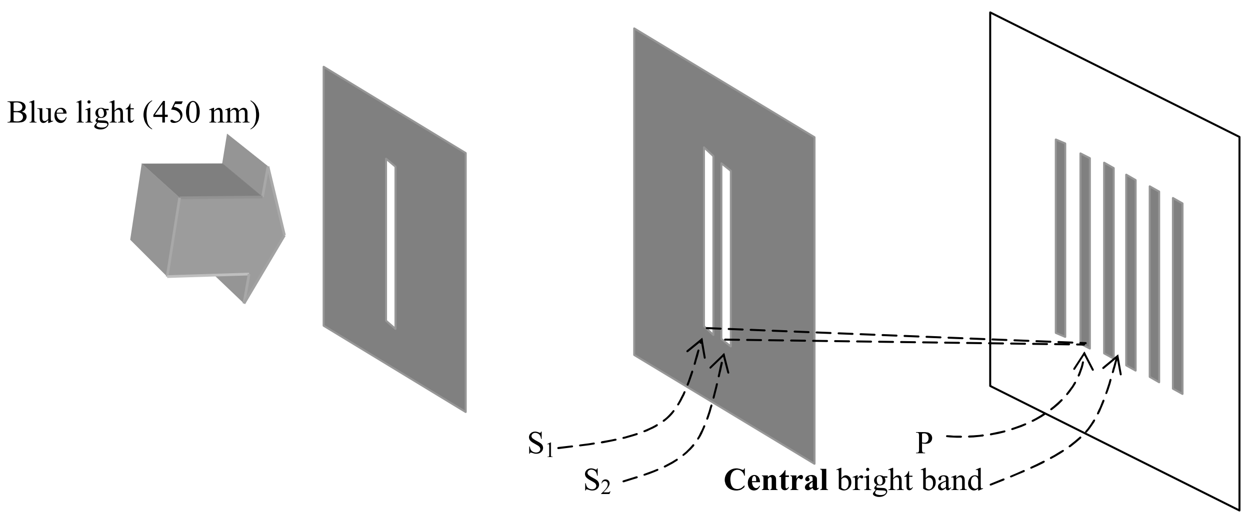
C. the two sources had different wavelengths.

D. the two sources had changing frequencies.

(One or more answers)

2 marks

A student carried out Young's double slits experiment using the following set-up.



Question 3 Explain the formation of the dark band marked P. Include calculation of the difference between the two distances PS_1 and PS_2.

nm

3 marks

Question 4 Name two changes to the interference pattern if blue light is replaced with red light.

2 marks

Question 5 Explain the purpose of the single narrow slit used in the experiment.

2 marks

Question 6 The sun appears red when the air is filled with smoke particles (e.g. from a bush fire). Use the wave nature of light to explain this phenomenon.

2 marks

Question 7 The work function of a piece of metal is 2.3 eV. Electromagnetic radiation of a single frequency is directed at the metal. The electromagnetic radiation that does **NOT** produce photoelectrons is

A. infrared light.

B. ultraviolet light

C. red light (630 – 750 nm)

D. green light (490 – 560 nm)

E. blue light (420 – 490 nm)

(One or more answers)

2 marks

Question 8 X-rays (1.0×10^{18} Hz) undergo diffraction when fired at a crystal. If electrons are used instead of X-rays, calculate the speed of the electrons required to produce the same diffraction pattern.

ms^{-1}

3 marks

Question 9 Which one of the following interactions between light and matter best demonstrates that light has momentum?

A. The photoelectric effect

B. Diffraction of light

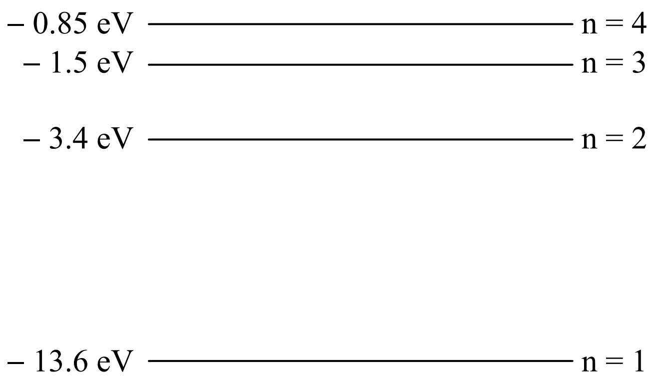
C. The Compton effect

D. Refraction of light

E. Absorption/emission of light by atoms

2 marks

The following diagram shows some of the energy levels of hydrogen.



Question 10 The wavelength of red light has the range 630 to 750 nm. The red line in the emission spectrum of hydrogen is most likely coming from the transition of electrons from

A. n = 2 to n = 1

B. n = 3 to n = 1

C. n = 3 to n = 2

D. n = 4 to n = 2

E. n = 4 to n = 3

2 marks

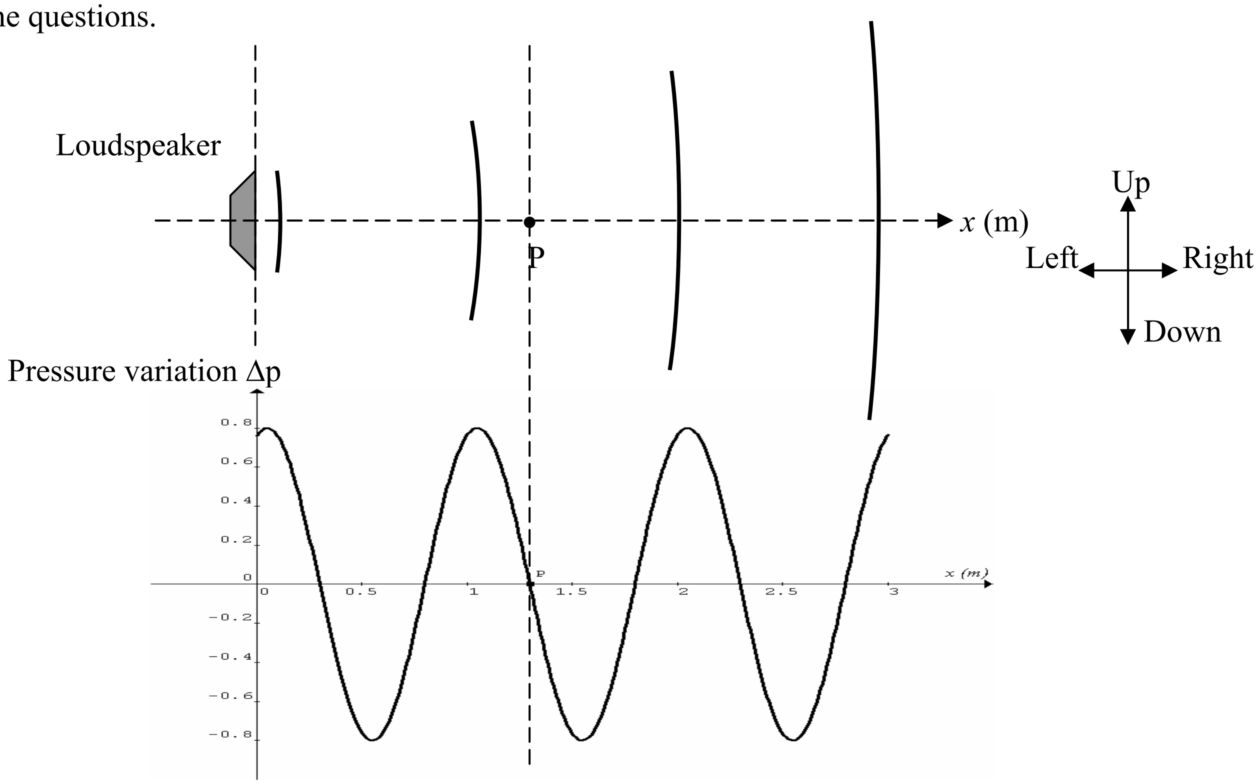
Question 11 Discuss how de Broglie's idea of matter waves can be used to explain the quantized energy levels of hydrogen.

3 marks

SECTION B – Detailed studies

Detailed study 3 − Sound (25 marks)

Answer **all** the questions.



The diagrams above show a loudspeaker sending out a sound wave and the corresponding graph of pressure variation versus distance from the loudspeaker at a particular time. The speed of sound is 340 ms^{-1}. Point P is a particular position in front of the loudspeaker.

Question 1 Estimate the frequency of the sound wave.

Hz

2 marks

Question 2 The particle displacement at position P **at that particular moment** is

A. upward **B.** downward **C.** to the left **D.** to the right

E. out of the page **F.** into the page **G.** zero

2 marks

Question 3 When a sound wave in air travels from a cool region to a warm region, which one of the following statements about frequency f, wavelength λ and speed v of the sound wave is correct?

A. All three quantities f, λ and v change in values.

B. The values of f and λ change but the value of v remains the same.

C. The values of v and λ change but the value of f remains the same.

D. The values of f and v change but the value of λ remains the same.

E. All three quantities f, λ and v remain constant in values.

2 marks

Two loudspeakers are connected in phase in open space and each one sends out sound of the same frequency. The sound intensity levels at positions P and Q are 95 dB and 52 dB respectively.

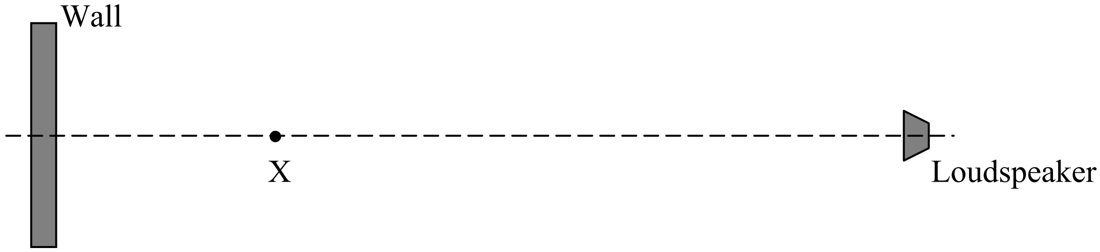
Question 4 Determine the value of the ratio $\frac{I_P}{I_Q}$, where I_P and I_Q are the sound intensities at P and Q respectively.

3 marks

Question 5 Give two good reasons why the inverse square law does not apply to the sound intensity in this situation.

2 marks

A loudspeaker sends out a continuous sound wave of frequency 580 Hz towards a smooth solid wall. The speed of sound is 340 ms^{-1}.



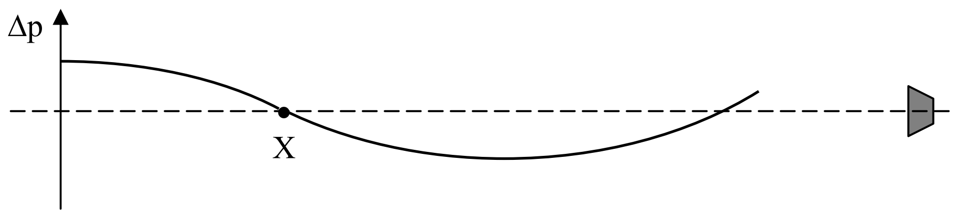
Question 6 Point X is the second node from the wall. Determine the distance of point X from the wall.

m

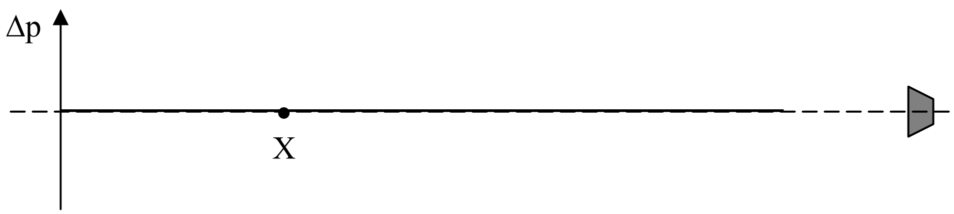
2 marks

Question 7 Which one of the following graphs is a possible representation of the pressure variation Δp in front of the wall at time *t*? (One or more answers)

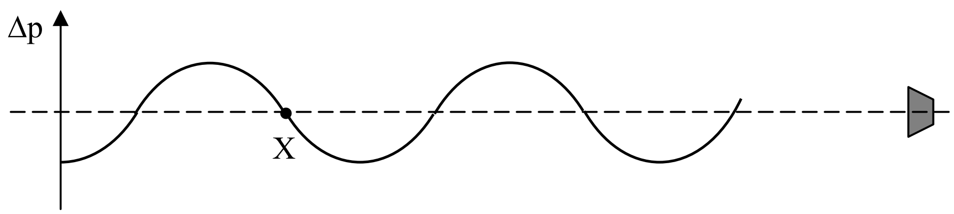
A.



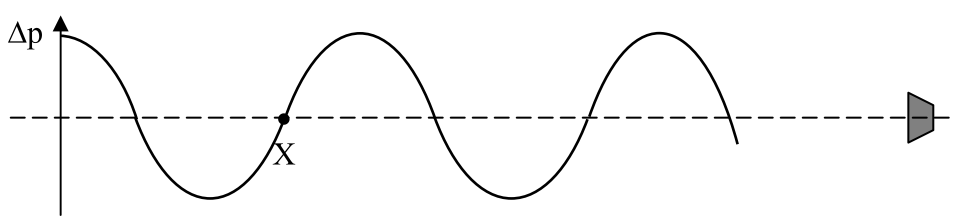
B.



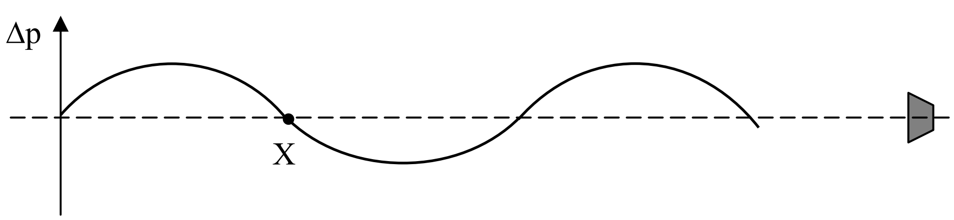
C.



D.



E.



2 marks

Question 8 The operation of each device in the following table is based on either electrical (E) or electromagnetic (EM) effect. Write E or EW under the heading 'operation' next to each device.

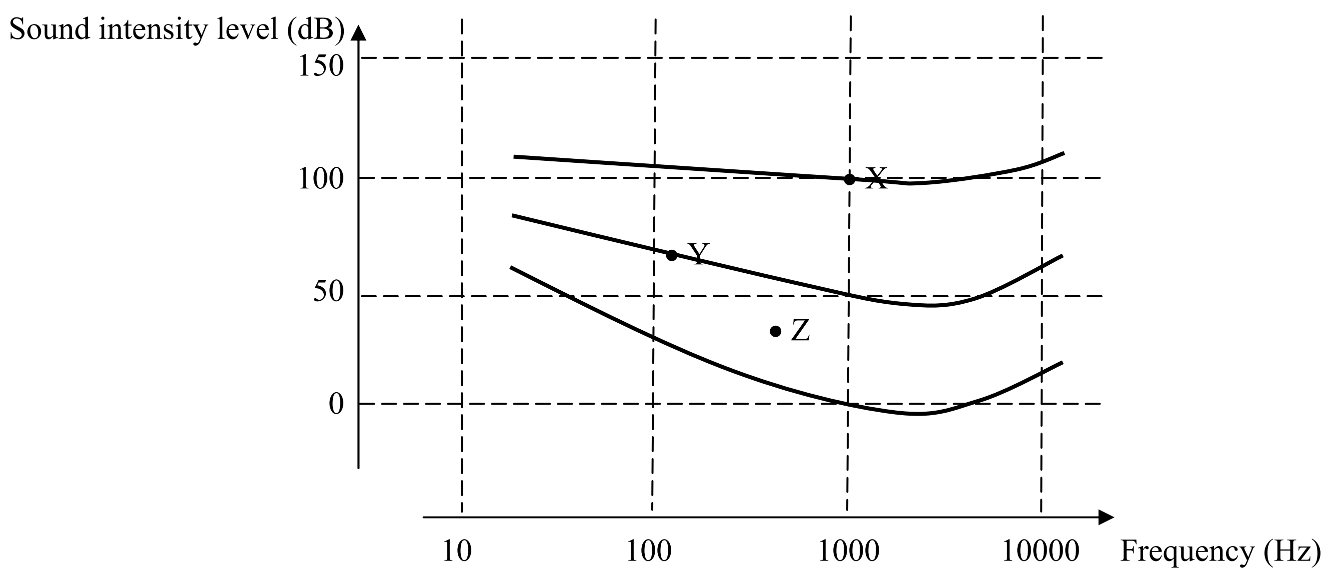
Device	Operation
Electret-condenser microphone	
Crystal microphone	
Velocity microphone	
Dynamic microphone	
Dynamic loudspeaker	

3 marks

Question 9 Explain two effects on the sound produced by a loudspeaker when it is stripped of baffles and enclosure.

2 marks

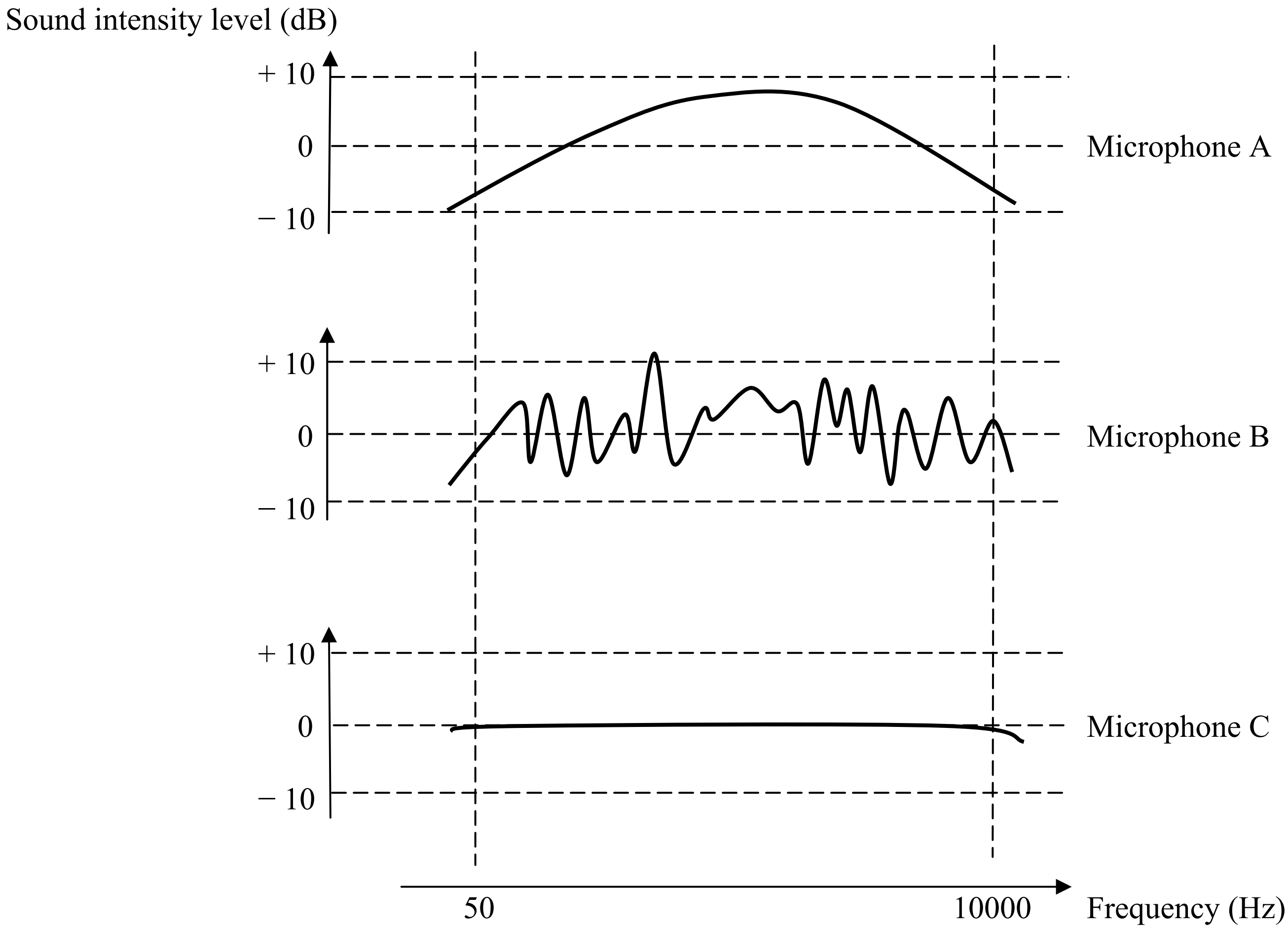
Question 10 Three frequency response curves of hearing are shown below. Estimate the loudness (in phon) of three sounds marked as X, Y and Z.



Sound	Loudness (phon)
X	
Y	
Z	

3 marks

Question 11 The frequency response curves of three microphones are shown below.



Explain which microphone gives the best response to music.

2 marks

End of Exam 2

