2013

PHYSICS

Time: 3 Hours 15 Minutes] [Full Marks: 80

Instructions to candidates:
Special credit will be given for answers which are brief and to the point.
Marks will be deducted for spelling mistakes, untidiness and bad handwriting.
Figures in the margin indicate full marks for the questions.

GROUP – A

1. Answer the following questions either in one word or in one sentence (Alternative are to be noted): 1 x 10 = 10
   a) What is the angular speed of second hand of a watch?
   b) Define universal gravitational constant.

      OR

      Magnitudes of acceleration due to gravity at a height h and at a depth x from the earth's surface are the same. Write down the relation between x and h (x and h are very small in comparison to the radius of the earth).
   c) Can light wave be longitudinal?
   d) The equation of a progressive wave is $y=A\ sin\ (kx - \omega t)$. What is the maximum value of velocity of a particle on the wave?

      OR

      The wavelength of a wave is 2m.What is the phase difference between two points on a wave separated by 1m in the medium?
   e) How much work is done in moving q coulomb of charge between two points separated by a distance r on an equipotential surface?

      OR

      Fill in the blanks:

      The surface density of charge of a charged conductor placed in air is σ. Electric intensity very near to the conductor is _____

   f) Write down the relation connecting electric vector, magnetic vector and direction of propagation of an electromagnetic wave.
   g) Which of the following is the unit of electric flux?
      i) Vm^{-1} ii) Vm
      iii) Vm^2 iv) Vm^{-2}

h) A long straight wire of length l is moving in a uniform magnetic field B with a velocity v perpendicular to the field. How much e.m.f will be induced?

OR

i) The permeability and permittivity of free space in vacuum are μ_o and ϵ_o respectively. What is the velocity of electromagnetic wave in vacuum?

OR

The wave length of an electromagnetic wave is 10 m. Does it represent a radio wave?

j) Find the de Broglie wavelength of an electron accelerated through a potential difference of 300 volt.

GROUP – B

2. Answer the following questions (Alternative are to be noted): 2 x 7 = 14

a) Write down the relations connecting pressure(P), volume(V) and temperature(T) of an ideal gas in cases of isothermal and adiabatic process. ½ + (½ + ½ + ½)

OR

Show that at same temperature the average translational kinetic energy of a molecule of all gases is the same.

b) The velocity of sound in a gas of molecular weight 4 is 582 ms^{-1}.Find the temperature of the gas.
[Given $\Upsilon = 1.63$, R $= 8.31 \times 10^7$ erg $mol^{-1}K^{-1}$]

OR

The speed of a wave in a medium is 760 ms^{-1}.If 3600 waves pass through a point in the medium in 2 minutes, find its wavelength.

c) The intensity of an electric field is $\vec{E} = (5\hat{\imath} + 3\hat{\jmath} + 2\hat{k})$ units. Calculate the electric flux passing through 200 unit area in the YZ plane.

OR

A capacitor of capacitance 20 μF charged to 20 volt is connected to an uncharged capacitor of capacitance of 10 μF. Find the common potential and the ratio of energies stored in the two capacitors. 1 + 1

d) Two point charges of $+q$ charge each, lying on a straight line are separated by a distance and another point charge $-2q$ is placed midway on the same straight line. Draw the directions of all the fields as also that of their resultant at a point on the perpendicular bisector of the line. 1 + 1

e) If the potential difference across a bulb decreases by 2%. What will be the change in the power dissipation of the bulb?

OR

The thermo-e.m.f of a thermocouple is given by
$E = 16.5t - 0.0165t^2$ μV. Show the nature of the E-t curve and hence find the temperature at which the curve intersects the t – *axis*. 1 + 1

f) i) Determine the r.m.s value of alternating electromotive force.
ii) The electric main of a house is 200V – 50 Hz. Write down the expression for the instantaneous voltage. 1 + 1

g) Write down Einstein's photoelectric equation and mention the symbols used.

GROUP – C

3. Answer the following questions (Alternative are to be noted): 4 x 11 = 44

a) i) Define angular momentum. Write down the differential equation relating torque and angular momentum in vector form.
ii) A solid sphere of mass 2 kg and radius 0.1 m is rolling down from the top of an inclined plane without slipping. What will be the ratio of rotational and translational kinetic energy of the body at the bottom of the inclined plane?
1 + 1 + 2

OR

i) Define moment of inertia. Is it a scalar or a vector?
ii) The mass of the bob of a simple pendulum is m. It is displaced from its position through angle θ and released. Find the expression for tension of the thread at the moment when the bob passes through the equilibrium position.
(1 + 1) + 2

b) i) Derive the expression showing the variation of acceleration due to gravity with latitude due to the diurnal motion of the earth.
ii) A body is thrown vertically from the earth surface with a velocity $v \ \ km\, s^{-1}$. Find the maximum height attained by it. The radius of the earth is R km. (Neglect all types of resistance) 2 + 2

OR

i) Show by graph the variation of acceleration due to gravity with distance from the centre of the earth.
ii) Explain why there is no atmosphere in the moon.
iii) Determine the expression for escape velocity of a body on the surface of the earth assuming the earth to be a perfect sphere of radius R. 1 + 1 + 2

c) i) An ideal gas at initial pressure P is adiabatically compressed so that its density becomes n times the initial value. Determine the final pressure.

$\left(\gamma = \frac{C_p}{C_v}\right)$

ii) For ideal gas prove that $C_p - C_v = R.$ Symbols have their usual meanings. 2 + 2

OR

i) The velocity of a meteorite of mass 840 kg is decreased from 35 $km\ s^{-1}$ to 15 $km\ s^{-1}$ while passing through atmosphere. Calculate the amount of heat produced during the process.
J = 4.2 x 10^7 erg cal^{-1}.

ii) The relation between pressure (P) and temperature (T) of an ideal gas in an adiabatic process is given by P proportional to T^n , where n is a constant. Determine $\frac{C_p}{C_v}$ of the gas. 2 + 2

d) Explain how pressure arises in a gas according to kinetic theory of gas and hence obtain the expression for pressure of an ideal gas. 1 + 3

e) i) What is a stationary wave?
ii) How does the restoring force arise in case of transverse vibration in a stretched string?
iii) The expression for displacement in a stationary wave is
$y\ (x, y) = 2 \sin (0.1\ \pi x) \cos 100\ \pi t$, where x, y are in cm and t is in second.
Determine the separation between a node and the next antinode of the wave.
1 + 1 + 2

OR

i) Show with diagram that in the vibration of an air column contained in a closed pipe only odd harmonics are present.

ii) What is end correction? 3 + 1

f) i) Write down the expression for the apparent frequency of a sound wave when both the source and the listener move towards each other.
ii) What will be the apparent frequency when they move away from each other? In which situation will Doppler Effect not occur? 2 + 1 +1

OR

i) When two lengths of 60 cm and 70 cm of the same wire are exited under the same tension by a tuning fork, 5 beats per second are produced in each case. Find the frequency of the fork.

ii) Does Doppler Effect occur for light wave? 3 + 1

g) i) What do you mean by coherent sources? How are they produced?

ii) In Young's double slit experiment the fringe with is 2.0 mm. Find the distance between the ninth bright fringe and the second dark fringe. 1 + 1 + 2

OR

i) Write down the conditions of sustained interference.

ii) Two coherent light sources of intensity ratio n are employed in Young's double slit experiment. Find the ratio of intensities of the maxima and minima in the interference pattern. 2 + 2

h) i) Does Peltier effect occur for alternating current? Explain?

ii) In domestic supply the voltage is 220V and the fuse is 5A.What is the maximum number of 60 watts bulbs that can be used at a time?

iii) How many joules equal to 1 B.O.T. unit? 1 + 2 + 1

i) i) At which place on the magnetic meridian of earth will the vertical and horizontal components of earth's magnetic field be equal?

ii) Write down the relation between magnetic susceptibility and relative magnetic susceptibility.

iii) The magnetic moment of a bar magnet of length 10 cm is 2 Am^2. It is placed in the magnetic meridian with the North Pole pointing north. If the horizontal intensity of magnetic field be 0.35 x 10^{-4} T, obtain the positions of the neutral points. 1 + 1 + 2

OR

i) Mention two essential differences between a motor and a dynamo.

ii) Write down the expression for the magnetic moment of a coil carrying current. State its direction.

iii) A wire of length 314 cm is used to form a circular coil of radius 2 cm. If the coil carries a current of 1 A, find the magnetic field at the centre of the coil.

(½ + ½) + (½ + ½) + (½ + ½)

j) i) What is mean by a p-n junction diode? Draw the I-V characteristics of p-n diode.

ii) Fill in the blank:

$(17.625)_{10} = (\ldots\ldots\ldots\ldots)_2$

iii) Draw the symbol of an OR gate. Write down its truth table.

(1 + 1) + 1 + (½ + ½)

OR

i) Draw the output and input characteristics of transistor in CE configuration.
ii) Distinguish between a conductor, an insulator and a semiconductor in light of band theory of solids. 2 + 2

k) i)Find the energy of an *X-ray* of wavelength 5 A in eV unit (h = 6.62 x 10^{-34}Js)
ii) On which fundamental property of elements does the frequency of characteristics *X-ray* depend and how? 2 + (1 + 1)

OR

i) The energy of an exited hydrogen atom is –1.51 eV. Determine the angular momentum of the electron according to Bohr's hypothesis.
ii) How many lines are obtained in hydrogen spectrum when the electron of a hydrogen atom jumps from the energy level $n = 4$ to $n = 1$?
iii) Energy of which one is greater — *X-ray* or *visible light*? Why? 2 + 1 + 1

GROUP – D

4. Answer the following questions (Alternative are to be noted): 6 x 2 = 12

a) i) State Gauss' Law in electrostatic and apply it to show that the electric intensity inside a hollow spherical charged conductor is zero.
ii) The surface density of a positively charged long vertical plate is $\sigma\ Cm^2$. A metallic ball of mass M and charge $+q$ is attached to the plate by means of a thread. Find the angle made by the thread with the plate with equilibrium.
iii) Two points charges $+q$ and $-q$ are separated by a distance x. Identify the zero potential surface for the system. (1 + 2) + 2 + 1

OR

i) A parallel plate capacitor is charged by a battery and disconnected. A dielectric slab is then introduced between the plates leaving no gap. Determine the changes that would occur in values of the charge, capacitance, potential difference and energy stored in the capacitor.
ii) The equivalent capacitance of two capacitors connected in series and in parallel are C_s and C_p respectively. Determine the capacitance of a capacitor. 4 + 2

b) i) Write down the vector form of Bio-Savart Law.
ii) An infinitely long straight conductor carrying a current I is aligned along the z-axis. Find the magnitude and specify the direction of the magnetic field at any point P (x, y) situated on the XY -plane. 2 + (3 +1)

OR

i)a rectangular coil of area A carrying a current I is placed perpendicular to a uniform magnetic field B. Calculate the magnitude and direction of the torque on the coil.

ii) Two long parallel straight wires X and Y carrying current of 10 A and 5A respectively in opposite directions are separated by a distance of 0.5m in air. Calculate the magnitude and direction of the force on 20 cm length of the wire Y.

2 + (3 +1)