Name: ___________________________________

1: _______/24 + ______ late

2: _______/11 + ______ late

3: _______/8 + ______ late

4: _______/12 + ______ late

5: ______/ 7 + ______ late

Incorrect/incomplete: –______

Scaled score: ______/50

Unit 3 Learning Goals – Force and Newton's Laws

Goal Set 1:

Students will be able to qualitatively and quantitatively analyze net external force and common forces.

4.0	I can analyze complex problems involving net external force and common forces.
3.0	**I can qualitatively and quantitatively analyze net external force and common forces.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Vectors, vector diagrams, component vectors, resultant vectors, free-body diagrams. • Force, contact force, field force, strong nuclear force, weak nuclear force, electromagnetic force, gravitational force, weight, mass, normal force. I am able to… • Create vector diagrams and perform vector addition and vector resolution. • Draw free-body diagrams. • Distinguish between the four different types of forces in our universe by comparing and contrasting them and ranking them both from strongest to weakest and from largest range to smallest range. • Distinguish weight from mass by comparing and contrasting them both qualitatively and quantitatively and generating examples of each. • Analyze normal force conceptually, qualitatively, and quantitatively.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) Define force and state its SI units.

2.) Contrast field forces from contact forces.

3.) Briefly describe the following types of forces by stating (A) what they act on (B) their relative strength and (C) their relative range of action.

a. Strong nuclear

b. Weak nuclear

c. Electromagnetic

d. Gravitational

4.) What is the measure of the quantity of matter?

5.) What is the measure of the force of gravity pulling on matter?

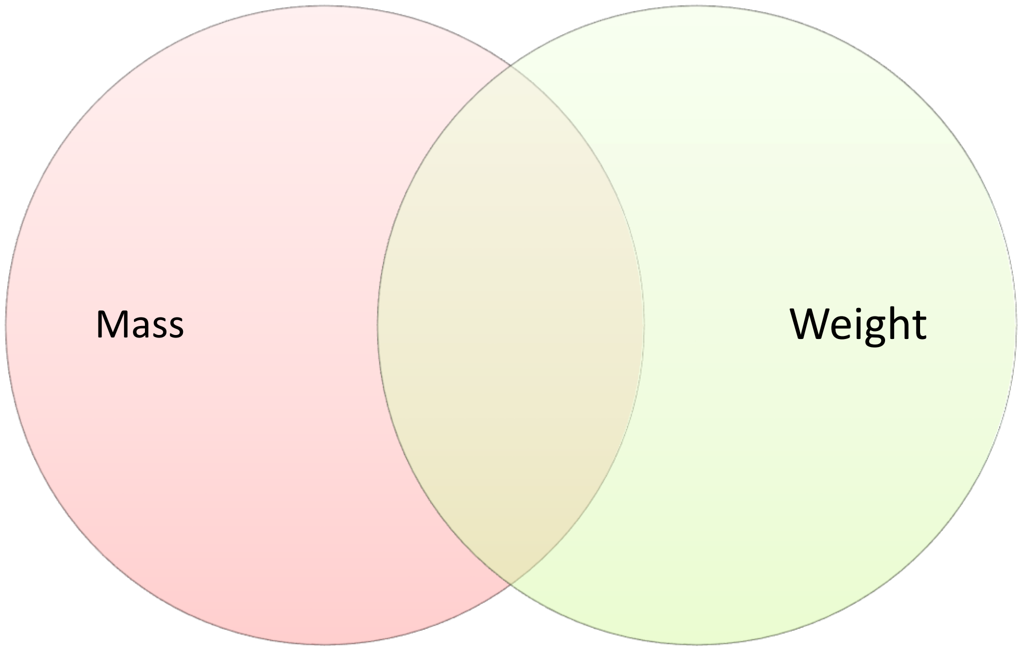
6.) What are the units that describe the amount of matter in something?

7.) What are the units describing weight?

8.) If you were to travel to outer space, what would change: your mass, your weight, both, or neither?

9.) If you were to step on a bathroom scale on the moon where the gravitational pull is about $^1/_6$ of Earth's, would it give you a higher, lower, or equal reading to what it would read on Earth?

10.) Create a Venn Diagram for weight and mass:



11.) Draw a free-body diagram for an object resting on a flat surface.

12.) Draw a free-body diagram for an object resting on a slanted surface.

13.) Draw a free-body diagram for an object that is being held up by a hand pushing it against a wall.

14.) What is the normal force acting on a 10 kg dog as it rests on the floor?

15.) What is the normal force on a 200 N suitcase as it rests on the floor?

16.) If you very slightly lift the suitcase from question 15 as you slide it across the floor, does the normal force increase, decrease, or remain the same?

Level 3.0

1.) The Liberty Bell in Philadelphia is a 940 kg object that hangs from the same beam ("yoke") of American elm that it was originally hung from.

   a. What's the bell's mass?

   b. What's its weight?

   c. Draw a free-body diagram for the Liberty Bell as it hangs at rest from the yoke.

2.) A giant 52kg crate marked “Fragile” rests upon the floor of the living room floor while Ralphie Parker stares at it with amazed curiosity. Ralphie’s ecstatic dad pushes the crate to move it to an area where he can pry it open. The Old Man (Ralphie’s dad) pushes with 45 N. (Ignore the effects of friction.)

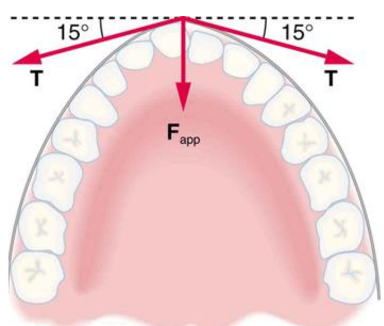
   a. Draw a free-body diagram to describe the crate.

   b. Draw a vector diagram to describe the crate.

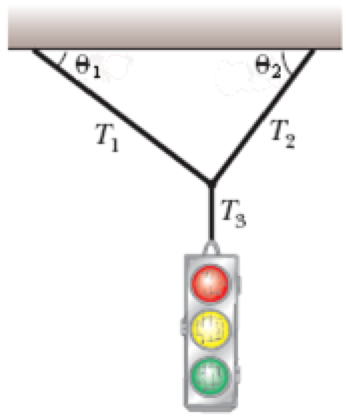
   c. Calculate the net external force on the crate.

<u>Level 4.0</u>

1.) An orthodontist creates a plan to push a tooth into place. The drawing below shows the treatment plan, and the wires are placed so that there is 21 N of force on each side of the tooth, as shown by the two forces T above. What is the net force pushing back on the tooth?



2.) Garret Morgan (1877-1963) was a black Cleveland inventor who patented the three-position stoplight (among other successes.) Here we see a modern stoplight supported by the tension forces in three wires such that θ_1 = 22º and θ_2 = 38º. If the stoplight is 6.8 kg and the tension force T_2 equals 72.8 N, what is the tension force T_1?



Goal Set 2:

Students will be able to analyze situations in which kinetic friction or static friction occur in order to determine how an object will move.

4.0	I can analyze complex situations in which kinetic friction or static friction occur in order to determine how an object will move.
3.0	**I can analyze situations in which kinetic friction or static friction occur in order to determine how an object will move.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Kinetic friction, static friction, normal force, mass, weight, net external force. I am able to… • Calculate net external force, mass, weight, and normal force. • Distinguish kinetic friction from static friction by recognizing and generating examples that compare and contrast both. • Calculate kinetic friction and static friction.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) Define friction.

2.) Define kinetic friction.

3.) Define static friction.

4.) Compare kinetic friction and static friction by identifying how they are similar.

5.) Contrast kinetic friction and static friction by identifying how they are different and by comparing their relative magnitudes. (In other words, which is greater.)

6.) A carpenter slides a 0.532 kg wooden block along her wooden work table. The coefficient of static friction for clean, dry wood on clean, dry wood is 0.30. The coefficient of kinetic friction is 0.25.

   a. How hard does the carpenter have to push to make the block start to slide?

   b. How hard does the carpenter have to push to keep the block in motion once it begins to slide?

Level 3.0

1.) Think back to a situation in which you had to push or pull something very heavy along the ground or the floor. Once you got the object moving, you probably tried to keep the object moving for as long as you could bear it before stopping. Explain this natural inclination in terms of the physics associated with this learning goal.

2.) Look back at question 6 from level 2.0. What would happen if…

   a. What would happen to the force required to move the block if the block were more massive? Explain.

   b. What would happen to the force required to move the block if the table were smoother? Explain.

   c. What would happen to the force required to move the block if the carpenter simultaneously pushed down on the block with her hands as she slid it? Explain.

Level 4.0

Look back at question 6 from level 2.0. Recalculate the answers for a situation in which the block was moving along a wooden ramp that was inclined at an angle of 12^o above horizontal?

Goal Set 3:

Students will be able to analyze elastic force qualitatively and quantitatively.

4.0	I can analyze complex situations involving elastic force.
3.0	**I can analyze elastic force qualitatively and quantitatively.**
2.0	I can recognize, recall, and explain specific vocabulary including: • Elastic force, spring constant. I am able to… • Relate the sign of the displacement of a spring to the sign of the elastic force.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) Define elastic force qualitatively and semi-quantitatively.

2.) Define spring constant and relate it to the stiffness of a spring. Include a discussion of the meaning of its units (N/m).

3.) As spring constant increases, the amount of force required to stretch the spring (increases/decreases – Circle one.) Therefore, explain how spring constant relates to the amount of elastic force created when a spring is stretched.

4.) Explain why there is a negative sign in the elastic force equation.

Level 3.0

1.) Two springs, A & B, are each stretched 0.02 m. It takes more force to stretch spring A. For the following two values, circle which is greater: Spring A or Spring B.

a. The elastic force within the spring now that it's stretched: Spring A Spring B
b. The spring constant: Spring A Spring B

2.) Two identical 0.250 kg masses hang from Spring C and Spring D. Spring C stretches 0.211m, and Spring D stretches 0.0560 m.
a. What is the spring constant for Spring C?

b. What is the spring constant for Spring D?

c. Which spring is stiffer?

Level 4.0

A person who weighs 670 N steps onto a scale in the bathroom. This particular scale works by compressing a spring. When the person steps on the scale, the spring compresses by 0.79 cm (7.9E-3 m).

1.) What is the spring constant of the spring?

2.) What is the weight of another person who compresses the spring by 0.34 cm (3.4E-3 m)?

<u>**Goal Set 4:**</u>

Students will be able to analyze the motion of an object in terms of the inertia of the object.

4.0	I can analyze complex problems involving inertial mass, inertia, and static equilibrium.
3.0	**I can analyze the motion of an object in terms of the inertia of the object.** • **This includes analyzing the inertial mass of an object.** • **This includes analyzing objects in and out of static equilibrium.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Mass, weight, inertial mass, inertia, static equilibrium. I am able to… • Distinguish mass from weight. • Draw or interpret a free-body diagram.
1.0	With help, partial success at 2.0 content

Check yourself:

<u>**Level 2.0**</u>

1.) Define mass:

2.) Explain how mass and weight are different. Include a reference to their units.

3.) Explain how inertia relates to mass.

4.) What does the phrase "inertial mass" mean?

5.) For an object that is in static equilibrium, describe:

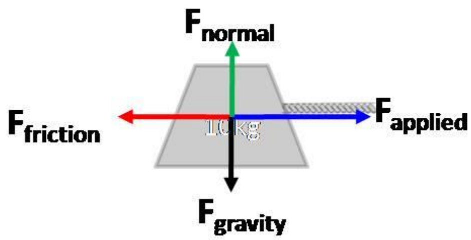
a. The net external force on the object.

b. The acceleration of the object.

6.) Regarding the free-body diagram below…

a. Is the object maintaining its velocity? (Circle one.) Yes No

b. Explain how you know.



Level 3.0

1.) A truck at a stoplight takes off with a lot of acceleration, and a ladder that had been improperly attached to the top falls off the back and lands on the street. Why does this happen?

2.) A ball rolling along the floor experiences some static friction yet keeps rolling for a long time. Why does this happen?

3.) Generate an example of an object that is at rest while in static equilibrium. Include a properly-labeled free-body diagram to prove that the object is in static equilibrium.

4.) Generate an example of an object that is moving while in static equilibrium. Include a properly-labeled free-body diagram to prove that the object is in static equilibrium.

5.) Imagine that you are at a stoplight. Sitting on your dashboard are the following items: your cell phone, a piece of paper with the phone number of your new crush, and one of those little Hawaiian hula girl figurines that is stuck with adhesive to the dashboard. When the light turns green, you accelerate forward faster than you intended to. Only one of the objects falls off of the dashboard onto the floor of the car. Which object is it, and why does it fall even though the other items don't?

Level 4.0

1.) Describe how the law of inertia relates to projectile motion.

2.) Is a net force being applied to an object when the object is moving downward with (a) an acceleration of $-9.80\ m/s^2$ and (b) with a constant velocity of $-9.80\ m/s$? Explain.

Goal Set 5:

Students will be able to analyze motion qualitatively and quantitatively in relationship to net external force, mass, acceleration and the other kinematic values based on Newton's second law and kinematic principles.

4.0	I can analyze complex problems involving net external force and kinematic values.
3.0	**I can analyze motion qualitatively and quantitatively in relationship to net external force, mass, acceleration and the other kinematic values based on Newton's second law and kinematic principles.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Net external force, mass, weight, acceleration, velocity, displacement, kinematics. I am able to… • Calculate net external force. • Perform calculations using the kinematic equations and the formula from Newton's second law.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

1.) A car moving at 12 m/s skids to a stop in 1.7 seconds. How long are the skid marks that the tires made?

2.) A 1.2 kg duck swims in a lake. It experiences 11.8 N of buoyant force[1] from the water, and it propels itself forward by applying 35 N of force to the water. While it does that, it experiences 25 N of resistance force from the water.

a. Draw a free-body diagram for the duck.
b. What is the net external force on the duck?
c. What is the duck's acceleration?

Level 3.0

1.) In an amusement park ride, powerful magnets accelerate a car and its riders from rest to 45 m/s (about 100 miles per hour) in 7.0 s. The mass of the car and riders is 5.5×10^3 kg.

a. What is the acceleration of the car?

b. What is the net force applied to the car?

2.) During a circus performance, a 72 kg human cannonball is shot out of an 18 m long cannon. If the human cannonball spends 0.95 s in the cannon, determine the average net force exerted on her in the barrel of the cannon?

[1] Buoyant force is the support force that the water applies to the duck preventing it from sinking.

Level 4.0

A duck has a mass of 2.5 kg. The duck is initially at rest when a wind gust applies a force of 0.10 N in a direction due east. In addition, the current of the water exerts a force of 0.20 N in a direction of 52^{o} south of east. Find the magnitude and direction (relative to east) of the displacement that the duck undergoes in 3.0 s while the forces are acting.

Goal Set 6:

Students will be able to analyze motion qualitatively and quantitatively in relation to action and reaction forces.

4.0	I can analyze complex problems involving Newton's third law, net external force, and kinematic values.
3.0	**I can analyze motion qualitatively and quantitatively in relation to action and reaction forces.**
2.0	I can recognize, recall, and explain specific vocabulary and concepts including: • Action force, reaction force. I am able to… • Explain Newton's third law. • Identify action and reaction forces and distinguish them from the results created by application of those forces.
1.0	With help, partial success at 2.0 content

Check yourself:

Level 2.0

Your fist applies a bump to your friend's fist.

1.) Identify the action and reaction forces involved in this situation.

2.) Draw a free-body diagram for your fist.

3.) Draw a free-body diagram for your friend's fist.

4.) Explain why your free-body diagrams look the way they do.

Level 3.0

1.) A cheerleader practices her toe touches by jumping on a trampoline. As she comes down on the trampoline, she and the trampoline interact.

a. Draw a free-body diagram for the cheerleader.

b. In which direction does the net external force on the cheerleader point?

c. What is the sign of the cheerleader's acceleration?

d. Comparing your answer to (c) to the cheerleader's velocity when the collision with the trampoline occurred, explain why the cheerleader stops moving downward and starts moving upward.

e. Draw a free-body diagram for the trampoline's fabric surface. (Don't include the whole trampoline.)

f. In which direction does the net external force on the trampoline's fabric surface point?

g. What is the sign of the trampoline's fabric surface's acceleration?

h. Comparing your answer to (g) to the trampoline's fabric surface's velocity when the collision with the cheerleader occurred, explain why the trampoline stretches downward.

2.) A 120kg rollerskater applies 50 N of force to a wall to push himself. He experiences 20 N of static friction, which he overcomes as he starts to move. What is his acceleration?

Level 4.0

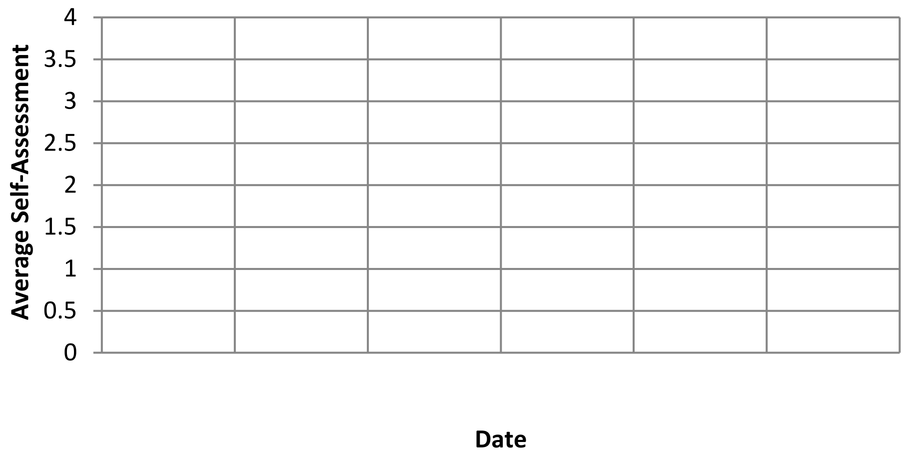
A reindeer pulls a sleigh. Here are the forces involved in the scenario, which involves the sleigh and reindeer as a system of objects. Consider the Earth to be outside of this system.

- The sleigh experiences friction.
- The reindeer pulls the sleigh forward.
- The reindeer pushes the ground backwards.
- Gravity acts on both the reindeer and the sleigh.
- The ground supports both the reindeer and the sleigh so that they do not sink.

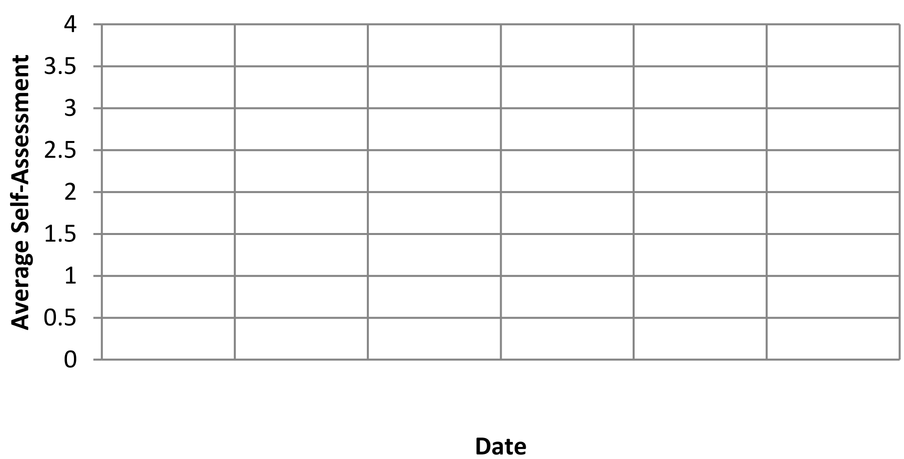
Draw a free-body diagram on both the sleigh and the reindeer, and explain why the reindeer-sleigh system moves forward even though the reindeer pulls the sleigh forward, and the sleigh pulls the reindeer backward.

<u>Chart your Progress</u>

Goal Set 1



Goal Set 2




Goal Set 3
Average Self-Assessment
4
3.5
3
2.5
2
1.5
1
0.5
0
Date


Goal Set 4
Average Self-Assessment
4
3.5
3
2.5
2
1.5
1
0.5
0
Date


Goal Set 5
4
3.5
3
2.5
2
1.5
1
0.5
0
Average Self-Assessment
Date


Goal Set 6
4
3.5
3
2.5
2
1.5
1
0.5
0
Average Self-Assessment
Date