Board Question Paper: March 2013
Physics

Time: 3 Hours **Total Marks: 70**

Note:

i. All questions are compulsory

ii. Neat diagrams must be drawn wherever necessary.

iii. Figure to the right indicate full marks.

iv. Use of logarithmic table is allowed.

v. All symbols have their usual meaning unless otherwise stated.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. The moment of inertia of a thin uniform rod of mass M and length L, about an axis passing through a point, midway between the centre and one end, perpendicular to its length is _____.

(A) $\frac{48}{7}ML^2$ (B) $\frac{7}{48}ML^2$ (C) $\frac{1}{48}ML^2$ (D) $\frac{1}{16}ML^2$

ii. 'n' droplets of equal size of radius r coalesce to form a bigger drop of radius R. The energy liberated is equal to _____. (T = Surface tension of water)

(A) $4\pi R^2T[n^{\frac{1}{3}}-1]$ (B) $4\pi r^2T[n^{\frac{1}{3}}-1]$

(C) $4\pi R^2T[n^{\frac{2}{3}}-1]$ (D) $4\pi r^2T[n^{\frac{2}{3}}-1]$

iii. The buckling of a beam is found to be more if _____.

(A) the breadth of the beam is large.

(B) the beam material has large value of Young's modulus.

(C) the length of the beam is small.

(D) the depth of the beam is small.

iv. When a transverse wave on a string is reflected from the free end, the phase change produced is _____.

(A) zero rad (B) $\frac{\pi}{2}$ rad (C) $\frac{3\pi}{4}$ rad (D) π rad

v. The number of degrees of freedom for a rigid diatomic molecule is _____.

(A) 3 (B) 5 (C) 6 (D) 7

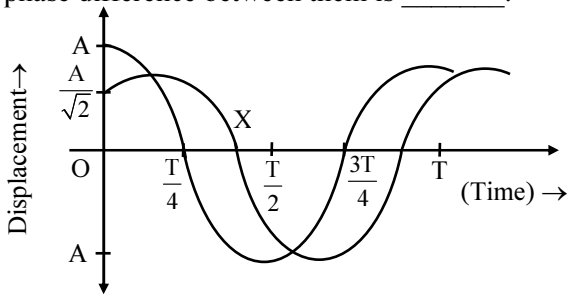
vi. Two particles perform linear simple harmonic motion along the same path of length 2A and period T as shown in the graph below. The phase difference between them is _____.

(A) zero rad

(B) $\frac{\pi}{4}$ rad

(C) $\frac{\pi}{2}$ rad

(D) $\frac{3\pi}{4}$ rad



vii. The light from the Sun is found to have a maximum intensity near the wavelength of 470 nm. Assuming the surface of the Sun as a black body, the temperature of the Sun is _____.
(Wien's constant $b = 2.898 \times 10^{-3}$ mK)
(A) 5800 K (B) 6050 K (C) 6166 K (D) 6500 K

Q.2. Attempt any SIX: **[12]**

i. State Kepler's law of orbit and law of equal areas.

ii. A car of mass 1500 kg rounds a curve of radius 250m at 90 km/hour. Calculate the centripetal force acting on it.

iii. Draw a neat labelled diagram for Ferry's perfectly black body.

iv. A mass M attached to a spring oscillates with a period of 2 seconds. If the mass is increased by 2 kg, the period increases by 1 second. Find the initial mass, assuming that Hooke's law is obeyed.

v. Differentiate between free and forced vibrations.

vi. 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)

vii. Derive the relation between surface tension and surface energy per unit area.

viii. A wheel of moment of inertia 1 kgm^2 is rotating 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.

Q.3. Attempt any THREE: **[9]**

i. 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.

ii. The Earth is rotating with angular velocity ω about its own axis. R is the radius of the Earth. If $R\omega^2 = 0.03386 m/s^2$, calculate the weight of a body of mass 100 gram at latitude 25°. ($g = 9.8\ m/s^2$)

iii. 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.

iv. A steel wire of diameter 1×10^{-3} m is stretched by a force of 20 N. Calculate the strain energy per unit volume. (Y steel = $2 \times 10^{11}\ N/m^2$)

Q.4. Define an ideal simple pendulum. Show that, under certain conditions, simple pendulum performs linear simple harmonic motion.

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) **[7]**

OR

Q.4. 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.

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) **[7]**

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. In the diffraction pattern due to a single slit of width 'd' with incident light of wavelength 'λ', at an angle of diffraction 'θ', the condition for first minimum is _____.

(A) $\lambda \sin\theta = d$ (B) $d \cos\theta = \lambda$

(C) $d \sin\theta = \lambda$ (D) $\lambda \cos\theta = d$

ii. Kirchhoff's junction law is equivalent to _____.

(A) conservation of energy

(B) conservation of charge

(C) conservation of electric potential

(D) conservation of electric flux

iii. let 'p' and 'E' denote the linear momentum and energy of emitted photon respectively. If the wavelength of incident radiation is increased _____.

(A) both p and E increase

(B) p increases and E decreases

(C) p decreases and E increases

(D) both p and E decrease

iv. The nuclei having same number of protons but different number of neutrons are called _____.

(A) isobars (B) α - particles

(C) isotopes (D) γ - particles

v. In case of transistor oscillator, to obtain sustained oscillations, the product of voltage gain without feedback and feedback factor should be _____.

(A) zero (B) less than 1

(C) one (D) infinity

vi. The process of regaining of information from carrier wave at the receiver is called _____.

(A) modulation (B) transmission

(C) propagation (D) demodulation

vii. Reactance of a coil is 157 Ω. On connecting the coil across a source of frequency 100 Hz, the current lags behind e.m.f. by 45°. The inductance of the coil is _____.

(A) 0.25 H (B) 0.5 H

(C) 4 H (D) 314 H

Q.6. Attempt any SIX: **[12]**

i. Draw a neat labelled diagram of a parallel plate capacitor completely filled with dielectric.

ii. 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.

iii. Obtain the expression for current sensitivity of moving coil galvanometer.

iv. 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).

v. Define magnetization. State its formula and S.I. unit.

vi. Electrostatic energy of 3.5×10^{-4} J is stored in a capacitor at 700 V. What is the charge on the capacitor?

vii. What is space wave propagation? State its three components.

viii. 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.)

Q.7. Attempt any THREE: **[9]**

i. With the help of neat labelled circuit diagram explain the working of half wave rectifier using semiconductor diode. Draw the input and output waveforms.

ii. A cell balances against a length of 200 cm on a potentiometer wire, when it is shunted by a resistance of 8 Ω. The balancing length reduces by 40 cm, when it is shunted by a resistance of 4 Ω. Calculate the balancing length when the cell is in open circuit. Also calculate the internal resistance of the cell.

iii. State the law of radioactive decay. Hence derive the expression $N = N_o e^{-\lambda t}$ where symbols have their usual meanings.

iv. 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)

Q.8. State Faraday's laws of electromagnetic induction and Lenz's law.
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.

A circular coil of 250 turns and diameter 18 cm carries a current of 12 A. What is the magnitude of magnetic moment moment associated with the coil? **[7]**

OR

Q.8. 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.

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? **[7]**

BOARD QUESTION PAPER: MARCH 2014
PHYSICS

Time: 3 Hours **Total Marks: 70**

Note:
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v. All symbols have their usual meaning unless otherwise stated.

SECTION – I

Q.1. Attempt any SIX : **[12]**

i. Explain the rise of liquid in the capillary on the basis of pressure difference.

ii. Show graphical representation of energy distribution spectrum of perfectly black body.

iii. The escape velocity of a body from the surface of the earth is 11.2 km/s. If a satellite were to orbit close to the surface, what would be its critical velocity?

iv. A pipe which is open at both ends is 47 cm long and has an inner diameter 5 cm. If the speed of sound in air is 348 m/s, calculate the fundamental frequency of air column in that pipe.

v. Show that R.M.S. velocity of gas molecules is directly proportional to square root of its absolute temperature.

vi. 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.

vii. 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° with vertical, calculate the centripetal force acting on the stone. ($g = 9.8\ m/s^2$).

viii. 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.

Q.2. Attempt any THREE: **[9]**

i. Derive an expression for acceleration due to gravity at depth 'd' below the earth's surface.

ii. A copper metal cube has each side of length 1 m. The bottom edge of the cube is fixed and tangential force 4.2×10^8 N is applied to a top surface. Calculate the lateral displacement of the top surface if modulus of rigidity of copper is $14 \times 10^{10}\ N/m^2$.

iii. 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.

iv. 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.

Q.3. State and prove the theorem of 'parallel axes'.

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.) **[7]**

OR

Q.3. 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.

When the length of a simple pendulum is decreased by 20 cm, the period changes by 10%. Find the original length of the pendulum. **[7]**

Q.4. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. The bulging of earth at the equator and flattening at the poles is due to _____.
(A) centripetal force (B) centrifugal force
(C) gravitational force (D) electrostatic force

ii. Young's modulus of material of wire is 'Y' and strain energy per unit volume is 'E', then the strain is
(A) $\sqrt{\frac{Y}{2E}}$ (B) $\sqrt{\frac{E}{Y}}$ (C) $\sqrt{\frac{2E}{Y}}$ (D) $\sqrt{2EY}$

iii. The wavelength range of thermal radiation is
(A) from 4000 Å to 7000 Å (B) from 7700 Å to 4×10^6 Å
(C) from 10^6 Å to 10^8 Å (D) from 4×10^{-12} Å to 4×10^8 Å

iv. A pipe open at both ends resonates to a frequency 'n_1' and a pipe closed at one end resonates to a frequency 'n_2'. If they are joined to form a pipe closed at one end, then the fundamental frequency will be _____.
(A) $\frac{n_1 n_2}{2n_2 + n_1}$ (B) $\frac{2n_2 n_1}{2n_2 + n_1}$
(C) $\frac{2n_2 n_1}{n_1 + n_2}$ (D) $\frac{n_2 + 2n_1}{n_1 n_2}$

v. The phase difference between displacement and acceleration of a particle performing S.H.M. is _____.
(A) $\frac{\pi}{2}$ rad (B) π rad (C) 2π rad (D) $\frac{3\pi}{2}$ rad

vi. Let n_1 and n_2 be the two slightly different frequencies of two sound waves. The time interval between waxing and immediate next waning is _____.
(A) $\frac{1}{n_1 - n_2}$ (B) $\frac{2}{n_1 - n_2}$ (C) $\frac{n_1 - n_2}{2}$ (D) $\frac{1}{2(n_1 - n_2)}$

vii. A metal ball cools from 64 °C to 50 °C in 10 minutes and to 42 °C in next 10 minutes. The ratio of rates of fall of temperature during the two intervals is _____.
(A) $\frac{4}{7}$ (B) $\frac{7}{4}$
(C) 2 (D) 2.5

SECTION – II

Q.5. Attempt any SIX : **[12]**

i. Show that the orbital magnetic dipole moment of a revolving electron is $\frac{evr}{2}$.

ii. Describe the construction of photoelectric cell.

iii. For a glass plate as a polariser with refractive index l.633, calculate the angle of incidence at which light is polarised.

iv. The susceptibility of magnesium at 300 K is 2.4×10^{-5}. At what temperature will the susceptibility increase to 3.6×10^{-5}?

v. Draw a neat labelled diagram for Davisson and Germer experiment, for diffraction of electron wave.

vi. Explain the terms : (a) Transmitter and (b) receiver in communication system.

vii. 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.

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

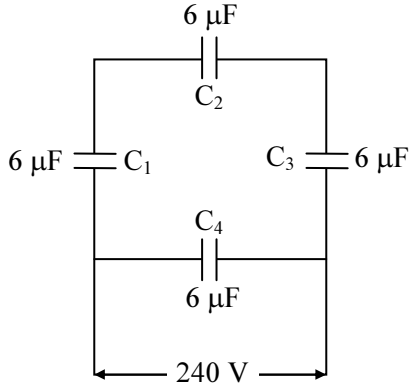
Q.6. Attempt any THREE : **[9]**

i. State Ampere's circuital law. Obtain an expression for magnetic induction along the axis of toroid.

ii. 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

iii. Explain the working of P-N junction diode in forward and reverse biased mode.

iv. A network of four capacitors of 6 μF each is connected to a 240 V supply. Determine the charge on each capacitor.



Q.7. Describe biprism experiment to find the wavelength of monochromatic light. Draw the necessary ray diagram for magnified and diminished images of virtual sources.

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) **[7]**

OR

Q.7. 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.

Two diametrically opposite points of a metal ring are connected to two terminals of the left gap of metre bridge. The resistance of 11 Ω is connected in right gap. If null point is obtained at a distance of 45 cm from the left end, find the resistance of metal ring. **[7]**

Q.8. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. Intensity of electric field at a point close to and outside a charged conducting cylinder is proportional to _____.
(r is the distance of a point from the axis of cylinder)

(A) $\frac{1}{r}$ (B) $\frac{1}{r^2}$

(C) $\frac{1}{r^3}$ (D) r^3

ii. When a hole is produced in P-type semiconductor, there is _____.
(A) extra electron in valence band
(B) extra electron in conduction band
(C) missing electron in valence band
(D) missing electron in conduction band

iii. The outermost layer of the earth's atmosphere is _____.
(A) stratosphere (B) mesosphere
(C) troposphere (D) ionosphere

iv. Accuracy of potentiometer can be easily increased by _____.
(A) increasing resistance of wire (B) decreasing resistance of wire
(C) increasing the length of wire (D) decreasing the length of wire

v. When electron in hydrogen atom jumps from second orbit to first orbit, the wavelength of radiation emitted is λ. When electron jumps from third orbit to first orbit, the wavelength of emitted radiation would be _____.

(A) $\frac{27}{32}\lambda$ (B) $\frac{32}{27}\lambda$

(C) $\frac{2}{3}\lambda$ (D) $\frac{3}{2}\lambda$

vi. An ideal voltmeter has _____.
(A) low resistance (B) high resistance
(C) infinite resistance (D) zero resistance

vii. The resolving power of telescope of aperture 100 cm for light of wavelength 5.5×10^{-7} m is _____.
(A) $0.149 \times 10^{+7}$ (B) $1.49 \times 10^{+7}$
(C) $14.9 \times 10^{+7}$ (D) $149 \times 10^{+7}$

BOARD QUESTION PAPER : MARCH 2015
PHYSICS

Time: 3 Hours **Total Marks: 70**

Note:

i. All questions are compulsory.

ii. Neat diagrams must be drawn wherever necessary.

iii. Figures to the right indicate full marks.

iv. Use of only logarithmic table is allowed.

v. All symbols have their usual meaning unless otherwise stated.

SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. The period of a conical pendulum in terms of its length (l), semivertical angle (θ) and acceleration due to gravity (g) is:

(A) $\frac{1}{2\pi}\sqrt{\frac{l\cos\theta}{g}}$ (B) $\frac{1}{2\pi}\sqrt{\frac{l\sin\theta}{g}}$

(C) $4\pi\sqrt{\frac{l\cos\theta}{4g}}$ (D) $4\pi\sqrt{\frac{l\tan\theta}{g}}$

ii. The kinetic energy of a rotating body depends upon

(A) distribution of mass only.

(B) angular speed only.

(C) distribution of mass and angular speed.

(D) angular acceleration only.

iii. If the metal bob of a simple pendulum is replaced by a wooden bob of the same size, then its time period will

(A) increase. (B) remain same.

(C) decrease. (D) first increase and then decrease.

iv. The graph between applied force and change in the length of wire within elastic limit is a

(A) straight line with positive slope. (B) straight line with negative slope.

(C) curve with positive slope. (D) curve with negative slope.

v. When longitudinal wave is incident at the boundary of denser medium, then

(A) compression reflects as a compression.

(B) compression reflects as a rarefaction

(C) rarefaction reflects as a compression.

(D) longitudinal wave reflects as transverse wave.

vi. The dimensions of universal gravitational constant are

(A) $[L^1M^0T^0]$ (B) $[L^2M^1T^0]$

(C) $[L^{-1}M^1T^{-2}]$ (D) $[L^3M^{-1}T^{-2}]$

vii. Two copper spheres of radii 6 cm and 12 cm respectively are suspended in an evacuated enclosure. Each of them are at a temperature 15 °C above the surroundings. The ratio of their rate of loss of heat is

(A) 2 : 1 (B) 1 : 4

(C) 1 : 8 (D) 8 : 1

Q.2. Attempt any SIX : **[12]**

i. 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.

ii. Explain why an astronaut in an orbiting satellite has a feeling of weightlessness.

iii. State theorem of parallel axes and theorem of perpendicular axes about moment of inertia.

iv. State:
   a. Wien's displacement law and
   b. first law of thermodynamics.

v. 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.

vi. The surface tension of water at 0 °C is 75.5 dyne/cm. Calculate surface tension of water at 25 °C. (α for water = 2.7×10^{-3}/ °C)

vii. 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.

viii. Calculate the period of revolution of Jupiter around the Sun. The ratio of the radius of Jupiter's orbit to that of the Earth's orbit is 5.
(Period of revolution of the Earth is 1 year)

Q.3. Attempt any THREE **[9]**

i. Derive an expression for excess pressure inside a drop of liquid.

ii. Explain what is Doppler effect in sound and state its any 'four' applications.

iii. Calculate the average molecular kinetic energy:
   a. per kilomole,
   b. per kilogram, of oxygen at 27 °C.
(R = 8320 J/k mole K, Avogadro's number = 6.03×10^{26} molecules/K mole)

iv. A uniform steel rod of 5 mm^2 cross section is heated from 0 °C to 25 °C. Calculate the force which must be exerted to prevent it from expanding. Also calculate strain.
(α for steel = 12×10^{-6}/ °C and γ for steel = 20×10^{10} N/m^2)

Q.4. A. 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.

B. A stretched wire emits a fundamental note of frequency 256 Hz. Keeping the stretching force constant and reducing the length of wire by 10 cm, the frequency becomes 320 Hz. Calculate the original length of wire.

OR

Q.4. A. Obtain an expression for potential energy of a particle performing simple harmonic motion. Hence evaluate the potential energy
   i. at mean position and
   ii. at extreme position.

B. 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 intertia 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. **[7]**

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. Electric field intensity in free space at a distance 'r' outside the charged conducting sphere of radius 'R' in terms of surface charge density 'σ' is

(A) $\frac{\sigma}{\varepsilon_0}\left[\frac{R}{r}\right]^2$ (B) $\frac{\varepsilon_0}{\sigma}\left[\frac{R}{r}\right]^2$

(C) $\frac{R}{r}\left[\frac{\sigma}{\varepsilon_0}\right]^2$ (D) $\frac{R}{\sigma}\left[\frac{r}{\varepsilon_0}\right]^2$

ii. Instrument which can measure terminal potential difference as well as electro motive force (e.m.f.) is

(A) Wheatstone's meter bridge (B) Voltmeter
(C) Potentiometer (D) Galvanometer

iii. If the frequency of incident light falling on a photosensitive material is doubled, then the kinetic energy of the emitted photoelectron will be

(A) same as its initial value. (B) two times its initial value.
(C) more than two times its initial value. (D) less than two times its initial value.

iv. Linear momentum of an electron in Bohr orbit of H-atom (principal quantum number n) is proportional to

(A) $\frac{1}{n^2}$ (B) $\frac{1}{n}$
(C) n (D) n^2

v. In a semiconductor, acceptor impurity is

(A) antimony (B) indium
(C) phosphorous (D) arsenic

vi. The power radiated by linear antenna of length 'l' is proportional to (λ = wavelength)

(A) $\frac{\lambda}{l}$ (B) $\left(\frac{\lambda}{l}\right)^2$

(C) $\frac{l}{\lambda}$ (D) $\left(\frac{l}{\lambda}\right)^2$

vii. The numerical aperture of objective of a microscope is 0.12. The limit of resolution, when light of wavelength 6000 Å is used to view an object is

(A) 0.25×10^{-7} m (B) 2.5×10^{-7} m
(C) 25×10^{-7} m (D) 250×10^{-7} m

Q.6. Attempt any SIX : **[12]**

i. What is a polaroid? State its 'two' uses.

ii. Draw a neat and labelled diagram of suspended coil type moving coil galvanometer.

iii. Define:
   a. Magnetization and
   b. magnetic intensity.

iv. Draw a block diagram of generalized communication system.

v. A solenoid 3.142 m long and 5.0 cm in diameter has two layers of windings of 500 turns each and carries a current of 5 A. Calculate the magnetic induction at its centre along the axis.

vi. A circular coil of 300 turns and average area 5×10^{-3} m^2 carries a current of 15 A. Calculate the magnitude of magnetic moment associated with the coil.

vii. The magnetic flux through a loop varies accroding 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 second?

viii. An electron is orbiting in 5^{th} Bohr orbit. Calculate ionisation energy for this atom, if the ground state energy is –13.6 eV.

Q.7. Attempt any THREE **[9]**

i. Obtain an expression for the radius of Bohr orbit for H-atom.

ii. What are α and β parameters for a transistor? Obtain a relation between them.

iii. 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 electric induction over the closed surface.

iv. The threshold wavelength of silver is 3800 Å. Calculate the maximum 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)

Q.8. A. 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).

B. Resistance of a potentiometer wire is 0.1 Ω/cm. A cell of e.m.f. 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. **[7]**

OR

A. Describe biprism experiment to calculate the wavelength of a monochromatic light. Draw the necessary ray diagram.

B. If the critical angle of a medium is $\sin^{-1}\left(\frac{3}{5}\right)$, find the polarising angle. **[7]**

BOARD QUESTION PAPER : MARCH 2016
PHYSICS

Time: 3 Hours
Total Marks: 70

Note:

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SECTION – I

Q.1. Attempt any SIX : **[12]**

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

ii. Derive an expression for critical velocity of a satellite revolving around the earth in a circular orbit.

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

iv. Define 'emissive power' and 'coefficient of emission of a body'.

v. 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 turnable 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].

vi. 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.

vii. A particle performing linear S.H.M. has a period of 6.28 seconds and a path length of 20 cm. What is the velocity when its displacement is 6 cm from mean position?

viii. 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.

Q.2. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. A particle rotates in U.C.M. with tangential velocity 'v' along a horizontal circle of diameter 'D'. Total angular displacement of the particle in time 't' is _____.

(A) vt

(B) $\left(\frac{v}{D}\right) - t$

(C) $\frac{vt}{2D}$

(D) $\frac{2vt}{D}$

ii. Two springs of force constants K_1 and K_2 ($K_1 > K_2$) are stretched by same force. If W_1 and W_2 be the work done stretching the springs then _____.

(A) $W_1 = W_2$

(B) $W_1 < W_2$

(C) $W_1 > W_2$

(D) $W_1 = W_2 = 0$

iii. A and B are two steel wires and the radius of A is twice that of B. If they are stretched by the same load, then the stress on B is _____.

(A) four times that of A

(B) two times that of A

(C) three times that of A

(D) same as that of A

iv. If sound waves are reflected from surface of denser medium, there is phase change of _____.

(A) 0 rad

(B) $\frac{\pi}{4}$ rad

(C) $\frac{\pi}{2}$ rad

(D) π rad

v. A sonometer wire vibrates with frequency n_1 in air under suitable load of specific gravity 'σ'. When the load is immersed in water, the frequency of vibration of wire n_2 will be _____.

(A) $n_1\sqrt{\frac{\sigma+1}{\sigma}}$

(B) $n_1\sqrt{\frac{\sigma-1}{\sigma}}$

(C) $n_1\sqrt{\frac{\sigma}{\sigma+1}}$

(D) $n_1\sqrt{\frac{\sigma}{\sigma - 1}}$

vi. For polyatomic molecules having 'f' vibrational modes, the ratio of two specific heats, $\frac{C_P}{C_V}$ is _____.

(A) $\frac{1+f}{2+f}$

(B) $\frac{2+f}{3+f}$

(C) $\frac{4+f}{3+f}$

(D) $\frac{5+f}{4+f}$

vii. A body of moment of inertia 5 kgm^2 rotating with an angular velocity 6 rad/s has the same kinetic energy as a mass of 20 kg moving with a velocity of _____.

(A) 5 m/s

(B) 4 m/s

(C) 3 m/s

(D) 2 m/s

Q.3. **A.** Define linear S.H.M. Show that S.H.M. is a projection of U.C.M. on any diameter.

B. A metal sphere cools at the rate of 4 °C/min. when its temperature is 50 °C. Find its rate of cooling at 45 °C if the temperature of surroundings is 25 °C **[7]**

OR

A. Explain analytically how the stationary waves are formed. Hence show that the distance between node and adjacent antinode is $\frac{\lambda}{4}$.

B. 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. **[7]**

Q.4. **Attempt any THREE:** **[9]**

i. What is the decrease in weight of a body of mass 600 kg when it is taken in a mine of depth 5000 m?

[Radius of earth = 6400 km, $g = 9.8\ m/s^2$]

ii. State and prove theorem of parallel axes about moment of inertia.

iii. Derive Laplace's law for spherical membrane of bubble due to surface tension.

iv. A steel wire having cross sectional area 1.5 mm^2 when stretched by a load produces a lateral strain 1.5×10^{-5}. Calculate the mass attached to the wire.

($Y_{steel} = 2 \times 10^{11}\ N/m^2$, Poisson's ratio $\sigma = 0.291$, $g = 9.8\ m/s^2$)

SECTION – II

Q.5. Attempt any SIX: **[12]**

i. What is 'diffraction of light'? Explain its two types.

ii. Draw a neat labelled diagram for the construction of 'cyclotron'.

iii. Distinguish between 'paramagnetic' and 'ferromagnetic' substances.

iv. Write a short note on surface wave propagation of electromagnetic waves.

v. The combined resistance of a galvanometer of resistance 500 Ω and its shunt is 21 Ω. Calculate the value of shunt.

vi. The susceptibility of magnesium at 200 K is 1.8×10^{-5}. At what temperature will the susceptibility decrease by 6×10^{-6} ?

vii. 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.

viii. The decay constant of radioactive substance is 4.33×10^{-4} per year. Calculate its half life period.

Q.6. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. If the polarising angle for a given medium is 60°, then the refractive index of the medium is _____

(A) $\frac{1}{\sqrt{3}}$

(B)
$\sqrt{\frac{3}{2}}$

(C)
1

(D)
$\sqrt{3}$

ii. The resolving power of a telescope depends upon the _____

(A)
length of the telescope

(B)
focal length of an objective

(C)
diameter of an objective

(D)
focal length of an eyepiece

iii. Electric intensity due to a charged sphere at a point outside the sphere decreases with _____

(A)
increase in charge on sphere.

(B)
increase in dielectric constant.

(C)
decrease in the distance from the centre of sphere.

(D)
Decrease in square of distance from the centre of sphere.

iv. In potentiometer experiment, if l_1 is the balancing length for e.m.f. of cell of internal resistance r and l_2 is the balancing length for its terminal potential difference when shunted with resistance R then:

(A)

$l_1 = l_2 \left[\frac{R+r}{R}\right]$

(B)

$l_1 = l_2 \left[\frac{R}{R+r}\right]$

(C)

$l_1 = l_2 \left[\frac{R}{R-r}\right]$

(D)

$l_1 = l_2 \left[\frac{R-r}{R}\right]$

v. The energy of photon of wavelength λ is _____.
[h = Planck's constant, c = speed of light in vacuum]

(A)
$hc\lambda$

(B)
$\frac{h\lambda}{c}$

(C)
$\frac{\lambda}{hc}$

(D)
$\frac{hc}{\lambda}$

vi. Which logic gate corresponds to the truth table given below?

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(A)
AND

(B)
NOR

(C)
OR

(D)
NAND

vii. The process of superimposing a low frequency signal on a high frequency wave is _____.

(A)
detection

(B)
mixing

(C)
modulation

(D)
attenuation

Q.7. **A.** 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.

B. 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.

[$\in_0$ = 8.85 × 10^{-12} S . I. units] **[7]**

OR

A. With the help of a neat labelled diagram, describe the Geiger-Marsden experiment. What is mass defect?

B. 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] **[7]**

Q.8. Attempt any THREE: **[9]**

i. 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)]

ii. In biprism experiment, 10^{th} dark band is observed at 2.09 mm from the central bright point on the screen with red light of wavelength 6400 Å. By how much will fringe width change if blue light of wavelength 4800 Å is used with the same setting?

iii. Describe Kelvin's method to determine the resistance of galvanometer by using metre bridge.

iv. Explain the elementary idea of an oscillator with the help of block diagram.

BOARD QUESTION PAPER : MARCH 2017
PHYSICS

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SECTION – I

Q.1. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. If the pressure of an ideal gas decreases by 10% isothermally, then its volume will _____.
(A) decrease by 9% (B) increase by 7%
(C) increase by 10% (D) increase by 11.4%

ii. Stretching of a rubber band results in _____.
(A) no change in potential energy. (B) zero value of potential energy.
(C) increase in potential energy. (D) decrease in potential energy.

iii. When the angular acceleration of a rotating body is zero, which physical quantity will be equal to zero?
(A) Angular momentum (B) Moment of inertia
(C) Torque (D) Radius of gyration

iv. In a damped harmonic oscillator, periodic oscillations have _____ amplitude.
(A) gradually increasing (B) suddenly increasing
(C) suddenly decreasing (D) gradually decreasing

v. A sine wave of wavelength ' λ' is travelling in a medium. What is the minimum distance between two particles of the medium which always have the same speed?
(A) λ (B) $\frac{\lambda}{2}$
(C) $\frac{\lambda}{3}$ (D) $\frac{\lambda}{4}$

vi. Velocity of transverse wave along a stretched string is proportional to _____. (T = tension in the string)
(A) $\sqrt{T}$ (B) T
(C) $\frac{1}{\sqrt{T}}$ (D) $\frac{1}{T}$

vii. Find the wavelength at which a black body radiates maximum energy, if its remperature is 427°C.
(Wein's constant b = 2.898×10^{-3} mK)
(A) 0.0414×10^{-6} m (B) 4.14×10^{-6} m
(C) 41.4×10^{-6} m (D) 414×10^{-6} m

Q.2. Attempt any SIX : **[12]**

i. Explain the concept of centripetal force.

ii. Prove that root mean square velocity of gas molecule is directly proportional to the square root of its absolute temperature.

iii. Obtain the differential equation of linear simple harmonic motion.

iv. Draw a neat, labelled diagram for a liquid surface in contact with a solid, when the angle of contact is acute.

v. A hole is drilled half way to the centre of the Earth. A body is dropped into the hole. How much will it weigh at the bottom of the hole if the weight of the body on the Earth's surface is 350 N?

vi. A solid sphere of mass 1 kg rolls on a table with linear speed 2 m/s, find its total kinetic energy.

vii. 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.

viii. A body cools at the rate of 0.5°C / minute when it is 25° C above the surroundings. Calculate the rate of cooling when it is 15°C above the same surroundings.

Q.3. Attempt any THREE **[9]**

i. Show that period of a satellite revolving around the Earth depends upon mass of the Earth.

ii. Obtain an expression for torque acting on a rotating body with constant angular acceleration. Hence state the dimensions and SI unit of torque.

iii. 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).

iv. A vehicle is moving on a circular track whose surface is inclined towards the horizon 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. [$\pi = 3.142$]

Q.4. A. 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.

B. Two sound notes have wavelengths $\frac{83}{170}$ m and $\frac{83}{172}$ m in the air. These notes when sounded together produce 8 beats per second. Calculate the velocity of sound in the air and frequencies of the two notes. **[7]**

OR

A. Explain the formation of stationary waves by analytical method. Show the formation of stationary wave diagramatically.

B. A mass of 1 kg is hung from a steel wire if radius 0.5 mm and length 4 m. Calculate the extension produced. What should be the area of cross-section of the wire so that elastic limit is not exceeded? Change in radius is negligible.

(Given : $g = 9.8\ m/s^2$; Elastic limit of steel is $2.4 \times 10^8\ N/m^2$;

Y for steel (Y_{steel}) = $20 \times 10^{10}\ N/m^2$; $\pi = 3.142$) **[7]**

SECTION – II

Q.5. Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

i. If A.C. voltage is applied to a pure capacitor, then voltage across the capacitor _____.

(A) leads the current by phase angle $\left(\frac{\pi}{2}\right)$ rad.

(B) leads the current by phase angle (π) rad.

(C) lags behind the current by phase angle $\left(\frac{\pi}{2}\right)$ rad.

(D) lags behind the current by phase angle (π) rad.

ii. In Doppler effect of light, the term "red shift" is used for _____.

(A) frequency increase (B) frequency decrease
(C) wavelength decrease (D) frequency and wavelength increase

iii. If a watch-glass containing a small quantity of water is placed on two dissimilar magnetic poles, then water _____.

(A) shows a depression in the middle. (B) shows an elevation in the middle.
(C) surface remains horizontal. (D) evaporates immediately.

iv. Any device that converts one form of energy into another is termed as _____.

(A) amplifier (B) transducer
(C) receiver (D) demodulator

v. When a p-n-p transistor is operated in saturation region, then its _____.

(A) base-emitter junction is forward biased and base-collector junction is reverse biased.
(B) both base-emitter and base-collector junctions are reverse biased.
(C) both base-emitter and base-collector junctions are forward biased.
(D) base-emitter junction is reverse biased and base-collector junction is forward biased.

vi. In a photon-electron collision _____.

(A) only total energy is conserved.
(B) only total momentum is conserved.
(C) both total energy and total momentum are conserved.
(D) both total momentum and total energy are not conserved.

vii. If the charge on the condenser of 10 μF is doubled, then the energy stored in it becomes _____.

(A) zero (B) twice that of initial energy
(C) half the initial energy (D) four times the initial energy

Q.6. Attempt any SIX: **[12]**

i. Distinguish between the phenomenon of interference and diffraction of light.

ii. Explain how moving coil galvanometer is converted into a voltmeter. Derive the necessary formula.

iii. State the advantages of potentiometer over voltmeter.

iv. Draw a neat, labelled block diagram of a receiver for the detection of amplitude modulated wave.

v. 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.

vi. 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?

vii. 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.

viii. Find the frequency of revolution of an electron in Bohr's 2^{nd} orbit; if the radius and speed of electron in that orbit is 2.14×10^{-10} m and 1.09×10^6 m/s respectively. [$\pi = 3.142$]

Q.7. Attempt any THREE: **[9]**

i. Explain with a neat diagram, how a p-n junction diode is used as a half wave rectifier.

ii. Explain self induction and mutual induction.

iii. 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 : $\in_0 = 8.85 \times 10^{-12}$ C^2/Nm^2]

iv. An electron in an atom revolves around the nucleus in an orbit of radius 0.53 Å. 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 = 8.8×10^{10} C/kg; $\pi = 3.142$]

Q.8. A. Describe the biprism experiment to find the wavelength of the monochromatic light. Draw the necessary ray diagram.

B. 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. **[7]**

OR

A. 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.

B. 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 Å?
[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] **[7]**