Textbook questions for self assessment

Fill in the blanks

1. Work done by a force is defined as _____.
2. SI unit of energy is _____.
3. Scalar (dot) product of two vectors A and B making an angle θ w.r.t each other is given by _____.
4. The work-energy theorem states that the change in kinetic energy of a body equals the _____ done on it by the net force.
5. Kinetic energy is given by the formula _____.
6. Potential energy due to gravity near the Earth's surface is expressed as _____.
7. Hooke's law states that the force exerted by a spring is proportional to its _____ from equilibrium.
8. A force that depends only on position and whose work is path independent is called _____.
9. The principle of conservation of mechanical energy applies when only _____ forces are present.
10. Negative work is done by a force when it acts _____ to the direction of displacement.
11. Power is defined as the _____ rate at which work is done.
12. In an elastic collision, both _____ and _____ are conserved.
13. The unit of power is _____.
14. The sum of kinetic and potential energy is called _____ energy.
15. When two bodies collide and stick together after collision, it is called a _____ collision.

Short Answer Subjective Questions

16. State the work-energy theorem and explain its significance in mechanics.
17. What is meant by a conservative force? Give two examples.
18. Explain why no work is done by the gravitational force on a satellite moving in a circular orbit around Earth.
19. How does the work done by friction differ for objects moving on rough versus smooth surfaces?
20. What happens to the potential energy when a ball is raised to a height h above the ground?
21. Define the scalar product of two vectors and mention two of its properties.
22. Give the mathematical expression of power and explain its physical meaning.

23. List three forms of energy and briefly describe how they can transform into each other.
24. In terms of energy, what happens during an inelastic collision?
25. Why does the kinetic energy of a car decrease when brakes are applied despite no changes in its mass?
26. What does the area under a force versus displacement curve represent?
27. Why is the zero of potential energy arbitrary? Give examples.
28. How is work calculated for a variable force?
29. Briefly explain the difference between elastic and completely inelastic collisions with examples.
30. Define coefficient of restitution.

Problems

31. A cyclist applies a force of 200 N against friction for a distance of 10 m. Calculate the work done by friction.
32. An object of mass 2 kg slides down a smooth incline from a height of 5 m. Calculate its speed at the bottom.
33. A force of $\boldsymbol{F} = 2\hat{i} + \hat{j} - 2\hat{k}$ causes a body to move from its initial location (0, 0, 2)m to a final position of (2, 4, 0)m. Find the work done by the force.
34. A spring with spring constant k = 500 Nm^{-1} is compressed by 0.1 m. Find the potential energy stored in the spring.
35. A person pushes a box with a force of 50 N over 4 m on a rough surface against frictional force of 30 N. Calculate (a) work done by the person (b) work done by the friction (c) work done by normal force (d) net work done on the body by all the forces.
36. A bullet of mass = 0.05 kg is fired at 300 ms^{-1} into a block of mass 0.95 kg suspended from a string. Find the height to which the block rises after impact if bullet is embedded in it.
37. Calculate the average power developed if 3000 J of work is done in 2 minutes.
38. A 1000 kg car moving at 10 ms^{-1} crashes and comes to rest in 0.2 s. What is the average braking force?
39. A ball of mass 0.2 kg moving at 5 ms^{-1} hits another stationary ball of mass 0.2 kg in an elastic collision. Find the final velocities of both balls.
40. How much energy is required to lift a 20 kg load to a height of 3 m?
41. If a person uses 2000 kcal of energy per day, how much is this in joules?
42. A 0.03 g raindrop falls from 500 m and hits the ground at 30 ms^{-1}. Find the work done by the resistive force (assume g=10 ms^{-2}).

43. A block of 2 kg moving at 4 ms^{-1} enters a rough patch with friction 5 N and comes to rest. How much work did friction do? How far did it slide?

44. How is the power developed by a force F = 20 N in moving an object at 3 ms^{-1}?

45. Two masses, m_1=1 kg moving at 2 ms^{-1}, and m_2=2 kg at rest, collide inelastically. Find their common velocity after collision and the kinetic energy lost as a result of the collision.

46. A pump lifts 500 kg of water to 10 m in 10 minutes. How much electric power is consumed, assuming 60% efficiency?

47. A force $F(x) = 3x$ acts upon a body over $0 < x < 2$ m. Find the work done by this force.

48. An electron (m = 9 x 10^{-31} kg) has kinetic energy 500 eV. Find its speed.

49. A spring of k =200 Nm^{-1} is stretched 5 cm from equilibrium. Find the force and potential energy.

50. A body falls from a height of 36m and rebounds to a height of 16m. Find the coefficient of restitution.