PHYSICS

2010

Trial Examination 2

Electric power
### Interactions of light and matter
Sound

(Note: Use information in the formula data sheet supplied by VCAA)

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

Area of study 1 – Electric power (38 marks)

Two electromagnets **A** and **B** are shown below. The electric current direction in each one is indicated by an arrow. PQRS is a **horizontal plane** between the two electromagnets.
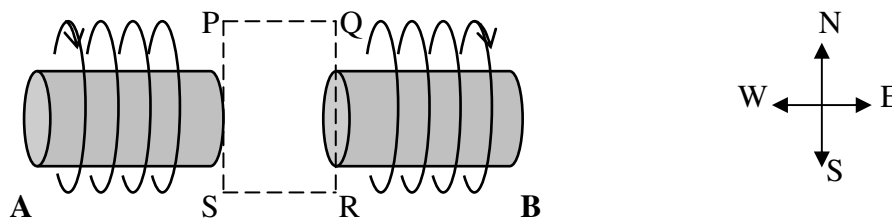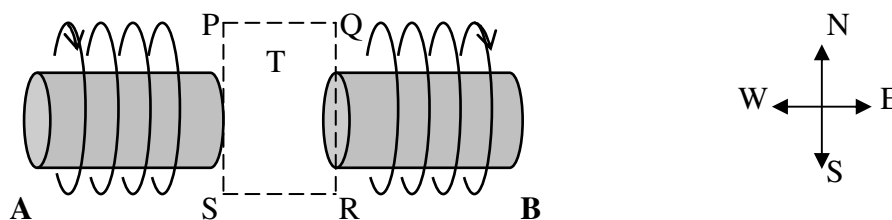
Question 1 Draw 3 appropriate magnetic field lines to indicate the magnetic field pattern of electromagnet **B** alone.

2 marks
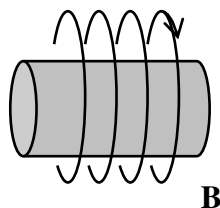
Question 2 Draw 3 appropriate magnetic field lines in the plane PQRS to indicate the magnetic field pattern produced by electromagnets **A** and **B**.
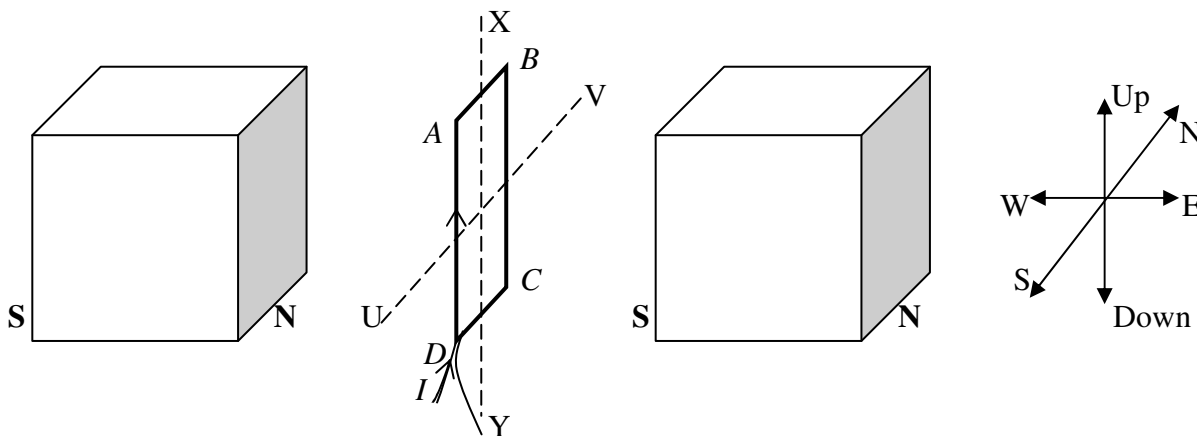
2 marks

Question 3 Assuming the earth's magnetic field is negligible, a compass needle placed at point T (see diagram in **Question 2**) on plane PQRS will align itself in the direction closest to

A. North-south   B. East-west   C. North-west   D. North-east   E. Upward   F. Downward
                                                                    (Out of the page)   (Into the page)

2 marks

Two permanent magnets produce a uniform magnetic field of 0.50 tesla in the region between them. *ABCD* is a rectangular current-carrying coil of 20 turns. *Initially* it is at rest and the uniform magnetic field is perpendicular to it. $I = 30$ mA, $AB = 5.0$ cm and $BC = 10$ cm.

Question 4   Calculate the magnitude of the magnetic force on side *AB*. Ignore the earth's magnetic field.

3 marks

N

Question 5   The direction of the magnetic force on side *AB* is

A. North   B. South   C. East   D. West   E. Upward   F. Downward

2 marks

Question 6   Describe and explain the motion (if any) of the coil relative to the axes UV or XY.

3 marks

Two permanent magnets produce a uniform magnetic field of 0.50 tesla in the region between them. *ABCD* is a closed rectangular circuit of 20 turns of continuous insulated wire. $AB = 5.0\,\text{cm}$ and $BC = 10\,\text{cm}$. *Initially* the uniform magnetic field is perpendicular to the circuit *ABCD*.
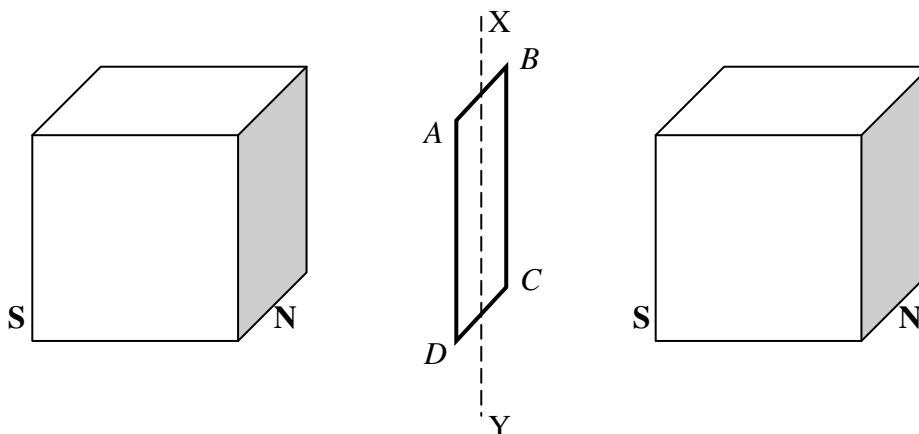
Question 7   Calculate the magnetic flux through the coil.   2 marks

Wb

Question 8   Describe and explain the direction of the induced current in the coil when the coil is rotated (i) *clockwise* by 60° (viewing from above) and, (ii) *anticlockwise* from its initial orientation by 60° (viewing from above). XY is the axis of rotation.

3 marks

Question 9   In **Question 8**, the magnitude of the average induced emf is 0.25 volts. Calculate the time taken to rotate the 60° angle.

3 marks

s

A simple dc motor has 2 half-ring commutators. It is used as a generator by rotating the axle manually at a frequency of 20 Hz. The peak voltage generated is 0.50 V.
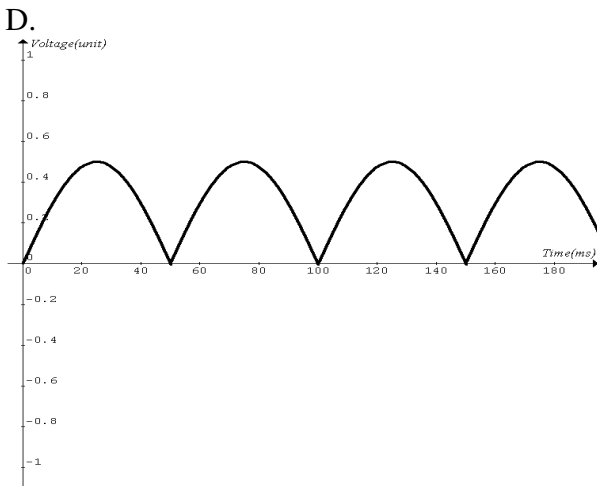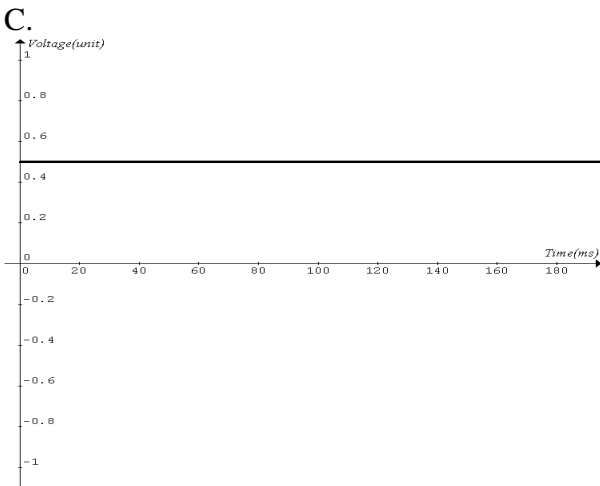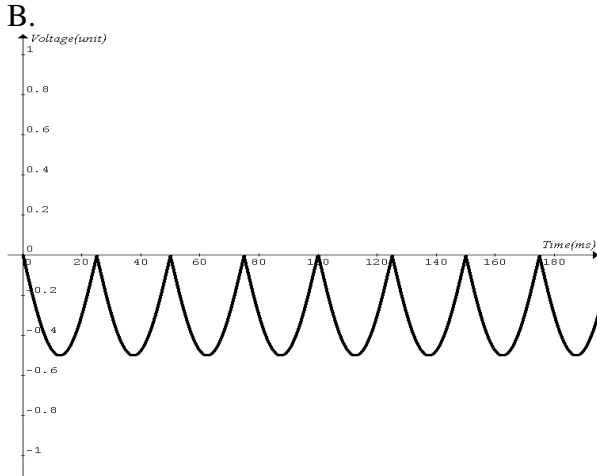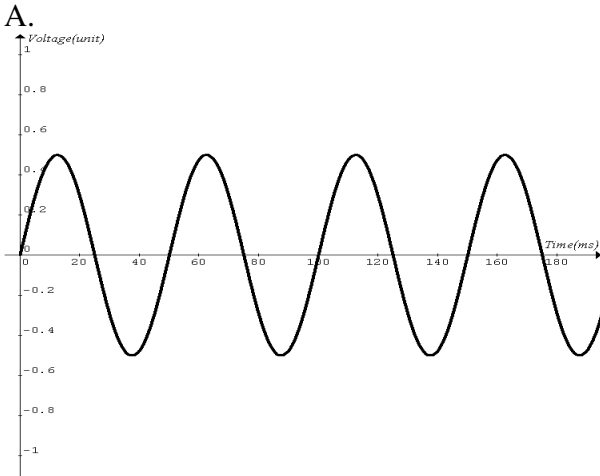
Question 10 Determine the period of the output voltage. 2 marks

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┌─────────────────────┐
│            ms       │
└─────────────────────┘
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Question 11 Which one of the following voltage-time graphs gives the best indication of the generator output? 2 marks

A.

B.

C.

D.

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┌─────────────────────┐
│                     │
└─────────────────────┘
```
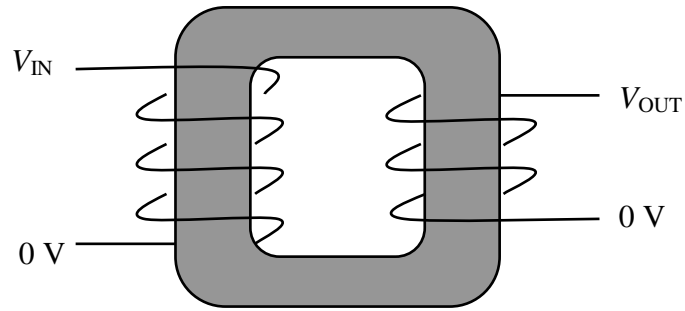
Question 12 What is the *rms* voltage of the generator output? 2 marks

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┌─────────────────────┐
│          V          │
└─────────────────────┘
```
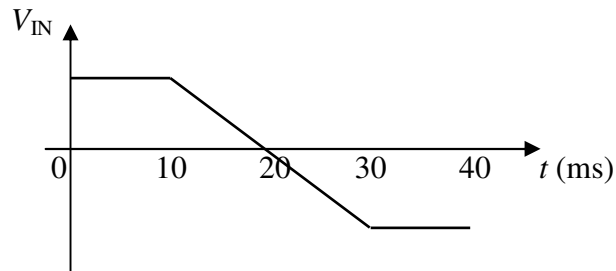
The following diagram shows a simple transformer. **The transformer has an efficiency of 95%.**

Question 13   The voltage at V_{IN} is shown below.

The shape of the voltage at V_{OUT} is best represented by

A.

B.

C.

D.

2 marks

Question 14   The average output power of the transformer is 12.0 W. What is the average input power of the transformer?   1 mark

W

A student builds a model circuit to show the transmission of electricity from a power station (power pack set at 6 V *DC*) to a home (6 V 20 W light globe). The long transmission wires have a total resistance of 1.2 Ω.

Question 15   The measured voltage across the light globe is 3.8 V. What is the current in the transmission wires? 2 marks

A

Question 16   What percentage of the power from the power pack is lost during transmission? 2 marks

%

Question 17   Without shortening the transmission wires how would you ensure a voltage of 6.0 V across the light globe? Show calculations to support your answer.

3 marks

Area of study 2 – Interactions of light and matter (28 marks)

Setup of Young's double-slit experiment is shown below. The wavelength of the laser light is 630 nm.
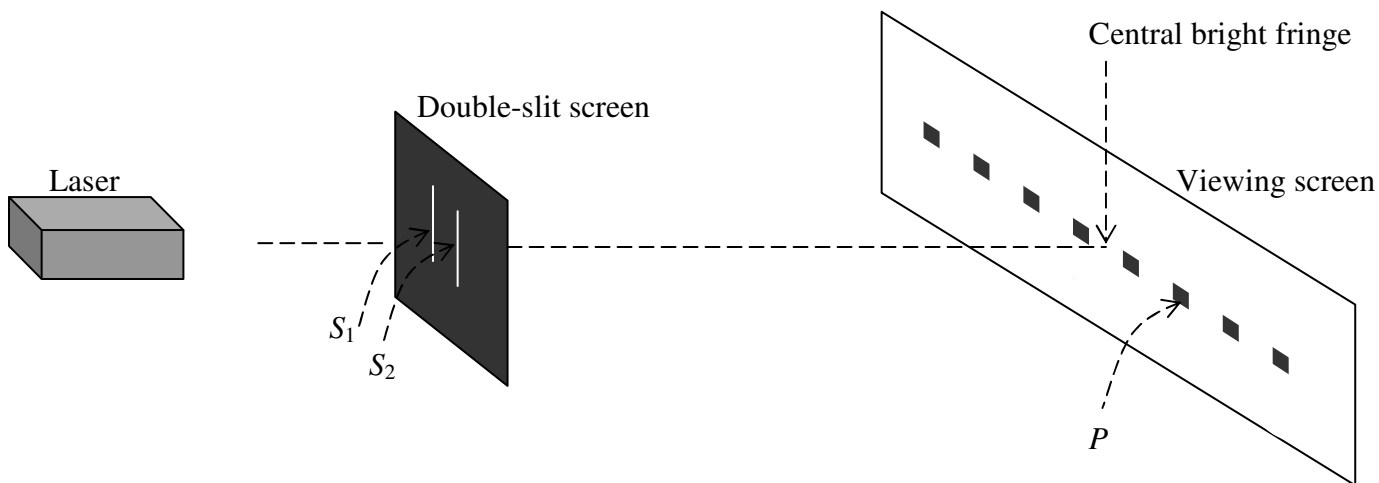
Question 1   Why is it necessary to use laser light instead of light from a light globe?   2 marks

Question 2   Calculate the difference between distance PS_1 and distance PS_2.   2 marks

m

Question 3   Which **one or more** of the following changes will decrease the fringe spacing on the screen?

A.   Increase the width of the slits.

B.   Move the laser closer to the double-slit screen.

C.   Decrease the distance between the double-slit screen and the viewing screen.

D.   Decrease the separation between the two slits.

E.   Increase the wavelength of the laser light.

2 marks

A photocell is used to investigate the photoelectric effect. Two sets of data (photoelectric current I versus applied voltage V) are shown below. One set of data is for light L_1, the other set for light L_2.
P is the intersection of the two sets of data.
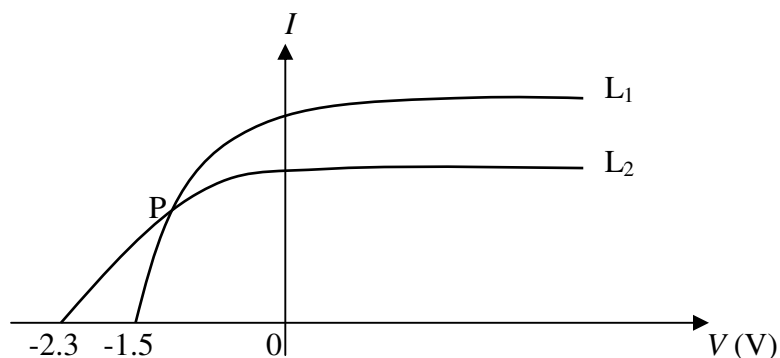
Question 4   Which one of the following statements is true?   2 marks

A.   Light of the same frequency and intensity is used to produce the two sets of data.

B.   At point P the light used has the same frequency and intensity.

C.   The light used to produce one of the two sets of data has longer wavelength and higher intensity.

D.   The light used to produce one of the two sets of data has higher frequency and intensity.

**Question 5**   One set of data has the highest photoelectron kinetic energy. Calculate this highest kinetic energy in joules.   2 marks

J

Question 6   If the cathode of the photocell is replaced with a different metal, does L_1 or L_2 has a better chance of producing photoelectrons? Explain your answer in terms of threshold frequency?   3 marks

In another photoelectric effect experiment, a set of data is collected and shown in the following *stopping voltage V_o versus frequency f* graph.
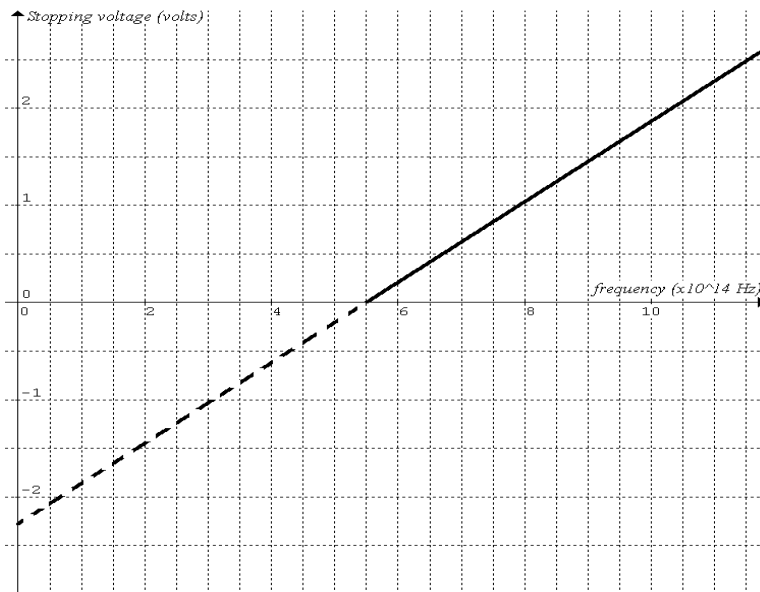
Question 7   What is the work function of the metal in eV? 1 mark

eV	

Question 8   Photoelectrons are emitted when UV light (10.1×10^{14} Hz) is directed at the cathode of the photocell. Determine the range of kinetic energy (J) of the electrons emitted. 3 marks

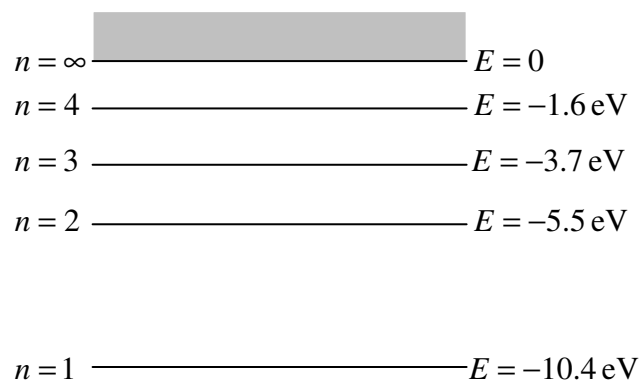|	
J	

Question 9   Now the cathode is replaced with a different metal and the experiment is repeated. The threshold frequency is 2.5×10^{14} Hz. Accurately draw a graph showing the results of the experiment on the same set axes shown above.

2 marks

Question 10   Determine whether or not significant diffraction will occur when a beam of electrons (moving at $1.2 \times 10^6 \, \text{ms}^{-1}$) passes through the gap between atoms in a crystal. The arrangement of the atoms in the crystal is lattice-like, and the layers of atoms are separated by a distance of 0.8 nm approximately. Show calculations and explanation.

3 marks

The energy level diagram for the mercury atom is shown below.

$n = \infty$ ──────────────── $E = 0$

$n = 4$ ──────────────── $E = -1.6 \, \text{eV}$

$n = 3$ ──────────────── $E = -3.7 \, \text{eV}$

$n = 2$ ──────────────── $E = -5.5 \, \text{eV}$

$n = 1$ ──────────────── $E = -10.4 \, \text{eV}$

Question 11   Describe the result of a collision between a photon of energy 11.3 eV and a mercury atom in the ground state. Include energy calculation in your answer.   3 marks

Question 12   A mercury atom makes a transition from the $n = 3$ state to a lower energy state. Calculate the shortest wavelength of light emitted.   3 marks
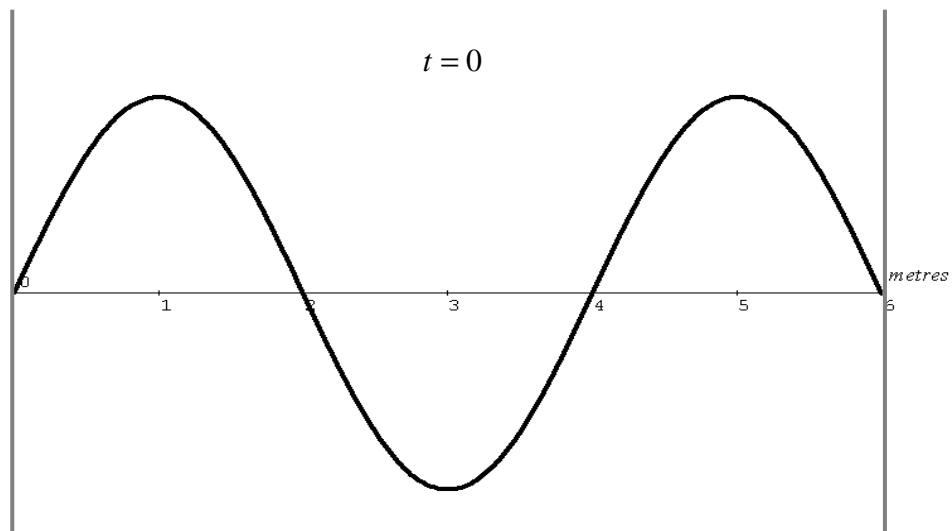
m

SECTION B – Detailed studies

Detailed study 3 – Sound (24 marks)
Answer **all** the questions.

Use the following information to answer Questions 1, 2 and 3

The graph shows the pressure variation of a standing sound wave set up between two parallel walls 6 metres apart. The wave reaches its *maximum* amplitude at $t = 0$ as shown below. The speed of sound is 338 ms^{-1}.
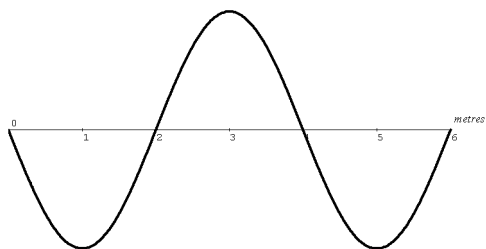

$t = 0$

Question 1   The frequency (Hz) of the sound wave is closest to

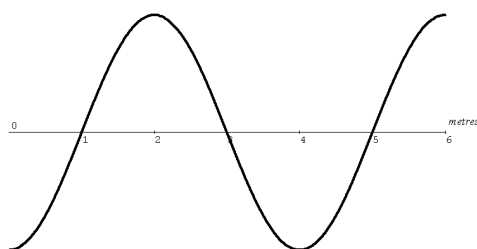A.   42   B.   85   C.   169   D.   0.0012

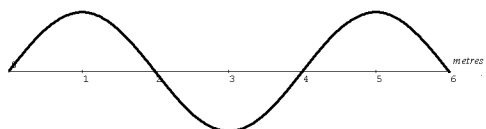**Question 2**   At $t = \dfrac{1}{4} \times the\ period\ of\ the\ sound\ wave$, the graph of the pressure variation is closest to
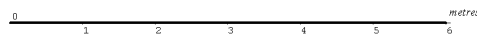
A.

B.

C.

D.

Question 3 Which one of the following statements is true?

A. The standing sound wave is a transverse wave.

B. The standing sound wave has two pressure antinodes at $t = 0$.

C. The standing sound wave always has three pressure antinodes.

D. The standing sound wave will not be affected if there is a change in air temperature between the walls.

Use the following information to answer Questions 4 and 5

Not drawn to scale
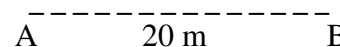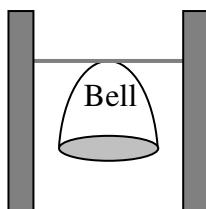
Point A is some distance from the bell, and point B is 20 m further from the bell. At A the sound intensity is 0.45 Wm^{-2}. At B it is reduced to 0.05 Wm^{-2}.
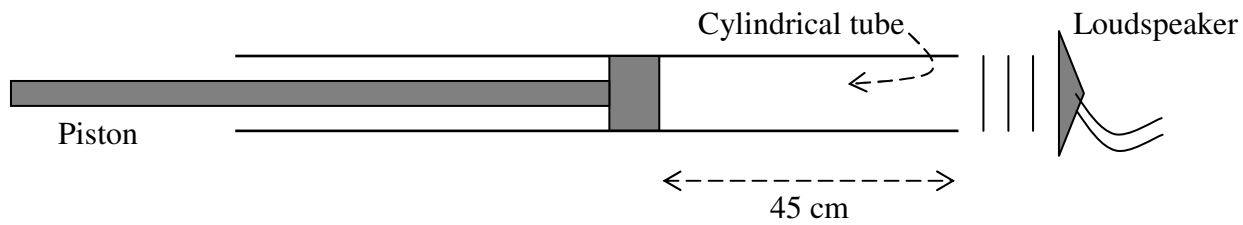
Question 4 The distance of point A from the bell is closest to

A. 5 m

B. 10 m

C. 15 m

D. 20 m

Question 5 The difference in sound intensity level (dB) between A and B is closest to

A. 5   B. 10   C. 15   D. 20

Use the following information to answer Questions 6, 7 and 8

The sound wave produced by the loudspeaker has a frequency of 564 Hz. The 45-cm cylindrical tube resonates at this frequency. Speed of sound is 338.4 ms^{-1}. By moving the piston the cylindrical tube can be lengthened or shortened.

Question 6   The 45-cm cylindrical tube resonates at

A.   its fundamental frequency

B.   its first harmonic

C.   its second harmonic

D.   its third harmonic.

Question 7   The cylindrical tube will also resonate when its length (cm) is

A.   15

B.   30

C.   60

D.   90

The length of the cylindrical tube is kept at 45 cm. Now the frequency of the sound wave is varied.

Question 8   The cylindrical tube will also resonate when the frequency (Hz) of the sound wave is

A.   376

B.   752

C.   940

D.   1128

The loudspeaker sends out two sound waves of frequencies 100 Hz and 10 kHz. At point X the sound intensity is the same for both frequencies. The wall in front of the loudspeaker is non-reflecting. X and Y are the same distance from the loudspeaker. I_{100} and I_{10k} represent the sound intensities of the 100 Hz and 10 kHz sound waves respectively.

Signal generator

Loudspeaker

Y

Non-reflecting wall   X

$\xleftarrow{\hspace{3cm}}\xrightarrow{\hspace{3cm}}$
80 cm

Z
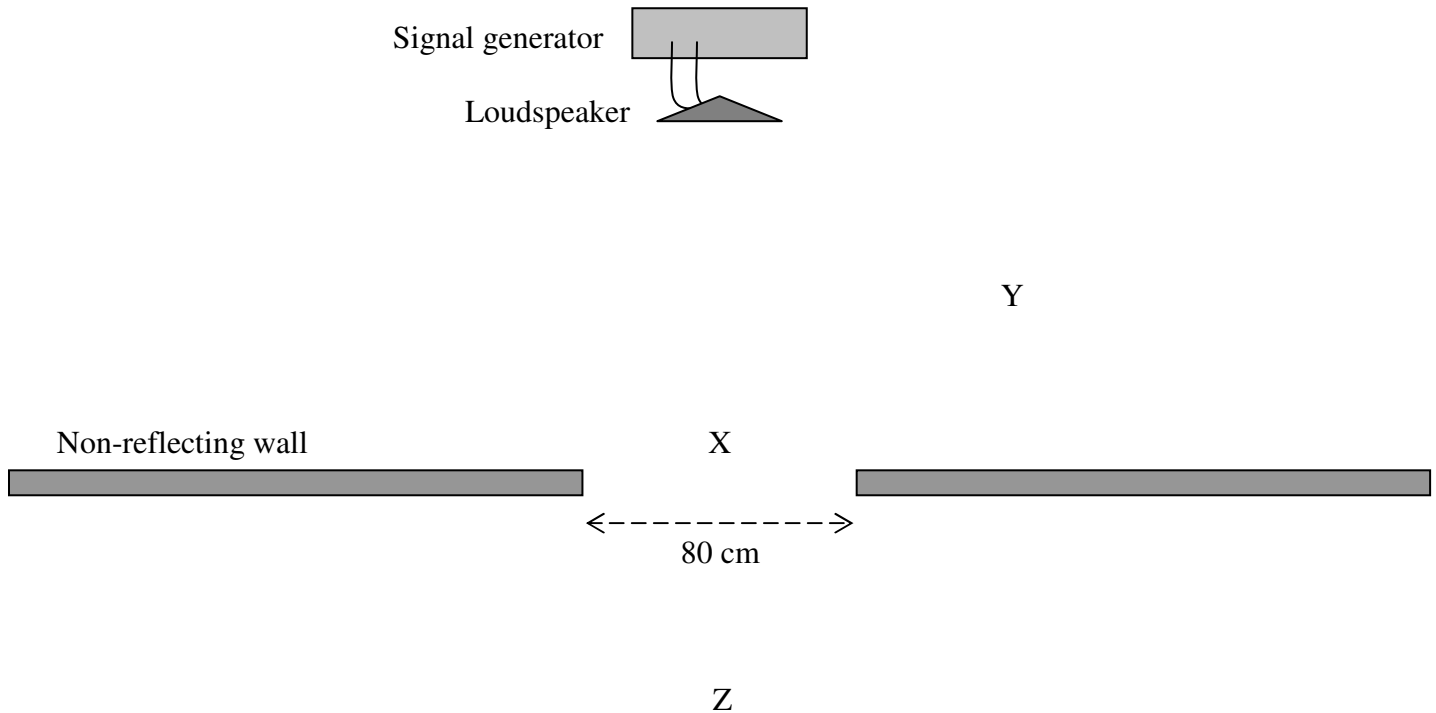
**Question 9**   Which one of the following statements is correct **at point Y**?

A. $I_{100} = I_{10k}$, but less than the sound intensity at point X.

B. $I_{100} > I_{10k}$

C. $I_{100} < I_{10k}$

D. $I_{100} = I_{10k}$, but greater than the sound intensity at point X.

Question 10   Which one of the following statements is correct **at point Z**?

A. $I_{100} = I_{10k}$, but less than the sound intensity at point X.

B. $I_{100} > I_{10k}$

C. $I_{100} < I_{10k}$

D. $I_{100} = I_{10k}$, but greater than the sound intensity at point X.

The following graph shows the frequency response of the hearing of a person. Any sounds on the curve are equally loud as perceived by the person. Two sounds are marked as A and B.
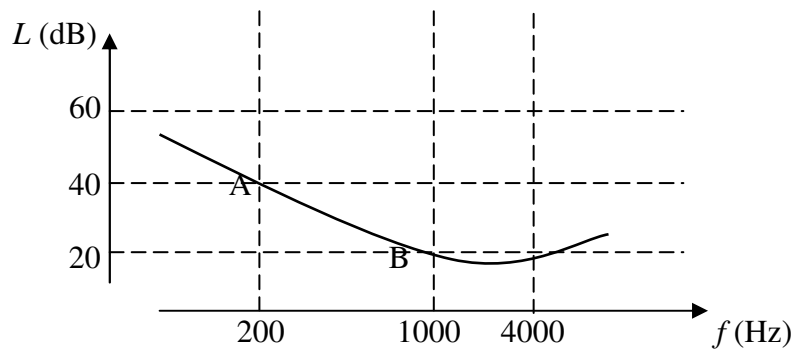
Question 11   The two sounds A and B

A.   have the same sound intensity level and the same phon level.

B.   have the same sound intensity level but different phon level.

C.   have the same phon level but different sound intensity level.

D.   have different phon level and different sound intensity level.

Question 12   The person is most sensitive to sound frequency (Hz) in the range

A.   lower than 200

B.   200 - 1000

C.   1000 - 4000

D.   higher than 4000.

End of Exam 2