Mid Term Review

Unit 1: Experimental Design, Measurement and Scientific Notation

1. Perform the following conversions
   a. 15 miles to km (1609 meters = 1 miles))

✓mi → m
✓m → km

$$15\ \text{mi} \left|\frac{1609\ \text{m}}{1\ \text{mi}}\right| \left|\frac{1\ \text{km}}{1000\ \text{m}}\right| = \frac{24135\ \text{km}}{1000} = 24.135\ \text{km}$$

   b. 45000 inches to kilometers (3.28 ft = 1 meter)

in → ft
ft → m
m → km

$$\frac{45000\ \text{in}}{} \left|\frac{1\ \text{ft}}{12\ \text{in}}\right| \left|\frac{1\ \text{m}}{3.28\ \text{ft}}\right| \left|\frac{1\ \text{km}}{1000\ \text{m}}\right| = \frac{45{,}000\ \text{km}}{39360} = 1.14\ \text{km}$$

   c. 45 km/h to m/s

✓km → m
✓h → min
✓min → s

$$\frac{45\ \text{km}}{1\ \text{hr}} \left|\frac{1000\ \text{m}}{1\ \text{km}}\right| \left|\frac{1\ \text{hr}}{60\ \text{min}}\right| \left|\frac{1\ \text{min}}{60\ \text{s}}\right| = \frac{45000\ \text{m}}{3600\ \text{s}} = 12.5\ \text{m/s}$$

2. You design an experiment to determine if salt changes the freezing point of an unknown liquid. You add different amounts of salt to different containers with the same amount of the liquid in them. You determine that as you add more salt, the freezing point gets lower and lower. What was the independent and dependent variable in this experiment? Explain your reasoning.

The independent variable is the amount of salt. That is the variable we control and change each time. The dependent variable is the freezing point because that is the variable we are measuring.

3. Put the following numbers into scientific notation
   a. 3,000,000 km/s (the speed of light in a vacuum)

3.0×10^6 km/s

   b. 93,000,000 miles (distance from Earth to the Sun)

9.3×10^7 mi

   c. 15,900 g (approximate mass of Stella)

1.59×10^4 g

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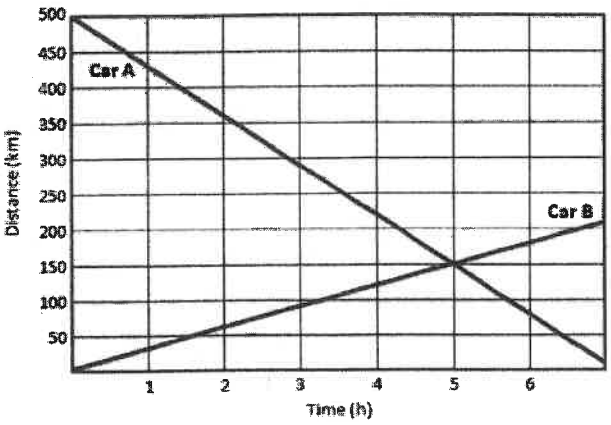
UNIT 2: CONSTANT MOTION

1. The graph to the right shows the distance versus time for two cars traveling on a straight highway.



   a. What can you determine about the relative direction of travel of the cars?

Car A is traveling in a negative direction, while Car B travels in a positive direction.

   b. At what time do they pass one another?

At 5 seconds the lines intersect.

   c. Which car is traveling faster? Explain.

Speed for A: $\frac{150-500\text{ km}}{5\text{ h}} = \frac{-350\text{ km}}{5\text{ h}} = -70\text{ km/h}$

Speed for B: $\frac{150-0\text{ km}}{5\text{ h}} = \frac{150\text{ km}}{5\text{ h}} = 30\text{ km/h}$

Car A goes faster, just in a negative direction.

   d. What is the speed of the slower car?

30 km/h

2. An airplane travels at a constant speed, relative to the ground, of 900.0 km/h.

   a. How far has the airplane traveled after 2.0 h in the air?

$v = 900\text{ km/h}$

$t = 2.0\text{ h}$

$X = vt = (900\text{ km/h})(2.0\text{ h}) = 1{,}800\text{ km}$

   b. How long does it take for the airplane to travel between City A and City B if the cities are 3240 km apart?

$t = \frac{X}{v} = \frac{3240\text{ km}}{900\text{ km/h}} = 3.6\text{ h}$

   c. If a second plane leaves 1 h after the first, and travels at 1200 km/h, which flight will arrive at City B first?

$t = \frac{X}{v} = \frac{3240\text{ km}}{1200\text{ km/h}} = 2.7\text{ h}$

$2.7\text{ h} + 1.0\text{ h} > 3.6\text{ h}$, so the first plane arrives first

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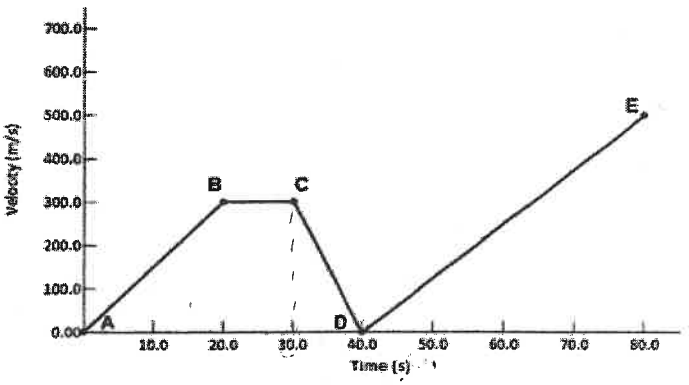
UNIT 3: ACCELERATED MOTION

1. Use the Velocity vs. Time graph to the right to calculate the following of the object whose motion is plotted on the graph.



   a. What is the initial velocity of the object?

$0\ m/s$

   b. What is the acceleration between the points on the graph labeled A and B?

$a = \frac{\Delta V}{t} = \frac{300\ m/s}{20s} = 15\ m/s^2$

   c. What is the acceleration between the points on the graph labeled B and C?

$a = \frac{\Delta V}{t} = \frac{0\ m/s}{10s} = 0\ m/s^2$

   d. What is the acceleration between the points on the graph labeled C and D?

$a = \frac{\Delta V}{t} = \frac{-300\ m/s}{10s} = -30\ m/s^2$

   e. What is the total distance that the object travels between points C and D?

$A = \frac{1}{2}bh = \frac{1}{2}(10)(300) = 1500\ m$

2. If you throw a ball straight upward, it will rise into the air and then fall back down toward the ground. Imagine that you throw the ball with an initial velocity of 13.7 *m/s*.

   a. How long does it take the ball to reach the top of its motion?

$a = \frac{V_f - V_i}{t}$: $-9.8\ m/s = \frac{0 - 13.7\ m/s}{t}$ $(9.8\ m/s^2)t = -13.7\ m/s$ $t = 1.4\ s$

   b. How far will the ball rise before it begins to fall?

$d = \left(\frac{V_i + V_f}{2}\right)t = \left(\frac{13.7\ m/s + 0}{2}\right)1.4\ s = 9.59\ m$

   c. What is its average velocity during this period?

$V_{avg} = \frac{V_i + V_f}{2} = \frac{13.7\ m/s + 0}{2} = 6.85\ m/s$

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Unit 4: Vector Addition and Relative Motion

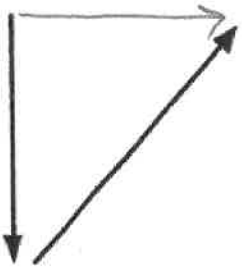
1. You are driving East relative to the ground at a constant speed of 25 mph when you see a dog on the side of the road sitting still (like a good boy). From your perspective, describe the dog's movement.

   The dog is moving 25 mph West.

2. Draw an arrow representing the sum of the following two vectors

   a. 

   b. 

   c. 

3. A duck swims up a river with a velocity of 15 m/s upstream. The water flows with a velocity of 3 m/s downstream. How fast is the duck moving relative to the shore?

   $V = 15\,m/s - 3\,m/s = 12\,m/s$ upstream

4. Jerry walks 30 meters East at a speed of 3 m/s. Terry runs 30 meters North with a speed of 9 m/s. Categorize each of the following as the same or different between the two travellers.

   a. Distance travelled — same
   b. Displacement — different
   c. Speed
   d. Velocity
   e. Direction travelled

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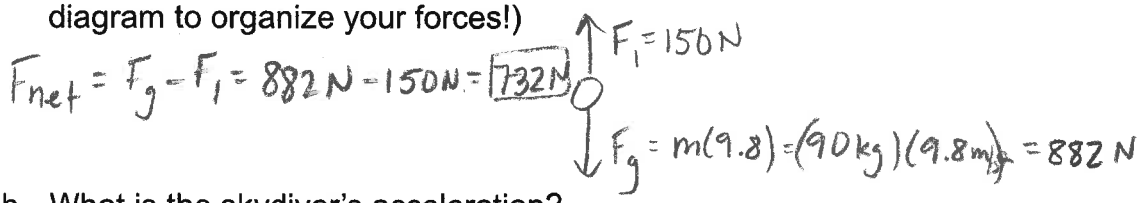
Unit 6: Newton's Laws

1. You and your bike have a combined mass of 80 kg. How much braking force has to be applied to slow you with an acceleration of -2.5 m/s²?

$$F = ma = (80\text{kg})(-2.5\text{m/s}^2) = -200\text{ N}$$

2. Before opening a parachute a skydiver with a mass of 90.0 kg experiences an upward force of 150 N.
   a. What is the net force acting on the skydiver? (Draw a free-body diagram to organize your forces!)



   b. What is the skydiver's acceleration?

$$a = \frac{F}{m} = \frac{732\text{ N}}{90.0\text{kg}} = 8.13\text{ m/s}^2$$

   c. How much force must air resistance exert to make the skydiver fall with a constant speed?

It will have to exert another 732 N to combat the net force so the skydiver will fall in equilibrium.

3. A car traveling at 30 m/s hits a patch of ice and slides into a stationary guard rail. During the slide the diver is unable to change the direction or speed of the car. The collision does noticeable damage to both the car and the guard rail.
   a. Explain how Newton's First Law (Inertia) applies to this situation.

An object in motion wants to stay in motion unless acted upon by an outside force. The car has no outside force to change its motion until it collides with the other car.

   b. Explain how Newton's Third Law (Action/Reaction) applies to this situation.

The force of car A on car B is the same as the force of car B on car A.

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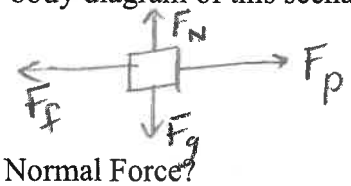
Unit 7: Friction and Forces in 2D

1. A 15 kg box is being pulled horizontally across a rough surface at a constant speed. The coefficient of friction between the box and floor is 0.25.
   a. Draw a free-body diagram of this scenario (don't forget your Fam)



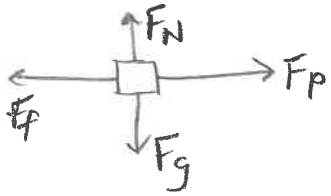
   b. What is the Normal Force?

$$F_N = F_g = m(9.8\,m/s^2) = (15\,kg)(9.8\,m/s^2) = 147\,N$$

   c. What is the frictional force?

$$F_f = \mu F_N = (0.25)(147\,N) = 36.75\,N$$

2. A wagon weighing 98 N has a force of 50 N exerted on it moving it to the right with an acceleration of 1.5 m/s^2.
   a. Draw a free-body diagram of this scenario (don't forget your Fam)



   b. What is the normal force acting on the wagon?

$$F_N = F_g = 98\,N$$

   c. What is the force of friction acting on the wagon?

$$F_{net} = F_p - F_f$$
$$ma = F_p - F_f$$
$$\left(\frac{98\,N}{9.8\,m/s^2}\right)(1.5\,m/s^2) = 50\,N - F_f$$
$$15\,N = 50\,N - F_f$$
$$F_f = 35\,N$$

   d. What is the coefficient of friction between the wagon and the ground?

$$\mu = \frac{F_f}{F_N} = \frac{35\,N}{98\,N} = 0.36$$