Registration Number

Candidate Name _____

NATIONAL JUNIOR COLLEGE
JC 2 TERM III COMMON TEST

PHYSICS **9248/1**
PAPER 1 Multiple Choice

Wednesday **2 July 2003** **50 min**

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write your **name** and **registration number** in the spaces at the top of this **answer sheet**.
There are 25 questions in this page. Answer **ALL** questions.

For each question there are 4 possible answers, **A, B, C** and **D**. Choose the one you consider correct and record your choice in soft pencil on the separate answer sheet.

INFORMATION FOR CANDIDATES

Each correct answer will score two marks. No marks will be deducted for a wrong answer.
Any rough working should be done in this booklet.

Answers :-

1. D	6. B	11. D	16. D	21. B
2. C	7. D	12. C	17. B	22. A
3. A	8. A	13. B	18. A	23. A
4. D	9. C	14. C	19. B	24. B
5. A	10. C	15. B	20. D	25. D

This section consists of 11 printed pages including this cover page.

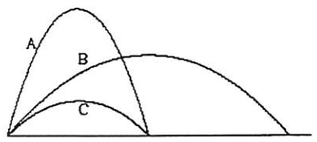
1 To determine the density of aluminium, the mass of a sheet of foil is subjected to 1 % uncertainty, its length 1 % and breadth 2 %. Its mean thickness is found by folding it twice to give a stack of four sheets, the thickness of which is measured to be 11.2 ± 0.4 mm, and the zero reading error of the screw gauge is recorded as +1.2 ± 0.4 mm. The percentage of uncertainty in the determination of the density is

A 4 % **B** 7 % **C** 8 % **D** 12 %

2 The dots below show the **positions** of two moving objects at successive time intervals, with clock readings marked in seconds.

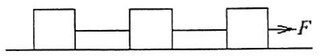
Nearest to which clock reading will the **speeds** of the two objects be approximately equal?
A 1 s **B** 2 s **C** 3 s **D** 4 s

3 The diagram below shows the trajectory of three artillery shells. Each was fired with the same initial speed. Which shell was in the air for the longest time? (Ignore air friction.)



A Shell A
B Shell B
C Shell C
D Shells A and C were in the air for equal time, which was longer than for shell B

4 Three blocks of identical mass are connected by strings as shown below. The whole system is accelerated to the right along a frictionless, horizontal surface by a force *F*. The net force acting on the middle block is

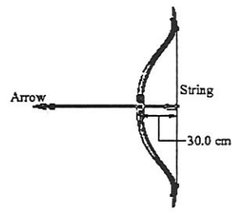


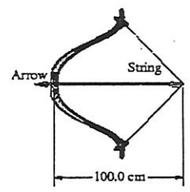
A zero. **B** *F*. **C** 2*F*/3. **D** *F*/3.

5 Two boys, Ah Hock and Ah Seng, both wearing roller skates and initially at rest, push each other apart on a smooth surface. Ah Hock has a mass of 50 kg and Ah Seng has a mass of 70 kg. After the boys push each other apart, Ah Hock has a speed of 6.0 ms^{-1}. As the boys move apart, Ah Seng has

A less kinetic energy than Ah Hock
B more kinetic energy than Ah Hock
C less momentum than Ah Hock
D more momentum than Ah Hock

6 A "full draw" is the maximum distance that an archer can pull back an arrow. Using the "recurve bow" shown below, a particular archer requires an average force of 130 N to pull a full draw of 70.0 cm.

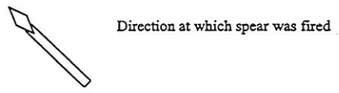




The maximum speed of a 20.6 g arrow leaving this bow from a full draw is

A 66.5 ms^{-1} **B** 94.0 ms^{-1} **C** 4.42 x 10^3 ms^{-1} **D** 8.83 x 10^3 ms^{-1}

7 A metallic spear was fired under water at the angle shown below.



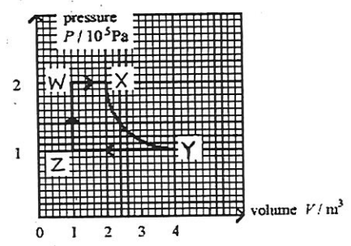
Which of the following shows the direction of the **resultant force** immediately after it was fired?

A 
B 
C 
D 

8 On the ground, the gravitational force on a satellite is W. What is the gravitational force on the satellite when at a height R /100, where R is the radius of the Earth?

A 0.98 W **B** 0.99 W **C** 1.01 W **D** 1.02 W

9 An ideal gas is taken through the series of changes shown:



Which one of the following statements is correct?

A No net work is done by the gas in completing one cycle.

B Net heat flows out of the system.

C The gas has the same temperature at X and at Y.

D The work done by the gas during the change WX is equal to that done on the gas during the change YZ.

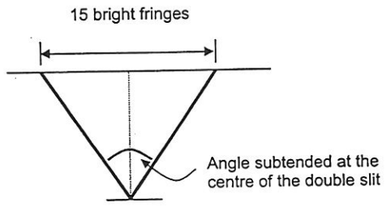
10 A solar furnace has a concave mirror of collecting area 0.8 m^2. The average thermal radiation from the sun reaching the earth is about 750 W m^{-2}. A small 0.5 kg mass, of specific heat capacity 2000 J kg^{-1} K^{-1}, is heated by the furnace from 10°C to 40°C. The time taken in seconds for the heating is

A 100 B 60 C 50 D 30

11 A 50 g mass suspended from a light helical spring oscillates with vertical simple harmonic motion of amplitude 2.5 cm. If the maximum kinetic energy of the mass is 3.0 x 10^{-3} J, the frequency of oscillation is

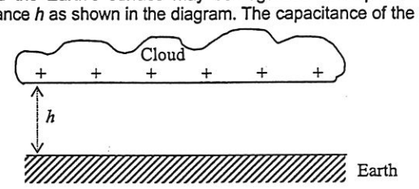
A 0.8 Hz B 1.1 Hz C 1.9 Hz D 2.2 Hz

12 In a Young's double slit experiment, a monochromatic light source of wavelength 700 nm is used and the separation of the slits is 0.1 mm. If 15 bright fringes are observed, what is the angle subtended by these fringes at the centre of the double slit?



A 4.8° B 5.2° C 5.6° D 6.4°

13 A thundercloud and the Earth's surface may be regarded as a pair of charged parallel plates separated by a distance h as shown in the diagram. The capacitance of the system is C.



When a lightning flash of time duration t occurs, the change in electric field strength between cloud and Earth is ΔE. The mean current of the lightning flash is

A $C\Delta E / t$ B $Ch\Delta E / t$ C $h\Delta E / Ct$ D $\Delta E / Ct$

14 Three resistors of resistance R1, R2 and R3 are connected in parallel. It is known that R1 > R2 > R3. The equivalent resistance of this combination is R. Which one of the following statements is correct?

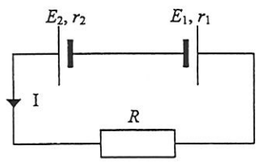
A Energy dissipated in moving 1 C of charge through the resistor of resistance R1 is greater than that through R3.

B R is greater than R2.

C If the resistor with resistance R1 is removed, the resulting equivalent resistance is increased.

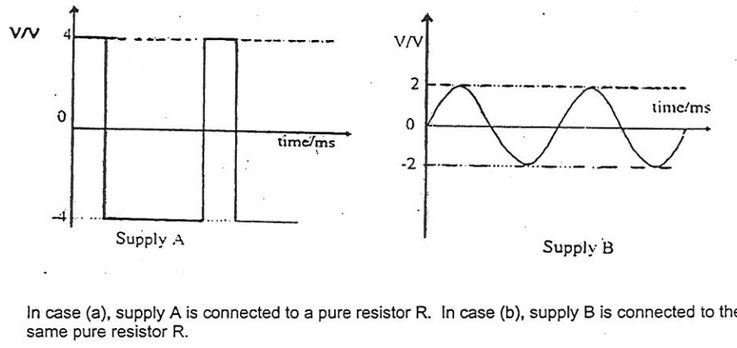
D If the resistor with resistance R3 is removed, the resulting equivalent resistance is decreased.

15 Two cells of e.m.f. E_1 and E_2, and internal resistances r_1 and r_2, are connected to a load resistance R in the circuit shown below. If the current flowing in the circuit is I and $E_1 < E_2$, what is the magnitude of the terminal p.d. across the cell E_1?



A $E_1 - Ir_1$
B $E_1 + Ir_1$
C $E_2 - I(r_1 + r_2 + R)$
D $E_2 + Ir_2 - IR$

16 The graphs show the variation of output voltage with time for two alternating power supplies A and B.

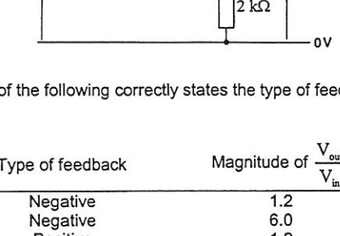


In case (a), supply A is connected to a pure resistor R. In case (b), supply B is connected to the same pure resistor R.

The ratio of $\frac{\text{Power dissipated in case (a)}}{\text{Power dissipated in case (b)}}$ is

A 1 **B** 2 **C** 4 **D** 8

17 The diagram shows an operational amplifier circuit.



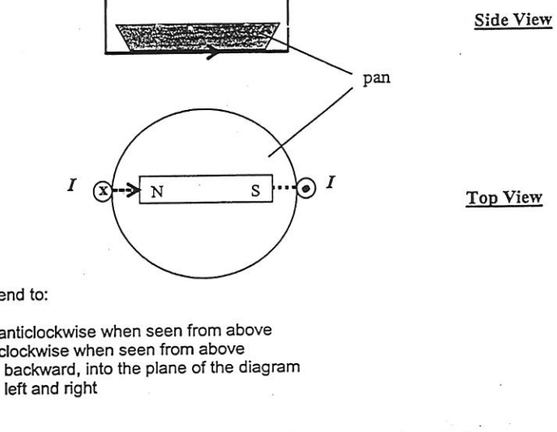
Which of the following correctly states the type of feedback and magnitude of $\frac{V_{out}}{V_{in}}$?

	Type of feedback	Magnitude of $\frac{V_{out}}{V_{in}}$
A	Negative	1.2
B	Negative	6.0
C	Positive	1.2
D	Positive	6.0

18 A charged oil drop of mass m falls with terminal velocity u between two horizontal metal plates which are separated by a distance d and are maintained at the same electric potential V_1.
When the upper metal plate is connected to a higher electric potential V_2, the same oil drop rises with terminal velocity u. Neglecting upthrust, the oil drop has a charge equal to

A $2mgd / (V_2 - V_1)$ **B** $2mgd / (V_2 + V_1)$ **C** $mgd / (V_2 - V_1)$ **D** $d / (V_2 - V_1)$

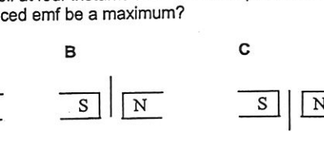
19 The supports to the wooden pan of a beam balance are made to carry a steady direct current. A bar magnet is held **fixed** above the pan and its length is on the same plane as the supports as shown below:



The magnet will tend to:

A Twist the pan anticlockwise when seen from above
B Twist the pan clockwise when seen from above
C Swing the pan backward, into the plane of the diagram
D Swing the pan left and right

20 A small rectangular coil is dropped between the poles of a magnet as shown below:



Snapshots of the coil at four instants are taken as it passes through the magnetic field. At which instant will the induced emf be a maximum?

A

B

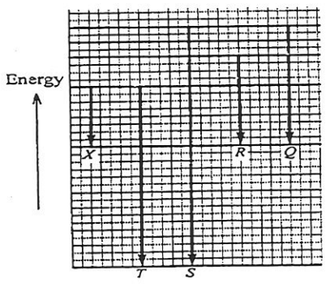
C

D

21 When a metal is illuminated with light of frequency *f*, the maximum kinetic energy of the photoelectrons is 1.30 eV. When the frequency is increased by 50 %, the stopping potential increased to 3.60 V. What is the work function of this metal?

A 2.08×10^{-19} J
B 5.28×10^{-19} J
C 5.76×10^{-19} J
D 7.36×10^{-19} J

22 The diagram shows some energy levels (drawn to scale) of a certain atom. Transition X results in the emission of a photon of wavelength 600 nm. Which transition (Q to T) would result in the emission of a photon of wavelength 300 nm?



A Q **B** R **C** S **D** T

23 Which one of the following statements concerning atomic nucleus is false?

A The mass difference of a nucleus = mass of neutrons – mass of protons

B The mass difference of a nucleus is a measure of the binding energy

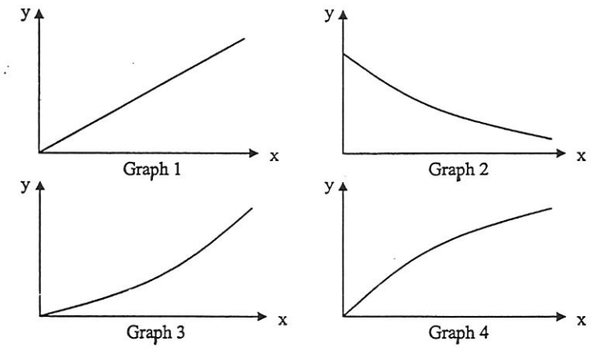
C To break up a nucleus into its constituent nucleons requires an amount of energy equal to the binding energy.

D The binding energy per nucleon may be used as a measure of the stability of a nucleus.

24 In the actinium radioactive series that starts with $^{235}_{92}U$, the final product is $^{207}_{82}Pb$. How many α particles and β particles are emitted?

	α	β
A	5	0
B	7	4
C	14	18
D	28	10

25 The atoms of an unstable element decay by α-particle emission into a stable daughter. The process is observed in an experiment.



Choose from the options below one that best describes the axis of the graphs.

	Number of daughter nuclei vs time	Rate of alpha emissions vs number of parent nuclei present
A	Graph 2	Graph 3
B	Graph 2	Graph 1
C	Graph 4	Graph 3
D	Graph 4	Graph 1

The End

Registration Number

Candidate Name _____

NATIONAL JUNIOR COLLEGE
JC 2 COMMON TEST 2

PHYSICS
PAPER 2 **9248**

Wednesday 2 July 2003 2h 10 min

INSTRUCTIONS TO CANDIDATES

Do not open this booklet until you are told to do so.
Write your name and registration number in the spaces at the top of this **answer sheet**.

Section A [60 marks]
Write your answers in the spaces provided on the question paper.

Section B [15 marks]
Write your answers on the writing paper provided.

Section C [20 marks] Answer ONLY one question.
Write your answers on the writing paper provided.

INFORMATION FOR CANDIDATES
For numerical answers, all working should be shown.
The number of marks is given in brackets [ ] at the end of each question or part question.
You are advised to spend 75 minutes on Section A.

FOR EXAMINER'S USE			
Section A		**Section B**	
Question	**Marks**	**Question**	**Marks**
26		32	
27			
28		**Section C**	
29		**Question**	**Marks**
30		33	
31		34	

Total: /95

This question paper consists of 15 printed pages including this cover page.

Section A Answer all questions in this section

(You are advised to spend not more than 75 minutes in this section.)

26 It is proposed to investigate the surface of the planet Mars by putting a spacecraft (the command module) into the orbit around the planet and sending an exploration module down to the surface of the planet and subsequently recovering it.

Mass of planet Mars $= 6.42 \times 10^{23}$ kg
Radius of the planet Mars $= 3.39 \times 10^{6}$ m

(a) The command module is positioned in a circular orbit at a height of 5.0×10^{5} m above the surface of the planet. Find the period of the orbit. [3]

(b) Sketch a graph on the axes provided showing how the magnitude of the gravitational field strength, g_M, due to the planet Mars varies with distance from the centre of the planet. You need to consider points external to the planet only. Label on the graph the gravitational field strength at the surface of the planet. Show your working clearly. [2]

26 (c) Find the change in gravitational potential energy in moving the exploration module of mass 1.2×10^{3} kg from the surface of the Mars to a point on the orbit of the command module. Explain if the work done on the module is positive or negative. [3]

(d) Assume that such a mission has been completed and that the spacecraft returns to Earth with a rock sample from the surface of Mars. Laboratory measurements show that this sample has a density of 2.0×10^{3} kgm^{-3}. Determine whether or not this is consistent with the hypothesis that Mars had a uniform density. [2]

27 Use the following physical data for ice, water and steam (when necessary) to answer this question:

	Ice	Water	Water	Steam
Temperature	0 °C	0 °C	100 °C	100 °C
Volume occupied by 1 kg at standard pressure/ m^3	0.00109	0.00100	0.00104	1.67
Kinetic energy of all the molecules in 1 kg/ 10^5 kg	1.89	1.89	2.58	2.58
Potential energy of all the molecules in 1 kg (referred to ice at 0 °C)/ 10^5 J	0	3.36	3.41	24.3
Internal energy of 1 kg/ 10^5 J				

(a) Explain why there is no change in the kinetic energy of the molecules when the ice at 0 °C changes to water at 0 °C. [1]

27 **(b)** Complete the table for the internal energy of the substance. [2]

(c) Determine the specific latent heat of fusion of ice. [2]

(d) Calculate how much work has to be done by 1 kg of water in order to change to steam at 100 °C and at atmospheric pressure of 1.01×10^5 Pa. [2]

(e) **(i)** State the *First Law of Thermodynamics*. [1]

(ii) Use the first law of thermodynamics to calculate the specific latent heat of vaporisation of water. [2]

28 A designer uses the circuit shown for the sidelights of a car. The lamps are each rated at 6.0 V, 12 W. The battery used is of negligible resistance.

28 **(a)** Calculate the current in the battery. [3]

(b) A fully charged battery is able to supply a total charge of 1.2×10^5 C. How long could the lamps operate when connected to a fully charged battery? [1]

(c) A user replaces one of the front lamps with one rated at 12 V, 24W. State and explain whether

(i) the **front** sidelights will operate at their normal rated power, [2]

(ii) the change has any effect on the brightness of the **rear** sidelights. [2]

(d) The original circuit is not normally used. In practice, four lamps, each rated at 12 V, are connected in parallel as shown below. Suggest why this is preferred. [1]

29 An ideal operational amplifier (op-amp) is used in the circuit shown in Fig 29.1. The input potential is V_{in} = – 1.0 V and the power supply for the amplifier is provided by two batteries, each of emf 15 V and zero internal resistance.

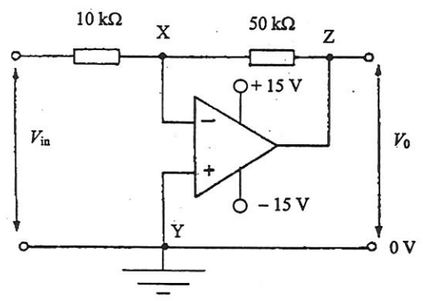


Fig 29.1

(a) State **TWO** properties of an ideal op-amp. [2]

(b) Briefly explain why point X is said to be "*virtually earthed*". [1]

(c) (i) Find the current flowing through the 10 kΩ resistor and state its direction of flow. [2]

(ii) Determine the current flowing through the 50 kΩ resistor. [1]

(d) What is the output potential V_0? [2]

29 **(e)** V_{in} is replaced by a sinusoidal-wave voltage which varies between – 5.0 V and + 5.0 V as shown in Fig 29.2. Sketch on the same axes, the variation of the output potential V_0, with time, t. Label your graph V_0. [3]

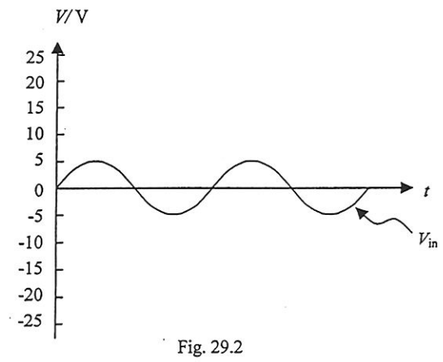


Fig. 29.2

30 An alternating current varies with time in the way shown in Fig. 30.1

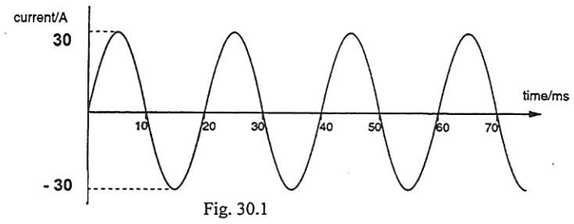


Fig. 30.1

(a) Use the graph to determine,
(i) the frequency [1]

(ii) the root-mean-square value. [1]

(b) On Fig. 30.1 sketch a graph which shows how the power supplied by this current to a resistor of resistance 5.0 Ω varies with time. Label the vertical axis as power and mark on this axis the maximum value of the power. [2]

30 (c) The current shown in Fig 30.1 is the input current in the 300 turn primary of an ideal transformer. The secondary of the transformer has 6000 turns.

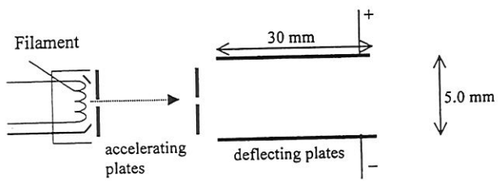
(i) Calculate the transformer's peak output current. [1]

(ii) A generator produces the current shown in Fig 30.1 at 400 V rms. The voltage is stepped up using the above transformer before the power is transmitted over a distance of 1.0 km through a power line of total resistance 50 Ω.

1 Determine the percentage of power loss in the transmission. [3]

2 If the electricity cost $0.50 per kilowatt hour, estimate the cost due to power loss in the transmission for one day. [2]

31



Electrons in a cathode ray tube are accelerated from rest to a speed of 2.0×10^7 ms^{-1}, travelling horizontally before passing between two horizontal deflecting plates that are 5.0 mm apart and 30 mm long. The potential difference applied across the deflecting plates is 60 V.

(a) Calculate

(i) the potential difference across the accelerating plates [2]

31(a)(ii) the speed of an electron after passing through the deflecting plates. [3]

(b) With the deflecting voltage maintained at 60 V, a magnetic field is applied between the deflecting plates so that the electrons are undeflected.

(I) Determine the magnitude and direction of the magnetic flux density of the field, [3]

(ii) If both fields at the deflecting plates are kept at these constant values, sketch the probable path of the electrons when the potential difference across the accelerating plates is increased. Justify your answer. [2]

Section B Physics of Fluids (Answer all the questions on writing paper)
(You are advised to spend not more than 20 minutes on question 32.)

32 (a) A container ship is a cargo vessel which is designed to carry cargo in its holds and on deck, as illustrated in Fig. 32.1.

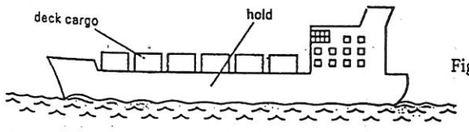


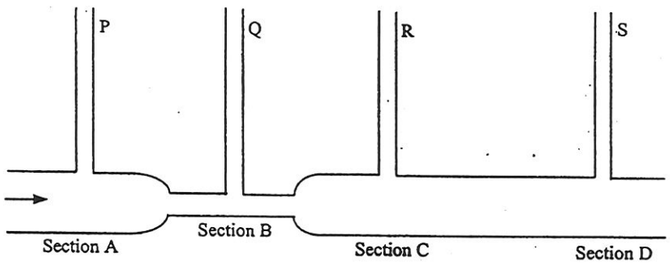
Fig. 32.1

(i) Explain how the stability of a ship is maintained. [4]

(ii) Hence discuss the importance of the correct loading of the container ship with regard to light and to heavy containers. [2]

(b) Icebergs commonly found floating in the North Atlantic are 30 m high (above the water) and 400 m × 400 m across. The density of ice is 920 kgm^{-3} and the density of seawater can be taken as 1000 kgm^{-3}. What is the total volume of such an iceberg (including the volume below the water)? [3]

(c) The diagram shows a Venturi Duct formed in a pipeline by replacing part of a horizontal tube of uniform cross-sectional area with a tube of smaller cross-sectional area.



1. An ideal liquid X of density 750 kgm^{-3} enters Section A at a speed of 0.67 ms^{-1}. The cross-sectional areas of Sections A and B are 0.040 m^2 and 0.010 m^2 respectively. The pressure at Section B is 0.60×10^5 Pa. Find the pressure at Section A. [2]

2. Copy the above diagram ***onto your answer script***, showing the possible liquid levels in each of the tubes P, Q, R and S, all of which are of the same size. [2]

3. Liquid X is replaced with an *incompressible* and ***viscous*** liquid Y. The direction of flow is unchanged. Show on the same diagram you have drawn for part **(c)2.** the possible liquid levels in each of the tubes R and S, assuming that the liquid level in P is the same as before. Label your answers clearly. [2]

Section C Answer only ONE question on writing paper.
(You are advised to spend not more than 30 minutes on a question.)

33(a) Fig. 33.1 shows a cross-section through a compact disc.
The metal layer of a CD is the recording surface and contains narrow ridges, which form a spiral around the disc.

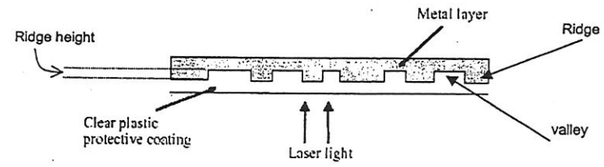


Fig. 33.1

Red ***monochromatic*** laser light of wavelength 780 nm is used to view these ridges. When the light meets a ridge some of it scatters in all directions and some ***interferes destructively*** with light reflected from neighbouring valleys.

(i) Explain the meaning of the words in *italics* in the passage above. [2]

(ii) Calculate the frequency of the red laser light. [1]

(iii) If the speed of laser in the plastic coating is 1.94×10^8 ms^{-1}, show that the wavelength of the laser light in the plastic coating is approximately 500 nm. [1]

(iv) The height of the ridges on a CD is approximately 125 nm. Explain how destructive interference occurs. [3]

(v) The infrared laser standard was fixed in 1980 because of the reliability and availability of relatively inexpensive lasers, which emit at 780 nm. However, blue light lasers are now being developed. These emit a wavelength about half that of the red light lasers. Will it be possible to play existing CDs using blue light laser CD players? Explain your answer. [2]

(b) Fig. 33.2 shows a uniform wire which is held taut but unstretched between a fixed point and a smooth cylindrical peg of radius 1.0 cm. The force constant of the wire is 9.6×10^2 Nm^{-1}. The tension in the wire can be increased by rotating the peg about its fixed axis so that some wire is wound onto the peg.

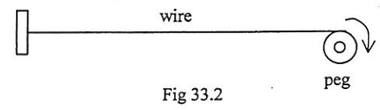


Fig 33.2

(i) **1** When the peg is rotated through an angle of 2π, calculate the tension in the wire.

2 Calculate the work done in rotating the peg through an angle of 2π. [4]

33(b)(ii) The above wire is part of a musical instrument. Two knife-edges, A and B, are placed 0.36 m apart under the stretched wire as shown in Fig. 33.3. The mass of the wire between A and B is 6.4×10^{-4} kg. (Assume that the two knife-edges would not affect the tension in the wire.) The speed of the waves in the wire is given by $v = (T / m)^{1/2}$ where T is the tension and *m* is the *mass per unit length*.

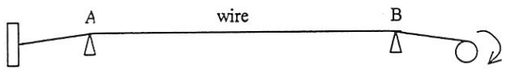


Fig 33.3

1 Calculate the frequency of the fundamental note emitted when the wire between A and B is plucked. [3]

2 State THREE differences between the waves in the wire and the emitted fundamental note. [3]

3 Fig 33.4 shows the shape of the vibrating wire at a certain instant. If the points on the wire are at maximum displacements at that instant, copy and sketch on the same diagram the shape of the wire after three-quarters of a period. [1]

Fig. 33.4

34(a) Distinguish between magnetic flux density B and magnetic flux Φ. [2]

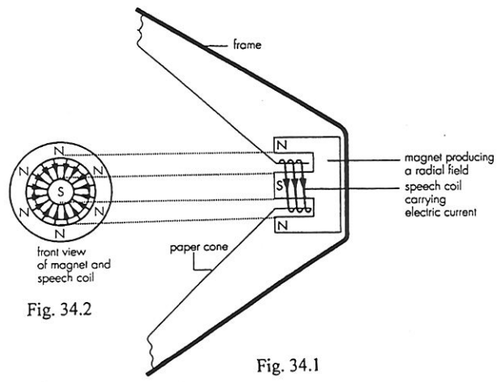


Fig. 34.2

Fig. 34.1

(b) Fig. 34.1 above shows the side view diagram of a moving coil loudspeaker. Electrical current is passed through the coil of wire which is in the gap between the poles of a permanent magnet. The shape of the magnet is such that it provides a radial field as shown in Fig. 34.2 which is a front view diagram of the speaker. The coil is attached to the paper cone. Vibration of the paper cone gives rise to a sound wave.

(i) 1 The field is radial as shown in Fig. 34.2. Refer to Fig. 34.1, state the direction of movement of the coil when the current is flowing in the direction shown. [1]

2 Explain why the coil oscillates when an alternating current passes through the coil. [2]

(ii) 1 For a loudspeaker the magnetic flux density in the air gap is 0.70 T. The coil has 150 turns and a diameter of 20 mm. Show that the force on the coil when a steady current of 50 mA passes through it is 0.33 N. [2]

2 The coil, paper cone and suspension of this loudspeaker may be treated as a mass attached to a spring of force constant 3.6×10^{3} Nm^{-1}. Calculate the displacement produced by the 0.33 N force. [2]

(c) One rigid conducting loop of diameter 10.0 cm is suspended freely with non-conducting cords. A 0.50 T uniform magnetic field is directed parallel to the axes of the loops as shown in Fig. 34.3.

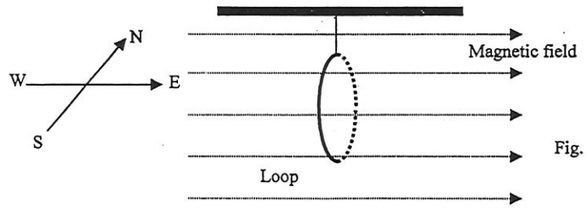


Fig. 34.3

(i) Determine the magnetic flux through the loop. [1]

(ii) The magnetic flux density falls to zero in a time of 0.010 s.

1. Using the law of electromagnetic induction, explain why a current flows in the loop. [1]

2. Copy the diagram of the loop and indicate the direction of the induced current in the loop. Justify your answer. [2]

3. Hence determine the average induced currents in the loop if the resistance is 0.10 Ω? [2]

(iii) State and explain what is likely to happen to the loop as the magnetic field reduces to zero. [2]

(iv) The loop can be set to swing with two modes of vibration of large amplitude. One is in the NS direction and the other in EW direction. Assuming no air resistance, describe and explain separately the motion of the loop in these two modes of vibration. [3]