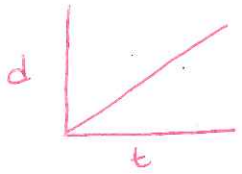
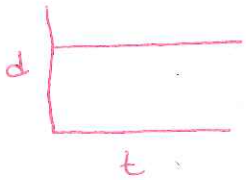
Semester 1 Exam Review A

1) Sketch position vs. time graphs for the following situations:

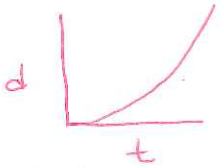
a) An object moving with constant positive velocity



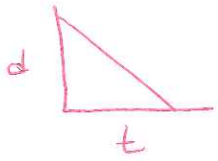
b) An object at rest



c) An object moving with constant acceleration



d) An object moving with constant negative velocity



2) How do you determine the displacement from a position vs. time graph?

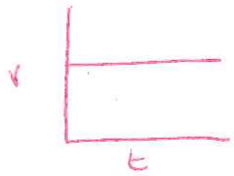
- easiest way is to use calculus to determine area under the curve
- otherwise, use $d = vt$ for constant speed, $d = v_i t + \frac{1}{2}at^2$ for changing speed.

3) How do you determine the velocity of an object from a position vs. time graph?

- slope of the line

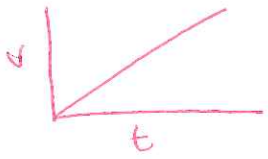
4) Sketch velocity vs. time graphs for the following situations:

a) An object moving with constant positive velocity

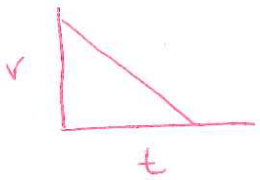


b) An object at rest

c) An object moving with constant positive acceleration



d) An object moving with constant negative acceleration



5) How do you determine the velocity of an object from a velocity vs. time graph?

- read the value of velocity from the graph (y-axis)

6) How do you determine the acceleration of an object from a velocity vs. time graph?

- calculate slope of the line.

7) How long would it take to travel 730 km at an average speed of 80 km/h?

$d = vt$

$730\ km = 80\ km/h\ (t)$

$t = 9.1\ hr$

8) What net force would be required to accelerate a 200-kg box with an acceleration of 4 m/s^2 south?

$F = ma$

$= 200\ kg(4\ m/s^2) =$ 800 N south

9) What acceleration would result from a net force of 200 N acting westward on a person with a mass of 80 kg?

$F = ma$

$200N = 80\ kg\ (a)$ $a = 2.5\ m/s^2$ west

10) A Volkswagen with a small driver has a mass of 1000 kg and can accelerate from rest to 22.4 m/s in 7.9 s. What is the net force on the VW?

$a = \frac{\Delta v}{\Delta t} = \frac{22.4\ m/s}{7.9\ s} = 2.84\ m/s^2$

$F = ma$

$F = 1000(2.84) =$ 2840 N

11) A drop of water falls from an icicle. How long does it take the drop to fall 5 meters?

$d = v_i t + \frac{1}{2} a t^2$

$5m = 0(t) + \frac{1}{2}(-9.8)t^2$

$t = 1.0\ s$

12) What is the average acceleration of a car that changes its velocity from -20 m/s to 20 m/s in 10 s?

$v_f = v_i + at$

$20 = -20 + (a)\ 10$

$a = +4\ m/s^2$

13) A ball is thrown into the air with an initial upward velocity of 19.62 m/s.

a) What is the velocity of the ball after 4 s?

$V_f = V_i + at$

$V_f = 19.62 + (-9.8)4$

$V_f = -19.58$ m/s

b) When should the ball reach its highest point?

$0 = 19.62 + -9.8(t)$

$t = 2.0$ s

c) Where is the ball after 4 s?

$d = 19.62(4) + \frac{1}{2}(-9.8)(4)^2$

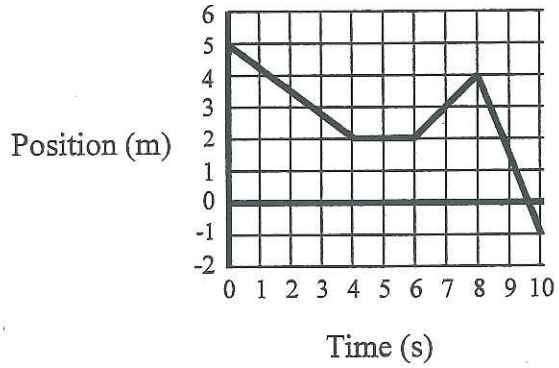
14) Define *vector* and give examples.

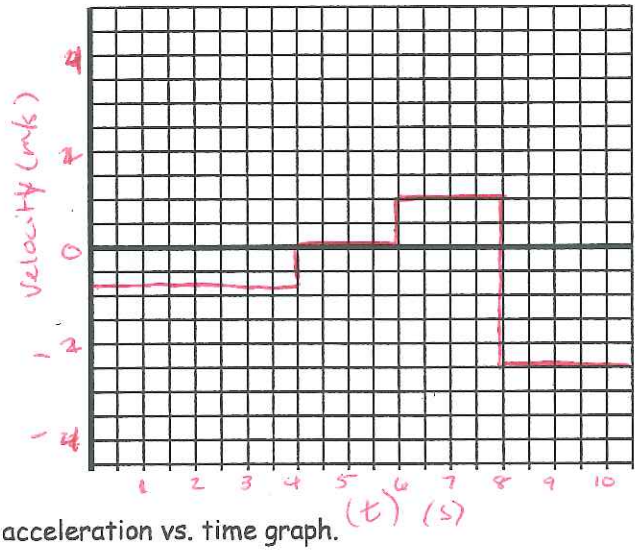
Vector is a magnitude (measurement) and a direction. examples would be velocity (-3 m/s or 45 mph south) or acceleration (-9.8 m/s^2 or down)

15) Define *scalar* and give examples.

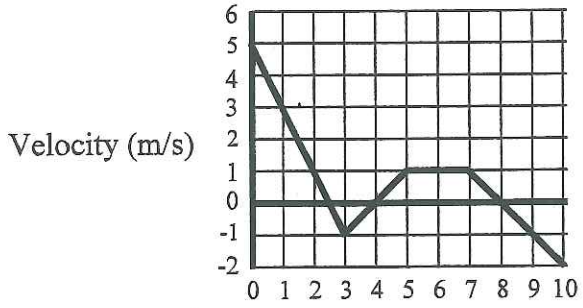
Scalar is a magnitude (without direction). Speed of 45 mph is an example (doesn't tell direction!)

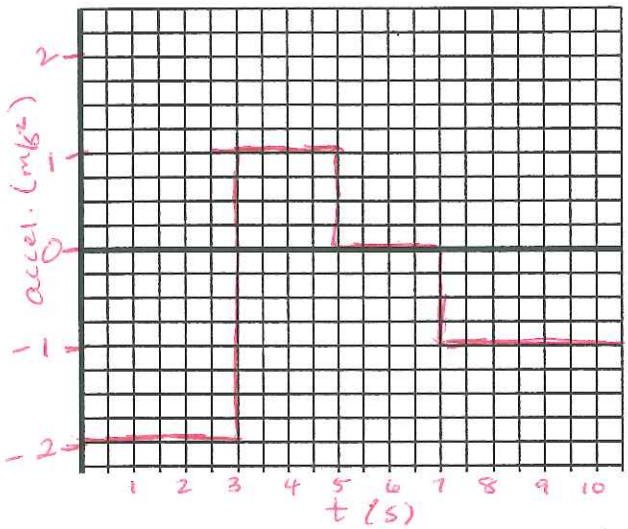
16) Convert the following position vs. time graph to a velocity vs. time graph.



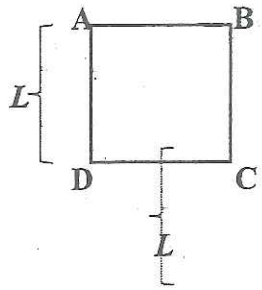


17) Convert the following velocity vs. time graph to an acceleration vs. time graph.





18) An ant is searching for food along the edges of a square picnic table of length L on each side. The corners of the table are labeled A, B, C, and D as in the figure on the right. The ant walks along the edge of the table from corner A to corner B to corner C to corner D to corner A, taking an amount of time t to walk along each edge of the table from corner to the next corner. Answer the following questions by writing an expression in terms of L and t.



a) What is the magnitude of the displacement of the ant for its trip from A to B?

L

b) What is the magnitude of the displacement of the ant for its trip from A to B to C?

$L\sqrt{2}$

c) What is the magnitude of the displacement of the ant for its trip from A to B to C to D?

L

d) What is the magnitude of the displacement of the ant for its complete round trip from A to A?

0

e) What is the average speed of the ant for its trip from A to B?

$\frac{L}{t}$

f) What is the average speed of the ant for its trip from A to B to C?

$\frac{2L}{2t} = \frac{L}{t}$

g) What is the average speed of the ant for its trip from A to B to C to D?

$\frac{3L}{3t} = \frac{L}{t}$

h) What is the average speed of the ant for its complete round trip from A to A?

$\frac{4L}{4t} = \frac{L}{t}$

i) What is the magnitude of the average velocity of the ant for its trip from A to B?

$\frac{L}{t}$

j) What is the magnitude of the average velocity of the ant for its trip from A to B to C?

$\frac{L\sqrt{2}}{2t}$

k) What is the magnitude of the average velocity of the ant for its trip from A to B to C to D?

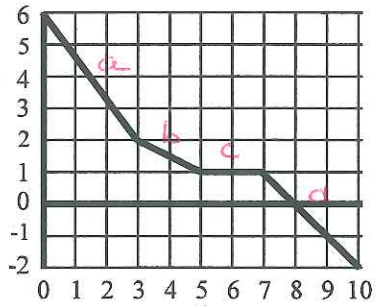
$\frac{L}{3t}$

l) What is the magnitude of the average velocity of the ant for its complete round trip from A to A?

0

Semester 1 Exam Review B

1) The graph on the right represents the velocity of a toy car as a function of time. Use the graph to answer the following questions.



$v_f^2 = v_i^2 + 2ad$

a) What was the displacement of the toy car during the entire ten seconds of its motion?

a) $2^2 = 6^2 + 2(-4/3)d \quad d = 12m$

b) $1^2 = 2^2 + 2(-1/2)d \quad d = 3m$

c) $d = 1m/s(2) = 2m$

d) $-2^2 = 1^2 + 2(-1)d \Rightarrow d = -1.5m$

$12 + 3 + 2 - 1.5 = \boxed{15.5\,m}$

b) What was the final position of the car if its initial position was -8.0 meters?

$\boxed{7.5\,m}$ $\quad -8 + 15.5 = 7.5m$

2) Define *terminal velocity*.

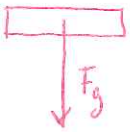
top speed of a falling object due to air resistance balancing gravity

3) Define *drag force*.

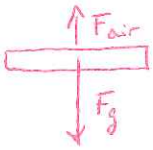
air resistance - particles running into falling object, reducing accel.

4) A careless tenant knocks a 0.80-kg seat cushion off the balcony of his high-rise apartment.

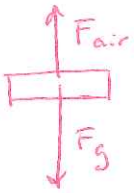
a) Draw a free body diagram of the seat cushion the moment it started to fall.



b) Draw a free body diagram of the seat cushion while it was falling faster and faster.



c) Draw a free body diagram of the seat cushion after it reached its terminal velocity.



d) Calculate the drag force on the seat cushion while the cushion fell at its terminal velocity.

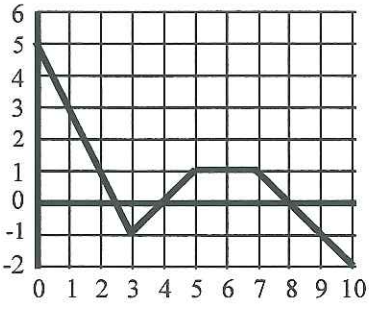
$F_g = 0.80\,kg(-9.8\,m/s^2) = +7.8\,N\ \uparrow$

6) The graph at right depicts the motion of a 2.5-kg radio controlled toy car.

a) Calculate the net force on the car when the clock read 4 seconds.

$F = ma$

$F = 2.5kg(+1\,m/s^2) = 2.5N$

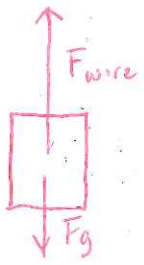


b) Calculate the net force on the car when the clock read 6 seconds.

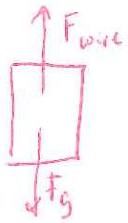
$F = 2.5kg\,(0\,m/s^2) = 0N$

5) A 1250-kg elevator car in an office building is lifted via a steel cable.

a) Draw a free body diagram of the elevator car as it starts speeding up on its way to the top floor.



b) The elevator car has reached a constant speed on its way upward. Draw a free body diagram of the elevator car as it moves at this speed.

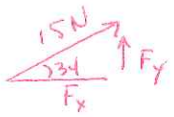


c) The elevator car would eventually have to slow down as it nears the top floor. Draw a free body diagram of the elevator car as it slows down.

d) Now the elevator car is on its way down to the first floor. As the elevator car nears the first floor the steel cable has a tension of 15000 newtons. What is the acceleration of the elevator car at this time?

$15000 = 1250(a)$ $\quad a = 12\ m/s^2$

7) A child puts her dog in a sled and pulls the sled with a force of 15 N along a rope inclined 34° above horizontal. If the combined mass of the sled and dog is 45 kg, what is their acceleration? Assume there is no friction acting on the sled as it moves horizontally.



$\cos 34 = \frac{F_x}{15}$ $\quad F_x = 12.4N = 45(a)$

$a = 0.276\ m/s^2$

8) State Newton's 3rd Law of Motion.

For every acting force, there is an equal and opposite force acting against the force.

9) How much does a 6.0-newton textbook weigh?

6.0N

10) How much does a 0.17-kg grapefruit weigh?

$0.17kg(9.8) = 1.7N$

11) A microscope rests on a table. The normal force acting on the microscope is 26 N. What is the mass of the microscope?

$26N = m(9.8)$ $\quad m = 2.6\ kg$

12) An 1100-kg airplane is flying horizontally through the air. The propellers provide a horizontal thrust force of 980 N in a direction 34° West of North. The wind pushes on the plane with a horizontal force of 250 N in a direction 26° East of North. What is the acceleration of the airplane as it flies?

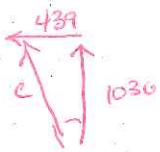
$\sin 34 = \frac{F_x}{980}$ $F_x = 548N$

$\cos 34 = \frac{F_y}{980}$ $F_y = 812\ N$

$\sin 26 = \frac{F_x}{250}$ $F_x = 109N$

$\cos 26 = \frac{F_y}{250}$ $F_y = 224N$

$548 - 109 =$



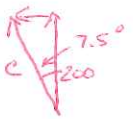
$1036^2 + 439^2 = c^2$

$c = 1125\ N$ @ 23° W of N

$\tan\theta = \frac{439}{1036}$ $1125 = 1100(a)$

$a = 1.0\ m/s^2$ @ 23° W of N

13) A 400 N sign is being suspended from a pole by two wires. The wires form an angle of 15° between them. What is the tension force on each of the two wires?



$\cos 7.5 = \frac{200}{c}$

$c = 202N$

14) At the end of *Thelma & Louise*, (spoiler alert!) a 2000 kg car drives off the 1700 m cliff into the Grand Canyon. If the car was traveling 45 miles per hour when it left the edge of the canyon, how long would the car be in the air? How far horizontally would the car travel? At what vertical speed would the car hit the ground? If the car came to a stop in 1.0 sec when it hit the ground, what acceleration would it experience? What force would the car experience?

$\frac{45\ mi}{hr}\left(\frac{1609\ m}{1\ mi}\right)\left(\frac{1\ hr}{3600s}\right) = 20.1\ m/s$

$d = v_i t + \frac{1}{2}at^2$

$-1700 = 0(t) + \frac{1}{2}(-9.8)t^2$

$t = 18.6s$

$d = 20.1(18.6) = 374\ m = x$

$V_f = V_i + at$

$V_f = 0 + (-9.8)18.6$

$V_{fy} = 182\ m/s$

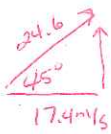
$0 = 182 + a(1.0)s$

$a = 182\ m/s^2$

$F = 2000(182) = 364{,}000\ N$

15) The Bengals are trailing by 5 with 4.0 seconds left in the game. Andy Dalton can throw a 1.5 kg football at 55 miles per hour. What is the farthest distance (in meters) that Dalton can throw a Hail Mary pass in order to win the game?

$$\frac{55\,mi}{1\,hr}\left(\frac{1609\,m}{1\,mi}\right)\left(\frac{1\,hr}{3600\,s}\right) = 24.6\,m/s$$



$\sin 45 = \frac{Y}{24.6}$ $\quad d = 17.4(3.6) = \boxed{62.6\,m}$ or $68.2\,yd$

$$-17.4 = +17.4 + -9.8(t)$$

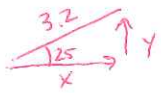
$$\boxed{t = 3.6\,s}$$

16) A student is swinging a yo-yo around their head. The yo-yo has a string length of 0.9 m and is moving around with a period of 0.75 s. What is the force and direction of the force that is applied to the 0.15 kg yo-yo?

$$V = \frac{2\pi r}{T} = \frac{2\pi(0.9)}{.75} = 7.5\,m/s \qquad a_c = \frac{v^2}{r} = \frac{7.5^2}{0.9} = 62.5\,m/s^2$$

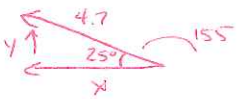
$F = ma = 0.15(62.5) = 9.4N$ toward middle of circle.

17) A hiker walks 3.2 km at a heading of 25° on the first day. On day 2, the hiker travels 4.7 km at a heading of 155°. On day 3, she goes 1.7 km at a heading Of 240°. What is the hiker's displacement from the original position?



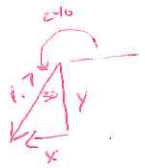
$\cos 25 = \frac{X}{3.2}$ $\quad X = 2.90m$

$\sin 25 = \frac{Y}{3.2}$ $\quad Y = 1.35\,m$



$\cos 25 = \frac{X}{4.7}$ $\quad X = -4.26\,m$

$\sin 25 = \frac{Y}{4.7}$ $\quad Y = 1.99\,m$

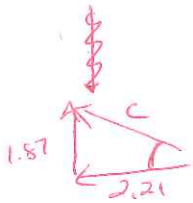


$\sin 30 = \frac{X}{1.7}$ $\quad X = -0.85\,m$

$\cos 30 = \frac{Y}{1.7}$ $\quad X = -1.47m$

$X = 2.90 - 4.26 - 0.85 = -2.21$

$Y = 1.35 + 1.99 - 1.47 = 1.87$



$2.21^2 + 1.87^2 = C^2$

$\boxed{C = 2.89\,m\ @\ 140°}$

$\tan\theta = \frac{1.87}{2.21} = 40°$

$180 - 40 = 140°$