Friction

1. A sled of mass 50 kg is pulled along snow covered, flat ground. The static friction coefficient is 0.3, and the sliding friction coefficient is 0.1.
   a. What does the sled weigh? $W = mg$ $= 50\,kg\ 9.8\frac{m}{s^2} =$ $4.90 \times 10^2 N$
   b. What force will be needed to start the sled moving? $F_{NET} = F_m - F_f$ $0 = F_m - F_f$ $F_m = F_f$ $F_f = \mu mg = (.3)490 =$ $1.47 \times 10^2 N$
   c. What force is needed to keep the sled moving at a constant velocity? $F_{NET} = F_m - F_f$ $F_m = F_f = (.1)\ 490 =$ $4.9 \times 10^1 N$
   d. Once moving, what total force must be applied to the sled to accelerate it 3 m/s2? $F_{NET} = F_m - F_f$ $(50)(3) = F_m - [.1(490)] =$ $1.99 \times 10^2 N$

2. A force of 40 N accelerates a 5 kg block at 6 m/s2 along a horizontal surface.
   $F_{NET} = 5(6) = 30N$
   a. How large is the frictional force? $F_{NET} = F_m - F_f$ $30N = 40 - F_f$ $F_f = 10N$
   b. What is the coefficient of friction? $F_f = \mu mg = 10N = \mu\ 5(9.8)$ $\mu = 0.2$

3. A 200 kg crate is pushed horizontally with a force of 700 N. If the coefficient of friction is 0.2 calculate the acceleration of the crate. $F = ma$ $F_f = (.2)\ (200)9.8 = 392N$ $F_{NET} = F_m - F_f = 700N - 392N = 308N$ $308 = 200a$ $a = 1.54\frac{m}{s^2}$

4. Safety engineers estimate that an elevator can hold 20 persons of 75 kg ~~each~~ average mass. The elevator itself has a mass of 500 kg. Tensile strength tests show that the cable supporting the elevator can tolerate a maximum force of 2.96 x 104 N. What is the greatest acceleration that the elevator's motor can produce without breaking the cable? $F_{NET} = F_m - F_D$ $F_m = 4.92 \times 10^4 N$ $2.96 \times 10^4 = F_m - 19600N$ $F = ma$ $4.92 \times 10^4 = 2000a$ $a = 24.6\frac{m}{s^2}$

   F=? $F_{NET} =$ $2.96 \times 10^4 N$ 2000kg W = 19600N

5. The instruments attached to a weather balloon have a mass of 5 kg.
   a. The balloon is released and exerts an upward force of 98 N on the instruments. What is the acceleration of the balloon and instruments?
   b. After the balloon has accelerated for 10 s, the instruments are released. What is the velocity of the instruments at the moment of release?
   c. What net force acts on the instruments after their release?
   d. When does the direction of their velocity first become downward?

98N 5kg W 49N

a) $F_{NET} = F_U - F_D$ $= 98N - 49N$ $F_{NET} = 49N$ $F = ma$ $49N = 5kg\ a$ $a = 9.8\frac{m}{s^2}$

b) $a = \frac{\Delta V}{\Delta t}$ $9.8\frac{m}{s^2} = \frac{\Delta V}{10s}$ $V = 98\frac{m}{s}$

c) GRAVITY

d) $V_i = 98\frac{m}{s}$ $V_f = 0$ $V_f = V_i + at$ $0 = 98\frac{m}{s} + 9.8\frac{m}{s^2}t$ $t = 10s$