Class XI: Physics
Chapter 6: Work, Energy and Power
Points to remember

Key learning:

1. Work done by a constant force is

$$W = Fs\cos\phi = \vec{F}.\vec{s}$$

2. Work done can be positive, negative or zero.

3. Work done by a variable force

$$W = \int_{s_1}^{s_2} F(s)ds$$

4. Work-energy theorem: The work done W by the net force on a particle equals the change in the particle's kinetic energy

$$FS = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$
$$W = K_f - K_i$$

5. Law of conservation of mechanical energy:
If gravity is the only external force that acts on the earth-ball system, then the total mechanical energy of the system always remains constant.

6. Gravitational potential energy does not depend upon the choice of the reference surface for me assuring height.

7. Gravitational Potential energy:
   (a) Energy possessed by a body changes with height with respect surface of earth.
   (b) GPE= - $W_{GravitaionalForce}$

8. Law of conservation of mechanical energy:

Total mechanical energy of the system always remains constant in the absence of dissipative forces.

9. Total mechanical energy of the system equals the sum of potential energy and the kinetic energy.

10. Work done on a system by conservative forces implies that the mechanical energy of the system remains constant.

11. Work done by the conservative force is the same along any path.

12. Total work done by the gravitational force on the body moving along a closed loop is always zero.

$$W_{graivity} \text{ in closed loop} = \text{Zero}$$

13. Work done on a system by non-conservative forces implies that the mechanical energy of the system is not conserved.

14. A conservative force is the negative gradient of potential energy function.

$$F(x) = -\Delta U/\Delta x$$

15. Power is the rate at which work is done or energy transformed.

16. The unit of power is Watt.

$$1 Watt = 1 Joule/second$$

17. Linear momentum of an isolated system is always conserved in a collision.

18. A collision in which the kinetic energy of the system is conserved is called elastic.

19. A collision in which the total kinetic energy of the system is not conserved is called inelastic.

20. When the two bodies collide, stick together and have a common final velocity, we say that the collision is completely inelastic.

Top formulae:

1. The Scalar Product

$$\mathbf{A.B} = AB\cos\theta$$

2. The scalar product follows the commutative law:

$$\mathbf{A.B = B.A}$$

3. The scalar product follows the distributive Law

$$\mathbf{A.\ (B + C) = A.B + A.C}$$

$$\lambda\ \mathbf{A.\ (}\lambda\ \mathbf{B) =}\ \lambda\ \mathbf{(A.B)}$$

Where λ is a real number.

4. Work

$$W = (F\cos\theta)\ d = \mathbf{f.d}$$

5. Kinetic Energy

$$KE = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

6. The equivalence of mass and energy

$$E = m\ c^2$$

7. Average power

$$P_{av} = \frac{W}{t}$$

8. Instantaneous power $P = \frac{dW}{dt}$

$$P = \mathbf{F.v}$$

9. Unit of power: horse – power (hp)

$$1\ hp = 746\ W$$

100 (Watt) x 10 (hour)

= 1000 watt hour

= 1 kilowatt hour (kWh)

= 10^3 (W) x 3600 (s)

= 3.6 x 10^6 J

10. Collisions in One Dimension

$$v_{1f} = \frac{(m_1 - m_2)}{m_1 + m_2} V_{1i}$$

$$v_{2f} = \frac{2m_1 v_{1i}}{m_1 + m_2}$$

If the two masses are equal

$$v_{1f} = 0$$

$$v_{2f} = v_{1f}$$

If one mass dominates, e.g. $m_2 >> m_1$

$$v_{1f} \; ; -v_{1f} \qquad v_{2f} \; ; 0$$

11. Work done by a variable force

$$W = \int_{r_1}^{r_2} \vec{F}.d\vec{r} = \text{Area under the } F-r \text{ curve and position axis}$$

$$W = \int_{x_1}^{x_2} F_x \, dx + \int_{y_1}^{y_2} F_y \, dy + \int_{z_1}^{z_2} F_z \, dz$$

12. Work done by spring force

$$W = \frac{1}{2}kx_2^2 = \frac{1}{2}kx_1^2 \text{ if } x_1 = 0 \text{ and } x_2 = x. \text{Then } W = \frac{1}{2}kx^2$$

13. For conservative force

$$W_{AB.\,1} = W_{AB.\,2}$$

14. For non conservative force

$$W_{AB.\,1} \neq W_{AB.\,2}$$

15. Potential Energy

(i) Of a system is always defined corresponding to a conservative internal force.

(ii) Change in P.E. = - Work done by the internal conservative force on the system.

$$\Delta U = U_f - U_i = -W_c = -\int^{\rightarrow} F_c.\vec{dr}$$

(iii) It is a respective quantity.

16. Gravitational P.E.

P.E. near the earth surface w.r.t ground = mgh

17. Spring potential energy = $\frac{1}{2}kx^2$

$$\Rightarrow F_c = -\vec{v}_c U = -\text{grad } U$$