7th FOUNDATION PLUS WORK ENERGY POWER SOLUTIONS

Teaching Task

1.

- Height of each step = 25 cm
- Number of steps = 40
- Total height = $40 \text{ steps} \times 25 \text{ cm/step} = 1000 \text{ cm}$
- Convert the total height to meters: $1000 \text{ cm} = 10 \text{ m}$

Step 2: Calculate the work done

The work done (W) in lifting an object against gravity is given by the formula:
$W = mgh$
where:

- m is the mass of the object (20 kg)
- g is the acceleration due to gravity (10 m/s^2)
- h is the total vertical height (10 m)

Substitute the values into the formula:

$$W = (20 \text{ kg}) \times (10 \text{ m/s}^2) \times (10 \text{ m})$$

$$W = 2000 \text{ J}$$

2.

- Mass (m) = (1/10) gram = 0.1 g
- Vertical distance (h) = 100 m
- Acceleration due to gravity (g) ≈ $9.8\ \text{m/s}^2$

Step 2: Convert units to SI

First, convert the mass from grams to kilograms:

$$m = 0.1\ \text{g} \times \frac{1\ \text{kg}}{1000\ \text{g}} = 0.0001\ \text{kg}$$

Step 3: Calculate the work done by gravity

Substitute the values into the work formula:

$$W_g = (0.0001\ \text{kg})(9.8\ \text{m/s}^2)(100\ \text{m})$$

$$W_g = 0.098\ \text{J}$$

3. First, use Newton's second law to find the tension force,

T, in the rope. The forces acting on the bucket are the gravitational force (mg) acting downwards and the tension force (T) from the rope acting upwards. Since the bucket is accelerating downwards at a rate of $a=g/4$, we can write the equation of motion as

$$mg - T = ma$$

Substitute the given acceleration $a = g/4$:

$$mg - T = m\left(\frac{g}{4}\right)$$

Now, solve for the tension T:

$$T = mg - m\left(\frac{g}{4}\right)$$

$$T = mg\left(1 - \frac{1}{4}\right)$$

$$T = \frac{3}{4}mg$$

- The force doing the work is the tension in the rope, $T = \frac{3}{4}mg$. This force acts **upwards**.
- The displacement of the bucket is d and it is moving **downwards**.
- The angle θ between the upward tension force and the downward displacement is $180°$.

herefore, the work done by the rope is:

$$W_{\text{rope}} = Td\cos(180°)$$

ince $\cos(180°) = -1$:

$$W_{\text{rope}} = \left(\frac{3}{4}mg\right)(d)(-1)$$

$$W_{\text{rope}} = -\frac{3}{4}mgd$$

4.

5.

$$a = \frac{F}{m}$$

Given:

- Force (F) = 2 N
- Mass (m) = 5 kg

$$a = \frac{2}{5} = 0.4 \text{ m/s}^2$$

$$d = ut + \frac{1}{2} at^2$$

Given:

- Initial velocity (u) = 0 m/s
- Acceleration (a) = 0.4 m/s²
- Time (t) = 10 s

$$d = (0)(10) + \frac{1}{2}(0.4)(10)^2$$

$$d = 0.2 \times 100$$

$$d = 20 \text{ m}$$

Step 3: Calculate the work done

Finally, the work done (W) is calculated by multiplying the force applied by the displacement of the body in the direction of the force.

$$W = F \times d$$

Given:

- Force (F) = 2 N
- Displacement (d) = 20 m

$$W = 2 \times 20$$

$$W = 40 \text{ J}$$

5.

- Given the forces are in ratio $1 : 2$,
- Displacements are in ratio $2 : 1$,
- Angles between the forces and displacements are 30° and 60°,
- Work done by a force is given by $W = F \cdot d \cdot \cos\theta$.

Hence, the ratio of work done is:

$$\frac{W_1}{W_2} = \frac{F_1 d_1 \cos 30^\circ}{F_2 d_2 \cos 60^\circ} = \frac{1 \times 2 \times \frac{\sqrt{3}}{2}}{2 \times 1 \times \frac{1}{2}} = \sqrt{3} : 1$$

So, the work done by the two forces are in the ratio $\sqrt{3} : 1$.

- **6.**

- Total length of chain = *L*
- Length hanging down = L/5
- Length on the table = 4L/5
- Mass is uniformly distributed, so mass per unit length = M/L
- Mass of hanging part = mass per unit length ×× length hanging down
- mhanging=M/L×L/5=M/5
- Distance of center of mass below table=L/2 xL/5=L/10

Work done to pull the hanging part back onto the table equals the potential energy gained by lifting the hanging portion from its center of mass to the table level.

Potential energy (work done) is:

$$W = m_{\text{hanging}} \times g \times \text{height lifted}$$

$$W = \frac{M}{5} \times g \times \frac{L}{10} = \frac{MgL}{50}$$

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- 7.

  Work done = Area covered in between force displacement curve and displacement axis

  = Mass × Area covered in between acceleration-displacement curve and displacement axis.

  $= 10 \times \frac{1}{2}(8 \times 10^{-2} \times 20 \times 10^{-2})$

  $= 8 \times 10^{-2}$ J

- 8.

  1. **Identify the hanging mass:** The problem states that one-third of the chain's length (L) is hanging. Therefore, the mass of the hanging portion is $\frac{m}{3}$.
  2. **Locate the center of mass:** For a uniform chain, the center of mass is at the midpoint of its length. Since the hanging part has a length of $\frac{L}{3}$, its center of mass is located at a distance of $\frac{1}{2} \times \frac{L}{3} = \frac{L}{6}$ below the table's edge.
  3. **Calculate the work done:** The work done to pull the chain onto the table is equal to the change in potential energy of the hanging portion. The work done (W) is given by the formula $W = \text{mass} \times g \times \text{height}$, where the height is the distance the center of mass is lifted.

     - Mass of hanging part = $\frac{m}{3}$
     - Height (distance the center of mass is lifted) = $\frac{L}{6}$
     - Work done (W) = $(\frac{m}{3}) \times g \times (\frac{L}{6}) = \frac{mgL}{18}$

- 9.

  First, convert the height of each step from centimeters to meters.
  20 cm=0.20 m20 cm equals 0.20 m

  Then, calculate the total vertical height the man ascends by multiplying the number of steps by the height of each step.

  The work done against gravity is equal to the change in gravitational potential energy, which can be calculated using the formula

  $W=mgh$

  . Use the standard value for the acceleration due to gravity,

  g≈9.8 m/^{s} W=(70 kg)×(9.8)×(7.2 m)=4939.2J
  10.

- Force (Tension), $F = 200\ \mathrm{N}$
- Displacement, $d = 20\ \mathrm{m}$
- Angle, $\theta = 600^\circ$

Substitute these values into the work done formula:

$$W = (200\ \mathrm{N})(20\ \mathrm{m})\cos(600^\circ)$$

Step 3: Calculate the cosine of the angle and the final work done

The cosine of 600° is equal to the cosine of $(600^\circ - 360^\circ) = 240^\circ$. The value of $\cos(240^\circ)$ is -0.5.

$$W = (200)(20)(-0.5)$$

$$W = 4000(-0.5)$$

$$W = -2000\ \mathrm{J}$$

Answer:

11.

The formula for kinetic energy (K.E.) is $\frac{1}{2}mv^2$.

- **Initial K.E.:** Since the particle starts from rest, its initial velocity is 0.
  Initial K.E. $= \frac{1}{2}(2)(0)^2 = 0$ J
- **Final K.E.:** Using the final velocity calculated in Step 1.
  Final K.E. $= \frac{1}{2}(2)(4)^2 = \frac{1}{2}(2)(16) = 16$ J

Step 3: Calculate the gain in kinetic energy

The gain in kinetic energy is the difference between the final and initial K.E.
Gain in K.E. = Final K.E. - Initial K.E.
Gain in K.E. = $16 - 0 = 16$ J

2.