Ch. 16.2 Dr. Bob

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1.

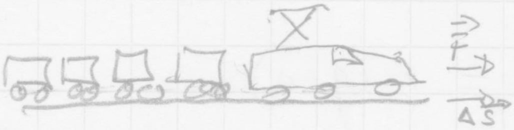
a) Zero work - force is perpendicular to motion.

b) Zero wor - same as above

c) Friction - Negative work
force is anti parallel to movement.

d) Positive work - force & motion in same direction.

2.



$F = 20{,}000\ N$
$\Delta s = 1000\ m$

$M_{tot} = 4(15{,}000\ kg) + 40{,}000\ kg = 1.00 \times 10^5\ kg$

$M_{tot} =$

$E_{ki} = 0\ J \qquad E_{kf} = ?$

a) $W = \vec{F} \cdot \Delta\vec{s} = F \cdot \Delta s = (20{,}000\ N)(1000\ m)$

$$\boxed{W = 2.00 \times 10^7\ J}$$

b) $\boxed{W_{tot} = 2.00 \times 10^7\ J}$ the other forces are $\perp$ to the motion

($\perp$ = perpendicular)

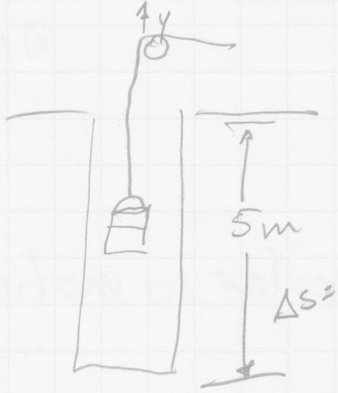
c) $W_{tot} = E_{kf} - \cancel{E_{ki}}$

$W_{tot} = \frac{1}{2} m V_f^2$

$V_f = \pm\sqrt{\frac{2 W_{tot}}{m}} = \sqrt{2(2.0 \times 10^7\ J)}$

$$\boxed{V_f = 20\ m/s}$$

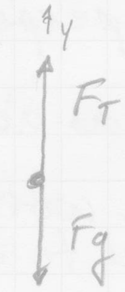
3.



F_T = Forcetension
F_g = Force gravity

$m = 10.0\,kg$

$\Delta s = 5m$ up $a = 0.250\,m/s^2$



$$\Sigma F_y = F_T - F_g = ma$$

$$F_g = mg$$

a) work done by F_T - tension in rope pulling on bucket.

$$F_T = mg + ma = m(g+a)$$

$$F_T = (10.0kg)(9.8m/s^2 + 0.250m/s^2)$$

$$F_T = 100.5\,N$$

$$W_T = \vec{F_T} \cdot \Delta\vec{s} = F_T \cdot \Delta s = (100.5N)(5m) \quad \cos 0° = 1$$

$$W_T = 502.5\,J$$

b) $$W_g = \vec{F_g} \cdot \Delta\vec{s} = -F_g \cdot \Delta s \quad \cos 180° = -1$$

$$W_g = -(10.0kg)(9.8m/s^2)(5m)$$

$$W_g = -490\,J$$

c) $$W_{tot} = W_T + W_g = 502.5J - 490J = 12.5J$$

$$\boxed{W_{tot} = 12.5J}$$

d) Assume $E_{ki} = 0$

$$W_{tot} = E_{kf} - \cancel{E_{ki}}^{\,0} = \tfrac{1}{2} m V_f^2$$

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3(cont'd)

d)

$$V_f = \sqrt{\frac{2W_{tot}}{m}} = \sqrt{\frac{2(12.5\,J)}{10.0\,kg}}$$

$$\boxed{V_f = 1.58\ m/s}$$

Check: $V_f^2 = \cancel{V_i^2}^{\,0} + 2a\Delta y$

$$V_f = \sqrt{2a\Delta y} = \sqrt{2(0.250\,m/s^2)(5\,m)}$$

$$V_f = 1.58\,m/s \ \checkmark$$

4.

$m = 0.170\,kg$

$V_i = 15.0\,m/s$

$V_f = 0\,m/s$

$\Delta x = 38.3\,m$

$$E_{ki} = \tfrac{1}{2}(0.170\,kg)(15.0\,m/s)^2$$

$$E_{ki} = 19.125\,J$$

$$E_{kf} = 0\,J$$

$$W_{tot} = \cancel{E_{kf}}^{\,0} - E_{ki} = F \cdot \Delta s$$

$$F = \frac{-E_{ki}}{\Delta s} = -\frac{19.125\,J}{38.3\,m} = -0.499\,N$$

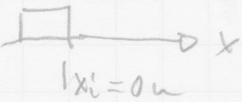
Magnitude of $F = 0.499\,N$

4) (cont'd)

Check w/ kinematic Eqn's

$V_i = 15\,m/s \qquad x_i = 0\,m \qquad \cancel{V_f^2}^{\,0} = V_i^2 + 2a\Delta X$

$V_f = 0\,m/s \qquad X_f = 38.3\,m$

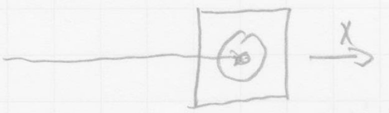


$$a = \frac{-V_i^2}{2\Delta X} = \frac{-(15\,m/s)^2}{2(38.3\,m)} = -2.94\,m/s^2$$

$$F_f = ma = (0.170\,kg)(-2.94\,m/s^2)$$

$$F_f = -0.499\,N$$

5. $m = 0.020\,kg \qquad \Delta s = 0.10\,m$



$V_i = 500\,m/s$

a) $E_K = \tfrac{1}{2} m V^2 = \tfrac{1}{2}(0.020\,kg)(500\,m/s)^2$

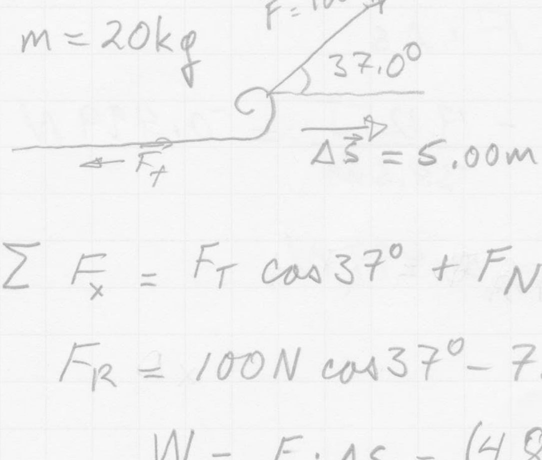
$E_K = 2500\,J \qquad 1\,J = 1\,N\cdot m$

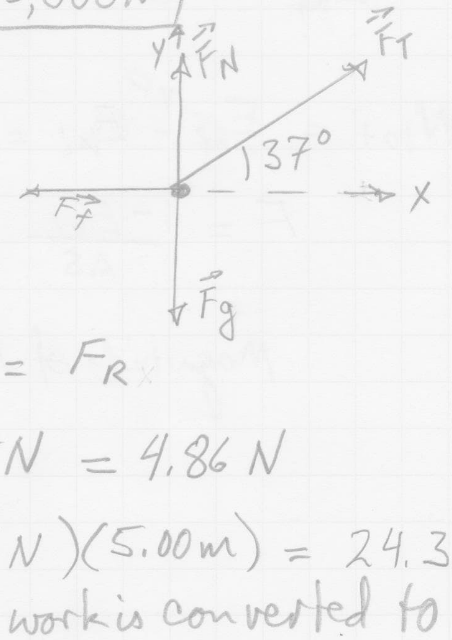
b) $W = \vec{F}\cdot\Delta\vec{s} = F\cdot\Delta s$

$$F = \frac{W}{\Delta s} = \frac{2500\,J}{0.10\,m} = -25{,}000\,N$$ (negative x-direction)

$$\boxed{F = -25{,}000\,N}$$

6. $m = 20\,kg$





$F_T = 100\,N$

$F_f = -75\,N$

$\Delta s =$

$$\Sigma F_x = F_T \cos 37° + F_N = F_R$$

$$F_R = 100\,N \cos 37° - 75\,N = 4.86\,N$$

$$W = F_R \cdot \Delta s = (4.86\,N)(5.00\,m) = 24.32\,J$$

All this work is converted to E_K.

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6. (cont'd)

$$W = E_K = \tfrac{1}{2}mV^2$$

$$V = \sqrt{\frac{2W}{m}} = \sqrt{\frac{2(24.32J)}{20kg}}$$

$$\boxed{V = 1.56\,m/s}$$

Check units $\sqrt{\frac{N \cdot m}{kg}} = \sqrt{\frac{kg\,m^2/s^2}{kg}} = \sqrt{m^2/s^2} = m/s$

7.

$y_f = 5.10\ m$

$m = 0.250kg$ $V_i = 10m/s$

$y_i = 0m$

a) $E_{ki} = \tfrac{1}{2}(0.250kg)(10m/s)^2$

$(E_{ki} = \tfrac{1}{2}m\,V_i^2)$

$E_{ki} = 12.5\,J$

b $E_{kf} = \tfrac{1}{2}(0.250kg)(0\,m/s)^2$

$E_{kf} = 0\,J$

$\Delta E_k = E_{kf} - E_{ki}$

$= 0J - 12.5J$

$$\boxed{\Delta E_k = -12.5J}$$

b) Work $= E_{kf} - E_{ki} =$

$$\boxed{W = -12.5\,J}$$

8. A. True. Net force in direction of motion means $a = \frac{F_R}{m}$ in direction of motion

B. False. It is accelerating.

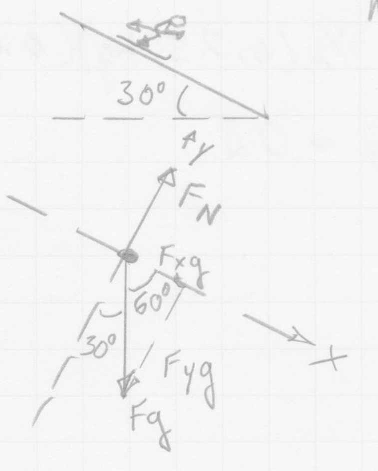
C. False. The resultant force is acting in the direction of motion, but there may be any number of other forces action on the object. These other forces would add up to the resultant force.

D. True. The force is doing positive work.

E. False. $W_{tot} = E_{kf} - E_{ki}$ $\quad E_k > E_i$

$\Rightarrow W_{tot} > 0$

9.



$m = 60.0\,kg$ $\qquad V_i = 0\,m/s$

$V_f = 100\frac{km}{h} = 27.\bar{7}\,m/s$

$$W_{tot} = E_{kf} - E_{ki}$$

$$= \tfrac{1}{2} m V_f^2 - \tfrac{1}{2} m V_i^2 \rightarrow 0$$

$$= \tfrac{1}{2}(60kg)(27.\bar{7}\,m/s)^2$$

$$W_{tot} = 23{,}148\,J$$

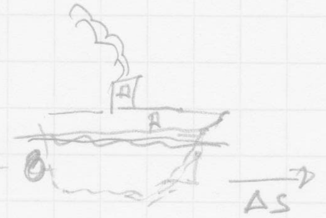
$$F_{xg} = F_g \cos 60° = mg \cos 60°$$

$$W_{tot} = F_{xg} \cdot \Delta s \qquad \Delta s = \frac{W_{tot}}{F_{xg}} = \frac{\tfrac{1}{2}\cancel{m} V_f^2}{\cancel{m} g \cos 60°}$$

$$\Delta s = \frac{\tfrac{1}{2}(27.7\,m/s)^2}{(9.8\,m/s^2)\cos 60°}$$

$$\boxed{\Delta s = 78.7\,m}$$

10. Dr. Bob



$m = 10^5$ tonnes $= 10^8$ kg

1 tonne $= 10^3$ kg

$V_i = 50.0$ km/h $=$

$V_i = 13.\bar{8}$ m/s

$\Delta S = 4.00$ km $= 4.00 \times 10^3$ m

$E_{ki} = \frac{1}{2} m V_i = \frac{1}{2}(10^8 \text{ kg})(13.\bar{8} \text{ m/s})^2 = 9.65 \times 10^9$ J

$E_{kf} = 0$ J

$W_{tot} = E_{kf} - E_{ki} = 0\text{ J} - 9.65 \times 10^9$ J

$W_{tot} = -9.65 \times 10^9$ J

$W_{tot} = F \cdot \Delta S$ $\qquad F = \frac{W_{tot}}{\Delta S}$

$F = \frac{(-9.65 \times 10^9 \text{ J})}{4.00 \times 10^3 \text{ m}}$

Units: $\frac{J}{m} = \frac{N \cdot \cancel{m}}{\cancel{m}} = N$

$\boxed{F = -2.41 \times 10^6 \text{ N}}$

Negative force means its opposing the motion.