

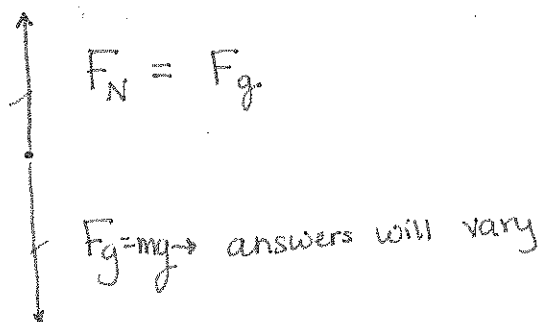
## PRACTICE WITH MASS, WEIGHT, AND EQUILIBRIUM ANSWER KEY

**Instructions:** Answer the following questions in your journal. Make sure to draw a FBD for each situation and show all of your work completely.

1. Suppose the acceleration of an object is zero. Does this mean that there are NO forces acting on it? Give an example supporting your answer.

NO! The object could be at rest with the forces cancelling out (trying to move a fridge, but friction cancels applied force) OR it could be moving at a constant velocity (skydiver falling at terminal velocity - weight is balanced by air resistance)

2. Draw a QUANTITATIVE free body diagram for you standing on the floor. Estimate your weight, and show your work for the conversion. (1 lb = 0.454 kg)



3. What is the weight of a 10.0 kg anvil on the surface of Mercury (g on Mercury is 0.38 times that on Earth)?

$$F_g = m \cdot g_{\text{mercury}} \quad g_{\text{mercury}} = 0.38 g_{\text{Earth}} = 0.38 (9.80 \text{ m/s}^2)$$

$$F_g = (10.0 \text{ kg})(3.72 \text{ m/s}^2)$$

$$F_g = 37.2 \text{ N}$$



4. George has a mass of 70.0 kg and then heads out in his homemade rocket to the moon ( $g_{\text{moon}} = 1.60 \text{ m/s}^2$ ).



- Once on the surface of the moon, he *weighs* himself on a Newton scale. What will it read? (Ignore his spacesuit's mass)
- What was Pat's *weight* back on Earth?
- Compare Pat's *mass* on Earth and on the Moon.

a.  $F_g = m g_{\text{moon}}$   
 $= (70.0 \text{ kg})(1.60 \text{ m/s}^2)$

$$F_g = 112 \text{ N}$$

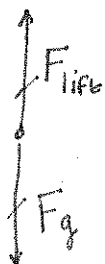
b.  $F_g = m \cdot g_{\text{earth}}$   
 $= (70.0 \text{ kg})(9.80 \text{ m/s}^2)$

$$F_g = 686 \text{ N}$$

c. His MASS is ALWAYS 70.0 kg! It doesn't change with location

5. On Planet X, a 50.0 kg barbell can be lifted by exerting a force of 180 N.

- What is the acceleration of gravity on Planet X?  $\rightarrow$  Assume  $v = \text{constant}$
- If the same barbell is lifted on Earth, what force is needed to hold it (at rest)?



a.  $F_{\text{NET}} = F_{\text{lift}} - F_g = 0$

$$F_g = F_{\text{lift}} \Rightarrow m g_x = F_{\text{lift}}$$

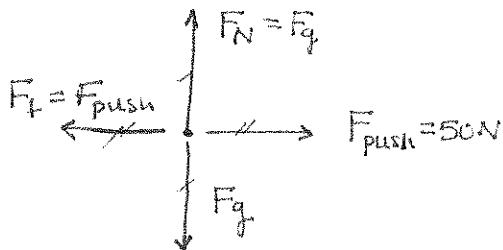
$$g_x = \frac{F_{\text{lift}}}{m} = \frac{180 \text{ N}}{50.0 \text{ kg}}$$

$$g_x = 3.60 \text{ m/s}^2$$

b.  $F_g = m g$   
 $= (50.0 \text{ kg})(9.80 \text{ m/s}^2)$

$$F_g = 490 \text{ N}$$

6. You are pushing a wooden tea crate across the floor at a constant speed. If you are pushing horizontally with a force of 50 Newtons, what is the force of friction acting on the crate? **(draw a free body diagram depicting all the forces acting on the crate)**



$$F_{NET} = 0N \Rightarrow \text{dynamic equilibrium}$$

$$F_{NET} = 0N = F_{push} - F_{friction}$$

$$F_f = F_{push} = 50N$$

7. For the following situations, draw a FBD and find the magnitudes of the forces involved.

- A 70.0 kg skydiver falls downward through the air at a constant velocity.
- A cable pulls a 5.0 kg crate at a constant speed across a horizontal surface with a force of 25 N.
- After takeoff, a 7500 kg rocket's vertical velocity is constant.

(ignoring air resistance)

