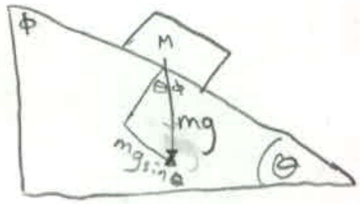
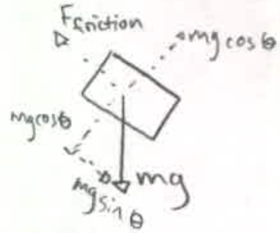
1.




The friction force points opposed to the component of the weight in the ramp's plane.




At maximum

$$F_{friction} = mg\sin\theta$$

$$mg\cos\theta\,\mu_s = mg\sin\theta$$

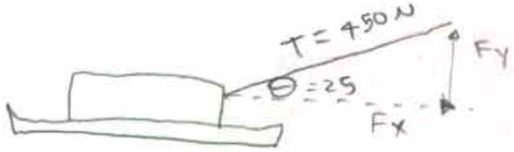
$$\mu_s = \tan\theta$$

$$\theta = \tan^{-1}(\mu_s)$$

$$\theta = \tan^{-1}(.77)$$

$$\theta = 38^\circ$$

2.




$F_x = T\cos\theta$

$F_x \Delta x = W$

$W = T\cos\theta \,\Delta x$

$W = 450\,N \times \cos(25°) \times 8\,m$

$W = 3.3 \times 10^3\,J$

3.


Truck travels in circular path so it feels a radial force of $\frac{mv^2}{r}$ towards the center

$$F_f = \frac{mv^2}{r}$$

$$\mu_s mg = \frac{mv^2}{r}$$

$$v = \sqrt{gr\mu}$$

$$v = \sqrt{(9.8\,m/s^2)(35\,m).6}$$

$$V = 14.3\ m/s$$

4.

$$W = F \cdot s = F \cdot \Delta x$$

$$W = ma\Delta x$$

$$v_f^2 = v_i^2 + 2a\Delta x$$

$$m\frac{v_f^2 - v_i^2}{2} = ma\Delta x$$

$$W = m\left[\frac{v_f^2 - v_i^2}{2}\right]$$

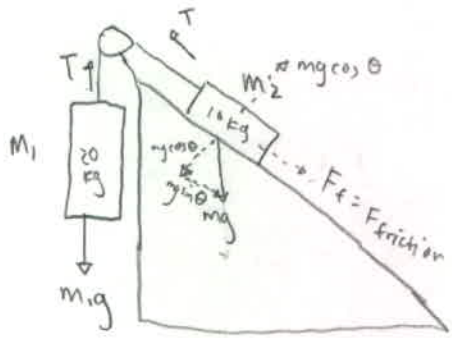
$$\frac{2W}{m} = v_f^2 - v_i^2$$

$$v_f = \sqrt{\frac{2W}{m} + v_i^2}$$

$$v_f = \sqrt{\frac{2 \times 4 \times 10^5}{1416\,kg} + \left(10\,\frac{m}{s}\right)^2}$$

$$v_f = 25.8\ m/s$$

5.




$$m_1 g - T = m_1 a$$

$$T - F_f - m_2 g \sin\theta = m_2 a$$

$m_1 = 20$ kg, $m_2 = 10$ kg, so $m_1 = 2m_2$

$$m_1 g - T = 2m_2 a$$

$$\frac{2m_2 g - T}{2} = m_2 a$$

$$\frac{2m_2 g - T}{2} = T - F_f - m_2 g \sin\theta$$

$$2m_2 g - T = 2T - 2F_f - 2m_2 g \sin\theta$$

$$2m_2 g(1 + \sin\theta) = 3T - 2F_f$$

$$F_f = m_2 g \cos\theta \, \mu_f$$

$$\frac{2m_2}{3} g (1 + \sin\theta + \cos\theta \mu_f) = T$$

from 1st equation

$$T = m_1(g - a) = 2m_2(g - a)$$

$$2m_2(g - a) = \frac{2}{3} m_2 g (1 + \sin\theta + \cos\theta \mu_f)$$

$$g - a = \frac{1}{3} g (1 + \sin\theta + \cos\theta \mu_f)$$

$$a = g - \frac{1}{3} g (1 + \sin\theta + \cos\theta \mu_f)$$

$$a = 9.8 \frac{m}{s^2} - \frac{9.8}{3} \frac{m}{s^2} (1 + \sin(30°) + \cos(30°) .3)$$

$$a = 4.1 \, m/s^2$$

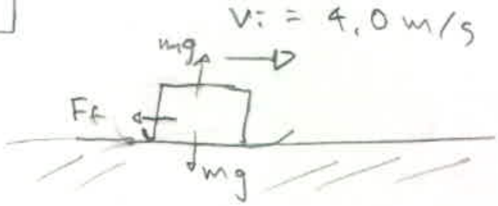
6.

$$\Delta E = mg\Delta h$$

$$\Delta E = (60\,kg)(9.8\,m/s^2)(4.0\,m) = 2352\,J$$

Ave Power $\frac{2352\,J}{4.2\,s} = 560\,W$

7.




$$E_1 = E_2 = \frac{1}{2} m v_1^2$$

$$W = F_f \Delta X = \mu_k mg \Delta x$$

$$E_2 = W_{(\text{to get there})} + \frac{1}{2} m v_2^2$$

$$E_2 = E_1$$

$$\mu_k mg \Delta x + \frac{1}{2} m v_2^2 = \frac{1}{2} m v_1^2$$

$$\Delta x = \frac{\frac{1}{2}(v_1^2 - v_2^2)}{g \mu_k}$$

$$\Delta x = \frac{\frac{1}{2}\left(4^2 \frac{m^2}{s^2} - 2^2 \frac{m^2}{s^2}\right)}{9.8 \frac{m}{s^2} \times .2}$$

$$\Delta x = 3\ m$$

8.

$$(\hat{i}, \hat{j}) = (\hat{x}, \hat{y})$$

$$\vec{F} = (4x^3, 3y^2) \text{ N}$$

$$W = \int \vec{F} \cdot \vec{dr}$$

$$\vec{F} = (F_x, F_y)$$

$$d\vec{r} = (dx, dy)$$

$$\vec{F} \cdot d\vec{r} = F_x\,dx + F_y\,dy$$

$$W = \int \vec{F} \cdot \vec{dr}$$

$$W = \int_{(x=1,\,y=2)}^{(x=3,\,y=4)} (F_x\,dx + F_y\,dy)$$

$$W = \int_1^3 F_x\,dx + \int_2^4 F_y\,dy$$

$$W = \int_1^3 4x^3\,dx + \int_2^4 3y^2\,dy$$

$$W = \left(x^4\Big|_1^3 + y^3\Big|_2^4\right) \text{ J}$$

$$W = \left([3^4 - 1^4] + [4^3 - 2^3]\right) \text{ J}$$

$$W = (80 + 56) \text{ J}$$

$$W = 136 \text{ J}$$