1. A force $\vec{F} = 6\hat{i} + 2\hat{j} - 3\hat{k}$ acts on a particle and displaces it through $\vec{S} = 2\hat{i} - 3\hat{j} + x\hat{k}$ The value of x for zero work is

1) 0.5

2) –2

3) +2

4) 6

Ans - 3 (2)

Sol$^{\underline{n}}$:- $W = \vec{F}.\vec{S}$

$$= (6\hat{i} + 2\hat{j} - 3\hat{k})(2\hat{i} - 3\hat{j} + x\hat{k})$$

Zero = $(6\times2)+(2\times-3)+(-3\times x)$

$\therefore$ x = 2

2. Two bodies with K.E. in the ratio 4 : 1 are moving with same linear momenta. The ratio of their masses is

1) 1 : 4

2) 1 : 1

3) 1 : 2

4) 4 : 1

$\therefore$ Ans – 1 (1 : 4)

$$K.E. = \frac{p^2}{2m}$$

$$K.E. \propto \frac{1}{m} \quad \therefore \frac{K.\ E_2}{K.\ E_1} = \frac{m_1}{m_2} = \frac{1}{4}$$

3. When a 1 kg mass hung from a spring 50 cm long, it stretches by 2 cm. The mass is then pulled down until the length of the spring becomes 60 cm. The amount of elastic energy stored in the spring in this condition when g is 10 ms^{-1} can be given as

1) 3J

2) 2J

3) 2.5J

4) 1.5J

∴ Ans – 3 (2.5 J)

Sol^{n} :- F = Kx

$$K = \frac{F}{x} = \frac{10}{2 \times 10^{-2}} = 5 \times 10^{2} Nm^{-1}$$

$$U = \frac{1}{2} kx^{2} = \frac{1}{2} 5 \times 10^{2} [(60 - 50)10^{-2}]$$

= 2.5 J

4. Feeling of weightlessness in a satellite or space ship is due to

1) absence of inertia
2) absence of gravity
3) absence of acceleration due to gravity
4) free fall of space ship

∴ Ans – 2 (absence of gravity)

Sol$^{\underline{n}}$:- In the artificial satellite ‘g’ is zero so weightlessness in a satellite is due to absence of acceleration due to gravity.

5. A wheel rotating at 900 rpm about its axis. It comes to rest in 60 s. The angular retardation in rad s^{-1} is

1) $\frac{\pi}{8}$ 2) $\frac{\pi}{4}$

3) $\frac{\pi}{6}$ 4) $\frac{\pi}{2}$

$\therefore$ Ans – 4 $\left(\frac{\pi}{2}\right)$

$$Using\ \alpha = \frac{w_2 - w_1}{t} = \frac{2\pi(n_2 - n_1)}{t}$$

$$= \frac{2\pi\left(0 - \frac{900}{60}\right)}{60} = -2\pi\left(\frac{900}{60 \times 60}\right)$$

$$= -\frac{\pi}{2} rads^{-2}$$

6. A ring is rolling on a surface without slipping. What is the ratio of its translational to rotational kinetic energies?

1) 5 : 7

2) 2 : 5

3) 2 : 7

4) 1 : 1

$\therefore$ Ans – 4 (1 : 1)

Rotational K. E. $= \frac{1}{2} I\omega^2$ But for a ring $I = mR^2$

Rotational K. E. $= \frac{1}{2} mR^2\omega^2$

$$K_R = \frac{1}{2} m(\omega R)^2 = \frac{1}{2} mv^2$$

So translational K. E. = Rotational K. E.

$\frac{K_T}{K_R} = \frac{1}{1}$ i.e. 1 : 1

7. A ring, a solid sphere and disc have the same mass and radius, which of them have the largest moment of inertia?

1) Ring
2) Solid sphere
3) Disc
4) All have the same moment of inertia

∴ Ans – 1 (Ring)

Sol$^{\underline{n}}$:- $I_{Ring} = MR^2$ $\quad I_{Sphere} = \frac{2}{5}mR^2$

$$I_{Disc} = \frac{1}{2}mR^2$$

$$\therefore I_{Ring} > I_{Disc} > I_{Sphere}$$

8. A fly wheel of mass 50 kg and radius of gyration about its axis of rotation of 0.5 m is acted upon by a constant torque of 12.5 N.m, Its angular velocity at t = 5 sec is:

1) 2.5 rad s^{-1}

2) 5 rad s^{-1}

3) 7.5 rad s^{-1}

4) 10 rad s^{-1}

$\therefore$ Ans – 2 ($5 rads^{-2}$)

Sol$^{\underline{n}}$:- $I = MR^2 = 50\times(0.5)^2$

$\tau = 12.5$ N.m

$$\therefore \alpha = \frac{\tau}{I} = \frac{12.5}{50 \times \left(\frac{1}{2}\right)^2}$$

$$= 1\, rads^{-2}$$

$$\omega = \omega_0 + \alpha t = 0 + 1 \times 5$$

$$= 5 rads^{-2}$$

9. An electric fan has blades of length 30 cm as measured from the axis of rotation. If the fan is rotating at 1200 rpm, the acceleration of point on the tip of the blade is about

1) 4740 ms^{-2}

2) 5055 ms^{-2}

3) 1600 ms^{-2}

4) 2370 ms^{-2}

$\therefore$ Ans –1 (4740 ms^{-2})

Sol^{n} :- r = 30 cm = 0.3 m

$$n = 1200 \text{ rpm} = \frac{1200}{60} = 20 \text{ rps}$$

$$\omega = 2\pi n = 2\pi 20 = 40\ \pi\ \text{rads}^{-1}$$

$$a = \omega^2 r = (40\pi)^2 0.3 = 4740\ \text{ms}^{-2}.$$

10. A homogeneous disc with a radius 0.2 m and mass 5 kg rotates around an axis passing through its centre. The angular velocity of the rotation of the disc as a function of time is given by the formula $\omega = 2 + 6t$. The tangential force applied to the rim of the disc is

1) 1 N 2) 2 N

3) 3 N 4) 4 N

$\therefore$ Ans – 3 (3N)

Sol$^{\underline{n}}$:- Given that $\omega = 2 + 6t$ $\alpha = \frac{d\omega}{dt} = 6$

But $\tau = I\alpha = \left(\frac{mR^2}{2}\right)\alpha = \frac{5 \times (0.2)^2 \times 6}{2}$

$= 0.6J$

Now $\tau = F \cdot R = F \times 0.2$

$\therefore F = \frac{\tau}{0.2} = \frac{0.6}{0.2}$ F = 3 N

11. When a body starts rolling on an inclined plane, the potential energy had by it is converted into

1) Translational K. E.
2) Translational and rotational K. E.
3) Rotational energy
4) None of these

$\therefore$ Ans –2 (Translational and rotational K. E.)

12. Height at which the value of g becomes 1/4th to that on earth is

1) R

2) 4R

3) 2R

4) $\frac{3}{2}R$

$\therefore$ Ans – 1 (R)

Soln :- $g' = \frac{gR^2}{(R+h)^2}$ $\frac{g'}{g} = \frac{R^2}{(R+h)^2}$

$\frac{1}{4} = \frac{R^2}{(R+h)^2}$ $\frac{1}{2} = \frac{R}{R+h}$

$\therefore R + h = 2R$

$\therefore h = 2R - R = R$

13. A satellite in circular orbit of radius R has a period of 4 hr, A satellite with orbital radius of 4R around the same planet will have a period

1) 8 hr

2) 16 hr

3) 32 hr

4) 64 hr

∴ Ans – 3 (32 hr.)

Soln :- $T^2 \propto R^3$ $i.e. \frac{T^2}{R^3} = constant$

$$\frac{4^2}{R^3} = \frac{T^2}{(4R)^3}$$

$T^2 = 16 \times 64$

$T = 32$ hr.

14. Escape velocity from earth is about 11 kms^{-1}. The escape velocity from a planet having twice the radius and the same mean density is

1) 22 kms^{-1}
2) 11 kms^{-1}
3) 0.55 kms^{-1}
4) 15.5 kms^{-1}

∴ Ans – 4 (15.5 kms^{-1})

Sol$^{\underline{n}}$:- $V_e = \sqrt{2gR} = 11\ kms^{-1}$

Escape velocity for planet

$$V_e' = \sqrt{2g2R} = \sqrt{2}\sqrt{2gR}$$

$$= \sqrt{2}V_e = 11 \times \sqrt{2}$$

$$V_e = 15.55 kms^{-1}$$

15. The gravitational potential energy of a body in the gravitational field of earth is minimum

1) On the surface of the earth
2) Below the surface of the earth
3) At infinity
4) between infinity and surface of the earth

∴ Ans –1 (On the surface of earth)

Sol$^{\underline{n}}$:- Gravitational energy decreases continuously from infinity to surface of earth and again increases inside the earth. So it is minimum at the surface of the earth.

16. A force of 10^{+6} Nm^{-2} is required for breaking a material. If the density of the material is 3×10^{3} kgm^{-3}, then the length of wire made of this material that breaks by its own weight is

1) 43 m
2) 34 m
3) 127 m
4) data incomplete

∴ Ans –2 (34 m)

Sol$^{\underline{n}}$:- Weight of the wire mg = F

F = volume × density × g = ALρg

Stress $= \frac{F}{A} = \frac{AL\rho g}{A} = L\rho g$

Breaking stress = 10^6 i.e. Lρg = 10^6

$$L = \frac{10^6}{\rho g} = \frac{10^6}{3 \times 10^3 \times 9.8} = 34 \text{ m}$$

17. How does the Young's modulus vary with the increase of temperature?

1) Decreases
2) Increases
3) Remains constant
4) First increases and then decreases

∴ Ans –1 (decreases)

Sol$^{\underline{n}}$:- The interatomic binding energy decreases with temperature, so more strain is produced at higher temperature. Hence y decreases

18. If both the length and radius of the wire are doubled, how does the modulus of elasticity change?

1) Becomes one fourth
2) Halved
3) Doubled
4) Remains unchanged

∴ Ans – 4 (Remains unchanged)

Sol$^{\underline{n}}$:- Modulus elasticity is a property of material. It does not depend on length or area of cross section.

19. According to the Hooke's law, the force required to change the length of a wire by 'l' is proportional to

1) l^{-2}

2) l^{-1}

3) l

4) l^2

∴ Ans – 3 (l)

Sol$^{\underline{n}}$:- From Hookes law $\frac{F}{A} \propto \frac{l}{L}$

Since A and L are fixed, therefore $F \propto l$.

20. Young's modulus of the material of a wire is 'y' If it is under a stress S, the energy stored per unit volume is given by

1) $\frac{1}{2}\frac{S}{y}$ 2) $\frac{1}{2}\frac{S^2}{y}$

3) $\frac{1}{2}\frac{S}{y^2}$ 4) $\frac{1}{2}\frac{S^2}{y^2}$

$\therefore$ Ans – 2 $\left(\frac{1}{2}\frac{S^2}{y}\right)$

Sol^n :- Energy stored (U) $= \frac{1}{2} stress \times strain$

$$y = \frac{stress}{strain} = \frac{1}{2} stress \times \left(\frac{strain}{y}\right)$$

Strain $= \frac{stress}{y}$

$$\therefore U = \frac{1}{2}\frac{S^2}{y}$$

21. A force of one newton doubles the length of a cord having cross-sectional area $1mm^2$. The young's modulus of the material of cord is

1) Nm^{-2}

2) $0.5\times10^6\ Nm^{-2}$

3) $10^6\ Nm^{-2}$

4) $2\times10^6\ Nm^{-2}$

$\therefore$ Ans – 3 (10^6 Nm^{-2})

Sol$^{\underline{n}}$:-

$$y = \frac{F}{A} \times \frac{l}{L} = \frac{1}{1 \times 10^{-6}} \times \frac{L}{L}$$

$$= 10^6\ Nm^{-2}$$

22. In which case potential energy decrease on

1) compressing the spring
2) stretching the spring
3) moving a body against gravitational pull
4) raising of an air bubble in water

∴ Ans – 4 (raising of an air bubble in water)

Sol$^{\underline{n}}$:- P. E. increases in 1, 2 and 3

The upthrust makes the air bubble rise in the water so there is decrease in energy

23. A 0.5 kg ball is thrown vertically up with 14 ms^{-1}. It attains a height of 8m. The energy dissipated by air drag acting on the ball during ascent is

1) 9.8 J

2) 4.9 J

3) 10 J

4) 19.6 J

∴ Ans – 1 (9.8 J)

Sol$^{\underline{n}}$:-

$$E = \frac{1}{2}mv^2 = \frac{1}{2}(0.5)(14)^2 = 49J$$

E\`= mgh = 0.5 ×9.8×8 = 39.2 J

Energy lost = E – E\`

= 49 – 39.2 = 9.8 J

24. If momentum of a body increases by 50% the kinetic energy will increase by

1) 50%
2) 150%
3) 125%
4) 100%

$\therefore$ Ans – 3 (125%)

Sol$\underline{\underline{n}}$:- $P' = \frac{3}{2}P$ $\quad \therefore V' = \frac{3}{2}V$ $\quad \therefore \frac{V'}{V} = \frac{3}{2}$

$$K.E. \propto V^2 \qquad \frac{K.E'.}{K.E.} = \frac{9}{4}$$

Increase in K.E

$$= \frac{K.E'. - K.E.}{K.E.} \times 100$$

$$= \frac{5}{4} \times 100 = 125\%$$

25. A bullet is fired from a rifle. If rifle recoils freely, then K.E. of bullet is

1) less than that of rifle
2) more than that of rifle
3) same as that of rifle
4) equal or less than that of rifle

∴ Ans – 2 (more than that of rifle)

Sol$^{\underline{n}}$:-

Velocity of bullet is more because it is very light as compared to the rifle, so K.E. of bullet is more

26. An object of mass 40 kg and having velocity 4 ms^{-1} collides with another object of mass 60 kg having velocity 2 ms^{-1}. The loss of energy when the collision is perfectly inelastic

1) 392 J
2) 440 J
3) 110 J
4) 48 J

$\therefore$ Ans – 4 (48 J)

Sol$\underline{\underline{n}}$:- $v = \frac{m_1 u_1^2 + m_2 u_2^2}{m_1 + m_2}$

$$= \frac{(40 \times 4) + (60 \times 2)}{40 + 60} = 2.8 ms^{-1}$$

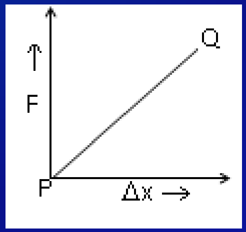
Loss of energy

$$= \frac{1}{2}[m_1 u_1^2 + m_2 u_2^2] - \frac{1}{2}[m_1 + m_2]V^2$$

$$= \frac{1}{2}[40 \times 16 + 60 \times 4 - 100(2.8)^2]$$

= 48 J

27. Graph between stretching force and extension of spring is shown in the figure. Change in the line PQ when same force is applied to a spring of half the length is given by



1) Same graph
2) line of double the length
3) shifting towards x – axis
4) shifting towards y – axis

∴ Ans – 4 (shifting towards y – axis)

Sol$^{\underline{n}}$:- Extension ∝ original length

So for halved spring the extension will be less for the same force, so the PQ line will shift towards y – axis.

28. Which of the following statement is true?

1) g is less at the earth's surface than at a height above it or a depth below it
2) g is the same at all places on the surface of the earth
3) g has its maximum value at the equator
4) g is greater at the places than at the equator.

$\therefore$ Ans – 4 (g is greater at the places than at the equator)

29. Two particles of equal mass go round a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

1) $v = \frac{1}{2R}\sqrt{\frac{1}{Gm}}$ 2) $v = \sqrt{\frac{Gm}{2R}}$

3) $v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$ 4) $v = \frac{1}{2}\sqrt{\frac{4Gm}{R}}$

$$\therefore \text{ Ans} - 3 \left(v = \frac{1}{2}\sqrt{\frac{Gm}{R}} \right)$$

Sol$\underline{\underline{n}}$:- $\frac{mv^2}{R} = \frac{Gm^2}{4R^2}$

Centripetal force = Gravitational force

$$v^2 = \sqrt{\frac{Gm}{4R}} = \frac{1}{2}\sqrt{\frac{Gm}{R}}$$

30. The force of gravitation is

1) repulsive

2) electrostatic

3) conservative

4) non-conservative

∴ Ans – 3 (conservative)

31. If the spinning speed of the earth is increased then weight of the body at the equator

1) increases
2) decreases
3) doubles
4) does not change

∴ Ans – 2 (decreases)

Sol$^{\underline{n}}$:-We know that g\` = g – ($R\omega^2$) at the equator. If spinning speed (angular velocity - ω) increases the value of g\` decreases i.e. weight of the body will decrease

32. If radius of earth is ‘R’ then the height ‘h’ at which the value of g becomes one fourth is

1) $\frac{R}{4}$ 2) $\frac{3R}{4}$

3) R 4) $\frac{R}{8}$

∴ Ans – 3 (R)

Sol$^{\underline{n}}$:-

$$\frac{g}{4} = \frac{Gm}{(R+h)^2} = \frac{gR^2}{(R+h)^2}$$

$$\frac{1}{4} = \frac{R^2}{(R+h)^2}$$

Taking Root

$$\frac{1}{2} = \frac{R}{R+h}$$

or h = R

33. Distance of a geostationary satellite from the surface of earth is

1) 6R
2) 7R
3) 5R
4) 3R

$\therefore$ Ans – 1 (6R)

Sol$\underline{\underline{n}}$:-Radius of orbit of geostationary satellite is = 7R

Its height from the surface of the earth = 7R – R = 6R

34. The angular momentum of a moving body remains constant if

1) net external force is applied
2) net pressure is applied
3) net external torque is applied
4) net external torque is not applied

$\therefore$ Ans – 4 (net external torque is not applied)

35. A hard boiled egg will spin faster than a raw egg because of

1) high moment of inertia
2) low moment of inertia
3) high angular velocity
4) Both high moment of inertia and high angular velocity

$\therefore$ Ans – 2 (low moment of inertia)

36. Rotational analogue of mass in linear motion is

1) weight
2) moment of inertia
3) torque
4) Angular momentum

∴ Ans – 2 (moment of inertia)

37. Which of the following affects the elasticity of a substance?

1) hammering and annealing
2) change in temperature
3) impurity in substance
4) all of these

∴ Ans – 4 (all of these)

Hint: Hammering – increases elasticity

Annealing – decreases elasticity

Increasing temperature – increase elasticity

Decrease in temperature – decrease elasticity

Impurity – increases elasticity,

So all are responsible for change in elasticity

38. The following four wires of length ‘L’ and radius ‘r’ are made of the same material which of these will have the largest extension when the same tension is applied?

1) L = 50 cm, r = 0.25 mm

2) L = 100 cm, r = 0.5 mm

3) L = 200 cm, r = 1 mm

4) L = 300 cm, r = 1.5 mm

∴ Ans – 1 (L = 50 cm, r = 0.25 mm)

Sol$^{\underline{n}}$:- Check $\frac{1}{r^2}$ is maximum

1) 8×10^6

2) 4×10^6

3) 2×10^6

4) 1.33×10^6

39. A rope made of steel has a diameter of 5 cm. The breaking strength of the rope is 2×10^8 N. The breaking strength of a similar rope of double diameter is

1) 2×10^8 N
2) 4×10^8 N
3) 1×10^8 N
4) 8×10^8 N

$\therefore$ Ans – 4 (8×10^8 N)

Sol$^{\underline{n}}$:- Breaking strength $\propto$ Area of cross section

$$S \propto \pi r^2$$

$$S` = \pi(2r)^2$$

$$= 4\pi r^2 = 4\times2\times10^8$$

$$= 8 \times 10^8$$

40. It is easier to draw up a wooden block along an inclined plane then have it up vertically, because

1) the mass becomes smaller

2) g becomes smaller

3) the friction is reduced

4) only a part of weight has to be overcome

∴ Ans – 4 (only a part of weight has to be overcome)

Sol$^{\underline{n}}$:- Only a component of weight acts along the inclined plane i.e. only a part of weight has to be taken care of by the applied force.

41. A fixed volume of iron is drawn into a wire of length '*l*'. The extension produced in this wire by a constant force F is proportional to

1) $\frac{1}{l^2}$ 2) $\frac{1}{l}$

3) l^2 4) l.

$\therefore$ Ans – 3 (l^2)

Hint:- If force is constant and volume is fixed, then extension $\propto$ (length)^2

42. The K. E. of a body becomes four times its initial value. The new momentum will be

1) same as initial value
2) twice as initial value
3) thrice as initial value
4) four times the initial value

$\therefore$ Ans – 2 (twice as initial value)

Hint:-

$K.E_1. = \frac{1}{2}mv_1^2$ $K.E_2. = \frac{1}{2}mv_2^2$

$K.E_2. = 4\,K.E_1.\ \therefore v_2 = 2v_1.$

43. A gymnast is sitting on a rotating stool with her arms outstretched. Suddenly folds her arms near her body which of the following is correct?

1) angular speed decreases
2) moment of inertia decreases
3) angular momentum decreases
4) angular speed remains constant

$\therefore$ Ans – 2 (moment of inertia decreases)

44. What is the velocity of the bob of a simple pendulum at its mean position, if it is able to rise to vertical height of 10cm (take g = $9.8 ms^{-2}$)

1) $0.6\ ms^{-1}$

2) $1.4\ ms^{-1}$

3) $1.9\ ms^{-1}$

4) $2.2\ ms^{-1}$

$\therefore$ Ans – 2 (1.4 ms^{-1})

Hint:- $\frac{1}{2}mv^2 = mgh$

$$v = \sqrt{2gh} = \sqrt{2 \times 9.8 \times 10 \times 10^{-2}}$$

v = 1.4 ms^{-1}

45. If central force is inversely proportional to distance R, then time period will be proportional to

1) R

2) $\frac{1}{R}$

3) $\frac{1}{R^2}$

4) R^2

$\therefore$ Ans – 1 (R)

Hint:-

$$\frac{mv^2}{R} \propto \frac{K}{R} \qquad \therefore v = \sqrt{\frac{K}{m}}$$

$$T = \frac{2\pi R}{v}$$

$$\therefore T \propto R$$

Vikasana - CET 2012