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PHYSICS

2008

Trial Examination 2

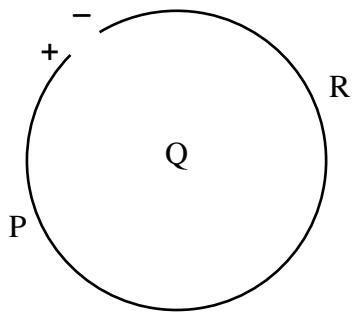
Electric power
Interactions of light and matter
Sound

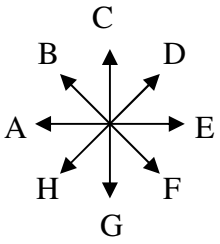
SECTION A – Core

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

Area of study 1 – Electric power (40 marks)

A circular loop of wire carries an electric current. Directions are indicated by arrows A to H, I (into the page) and J (out of the page).



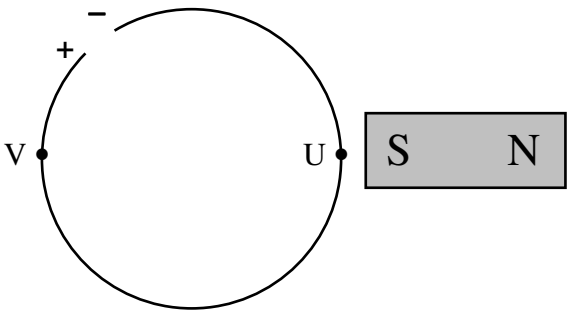


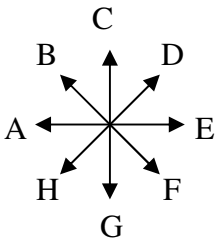
Question 1 Determine the directions (A to J) of the magnetic field produced by the current-carrying loop at points P, Q and R.

at P	at Q	at R

3 marks

A bar magnet is now placed next to the current-carrying loop. At point U the magnetic field strength is 0.010 T approximately.





Question 2 Determine the directions (A to J) of the magnetic force on the current-carrying loop at U and V.

at U	at V

2 marks

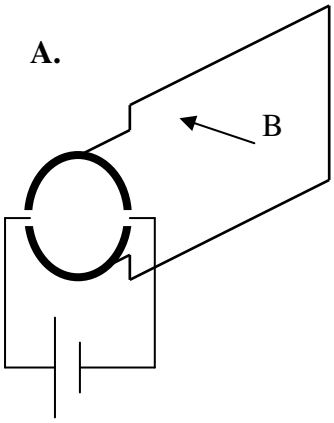
Question 3 Calculate the magnitude of the magnetic force on a 1.0-mm section of the loop at point U, given the resistance of the loop is 2.0 Ω and the potential difference at the two ends of the loop is 0.20V.

N

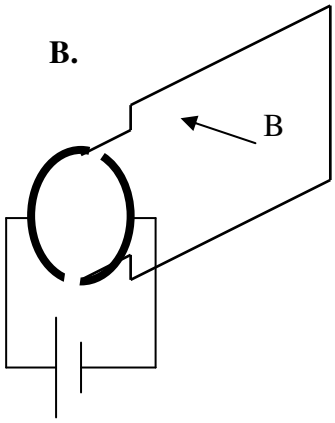
3 marks

Question 4 Which one of the following diagrams (**A**-**D**) shows the best connection of a split-ring commutator to the coil in a simple single-coil d c motor to maximise the average torque (turning effect) on the coil?

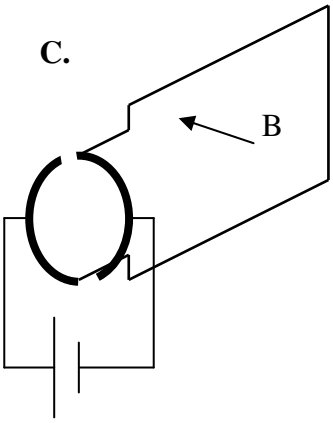
A.



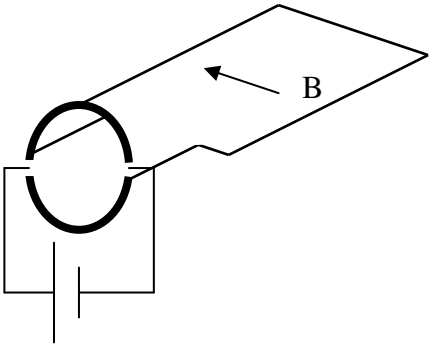
B.



C.



D.

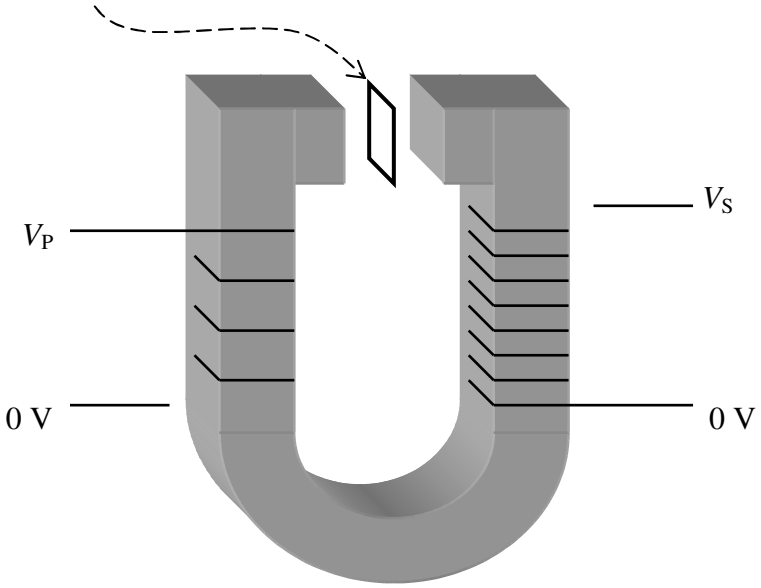


2 marks

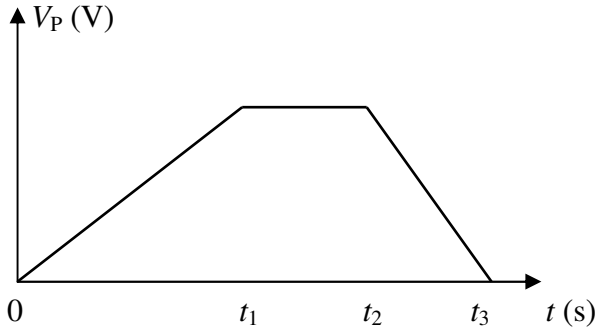
Question 5 Explain your choice of answer to **Question 4**.

3 marks

A closed loop of wire of resistance 0.25 Ω is placed between the poles of the electromagnet.

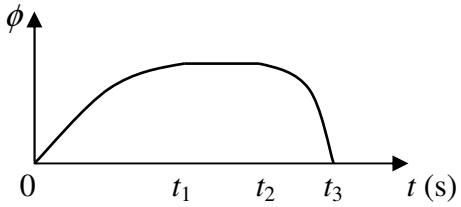


The voltage V_P (see the following graph) is applied to the insulated coil on the left.



Question 6 Which one of the following graphs (**A**-**D**) best shows the variation of the magnetic flux ϕ through the closed loop between the poles of the electromagnet when V_P is applied?

A.



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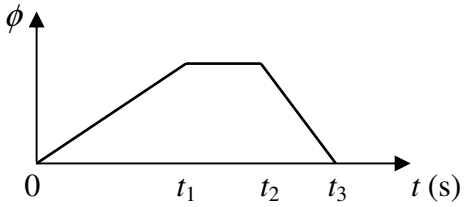

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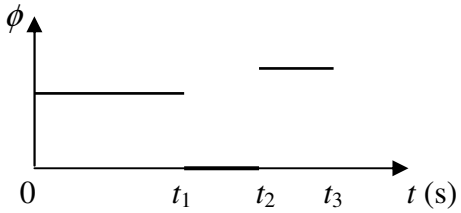
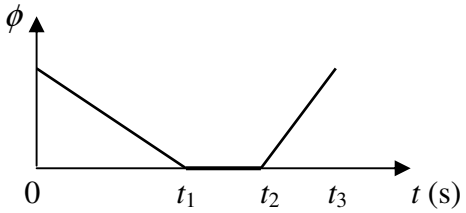


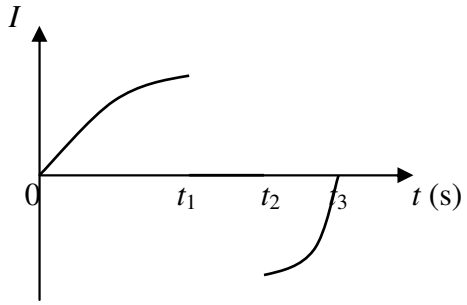
D.



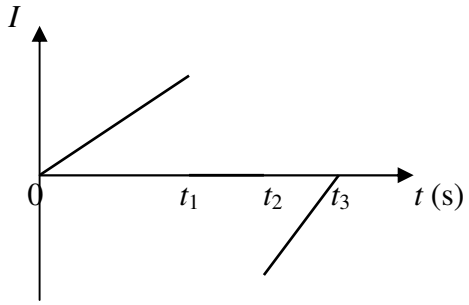
2 marks

Question 7 Which one of the following graphs (**A**-**D**) best shows the variation of the current I induced in the closed loop between the poles of the electromagnet when V_P is applied?

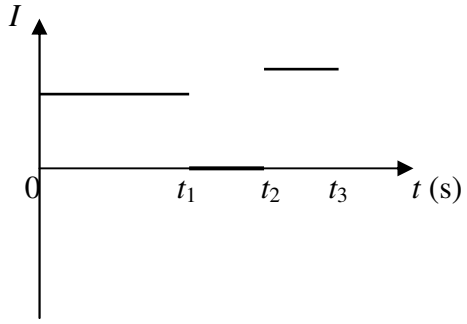
A.



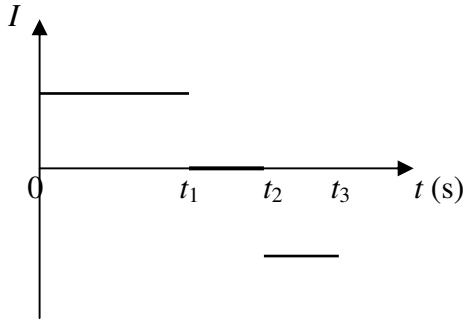
B.



C.



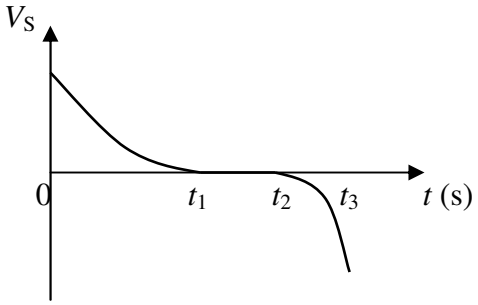
D.



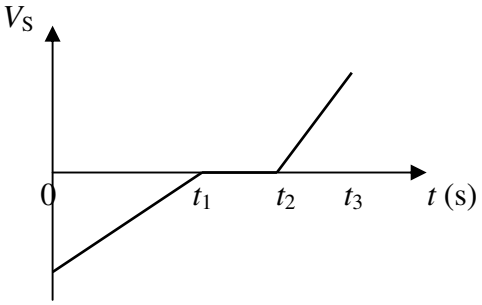
2 marks

Question 8 Which one of the following graphs (**A**-**D**) best shows the variation of the voltage V_S induced in the insulated coil on the right when V_P is applied?

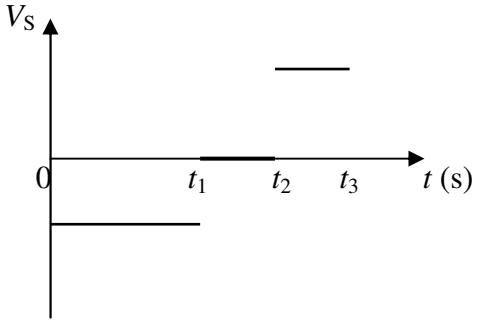
A.



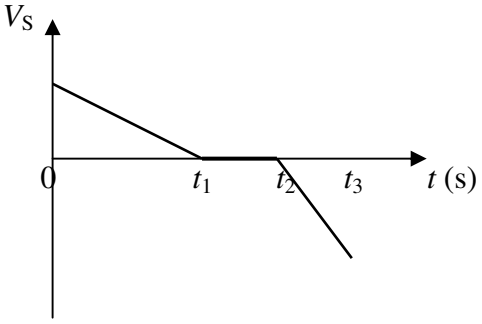
B.



C.

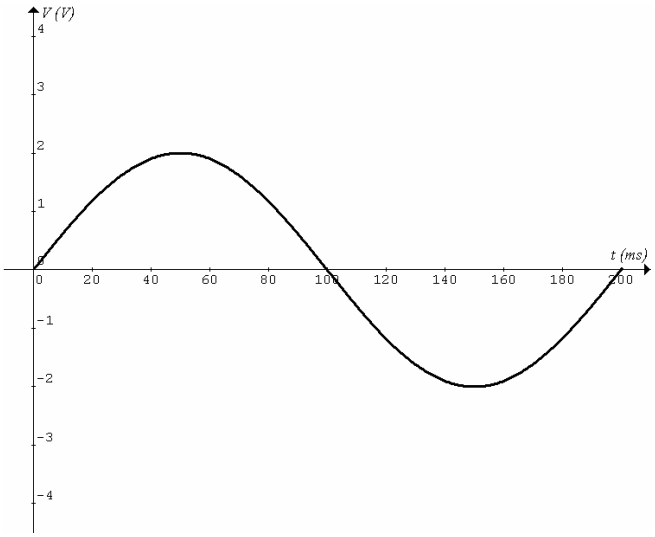


D.



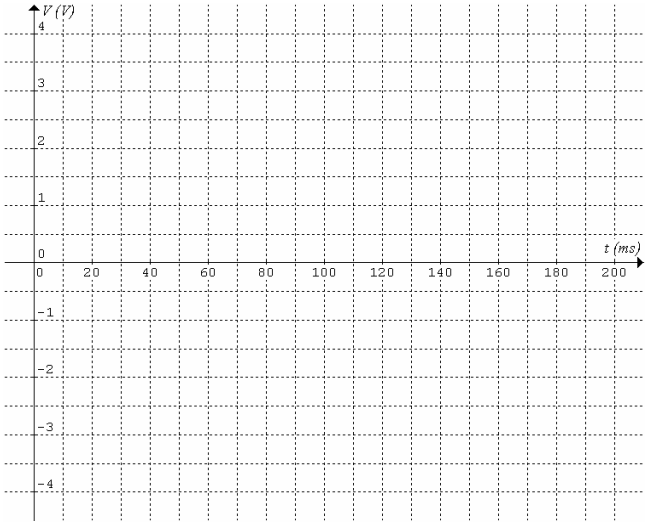
2 marks

An alternator consists of a coil rotating in a magnetic field. The sinusoidal a c voltage generated is shown in the graph below.



The slip rings in the alternator are now replaced with a split-ring commutator, and the frequency of rotation of the coil is doubled.

Question 9 Sketch in the grid below the graph of the voltage generated.



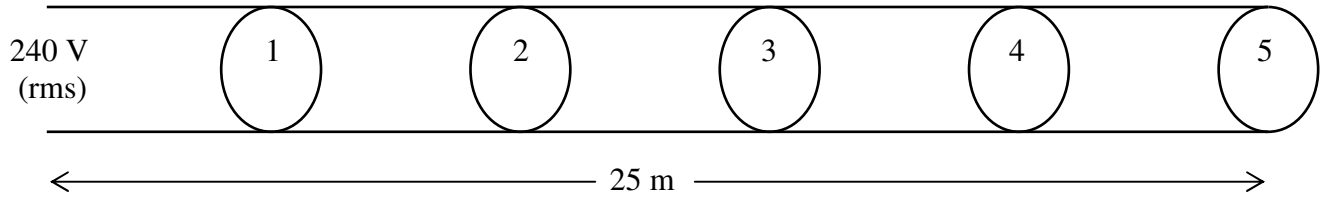
3 marks

Question 10 Which one of the batteries (**A**-**E**) below will provide approximately the same power as this modified generator? Show working and explanation.

A. 1.5 V battery **B.** 3.0 V battery **C.** 6.0 V battery **D.** 9.0 V battery **E.** 12.0 V battery

3 marks

Five working identical light globes are connected in parallel to a 240 V (rms) power supply at 5 metres apart. The resistance of the connecting wires is 0.50 Ω **per metre**.



The current in light globe 1 is 0.25 A.

Question 11 Determine the **approximate** voltages across light globe 1 and light globe 5.

Globe 1 V	Globe 5 V

4 marks

Question 12 Determine the **approximate** total power loss in the wires connecting the light globes.

W

3 marks

Question 13 Suggest a simple and practical way to increase the power output of the light globes without changing the locations of the light globes from the power supply.

2 marks

A neighbourhood transformer transforms 11 kV to 240 V for household use. It has an efficiency of 98%.

Question 14 For this neighbourhood transformer determine the value (3 significant figures) of the following ratio.

Number of turns in the secondary coil **:** number of turns in the primary coil

2 marks

Question 15 Which one of the following statements (**A**-**D**) is correct for this neighbourhood transformer?

A. The input power equals the output power.

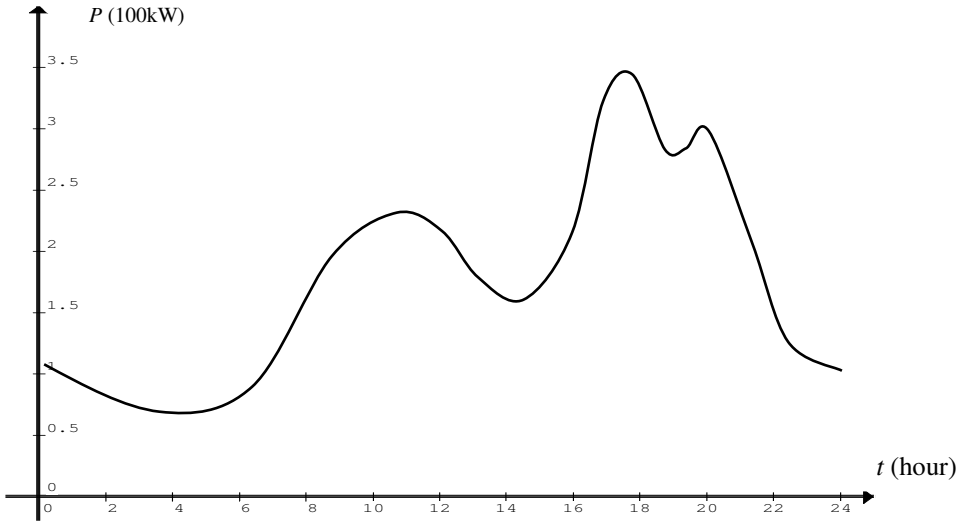
B. The input power is greater than the output power.

C. The current in the primary coil is higher than that in the secondary coil.

D. The currents in the primary and secondary coils are equal.

2 marks

The electricity usage of the neighbourhood serviced by this transformer on a particular day is shown in the following load curve.



Question 16 Determine the time of the day when the household voltage is lowest.

2 marks

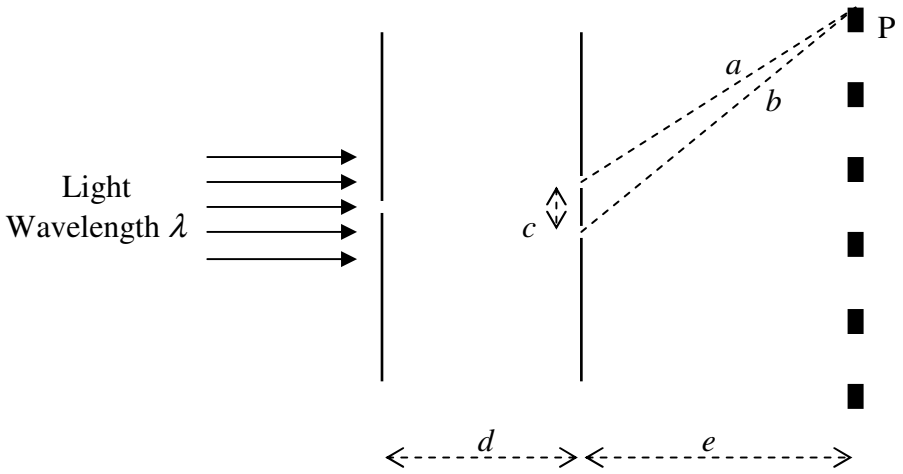
Area of study 2 – Interactions of light and matter (26 marks)

Question 1 Write coherent or incoherent under **Property 1**, discrete spectrum or continuous spectrum under **Property 2** for the light emitted by each of the light sources.

Source	Property 1	Property 2
Candle		
Laser		
Sodium vapour lamp		

3 marks

The following diagram shows the setup of Young's double-slit experiment. The distances *a* and *b* are from **dark** fringe P to the slits. The separation of the two slits is *c*.



Question 2 Light of wavelength $\lambda = 589$ nm is used to illuminate the single slit. Calculate the difference in length between *a* and *b*.

m

2 marks

Question 3 Which one or more (**A**-**D**) of the following changes will increase the spacing between the fringes?

A. Increase the wavelength λ of light.

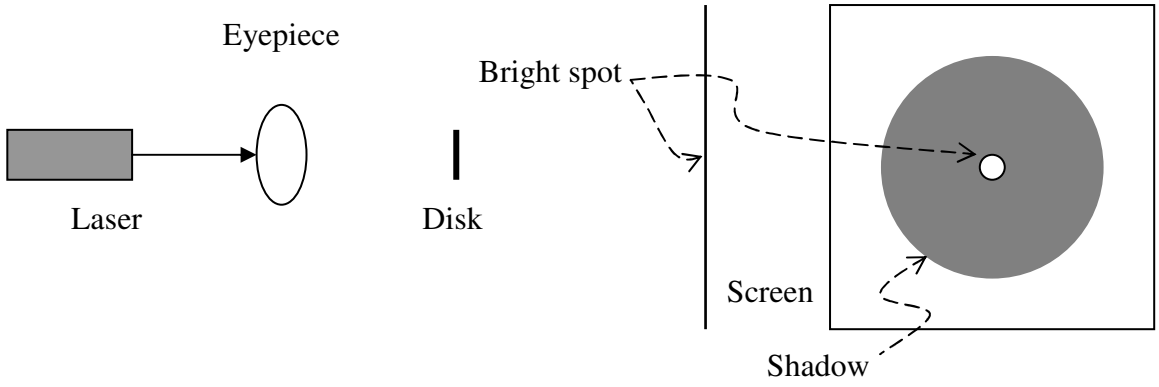
B. Increase the separation *c* of the two slits.

C. Increase the distance *d* between the single-slit and the double-slit.

D. Increase the distance *e* between the screen and the double-slit.

2 marks

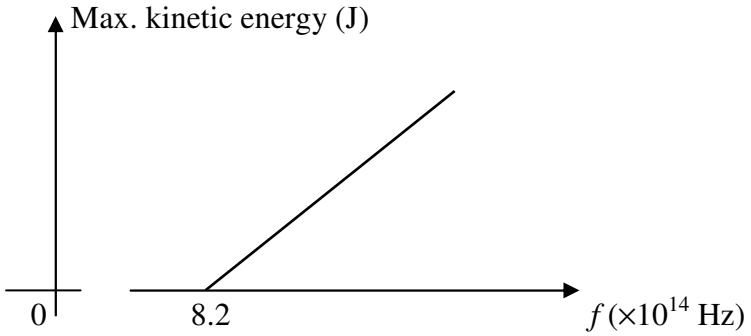
When a laser light passes through an eyepiece (convex lens) onto a small circular solid disk, a bright spot will appear at the centre of the shadow.



Question 4 Use some of the wave properties of light to explain the formation of the bright spot.

2 marks

The maximum kinetic energy of an electron ejected from metal X varies with the frequency of light illuminating it. The graph below shows the variation.



Question 5 Determine the work function of metal X.

J

2 marks

Question 6 Determine the maximum kinetic energy of an ejected electron when metal X is illuminated by light of wavelength 340 nm.

J

2 marks

The electron microscope and other similar devices are far more superior in using the wave properties of particles to create greatly magnified images of materials with high resolution (sharpness) than the ordinary light microscope.

Question 7 Which one of the following wave properties (**A**-**D**) will affect the resolution of the image the most?

A. Reflection **B.** Refraction **C.** Diffraction **D.** Dispersion

2 marks

Question 8 Two images, I and II, of a material were obtained with an electron microscope. Image I was taken when the electrons were accelerated by a voltage of 1.0×10^5 V, and image II by 1.0×10^2 V.
Which image (I or II) has a higher resolution? **Justify your answer**.

3 marks

Question 9 Compare the momentum of an electron of 2.0 eV kinetic energy with the momentum of a 2.0 eV photon. Show calculations.

Electron: kgms^{-1}	Photon: kgms^{-1}

3 marks

One of de Broglie's original arguments in favour of the wave model of electrons was that it provided an explanation for Bohr's theory of the hydrogen atom. He proposed that each electron orbit in an atom is a standing wave. The following diagrams show two such standing waves.

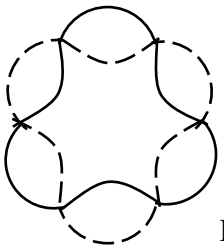


Fig. 1

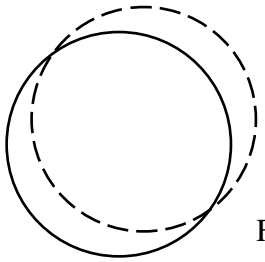
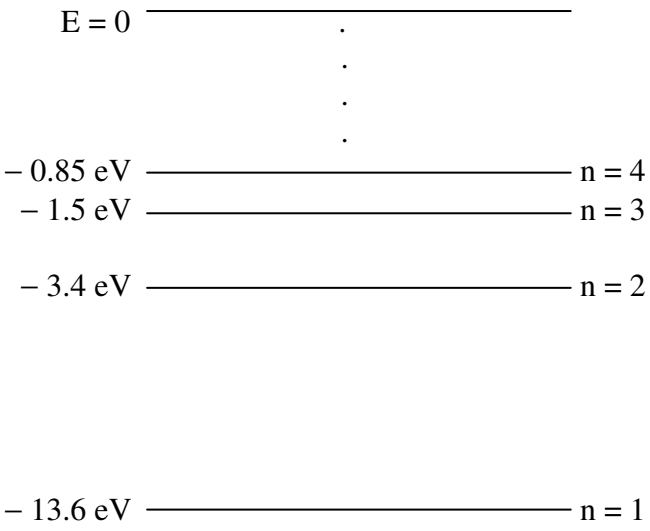


Fig. 2

Energy-level diagram for the hydrogen atom is shown below.



Question 10 Write down the energy level that corresponds to each of the standing waves in Fig. 1 and Fig. 2.

Fig. 1 n =	Fig. 2 n =

2 marks

Question 11 Determine the wavelength of the photon emitted when the electron in the hydrogen atom changes from one state to the other as shown in Fig. 1 and Fig. 2.

nm

3 marks

SECTION B – Detailed studies

Detailed study 3 – Sound (24 marks)

Answer **all** the questions.

Question 1 Which one of the following statements best describes sound in air?

A. Sound is the transmission of energy via longitudinal pressure waves.

B. Sound is the transmission of energy via transverse pressure waves.

C. Sound is the transmission of energy via transverse particle-displacement waves.

D. Sound is the transmission of energy via particle motion from the source to the receiver.

2 marks

Question 2 When a sound travels from air into water, which one of the following statements about frequency f, wavelength λ and speed v of the sound is correct?

A. f is directly proportional to v.

B. f is inversely proportional to λ.

C. λ is directly proportional to v.

D. λ is directly proportional to v and inversely proportional to f.

2 marks

Question 3 Which one of the following statements is correct when sound intensity level increases by 10 dB?

A. The sound intensity is $1.0\times10^{-11}\,\text{Wm}^{-2}$.

B. The sound intensity increases by $1.0\times10^{-11}\,\text{Wm}^{-2}$.

C. The sound intensity increases by 10 times of the original intensity.

D. The sound intensity is 10 times of the original intensity.

2 marks

Question 4 A person listens to two sounds of the same frequency (1000 Hz) in the open.
Sound I is from a source at 5 metres away, and the source has an acoustic power of 10 W. Sound II is from a different source at 10 metres away, and the acoustic power of this source is 20 W.
Which one of the following statements best predicts the relative loudness of the sounds heard by the person?

A. Sound I is louder than sound II.

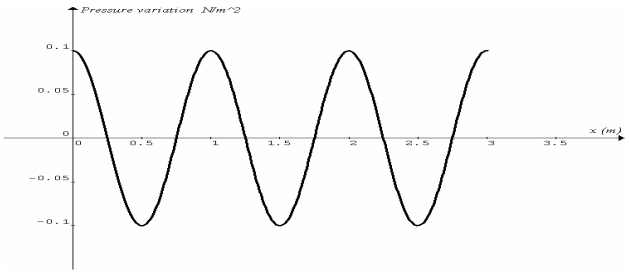
B. Sound II is louder than sound I.

C. Sound I and sound II have the same loudness.

D. Not enough information to make a prediction.

2 marks

The pressure variation with position of a **resonance** (standing sound wave) in air at a particular time is shown in the graph below. The speed of sound in air is 330 ms^{-1}.



Question 5 The resonance frequency is

A. 330 Hz **B.** 1 Hz **C.** 6.28 Hz **D.** 660 Hz

2 marks

Question 6 The amplitude of the standing sound wave is

A. 0.1 Nm^{-2} **B.** 0.2 Nm^{-2} **C.** 1 m **D.** **indeterminable** from the given information.

2 marks

Question 7 If the above graph shows the pressure variation with position of a **travelling** sound wave in air at a particular time instead of a standing sound wave, which one of the following statements is correct?

A. There are 5 pressure nodes shown in the graph.

B. There are 6 pressure antinodes shown in the graph.

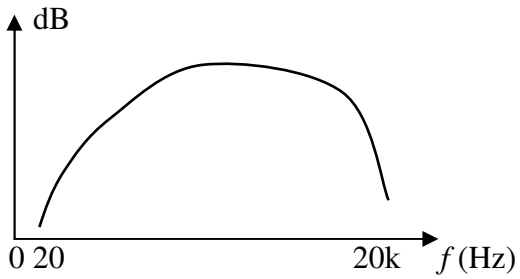
C. There are 8 pressure antinodes shown in the graph.

D. There are no nodes or antinodes in the travelling sound wave.

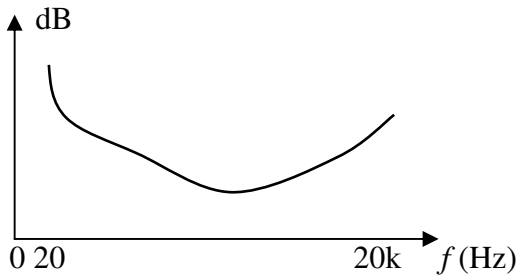
2 marks

Question 8 Four microphones are tested for their frequency responses and the results are presented below. The frequency axis uses a log scale. Which one (**A**-**D**) will best respond to music?

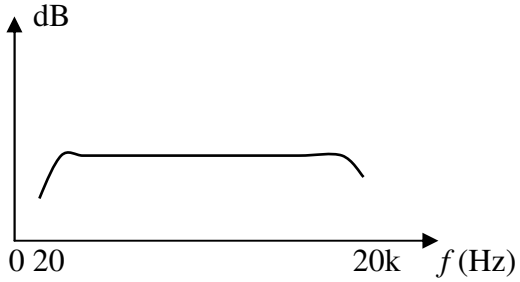
A.



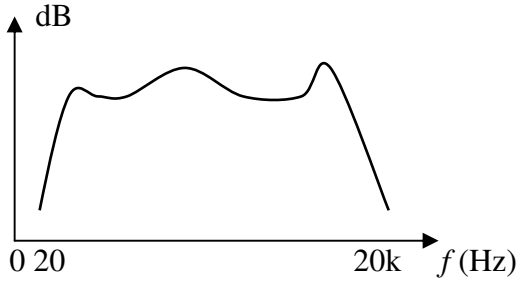
B.



C.

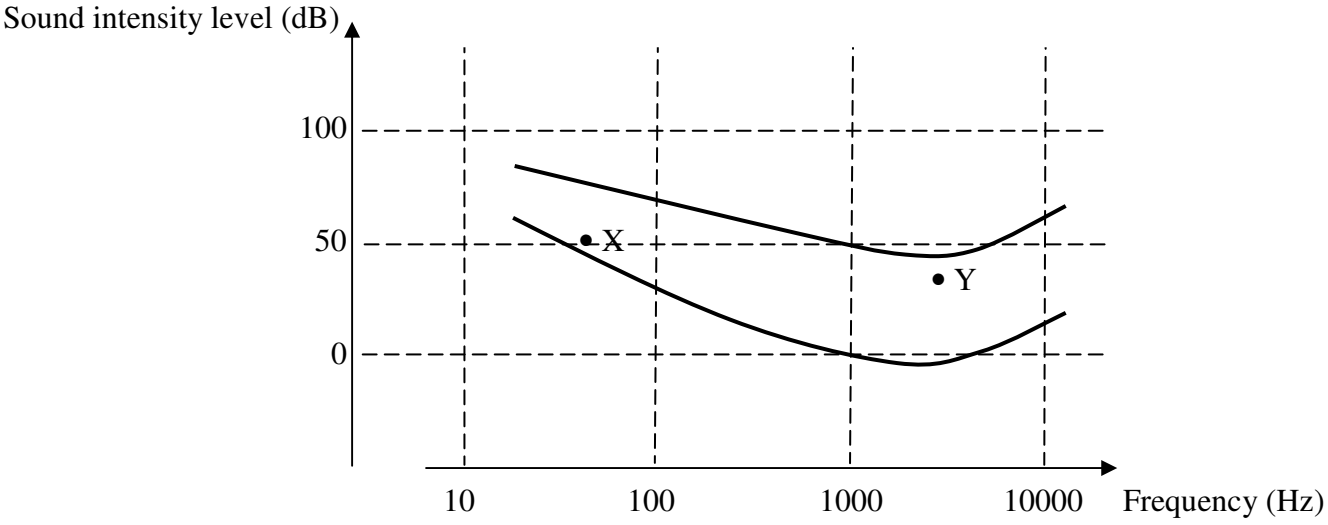


D.



2marks

Two frequency response curves of hearing for a listener are shown below. Two sounds are marked as X and Y.



Question 9 Which one of the following statements best describes the loudness of X and Y **to the listener**?

A. Sound X is louder than sound Y.

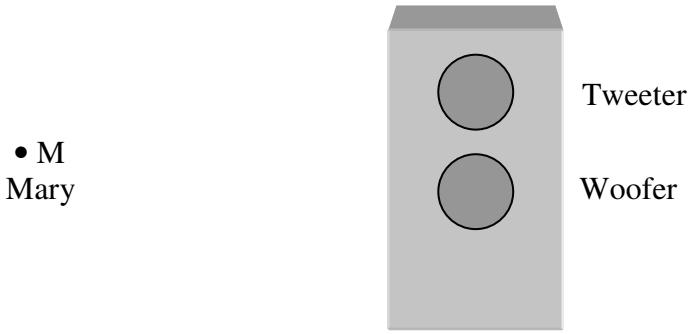
B. Sound X and sound Y are of the same loudness.

C. Sound Y is louder than sound X.

D. Sound X is louder than sound Y by 15 dB approximately.

2 marks

Two custom made loudspeakers of the same diameter, a tweeter (2k to 20k Hz) and a woofer (20 to 3k Hz), are mounted on the baffle of a rectangular enclosure. Tom sits directly in front of the loudspeakers, and Mary sits at point M as shown in the diagram below.



Question 10 Mary and Tom listen to music from the loudspeakers. Which one of the following statements best describes what they hear?

A. Mary can hear the sounds from both loudspeakers equally well.

B. Tom can hear the sounds from the tweeter much better than that from the woofer.

C. Tom can hear the sounds from the woofer much better than that from the tweeter.

D. Mary can hear the sounds from the woofer much better than that from the tweeter.

2 marks

Question 11 Which one of the following statements best explains the use of the rectangular enclosure for the loudspeakers?

A. The enclosure prevents the sounds from one loudspeaker interfering with the sounds from the other one.

B. The enclosure supports the loudspeakers.

C. The enclosure prevents the occurrence of resonance for certain frequencies.

D. The enclosure prevents destructive interference of sounds from the front and back of each loudspeaker.

2 marks

Question 12 A 0.34-m long cylindrical pipe (closed at one end) makes a sound when it is placed across a strong wind in the open. Which one of the following **cannot** be one of the possible frequencies of the sound?

A. 1230 Hz **B.** 249 Hz **C.** 83 Hz **D.** 745 Hz

2 marks

End of Exam 2

