Probset Solutions

Exercises

E1(a)

Work done by Denise = $Fx \cos \theta$

$= (30)\ (5.0)\ (\cos 60^{o})$

$= 75$ J

E1(b)

Hilda does not do work on the book because the book's displacement is zero.

E2. (a) Can work done be positive or negative? State the condition for it.

Yes, work done can be positive or negative.

When force and displacement are in same direction, workdone is positive.

When force and displacement are in opposite direction, workdone is negative.

(b) Can work done be zero? State the condition(s) for it.

Yes. Conditions: - force is zero

- Displacement is zero
- Force and displacement is perpendicular to each other.

E3 The elastic potential energy stored in the bow just before the release of an arrow is 95 J. When the arrow of mass 170 g is fired, 90% of the elastic potential energy is transferred to the arrow. Show that the speed of the arrow as it leaves the bow is 32 ms^{-1}.

$$\text{Amount of energy transferred to the arrow} = \frac{90}{100} \times 95 = 85.5 \text{ J}$$

$$\Rightarrow \frac{1}{2}mv^2 = 85.5$$

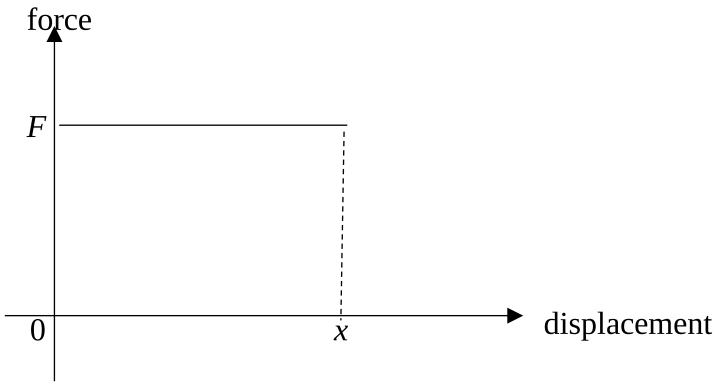
$$v = 32 \text{ m s}^{-1}$$

E4. An object at rest is pulled by a constant horizontal force, *F* on a smooth floor to a displacement of *x.*

(i) Sketch a graph of force applied on object against the displacement. Label *F* and *x* in the graph.

(ii) What does the area under force against displacement graph in **(i)** represent? Hint: work done.

(i)



(ii) Area under force against displacement graph represent the work done by force on object.
Work done = $F(x)$

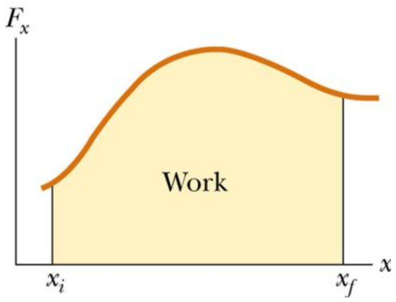
E5. An object at rest is pulled by a varying horizontal force, F_x on a smooth floor to a displacement of x.
(i) Can we still use this formula to calculate the work done by Fx, *i.e workdone* = $F_x(x)$?

No. The formula work done = $F_x(x)$ is only for a constant force.

(ii) How can the work done by F_x be calculated?

To calculate the work done by a varying force acting on an object that

Work done by a varying force is equal to the area under the force–displacement graph.



E6(a)
Gain of KE of the sack = Work done on the sack = $2.0 \times 0.35 = 0.70$ J

E6(b)
$$\frac{1}{2}mv^2 = 0.7 \Rightarrow v = 0.37 \text{ ms}^{-1}$$

E7(a)
By Principle of COE,
Loss of GPE = Gain in KE
m(9.81)(30) – 0 = ½ m $(2.80)^2$ - 0
$\therefore$ v = 24.4 m s^{-1} (3 s.f.)

OR

By Principle of COE,
GPE at A + KE at A = GPE at B + KE at B
m(9.81)(30) + ½ m $(2.80)^2$ = 0 + ½ m v^2
$\therefore$ v = 24.4 m s^{-1} (3 s.f.)

E7(b)
By Principle of COE,
Loss of GPE = Gain in KE
m(9.81)(30) – m(9.81)(25) = ½ m $(2.80)^2$ - 0
$\therefore$ v = 10.3 m s^{-1} (3 s.f.)

OR

By Principle of COE,

GPE at A + KE at A = GPE at C + KE at C

$m(9.81)(30) + \frac{1}{2} m (2.80)^2 = m(9.81)(25) + \frac{1}{2} m v^2$

$\therefore v = 10.3\ m\ s^{-1}$ (3 s.f.)

E8(a)

Work done in compressing spring = Elastic PE stored in spring

$$= \frac{1}{2}kx^2$$

$$= \frac{1}{2}(500)(0.10)^2$$

$$= 2.5\ J$$

E8(b)

Assume all the elastic PE stored in the spring is converted to kinetic energy.

$$\Rightarrow \frac{1}{2}mv^2 = 2.5$$

$$\Rightarrow v = \sqrt{\frac{2(2.5)}{2.0}} = 1.6\ ms^{-1}$$

E9

Power of engine $P = F_e(v)$ where Fe is driving force from engine.

At maximum speed, acceleration = 0

⇨ $D = F_e$

$P = F_e\ v$

$P = D\ v$, $D\ \alpha\ v^2$

$P \alpha\ v^3$

72 k $\alpha\ 12^3$

36 k $\alpha\ v_{one}{}^3$

$V_{one} = 9.5\ m\ s^{-1}$ (Ans D)