CONSERVATION OF ENERGY AND MOTION IN A VERTICAL CIRCLE

1. A spring of un-stretched length L and force constant k is stretched by a small length x. It is further stretched by another small length y. The work done in the second stretching is:
   (a) $\frac{1}{2}ky^2$ **(b)** $\frac{1}{2}ky\ (2x+y)$ (c) $\frac{1}{2}k\ (x^2+y^2)$ (d) $\frac{1}{2}k(x+y)^2$
2. A spring, which is initially in its un-stretched condition, is first stretched by a length x and then again by a further length x. The work done in the first case is W_1 and in the second case is W_2. Then:
   (a) $W_2 = 2W_1$ **(b)** $W_2 = 3W_1$ (c) $W_2 = 4W_1$ (d) $W_2 = 5W_1$
3. If the potential energy of a gas molecule is $U = \frac{a}{r^6} - \frac{b}{r^{12}}$, *a* and *b* being positive constants, then the potential energy at equilibrium must be:
   (a) zero **(b)** $\frac{a^2}{4b}$ (c) $\frac{b^2}{4a}$ (d) $\frac{ba^2}{4}$
4. The potential energy for a conservative system is given by U = $ax^2 - bx$ where *a* and *b* are positive constants. The law of the force governing the system is:
   (a) F = - 2*a* (b) F = *bx* - 2*a* **(c)** F = *b* - 2*ax* (d) *F* = 2*ax*
5. The potential energy of a particle of mass 2 kg moving in the x-y plane is given by U = (8x − 6y) J, x and y being in metre. If the particle starts from origin, then the speed of particle at t = 1 s is:
   (a) 5 m/s (b) 4 m/s (c) 3 m/s (d) 7 m/s
6. Two springs of spring constants 400 N/m and 300 N/m are stretched with same force. They will have potential energy in the ratio:
   (a) 16 : 9 (b) 1 : 2 (c) 2 :1 **(d)** 3 : 4
7. Two springs A and B are identical but A is harder than B ($k_A > k_B$). Let W_A and W_B represent the work done when the springs are stretched through the same distance and W'_A and W'_B are the work done when these are stretched by equal forces, then which of the following is true?
   (a) $W_A > W_B$ and $W'_A < W'_B$ (b)) $W_A > W_B$ and $W'_A > W'_B$ (c)) $W_A > W_B$ and $W'_A = W'_B$ (d) $W_A < W_B$ and $W'_A < W'_B$
8. Which one of the following is not a conservative force?
   (a) Gravitational force (b) Electrostatic force between two charges (c) Magnetic force between two magnetic dipoles **(d)** Frictional force
9. A rod of mass m and length L is made to stand at an angle of 30° with the horizontal. Potential energy of the rod in this position is:
   (a) mgL (b) 2mgL **(c)** mgL/4 (d) mgL/2
10. A ball falls under gravity from a height 20 m with an initial velocity u. It hits the ground, loses 50% of its energy in collision and it rises to the same height, what is the value of u?
    (a) 20 m/s (b) 14.1 m/s (c) 28.2 m/s (d) 9.8 m/s
11. The potential energy of a particle of mass 1 kg free to move along x-axis is given by $U(x) = \frac{x^4}{4} - \frac{x^2}{2}$ J. The total mechanical energy of the particle is 2 J. Then, the maximum speed (in m/s) is:
    (a) 2 **(b)** $\frac{3}{\sqrt{2}}$ (c) 3 (d) $\frac{2}{\sqrt{2}}$
12. A particle is released from a height h. At a certain height, its kinetic energy is two times its potential energy. Height and speed of the particle at that instant are:

(a) $\frac{h}{3}, \sqrt{\frac{gh}{3}}$(b)) $\frac{h}{4}, \sqrt{\frac{2gh}{5}}$ (c)) 2 $\frac{h}{3}, \sqrt{\frac{2gh}{3}}$ **(d)**) $\frac{h}{3}, \sqrt{\frac{4gh}{3}}$

13. A body of mass 2 kg falls from rest through a distance of 100 m and acquires a speed of 40 m/s. Work done against friction of air is: (Take g = 10 m/s^2):
    (a) 200 J (b) 250 J **(c)** 400 J (d) 560 J
14. A stone is projected vertically up to reach maximum height h. The ratio of its kinetic energy to its potential energy at a height 3h/5, will be:
    (a) 1: 4 (b) 3: 5 **(c)** 2: 3 (d) 5: 1
15. A spring gun of spring constant 90 N/cm is compressed 12 cm by a ball of mass 16 g. If the trigger is pulled, the velocity of the ball is:
    (a) 50 m/s (b) 40 m/s c) 60 m/s **(d)** 90 m/s
16. A stone of mass 1 kg tied to a light inextensible string of length L = 5/3 m, is whirled in a vertical circle of radius L. If the ratio of the maximum and minimum tension in the string is 4 and g = 10 m/s^2, the speed of stone at the highest point of the circle is:
    (a) $5\sqrt{2}$ m/s (b) $5\sqrt{3}$ m/s (c) $5\sqrt{5}$ m/s (d) 10 m/s
17. An object is tied to a string and rotated in a vertical circle of radius r. Constant speed is maintained along the trajectory. If the ratio of maximum tension and minimum tension is 2, then v^2/rg is:
    (a) 4 **(b)** 3 (c) 2 (d) 1
18. A body of mass 2 kg is moving in a vertical circular path of radius 1 m. The difference between the kinetic energies at the highest and lowest position is:
    (a) 20 J (b) 30 J **(c)** 40 J (d) 45 J