1. (10 pts)
   (a) Use $D = (1/2)at^2$, with $D = 1/4$ mile $= 402.3$ meters (using 400 meters is fine too), and $a = 9.8$ m/s$^2$. This gives t = a little over 9 seconds (9.06 seconds if you use 402.3 meters)
   (b) If you simply plugged in the height of the space shuttle, you would not get the correct time. This is because "g" is smaller further away from the Earth (but still not near zero), so you could not use g = 9.8. Furthermore, g is changing as you approach the Earth, so you'd have to take an average "g" or use calculus. (On top of this, there's the problem of air drag, which we really could not ignore.)

2. (10 pts) This law really says "For every force that object A exerts on object B, object B exerts the same magnitude force, but in opposite direction, back on object A." So the forces are on two different objects. The total force on any one object does not by any means have to be zero. For example, in class I sat on a cart and threw a medicine ball. As I pushed on the ball, it moved to the right. The ball exerted the same force back on me, so I moved to the left. Thus we both moved.

3. (10 pts) Use the definition of acceleration: a = (change in velocity)/(change in time) = $(1 \text{ m/s})/(2\text{s}) = 0.5$ m/s$^2$. This acceleration is caused by the force of friction, so F=ma=(70 kg)(0.5 m/s$^2$) = 35 Newtons.

4. (10 pts) You must sketch this for full credit. In order to stay balanced, your center of mass must be within your support base. When your feet are turned away from each other, you can lean over further without falling, since the extent of your support is increased.

5. (20 pts) (a) Suppose you climb 3 flights of stairs, each of 10 steps, and the vertical height of each step is 20 cm. This is a total of 6 meters.
   (b) It took 9 seconds to climb the 6 meters.
   (c) If the person's weight is 150 pounds, this is about 68.2 kg)
   (d) Power = work/time = mgh/t = (68.2 kg)(9.8 m/s$^2$)(6 m)/(9s) = (4010 J)/(9s) = 446 Watts, or about 0.6 hp
   (e) 4186 Joules = 1 food calorie, so 4010 Joules gives 0.96 food calories, at 100% efficiency.
   (f) With a more realistic 20% efficiency, your body burns five times the number calculated above, or about 4.8 food calories.

6. (20 pts)
    (a) the scale reads 40 pounds, so this is the force the feet are exerting on the floor. Newton's $3^{rd}$ law says this is also the force the floor is exerting on the feet
    (b) the feet and hands combined support all the weight, and 120 pounds is what's left
    (c) balance the torques about any axis; this is the condition for no rotation
    (d) for example, I'll pick the point of contact between the feet and the floor as the axis; then balancing the torques gives: (D1)(weight)=(D1 +D2)(force of floor on hands) or putting in numbers: (D1)(160)=(1.4)(120) which gives D1 = 1.05 meters. Then D2 = 1.4 - 1.05 = 0.35 meters.
    (e) D1/D2 = 3. This is the same as the hands/feet ratio of force.
    (f) you should have measured D1 and D2 for your own body. Let's say you measure D1= 1 meter and D2 = .5 meter. Then D1/D2 is 2. This means if your weight is W, your hands are supporting 2W/3, or about 66%, and your feet are supporting W/3, or about 33%.

7. (20 pts)
    (a) you must sit on the side with the lighter child; this is the only way you can supply clockwise torque to help it balance
    (b) call the distance from your center of mass to the fulcrum "x"; then to balance the torques: (5 ft)(50 lbs) = (x)(130 lbs) + (5 ft)(24 lbs). This gives x = 1 foot.
    (c) It doesn't matter what the seesaw weighs as long as its center of mass (which is the center of the plank) is over the fulcrum. Then the seesaw itself doesn't add any torque, because the lever arm for that force is zero. If the fulcrum is not under the center of the seesaw, then its mass DOES matter.