Work, Energy and Power

Worksheet -2

1. When an air bubble rises in water, what happens to its potential energy? 1

Ans. Decreases because work is done by upthrust on the bubble.

2. What should be the angle between the force and the displacement for maximum and minimum work? 1

Ans. Maximum = 0^o, minimum = 90^o

3. What is work done in holding a 15kg suitcase while waiting for a bus for 15 minutes? 1

Ans. Zero as displacement is zero

4. A light body and a heavy body have same kinetic energy. Which one has greater linear momentum? 1

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

$p = \sqrt{2mK}$

As the kinetic energy for both the bodies is same, it implies that momentum is directly proportional to the square root of the mass.

As the mass of the heavy body is more so its linear momentum will be greater.

5. Can a body have energy without momentum? 1

Ans. Yes, when p = 0, K = 0

But E = K + U = U (Pot. Energy), which may or may not be zero.

6. A particle moves along the x – axis form x = 0 t x = 5m influence of force given by $F = 7 - 2x + 3x^2$. Calculate the work done in doing so. 2

Ans. $dW = Fdx$

$$W = \int_0^5 Fdx$$

$$= \int_0^5 (7 - 2x + 3x^2)dx$$

$$= \int_0^5 7dx - \int_0^5 2xdx + \int_0^5 3x^2dx$$

$$= 7\int_0^5 dx - 2\int_0^5 xdx + 3\int_0^5 x^2dx$$

$$= 7\left[x\right]_0^5 - 2\left[\frac{x^2}{2}\right]_0^5 + 3\left[\frac{x^3}{3}\right]_0^5$$

$$= 7[5-0] - [25-0] + [125-0]$$

$$= 135J$$

7. A body of mass 3kg makes an elastic collision with another body at rest and continues to move in the original direction with a speed equal to one – third of its original speed. Fine the mass of the second body. 2

Ans. *Given*: $m_1 = 3kg,\ u_1 = u$

$v_1 = u/3,\quad u_2 = 0$

To find: $m_2 = ?$

Sol^n: $v_1 = \dfrac{(m_1 - m_2)u_1 + 2m_2u_2}{m_1 + m_2}$

$$\frac{u}{3} = \frac{(3 - m_2)u + 2m_2(0)}{3 + m_2}$$

$$\frac{u}{3} = \frac{(3 - m_2)u}{3 + m_2}$$

$$3 + m_2 = 3(3 - m_2)$$

$$3 + m_2 = 9 - 3m_2$$

$$4m_2 = 6$$

$$m_2 = 3/2$$

8 Show that for a freely falling body the sum of its kinetic energy and potential energy remains constant at all points during its fall? 2

Ans.

9. Ball A of mass m moving with velocity u collides head on with ball B of mass m at rest. If e be the coefficient of restitution then determine the ratio of final velocities of A and B after the collision. 3

Ans.

$$e = \frac{v_2 - v_1}{u_1 - u_2}$$

$$e = \frac{v_2 - v_1}{u - 0}$$

$$v_2 - v_1 = eu \qquad \rightarrow (1)$$

Also, $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$$mu + m(0) = mv_1 + mv_2$$

$$mu = m(v_1 + v_2)$$

$$v_1 + v_2 = u \qquad \rightarrow (2)$$

$(1) + (2)$

$$2v_2 = u(e+1)$$

$$v_2 = \frac{u(e+1)}{2}$$

From (2)

$$v_1 + \frac{u(e+1)}{2} = u$$

$$v_1 = u - \frac{u(e+1)}{2}$$

$$v_1 = \frac{u(1-e)}{2}$$

Now, $\frac{v_1}{v_2} = \frac{\frac{u(1-e)}{2}}{\frac{u(e+1)}{2}}$

$$\frac{v_1}{v_2} = \frac{1-e}{1+e}$$

10. If the momentum of the body increases by 20% what will be the increase in the K.E. of the body? 2

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

$$p' = p + \frac{20}{100}p = \frac{120}{100}p = \frac{6}{5}p$$

$$K' = \frac{(p')^2}{2m} = \frac{36p^2}{50m} = \frac{18p^2}{25m}$$

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

$$= \frac{\frac{18p^2}{25m} - \frac{p^2}{2m}}{\frac{p^2}{2m}} \times 100\%$$

$$= \frac{\frac{36p^2 - 25p^2}{50m}}{\frac{p^2}{2m}} \times 100\%$$

$$= \frac{\frac{11p^2}{50m}}{\frac{p^2}{2m}} \times 100\%$$

$$= \frac{11}{25} \times 100\%$$

$$= 44\%$$