

Model Questions – 2078 (2022)

Subject: Physics (1021)

Full Marks: 75

Time: 3 hrs.

SET A

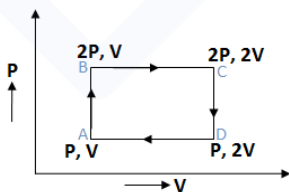
Attempt all questions.

GROUP – A

Circle the best alternative to the following questions.

[11×1=11]

1. The moment of inertia of a body of mass M about a given axis is I . What is the radius of gyration?
a) $\frac{I}{M}$ b) IM c) $\sqrt{\frac{I}{M}}$ d) \sqrt{IM}
2. Two simple harmonic motion are given by $x_1 = a \sin(\omega t)$ and $x_2 = b \cos(\omega t)$. The phase difference between them, in radians, is:
a) π b) $\frac{\pi}{2}$ c) $\frac{\pi}{4}$ d) 0
3. What fraction of a wooden raft of density 0.8 g/cc will be outside the sea water of density 1.2 g/cc?
a) $\frac{2}{3}$ b) $\frac{1}{2}$ c) $\frac{2}{5}$ d) $\frac{1}{3}$
4. An ideal gas undergoes a reversible isothermal expansion from a state i to f. The change in entropy $\Delta S(i \rightarrow f)$ is
a) 0 b) >0
c) <0 d) not defined for this process
5. An ideal mono-atomic gas is taken round the cycle ABCDA as shown in figure. The work done during the cycle is



- a) PV b) 2PV c) PV/2 d) ZERO

6. Which one of the following represents progressive wave?
 - a) $y = A \sin Kx$
 - b) $y = A \sin t$
 - c) $y = A \cos (at - bx + c)$
 - d) none of these
7. Laplace correction makes use of which of the following process?
 - a) Isobaric
 - b) Isothermal
 - c) Adiabatic
 - d) Isochoric
8. A transformer core is laminate to
 - a) Reduce hysteresis losses.
 - b) Reduce eddy current losses.
 - c) Reduce copper losses.
 - d) Reduce all above losses.
9. The thermocouple cannot measure the temperature:
 - a) Between cold junction temperature and neutral temperature
 - b) Between neutral temperature and inversion temperature
 - c) Between cold junction temperature and inversion temperature
 - d) Just above the cold junction temperature
10. Curie temperature is the temperature above which
 - a) A ferromagnetic substance becomes paramagnetic.
 - b) A paramagnetic substance becomes ferromagnetic.
 - c) A paramagnetic substance becomes diamagnetic.
 - d) A ferromagnetic substance becomes diamagnetic.
11. Which of the following particle is considered as God particle?
 - a) Neutrino
 - b) Higgs Boson
 - c) Meson
 - d) Positron

GROUP – B

Answer the following questions.

[8×5 = 40]

1. a) What is couple of force? Give an example applied in your home. [1+1]
 b) Obtain the moment of inertia of a thin rod about an axis passing through its centre and perpendicular to its plane. [3]
2. a) Giving an example of each type, compare between periodic and simple harmonic motions. [2]
 b) A certain simple pendulum has a period on the earth of 1.60 s. What is its period on the surface of Mars, where $g = 3.71 \text{ m/s}^2$? [3]

OR

- a) Define Capillarity. Why undergarments are usually made of cotton? [1+1]
- b) What correction is to be made in a barometer reading if the barometer has a glass tube of internal diameter 3mm ? (Surface tension of mercury = 0.545 Nm^{-1} , density of mercury = $13.6 \times 10^3 \text{ kgm}^{-3}$; angle of contact = 140°) [3]
3. a) When we blow air with our mouth narrow open, we feel the air cool. When the mouth is made wide open, we feel the air warm. What are the thermodynamic processes involved in these processes? Explain. [2]
- b) In case of petrol engine, in which strokes do the adiabatic processes occur? [1]
- c) In a petrol engine, the rate of production of heat due to the combustion of petrol is $7.45 \times 10^5 \text{ cal/hr}$. The efficiency of the engine is 30%. Calculate the power of the engine. [2]
4. a) State and explain Huygen's principle [2]
- b) Verify the laws of refraction of light by using Huygen's principle. [3]

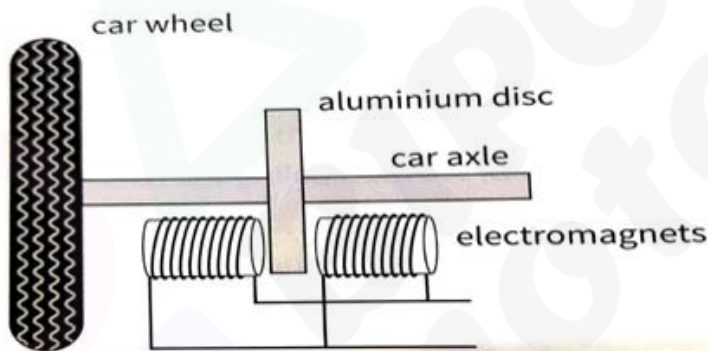
OR

- a) Compare between interference & diffraction of light. [2]
- b) A plane transmission grating gives an angle of diffraction of line at 30° in the second order. Find the number of lines per cm on the grating if the wavelength of light used is $5 \times 10^{-5} \text{ cm}$. [3]
5. A shunt is used to convert a galvanometer of resistance G into an ammeter.
- a) A shunt must have very low resistance. Why? [1]
- b) To increase the range of ammeter n times, what value of shunt is required? [1]
- c) If the galvanometer shows the deflection out of range in the experiment, what conclusion can be drawn? [1]
- d) While converting the galvanometer of resistance 10Ω into an ammeter in the range 1A, a very small resistance 0.1Ω in parallel and a resistor

89.9 Ω in series are required with the galvanometer. What is full scale reading in the galvanometer? [2]

OR

- a) An alternating emf is applied across a capacitor. Justify that current in it leads to the applied emf by phase angle $\frac{\pi}{2}$. [3]
 - b) Write the equation of house-hold AC supply in Nepal (i.e. 220 V and 50 Hz). [2]
6. a) State Lenz's law and explain how you would use a coil to demonstrate the law. [3]
- b) A vehicle brake consists of an aluminium disc attached to a car axle as in figure. Electromagnets cause an emf to be induced in the disc. Explain how the induction of an emf causes the wheel to slow down. [2]



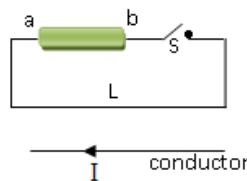
7. a) Can X-ray diffraction experiment be performed by an ordinary grating? Justify. [2]
- b) The spacing of atomic planes in a crystal is $1.1 \times 10^{-10}\text{m}$ and when a monochromatic beam of X-rays incident on them at a glancing angle of 5.0° , a first order image is produced. Calculate the wavelength. What is the glancing angle for a second order range? Interpret result. [3]
8. a) A nucleus contains no electrons, yet it ejects them. Explain. [2]
- b) A radioactive source has decayed to one tenth of one percent of its initial activity in 100 days. What is its half life period? [3]

GROUP – C

Give long answer to the following questions.

[3 × 8 = 24]

9. a) In the circuit shown in fig, ab is battery. When switch S is suddenly closed, the wire L is pulled towards the lower conductor parallel with the wire carrying current I.



- i. Which (a or b) is the positive terminal of the battery? Explain. [2]
- ii. Is the wire pulled towards the conductor if it is not parallel with the conductor? Justify it. [1]
- b) A closed curve encircles several conductors. The line integral around this curve is $3.83 \times 10^{-4} \text{ Tm}$. What is the net current enclosed in the conductor? [1]
- c) A current carrying solenoid produces magnetic field along its axis. Does the magnetic field at its center change if the iron rod is inserted inside it? If yes, by which factor? Explain. [2]
- d) In Hall effect experiment, is it possible that no transverse potential difference will be observed? Under what circumstances might this happen? [2]
10. a) What is Doppler's effect? Explain. [2]
- b) Find an expression for change in apparent frequency heard by observer while a source is moving towards and away from stationary observer. [3]
- c) A car sounding a horn and producing note of 500 Hz, approaches and then passes a stationary observer at a steady speed of 20 m/s. Calculate the change in frequency heard by the observer [velocity of sound is 340 m/s] [3]
11. a) i. What do you mean by quantization of charge? [1]
- ii. The terminal velocity of the drop will be changed in the Millikan's oil drop experiment if more intense X ray is passed. Why? [2]
- b) In the absence of electric field, the drop will have certain velocity. When electric field is switched on and X-ray is passed, what

observation on the different terminal speeds of the drop, suggest about the quantization of charge? [2]

- c) i. In a Millikan's apparatus, an oil drop of weight 2.0×10^{-15} kg acquires two surplus electrons. When a p.d. of 620 V is applied between the pair of horizontal metallic plates, the drop is in equilibrium. Find the distance between the plates. [2]
- ii. Sketch the nature of force involving in the process in part c(i) showing their proper direction. [1]

OR,

In the photoelectric effect, when electromagnetic radiation strikes the surface of a metal, electrons leave the metal surface. However, when radiation of less than a certain frequency strikes the surface, it is observed that there is no emission of electrons.

- a) i. Explain why there is no emission of an electron if the frequency is too low. [2]
- ii. State two other pieces of evidence provided by the photoelectric effect which suggest that electromagnetic radiation has particle properties. [1]
- b) i. The work function of the metal is 3.8 eV. Calculate the minimum frequency of electromagnetic radiation that causes photoelectric emission. [2]
- ii. An electron at the surface of the metal is emitted with a kinetic energy of 4.5×10^{-19} J. Calculate the energy of the incident photon in eV. [2]
- c) Mention any two applications of photo-electric effect in our daily life. [1]



SET B

Attempt all questions.

GROUP – A

Circle the best alternative to the following questions.

[11x 1 = 11]

1. When torque acting upon a system is zero, which of the following will be constant?
 - a) Force
 - b) Linear momentum
 - c) Angular momentum
 - d) Impulse
2. A hole is bored in the earth along its diameter. When a ball is dropped from its one end,
 - a) it remains stationary.
 - b) it moves and stops at the centre.
 - c) it exhibits SHM.
 - d) it comes out from the other end.
3. If the surface tension of a soap solution is T , what is the work done in blooming a soap bubble of radius r ?
 - a) $\pi r^2 T$
 - b) $2\pi r^2 T$
 - c) $4\pi r^2 T$
 - d) $8\pi r^2 T$
4. A Carnot's cycle contains
 - a) Two isothermal processes only
 - b) Two adiabatic processes only
 - c) Two isothermal processes and two adiabatic processes
 - d) Two isothermal processes and two isobaric processes
5. First law of thermodynamics is the law of conservation of
 - a) Mass
 - b) energy
 - c) momentum
 - d) heat
6. Light waves are transverse because they
 - a) get reflected
 - b) get refracted
 - c) get polarized
 - d) do not get polarized

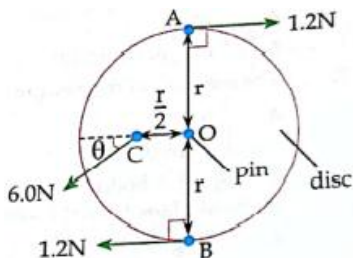
7. Speed of sound in a gas depends on
 - a) temperature and pressure
 - b) surface area and volume
 - c) temperature and composition
 - d) composition and surface area
8. Three charged particles H^+ , He^+ and O^+ moving with the same energy enter normally in a uniform magnetic field. Then,
 - a) H^+ deflects most
 - b) H^+ and He^+ deflect equally
 - c) He^+ deflect least
 - d) all deflect equally
9. The Cold Junction of a thermocouple is maintained at $10^\circ C$. No thermos emf is developed when the junction is maintained at $530^\circ C$, then the neutral temperature is:
 - a) $520^\circ C$
 - b) $540^\circ C$
 - c) $270^\circ C$
 - d) $265^\circ C$
10. Current in the LCR circuit becomes extremely large when
 - a) Frequency of AC supply is increased.
 - b) Frequency of AC supply is decreased.
 - c) Inductive reactance becomes equal to capacitive reactance.
 - d) Inductance becomes equal to capacitance
11. The momentum of a photon of wavelength λ is
 - a) $h \lambda$
 - b) h/λ
 - c) λ/h
 - d) $h/c\lambda$

GROUP – B

Answer the following questions.

[8 × 5 = 40]

1. a) Define the torque of a couple. [1]
 - b) A thin disc of radius r is supported at its center O by a pin. The disc is supported so that it is vertical. Three forces act in the plane of the disc, as shown in Fig.



Two horizontal and opposite forces, each of magnitude 1.2 N , act at points A and B on the edge of the disc. A force of 6.0 N , at an angle θ below the horizontal, acts on the midpoint C of a radial line of the disc, as shown in Fig. The disc has negligible weight and is in equilibrium.

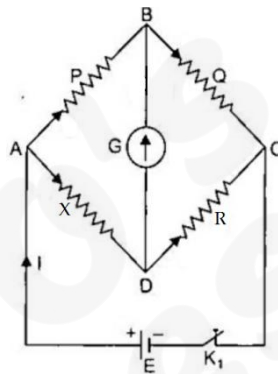
- i. State an expression, in terms of r , for the torque of the couple due to the forces at A and B acting on the disc. [1]
 - ii. Friction between the disc and the pin is negligible. Determine the angle θ . [2]
 - iii. State the magnitude of the force of the pin on the disc. [1]
2. a) Write two differences between viscous force and Solid friction. [2]
 - b) What is the magnitude and direction of the terminal velocity when an air bubble of 1 mm in diameter rises in a liquid of viscosity 150 centipoise and density 0.9 gcm^{-3} ? ($g = 981\text{ in cgs}$) [3]
 3. a) Why don't we obtain 100% efficiency in Carnot's engine? [2]
 - b) A Carnot's engine has 50% efficiency with sink at 9°C . By how many degrees should temperature of source be increased in order to raise the efficiency to 70% ? [3]

OR

- a) What is an isothermal process? Derive the expression for the work done in isothermal process. [1+3]
- b) Can work be done by the system without changing its volume?[1]
4. a) Write down purpose of performing Young's Double Slits Experiment. [1]
- b) i. Show that the bright and dark fringes are equally spaced in Young's Double Slits Experiment. [3]
- ii. What will be the effect on the fringe width if the double slit experiment is performed in water? [1]

5. a) What is wattless current?
- b) An alternating current having peak value 14 A is used to heat a metal wire. To produce the same heating effect in equal time what constant current that should be applied on the wire?
- c) Find the time required for 50 Hz alternating current to reach its value from zero to rms value. [2]

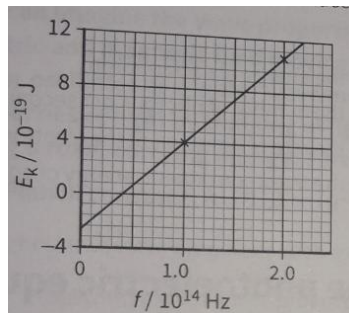
6. A Wheatstone Bridge circuit is shown in fig in which four resistances and galvanometer are connected. Resistances P, R and Q are known and X is unknown.



- a) Define Wheatstone bridge and write its one application. [1]
 - b) While doing experiment, Current flows through the circuit, through all resistors and also through the galvanometer. What is the condition of bridge?
 - i. If current flows from B to D through the galvanometer and vice versa? [1]
 - ii. If no current flows through the galvanometer. Is this condition useful in the given fig, how? [2]
 - c) What happens in the sensitivity of bridge if the value of P is made very large? [1]
7. a) What do you mean by specific charge of an electron? Is its value a universal constant for an electron? [1]
 - b) The value of specific charge (e/m) is constant for cathode rays (or electrons) but not for positive rays. Why? [2]
 - c) In an evacuated tube electrons are accelerated from rest through a potential difference of 3600 V and then travel in a narrow beam through a field free space before entering a uniform magnetic field of $2 \times 10^{-3} \text{ T}$, the flux lines of which are perpendicular to the beam. In the magnetic field the electrons describe a circular arc of radius 0.1 m, calculate e/m of the electron. [2]

OR

- a) This graph shows the variation with frequency f of the maximum kinetic energy E_k of the electrons emitted from the surface of a metal: [3]



i. Use the photoelectric equation to show that the gradient of the graph is equal to Planck's constant.

ii. Obtain a value for Planck's constant from the graph.

iii. State how the work function energy can be obtained from the graph.

b) Obtain a value for the work function energy. [1]

c) Imagine that the graph is redrawn for a metal with a smaller work function. State how the gradient and intercept of the new graph compare with the old graph. [1]

8. a) i. What is potential barrier? [1]

ii. What is the effect of temperature on the potential barrier of a diode? [2]

b) Is it possible to measure barrier potential of junction diode by using sensitive voltmeter? [2]

GROUP – C

Give the long answer to the following questions. [3 x 8 =24]

9. a) What do you mean by intensity of sound ? [2]

b) Prove that the intensity of sound is directly proportional to square of amplitude [3]

c) A baby's mouth is 30 cm from her father's ear and 1.50 m from her mother's ear. What is the difference between the sound intensity level heard by the father and by the mother? [3]

OR,

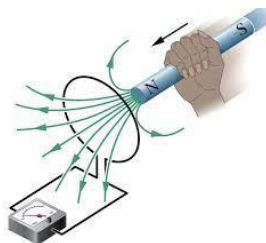
a) What do you mean by diffraction of light? Mention the types of diffraction pattern. [2]

b) In diffraction through single slit, the width of central maxima is twice of width of first maxima. Prove it. [4]

- c) What happens to the width of central diffraction pattern when the experimental setup is emerged in water? [2]

10. An ammeter registers a current in the wire loop when magnet is moving with respect to the loop.

- a) Name the current thus developed in the loop wire. [1]
 b) How can you find the direction of current developed in the loop wire? [1]



- c) The magnetic flux through a coil is varying according to the relation, $\phi = (4t^3 + 5t^2 + 8t - 3) \text{ Weber}$, calculate the induced current through the coil at $t = 2 \text{ sec}$ if the resistance of the coil is 3.1Ω . [3]
 d) Write the working principle of transformer. Suggest any two ideas to reduce the losses in transformer. [1 + 2]

OR.

- a) Write one significant difference between Bio-Savart's law and Ampere's law. [1]
 b) A straight wire carries a 10A current. ABCD is a rectangle with point D in the middle of a 1.1 mm segment of the wire as shown in figure.

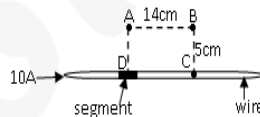
- i. Find the magnetic field at point A due to this segment. [1]

- ii. If the wire is made semi-infinite, obtain the expression of magnetic field at any point P at minimum distance 'a' from the wire. [1]

- iii. Sketch the graph for the variation of the magnetic field B due to the whole wire with the distance. [1]

- c) What is the physical significance of radial magnetic field in the moving coil galvanometer? [2]

- d) A wooden ring whose mean diameter is 14cm is wound with a closely spaced toroidal windings of 600 turns. Compute the magnitude of magnetic field at the center of the cross section of the windings when the current in the windings is 0.65A. [2]



11. Electrons are known to show wave properties, with a wavelength given by the de Broglie equation.

a) State the de-Broglie equation in words. [1]

b) i. Show that the wavelength of an electron of kinetic energy E is

given by the equation: $\lambda = \frac{h}{\sqrt{2mE}}$, where m is the mass of the

electron. [2]

ii. Sketch nature of graphical relationship between λ & E for an electron. [1]

c) Calculate the de-Broglie wavelength of an electron accelerated through a p.d. of 2.0 kV. [2]

d) The electrons in *part c* are passed through a crystal structure and diffract. Explain why the electrons are diffracted? [2]

OR,

Iodine -131 ($_{53}\text{I}^{131}$) is a radioactive isotope with a decay constant of $9.9 \times 10^{-7} \text{ s}^{-1}$.

a) State what is meant by: i. radioactive ii. decay constant. [2]

b) Obtain a relation between half life and decay constant. [3]

c) i. Some water becomes contaminated with iodine-131. The activity of the iodine – 131 in 1.0kg of water is 560 Bq. Determine the number of iodine-131 atoms in 1.0kg of water. [1]

ii. Regulations require that the activity of iodine -131 in 1.0kg of water is to be less than 170 Bq. Calculate the time, in days, for the activity of the contaminated water in (i) to be reduced to 170 Bq. [2]



SET C

Attempt all questions.

GROUP – A

Circle the best alternative to the following questions.

[11 × 1 = 11]

- The spokes are used in bicycle wheel to
 - ↑ frictional force
 - ↓ frictional force
 - ↑ moment of inertia
 - ↑ angular momentum
 - Radius of Gyration of an uniform rod about an axis through its middle is
 - $L/(3)^{1/2}$
 - $L/(8)^{1/2}$
 - $L/(12)^{1/2}$
 - $L/(2)^{1/2}$
 - Viscosity of liquid and gases, with increase in temperature.
 - decreases and increases
 - increases
 - increases and decreases
 - decreases
 - In pressure-volume diagram given below, the isochoric, isothermal, isobaric and isentropic path respectively are
 - BA, AD, DC, CB
 - DC, CB, BA, AD
 - AB, BC, CD, DA
 - CD, DA, AB, BC
-
- A gas is initially at 27°C. It is compressed adiabatically from 27 litres to 8 litres. The rise in temperature is ($\gamma = 1.4$)
 - 402°C
 - 215°C
 - 675°C
 - 273°C
 - A parallel beam of light of wavelength 450 nm passes through a long slit of width 0.2 mm. The angular divergence in which most of the light is diffracted is
 - 0.29°
 - 0.146°
 - 0.257°
 - 0.292°
 - The expression relating polarizing angle and refractive index is
 - $\mu \sin \theta_p = 1$
 - $\mu \cot \theta_p = 1$
 - $\mu \tan \theta_p = 1$
 - $\mu \cos \theta_p = 1$

8. If a wire carrying current 'I' is bent to two arms making the right angle between them then the magnetic field intensity 'B' at the distance 'a' from both arms is:

a) $\frac{\mu_0 I}{4\pi a}$

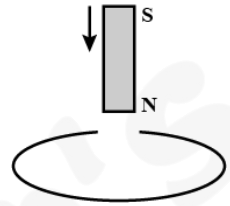
b) $\frac{\mu_0 I}{2\pi a}$

c) $\frac{\mu_0 I}{\sqrt{2}4\pi a}$

d) $\frac{\mu_0 I}{\sqrt{2}2\pi a}$

9. A copper ring having cut such as not to form a complete loop is held horizontally and a bar magnet is dropped through the ring with its length along the axis of ring, then acceleration of falling magnet is

- a) g
- b) less than g.
- c) more than g.
- d) zero.



10. Area of hysteresis curve indicates

- a) Retentivity
- b) Coercivity
- c) Loss of energy per cycle.
- d) All of the above.

11. The value of specific charge (e/m) of an electron is

- a) $1.6 \times 10^{-19} \text{ C/kg}$
- b) $1.77 \times 10^{11} \text{ C/kg}$
- c) $1.77 \times 10^{-11} \text{ C/kg}$
- d) $9.1 \times 10^{-31} \text{ C/kg}$

GROUP – B

Answer the following questions.

[8 × 5 = 40]

1. a) State, by reference to displacement, what is meant by simple harmonic motion ? [2]
 b) Derive an expression for the time period of the simple pendulum if its motion is simple harmonic. [3]
2. a) Define adhesive and cohesive forces with an example each. [2]
 b) Show that the surface tension of a liquid is numerically equal to its surface energy. [3]
3. a) Why does a gas have two specific heat capacities? Explain. [2]

b) Establish the relation between C_p and C_v for a gas. [3]

OR

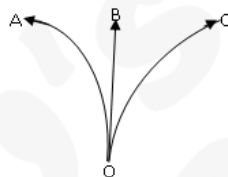
a) We cannot convert heat energy to mechanical work without creating a temperature difference. Explain on the basis of second law of thermodynamics. [2]

b) Explain the working of petrol engine with PV diagram. [3]

4. a) How stationary wave is formed? Explain. [2]

b) Prove that the distance between any two consecutive nodes or antinodes is $\lambda/2$. [3]

5. a) A neutron, a proton and an electron enter vertically upward with equal velocity in a region of the uniform magnetic field applied inward normal to the plane of paper as shown in fig.



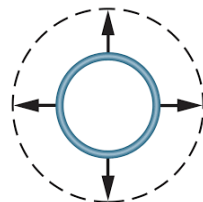
i. Which particles go along OA and OC, why? [2]

ii. What physical phenomenon can be concluded from the particle moving along OB? [1]

b) When a charge particle moves in a magnetic field, magnetic force $F = Bqv\sin\theta$ acts on it. A conductor contains large number of charges, then obtain the expression of magnetic force on the conductor from above equation. [2]

OR

a) If the circular conductor shown in figure undergoes thermal expansion while it is in uniform magnetic field, a current is induced clockwise around it. Is the magnetic field directed into or out of the page? [1]



b) Explain how the concept of mutual inductance is used in the working principle of transformer. [2]

c) Calculate the value of inductance needed to store 1 kWh of energy in a coil carrying 200 A current. [2]

6. a) What do you mean by phasor diagram? Draw phasor diagram for an AC circuit containing inductor and resistor connected in series.

b) A circuit consists of an inductor of $200\ \mu\text{H}$ and resistance of $10\ \Omega$ in series with a variable capacitor and a $0.10\ \text{V}$ (rms), $1.0\ \text{MHz}$ supply.

Calculate (i) capacitance to give resonance (ii) the quality factor of circuit at resonance. [3]

7. a) Can one photon eject more than one electron at a time? Explain. [2]
b) Copper and sodium have work function 4.5eV and 2.0eV, respectively. Radiation of wave length 4000\AA fall on the two surfaces. Can there be photoelectric emission in both metals? [2]
c) Explain, how is photoelectric effect used in fire alarms? [1]
8. a) i. What is a logic gate?
ii. Write down the Boolean expression for AND, OR and NOT gate? [2]
b) How is a NOT gate different from AND or OR gate? Can NOT gate be made from junction diodes? [2]
c) The output of two-input AND gate is fed to a NOT gate. Give its logic symbol and write down its truth table. Identify the new logic gate formed. [1]

OR

- a) What do you meant by: i. the decay constant λ of radioactive material, ii. the half life $T_{1/2}$? [2]
- b) The decay constant and half life are related by the equation: $\lambda = \frac{0.693}{T_{1/2}}$.
The half life of $^{27}\text{Co}^{60}$ is 5.26 years.
i. What do the numbers 27 & 60 represents?
ii. Calculate the decay constant of $^{27}\text{Co}^{60}$.
iii. Calculate the activity of 1.00 gm of $^{27}\text{Co}^{60}$. [Given, 60 gm of $^{27}\text{Co}^{60}$ contain 6.023×10^{23} atoms.] [3]

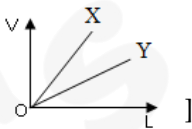
GROUP – C

Give the long answer to the following questions. [3 x 8 =24]

9. a) How plane transmission grating is formed? [2]
b) Derive an expression for grating equation. [3]
c) A plane transmission grating having 500 lines per mm is illuminated normally by a light source of 600 nm wavelength. How many diffraction maxima will be observed on a screen behind the grating? [3]

OR

- a) How stationary wave is formed in an organ pipe? [2]
b) Show that all harmonics are present in open organ pipe [3]

- c) An open pipe 30 cm long and a closed pipe 23 cm long, both of the same diameter are each sounding its first overtone and these are in unison. What is the end correction of these pipes? [3]
10. a) To measure an emf of an unknown cell, a potentiometer wire of uniform cross section is used.
- Why should it be uniform cross section? [1]
 - What will be the effect in the experiment if the polarity of unknown cell is reversed? [1]
- b) The variation of potential difference V with length L in case of two potentiometers X and Y is as shown in diagram. Which one of these two will you prefer for comparing the emf's of two cell? Justify your logic.
- 
- c) In a potentiometer experiment, two primary cells are connected in series to support each other and then connected to oppose each other. The balance point for a cell, in these cases were obtained at 4m and 1m respectively. Calculate the ratio of emf of those two primary cells. [2]
- d) What is the significance of potentiometer working on the basis of null method to measure the potential difference of cell? [2]
11. a) Describe the theory of Millikan's oil drop experiment to determine the charge of an electron. [3]
- b) How does this experiment verify the quantization of charge? [2]
- c) In Millikan's oil drop apparatus, the horizontal plates are 1.5 cm apart. With the electric field switched off an oil drop is observed to fall with the steady velocity $2.5 \times 10^{-2} \text{ cm/s}$. When the field is switched on the upper plate being positive, the drop just remains stationary when the potential difference between the plates is 1500V. Calculate the radius of the drop and the number of electronic charges. (Given, density of oil = 900 kg/m^3 and viscosity of air = $1.8 \times 10^{-5} \text{ Nsm}^{-2}$, neglect air density) [3]



SET D

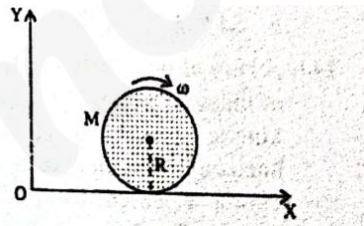
Attempt all questions.

GROUP – A

Circle the best alternative to the following questions.

[11 × 1 = 11]

1. A person standing on a rotating platform has his hands lowered. If he suddenly outstretches his arms, then angular momentum of the platform person system
 - a. Increases
 - b. Decreases
 - c. Remains constant
 - d. Becomes zero
2. An electric fan rotating initially at 300 rpm comes to rest in 10 seconds at constant angular retardation after it is switched off. The total number of rotations made by it till rest, is
 - a. 100
 - b. 50
 - c. 30
 - d. 25
3. A disc of mass M and radius R is rolling with an angular velocity ω on the horizontal plane as shown in fig. The magnitude of the angular momentum of the disc about the origin is :
 - a. $\frac{1}{2}MR^2\omega$
 - b. $MR^2\omega$
 - c. $\frac{3}{2}MR^2\omega$
 - d. $2MR^2\omega$
4. Buoyancy depends on
 - a. Shape of the body
 - b. Depth
 - c. Mass of the body
 - d. Mass of the liquid displaced



5. An aeroplane of mass $3 \times 10^4 \text{ kg}$ and total wing area 120 m^2 is in level flight at some height. The difference in pressure between upper and lower surface of wing is
- $2.5 \times 10^3 \text{ N/m}^2$
 - $5 \times 10^3 \text{ N/m}^2$
 - $10 \times 10^3 \text{ N/m}^2$
 - $12.5 \times 10^3 \text{ N/m}^2$
6. According to second law of thermodynamics, an engine cannot perform in the reverse direction if it is working at the constant
- Volume
 - Pressure
 - Temperature
 - Heat
7. 1 mole of mono-atomic ideal gas is mixed with 1 mole of di-atomic ideal gas. The molar specific heat capacity of the mixture at constant volume is
- $4R$
 - $2R$
 - $3R/2$
 - $5R/2$
8. In meter bridge experiment, the ratio of the left gap resistance to right gap resistance is 2:3, the balance point from the left is
- 60cm
 - 50cm
 - 40cm
 - 30cm
9. To convert the galvanometer into voltmeter, the resistor used is:
- high resistance and connected in parallel with galvanometer
 - high resistance and connected in series with galvanometer
 - low resistance and connected in parallel with galvanometer
 - low resistance and connected in series with galvanometer
10. In the given thermocouple, the minimum thermoemf is produced by
- Sb-Bi
 - Fe-Ni
 - Zn-Bi
 - Au-Mo

11. A device which converts AC into DC is
- An oscillator
 - a rectifier
 - an amplifier
 - An Zener diode

GROUP – B

Answer the following questions.

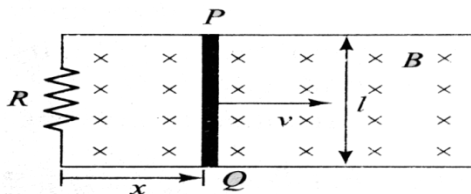
[8 × 5 = 40]

- Why does a refrigerator consumes more power in summer than in winter to cool the same quantity of food by same degree? [2]
 - Find out the expression for coefficient of performance of refrigerator. [3]

OR

- The internal energy of compressed gas is less than that of rarefied gas at the same temperature. Why? [2]
 - The adiabatic equation is $PV^\gamma = \text{constant}$. Starting from this equation, derive the adiabatic equation in terms of (i) temperature and volume and (ii) temperature and pressure. [3]
- Write down the differences between progressive and stationary wave. [3]
 - A wave has the equation $y = 0.02 \sin(30t - 4x)$. Find its frequency, speed and wavelength. [2]
 - We cannot hear echo in a room. Explain. [2]
 - What discrepancy was there in Newton's formula for the velocity of sound in air? What correction was made by Laplace? [1+1]
 - What is the effect of atomicity of gas on speed of sound? [1]
 - Does the value of polarizing angle depends upon colour of incident light? [2]
 - Derive an expression for Brewster's law in polarization and then state it. [2+1]
 - State Faraday's laws of electromagnetic induction. [2]

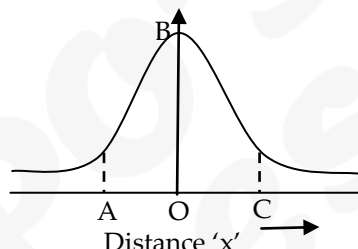
- b) Figure shows the top view of a rod that can slide without friction. The resistance 6Ω and magnetic field 2.5 T is directed perpendicularly downward into the paper. Calculate the force required to move the rod of length 1.20 m to the right at constant speed 2 m/s . [3]



6. a) The graph represents the variation of magnetic field B along the axis of a circular loop of radius R .

i. Write the appropriate equation at point O for which $x = 0$ and at point C of distance x from O .

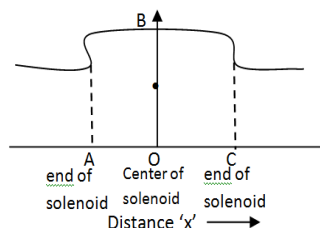
ii. Also discuss the nature of magnetic fields in both cases.



- b) A vertical conductor carries a downward current of 5 A . What is the flux density due to the current at a point P 10 cm due east of conductor? If the earth's horizontal magnetic flux density has a value $4 \times 10^{-5}\text{ T}$, calculate the resultant flux density at P and its direction. [2]
- c) Stream of charged particles emitted from the sun during periods of solar activity create a disturbance in the earth's magnetic field. How does this happen? [1]

OR

- a) The graph shows the variation of the magnetic field B on the axis of the long straight solenoid with the distance x from the center O .



- i. Write the equations of magnetic field at points O and C. Also find the relation between them. [1+1]
- ii. Describe the nature of magnetic fields inside and outside of such solenoid. [1]
- b) A body is suspended through the spring balance and it measures its mass about 50kg. What physical phenomenon is concluded if the balance is connected to the source? Explain. [2]
7. a) i. An electron & proton enter a transverse electric field with the same velocity. Name the particle whose trajectory is more curved?
ii. Instead of an electron & a proton, if neutron enters normally to the electric field, what will be the nature of trajectory? [1 + 1]
- b) If they have same initial K.E. & then enter normally into an electric field, which one has path more curved? Justify. [2]
- c) Sketch nature of graph between acceleration with applied p.d. for an electron moving in uniform electric field. [1]

OR,

- a) i. What is photon?
ii. Do all photons have same mass? Explain. [2]
- b) Does the mass of a body change when it emits or absorbs photons? Explain. [2]
- c) Calculate the energy of a photon whose (i) frequency is 1000 KHz. Also express the energy of the photon in eV in each case. [Given, $1\text{eV} = 1.6 \times 10^{-19} \text{ J}$, $h = 6.62 \times 10^{-34} \text{ Js}$] [1]
8. a) Does Newton's law of universal gravitation provide existence of gravitational wave? [1]
- b) What are gravitational waves? Explain. [2]
- c) What are the causes of gravitational waves? Mention. [2]

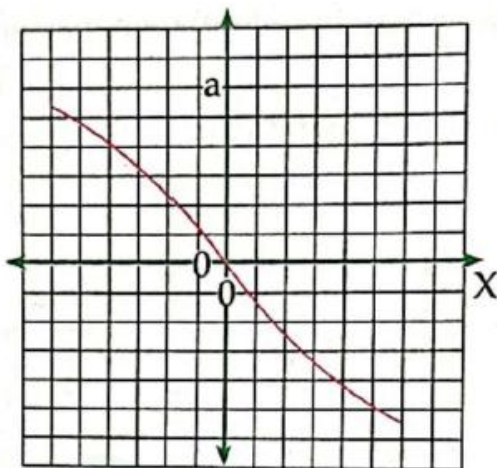
GROUP – C

Give long answer to the following questions.

[3 × 8 = 24]

9. a) Define resonance. [1]
- b) What happens to the period of oscillation of a simple pendulum if its bob is made up of ice? Explain. [2]
- c) A mass is undergoing oscillation in a vertical plane.

The variation with displacement x and acceleration a of the mass is shown in figure.



State two reasons why motion of the mass is not simple harmonic. [2]

- d) A tunnel is dug along the diameter of earth. If an object is dropped through one end. How much time would it take to reach other end? ($g = 10$ in SI unit and $R = 6380$ km) [3]

OR

- Give the concept of surface tension with an example. [2]
- Why does hot soup taste better than cold one? Explain. [2]
- A rectangular plate of dimensions 6 cm by 4 cm and thickness 2 mm is placed with its largest face flat on the surface of water.
 - Calculate the downward force on the plate due to surface tension assuming zero angle of contact. [2]
 - What is the downward force if the plate is placed vertical so that its longest side just touches the water? (Surface tension of water = 7×10^{-2} N/m) [2]

10. a) What do you mean by impedance of LCR circuit? Write the expression for it. What is the condition for resonance? [1 + 1 + 1]
- A 220 V AC is more dangerous than 220 V DC. Why? [2]
 - The wiring for a refrigerator contains a starter capacitor. A voltage of amplitude 170 V and frequency 60 Hz is applied across the capacitor is

to produce a current amplitude of 0.85 A through the capacitor. What capacitance C is required? [3]

11. a) What are Bohr's postulates of hydrogen atom? [2]
- b) i. In hydrogen atom we have only one electron, but its emission spectrum shows many lines. Explain.
- ii. If an electron in Hydrogen atom jumps from $n = 1$ to $n = 4$ orbit, what would be the maximum number of photons emitted?
- iii. In the hydrogen atoms, the electrons make transitions from $n = 1$ to $n = 4$. What will be the maximum number of emission lines? [3]
- c) Rydberg's constant is equal to $1.09678 \times 10^7 \text{m}^{-1}$. Calculate the wavelength of the first number of Balmer series. [3]



Attempt all questions.

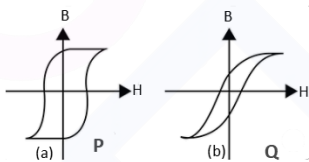
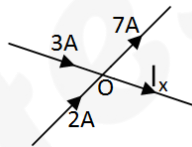
GROUP – A

Circle the best alternative to the following questions.

[11 × 1 = 11]

1. In which process the internal energy of the system remains constant?
 - a) Adiabatic process
 - b) Isochoric process
 - c) Isothermal process
 - d) Isobaric process
2. The door of the refrigerator is kept open. Which of the following is true?
 - a) Room is cooled.
 - b) Room is heated
 - c) Room is neither heated nor cooled
 - d) Room will be cooled in summer and heated in winter
3. There is no net transmission of energy in:
 - a) electromagnetic wave
 - b) Simple harmonic wave
 - c) Longitudinal wave
 - d) Stationary waves
4. The speed of sound in air is 350 m/s. The fundamental frequency of an open pipe of length 50 cm is
 - a) 100 Hz
 - b) 250 Hz
 - c) 350 Hz
 - d) 400 Hz
5. A weight of 5 Kg required to produce the fundamental frequency of a sonometer wire. What weight is required to produce its octave?
 - a) 10 Kgt
 - b) 20 Kg wt
 - c) 30 Kg wt
 - d) 40 Kg wt

6. If two light waves having same frequency have intensity ratio 4:1 and they interfere the ratio of maximum to minimum intensity will be
- 9:1
 - 3:1
 - 25:9
 - 16:25
7. The angle of incidence at which reflected light is totally polarized for reflection from air to glass (μ) is
- $\sin^{-1}(\mu)$
 - $\sin^{-1}\left(\frac{1}{\mu}\right)$
 - $\tan^{-1}\left(\frac{1}{\mu}\right)$
 - $\tan^{-1}(\mu)$
8. From the given diagram, Using Kirchhoff's law, the value and actual direction of current I_x is:
- 2A and towards O
 - 2A and same as in figure
 - 2A and same as in figure
 - 2A and towards O
9. B-H curve of the sample P and Q of iron are shown in figure, then we may conclude that



- Both P and Q are suitable for making permanent magnet
- P is suitable for making permanent magnet and Q is for making electromagnet.
- P is suitable for making electromagnet and Q for permanent magnet.
- Both P and Q are suitable for making electromagnet.

10. An electron is moving along positive X-direction and the magnetic field is along positive Y-direction. Then the motion of the electron is:
- Straight
 - Circular motion in XY
 - Circular motion in YZ
 - Circular motion in XZ
11. The ratio of the radius of the Bohr's first orbit to that of second orbit is
- 2:1
 - 4:1
 - 1:4
 - 1:8

GROUP – B

Answer the following:

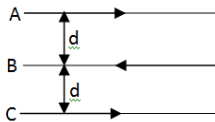
[8×5 = 40]

- State Bernoulli's Theorem and Write one application . [1+1]
 - If winds blows at 30 m/s over the house, what is the net force on the roof if its area is 300 m^2 . (Density of air = 1.29 kgm^{-3}) [3]
- What happens to the mileage per litre of a diesel vehicle when it moves from a hot Terai region to colder Mustang? Explain. [2]
 - A diesel engine performs 2200J of mechanical work and discards 4300J of heat in each cycle. What is the efficiency of the engine? [3]
- What is pressure amplitude? [2]
 - Show that the pressure amplitude is directly proportional to displacement amplitude [3]
- Show that only odd harmonics are present in closed organ pipe. [3]
 - Define overtone and harmonic. [2]

OR,

- Compare between Threshold of hearing and threshold of pain? [2]
 - Establish the relation between intensity and loudness of sound. [3]
- Distinguish the dia and para-magnetic substances on the basis of susceptibility. [2]

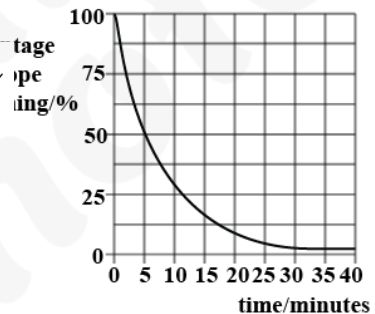
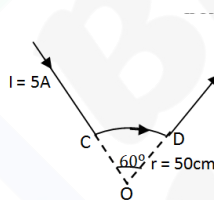
- b) Discuss the relationship between relative permeability and susceptibility. [3]
6. a) Define one ampere current due to force between two current carrying parallel conductor. [1]
- b) Three parallel wires A, B & C each carry current I in the directions



shown in figure. If the separation between adjacent wires is d , then write the expression of the magnetic force per unit length on wire A due to current in the wire B and C. [2]

- c) In the given figure, r be the radius of circular segment and I be the current. Find the magnetic field at point O due the current. [2]
7. a) Define the terms half life and mean life of a radioactive substance. What is relationship between them? [2]

- b) The graph shows the



percentage of a radioactive isotope that remains as time passes. A student measures the initial rate of emission of this isotope as 40000 emissions per second.

- What is the value of Half-life of given radio-active substance? [1]
- Determine the average life time of given radioactivity material. [1]
- How long does it take for the rate of emission to fall to 5000 emissions per second? [1]

8. a) i. What is Zener diode? [1]
 ii. What is the necessity of reverse biasing in Zener diode? [1]
 b) Draw a circuit diagram for the use of Zener diode as voltage regulator? Describe its working. [3]

GROUP – C

Give long answer to the following questions: [3×8 =24]

9. a) Define moment of inertia of rigid body in terms of K.E. [2]
 b) Derive an expression for kinetic energy of a rolling body. [3]
 c) A disc having moment of inertia 0.1 kg m^2 about its centre and radius 0.2 m is released from a plane inclined at 30° to the horizontal. Calculate the angular velocity after it has rolled 2 m down the plane if its mass is 5 kg . [3]

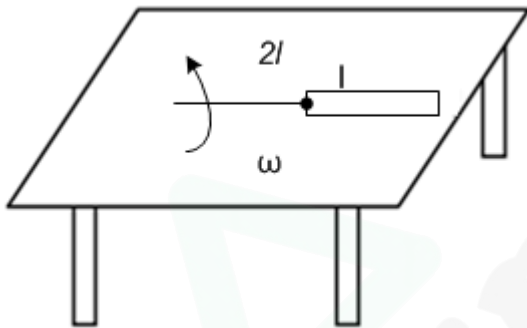
OR

- a) (i) State Stoke's law of viscosity. [1]
 (ii) Draw the graph representing the variation between terminal velocity and time. [1]
 b) Derive an expression of coefficient of viscosity by using Stokes law. [3]
 c) Write an application of Stoke's law related in your daily life. [1]
 d) What is the velocity of surface layer of water in a river, if the river is 2.5 m deep and shearing stress between the horizontal layers of water is $2 \times 10^{-3} \text{ Nm}^{-2}$ ($\eta = 10^{-3} \text{ deca-poise}$) [2]
10. a) State the relationship between peak current I_0 and rms current I_{rms} for sinusoidal alternating current. [1]
 b) The current in ampere of an alternating current is represented by the relation: $I = 2 \sin(50\pi t)$.
 (i) What is the peak value of current? [1]
 (ii) What is the frequency of supply? [1]
 (iii) What is the RMS value of current? [1]
 c) What is the phase relationship between current and voltage in a pure inductive AC circuit? Explain with phasor diagram. [2]
 d) A 50 V , 50 Hz ac supply is connected to a resistor of resistance 40Ω in series with a solenoid whose inductance is 0.2 H . The pd between the

ends of resistor is found to be 20 V. What is the resistance of the wire of solenoid? [2]

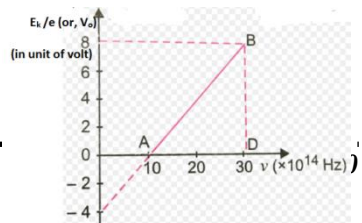
OR

- a) A metallic rod of length l is tied to a non-conducting string of length $2l$ and made to rotate with angular speed ω on a horizontal table with one end of string fixed. If there is a vertical magnetic field 'B' in the region, then write the expression for emf induced across the ends of the rod. [2]



- b) Show that the energy stored in an inductor of inductance L when current I is established through it is $\frac{1}{2}LI^2$. [3]
- c) A step up transformer operates on 220V lines and its secondary supplies a current of 1A. The ratio of primary and secondary windings is 1:10. Calculate the voltage across secondary, current in the primary and output power. [3]

11. a) What is the value of Planck's constant? How can you determine its value? [2]
- b) Why, evacuated metal chamber is used in Millikan's experiment? Is it possible to carry experiment using metal chamber in normal pressure without evacuation? [2]
- c) The given graph is the experimental plot obtained in Millikan's experiment for photoelectric effect for a particular metal.



- (i) What does slope of line represent? Determine its value. [1]
- (ii) Write down value of threshold frequency & then obtain the value of work function of metal. [1]
- (iii) Is the nature of plot is found to similar for all alkali metals as in given graph? Discuss. [2]

OR

Consider a hydrogen atom in stationary state n .

- a) Find the relation between r_n and r_1 . [3]
- b) Show that the orbital period of an electron in quantum state n is $T = n^3 T_1$. [3]
- c) On average, an atom stays in the $n=2$ state for 16ns before undergoing a quantum jump to the $n=1$ state. On average, how many revolutions does the electron make before the quantum jump? [2]

