SEPTEMBER 2021

Time: 3 Hours] **PHYSICS** **[Max. Marks: ~~80~~ 70**

General Instructions:

The question paper is divided into four sections:

(1) **Section A:** *Q. No. 1 contains **Ten multiple choice type** of questions carrying **One mark** each.*

*Q. No. 2 contains **Eight very short answer type** of questions carrying **One mark** each.*

(2) **Section B:** *Q. No. 3 to Q. No. 14 contain **Twelve short answer type** of questions carrying **Two marks** each. (Attempt **any Eight**)*

(3) **Section C:** *Q. No. 15 to Q. No. 26 contain **Twelve short answer type** of questions carrying **Three marks** each. (Attempt **any Eight**)*

(4) **Section D:** *Q. No. 27 to Q. No. 31 contain **Five long answer type** of questions carrying **Four marks** each. (Attempt **any Three**)*

*(5) Use of the log table is allowed. Use of calculator is **not** allowed.*

(6) Figures to be right indicate full marks.

(7) For each multiple choice type of question, it is mandatory to write the correct answer along with its alphabet. e.g. (a) ....../ (b) ....../ (c) ....../ (d) ...... No mark(s) shall be given if ONLY the correct answer or the alphabet of the correct answer is written. Only the first attempt will be considered for evaluation.

(8) Physical Constants:

(i) $h = 6.63 \times 10^{-34}$ Js

(ii) $\pi = 3.142$

(iii) $g = 9.8\ m/s^2$

(iv) $\mu_0 = 4\pi \times 10^{-7}$ Wb/Am

(v) $\varepsilon_0 = 8.85 \times 10^{-12} \dfrac{C^2}{Nm^2}$

(vi) $\dfrac{1}{4\pi\varepsilon_0} = 9 \times 10^9$ SI unit

(vii) $R = 8.319$ SI unit

Section – A

Q.1. Select and write the correct answers for the following multiple choice type of questions: **[10]**

(i) The SI unit of viscosity is ________.

(a) $\dfrac{Ns}{m^2}$ (b) $\dfrac{Nm^2}{s}$ (c) $\dfrac{N^2s^2}{m}$ (d) $\dfrac{m^2}{Ns}$

(ii) Colours of a shinning bright star is an indication of its ________.

(a) distance from earth (b) size

(c) temperature (d) mass

(iii) In which thermodynamic process does the volume of system remain constant?

(a) isobaric (b) isothermal (c) adiabatic (d) isochoric

(iv) If in a resonance tube a oil of density higher than that of water is used then resonance frequency would ________.

(a) increase (b) decrease

(c) slightly increase (d) remain the same

(v) In an interference experiment a transparent glass plate with refractive index 'n' and thickness 't' is introduced between the slit and the screen, the optical path shifts by ______________.

(a) $(n + 1)t$ (b) $(n - 1)t$ (c) $(n - 1)^2t$ (d) $(n - 1)t^2$

(vi) For a series LCR circuit at resonance the impedance of the circuit is equal to __________.

(a) inductive reactance (b) capacitive reactance

(c) resistance (d) inductive and capacitive reactance both

(vii) In Bohr model of an atom which of the following is an integral multiple of $\frac{h}{2\pi}$?

(a) Kinetic energy (b) Radius of the atom

(c) Potential energy (d) Angular momentum

(viii) A mass 'm' attached to a spring oscillates every 2 seconds. If the mass is increased by 2 kg then the time period increases by 1 second. The initial mass is ______________.

(a) 1.6 kg (b) 2.4 kg (c) 3.2 kg (d) 1.4 kg

(ix) In biprism experiment, the distance of a point on the screen shifts from the slits is 1.8×10^{-5} m and 1.23×10^{-5} m. If the wavelength of light used is 6000 Å, the fringe formed at that point is ______________.

(a) 10^{th} bright (b) 10^{th} dark (c) 9^{th} dark (d) 9^{th} bright

(x) In common emitter amplifier, current gain is 80 and emitter current is 9 mA. The base current is ______________.

(a) $\frac{1}{81}$ mA (b) 8 mA (c) $\frac{1}{8}$ mA (d) $\frac{1}{9}$ mA

[Ans.	(i) - (a)	(ii) - (c)	(iii) - (d)	(iv) - (d)	(v) - (b)
	(vi) - (c)	(vii) - (d)	(viii) - (a)	(ix) - (b)	(x) - (d)]

Q.2. Answer the following questions: **[8]**

(i) State the formula for moment of inertia of a solid sphere about an axis passing through its centre.

(ii) Define angle of contact.

(iii) What is an isothermal process?

(iv) At which position, the restoring force acting on a particle executing linear SHM is maximum?

(v) When is an AC circuit non inductive?

(vi) What is the phase difference between input signal voltage and output signal voltage in CE amplifier?

(vii) Calculate the minimum energy required to take an electron from the ground state to the first excited state in hydrogen atom. [Ans.: 10.2 eV]

(viii) If a charge of 50 μC is moving with speed of 50 m/s parallel to the direction of magnetic field, find the mechanical force acting on charged particle. [Ans.: F = 0]

Section – B

Attempt any EIGHT questions of the following : **[16]**

Q. 3. Draw a neat labelled diagram of Ferry's black body.

Q. 4. Write a note on free expansion in thermodynamic process.

Q. 5. What is magnetization? Write its unit and dimensions.

Q. 6. State any two conditions for steady interference pattern.

Q. 7. With the help of suitable diagram state the expression for Biot-Savart's law in vector form.

Q. 8. State Faraday's laws of electromagnetic induction.

Q. 9. Explain why the total impedance of a circuit decreases when a capacitor is added in series with inductor and resistor.

Q.10. A motor cyclist (to be treated as a point mass) is to undertake horizontal circles inside the cylindrical wall of a well of inner radius 4 m. The co-efficient of static friction between tyres and the wall is 0.2. Calculate the minimum speed and period necessary to perform this stunt.
[**Ans.:** v_{min} = 14 m/s, T = 1.795 sec.]

Q.11. Compare the amount of work done in blowing two soap bubbles of radii in the ratio 4:5. [**Ans.:** $W_1 : W_2 = 16 : 25$]

Q.12. Find the distance between two successive antinodes in a stationary wave on a string vibrating with frequency 32 Hz. [*Speed of wave = 48 m/s*]
[**Ans.:** 0.75 m]

Q.13. The e.m.f. of a cell is balanced by a length of 320 cm of the potentiometer wire. When a cell is shunted by a resistance of 50 Ω the balancing length is reduced by 20 cm. Find internal resistance of the cell. [**Ans.:** r = 3.333 Ω]

Q.14. The photoelectric work function for a metal is 5 eV. Calculate the threshold frequency for the metal. [**Ans.:** $v_0 = 1.207 \times 10^5$ Hz]

Section – C

Attempt any EIGHT questions of the following : **[24]**

Q.15. With a neat, labelled schematic diagram, explain the experimental set-up for photoelectric effect.

Q.16. What is light emitting diode? Explain working of a LED.

Q.17. Obtain an expression for equivalent capacity for combination of three capacitors connected in series.

Q.18. Explain surface tension on the basis of molecular theory.

Q.19. Derive an expression for period of a simple pendulum.

Q.20. State Huygens' principle. Explain geometrical construction of a plane wavefront.

Q.21. Obtain the expression for Bohr magneton.

Q.22. The wavelength of two sound waves in air are $\frac{82}{173}$ and $\frac{82}{171}$ m. They produce 9 beats per second. Calculate the velocity of sound in air.
[**Ans.:** v = 369 m/s]

Q.23. A circular loop of radius 9.2 cm carries a current of 2.3 A. Obtain the magnitude of magnetic field at the centre of loop. [**Ans.:** $B = 1.571 \times 10^{-5}$ T]

Q.24. 0.5 mole of gas at temperature 450 K expands isothermally from an initial volume of 3 L to final volume of 9 L.

(a) What is the work done by the gas? ($R = 8.319\ J\ mol^{-1}\ K^{-1}$)

(b) How much heat is suppled to the gas?

[**Ans.: (a)** 2.057 kJ, **(b)** 2.057 kJ,]

Q.25. An alternating e.m.f. $e = 200 \sin 314.2t$ volt is applied between the terminals of an electric bulb whose filament has a resistance of 100 Ω. Calculate the following:

(a) RMS current

(b) Frequency of AC signal

(c) Period of AC signal. [**Ans.: (a)** 1.414 A **(b)** 50 Hz **(c)** 0.02 sec]

Q.26. Two charges of magnitude 5 nC and – 2 nC are placed at points (2 cm, 0, 0) and (20 cm, 0, 0) in a region of a space where there is no external field. Find electrostatic potential energy of the system. [**Ans.:** $U = -0.5\ \mu J$]

Section – D

Attempt any THREE questions of the following: **[12]**

Q.27. Using the energy conservation, derive the expression for minimum speeds at different locations along a vertical circular motion controlled by gravity.

Q.28. Explain the conversion of a Moving Coil Galvanometer (MCG) into an ammeter. Obtain necessary formula.

State any two advantages of potentiometer over voltmeter.

Q.29. State:

(a) Stefan - Boltzmann law of radiation.

(b) Wien's displacement law.

The difference between two molar specific heat of a gas is 6000 J/kg K. If the ratio of specific heat is 1.4, calculate the molar specific heat at constant volume. [**Ans.:** $C_V = 15000$ J/kg K]

Q.30. Define the following:

(a) Self inductance

(b) Mutual inductance

A straight conductor is moving with a velocity of 3 m/s, at right angles to a magnetic field 4.5×10^{-5} Wb/m^2. If an e.m.f. developed between its ends is 1.35×10^{-4} volt, calculate the length of straight conductor. [**Ans.:** $l = 1$ m]

Q.31. State any two limitations of Bohr's atomic model.

The half life of a radioactive species is 3.2 days. Calculate decay constant (per day). [**Ans.:** $\lambda = 0.2165$ per day]

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SUMMARY OF QUESTIONS ASKED IN PREVIOUS EXAM

1. ROTATIONAL DYNAMICS

Theory :

(1) Derive an expression for linear acceleration of a particle performing U.C.M. *(March 2008)*

(2) Obtain the relation between linear velocity and angular velocity in U.C.M. *(March 2008, 2012; Oct. 2009)*

(3) Derive an expression for period of a conical pendulum. *(March 2008)*

(4) Show that the kinetic energy of a rotating body about a given axis is equal to $\frac{1}{2}$ Lω, where, L is angul momentum and ω is angular velocity. *(March 2008)*

(5) Define radius of gyration. Explain its physical significance. *(March 2008, 2019, July 2018)*

(6) Define moment of inertia. State its SI unit and dimensions. *(October 2008, March 2018)*

(7) Derive an expression for the kinetic energy of body rotating with uniform angular speed. *(March 2009)* (2

(8) Distinguish between centripetal force and centrifugal force. *(March 2009, 2010, 2018)* (2

(9) For a conical pendulum prove that $\tan\theta = \frac{v^2}{rg}$ *(Oct. 2009)* (3)

(10) Obtain an expression for maximum speed with which a vehicle can be driven safely on a banked road. Show that the safety speed limit is independent of the mass of the vehicle. *(March 2010, Oct. 2010)* (3)

(11) State and prove the principle of perpendicular axes. *(March 2010)* (3)

(12) State and prove the law of conservation of angular momentum. *(March 2011, 2018; Oct. 2011, 2015)* (2)

(13) Show that total energy of a body performing vertical circular motion is conserved. *(March 2011)* (3)

(14) Define centripetal force and give its any two examples. *(March 2011)* (2)

(15) Derive an expression for linear velocity at lowest point and at highest point for a particle revolving in vertical circular motion. *(Oct. 2011)* (3)

(16) What is banking of roads? Obtain an expression for the maximum safety speed of a vehicle moving along a curve horizontal road. *(March 2012)* (3)

(17) Derive an expression for the kinetic energy of a body of mass M rotating uniformly about a given axis. Show that the rotational kinetic energy = $\frac{1}{2M}\times\left(\frac{L}{K}\right)^2$ *(March 2012)* (3)

(18) State S.I. unit of angular momentum. Obtain its dimensions. *(March 2012)* (2)

(19) Derive an expression for kinetic energy, when a rigid body is rolling on a horizontal surface without slipping. Hence find kinetic energy for a solid sphere. *(March 2013)* (3)

(20) A particle of mass m, just completes the vertical circular motion. Derive the expression for the difference in tensions at the highest and the lowest points. *(March 2013)* (3)

(21) For a particle performing uniform circular motion $\vec{v} = \vec{\omega}\times\vec{r}$. Obtain an expression for linear acceleration of the particle performing non-uniform circular motion. *(Feb. 2014)* (2)

(22) State and prove the theorem of 'parallel axes'. *(Feb. 2014, 2016)* (4)

(23) State the law of conservation of angular momentum and explain with a suitable example. *(Oct. 2014)* (2)

(24) Draw a diagram showing all components of forces acting on a vehicle moving on a curved banked road. Write the necessary equation for maximum safety, speed and state the significance of each term involved in it. *(Oct. 2014)* (3)

(25) In circular motion, assuming $\vec{v}=\vec{\omega}\times\vec{r}$, obtain an expression for the resultant acceleration of a particle in terms of tangential and radial component. *(Feb. 2015)* (2)

(26) State the theorem of parallel axes and theorem of perpendicular axes about moment of inertia. *(Feb. 2015)* (2)

(27) State an expression for the moment of inertia of a solid uniform disc, rotating about an axis passing through its centre, perpendicular to its plane. Hence derive an expression for the moment of inertia and radius of gyration : (i) about a tangent in the plane of the disc, and (ii) about a tangent perpendicular to the plane of the disc. *(Oct. 2015)* (4)

(28) Draw a neat labelled diagram of conical pendulum. State the expression for its periodic time in terms of length. *(Oct. 2015)* (2)

(29) In U. C. M. (Uniform Circular Motion), prove the relation $\vec{v}=\vec{\omega}\times\vec{r}$, where symbols have their usual meanings. *(Feb. 2016)* (2)

(30) Obtain an expression for total kinetic energy of a rolling body in the form $\frac{1}{2}MV^2\left[1+\frac{K^2}{R^2}\right]$ *(Feb. 2016)* (2)

(31) Obtain an expression for torque acting on a body rotating with uniform angular acceleration. ***(July 2016, 2017)*** **(3)**

(32) Draw a neat labelled diagram showing the various forces and their components acting on a vehicle moving along curved banked road. ***(July 2016)*** **(2)**

(33) Explain the concept of centripetal force. ***(March 2017)*** **(2)**

(34) Explain the physical significance of radius of gyration. ***(July 2017)*** **(2)**

(35) What is the value of tangential acceleration in U.C.M.? ***(March 2019)*** **(1)**

(36) Obtain expressions of energy of a particle at different positions in the vertical circular motion. ***(March 2019)*** **(3)**

Problems :

(1) An object of mass 1 kg is tied to one end of a string of length 9 m and whirled in a vertical circle. What is the minimum speed required at the lowest position to complete a circle? ***(Oct. 2008)*** **(2)**

(2) An object of mass 2 kg attached to a wire of length 5 m is revolved in a horizontal circle. If it makes 60 r.p.m. find its
(a) Angular speed **(b)** Linear speed **(c)** Centripetal acceleration **(d)** Centripetal force ***(March 2009)*** **(4)**

(3) A torque of 1500 Nm acting on a body produces an angular acceleration of 3.2 rad/s^2. Find M.I. of the body. ***(March 2009)*** **(2)**

(4) A torque of magnitude 1000 Nm acting on a body produces an angular acceleration of 2 rad/s^2. Calculate the moment of inertia of the body. ***(Oct. 2009, March 2010)*** **(2)**

(5) Moment of inertia of a disc about an axis passing through its centre and perpendicular to its plane is 10 kg-m^2. Find its moment of inertia about the diameter. ***(Oct. 2010)*** **(2)**

(6) A stone of mass one kilogram is tied to the end of a string of length 5 m and whirled in a vertical circle. What will be the minimum speed required at the lowest position to complete the circle? (***Given:*** *g = 9.8 m/s^2*) ***(Oct. 2010)*** **(2)**

(7) A coin kept on a horizontal rotating disc has its centre at a distance of 0.1 m from the axis of the rotating disc. If the coefficient of friction between the coin and the disc is 0.25; find the angular speed of disc at which the coin would be about to slip off. (***Given:*** *g = 9.8 m/s^2*) ***(Oct. 2011)*** **(2)**

(8) A car of mass 1500 kg rounds a curve of radius 250 m at 90 km/hour. Calculate the centripetal force acting on it. ***(March 2013)*** **(2)**

(9) A wheel of moment of inertia 1 kgm^2 is rotationg at a speed of 40 rad/s. Due to friction on the axis, the wheel comes to rest in 10 minutes. Calculate the angular momentum of the wheel, two minutes before it comes to rest. ***(March 2013)*** **(2)**

(10) A ballet dancer spins about a vertical axis at 2.5π rad/sec. with his both arms outstretched. With the arms folded, the moment of inertia about the same axis of rotation changes by 25%. Calculate the new rotation in r.p.m. ***(Oct 2013)*** **(3)**

(11) A racing car completes 5 rounds on a circular track in 2 minutes. Find the radius of the track if the car has uniform centripetal acceleration of π^2 m/s^2. ***(Oct 2013)*** **(2)**

(12) In a conical pendulum, a string of length 120 cm is fixed at rigid support and carries a mass of 150 g at its free end. If the mass is revolved in a horizontal circle of radius 0.2 m around a vertical axis, calculate tension in the string *(g = 9.8 m/s^2)* ***(Oct 2013)*** **(3)**

(13) A stone of mass 1 kg is whirled in horizontal circle attached at the end of a 1 m long string. If the string makes an angle of 30^0 with vertical, calculate the centripetal force acting on the stone. (g = 9.8 m/s^2). ***(Feb. 2014)*** **(2)**

(14) A solid cylinder of uniform density of radius 2 cm has mass of 50 g. If its length is 12 cm, calculate its moment of inertia about an axis passing through its centre and perpendicular to its length. ***(Feb. 2014)*** **(2)**

(15) A body starts rotating from rest. Due to a couple of 20 Nm it completes 60 revolutions in one minute. Find the moment of inertia of the body. ***(Oct. 2014)*** **[3]**

(16) A stone of mass 5 kg, tied to one end of a rope of length 0.8 m, is whirled in a vertical circle. Find the minimum velocity at the highest point and at the midway point. *[g = 9.8 m/s^2]* ***(Oct 2014)*** **(2)**

(17) The spin dryer of a washing machine rotating at 15 r.p.s. slows down to 5 r.p.s. after making 50 revolutions. Find its angular acceleration. ***(Feb. 2015)*** **(2)**

(18) A horizontal disc is freely rotating about a transverse axis passing through its centre at the rate of 100 revolutions per minute. A 20 gram blob of wax falls on the disc and sticks to the disc at a distance of 5 cm from its axis. Moment of inertia of the disc about its axis passing through its centre of mass is 2×10^{-4} kg m^2. Calculate the new frequency of rotation of the disc. ***(Feb. 2015)*** **(3)**

(19) A stone of mass 100 g attached to a string of length 50 cm is whirled in a vertical circle by giving velocity at lowest point as 7 m/s. Find the velocity at the highest point. *[Acceleration due to gravity = 9.8 m/s^2]* ***(Oct. 2015)*** **(3)**

(20) A coin kept at a distance of 5 cm from the centre of a turntable of radius 1.5 m just begins to slip when the turntable rotates at a speed of 90 r.p.m. Calculate the coefficient of static friction between the coin and the turntable. *[g = 9.8 m/s^2].* ***(Feb. 2016)*** **(2)**

(21) A stone of mass 2 kg is whirled in a horizontal circle attached at the end of 1.5 m long string. If the string makes an angle of 30° with vertical, compute its period. ($g=9.8\ m/s^2$) *(July 2016)* **(2)**

(22) A uniform solid sphere has a radius 0.1 m and density $6 \times 10^3\ kg/m^3$. Find its moment of inertia about a tangent to its surface. *(July 2016)* **(2)**

(23) A solid sphere of mass 1 kg rolls on a table with linear speed 2 m/s, find its total kinetic energy. *(March 2017)* **(2)**

(24) A vehicle is moving on a circular track whose surface is inclined towards the horizontal at an angle of 10°. The maximum velocity with which it can move safely is 36 km/hr. Calculate the length of the circular track. [$\pi = 3.142$] *(March 2017)* **(3)**

(25) A small body of a mass 0.3 kg oscillates in vertical plane with the help of a string 0.5 m long with a constant speed of 2 m/s. It makes an angle of 60° with the vertical. Calculate tension in the string ($g = 9.8\ m/s^2$) *(July 2017)* **(2)**

(26) A uniform solid sphere has radius 0.2 m and density $8 \times 10^3\ kg\ m^3$. Find the moment of inertia about the tangent to its surface. ($\pi = 3.142$) *(July 2017)* **(3)**

(27) A flat curve on a highway has a radius of curvature 400 m. A car goes around a curve at a speed of 32 m/s. What is the minumum value of coefficient of friction that will prevent the car from sliding? ($g = 9.8\ m/s^2$) *(March 2018)* **(2)**

(28) The frequency of revolution of a particle performing circular motion changes from 60 r.p.m. to 180 r.p.m. in 20 seconds. Calculate the angular acceleration of the particle. ($\pi = 3.142$) *(July 2018)* **(2)**

(29) A meter gauge train is moving at 72 km/hr along a curved railway of radius of curvature 500 m at a certain place. Find the elevation of outer rail above the inner rail so that there is no side pressure on the rail. ($g = 9.8\ m/s^2$) *(July 2018)* **(3)**

(30) A solid sphere of diameter 50 cm and mass 25 kg rotates about an axis through its centre. Calculate its moment of inertia. If its angular velocity changes from 2 rad/s to 1 rad/s in 5 seconds, calculate the torque applied. *(July 2018)* **(3)**

(31) A wheel of moment of inertia $1\ kg\ m^2$ is rotating at a speed of 30 rad/s. Due to friction on the axis, it comes to rest in 10 minutes. Calculate the average torque of the friction. *(March 2019)* **(2)**

(32) The radius of gyration of a body about an axis, at a distance of 0.4 m from its centre of mass is 0.5 m. Find its radius of gyration about a parallel axis passing through its centre of mass. *(March 2019)* **(2)**

2. MECHANICAL PROPERTIES OF FLUID

Theory :

(1) Define the terms: **(a)** Sphere of influence **(b)** Angle of contact. *(March 2008)* **(2)**

(2) Explain the phenomenon of surface tension on the basis of molecular theory. *(March 2008)* **(4)**

(3) Define surface tension. Explain the effect of impurity on surface tension. *(October 2008)* **(3)**

(4) What is surface energy? Obtain the relation between surface tension and surface energy. *(October 2008, 2010)* **(3)**

(5) Define angle of contact. State its four characteristics. *(March 2009, October 2009)* **(3)**

(6) Define surface tension. State its S.I. unit and dimensions. *(March 2009)* **(2)**

(7) Derive an expression for height of liquid coloumn when a capillary is vertically dipped in a liquid. *(Oct. 2009)* **(3)**

(8) Draw a neat diagram for the rise of liquid in a capillary tube showing the components of a surface tension T. *(March 2010, July 2016)* **(2)**

(9) What is capillarity? Give any 'two applications of capillarity. *(October 2010, March 2011, July 2018)* **(2)**

(10) Explain the formation of concave and convex surface of liquid on the basis of molecular forces. *(March 2011)* **(4)**

(11) Define angle of contact. State its any two characteristics. *(Oct. 2011, 2014)* **(2)**

(12) Explain why the angle of contact is acute for Kerosene-glass pair and is obtuse for Mercury-glass pair. *(March 2012)* **(4)**

(13) Derive the relation between surface tension and surface energy per unit area. *(March 2013)* **(2)**

(14) Show that the surface tension of a liquid is numerically equal to the surface energy per unit area. *(Oct 2013)* **(2)**

(15) Explain the rise of liquid in the capillary on the basis of pressure difference. *(Feb. 2014)* **(2)**

(16) Derive an expression for excess pressure inside a drop of liquid. *(Feb. 2015)*

(17) Draw a neat labelled diagram showing forces acting on the meniscus of water in a capillary tube. *(Oct. 2015)* **(2)**

(18) Derive Laplace's law for spherical membrane of bubble due to surface tension. *(Feb. 2016, March 2018)* **(3)**

(19) Draw a neat labelled diagram for a liquid surface in contact with a solid, when the angle of contact is acute. *(March 2017)*

(20) Define surface tension and surface energy. *(July 2017)* **(2)**

(21) Obtain an expression for the rise of a liquid in a capillary tube. *(March 2019)* **(3)**

Problems :

(1) Calculate the workdone when a spherical drop of mercury of radius 2 mm, falls from some height and breakes into a million droplets, each of the same size. The surface tension of mercury is $T = 0.5$ N/m *(March 2010)* **(4)**

(2) A drop of mercury 2 mm in diameter breaks into a million small spherical droplets, all of same size. Calculate the workdone. *(Surface tension of mercury = 460×10^{-3} N/m)* *(Oct. 2011)* **(4)**

(3) A liquid rises to a height of 5 cm in a glass capillary of radius 0.02 cm. What will be the height of the same liquid in a glass capillary of radius 0.04 cm? *(March 2012)* **(2)**

(4) The surface tension of water at 0°C is 75.5 dyne/cm. Find surface tension of water at 25°C. *[α for water = 0.0021/°C]* *(March 2013)* **(2)**

(5) A soap bubble of radius 12 cm is blown. Surface tension of soap solution is 30 dyne/cm. Calculate the work done in blowing the soap bubble. *(Oct 2013)* **(2)**

(6) Calculate the density of paraffin oil, if glass capillary of diameter 0.25 mm dipped in paraffin oil of surface tension 0.0245 N/m rises to a height of 4 cm.
(Angle of contact of paraffin with glass = 28° and acceleration due to gravity = 9.8 m/s^2.) *(Feb. 2014)* **(3)**

(7) Water rises to a height 3.2 cm in a glass capillary tube. Find the height to which the same water will rise in another glass capillary having half area of cross section. *(Oct. 2014)* **(2)**

(8) A raindrop of diameter 4 mm is about to fall on the ground. Calculate the pressure inside the raindrop.
[Surface tension of water T = 0.072 N/m, atmospheric pressure = 1.013×10^5 N/m^2] *(Oct. 2015)* **(2)**

(9) The energy of the free surface of a liquid drop is 5π times the surface tension of the liquid. Find the diameter of the drop in C.G.S. system. *(Feb. 2016)* **(2)**

(10) The total free surface energy of a liquid drop is $\pi\sqrt{2}$ times the surface tension of the liquid. Calculate the diameter of the drop in S.I. unit. *(July 2016)* **(2)**

(11) The total energy of free surface of a liquid drop is 2π times the surface tension of the liquid. What is the diameter of the drop? *[Assume all terms in SI unit].* *(March 2017)* **(3)**

(12) Two soap bubbles have radii in the ratio 4:3. What is the ratio of work done to blow these bubbles? *(July 2017)* **(2)**

(13) Calculate the work done in increasing the radius of a soap bubble in air from 1 cm to 2 cm. The surface tension of soap solution is 30 dyne/cm. *($\pi = 3.142$)* *(March 2018)* **(2)**

(14) A horizontal circular loop of a wire of radius 0.02 m is lowered into crude oil and a film is formed. The force due to the surface tension of the liquid is 0.0113 N. Calculate the surface tension of the crude oil. *($\pi = 3.142$)* *(July 2018)* **(3)**

3. KINETIC THEORY OF GASES AND RADIATION

Theory :

(1) Assuming the expression for pressure of an ideal gas, show that R.M.S. velocity of gas molecule is directly proportional to the square root of its absolute temperature. *(March 2009)* **(3)**

(2) On the basis of the kinetic theory of gases, derive an expression for the pressure exerted by a gas. *(March 2010)* **(4)**

(3) Define R.M.S. velocity. *(March 2011)* **(1)**

(4) What is perfectly black body? Draw a neat labelled diagram of artificial perfectly black body. *(October 2008)* **(3)**

(5) Show graphically spectrum of energy distribution of black body in terms of wavelengths. *(Oct. 2008, 2009, Feb. 2014)* **(2)**

(6) Define : (a) Coefficient of absorption (b) Coefficient of reflection (c) Coefficient of transmission and obtain the relation between them. *(March 2010, October 2010)* **(3)**

(7) Define perfectly black body. How can it be realized in practice? *(October 2010)* **(2)**

(8) State Wien's displacement law for black body and define solar constant. *(March 2011)* **(2)**

(9) Using the expression for pressure exerted by gas deduce expression for
(a) Kinetic energy of a gas (b) Kinetic energy per unit volume (c) Kinetic energy per mole. *(October 2011)* **(3)**

(10) Prove Kirchhoff's law of radiation and prove it theoretically. *(March 2012, July 2017)* **(3)**

(11) Draw a neat labelled diagram for Ferry's perfectly black body. *(March 2013, July 2018)* **(2)**

(12) Explain black body radiation spectrum in terms of wavelength. *(Oct 2013)* **(2)**

(13) Show that R.M.S. velocity of gas molecules is directly proportional to square root of its absolute temperature. *(Feb. 2014, March 2017)* **(2)**

(14) Explain Maxwell distribution of molecular speed with necessary graph. *(Oct 2014)* **(3)**

(15) With a neat and labelled diagram, explain Ferry's perfectly black body. *(Oct. 2014)* **(2)**

(16) State: (a) Wein's displacement law and (b) First law of thermodynamics. *(Feb. 2015)* **(2)**

(17) Define 'emissive power' and 'coefficient of emission of a body'. *(Feb. 2016)* **(2)**

(18) What is perfectly black body? Explain Ferry's black body. *(March 2019)* **(3)**

Problems :

(1) The velocities of three molecules of a gas are 2 ms^{-1}, 3 ms^{-1} and 4 ms^{-1} respectively. Find, the mean velocity and RMS velocity of the molecules. *(March 2008)* **(2)**

(2) A heated metal ball is placed in cooler surroundings. Its rate of cooling is 2°C per minute when its temperature is 60°C and 1.2°C per minute when its temperature is 52°C. Determine the temperature of the surroundings; and the rate of cooling when the temperature of the ball is 48°C. Also find the temprature at which the rate of cooling is 0.6°C per minute. *(March 2008)* **(4)**

(3) If the r.m.s. velocity of oxygen molecules at N.T.P. is 460 m/s, determine the r.m.s. velocity of hydrogen molecules at N.T.P. *[Molecular weight of oxygen = 32, molecular weight of hydrogen = 2]* *(Oct. 2009)* **(2)**

(4) A metal sphere cools at the rate of 4°C per minute at the temperature of 60°C. Calculate the rate of cooling at 40°C, if temperature of the surrounding is 30°C. *(March 2010)* **(2)**

(5) Calculate the Kinetic energy of helium molecules in 1 cm^3 at pressure 2 atmosphere. *(1 atmosphere = 1.013×10^5 N/m^2)* *(March 2011)* **(2)**

(6) Assuming Stefan's law, compare the rate of loss of heat by the body at temperature 527°C and 127°C, if the temperature of the surrounding is 27°C. *(October 2011)* **(2)**

(7) Calculate the kinetic energy of 10 gram of Argon molecules at 127°C. *(Universal gas constant R = 8320 J/k mole K, Atomic weight of Argon = 40)* *(March 2013)* **(3)**

(8) The Kinetic energy of nitrogen per unit mass at 300 K is 2.5×10^6 J/kg. Find the kinetic energy of 4 kg oxygen at 600 K. *(Molecular weight of nitrogen = 28, Molecular weight of oxygen = 32)* *(Oct 2013)* **(3)**

(9) Calculate the average molecular kinetic energy:
(a) per kilomole (b) per kilogram of oxygen at 27°C
[R = 8320 J/kmole K, Avogadros number = 6.03×10^{26} molecules/K mole] *(Feb. 2015)* **(3)**

(10) A pinhole is made in a hollow sphere of radius 5 cm whose inner wall is at temperature 727°C. Find the power radiated per unit area. *[Stefan's constant $\sigma = 5.7 \times 10^{-8}$ J/m^2sK^4, emissivity (e) = 0.2]* *(Oct. 2015)* **(2)**

(11) Compute the temperature at which the r.m.s. speed of nitrogen molecules is 832 m/s. *[Universal gas constant, R = 8320 J/k mole K, molecular weight of nitrogen = 28.]* *(Oct. 2015)* **(2)**

(12) At what temperature will average kinetic energy of gas be exactly half of its value at N.T.P.? *(July 2017)* **(2)**

4. THERMODYNAMICS

(1) State first law of thermodynamics *(Feb. 2015)* **(4)**

5. OSCILLATIONS

Theory :

(1) Two S.H.M. are represented by $x_1 = a_1 \sin(\omega t + \alpha_1)$ and $x_2 = a_2 \sin(\omega t + \alpha_2)$. Obtain the expressions for the displacement, amplitude and initial phase of the resultant motion. *(March 2008)* **(3)**

(2) Represent graphically the displacement, velocity and acceleration against time for a particle performing linear S.H.M., when it starts from the mean position. *(March 2008, 2013, Oct. 2010)* **(3)**

(3) Represent graphically the variations of K.E., P.E. and T.E. of a particle performing linear S.H.M. with respect to displacement. *(October 2008, March 2009)* **(2)**

(4) Give graphical representation of S.H.M. when particle starts from the positive extreme position. *(Octoebr 2009)* **(2)**

(5) Define angular S.H.M. State its differential equation. *(March 2010)* **(2)**

(6) Define an ideal simple pendulum. Show that the motion of a simple pendulum under certain conditions is simple harmonic. Obtain an expression for its period. *(March 2010, 2013, July 2018)* **(4)**

(7) Show that for a small amplitude, the motion of a simple pendulum is linear S.H.M. Hence find its period. *(March 2011)* **(3)**

(8) Show that linear S.H.M. is the projection of uniform circular motion on any diameter. *(March 2011)* **(3)**

(9) Show graphically the variation of velocity and acceleration in S.H.M. with phase, if motion starts from extreme position. *(Oct. 2011)* **(2)**

(10) A particle performing S.H.M. starts from extreme position. Plot the graph of velocity and displacement against time. *(March 2012)* **(2)**

(11) Derive an expression for the period of motion of a simple pendulum. On which factors does it depend? *(Oct 2013)* **(4)**

(12) State an expression for K.E. (kinetic energy) and P. E. (potential energy) at displacement 'x' for a particle performing linear S.H.M. Represent them graphically. Find the displacement at which K. E. is equal to P. E. *(Feb. 2014)* **(3)**

(13) Define phase of S.H.M. Show variation of displacement, velocity and acceleration with phase for a particle performing linear S.H.M. graphically, when it starts from extreme position. *(Oct. 2014)* **(4)**

(14) Obtain an expression for potential energy of a particle performing simple harmonic motion. Hence evaluate the potential energy, (a) at mean position and (b) at extreme position. *(Feb. 2015, March 2019)* **(4)**

(15) Discuss the composition of two S.H.M.s along the same path having same period. Find the resultant amplitude and initial phase. *(Oct. 2015)* **(4)**

(16) Define linear S.H.M. Show that S.H.M. is a projection of U.C.M. on any diameter. ***(Feb. 2016)*** **(2)**

(17) Define practical simple pendulum.
Show that motion of bob of pendulum with small amplitude is linear S.H.M. Hence obtain an expression for its period. What are the factors on which its period depends? ***(July 2016)*** **(5)**

(18) Obtain the differential equation of linear simple harmonic motion. ***(March 2017)*** **(2)**

(19) Prove the law of conservation of energy for a particle performing simple harmonic motion. Hence graphically show the variation of kinetic energy and potential energy w. r. t. instantaneous displacement. ***(March 2017)*** **(4)**

(20) Define linear simple harmonic motion. Assuming the expression for displacement of a particle starting from extreme position, explain graphically the variation of velocity and acceleration w.r.t. time. ***(July 2016)*** **(4)**

(21) State the differential equation of linear simple harmonic motion. Hence obtain the expression for acceleration, velocity and displacement of a particle performing linear S.H.M. ***(March 2018)*** **(4)**

(22) From differential equation of linear S.H.M., obtain an expression for acceleration, velocity and displacement of a particle performing S.H.M. ***(March 2019)*** **(3)**

Problems :

(1) The displacement of particle performing S.H.M. is given by
$x = \left[5\sin\pi t + 12\sin\left(\pi t + \frac{\pi}{2}\right)\right]$ cm. Determine the amplitude, period and initial phase of the motion. ***(Oct.2008)*** **(4)**

(2) The period of a simple pendulum increases by 10% when its length is increased by 21 cm. Find the original length and period of the pendulum. ($g = 9.8\ m/s^2$) ***(Oct. 2009)*** **(4)**

(3) S.H.M. is given by the equation $x = 8\sin(4\pi t) + 6\cos(4\pi t)$ cm.
Find its (a) amplitude (b) initial phase (c) period (d) frequency ***(Oct. 2010)*** **(4)**

(4) A particle of mass 10 gm executes linear S.H.M. of amplitude 5 cm. With a period of 2 second. Find its potential energy, kinetic energy $\left(\frac{1}{6}\right)^{th}$ second after it has passed through the mean position. ***(Oct. 2011)*** **(4)**

(5) The period of simple pendulum is found to increase by 50% when the length of the pendulum is increased by 0.6 m. Calculate the initial length and initial period of oscillation at a place where g = 9.8 m/s^2. ***(March 2012)*** **(4)**

(6) A body of mass 1 kg is made to oscillate on a spring of force constant 16 N/m. Calculate :
(a) angular frequency, (b) frequency of vibration. ***(Oct 2013)*** **(2)**

(7) When the length of a simple pendulum is decreased by 20 cm, the period changes by 10%. Find the original length of the pendulum. ***(Feb. 2014)*** **(3)**

(8) The maximum velocity of a particle performing linear S.H.M. is 0.16 m/s. If its maximum acceleration is 0.64 m/s^2, calculate its period. ***(Oct. 2014)*** **(2)**

(9) A particle in S.H.M. has a period of 2 seconds and amplitude of 10 cm. Calculate the acceleration when it is at 4 cm from its positive extreme position. ***(Feb. 2015)*** **(2)**

(10) The periodic time of a linear harmonic oscillator is 2π second, with maximum displacement of 1 cm. If the particle starts from extreme position, find the displacement of the particle after $\frac{\pi}{3}$ seconds. ***(Feb. 2015)*** **(2)**

(11) A particle performing linear S.H.M. has a period of 6.28 seconds and a pathlength of 20 cm. What is the velocity when its displacement is 6 cm from mean position? ***(Feb. 2016)*** **(2)**

(12) A particle executes S.H.M. with a period of 10 seconds. Find the time in which its potential energy will be half of its total energy. ***(July 2016)*** **(2)**

(13) A clock regulated by seconds pendulum, keeps correct time. During summer, length of pendulum increases to 1.005 m. How much will the clock gain of loose in one day? ($g = 9.8\ m/s^2$ and $\pi = 3.142$) ***(July 2017)*** **(3)**

(14) A particle performing linear S.H.M. has maximum velocity of 25 cm/s and maximum acceleration of 100 cm/s^2. Find the amplitude and period of oscillation ($\pi = 3.142$) ***(March 2018)*** **(2)**

(15) A simple pendulum of length 1 m and mass 10 g oscillates freely with amplitude 2 cm. Find its potential energy (P.E) at the extreme position. ($g = 9.8\ m/s^2$) ***(July 2018)*** **(2)**

(16) The length of the second's pendulum in a clock is increased to 4 times its initial length. Calculate the number of oscillations completed by the new pendulum in one minute. ***(March 2019)*** **(2)**

(17) A body of mass 1 kg is made to oscillate on a spring of force constant 16 N/m. Calculate
(a) Angular frequency, (b) Frequency of vibrations. ***(March 2019)*** **(2)**

6. SUPERPOSITION OF WAVES

Theory :

(1) What are beats? Prove that the frequency of beats is equal to the difference between the frequencies of the two sound notes giving rise to beats. ***(Oct. 2008)*** **(4)**

(2) Derive an equation of a simple harmonic progressive wave and express it in different forms. ***(Oct. 2009)*** **(4)**

(3) State the points of comparison between progressive waves and stationary waves. *(March 2009)* **(3)**
(4) What are beats? Deduce analytically the expression for beat frequency. *(Oct. 2011)* **(4)**
(5) Derive an expression for one dimensional - Simple harmonic progressive wave travelling in the direction of positive X-axis. Express it in 'two' different forms. *(Oct 2013)* **(3)**
(6) Explain what is Doppler effect, in sound and state its any 'four' applications. *(Feb. 2015)* **(3)**
(7) Show that beats frequency is eual to frequency difference between two interfering waves. *(July 2018)* **(3)**
(8) Explain the reflection of transverse and longitudinal waves from a denser medium and a rarer medium. *(March 2019)* **(3)**
(9) Draw a neat labelled diagram of the first two modes of vibration of string stretched between two rigid supports. *(March 2008)* **(2)**
(10) Draw the neat labelled diagrams of the first two modes of vibrations of an air column open at both ends. *(October 2008)* **(2)**
(11) Show that only odd harmonics are present in the vibrations of air column in a pipe closed at one end. *(March 2010)* **(3)**
(12) Draw a neat labelled diagrams for the fundamental mode of vibrations of air column in a pipe
(a) Open at both the ends **(b)** Open at one end
Write formula for the corresponding fundamental frequency in each case. *(October 2010)* **(3)**
(13) Derive expression for formation of stationary wave by analytical method. Show that nodes or antinodes are equally spaced. *(October 2010)* **(4)**
(14) With neat diagrams explain various modes of vibrations of a stretched string. *(Oct. 2011)* **(3)**
(15) Explain analytically how stationary waves are formed. What are nodes and antinodes? Show that distance between two adjacent nodes or antinode is $\frac{\lambda}{2}$ *(March 2012, 2019)* **(4)**
(16) Differentiate between free and forced vibrations *(March 2013)* **(2)**
(17) With a neat labelled diagram, show that all harmonics are present in an air column contained in a pipe open at both the ends. Define end correction *(March 2013)* **(4)**
(18) Draw neat labelled diagrams for modes of vibrations of an air column in a pipe when it is
(a) open at both ends **(b)** closed at one end.
Hence derive an expression for fundamental frequency in each case. *(Oct 2013, July 2018)* **(4)**
(19) A wire of density 'ρ' and Young's modulus 'Y' is stretched between two rigid supports separated by a distance 'L' under tension 'T'. Derive an expression for its frequency in fundamental mode. Hence show that $n = \frac{1}{2L}\sqrt{\frac{YL}{\rho L}}$, where symbols have their usual meanings. *(Feb. 2014)* **(4)**
(20) Distinguish between forced vibrations and resonance. Draw neat, labelled diagrams for the modes of vibration of a stretched string in second harmonic and third harmonic. *(Oct. 2014)* **(4)**
(21) What are forced vibrations and resonance? Show that only odd harmonics are present in an air column vibrating in a pipe closed at one end. *(Feb. 2015)* **(4)**
(22) Show that all harmonics are present on a stretched string between two rigid supports. *(Oct. 2015)* **(3)**
(23) Explain analytically how the stationary waves are formed. Hence show that the distance between node and adjacent antinode is $\frac{\lambda}{4}$. *(Feb. 2016)* **(2)**
(24) Explain the formation of stationary wave by analytical method. Show that nodes and antinodes are equally spaced in a stationary wave. *(July 2016)* **(4)**
(25) Explain the formation of stationary waves by analytical method. Show the formation of stationary wave diagramatically. *(March 2017)* **(4)**
(26) Discuss different modes of vibrations in an air column of a pipe open at both the ends. State the cause of end correction. Find the end correction for the pipe open at both the ends in fundamental mode. *(July 2017)* **(5)**
(27) What is meant by harmonics? Show that only odd harmonics are present as overtones in the case of an air column vibrating in a pipe closed at one end. *(March 2018)* **(4)**
(28) Show that even as well as odd harmonics are present as overtones in the case of an air column vibrating in a pipe open at both the ends. *(March 2019)* **(3)**

Problems :

(1) Wavelengths of two notes in air are $\frac{83}{170}$ m and $\frac{83}{172}$ m. Each of these notes produce 4 beats per second with the third note of fixed frequency. Find the velocity of sound in air. *(March 2008)* **(4)**
(2) The velocity of sound in air at room temperture is 350 m/s. An air column is 35 cm in length. Find the frequency of third overtone in a pipe, when it is **(a)** closed at one end **(b)** open at both ends. *(March 2008)* **(4)**

(3) A sonometer wire is in unision with a tuning fork when stretched by a weight of specific gravity "nine" on completely immersing the weight in water, wire produces 4 beats per second with the fork. Calculate the frequency of the fork. **(March 2009)** (4)

(4) Two sound notes have wavelengths $\frac{83}{170}$ m and $\frac{83}{172}$ m in air. These notes when sounded together produce 8 beats per second. Calculate the velocity of sound in air and frequencies of two notes. **(March 2009, 2017)** (4)

(5) The consecutive harmonics of an air column closed at one end are 405 Hz and 675 Hz respectively. Find the fundamental frequency of the similar air column but open at both ends. **(Oct. 2009)** (4)

(6) A simple harmonic progressive wave is given by the equation $Y = 0.1 \sin 4\pi (50\,t - 0.1\,x)$ in S.I. units. Find the amplitude frequency, wavelength and velocity of the wave. **(March 2010)** (4)

(7) 32 tuning forks are arranged in descending order of frequencies. If any two consecutive tuning forks are sounded together the number of beats heared is eight per second. The frequency of the first tuning fork is octave that of the last fork. Calculate the frequency of the first, last and the 21st fork. **(Oct. 2010)** (4)

(8) A set of 12 tuning forks is arranged in the increasing order of frequencies. Each tuning fork produce '*Y*' beats per second with previous one. The last tuning fork is an octave of the first. The fifth tuning fork has the frequency 90 Hz. Find *Y* and hence find the frequency of the last fork. **(March 2011, 2017)** (4)

(9) In a resonance tube experiment the shortest length of an air column is resonating with a tuning fork of frequency 300 Hz is 25 cm. The next resonance occurs when water level is 80 cm below the open tube. Find the velocity of sound in air and diameter of the tube. **(March 2011)** (4)

(10) In a resonance tube experiment a tuning fork resonates with an air column 10 cm long and again resonates when it is 32.2 cm long. Calculate the wavelength of the wave and end correction. **(Oct. 2011)** (4)

(11) A cylindrical glass tube is 35 cm long. If both ends of the tube are open. What is the fundamental frequency of vibration of air column? Neglect end correction. (*Velocity of sound in air = 350 m/s*) **(March 2012)** (2)

(12) A transverse wave of amplitude 0.01 m and frequency 500 Hz is travelling along a stretched string with a speed of 200 m/s. Find the displacement of a particle at a distance of 0.7 m from the origin after 0.01 sec. Also find the phase difference between the point where wave reaches from the origin. **(March 2012)** (4)

(13) A train blows a whistle of frequency 640 Hz in air, Find the difference in apparent frequencies of the whistle for a stationary observer, when the train moves towards and away from the observer with the speed of 72 km/hour *[Speed of sound in air = 340 m/s]* **(March 2013)** (3)

(14) The equation of simple harmonic progressive wave is given by $Y = 0.05 \sin \pi\left[20t - \frac{x}{6}\right]$, where all quantities are in S.I. units, Calculate the displacement of a particle at 5 m from origin and at the instant 0.1 second. **(Feb. 2014)** (3)

(15) A pipe which is open at both ends is 47 cm loag and has an inner diameter 5 cm. If the speed of sound in air is 348 m/s, calculate the tundamental frequency of air column in that pipe. **(Feb. 2014)** (2)

(16) A 36 cm long sonometer wire vibrates with frequency of 280 Hz in fundamental mode, when it is under tension of 24.5 N. Calculate linear density of the material of wire. **(Oct. 2014)** (2)

(17) Wavelengths of two notes in the air are $\left(\frac{70}{153}\right)$ m and $\left(\frac{70}{157}\right)$ m. Each of these notes produces 8 beats per second with a tuning fork of fixed frequency. Find the velocity of sound in the air and frequency of the tuning fork. **(Oct. 2014)** (3)

(18) A streched wire emits fundamental note of frequency 256 Hz. Keeping the streching force constant and reducing the length of wire by 10 cm, the frequency becomes 320 Hz. Calculate the original length of wire. **(Feb. 2015)** (3)

(19) A sonometer wire is in unison with a tuning fork of frequency 125 Hz when it is stretched by a weight. When the weight is completely immersed in water, 8 beats are heard per second. Find the specific gravity of the material of the weight. **(Oct. 2015)** (3)

(20) In a set, 21 tuning forks are arranged in a series of decreasing frequencies. Each tuning fork produces 4 beats per second with the preceding fork. If the first fork is an octave of the last fork, find the frequencies of the first and tenth forks. **(Oct. 2015)** (3)

(21) A set of 48 tuning forks is arranged in a series of descending frequencies such that each fork gives 4 beats per second with preceding one. The frequency of first fork is 1.5 times the frequency of the last fork, find the frequency of the first and 42nd tuning fork. **(Feb. 2016)** (3)

(22) The fundamental frequency of an air column in a pipe closed at one end is in unison with the third overtone of an open pipe. Calculate the ratio of lengths of their air columns. **(Feb. 2016)** (2)

(23) A tube open at both ends has length 47 cm. Calculate the fundamental frequency of air column. *(Neglect end correction. Speed of sound in air is 3.3×10^2 m/s).* **(July 2016)** (2)

(24) The speed limit for a vehicle on road is 120 km/hr. A policeman detects a drop of 10% in the pitch of horn of car as it passes him. Is the policeman justified in punishing the car driver for crossing the speed limit? *(Given : Velocity of sound = 340 m/s)* **(July 2016)** (3)

(25) A transverse wave is produced on a stretched string 0.9 m long and fixed at its ends. Find the speed of the transverse wave, when the string vibrates while emitting second overtone of frequency 324 Hz. (March 2017) (2)

(26) What should be tension applied to a wire of length 1m and mass 10 gram, if it has to vibrate with fundamental frequency of 50 Hz? (July 2017) (2)

(27) The wavelength of two sound waves in air are $\frac{81}{173}$ m and $\frac{81}{170}$ m. They produce 10 beats per second. Calculate the velocity of sound in air. (March 2018) (3)

(28) The length of an air column for a fundamental mode in a resonance tube is 16 cm and that for second resonance is 50.25 cm. Find the end correction. (July 2018) (2)

(29) A stretched sonometer wire is in unison with a tuning fork. When the length of the wire is increased by 5%, the number of beats heard per second is 10. Find the frequency of the tuning fork. (March 2019) (2)

(30) A sonometer wire 1 metre long weighing 2 g is in resonance with a tuning fork of frequency 300 Hz. Find tension in the sonometer wire. (March 2019) (2)

7. WAVE OPTICS

Theory :

(1) What is interference of light? With the help of neat ray diagram, describe how the distance between two virtual sources in biprism experiment is measured. Derive the necessary formula. (March 2008) (4)

(2) State the conditions necessary for obtaining sharp and steady interference pattern. (March 2008, Oct. 2014) (2)

(3) Explain the resolving power of a telescope with the help of a neat ray diagram. On what factors does it depend? (October 2008) (3)

(4) Using analytical method, obtain an expression for path difference between two interfering light waves. Hence show that bright and dark bands are produced alternately in the interference pattern. (Octoebr 2008) (3)

(5) State Huygen's principle. Explain refraction of a plane wavefront at a plane surface on the basis of Huygen's wave theory of light. (October 2008) (4)

(6) In a biprism experiment show that $d = \sqrt{d_1 d_2}$, using the conjugate foci method. Draw the necessary ray diagrams. (March 2009) (3)

(7) What is resolving power of an optical instrument? Explain Rayleigh's criterion for central maximum. (October 2009) (3)

(8) Draw a neat labelled ray diagram of a biprism experiment showing clearly two virtual sources and the region of interference. (March 2010) (2)

(9) Draw neat labelled diagrams showing magnified and diminished images formed by a convex lens in biprism experiment. (October 2010, March 2011) (2)

(10) Draw a neat labelled ray diagram of refraction of a plane wavefront at a plane surface. (October 2010, 2011) (2)

(11) Distinguish between the phenomenon of interference and diffraction. (October 2011, March 2017) (2)

(12) Give analytical treatment of interference bands and hence obtain the expression for fringe width. (March 2012) (4)

(13) Explain Huygen's construction of spherical wavefront. (March 2012) (2)

(14) Draw a neat labelled diagram of reflection of light from a plane reflecting surface on the basis of wave theory. (March 2012) (2)

(15) On the basis of Huygens' wave theory of light prove that velocity of light in a rarer medium is greater than velocity of light in a denser medium. (March 2013) (4)

(16) Describe biprism experiment to find the wavelength of monochromatic light. Draw the necessary ray diagram for magnified and diminished images of virtual sources. (Feb. 2014, March 2017) (5)

(17) Draw a neat labelled diagram showing the plane of vibration and plane of polarisation for polarised light. (Oct. 2014) (2)

(18) What is a poloroid? State its 'two' uses. (Feb. 2015) (2)

(19) Describe biprism experiment to calculate the wavelength of a momochromatic light. Draw the necessary ray diagram. (Feb. 2015) (3)

(20) With the help of neat diagrams, explain how the non-polar dielectric material is polarised in external electric field of increasing intensity. Define polarisation in dielectrics. (Oct. 2015) (3)

(21) What is 'diffraction of light'? Explain its two types. (Feb. 2016) (2)

(22) Using analytical method for interference bands, obtain an expression for path difference between two light waves. (July 2016) (3)

(23) Obtain an expression for path difference and fringe width of interference pattern in Young's double slit experiment. Show that the fringe width is same for consecutive bright and dark bands. (July 2017) (3)

(24) Explain the construction of plane wavefront using Huygens' principle. (July 2017) (3)

(25) State the conditions to get constructive and distructive interference of light. (March 2018) (2)

(26) State Brewster's law and show that when light is incident at polarizing angle the reflected and refracted rays are mutually perpendicular to each other. *(March 2019)* **(3)**

(27) Explain refraction of light on the basis of wave theory. Hence prove the laws of refraction. *(March 2019)* **(3)**

Problems :

(1) Determine the change in wavelength of light during its passage from air to glass, if refractive index of glass with respect to air is 1.5 and frequency of light is 4×10^{14} Hz. Find the wave number of light in glass. *[Velocity of light in air = 3×10^8 m/s]* *(March 2008)* **(4)**

(2) In a biprism experiment the slit is illuminated by a light of wavelength 4800 A.U. The distance between slit and biprism is 20 cm and the distance between biprism and eye piece is 80 cm. If the distance between virtual sources is 3 mm, determine the distance between the 5th bright band on one side of the central band and 5th dark band on other side. *(Oct. 2009)* **(4)**

(3) In a double slit experiment, the optical path difference between the rays from two coherent sources at a point P on one side of the central bright band is 7.5×10^{-6} m and at a point Q on the other side of the central bright band is 1.8×10^{-6} m. How many bright and dark bands are observed between the points P and Q is wavelength of light used is 6×10^{-7} m? *(March 2009)* **(4)**

(4) In Young's experiment, two slits separated by 4 mm are illuminated by a light of wavelength 6400 A.U. Interference fringes are obtained at a distance of 60 cm from the slits. Find the changes in the fringe width, if the separation between the slits is -
(a) increased by 1 mm, and
(b) decreased by 1 mm *(March 2010)* **(4)**

(5) A ray of light is incident on a water surface of refractive index $\frac{4}{3}$ making an angle of 40° with the surface. Find the angle of refraction. *(March 2010)* **(2)**

(6) The number of waves in 6 cm of vaccum is same as the number of waves in x cm of a medium. If the refractive index of the medium is $\frac{3}{2}$, find x. *(Oct. 2010)* **(2)**

(7) In Young's experiment, the sepration between the slits is 3 mm and the distance between the slits and the screen is 1m. If wavelength of light used is 6000 A.U., calculate the fringe width what will be the change in fringe width, if entire apparatus is immersed in a liquid of refractive index $\frac{4}{3}$. *(Oct. 2010)* **(4)**

(8) Monochromatic light from a narrow slit illuminates two narrow slits 0.3 mm apart producing an interference pattern with bright fringe 1.5 mm apart on a screen 15 cm away. Find the wavelength of light. How much will the fringe width altered if
(a) the distance of the screen is doubled.
(b) the sepration between the slit is doubled. *(March 2011)* **(4)**

(9) The wavelength of a beam of light in air is 3750 A°. Find the number of waves of the beam in 10 cm of glass. Also find the time required by the beam to pass through 10 cm of glass of refractive index is. *[Velocity of light in air = 3×10^8 m/s]* *(March 2011)* **(4)**

(10) If the difference in the velocities of light in glass and water is 0.25×10^8 m/s. Find the velocity of light in glass. *[Given : $\mu_g = \frac{3}{2}$ and $\mu_w = \frac{4}{3}$].* *(Oct. 2011)* **(2)**

(11) In biprism experiment the fringes are observed in the focal plane of the eyepiece at a distance of 1.5 m from the slit. The distance between the central band and 15th dark band is 3 mm. When a convex lens is interposed between the biprism and the eyepiece at a distance of 112.5 cm from the eyepiece, the distance between two magnified virtual images is found to be 1.125 cm. Find the wavelength of light used. *(Oct. 2011)* **(4)**

(12) In a biprism experiment a source of wavelength 6500 A° is replaced by source of wavelength 5500 Å. Calculate the change in fringe width if the screen is at 1m distance from the slits which are 1 mm apart. *(March 2012)* **(2)**

(13) A point is situated at 7 cm and 7.2 cm from two coherent sources. Find the nature of illumination at the point if wavelength of light is 4000 Å. *(March 2013)* **(2)**

(14) In Young's experiment the ratio of intensity at the maxima and minima in the interference pattern is 36 : 16. What is the ratio of the widths of the two slits? *(March 2013)* **(3)**

(15) In Young's experiment, the ratio of intensity at the maxima and minima in an interference pattern is 36 : 9. What will be the ratio of intensities of two interfering waves? *(Oct 2013)* **(3)**

(16) The minimum angular reparation between two stars is 4×10^{-6} rad, if telescope is used to observe them with an objective of aperture 16 cm. Find the wavelength of light used. *(Oct 2013)* **(2)**

(17) The refractive indices of water for red and violet colours are 1.325 and 1.334 respectively. Find the difference between the velocities of rays for these two colours in water. *($c = 3 \times 10^8$ m/s)* *(Oct. 2013)* **(3)**

(18) For a glass plate as a polarizer with refractive index 1.633, calculate the angle of incidence at which light is polarised.

(19) If the difference in velocities of light in glass and water is 2.7×10^7 m/s, find the velocity of light in air. *(Refractive index of glass = 1.5, Refractive index of water = 1.333)* **(Feb. 2014)** (2)

(20) A red light of wavelength 6400 $\mathring{A}$ in air has wavelength 4000 $\mathring{A}$ in glass. If the wavelength of violet light in air is 4400 $\mathring{A}$, find its wavelength in glass. *(Assume that $\mu_r \approx \mu_v$)* **(Oct. 2014)** (2)

(21) In a biprism experiment, a slit is illuminated by a light of wavelength 4800 $\mathring{A}$. The distance between the slit and biprism is 15 cm and the distance between the biprism and eyepiece is 85 cm. If the distance between virtual sources is 3 mm, determine the distance between 4th bright band on one side and 4th dark band on the other side of the central bright band. **(Oct. 2014)** (3)

(22) If the critical angle of a medium is $\sin^{-1}\left(\frac{3}{5}\right)$ find the polorising angle. **(Feb. 2015)** (3)

(23) In a biprism experiment, when a convex lens was placed between the biprism and eyepiece at a distance of 30 cm from the slit, the virtual images of the slits are found to be separated by 7 mm. If the distance between the slit and biprism is 10 cm and between the biprism and eyepiece is 80 cm, find the linear magnification of the image. **(Oct. 2015)** (3)

(24) In a single slit diffraction pattern, the distance between first minima on the right and first minima on the left of central maximum is 4 mm. The screen on which the pattern is displaced, is 2 m from the slit and wavelength of light used is 6000 $\mathring{A}$. Calculate width of the slit and width of the central maximum. **(Oct. 2015)** (3)

(25) A parallel beam of monochromatic light is incident on a glass slab at an angle of incidence 60°. Find the ratio of width of the beam in the glass to that in the air if refractive index of glass is $\frac{3}{2}$. **(Oct. 2015)** (3)

(26) Determine the change in wavelength of light during its passage from air to glass. If the refractive index of glass with respect to air is 1.5 and the frequency of light is 3.5×10^{14} Hz, find the wave number of light in glass. *[Velocity of light in air, $c = 3 \times 10^8$ m/s]* **(Feb. 2016)** (3)

(27) In biprism experiment, 10th dark band is observed at 2.09 mm from the central bright point on the screen with red light of wavelength 6400 $\mathring{A}$. By how much will fringe width change if blue light of wavelength 4800 $\mathring{A}$ is used with the same setting? **(Feb. 2016)** (3)

(28) A point is situated at 6.5 cm and 6.65 cm from two coherent sources. Find the nature of illumination at the point, if wavelength of light is 5000 $\mathring{A}$. **(July 2016)** (2)

(29) Determine the change in wavelength of light during its passage from air to glass, if the refractive index of glass with respect to air is 1.5 and the frequency of light is 5×10^{14} Hz. Find the wave number of light in glass. *[Velocity of light in air, $c = 3 \times 10^8$ m/s]* **(July 2016)** (3)

(30) The width of plane incident wavefront is found to be doubled on refraction in denser medium. If it makes an angle of 65° with the normal. Calculate the refractive index for the denser medium. **(March 2017)** (3)

(31) The refractive indices of glass and water w.r.t. air $\frac{3}{2}$ and $\frac{4}{3}$ respectively. Dertmine the refractive index of glass w.r.t. water. **(July 2017)** (3)

(32) The refractive indices of water and diamond are $\frac{4}{3}$ and 2.42 respectively. Find the speed of light in water and diamond *($c = 3 \times 10^8$ m/s)* **(March 2018)** (3)

(33) In a biprism experiment light of wavelength 5200 $\mathring{A}$ is used to get an interference pattern on the screen. The fringe width changes by 1.3 mm when the screen is moved towards biprisim by 50 cm. Find the distance between two virtual images of the slit. **(March 2018)** (3)

(34) In Young's double slit experiment, the slits are 0.5 mm apart and interference is observed on a screen placed at a distance of 100 cm from the slit. It is found that 9th bright fringe is at a distance of 8.835 mm from the 2nd dark fringe, on the same side of the centre of the fringe pattern. Find the wavelength of light used. **(July 2018)** (3)

(35) The optical path difference between two identical waves arriving at a point is 371λ. Is the point bright or dark? If the path difference is 0.24 mm, calculate the wavelength of light used. **(July 2018)** (3)

(36) Determine the change in wavelength of light during its passage from air to glass, if the refractive index of glass with respect to air is 1.5 and frequency of light is 4×10^{14} Hz. *($c = 3 \times 10^8$ m/s)* **(July 2018)** (3)

(37) In Young's experiment interference bands were produced on a screen placed at 150 cm from two slits, 0.15 mm apart and illuminated by the light of wavelength 6500 $\mathring{A}$. Calculate the fringe width. **(March 2019)** (2)

(38) Two coherent sources of light having intensity ratio 81:1 produce interference fringes. Calculate the ratio of intensities at the maxima and minima in the interference pattern. **(March 2019)** (2)

(39) Monochromatic light of wavelength 4300 Å falls on a slit of width 'a'. For what value of 'a' the first maximum falls at 30°? ***(March 2019)*** **(2)**

8. ELECTROSTATICS

Theory :

(1) State and prove Gauss's theorem in an electrostatics. ***(March 2008, 2009, 2011)*** **(4)**

(2) Derive an expression for the mechanical force per unit area of a charged conductor. ***(Oct. 2008, March 2010)*** **(3)**

(3) Describe the construction of van-de-Graaf generator. ***(March 2009)*** **(2)**

(4) Derive an expression for electric intensity at a point outside a charged spherical conductor. ***(Oct. 2009)*** **(2)**

(5) Derive an expression for the energy of a charged condenser. Express it in different forms. ***(Oct. 2010)*** **(3)**

(6) Derive an expression for the capacity of a parallel plate condenser filled with dielectric. ***(Oct. 2011)*** **(3)**

(7) Derive an expression for energy stored in a charged condenser. Obtain its different forms. ***(March 2012)*** **(3)**

(8) State Gauss theorem and state its any two applications.

(9) Draw a neat labelled diagram of a parallel plate capacitor completely filled with dielectric. ***(March 2013)*** **(2)**

(10) What do you mean by polar molecules and non-polar molecules? Give one example each. ***(Oct. 2013)*** **(2)**

(11) With the help of a neat diagram, describe the construction and working of van de Graff generator. ***(July 2016)*** **(4)**

(12) Obtain an expression for electric field intensity at a point outside uniformly charged thin plane sheet. ***(July 2017)*** **(2)**

(13) State Gauss's theorem in electrostatics. State the expression for electric field intensity at a point outside an infinitely long charged conducting cylinder. ***(July 2018)*** **(2)**

(14) Define capacitance of a capacitor and its SI unit. ***(March 2019)*** **(2)**

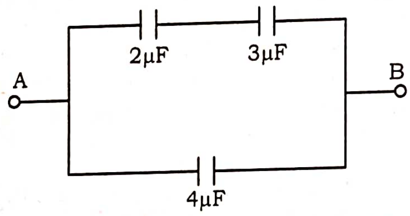
Problems :

(1) A parallel plate air condenser has an area 2×10^{-4} m^2 and sepration between the two plate is 1 mm. Find its capacity. *[$\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/Nm^2]* ***(March 2008)*** **(2)**

(2) Energy stored in a charged capacitor of capacity 25 pF is 4 J. Find the charge on its plate. ***(Oct. 2008)*** **(2)**

(3) A parallel plate capacitor has circular plate, each of diameter 20 cm seprated by a distance of 2 mm. The potential difference between the plates is maintain at 360 V. Calculate the capacitance and charge. Waht is the intensity of electric field between the plate of capacitor? *[**Given:** K = 1]* ***(Oct. 2009)*** **(4)**

(4) A condenser of capacity 100 μF is charged to a potential of 1 kV. Calculate the energy stored in the condenser. ***(March 2010)*** **(2)**

(5) 

Three condensers are connected as shown in figure below. Calculate the effective capacitance between A and B. ***(Oct. 2010)*** **(2)**

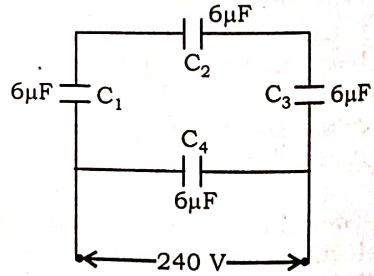
(6) A capacitor carries a charge of 8 μF at a potential 400 V. How much electrostatic energy stored in the capacitor? ***(March 2011)*** **(2)**

(7) The surface density of charge on the spherical surface is 2.65×10^{-9} C/m^2. If the radius of the sphere is 6.4×10^6 m, find the charge carried by the sphere. ***(Oct. 2011)*** **(2)**

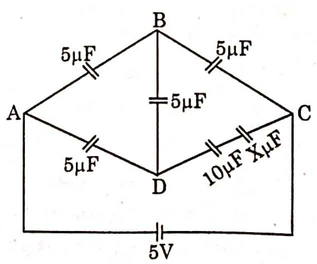
(8) Electrostatic energy of 3.5×10^{-4} J is stored in a capacitor at 700 V. What is the charge on the capacitor? ***(March 2013)***

(9) The energy density at a point in a medium of dielectric constant 6 is 26.55×10^6 J/m^3. Calculate electric field intensity at that point. *($\varepsilon_0 = 8.85 \times 10^{-12}$ SI units)* ***(Oct 2013)*** **(3)**

(10) A network of four capacitors of 6 μF each is connected to a 240 V supply. Determine the charge on each capacitor. ***(Feb. 2014)*** **(3)**



(11) Six capacitors of capacities 5, 5, 5, 5, 10 and X μF are connected as shown in the network given below. Find : **(a)** The value of X if the network is balanced, and **(b)** The resultant capacitance between A and C.



(Oct. 2014) **(3)**

(12) Two metal spheres having charge densities 5 $\mu C/m^2$ and -2 $\mu C/m^2$ with radii 2 mm and 1 mm respectively are kept in a hypothetical closed surface. Calculate total normal electrical induction over the closed surface. *(Feb. 2015)* **(2)**

(13) A conductor of any shape, having area 40 cm^2 placed in air is uniformly charged with a charge 0.2 μC. Determine the electric intensity at a point just outside its surface. Also, find the mechanical force per unit area of the charged conductor. *[ε_0 = 8.85 × 10^{-12} S.I. Units]* *(Feb. 2016)* **(3)**

(14) A cube of marble having each side 1 cm is kept in an electric field of intensity 300 V/m. Determine the energy contained in the cube of dielectric constant 8. *[Given : ε_0 = 8.85 × 10^{-12} C^2/Nm^2]* *(March 2017)* **(3)**

(15) Three capacitors of capacities 8 μF, 8 μF and 4 μF are connected in a series and a potential difference at 120 volt is maintained across the combination. Calculate the charge on capacitor of capacity 4 μF. *(July 2017)* **(2)**

(16) A parallel plate air condenser has a capacity of 20 μF. What will be the new capacity if:
(a) the distance between the two plates is double?
(b) a marble slab of dielectric constant 8 is introduced between the two plates? *(March 2018)* **(2)**

(17) A 10 μF capacitor is connected with 100 V battery. What would be the electrostatic energy stored? *(July 2018)* **(2)**

9. CURRENT ELECTRICITY

Theory :

(1) Describe how potentiometer is used to compare the e.m.f.s of two cells by sum and difference method. *(March 2008)* **(3)**

(2) Obtain the balancing condition of Wheatstone's network. *(October 2008, March 2011)* **(3)**

(3) Draw a neat labelled circuit diagram to determine resistance of a galvanometer using Kelvin's method. *(October 2008, 2011)* **(2)**

(4) Describe meter bridge experiment to determine resistance of galvanometer by Kelvin's method. *(March 2009)* **(3)**

(5) Describe how a potentiometer is used to compare the emf's of two cells by connecting them separately. *(October 2009)* **(3)**

(6) State Kirchhoff's laws in electricity. *(March 2010, July 2018)* **(2)**

(7) State and explain principle of potentiometer. *(March 2011, Oct 2013)* **(2)**

(8) Explain with neat circuit diagram how will you determine unknown resistance by using meterbridge experiment. *(March 2012)* **(3)**

(9) State any 'two' possible sources of errors in meter-bridge experiment. How can they be minimised? *(Oct. 2015)* **(2)**

(10) Describe Kelvin's method to determine the resistance of galvanometer by using metre bridge. *(Feb. 2016)* **(2)**

(11) State the advantages of potentiometer over voltmeter. *(March 2017)* **(2**

(12) Explain with a neat circuit diagram how will you determine unknown resistance 'X' by using meter bridge. *(March 2018)* **(3**

Problems :

(1) A potentiometer wire has a resistance per unit length 0.1 Ω/m. A cell of e.m.f. 1.5 V balances against 300 c length of the wire. Find the current through potentiometer wrie. *(March 2009)* **(**

(2) The potentiometer wire has length 10 m and resistance 10Ω. If the current flowing through it is 0.4 A, what a the balancing lengths when two cells of e.m.f.s 1.3 V and 1.1 V are connected so as to **(a)** assist and **(b)** oppo each other? *(March 2010)* (

(3) The length of potentiometer wire is 4m and its resistance is 18Ω. A battery of e.m.f. 2V and internal resista 2 Ω is connected across the wire. Calculate the potential gradient. If the balancing length for a cell of e.m.f. is 200 cm, calculate E_1. *(Oct. 2010)*

(4) A cell balances against a length of 250 cm on a potentiometer wire, when it is shunted by a resistance of 1 The balancing length becomes 200 cm, when it is shunted by a resistance of 5Ω. Calculate the balancing le when the cell is in open circuit and also find internal resistance of the cell. *(Oct. 2011)*

(5) In a potentiometer the balancing length of the string is found to be 2.5 m for a cell of e.m.f. 1.5 V. Find balancing length of the string for another cell of e.m.f. 1.2 V on the same potentiometer. *(March 2012)*

(6) A cell balances against a length of 200 cm on a potentiometer wire, when it is shunted by a resistance of The balancing length reduces by 40 cm, when it is shunted by a resistance of 4 Ω. Calculate the bala length when the cell is in open circuit. Also calculate the internal resistance of the cell. *(March 2013)*

(7) Four resistances 4Ω, 8Ω, XΩ and 6Ω are connected in a series so as to form Wheatstone's network. network is balanced, find the value of X. *(Oct 2013)*

(8) Two diametrically opposite points of a metal ring are connected to two terminals of the left gap of meter b The resistance of 11Ω is connected in right gap. If null point is obtained at a distance of 45 cm from the le find the resistance of metal ring. *(Feb. 2014)*

(9) A potentiometer wire has a length of 4 m and a resistance of 5 Ω. What resistance should be conne series with a potentiometer wire and a cell of e.m.f. 2 V having internal resistance 1 Ω to get a p gradient of 10^{-3} V/cm? *(Oct. 2014)*

(10) Resistance of a potentiometer wire is 0.1 Ω/cm. A cell of emf 1.5 V is balanced at 300 cm on this potentiometer wire. Calculate the current and balancing length for another cell of e.m.f. 1.4 V on the same potentiometer wire. *(Feb. 2015)* **(3)**

(11) A potentiometer wire has resistance of per unit length of 0.1Ω/m. A cell of e.m.f. 1.5 V balances against 300 cm length of the wire. Find the current in the potentiometer wire. *(Oct. 2015)* **(2)**

(12) A potentiometer wire has length of 2 m and resistance 10 Ω. It is connected in series with resistance 990 Ω and a cell of e.m.f. 2 V. Calculate the potential gradient along the wire. *(July 2016)* **(2)**

(13) An unknown resistance is placed in the left gap and resistance of 50 ohm is placed in the right gap of a meter bridge. The null point is obtained at 40 cm from the left end. Determine the unknown resistance. *(March 2017)* **(2)**

(14) When a resistance of 12 ohm is connected across a cell, its terminal potential difference is balanced by 120 cm length of poteniometer wire. When the resistance of 18 ohm is connected across the same cell, the balancing length is 150 cm. Find the balancing length when the cell is in open circuit. Also calculate the internal resistance of the cell. *(July 2017)* **(3)**

(15) In a potentiometer the balancing length of the wire is found to be 2.5 m for a cell of e.m.f. 1.5 V. Find the balancing length of the wire for another cell of e.m.f. 1.2 V on the same potentiometer. *(July 2018)* **(2)**

(16) When a resistor of 5Ω is connected across the cell, its terminal potential difference is balanced by 150 cm of potentiometer wire and when a resistance of 10 Ω is connected across cell, the terminal potential difference is balanced by 175 cm same potentiometer wire. Find the balancing length when the cell is in open circuit and the internal resistance of the cell. *(March 2019)* **(3)**

10. MAGENTIC FIELDS DUE TO ELECTRIC CURRENT

Theory :

(1) Explain how a moving coil galvanometer can be converted into voltmeter. *(March 2008)* **(2)**

(2) State the principle of moving coil galvanometer and explain its working. *(October 2008, March 2011)* **(3)**

(3) State Ampere's law and hence obtain an expression for the magnetic induction at any point near a straight conductor carrying a current. *(March 2009)* **(3)**

(4) Give the construction of a suspended coil type of moving coil galvanometer. *(March 2009)* **(3)**

(5) Explain the principle of moving coil galvanometer (suspended coil type) *(March 2010)* **(3)**

(6) Explain the construction and working of cyclotron. *(October 2010)* **(3)**

(7) State the formula for sensitivity of a moving coil galvanometer. How can sensitivity be increased? *(Oct. 2010)* **(2)**

(8) State the principle of cyclotron. With a neat diagram explain its construction. *(Oct. 2011)* **(3)**

(9) State Ampere's circuital law and write its mathematical expression. *(Oct. 2011)* **(2)**

(10) Explain how a moving coil galvanometer is converted into an ammeter. Derive the necessary formula. *(March 2012)* **(3)**

(11) State and explain Ampere's circuital law. *(March 2012, 2018)* **(2)**

(12) Obtain the expression for current sensitivity of moving coil galvanometer. *(March 2013)* **(2)**

(13) State Ampere's circuital law. Obtain an expression for magnetic induction along the axis of toroid. *(Feb. 2014)* **(3)**

(14) Show that the current flowing through a moving coil galvanometer is directly proportional to the angle of deflection of coil. *(Oct. 2014)* **(3)**

(15) Draw a neat and labelled diagram of suspended coil type moving coil galvanometer. *(Feb. 2015)* **(2)**

(16) Draw a neat labelled diagram for the construction of 'cyclotron'. *(Feb. 2016)* **(2)**

(17) Explain how moving coil galvanometer is converted into a voltmeter. Derive the necessary formula. *(March 2017)* **(2)**

(18) Obtain an expression for magnetic induction along the axis of toroid on the basis of Ampere's circuital law. *(July 2017)* **(3)**

Problems :

(1) A voltmeter of resistance 500 Ω can measure a maximum voltage of 5 volt. How can it he made to measure a maximum voltage of 100 volt? *(Oct. 2009)* **(2)**

(2) In a cyclotron, magnetic field of 3.5 Wb/m^2 is used to accelerate protons. What should be the time interval in which the electric field between the Dees be reversed?
(Mass of proton = 1.67×10^{-27} kg, Charge on proton = 1.6×10^{-19} C) *(March 2013)* **(2)**

(3) A galvanometer has a resistance of 16Ω. It shows full scale deflection, when a current of 20 mA is passed through it. The only shunt resistance available is 0.06Ω which is not appropriate to convert a galvanometer into an ammeter. How much resistance should be connected in series with the coil of the galvanometer, so that the range of ammeter is 8 A ? *(Oct 2013)* **(3)**

(4) A rectangular coil of a moving coil galvanometer contains 50 turns each having area $12 cm^2$. It is suspended in radial magnetic field 0.025 Wb/m^2 by a fibre of twist constant 15×10^{-10} N-m/degree. Calculate the sensitivity of the moving coil galvanometer. *(Oct 2015)* **(3)**

(5) A coil of 100 turns, each of area 0.02 m^2 is kept in a uniform field of induction 3.5×10^{-5} T. If the coil rotates with a speed of 6000 r.p.m. about an axis in the plane of the coil and perpendicular to the magnetic induction, calculate peak value of e.m.f. induced in the coil. ***(Oct 2015)*** **(2)**

(6) The combined resistance of a galvanometer of resistance 500 Ω and its shunt is 21Ω. Calculate the value of shunt. ***(Feb. 2016)*** **(2)**

(7) A voltmeter has a resistance of 100 Ω. What will be its reading when it is connected across a cell of e.m.f. 2V and internal resistance 20Ω ? ***(July 2016)*** **(2)**

(8) A moving coil galvanometer has a resistance of 25Ω and gives a full scale deflection for a current of 10 mA. How will you convert it into a voltmeter having range 0 – 100 V? ***(July 2016)*** **(3)**

(9) A rectangular coil of a moving coil galvanometer contains 100 turns, each having area 15 cm^2. It is suspended in the radial magnetic field 0.03 T. The twist constant of suspension fibre is 15×10^{-10} N-m/degree. Calculate the sensitivity of the moving coil galvanometer. ***(March 2017)*** **(2)**

(10) In a cyclotron, magnetic field of 1.4 Wb/m^2 is used. To accelerate protons, how rapidly should the electric field between the Dees be reversed? ($\pi = 3.142$, $M_p = 1.67 \times 10^{-27}$ kg, $e = 1.6 \times 10^{-19}$ C) ***(March 2018)*** **(2)**

(11) A rectangular coil having 100 turns each of length 1 cm and bredth 0.5 cm is suspended in radial magnetic induction 0.002 T. The torsional constant of suspension fiber is 2×10^{-8} Nm/degree. Calculate the current sensitivity of a moving coil galvanometer. ***(July 2018)*** **(3)**

(12) A cyclotron is used to accelerate protons to a kinetic energy of 5 MeV. If the strength of magnetic field in the cyclotron is 2T, find the radius and the frequency needed for the applied alternating voltage of the cyclotron. (**Given:** *Velocity of proton* = 3×10^7 m/s) ***(March 2019)*** **(3)**

11. MAGNETIC MATERIALS

Theory:

(1) Explain ferromagnetism on the basis of domain theory. ***(Oct. 2008, Oct. 2011)*** **(3)**

(2) Define magnetization. State its formula and S. I. unit. ***(March 2013)*** **(2)**

(3) What is - **(a)** Magnetization and **(b)** Magnetic intensity ? ***(Oct 2013, Feb. 2015)*** **(2)**

(4) Show that the orbital magnetic dipole moment of a revolving electron is $\frac{eVr}{2}$ ***(Feb. 2014)*** **(2)**

(5) Give any 'two' points of differences between diamagnetic and ferromagnetic substances. ***(Oct. 2015)*** **(2)**

(6) Distinguish between 'paramagnetic' and 'ferromagnetic' substances. ***(Feb. 2016)*** **(2)**

(7) Draw the diagrams showing the dipole moments in paramagnetic substance when external magnetic field is **(a)** absent **(b)** strong. ***(July 2016)*** **(2)**

(8) Distinguish between diamagnetic and paramagnetic substances. ***(July 2017)*** **(2)**

(9) Define magnetization. Write its SI unit and dimensions. ***(March 2018)*** **(2)**

(10) What happens to a ferromagnetic substance heated above Curie temperature? ***(March 2019)*** **(1)**

Problems :

(1) A circular coil of 250 turns and diameter 18 cm carriers a current of 12 A. What is the magnitude of magnetic moment associated with the coil? ***(March 2013)*** **(2)**

(2) The magnetic susceptibility of annealed iron at saturation is 4224. Find the permeability of annealed iron at saturation. ($\mu_o = 4\pi \times 10^{-7}$ *S.I. unit*) ***(Oct 2013)*** **(2)**

(3) The susceptibility of magnesium at 300 K is 2.4×10^{-5}. At what temperature will the susceptibility increase to 3.6×10^{-5} ? ***(Feb. 2014)*** **(2)**

(4) The magnetic moment of a magnet of dimensions 5 cm × 2.5 cm × 1.25 cm is 3 Am^2. Calculate the intensity of magnetization. ***(Oct. 2014)*** **(2)**

(5) A circular coil of 300 turns and average area 5×10^{-3} m^2 carries a currrent of 15 A. Calculate the magnitude of magnetic moment associated with the coil. ***(Feb. 2015)*** **(2)**

(6) An iron rod of area of cross-section 0.1m^2 is subjected to a magnetising field of 1000 A/m. Calculate the magnetic permeability of the iron road.
[*Magnetic susceptibility of iron* = 59.9, *magnetic permeability of vacuum* = $4\pi \times 10^{-7}$ *S. I. Unit.*] ***(Oct. 2015)*** **(2)**

(7) The susceptibility of magnesium at 200 K is 1.8×10^{-5}. At what temperature will the susceptibility decrease by 6×10^{-6}? ***(Feb. 2016)*** **(2)**

(8) The susceptibility of magnesium at 300 K is 1.2×10^{-5}. At what temperature will the susceptibility increase to 1.8×10^{-5} ? ***(July 2016)*** **(2)**

(9) Find the magnetization of a bar magnet of length 10 cm and cross-sectional area 4 cm^2, if the magnetic moment is 2 Am^2. ***(July 2017)*** **(2)**

(10) The susceptibility of magnesium at 300 K is 1.2×10^{-5}. What will be its susceptibility at 200 K? ***(March 2019)*** **(2)**

12. ELECTROMAGNETIC INDUCTION

Theory :

(1) What are eddy current? State any two applications of eddy currents. *(March 2008, October 2009)* **(2)**
(2) State Faraday's laws of electromagnetic induction. *(October 2008)* **(2)**
(3) Distinguish between step-up and step-down transformer. *(March 2009)* **(2)**
(4) State the principle on which a transformer works with neat diagram, explain the construction of a step-up transformer.*(March 2010)* **(3)**
(5) Obtain an expression for the e.m.f. induced in a coil rotating in a uniform magnetic field. Show graphically the variation of induced e.m.f. with respect to time. *(October 2010)* **(3)**
(6) Prove theoretically, the relation between e.m.f. induced and rate of change of magnetic flux in the electric circuit in electromagnetic induction. *(March 2011, 2018)* **(4)**
(7) Obtain an expression for e.m.f. induced in a coil rotating with uniform angular velocity about its diameter perpenclicular to uniform magnetic field. *(Oct. 2011)*
(8) Obtain an expression for the e.m.f. induced in a coil rotating in uniform magnetic field. *(March 2012)* **(3)**
(9) State Faraday's laws of electromagnetic induction and Lenz's law. *(March 2013)* **(2)**
(10) Prove theoretically, the relation between e.m.f. induced and rate of change of magnetic flux in a coil moving in a uniform magnetic field. *(March 2013)* **(3)**
(11) Obtain an expression for the induced e.m.f. in a coil rotating with uniform angular velocity in uniform magnetic field. Plot a graph of variation of induceed e.m.f. against phase ($\theta = \omega t$) over one cycle. *(Oct 2013)* **(4)**
(12) State the principle of a transformer. Explain its construction and working. Derive an expression for the ratio of e.m.f.s in terms of number of turns in primary and secondary coil. *(Feb. 2014)* **(4)**
(13) Explain the phenomenon of self induction and mutual induction. Define coefficient of self induction and mutual induction. Write the SI unit and dimensions of coefficient of self induction. *(Oct. 2014)* **(4)**
(14) Obtain an expression for e.m.f. induced in a coil rotating with uniform angular velocity in a uniform magnetic field. Show graphically the variation of e.m.f. with time (t). *(Feb. 2015)* **(4)**
(15) Obtain an expression for average power dissipated in a purely resistive A.C. circuit. Define power factor of the circuit and state its value for purely resistive A. C. circuit. *(Oct. 2015)* **(3)**
(16) State the principle on which transformer works. Explain its working with construction. Derive an expression for ratio of e.m.f.s and currents in terms of number of turns in primary and secondary coil. *(Feb. 2016)* **(4)**
(17) What is electromagnetic induction? Prove theoretically $e = -\frac{d\phi}{dt}$ *(July 2016)* **(5)**
(18) Explain self induction and mutual induction. *(March 2017)* **(3)**
(19) State the principle of working of transformaer. Explain the construction and working of a transfer. Derive an expression for e.m.f. and current in terms of turns ratio. *(July 2017)* **(5)**
(20) What is series LCR circuit? Obtain the expression for impedance. Hence state the conditions for series resonance and derive the expression for resonant frequency. *(July 2018)* **(4)**
(21) Explain the working of a transistor as a switch. *(July 2018)* **(3)**
(22) At which position of the plane of the rotating coil with the direction of magnetic field, the e.m.f. induced in the coil is maximum? *(March 2019)* **(1)**
(23) Assuming expression for impedance in a parallel resonant circuit, state the conditions for parallel resonance. Define resonant frequency and obtain an expression for it. *(March 2019)* **(3)**

Problems :

(1) An LCR series combination has $R = 10\ \Omega$, L = 1 mH and C = 2 μF. Determine **(a)** The resonant frequency, **(b)** The current in the circuit and **(c)** Voltage across L and C when an alternating voltage of 10 mV operating at the resonant frequency, is applied to the series combination. *(March 2008)* **(4)**
(2) An alternating e.m.f. of peak value 110V and frequency 50 Hz is connected across *LCR* series circuit with $R = 100\Omega$ L = 10 mH and C = 25 μF. Calculate the inductive reactance capacitive reactance and impedance of the circuit. *(Oct. 2008)* **(4)**
(3) An A.C. supply of frequency 50 Hz is supplied to a series combination of 25 μF condenser, 0.1 henry inductor and 24Ω resistor. Calculate inductive and capactivie reactance. Also find impedance of the circuit. *(March 2009)* **(4)**
(4) A rectangular coil of length 0.5 m and breadth 0.4 m has resistance of 5Ω. The coil is placed in a magnetic induction of 0.05 T and the direction is perpendicular to the plane of the coil. If the magnetic induction is uniformly reduced to zero in 5 milts seconds, find the emf and current induced in the coil. *(Oct. 2009)* **(4)**
(5) An A.C. voltage of r.m.s. value 1 V is applied to a parallel combination of inductor L = 10 mH and capacitor C = 4μF. Calculate the resonant frequency and current through each branch at resonance. *(March 2010)* **(4)**
(6) In a series LCR circuit, the inductor of inductance 100mH, a resistor of 10Ω and variable capacitor are connected across 20V, 50 Hz supply. At what capacitance will resonance occur? Find the corresponding current. *(Oct. 2010)* **(4)**
(7) A series LCR circuit has capacitor 0.2 μF and inductor of 8mH. Find its resonance frequency. *(March 2011)* **(2)**
(8) An AC circuit consist of resistor of 5Ω, inductor of inductive reactance 62.8Ω and a capacitor of capacitive reactance 127.38Ω in series across 200 supply. Determine **(a)** Impendance **(b)** Current of the circuit **(c)** Power factor **(d)** Power dissipated in the circuit. *(Oct. 2011)* **(4)**

(9) An alternating e.m.f. $e = 220 \sin(120\pi t)$ volt is applied to a bulb of resistance 110Ω. Find peak value, effective value, frequency and period of alternating current through bulb. ***(March 2012)*** **(4)**

(10) A metal rod $\frac{1}{\sqrt{\pi}}$ m long rotates about one of its ends perpendicular to a plane whose magnetic induction is 4×10^{-3} T. Calculate the number of revolutions made by the rod per second if the e.m.f. induced between the ends of the rod is 16 mV. ***(Feb. 2014)*** **(2)**

(11) An A.C. circuit consists of inductor of inductance 125 mH connected in parallel with a capacitor of capacity 50 μF. Determine the resonant frequency. ***(Oct. 2014)*** **(2)**

(12) A solenoid 3.142 m long and 5.0 cm in diameter has two layers of windings of 500 turns each and carries a curent of 5 A. Calculate the magnetic induction at its centre along the axis. ***(Feb. 2015)*** **(2)**

(13) The magnetic flux through a loop varies according to the relation $\phi = 8t^2 + 6t + C$, where 'C' is constant, 'ϕ' is in milliweber and 't' is in second. What is the magnitude of induced e.m.f. in the loop at $t = 2$ seconds? ***(Feb. 2015)*** **(2)**

(14) The co-efficient of mutual induction between primary and secondary coil is 2H. Calculate induced e.m.f. if current of 4A is cut off in 2.5×10^{-4} seconds. ***(Feb. 2016)*** **(2)**

(15) The magnetic flux through a loop is varying according to a relation $\phi = 6t^2 + 7t + 1$ where ϕ is in milliweber and t is in second. What is the e.m.f. induced in the loop at t = 2 second? ***(March 2017)*** **(2)**

(16) A capacitor of capacitance 0.5 μF is connected to a source of alternating e.m.f. of frequency 100 Hz. What is the capacitive reactance? ($\pi = 3.142$) ***(March 2018)*** **(2)**

(17) A closely wound solenoid of 1000 turns and area of cross-section 2×10^{-4} m^2 carries a current of 1A. It is placed in a horizontal plane with its axis making an angle of 30° with the direction of uniform magnetic field of 0.16 T. Calculate the torque acting on the solenoid. ***(July 2018)*** **(2)**

13. AC CIRCUITS

(New chapter for this course)

14. DUAL NATURE OF RADIATION AND MATTER

Theory :

(1) State Einstein's photoelectric equation. Explain two characteristic of photoelectric effect on the basis of Einstein photoelectron equation. ***(March 2008, 2013; Oct. 2010)*** **(3)**

(2) With the help of circuit diagram describe an experiment to study photoelectric effect? ***(Oct. 2009)*** **(3)**

(3) With the help of circuit diagram, describe the experiment to study the characterstic of photo electric effect. Hence discuss any two characterstics of photoelectric effect. ***(Oct. 2011)*** **(4)**

(4) State Einstein's photoelectric equations. Explain 'two' characterstics on the basis of this equation. ***(March 2012)*** **(3)**

(5) Draw a well labelled diagram of photoelectric cell. Explain the observations made by Hertz and Lenard about the phenomenon of photoelectric emission. ***(Oct 2013)*** **(3)**

(6) Describe the construction of photoelectric cell. ***(Feb. 2014)*** **(2)**

(7) Draw a neat labelled circuit diagram of experimental arrangement for study of photoelectric effect. ***(Oct. 2015)*** **(2)**

(8) With the help of a neat circuit diagram, explain the working of a photodiode. State its any 'two' uses. ***(Oct. 2015)*** **(2)**

(9) What is photoelectric effect? Define (i) Stopping potential, (ii) Photoelectric work function. ***(March 2019)*** **(3)**

Problems :

(1) The threshold wavelength for silver is 3800 Å. Calculate maximum kinetic energy in eV of photoelectrons emitted, when ultraviolet light of wavelength 2600 Å falls on it. Also calculate stopping potential.
[1eV = 1.6×10^{-19}J, Plank's constant = 6.63×10^{-34} J-s, speed of light in vacuum = 3×10^8 m/s] ***(Oct. 2008)*** **(4)**

(2) The photoelectric work function for a metal is 4.2 eV. If the stopping potential is 3 V, find the threshold wavelength and maximum kinetic energy of emitted electrons. *(Velocity of light in air = 3×10^8 m/s,)* Planck's constant = 6.63×10^{-34} J-s, Charge on electron = 1.6×10^{-19} C) ***(March 2013)*** **(3)**

(3) Find the wave number of a photon having an energy of 2.072 eV.
Given : Charge on electron = 1.6×10^{-19} C, Velocity of light air = 3×10^8 m/s,
Planck's constant = 6.63×10^{-34} J-s. ***(Feb. 2014)*** **(2)**

(4) The photoelectric threshold wavelength of a metal is 230 nm. Determine the maximum kinetic energy in joule and in eV of the ejected electron for the metal surface when it is exposed to a radiation of wavelength 180 nm.
[Planck's constant : h = 6.63×10^{-34} Js, Velocity of light : c = 3×10^8 m/s.] ***(Oct. 2014)*** **(3)**

(5) The threshold wavelength of silver is 3800 Å. Calculate the maxmium kinetic energy in eV of photoelectrons emitted, when ultraviolet light of wavelength 2600 Å falls on it. *[Planck's constant, $h = 6.63 \times 10^{-34}$ J.s., Velocity of light in air, $c = 3 \times 10^8$ m/s]* ***(Feb. 2015)*** **(2)**

(6) The photoelectric current in a photoelectric cell can be reduced to zero by a stopping potential of 1.8 volt. Monochromatic light of wavelength 2200 Å is incident on the cathode. Find the maximum kinetic energy of the photoelectrons in joules. *[Charge on electron = 1.6×10^{-19} C]* ***(Oct. 2015)***

(7) The photoelectric work function for a metal surface is 2.3 eV. If the light of wavelength 6800 Å is incident on the surface of metal, find threshold frequency and incident frequency. Will there be an emission of photoelectrons or not? *[Velocity of light $c = 3 \times 10^8$ m/s, Planck's constant, $h = 6.63 \times 10^{-34}$ Js]* ***(Feb. 2016)***

(8) Light of wavelength 3000 Å falls on a metal surface having work function 2.3 eV. Calculate the maximum velocity of ejected electrons. *(Planck's constant $h = 6.63 \times 10^{-34}$ J.s., Velocity of light $c = 3 \times 10^8$ m/s, mass of an electron = 9.1×10^{-31} kg)* ***(July 2016)*** **(3)**

(9) The work functions for potassium and caesium are 2.25 eV and 2.14 eV respectively. Is the photoelectric effect possible for either of them if the incident wavelength is 5180 ?
*[**Given :** Planck's constant = 6.63×10^{-34} J.s.;
Velocity of light = 3×10^8 m/s; 1 eV = 1.6×10^{-19}J]* ***(March 2017)*** **(3)**

(10) If the total energy of radiation of frequency 10^{14} Hz is 6.63 J, calculate the number of photons in the radiation. *(Planck's constant = 6.63×10^{-34} J.s.)* ***(July 2017)*** **(2)**

(11) If the work function of a metal is 3 eV, calculate the threshold wavelength of that metal. ***(July 2017)*** **(2)**

(12) The work function for a metal surface is 2.2 eV. If light of wavelength 5000 Å is incident on the surface of the metal, find the threshold frequency and incident frequency. Will there be an emission of photoelectrons or not? *($c = 3 \times 10^8$ m/s, 1 ev = 1.6×10^{-19} J, $h = 6.63 \times 10^{-34}$ J.s.)* ***(March 2018)*** **(3)**

15. STRUCTURE OF ATOMS AND NUCLEI

Theory :

(1) Derive an expression for de Broglie wavelength of an electron moving under a potential difference of V volt. ***(October 2008)*** **(2)**

(2) State de-Broglie hypothesis of matter waves and derive an expression for de-Broglie wavelength. ***(March 2009)*** **(3)**

(3) State the postulates of Bohr's theory of hydrogen atom. Write down necessary equation. ***(October 2009)*** **(3)**

(4) State Bohr's third postulate for hydrogen atom and hence derive Bohr's formua for wave number. ***(March 2010)*** **(3)**

(5) Draw a neat labeled energy level diagram for hydrogen atom. ***(October 2010, March 2012)*** **(2)**

(6) Show that the radius of Bohr orbit is directly proportional to the square of the principle quantum number. ***(March 2011, Oct. 2011)*** **(2)**

(7) Draw a neat labelled energy level diagram of first four series for hydrogen atom. ***(October 2011)*** **(2)**

(8) Write notes on —
(a) Nuclear fission **(b)** Nuclear fusion ***(Oct 2013)*** **(4)**

(9) In a hydrogen atom, an electron carrying charge 'e' revolves in an orbit of radius 'r' with speed 'v'. Obtain an expression for the magnitude of magnetic moment of a revolving electron. ***(Oct. 2014)*** **(2)**

(10) Derive an expression for the total energy of electron in 'n'th Bohr orbit. Hence show that energy of the electron is inversely proportional to the square of principal quantum number. Also define binding energy. ***(Oct. 2014)*** **(4)**

(11) Obtain an expression for the radius of Bohr orbit for H-atom. ***(Feb. 2015)***

(12) State Bohr's third postulate for hydrogen (H_2) atom. Derive Bohr's formula for the wave number. Obtain expressions for longest and shortest wavelength of spectral lines in ultraviolet region for hydrogen atom. ***(Oct. 2015)*** **(7)**

(13) With the help of a neat labelled diagram, describe the Geiger-Marsden experiment. What is mass defect? ***(Feb. 2016)*** **(4)**

(14) State law of radioactive decay. Hence derive the relation $N = N_o e^{-\lambda t}$. Represent it graphically. ***(July 2016, March 2013, 2019)*** **(3)**

(15) Draw a neat, labelled energy level diagram for H atom showing the transitions.
Explain the series of spectral lines for H atom, whose fixed inner orbit numbers are 3 and 4 respectively. ***(March 2017)*** **(4)**

(16) Draw a neat and labelled energy level diagram and explain Balmer series and Brackett series of spectral lines for hydrogen atom. ***(March 2018)*** **(4)**

(17) Obtain an expression for energy of an electron in Bohr orbit. Hence obtain the expression for its binding energy. *(July 2018)* (4)

(18) Using an expression for energy of electron, obtain the Bohr's formula for hydrogen spectral lines. *(March 2019)* (3)

Problems :

(1) Find the energy of the electron in second Bohr orbit of hydrogen atom [Energy of an electron in the first Bohr orbit = –13.6 eV] *(March 2008)* (2)

(2) Second member of Balmer series of hydrogen atom has wavelength 4800 A.U. Calculate Rydberg's constant. Hence calculate energy in ev when electron is orbiting in third Bohr orbit. *[Planck's constant = 6.63×10^{-34} J.s. Speed of light in vacuum = 3×10^8 m/s , 1eV = 1.6×10^{-14} J]* *(Oct. 2008)* (4)

(3) The velocity of electron in the first Bohr orbit of radius 0.5 A.U. is 2.24×10^6 m/s. Calculate the period of revolution of electron in the same orbit. *(March 2009)* (2)

(4) Calculate the de-Broglie wavelength of proton; if it is moving with a speed of 2×10^5 m/s. *(Oct. 2009)* (2)

(5) The wavelength of H_α line of Balmer series of Hydrogen Spectrum is 6563 Å. Find the (a) wavelength of H_r line of Balmer series. (b) shortest wavelength of Brackett series. *(March 2011)* (4)

(6) The shortest wavelength for lyman series is 912 A.U. Find shortest wavelength for paschen and Brackett series in Hydrogen atom. *(March 2012)* (4)

(7) Find the value of energy of electron in eV in the third Bohr orbit of hydrogen atom. (*Rydberg's constant (R) = 1.097×10^7 m^{-1}, Planck's constant (h) = 6.63×10^{-34} J - s, Velocity of light in air (c) = 3×10^8 m/s.)* *(March 2013)* (2)

(8) The velocity of electron in the 1st Bohr-orbit having radius 0.53 Å is 2200 km/s. Calculate the frequency of revolution of electron in the same orbit. *(Oct 2013)* (2)

(9) Calculate the radius of second Bohr orbit in hydrogen atom from the given data.
Mass of electron = 9.1×10^{-31} kg
Charge on the electron = 1.6×10^{-19} C
Planck's constant = 6.63×10^{-34} J–s.
Permittivity of free space = 8.85×10^{-12} C^2/Nm^2 *(Feb. 2014)* (3)

(10) Calculate the de Broglie wavelength of an electron moving with $\left(\frac{1}{3}\right)^{rd}$ of the speed of light in vacuum (Negelct relativistic effect) *(Planck's constant : h = 6.63×10^{-34} Js, Mass of electron : m = 9.11×10^{-28} g)* *(Oct. 2014)* (2)

(11) An electron is orbiting in 5th Bohr orbit. Calculate ionisation energy for this atom, if the ground state energy is –13.6 eV. *(Feb. 2015)* (2)

(12) The decay constant of radioactive substance is 4.33×10^{-4} per year. Calculate its half life period. *(Feb. 2016)* (2)

(13) What is de Broglie wavelength of an electron accelerated through 25000 volt? *(July 2016)* (2)

(14) Find the frequency of revolution of an electron in Bohr's 2nd orbit; if the radius and speed of electron in that orbit is 2.14×10^{-10} m and 1.09×106 m/s respectively. [π = 3.142] *(March 2017)* (2)

(15) An electron in an atom revolves around the nucleus in an orbit of radius 0.53. If the frequency of revolution of an electron is 9×10^9 MHz. Calculate the orbital angular momentum.
*[**Given :** Charge on an electron = 1.6×10^{-19} C;
Gyromagnetic ratio = 8.8 x 1010 C/kg; π = 3.142]* *(March 2017)* (3)

(16) Thorium $_{90}Th^{232}$ is distintegrated into lead $_{82}Pb^{200}$. Find the number of a and b particles emitted in disintegration. *(July 2017)* (2)

(17) Find the ratio of longest wavelength in Paschen series to shortes wavelength in Balmer series. *(July 2017)* (2)

(18) The electron in the hydrogen atom is moving with a speed of 2.3×10^6 m/s in an orbit of radius 0.53 Å. Calculate the period of revolution of electron ($\pi = 3.142$) *(March 2018)* (2)

(19) Calculate the de-Broglie wavelength of an electron moving with one fifth of the speed of light. Neglect relativistic effects. ($h = 6.63 \times 10^{-34}$ J.s., $c = 3 \times 108$ m/s, mass of electron = 9×10^{-31} kg) *(March 2018)* (2)

(20) The energy of an excited hydrogen atom is –0.85 eV. Find the angular momentum of the electron. ($h = 6.63 \times 10^{-34}$ J.s., $\pi = 3.142$, $E_1 = -13.6$ eV) *(July 2018)* (2)

16. SEMICONDUCTORS DEVICES

Theory :

(1) Draw the logical symbol of NAND gate. *(March 2008)* (3)

(2) Draw a neat labelled circuit diagram, of a transistor used as common emitter amplifier. *(March 2008)* (2)

(3) What is a rectifier? With a neat circuit diagram, explain working of p-n junction diode as a full wave rectifier. *(October 2008)* (4)

(4) Draw a neat labelled circuit diagram for NPN transistor as an amplifier in common emitter mode and explain its working. *(March 2009, 2011)* (3)

(5) State the principle and uses of solar cell. *(March 2009)* (2)

(6) With neat circuit diagram, explain p-n junction diodes as full wave rectifier. Draw necessary graphs. *(Oct. 2009)* (4)

(7) Describe construction and working of light emitting diode (L.E.D.) State its any two uses. *(March 2010)* (4)

(8) What is p-n junction diode? With a neat circuit diagram explain the use of p-n junction diode as a full wave rectifier. *(October 2010)* (4)

(9) Draw neat labelled circuit diagram of full wave rectifier using semiconductor diode. *(March 2011)* (2)

(10) Draw a neat circuit diagram for transistor as common emitter amplifier and explain its working. *(Oct. 2011)* (4)

(11) What is rectifier? Explain with neat circuit diagram the action of semiconductor diode as a full wave rectifier *(March 2012)* (4)

(12) With the help of neat labelled circuit diagram explain the working of half wave rectifier using semiconductor diode. Draw the input and output waveforms. *(March 2013)* (3)

(13) Explain the working of transistor as a switch. *(Oct 2013)* (3)

(14) Explain the working of P-N juction diode in forward and reverse biased mode. *(Feb. 2014)* (3)

(15) Explain the formation of energy band diagram in case of conductor and semiconductor. *(Oct. 2014)* (3)

(16) What are α and β parameters for a transistor? Obtain a relation between them. *(Feb. 2015)*

(17) Distinguish between intrinsic and extrinsic semiconductor. (Give any two points). *(July 2016)* (2)

(18) Draw the schematic symbols for AND, OR, NOT and NAND gate. *(July 2016)* (2)

(19) Explain with a neat diagram , how a p-n junction diode is used as a half wave rectifier. *(March 2017)* (3)

(20) Draw a neat circuit diagram to study the characteristics of common emitter n-p-n transitor. With the help of a graph, explain the output characteristics of this transistor. *(July 2017)* (3)

(21) What is Zener diode? How is it used as a voltage regulator? *(March 2018)* (3)

(22) Distinguish between p-type and n-type semiconductors. *(March 2019)* (2)

(23) Name the logic gate which generates high output when at least one input is high. *(March 2019)* (1)