विद्या सर्वार्थि साधिका

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PERIODIC TEST -3

Class: XI

Subject: Physics (042) MM : 40

Date : 06-01-2025 Time: 1Hr 30 min

General Instructions:

1. There are 20 questions in all. All questions are compulsory.
2. This question paper has five sections: Section A, Section B, Section C, Section D and Section E.
3. Section A consists of 12 MCQs of 1 mark each, Section B consists of 2 very short answer type questions of 2 marks each, Section C consists of 2 short answer type questions of 3 marks each, Section D consists of 2 case study-based questions of 4 marks each and Section E consists 3 long answer type questions of 5 marks each.
4. There is no overall choice. However, an internal choice has been provided in section D and E. You have to attempt only one of the choices in such questions.
5. Use of calculators is not allowed.
6. Take g near the surface of earth as 10 m/s^2.

SECTION A

1. The acceleration due to gravity inside a hollow spherical mass M of radius R at a distance of d from the surface is _____. (1)

   (A) zero (B) $\frac{GM}{R^2}$ (C) $\frac{GM}{R^2}\left(1-\frac{2d}{R}\right)$ (D) $\frac{GM}{R^2}\left(1-\frac{d}{R}\right)$

2. An artificial earth satellite of mass m is circling round the earth in an orbit of radius *r*. If the mass of the earth is *M*, then the total energy of the satellite is: (1)

   (A) $-\frac{GMm}{r}$ (B) $-\frac{GMm}{2r}$ (C) $-\frac{3GMm}{2r}$ (D) $\frac{GMm}{r}$

3. A planet is revolving around the Sun. According to Kepler's law of planetary motion, which of the following quantity would remain constant? (1)

   (A) Momentum (B) speed (C) Areal velocity (D) Distance from the sun

4. A steel wire of length *l* and radius r has Young's modulus Y. What will be the Young's modulus of another steel wire of length 2*l* and radius r? (1)

   (A) Y (B) 2Y (C) $\frac{Y}{2}$ (D) 3Y

5. A rod elongated by a length *x* when a mass M is suspended from it. The work done is _____. (1)

   (A) Mgx (B) $\frac{1}{2}Mgx$ (C) $2Mgx$ (D) zero

6. The maximum load a wire can withstand without breaking, when its length is reduced to half of its original length, will _____. (1)

   (A) be double. (B) be half. (C) be four times. (D) remain same.

7. The pressure inside the two bubbles is 1.01 and 1.02 atm sphere. The ratio of their respective volumes is _____. (1)

   (A) 16 (B) 8 (C) 4 (D) 2

8. The mass of water rises in capillary tube of radius *R* is *M*. The mass of water that rises in tube of radius 2 *R* is _____.

   (A) *M* (B) *M*/2 (C) 2 *M* (D) 4 *M*

9. A freely falling object through a viscous medium attains a maximum speed after some time. This speed is known as _____. (1)

   (A) terminal velocity (B) critical velocity (C) uniform speed (D) constant speed

10. A certain liquid wets a surface. The angle of contact is _____. (1)
(A) acute (B) obtuse (C) 90° (D) zero

For question numbers 11 and 12, select the correct answer to these questions of Assertion (A) and Reason (R) from the codes (A), (B), (C) and (D) as given below.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is NOT the correct explanation of (A).
(C) (A) is true but (R) is false
(D) (A) is false and (R) is also false.

11. (A): If we double the radius of the orbit of a satellite, its potential energy and kinetic energy would become half. (1)
(R): The orbital velocity is proportional to $\frac{1}{\sqrt{r}}$.

12. (A): On increasing the temperature, the viscosities of liquid and gases increase. (1)
(R): On heating the distance between the molecules increases in liquids and it decreases in gases.

SECTION B

13. A steel wire of length 6 m and radius 2 mm is stretched by 4 kgwt. Find the increase in its length, if the Young's modulus of steel wire is $240 \times 10^9 N/m^2$. (2)

14 Obtain Stokes formula using dimensional analysis. (2)

SECTION C

15. Draw typical stress Vs strain curve. Mark in the graph: (a) proportional limit, (b) yield point, (c) ultimate tensile strength and (d) fracture point. (3)

16. (a) Define gravitational potential energy. (3)
(b) Two masses 'M' kg each are separated by a distance 'd' meter. What will be the gravitational force acting on a third mass 'm' kg kept on the midpoint of the masses? What will be the gravitational potential energy of the third mass?

SECTION D

Question numbers 17 and 18 are case based questions.

17. For small deformations, stress is directly proportional to the strain for many materials. This is known as Hooke's law. The constant of proportionality is called modulus of elasticity. Three elastic moduli viz., Young's modulus, shear modulus and bulk modulus are used to describe the elastic behaviour of objects as they respond to deforming forces that act on them. A class of solids called elastomers does not obey Hooke's law
In the field of elasticity, Poisson's ratio (ν) is a fundamental material property that describes the ratio of the lateral strain to the longitudinal strain when a material is stretched or compressed. Cork has a Poisson's ratio close to 0. (4)

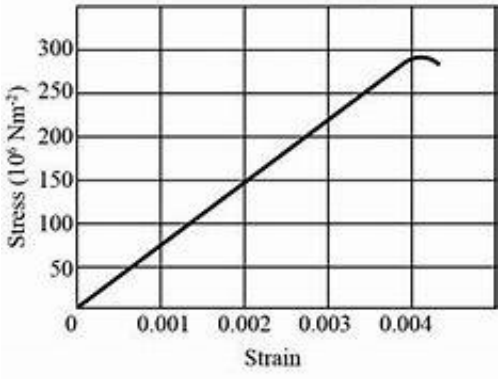


Figure I

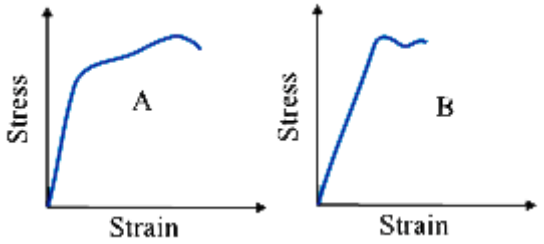


Figure II

(i) What is the Young's modulus of the material used in Figure I? (1)
(A) 75 Pa (B) 75 GPa (C) 275 Pa (D) 275 GPa

(ii) What is the approximate yield strength of the material shown in Figure I? (1)
(A) 150 GPa (B) 150 N (C) 300 GPa (D) 300 N

(iii) (a) Which of the materials has the greater Young's modulus in Figure II? (2)
(b) Which of the two is the stronger material in Figure II?

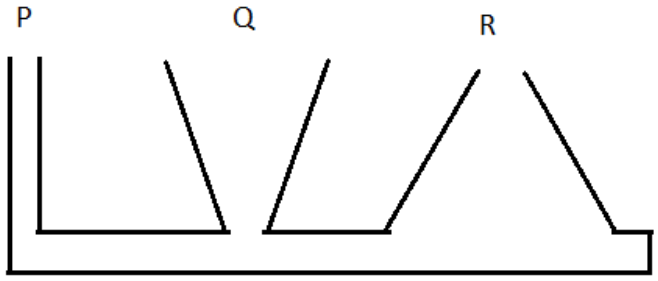
OR

(iii) (a) What is Poisson's ratio?
(b) Why is a cork, a good choice for bottle stoppers?

18. The French scientist Blaise Pascal observed that the pressure in a fluid at rest is the same at all points if they are at the same height. Whenever external pressure is applied on any part of a fluid contained in a vessel, it is transmitted undiminished and equally in all directions. This is another form of the Pascal's law and it has many applications in daily life. A number of devices, such as hydraulic lift and hydraulic brakes, are based on the Pascal's law.
The pressure of the atmosphere at any point is equal to the weight of a column of air of unit cross-sectional area extending from that point to the top of the atmosphere. At sea level, it is 1.013×10^5 Pa (1atm). Italian scientist Evangelista Torricelli (1608–1647) devised for the first time a method for measuring atmospheric pressure. This device is known as 'mercury barometer'.

(i) What will be the pressure 10 m below the surface of water in a lake? The density of water is 1000 kg/m^3.
(A) 10^5 Pa (B) 10^{10} Pa (C) 2×10^5 Pa (D) 2×10^{10} Pa

(ii) Consider three vessels P, Q and R of different shapes. They are connected at the bottom by a horizontal pipe. On filling with water, in which vessel the water level will be higher?



(A) P (B) Q (C) R (D) All will be same

(iii) Hydraulic lift works on the principle of _____.
(A) Bernoulli's principle (B) Torricelli law
(C) Pascal's law (D) Stokes law

(iv) The ratio of gauge pressure and actual pressure at a depth h under water is _____.
(A) equal to one (B) greater than one (C) less than one (D) zero

OR

(iv) A hydraulic automobile lift is designed to lift cars with a maximum mass of 3000 kg. The area of cross-section of the piston carrying the load is 425 cm^2. What maximum force would the smaller piston of area of cross section 85 cm^2 have to bear?
(A) 7.05 N (B) 35 N (C) 6000 N (D) 600 N

SECTION E

19. (a) Prove Bernoulli's theorem (5)
(b) The cylindrical tube of a spray pump has a cross-section of 8.0 cm^2 one end of which has 40 fine holes each of diameter 1.0 mm. If the liquid flow inside the tube is 2.5 cm/s, what is the speed of ejection of the liquid through the holes?

OR

(a) A spherical liquid drop has radius r. The surface tension of the liquid is T. Derive an expression for the excess pressure inside the drop?

(b) Toricelli's barometer used mercury (density 13600 kg m^{-3}). Pascal duplicated it using French wine of density 984 kg m^{-3}. Determine the height of the wine column for normal atmospheric pressure.

20. (a) Derive an expression to show that the acceleration due to gravity decreases with depth. Assume that the earth is spherical and of uniform density. (5)

(b) At what height the acceleration due to gravity becomes half of that at the surface of earth?

OR

(a) Derive the expression for (i) orbital velocity and (ii) the time period of a satellite revolving in a circular orbit around a planet.

(b) A planet revolves around sun at a distance 'x' with time period 'T'. Compare the time period of earth which is at a distance $3x$ from the sun.