6E. A floating ice block is pushed through a displacement $\vec{d} = (15\text{ m})\hat{i} - (12\text{ m})\hat{j}$ along a straight embankment by rushing water, which exerts a force $\vec{F} = (210\text{ N})\hat{i} - (150\text{ N})\hat{j}$ on the block. How much work does the force do on the block during the displacement?

$$W = \vec{F} \cdot \vec{d} = (210\hat{i} - 150\hat{j}) \cdot (15\hat{i} - 12\hat{j})$$

$$= \boxed{4950\text{ J}}$$

10P. A force acts on a 3.0 kg particle-like object in such a way that the position of the object as a function of time is given by $x = 3.0t - 4.0t^2 + 1.0t^3$, with x in meters and t in seconds. Find the work done on the object by the force from $t = 0$ to $t = 4.0$ s. (*Hint:* What are the speeds at those times?)

$$W = \Delta K = \frac{1}{2} m \left(v_f^2 - v_i^2 \right)$$

at $t = 0 \Rightarrow v_i$ and at $t = 4\text{ s} \Rightarrow v_f$

$$v = \frac{dx}{dt} = 3 - 8t + 3t^2$$

$v_i = 3$ m/s $\qquad v_f = -9$ m/s

$$W = \frac{1}{2} (3) \left((-9)^2 - (3)^2 \right) = \boxed{108\text{ J}}$$

13P. Figure 7-27 shows an overhead view of three horizontal forces acting on a cargo canister that was initially stationary but that now moves across a frictionless floor. The force magnitudes are $F_1 = 3.00$ N, $F_2 = 4.00$ N, and $F_3 = 10.0$ N. What is the net work done on the canister by the three forces during the first 4.00 m of displacement? ssm

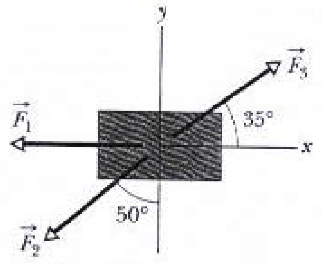


Fig. 7-27 Problem 13.

$$W_{net} = W_1 + W_2 + W_3 = \vec{F}_{net} \cdot \vec{d} = F_{net}\, d \cos\theta$$

here $\theta = 0 \Rightarrow W_{net} = F_{net}\, d$

$$\vec{F}_{net} = \vec{F}_1 + \vec{F}_2 + \vec{F}_3 = -3\hat{i} + (-4 \sin 50^\circ \hat{i} - 4 \cos 50^\circ \hat{j})$$

$$+ (10 \cos 35^\circ \hat{i} + 10 \sin 35^\circ \hat{j})$$

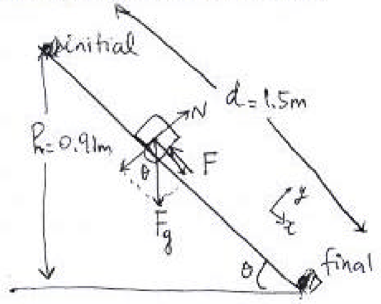
$$= 2.1\,\hat{i} + 3.1\,\hat{j}$$

$$F_{net} = \sqrt{(2.1)^2 + (3.1)^2} = 3.7 \text{ N}$$

$$d = 4 \text{ m}$$

$$\Rightarrow \boxed{W_{net} = 15 \text{ J}}$$

16E. A 45 kg block of ice slides down a frictionless incline 1.5 m long and 0.91 m high. A worker pushes up against the ice, parallel to the incline, so that the block slides down at constant speed. (a) Find the magnitude of the worker's force. How much work is done on the block by (b) the worker's force, (c) the gravitational force on the block, (d) the normal force on the block from the surface of the incline, and (e) the net force on the block?



a) $\sum F_x = ma = 0 = mg\sin\theta - F \Rightarrow F = mg\sin\theta$

$\sin\theta = \frac{h}{d} \Rightarrow F = mg\frac{h}{d} = 45 \times 9.8 \times \frac{0.91}{1.5}$

$= \boxed{268\text{ N}}$

b) $W_1 = F\,d\cos 180^\circ = -Fd = -268 \times 1.5 = \boxed{-402\text{ J}}$

c) $W_2 = mgh = 45 \times 9.8 \times 0.91 = \boxed{402\text{ J}}$

d) $W_3 = N \cdot d\cos 90^\circ = 0$

e) $F_{net} = ma = 0 \Rightarrow \vec{F}_{net} = 0$

note $W_{net} = F_{net}\,d = 0 \times 1.5 = 0$

also $W_{net} = W_1 + W_2 + W_3 = -402 + 402 + 0 = 0$

23P. The only force acting on a 2.0 kg body as it moves along the positive x axis has an x component $F_x = -6x$ N, where x is in meters. The velocity of the body at $x = 3.0$ m is 8.0 m/s. (a) What is the velocity of the body at $x = 4.0$ m? (b) At what positive value of x will the body have a velocity of 5.0 m/s? ssm

$F_x = -6x \quad (N)$

$v_1 = 8\ m/s \quad \text{at } x_1 = 3\ m$

a) $v_2 = ? \quad \text{at } x_2 = 4\ m$

Use $W = \Delta K = \frac{1}{2} m (v_f^2 - v_i^2)$

$$W = \int_3^4 F\, dx = -6 \int_3^4 x\, dx = -6 \left. \frac{x^2}{2} \right|_3^4$$

$$= -3\left((4)^2 - (3)^2\right) = -21\ J$$

$$-21 = \frac{1}{2}(2)\left[v_2^2 - (8)^2\right] \Rightarrow \boxed{v_2 = 6.6\ m/s}$$

b) $v_3 = 5\ m/s \quad \text{at } x_3 = ?$

$$W = \int_4^{x_3} F\, dx = -6 \left. \frac{x^2}{2} \right|_4^{x_3} = -3\left[x_3^2 - 16\right]$$

$$= -3x_3^2 + 48 = K_f - K_i = \frac{1}{2} m (v_f^2 - v_i^2)$$

$$-3x_3^2 + 48 = \frac{1}{2}(2)\left[(5)^2 - (6.6)^2\right] \Rightarrow \boxed{x_3 = 4.7\ m}$$

25E. A 10 kg brick moves along an x axis. Its acceleration as a function of its position is shown in Fig. 7-32. What is the net work performed on the brick by the force causing the acceleration as the brick moves from $x = 0$ to $x = 8.0$ m? ssm ilw

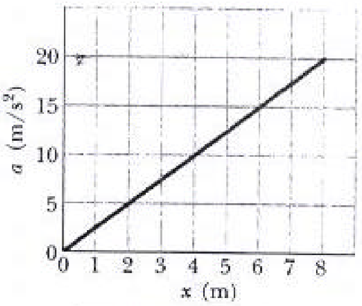


Fig. 7-32 Exercise 25.

Work = area under the curve

$$W = \frac{1}{2}\left(20 \times 10 \times 8\right) = \boxed{800\ J}$$

26P. The only force acting on a 2.0 kg body as the body moves along the x axis varies as shown in Fig. 7-33. The velocity of the body at $x = 0$ is 4.0 m/s. (a) What is the kinetic energy of the body at $x = 3.0$ m? (b) At what value of x will the body have a kinetic energy of 8.0 J? (c) What is the maximum kinetic energy attained by the body between $x = 0$ and $x = 5.0$ m?

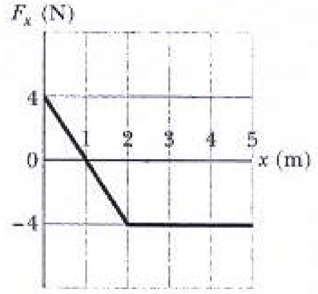


Fig. 7-33 Problem 26.

a) $W = \Delta K$

W = area under the curve

$x = 0 \longrightarrow x = 3\,m \qquad W = \frac{1}{2}(4\times1) - \frac{1}{2}(4\times1) - 4\times1$

$= -4\,J$

$\Delta K = K_f - K_i = K_f - \frac{1}{2}(2)(4)^2 = K_f - 16$

$\Rightarrow K_f - 16 = -4 \Rightarrow \boxed{K_f = 12\,J}$ at $x = 3\,m$

b)

$\Delta K = W \Rightarrow K_f - K_i = 8 - 12 = -4(x_f - 3)$

$= 12 - 4x_f$

$\Rightarrow \boxed{x_f = 4\,m}$

32E. (a) At a certain instant, a particle-like object is acted on by a force $\vec{F} = (4.0\text{ N})\hat{i} - (2.0\text{ N})\hat{j} + (9.0\text{ N})\hat{k}$ while having a velocity $\vec{v} = -(2.0\text{ m/s})\hat{i} + (4.0\text{ m/s})\hat{k}$. What is the instantaneous rate at which the force does work on the object? (b) At some other time, the velocity consists of only a y component. If the force is unchanged, and the instantaneous power is -12 W, what is the velocity of the object just then?

a) $P = \vec{F} \cdot \vec{v} = (4\hat{i} - 2\hat{j} + 9\hat{k}) \cdot (-2\hat{i} + 4\hat{k})$

$= -8 + 36 = \boxed{28\ W}$

b) $P = \vec{F} \cdot \vec{v} = -2\,v_y = -12 \Rightarrow \boxed{v_y = 6\ m/s}$

$\vec{v} = 6\hat{j}\ (m/s)$

40P. An initially stationary 2.0 kg object accelerates horizontally and uniformly to a speed of 10 m/s in 3.0 s. (a) In that 3.0 s interval, how much work is done on the object by the force accelerating it? What is the instantaneous power due to that force (b) at the end of the interval and (c) at the end of the first half of the interval?

a) $W = \Delta K = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$

$= \frac{1}{2}(2)(10)^2 - 0 = \boxed{100\ J}$

b) $P = F v = m a v$

$a = \frac{\Delta v}{\Delta t} = \frac{10}{3} = 3.3\ m/s^2$

$P = (2)(3.3)(10) = \boxed{66\ W}$

c) $v = at + \cancel{v_0}^{0} = 3.3 \times 1.5 = 5\ m/s$

$P = mav = (2)(3.3)(5) = \boxed{33W}$