1. Suppose a rocket has a weight of 10,000 N, and the rocket motor’s thrust is 25,000 N upward. Find the upward acceleration of the rocket. (Hint: you will have to find the mass first.)

We have to draw a free-body diagram (also called a force diagram) of the rocket to start. The upward thrust is 25,000 N, and the weight $mg$ of the rocket is 10,000 N. Since these are in opposite directions, the net force is

$$F_{NET} = 25,000 \text{ N} - 10,000 \text{ N} = 15,000 \text{ N}$$

Now, we must know the mass to find the acceleration. We know that $10,000 \text{ N} = mg$, so solve for $m$:

$$m = \frac{10,000 \text{ N}}{9.8 \text{ m/s}^2} = 1020 \text{ kg}.$$ 

Now we apply Newton’s second law:

$$F_{NET} = ma$$

$$a = \frac{F_{NET}}{m} = \frac{15,000 \text{ N}}{1020 \text{ kg}} = 14.7 \text{ m/s}^2.$$ 

2. A parent pulls his child on a sled at a constant velocity. The forward force exerted by the rope is 30.0 N. The mass of the child plus sled is 40.0 kg.

(A) Draw a force diagram for the sled, showing all forces including friction.

(B) What is the magnitude (size) of the force of friction? How do you know?

(C) Suppose the parent increased the forward force to 40.0 N (instead of 30.0 N.) What would the acceleration of the sled be then?

(D) Now suppose the parent lets go of the tow rope, so there is no forward force. Immediately after, what is the acceleration of the sled? Do we have enough information to determine how long the sled will continue to move forward?

(A)
(B) The velocity is constant, so we know that acceleration $a$ is zero. That means that the net force on the sled must be zero. Since the only two horizontal forces are the rope’s force and friction, they must be equal and opposite. Therefore $f = 30 \text{ N}$.

(C) If the rope’s force is 40.0 N, then the net force is now $40.0 \text{ N} - 30.0 \text{ N} = 10.0 \text{ N}$. We may apply Newton’s second law:

$$F_{\text{NET}} = ma$$
$$a = \frac{F_{\text{NET}}}{m} = \frac{10 \text{ N}}{40 \text{ kg}}$$
$$= 0.25 \text{ m/s}^2$$

(D) If the rope’s force goes to zero, the only force left is friction, which is -30 N. So again, applying the second law,

$$a = \frac{F_{\text{NET}}}{m} = \frac{-30 \text{ N}}{40 \text{ kg}}$$
$$= -0.75 \text{ m/s}^2 \text{(in the reverse direction)}$$

No, we don’t have enough information to find how long it travels. We would have to know the initial velocity to do that.