B. Sc. I Year Physics (Semester-I)

(Mechanics, Properties of matter and Sound)

Course Code – phy101

Paper – I

Questions:

1. What is a compound pendulum? Obtain an expression for its periodic time. Show that the centre of suspension and centre of oscillation can be interchanged.
2. Give the theory of Kater's pendulum and obtain an expression for the acceleration due to gravity in terms of two nearly equal time period of oscillation about the two parallel knife edges.
3. State and explain Newton's law of gravitation. Define gravitational constant, state its unit and dimensions.
4. Explain the meaning of gravitational field and gravitational potential. Establish a relationship between them. What are their units?
5. Deduce expression for the gravitational potential at a point due to point mass.
6. Obtain expressions for gravitational potential and gravitational field (attraction) due to a uniform Spherical shell at a point (i) out side (ii) on the surface, and (iii) inside the shell .Draw graphs to show the variations.
7. Deduce expressions for gravitational potential due to a uniform solid sphere at a point: (i) outside, (ii) on the surface, and (iii) inside the sphere. Also find the gravitational field at these points, and hence prove that the gravitational potential at the centre of sphere is $\frac{3}{2}$ times that on its surface.
8. A thin uniform bar of length 120 cm is made to oscillate about an axis through its end. Find the time period of oscillation and other points about which it can oscillate with the same period. (Ans: 1.796 s, 80 cm)
9. A body of mass 200 gm oscillates about a horizontal axis at a distance of 20 cm from its centre of gravity. If the length of the equivalent simple pendulum is 35 cm, find its moment of inertia about the axis of suspension. (Ans: 14×10^6 gm.cm^2)
10. The length between the knife edges of a Kater's pendulum is 89.28 cm, while the periods of oscillation about the two knife edges are 1.920 sec and 1.933 sec respectively. The centre of gravity of the pendulum is 54.4 cm from one knife edge. What is the value of g? (Ans: 979 cm/sec^2)
11. Assuming that a sphere of mass 40 kilograms is attracted by a second sphere of mass 80 kilograms, when their centres are 30 cm apart, wit a force equal to the weight of ¼ mg.; calculate the Constant of Gravitation. (Ans: 6.898×10^{-8} C.G.S. units)
12. The radius of the earth is 6.37×10^{-8} cm, its mean density, 5.5 gm/cc and the gravitational constant, 6.66×10^{-8} c.g.s. units. Calculate the earths surface potential. (Ans: 6.27×10^{10} ergs/gm)

13. If G = 6.66 x 10^{-11} n.m^2/kg^2, what is the force between two spheres weighing 2 kg, each, placed 30 cm apart. (Ans: 2.961 x 10^{-9} newton)
14. If the earth were a solid sphere of iron, of radius 6.37 million metre, and of density 7.86 gm./cm^3, what would be the value at its surface, taking the gravitational constant to be 6.658 x 10^{-8} c.g.s. units? (Ans: 1396 cm/sec^2)
15. Calculate the radius of the earth if g = 9.8 m/s^2, G = 6.7x10^{-11} Nm^2/kg^2 and M = 6x10^{24} kg.
16. Explain the meaning of stress and strain. State Hooke's law of elasticity hence define Young's modulus, bulk modulus and rigidity modulus of an isotropic, homogeneous substance.
17. Deduce an expression for the couple per unit twist of a uniform solid cylinder.
18. What do you mean by the torsion in a cylinder? Obtain an expression for the torque required to twist a uniform solid cylinder.
19. What is a beam? Explain the meaning of the following terms: (i)Neutral layer, (ii) plane of bending (iii) Bending moment.
20. What do you understand by terms neutral surface, plane of bending, neutral axis and bending moment? Drive an expression for the moment of couple required to bend uniform metallic bar into an arc of a circle of small curvature.
21. What is bending moment? Deduce an expression for it if the beam is of (i) rectangular (ii) circular in cross-section.
22. What is cantilever? Deduce an expression for the depression when the cantilever is loaded at one end, if the weight of the cantilever is negligible.
23. What is bending moment? Obtain an expression for the depression at a point distant x from the fixed end of a cantilever, if the weight of the cantilever is effective.
24. What do you mean by bending moment? Drive an expression for the depression of a uniform beam supported at its ends loaded in the middle.
25. Show that the depression at the free end of a light cantilever, when the end is loaded is proportional to the cube of its length.
26. A wire 300 cm long and 0.625 sq. cm in cross section is found to stretch 0.3 cm under a tension of 1200 kilogram. What is the Young's modulus of the material of the wire? (Ans: 2.3 x 10^{12} dynes/sq cm.)
27. What couple must be applied to a wire, 1 meter long, 1mm diameter, in order to twist one end of it through 90^o, the other end remaining fixed? The rigidity modulus is 2.8 x 10^{11} dynes/cm^{-2} . (Ans: 4.3 x 10^6 dynes.cm)
28. A uniform rigid rod 120 cm long is clamped horizontally at one end. A mass of 100 gm is attached to the free end. Calculate the depression of point 90 cm distant from the clamp end. The diameter of the rod is 2cm. Young's modulus of the material of the rod is 1.013 x 10^{11} dynes per sq cm and g = 980 cm/sec^2 (Ans: 2.834mm)
29. A bar, one meter long, 5mm square in section, supported horizontally at its ends and locked at the middle, it depressed 1.96 mm by a load of 100 gm. Calculate the Young's modulus for the material of the bar.(Take g = 980 cm/sec^2) (Ans: 19.99 x 10^{11} dynes cm^{-2})
30. A brass bar 1cm square in cross section is supported on two knife edges 100 cm apart. A load of 1 kg at the centre of the bar depresses that point by 2.51mm. What is Young's modulus for brass? (Ans: 9.77 x 10^{11} dynes/cm^2)

31. A cylindrical rod of diameter 14 mm rests on two knife edges 0.8 m apart and a load of 1 kg is suspended from its midpoint. Neglecting the weight of the rod, calculate the depression of the midpoint if Y for its material be 2.04 x 10^{11} N/m^2. (Ans: 0.272 mm)
32. What is Viscosity? What are the various forms of energy possessed by a liquid? Show that the various types of energy possessed by a liquid are mutually convertible, one into another.
33. State and prove Bernoulli's theorem of Viscosity.
34. Explain practical applications of Bernoulli's theorem such as (i) Law of hydrostatic pressure (ii) Filter pump.
35. Define 'coefficient of viscosity' for a liquid. Derive Poiseuille's formula for coefficient of viscosity of liquid.
36. Describe the Ostwald's Viscometer and explain the method of comparison of coefficient of viscosity of two liquids.
37. What do you mean by Surface Tension of liquid? Explain with examples.
38. Discuss difference of pressure across a curved surface due to Surface Tension of liquid.
39. Describe Jaeger's method to determine the Surface Tension of liquid.
40. Water is conveyed through a horizontal tube 8 cm in diameter and 4 km in length, at the rate of 20 litres per sec. Assuming only viscous resistance, calculate the pressure required to maintain the flow. (Ans: 1.274x10^7 dyne/cm^2)
41. Calculate the mass of water flowing in 10 minutes through a tube 0.1 cm in diameter, 40 cm long, if there is a constant pressure head of 20 cm of water. The coefficient of viscosity of water is 0.0089 c.g.s. units. (81.19 gm)
42. A vessel of cross section 20 cm^2 has at the bottom a horizontal capillary tube of length 10 cm and internal radius 0.5 mm. It is initially filled with water to height of 20 cm above the capillary tube. Find the time taken by the vessel to empty one-half of its contents, given that viscosity of water is 0.01 c.g.s.unit. (Ans: 9 min, 36 sec.)
43. A capillary tube, 1 mm in diameter and 20 cm in length, is fitted horizontally to a vessel kept full of alcohol of density 8 gm/cc. The depth of centre of capillary tube below the surface of alcoholis 30 cm. If the viscosity of alcohol is 0.012 c.g.s.unit. Find the amount that will flow out in 5 minutes. (Ans: 57.74 gm)
44. Calculate the rate of flow of water through a horizontal capillary of radius 0.07 mm and length of 0.7 m. The pressure difference of 9800 N/m^2 of water column is maintained between two ends of tube. Consider viscosity of liquid as 10^{-3} Ns/m^2.
45. The pressure of air in a soap bubble of 0.7 cm diameter is 8 mm of water above the atmospheric pressure. Calculate the surface tension of the soap solution. (Ans: 68.66 dyne/cm)
46. Calculate the excess pressure in a drop of water with a radius 10^{-3} mm, if the surface tension is 10-9- N/m^2 . (Ans: 14x 10^3 N/m^2)
47. What are Ultrasonics waves? Explain Piezo-electric effect. Give construction and working of Piezo-electric generator for production of Ultrasonics.
48. State Magnetostriction effect. Describe construction and working of Magnetostriction generator for production of ultrasonics.

49. Mention various applications of Ultrasonics. Give in detail applications in respect of depth of sea, chemical and medical applications of Ultrasonics.
50. What do you mean by Reverberation of sound? Give the requirements of good Accoustical demands of an auditorium.
51. Derive Sabine's formula for time of reverberation.
52. State conditions of good acoustical designs of room/auditorium.
53. A quartz crystal is vibrating at resonance. The length of crystal is 0.05 m. Y for quartz is 7.9×10^{10} N/m^2 and density for quartz is 2650 kg/m^3. Calculate fundamental frequency for it.
54. A hall is having volume 3000 m^3 with a capacity of 300 peoples. If the absorption due to ceiling is 12, due to chairs is 250 and due to aqudience is 80, then calculate the reverberation time.

Multiple Choice Questions (MCQ's):

1. The dimensions of gravitational constant are:

   (a) $[M^{-1}L^2T^{-2}]$ (b) $[M^{-1}L^1T^{-2}]$ (c) $[M^1L^2T^{-2}]$ (d) $[M^{-1}L^3T^{-2}]$

2. If V is the gravitational potential on the surface of a thin spherical shell, then the potential at the centre of the shell is :

   (a) Zero (b) V (c) V/2 (d) infinite

3. The ratio of the gravitational potential at the surface of a solid sphere to that at the centre is

   (a) $\frac{1}{2}:1$ (b) 1:2 (c) 2:3 (d) 3:2

4. The ratio of the gravitational potentials at the centre and on the surface of a solid sphere is:

   (a) $\frac{1}{2}$:1 (b) 1:1 (c) $\frac{3}{2}:1$ (d) 2:1

5. The value of gravitational potentials energy is:

   (a) Always positive (b) always negative
   (c) positive or negative (d) always zero

6. The nature of gravitational field is:

   (a) Conservative field (b) non conservative field
   (c) pseudo field (d) solenoidal field.

7. The gravitational potential on the earth's surface is:

   (a) - 6.2 X 10^7 joule/kg (b) 11.2 X 10^7 joule/kg
   (c) 6.2 X 10^7 joule/kg (d) none of these.

8. The value of gravitational field at the centre of the sphere is:

   (a) GM/r (b) –GM/r^2 (c) zero (d) Mr/G

9. The value of the gravitational field at a point inside solid sphere is:
   (a) Zero (b) constant
   (c) Directly proportional to the distance of point from its centre.
   (d) Inversely proportional to the distance of point from its centre.
10. Gravitational potential on the surface of a spherical shell of mass M and radius 'a' is:
   (a) $\frac{-MG}{a^2}$ (b) $\frac{-MG}{a}$ (c) $\frac{-MG}{2a}$ (d) $\frac{-MG}{2a^2}$
11. If the distance between two point masses is doubled, the gravitational attraction between them
   (a) Is doubled (b) becomes four times
   (c) is reduced to half (d) is reduced to a quarter
12. The Kater's Pendulum is used to determine the value of
   (a) Gravitational Constant (b) acceleration due to gravity
   (c) mass of the earth (d) none of above.
13. The twisting couple on a cylinder or wire per unit twist is:
   (a) $\frac{\pi \eta r^2}{2\ell}$ (b) $\frac{\pi \eta r^2}{4\ell}$ (c) $\frac{\pi \eta r^4}{2\ell}$ (d) $\frac{\pi \eta r^4}{4\ell}$
14. For given load and same cross-section, the ratio of depression for a rod of square and circular cross is
   (a) 9 : π (b) 4 : π (c) 3 : π (d) 16 : π
15. A beam of length L, width b and thickness d is supported at its ends and loaded in the middle, and then the depression at the middle point is:
   (a) $\frac{W L^2}{4Y b d^3}$ (b) $\frac{W L^3}{4Y b d^3}$ (c) $\frac{W L^4}{4Y b d^3}$ (d) $\frac{W L^2}{8Y b d^2}$
16. The depression produced at the free end of a loaded cantilever of length L, beadth b and depth d if its weight is ineffective is:
   (a) $\frac{4WL^2}{Y b d^3}$ (b) $\frac{4W L^3}{Y b d^3}$ (c) $\frac{W L^2}{4Y b d^3}$ (d) $\frac{W L^2}{4Y b d^3}$
17. Cross- sectional area of a wire is 0.5 cm^2. Young's modulus is $2x10^{11}$ N/ m^2. What will be the magnitude of force required to double the length of wire?
   (a) 10^7N (b) 10^8N (c)10^{10}N (d) zero
18. The depression at the free end of a cantilever of uniform cross-sectional area and length l is δ. The depression at a distance of l/4 from the fixed end of the cantilever will be:
   (a) 0.086 δ (b) δ (c) 0.88 δ (d) 1.5 δ

19. If the length of a wore is doubled by applying a stress of magnitude 10 x10^8N/m^2, then the Young's modulus of the material of wire is:
    (a) 20x10^8N/m^2 (b) 10x108N/m^2 (c) 5x10^8N/m^2 (d) 15x108N/m^2
20. A steel wire of 1 mm radius is bent in the form of a circular arc of radius 50cm.Given Young's modulus for steel is 2x10^2 dynes/cm^2. The bending moment will be
    (a) 2πx10^6 dyne-cm (b) π x10^6 dyne-cm
    (c) $\frac{\pi}{2}$x10^6 dyne-cm (d) 4πx10^6 dyne-cm
21. A steel wire of 1 mm radius is bent in the form of a circular arc of radius 50cm.Given Young's modulus for steel is 2x10^2 dynes/cm^2. The maximum stress will be
    (a) 2x10^9 dyne-cm^2 (b) 4 x10^9 dyne-cm^2
    (c) 8x10^9 dyne-cm^2 (d) 1x10^9 dyne-cm^2
22. When an external deforming force is removed the body regains its original shape and size. This property is called as:
    (a) Plasticity (b) elasticity
    (c) either plasticity or elasticity (d) ductability
23. Bending moment of beam of circular cross section of radius 'r' is:
    (a) $\frac{Y\pi r^2}{4R}$ (b) $\frac{Y\pi r^3}{4R}$ (c) $\frac{Y\pi r^4}{4R}$ (d) $\frac{Y\pi r^4}{2R}$
24. The Young's modulus of a wire is given by formula:
    (a) $\frac{Mgr^2}{4r^2\ell}$ (b) $\frac{MgL}{\pi r^2\ell}$ (c) $\frac{gL}{\pi r^2\ell}$ (d) $\frac{MgL}{r^2\ell}$
25. If by applying a force the length of a body is changed, the corresponding stress is known as:
    (a) Tensile stress (b) bulk stress
    (c) shearing stress (d) compressive stress
26. For an ideal fluid, the value of coefficient of viscosity is:
    (a) Zero (b) infinity (c) negative (d) positive
27. A cylindrical container has an orifice near the bottom. The velocity of the flowing liquid out of the orifice does not depend on:
    (a) Area of orifice (b) height of the liquid surface over the orifice
    (c) Density of the liquid (d) acceleration due to gravity
28. Venturimeter work on:
    (a) Principle of Archimedes (b) height of the liquid surface over the orifice
    (c) Bernoulli's theorem (d) Equation of continuity
29. Bernoulli's theorem is based on the principle of conservation of
    (a) Momentum (b) mass (c) energy (d) angular momentum

30. A cylinder is filled with non-viscous liquid of density p to h_0 and a hole is made at a height h_1 from the bottom of the cylinder. The velocity of the liquid coming out of the hole is:
    (a) $\sqrt{2h_0}g$ (b) $\sqrt{2g(h_0 - h_1)}$ (c) $\sqrt{gph_1}$ (d) $\sqrt{gph_0}$
31. A water tank on the top of a tall building feeds water in the taps on different floors. The water will rush out at highest speed from a tap on floor
    (a) Nearest to the rank (b) farthest from the tank
    (c) Near middle of the building (d) speed will be the same on all the floors.
32. Flight of an aeroplane works on:
    (a) Archimedes principle (b) Pascal's law
    (c) Bernoulli's theorem (d) Stoke's law
33. Water is flowing in a capillary tube, if the velocity flow of water is m/s, the velocity head of water will be
    (a) 6 m (b) 60 m (c) 18 m (d) 1.8 m
34. The unit of velocity head is:
    (a) metre (b) kg/s (c) m/s^2 (d) m/s
35. The property of viscosity is found:
    (a) Only in liquids (b) only in solids
    (c) in solids and liquids (b) in liquids and gases
36. The dimension of velocity gradient is:
    (a) $[LT^{-1}]$ (b) $[T^{-1}]$ (c) $[L^2 T^{-1}]$ (d) $[LT^{-2}]$
37. The coefficient of viscosity of a liquid is equal to the external force that acts between two successive layers of unit cross sectional area of liquid to:
    (a) Balance internal frictional force between layers
    (b) Annul viscous force between layers
    (c) Maintain unit velocity gradient between layers
    (d) Maintain the motion of liquid between the layers
38. The property of a liquid by virtue to which it opposes the relative motion between its different layers is:
    (a) Elasticity (b) surface tension (c) viscosity (d) none of these
39. An object entering the earth's atmosphere at a high velocity catches fire due to:
    (a) Viscosity of air (b) the heat content of the atmosphere
    (c) pressure of the certain larger gases (d) the higher force of gravity
40. Rate of flow of a liquid in a capillary:
    (a) Directly proportional to the pressure difference across its ends
    (b) Directly proportional to the cross sectional area of the capillary
    (c) Directly proportional to the length of the capillary
    (d) Directly proportional to the coefficient of viscosity of flowing liquid

41. Raindrop falls near the surface of the earth with:
    (a) Terminal acceleration (b) terminal velocity
    (c) Terminal retardation (d) varying velocity
42. Cohesive forces are directly proportional to
    (a) r^{-15} (b) r^{-12} (c) r^{-8} (d) r^{-2}
43. The maximum distance up to which cohesive forces can act:
    (a) 1cm (b) 10^{-2}cm (c) 10^{-7} cm (d) 10^{-4}cm
44. The unit of surface tension is:
    (a) Joule /meter^2 (b) newton/meter (c) newton-meter (d) newton/meter^2
45. The excess pressure inside a spherical liquid drop of radius R and surface tension T is
    (a) T/R (b) 2T/r (c) 4T/r (d) 2πT/R
46. The excess pressure inside a bubble (surface tension T and radius r) is
    (a) T/r (b) 2T/r (c)4T/r (d) – T/r
47. When 10^3 small droplets combine energy:
    (a) Decreases (b) increases (c) remains unchanged (d) zero
48. If more air is blown in a soap bubble, then pressure inside it will
    (a) Increase (b) decrease (c) will not change (d) become zero
49. Two soap bubbles have radii in the ratio 2:1, what is the ratio of excess pressure inside them?
    (a) 1:2 (b) 2:1 (c) 1:4 (d) 4:1
50. The force per unit length acting normally along a line tangent to its free surface of liquid is called as:
    (a) Elasticity (b) Pressure (c) Surface tension (d) Viscosity
51. If surface tension of water is 72 dyne/cm then excess pressure inside the water drop of radius 0.2 cm is
    (a) 600 dyne (b) 650 dyne/cm^2 (c) 800 dyne/cm^2 (d) 720 dyne/cm^2
52. Filter pump is used to generate:
    (a) Pressure (b) force (c) electricity (d) vacuum.
53. If a liquid is flowing from a height 100 m having density 900 kg/m^3, then the potential energy per unit volume will be:
    (a) $88.2\text{x}10^4$ J (b) $8.82\text{x}10^4$ J (c) $0.882\text{x}10^4$ J (d) $8.28\text{x}10^4$ J
54. Excess pressure inside a water drop is given by:
    (a) $\frac{T}{4R}$ (b) $\frac{4T}{R}$ (c) $\frac{T}{R}$ (d) $\frac{2T}{R}$
55. The frequency of Ultrasonic waves is more than
    (a) 10 Hz (b) 20 Hz (c) 10 KHz (d) 20 KHz
56. The dimensions of quartz crystal for observing Piezo-electric effect has to be:
    (a) very small (b) very large (c) of any dimension (d) zero dimension

57. The Sabine's formula is given as:

(a) $E = e^{-\alpha t}$ (b) $E = E_m e^{\alpha t}$ (c) $E = E_m e^{-\alpha t}$ (d) $E = E_m e^{\alpha t^2}$

58. Reverberation in hall is due to:

(a) Reflection of sound (b) Refraction of sound

(c) Refraction of light (d) none of above.

59. Piezo-electric effect is observed in:

(a) Diamond (b) Nickel (c) Gold (d) Quartz crystal

60. In magnetostriction method waves produced in a bar are

(a) Stationary (b) electromagnetic (c) longitudinal (d) transverse

Answer key:

1.	(d)	2.	(b)	3.	(c)	4.	(c)	5.	(b)
6.	(a)	7.	(a)	8.	(c)	9.	(c)	10.	(b)
11.	(d)	12.	(b)	13.	(c)	14.	(c)	15.	(c)
16.	(b)	17.	(a)	18.	(a)	19.	(b)	20.	(b)
21.	(b)	22.	(b)	23.	(c)	24.	(b)	25.	(a)
26.	(a)	27.	(c)	28.	(c)	29.	(c)	30.	(b)
31.	(b)	32.	(c)	33.	(d)	34.	(a)	35.	(d)
36.	(b)	37.	(c)	38.	(c)	39.	(a)	40.	(a)
41.	(b)	42.	(c)	43.	(c)	44.	(a)	45.	(b)
46.	(c)	47.	(a)	48.	(b)	49.	(a)	50.	(c)
51.	(d)	52.	(a)	53.	(a)	54.	(d)	55.	(d)
56.	(a)	57.	(c)	58.	(a)	59.	(d)	60.	(c)