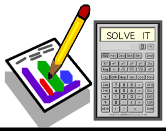
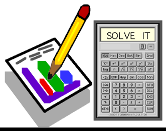


Worksheet 1.1 – Kinematics in 1D

Solve all problems on your own paper showing all work!

1. A tourist averaged 82 km/h for a 6.5 h trip in her Volkswagen. How far did she go?
2. Change these speeds so that they are expressed in m/s:
   a) 50. km/h   b) 80. km/h
3. A certain airplane has an acceleration of 15.0 m/s^2.
   a) How fast will it be moving 2.5 s after it starts down the runway?
   b) How far down the runway will it travel during the 2.5 s?
   c) Minimum take-off speed is 60.0 m/s. How long must the runway be?
4. You are driving along the road at 80 km/h when you see a moose 50.0 m in front of your car. Your reaction time is 0.40 s, and when you finally hit the brakes your car decelerates at a rate of 6.4 m/s^2.
   a) Will your car stop in time to avoid the moose?
   b) If the road is wet and your car decelerates at a rate of 4.8 m/s^2, what will happen? Show your calculations.
5. A car traveled up a hill at constant speed of 10.0 m/s and then returned down the hill at 20.0 m/s. If the time to turn around is ignored,
   a. what was the average speed for the trip?
   b. what was the average velocity for the trip?
6. A ball is thrown straight down with a speed of 50.0 m/s. What would be its' speed after 2.00 seconds?
7. An object moving with uniform acceleration changes its speed from 25 m/s to 45 m/s in 5.0 s. What is the acceleration?
8. How long would it take a truck to uniformly accelerate from 10.0 m/s to 30.0 m/s over a distance of 80.0 m?
9. A late passenger, sprinting at 8.0 m/s, is 30.0 m away from the rear end of a train when it starts out of the station with uniform acceleration of 1.0 m/s^2. Can the passenger catch the train if the platform is long enough?



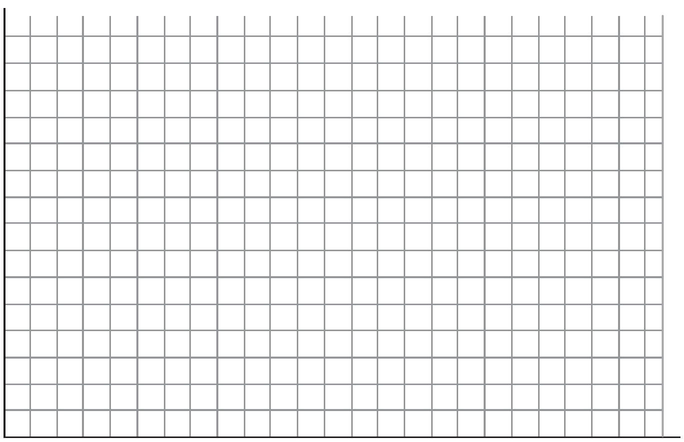
Worksheet 1.3 – Graphing

Solve on this sheet!

1) An experiment was performed on the surface of an asteroid. A mass was dropped from various heights and the time taken to fall was recorded.

d(m)	t(s)	$t^2(s^2)$
0	0	
0.50	1.31	
0.70	1.56	
0.90	1.77	
1.20	2.05	
1.30	2.15	

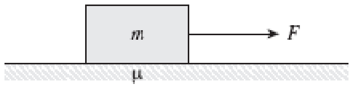
a) Plot a straight line graph. **(2 marks)**



b) From your straight line graph, determine the slope of the line. (Include units.) **(1 mark)**

c) What is the acceleration due to gravity on the surface of this asteroid? **(2 marks)**

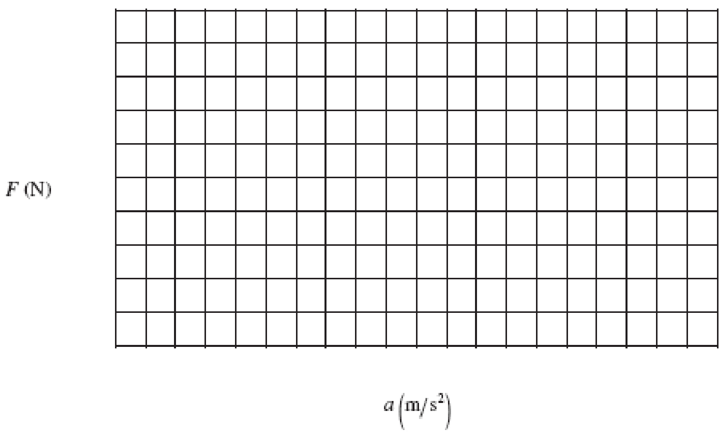
2) A force (F) was used to pull a wooden block across a floor as shown below.



The size of the force was varied and the data table below shows the size of the force and the block's resulting acceleration.

F (N)	$a\left(\text{m/s}^2\right)$
20	0.25
25	0.85
30	1.35
35	1.95

Plot the data on the graph below and draw a line of best fit. Extend the line back to the 'y' axis so that you have a y-intercept point and determine the slope of the line.

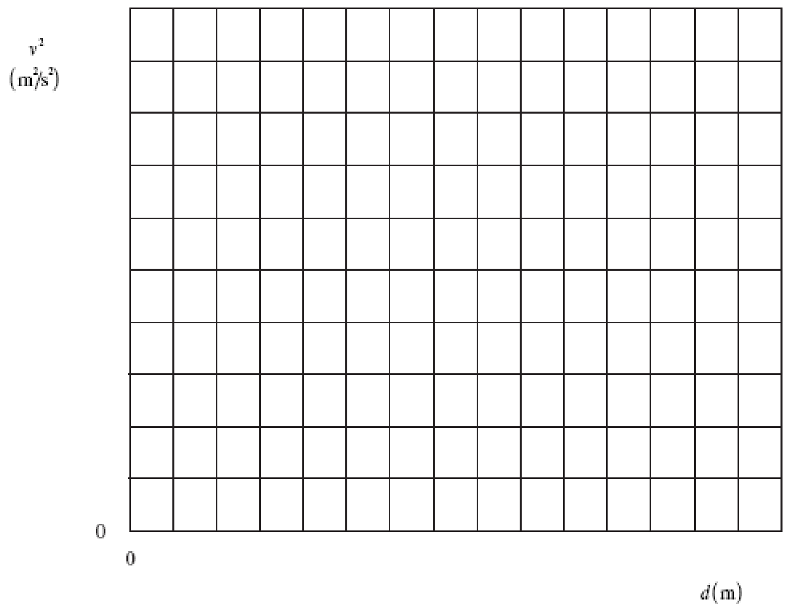


Using your slope value and your y-intercept value from the graph, determine the coefficient of friction between the block and the floor.

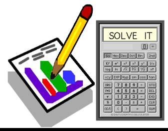
3) A student measures the final speed of an accelerating car at various displacements. The data collected is shown below.

FINAL SPEED (m/s)	v^2	DISPLACEMENT (m)
5.9		2.0
6.5		4.0
7.2		6.0
7.9		8.0
8.4		10.0
9.0		12.0

Plot a graph of the final speed squared, v_2, versus the displacement, *d*, of the car on the graph below.



Determine the slope of the line of best fit to the data and state what the slope represents. Extend the line to the *y*-axis and use the *y*-intercept to determine the initial speed of the car.

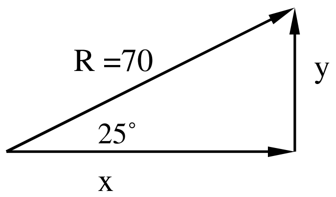


Worksheet 1.3 – Vector Addition

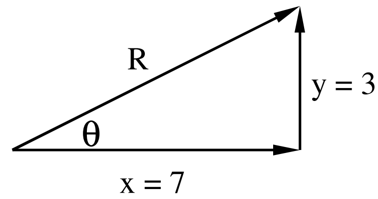
Do your work on this page

For each question, find the value of x, y, R and/or theta as needed (R is the resultant vector)

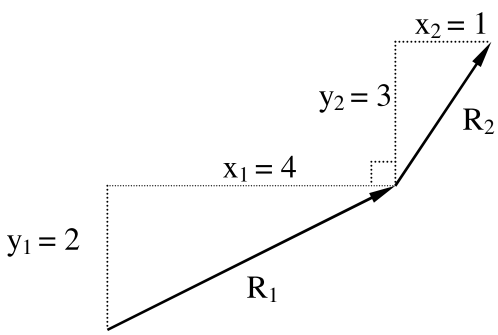
1.



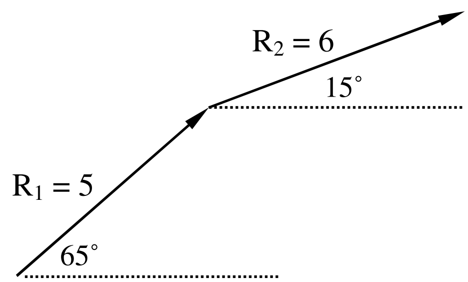
2.



3.



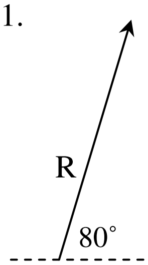
4.



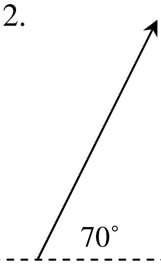
Find $R_{resultant}$

Break up the following vectors into their vertical and horizontal components i.e. the R_x and R_y. The length of each vector R is 10.0 cm.

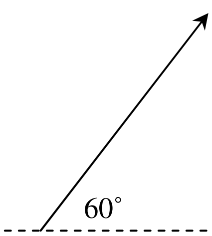
1.



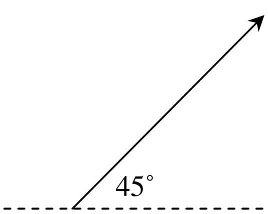
2.



3.

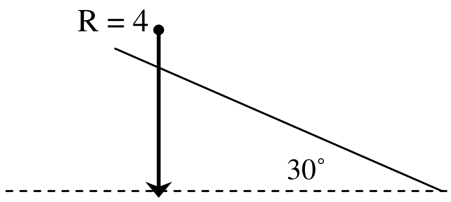


4.

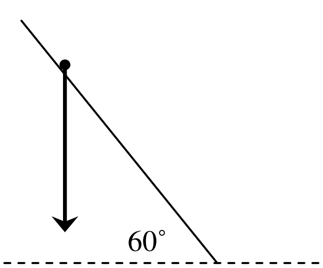


Break up the following vectors into their components that are perpendicular and parallel to the slope components i.e. the $R_{||}$ and $R_{\perp}$. The length of each vector R is 4.0 cm.

5.



6.



Vector Addition by Components: Trig. and Vectors

1. Draw these three vectors

   A = 5.5 cm [20^o] B = 1.8 cm [160^o] C = 2.5 cm [295^o]

2. Using trigonometry, find the x and y components of the three vectors (above)

   A_x = B_x = C_x =

   A_y = B_y = C_y =

3. Find the resulting x component

   $R_x = A_x + B_x + C_x$

4. Find the resulting y component

   $R_y = A_y + B_y + C_y$

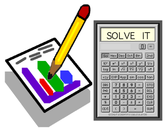
5. Add R_x and R_y vectorally and draw the resultant.

6. Use trig and Pythagoras to find the magnitude and direction of R.

Draw and add the vectors

1. 8 m N & 5 m 30^o N of E

2. 200 m/s 20^o W of S & 15 m/s 20^o W of N

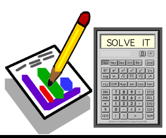


The Change "Δ" Of A Quantity a.k.a. Vector Subtraction

This deals with the change of a quantity, which can be solved by vector subtraction. We will deal only with $\Delta v = v_f - v_i$ in these questions but the concept will appear several more times in this course. Remember that each term is a vector (therefore, do not expect to simply subtract the values!!)

Solve all problems on your own paper showing all work!

1. If a car that was originally going 40. m/s towards the east took 5.0 s to turn and go 30. m/s towards the south, what is the acceleration of the car?
2. What is the acceleration of a car that changes from 60. m/s to the north to 60. m/s to an angle of 45° East of North in a time of 3.0 s?
3. What is the acceleration of a bullet that was shot at 40. m/s in the horizontal and then changed to a velocity of 44.5 m/s at 26.1° below the horizontal in a time of 2.0 seconds?
4. What is the acceleration of a ball that bounces off a wall in 0.30 s if its incoming velocity is 60. m/s and its recoil velocity is 50. m/s?
5. A car is traveling at 100 km/h, due northwest. The driver puts on the brakes and turns the corner. Four seconds later, he is heading east at 50 km/h. What is the average acceleration?



Relative Velocity and Navigation

Solve all problems on your own paper showing all work!

The Across the River Problem

1. A boat can travel 2.30 m/s in still water. If the boat heads directly across a river with a current of 1.50 m/s:
   a) What is the velocity of the boat relative to the shore?
   b) At what angle compared to straight across is it traveling?
   c) How far from its point of origin is the boat after 8.0 s?
   d) At what upstream angle (compared to straight across) must the boat travel in order to the other bank directly opposite its starting point? How fast across the stream is it traveling?

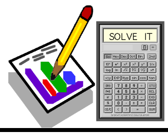
Vector Problems (Trig. Solutions)

1. How far east has a person walked if he travels 350 m in a direction 25° E of N?
2. What would be the resulting displacement if a snail crawls 2.0 m north and then 3.0 m east? What is the snail's direction from the starting point?
3. Find the magnitude and direction from the horizontal of a 40.0 N upward force and 17.0 N horizontal force.

4. A boat travels east at 13 km/hr when a tide is flowing north at 1.2 m/s. Find the actual velocity and heading of the boat.
5. A person that swims at 3.2 m/s swims straight across a river with a current of 1.4 m/s. What is the resulting velocity of the swimmer (across and down stream)? At what angle compared to straight across is the swimmer moving?
6. The swimmer above decides to swim into the current at such an angle that he will travel straight across. Find the angle (compared to straight across) at which he would have to swim. Calculate the velocity across the stream.
7. If the river above is 1.58 km across how long will it take for each of the swimmers in question 5 & 6 to cross the river? How far downstream will the swimmer in question 5 land?
8. A plane with an air speed of 400 km/hr wants to go north but a wind of 70 km/hr is blowing west. What must be the plane's heading (to go north)? What will be its resulting ground speed?
9. A plane is traveling at 650 km/hr in a direction 37° east of north. Find the how fast the plane is traveling north and east. Find how far north and how far east it would travel in 90 minutes.
10. A boat has a speed of 9.0 km/hr, in still water and is traveling down a river with a current of 2.0 m/s. What will be its "riverbank" velocity going downstream? At what angle would this boat have to travel across the river in order to move straight across and what will be its resultant velocity as measured from the riverbank?

<u>Vector problems (Component or Sine-Cosine Law Solutions)</u>

1. A seagull flying with an air speed of 10 km/h is flying north but suddenly encounters a wind of 5 km/h at 20° south of east. What will be the new direction and airspeed of the seagull?
2. A pilot wishes to reach a city 600.0 km away in a direction of 15° S of W in two hours. If there is a wind of 70 km/h blowing at 10° W of S. What must be the heading and air speed of the plane?
3. A plane that can fly at 250 km/h wishes to reach an airport that has a bearing of 25° W of N from its present location. If there is a 50.0 km/h wind blowing directly to the west what should be the heading of the plane. What will be its ground speed? How long would it take to get to the airport if it were 560 km away?
4. A pilot of an airplane with an air speed of 300. km/h is on a heading of due north but finds he is actually traveling 350 km/h 8° W of N. What must be the wind velocity and direction?
5. A plane heading due north with an air speed of 250 km/h is blown off course by a wind blowing at 50 km/h to the NE. What will be the ground speed and direction of the plane?
6. A boat capable of 10.5 knots in still water wishes to cross a narrows at a bearing of 23° N of E. If the current in the narrows is at 3.7 knots at 8° E of S. What must be the heading of the boat and what will be its chart speed?



Worksheet 1.5 - Projectiles

Solve all problems on your own paper showing all work!

1. A golf ball was struck from the first tee at Lunar Golf and Country Club. It was given a velocity of 48 m/s at an angle of 40˚ to the horizontal. On the moon, $g = -1.6\ m/s^2$.
   (a) What are the vertical and horizontal components of the ball's initial velocity?
   (b) For what interval of time is the ball in flight?
   (c) How far will the ball travel horizontally?

2. A rock is thrown horizontally from the top of a cliff 98 m high, with a horizontal speed of 27 m/s.
   (a) For what interval of time is the rock in the air?
   (b) How far from the base of the cliff does the rock land?
   (c) With what velocity does the rock hit?

3. A batter hits a ball giving it a velocity of 48 m/s at an angle of 50˚ above the horizontal.
   (a) What are the vertical and horizontal components of the ball's initial velocity?
   (b) How long is the ball in the air?
   (c) What is the horizontal distance covered by the ball while in flight?
   (d) What velocity does the ball have at the top of its trajectory?

4. A rescue pilot wishes to drop a package of emergency supplies so that it lands as close as possible to a target. If the plane travels with a velocity of 81 m/s and is flying 125 m above the target, how far away (horizontally) from the target must the rescue pilot drop the package?

5. An archer standing on the back of a pickup truck moving at 28 m/s fires an arrow straight up at a duck flying directly overhead. The archer misses the duck! The arrow was fired with an initial velocity of 49 m/s relative to the truck.
   (a) For how long will the arrow be in the air?
   (b) How far will the truck travel while the arrow is in the air?
   (c) Where, in relation to the "duckless" archer, will the arrow come down? Will the archer have to 'duck'?

6. A bullet is fired with a horizontal velocity of 330 m/s from a height of 1.6 m above ground. Assuming the ground is level how far from the gun will the bullet hit the ground?

7. A ball is thrown with a velocity of 24 m/s at an angle of 30˚ to the horizontal.
   (a) What are the vertical and horizontal components of the initial velocity?
   (b) How long is the ball in the air?
   (c) How far away will the ball land?
   (d) To what maximum height will the ball rise?
   (e) With what velocity will the ball land?

8. A youngster hits a baseball giving it a velocity of 22 m/s at an angle of 62˚ with the horizontal. How far will the ball travel before it is caught by a fielder (assuming the fielder catches the ball at the same height that it is hit)?

9. A pebble is fired from a slingshot with a velocity of 30 m/s. If it is fired at an angle of 30˚ to the horizontal, what height will it reach? If its flight is interrupted by a vertical wall 12 m away, at what height will it hit the wall?

10. A fireman is standing on top of a building 20 m high. He finds that if he holds the hose so that water issues from it horizontally at 12 m/s, the water will hit a burning wall of an adjacent building at a height of 15 m above the ground. What is the horizontal distance from the fireman to the building?

11. A diver takes off with a speed of 8.0 m/s from a 3.0 m high diving board at 30˚ above the horizontal. How much later does she strike the water?

12. A pilot cuts loose two fuel tanks in an effort to gain altitude. At the time of release, the plane was 120 m above the ground and traveling upward at 30˚ to the horizontal, with a speed of 84 m/s. For how long did the tanks fall and with what speed did they hit the ground?

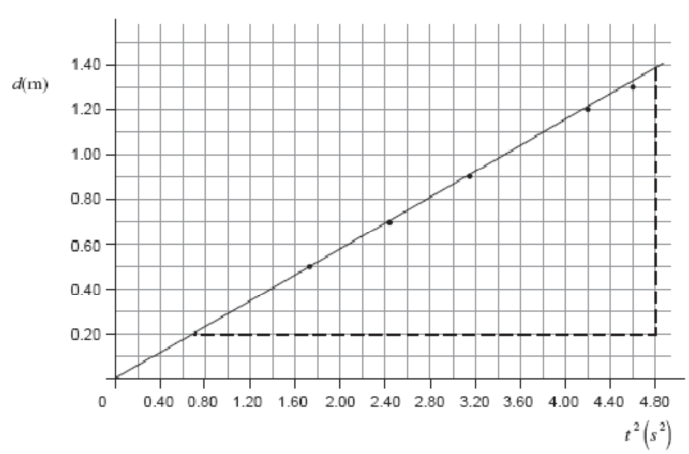
13. On level ground, a ball is thrown forward and upward. The ball is in the air 2.0 s and strikes the ground 30 m from the thrower. What was the ball's initial velocity?

Unit 1 – Worksheet Answer Key

Worksheet 1.1
1) $5.33\text{x}10^5$ m
2)a.. 14 m/s b. 22 m/s
3)a. 38 m/s b. 47 m c. 120 m
4) a. d_{total} = 47.4 m → so OK! b. d_{total} = 60.2 m → Mooseburgers!
5) a. 13.3 m/s b. 0 m/s
6) 69.6 m/s
7) 4.0 m/s^2
8) 4.0 s
9) Yes, after 8 s the passenger is 64 m from station, and train is 62 m. Therefore they meet.

Worksheet 1.3
1)

a) Plot a straight line graph of *d* vs. t^2. **(2 marks)**



b) From your straight line graph, determine the slope of the line. (Include units.) **(1 mark)**

$slope = \frac{\Delta d}{\Delta t^2} = 0.28\ m/s^2$ ← **1 mark**

c) What is the acceleration due to gravity on the surface of this asteroid? **(2 marks)**

$d = \frac{1}{2}at^2$

$d = \left(0.28\ m/s^2\right)t^2$

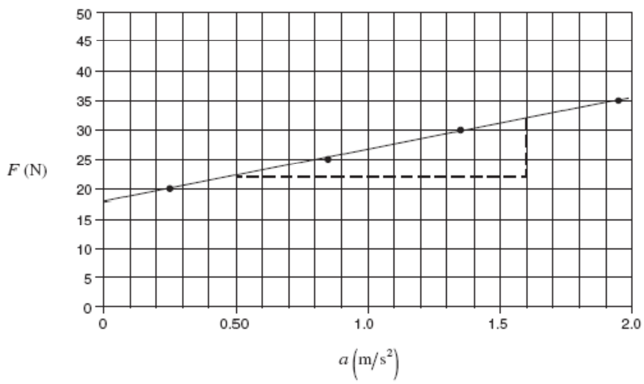
$\therefore \frac{1}{2}a = 0.28\ m/s^2$

$a = 0.56\ m/s^2$ ← **2 marks**

(Allocate one mark for 0.28 m/s^2 only.)

2)

Plot the data on the graph below and draw a line of best fit. Extend the line back to the 'y' axis so that you have a y-intercept point and determine the slope of the line.



(1 mark)

$$slope = \frac{10\text{ N}}{1.1\text{ m/s}^2}$$

$= 9.1$ kg $\leftarrow$ **2 marks**

Using your slope value and your y-intercept value from the graph, determine the coefficient of friction between the block and the floor.

$$F - F_{fr} = ma$$

$$F = ma + F_{fr}$$

$$y\text{-intercept} = F_{fr} = 17.5\text{ N}$$

$$slope = mass = 9.1\text{ kg}$$

$$17.5 = \mu mg$$

$17.5 = \mu(9.1)9.8$ $\leftarrow$ **1 mark**

$\mu = 0.20$ $\leftarrow$ **1 mark**

3)

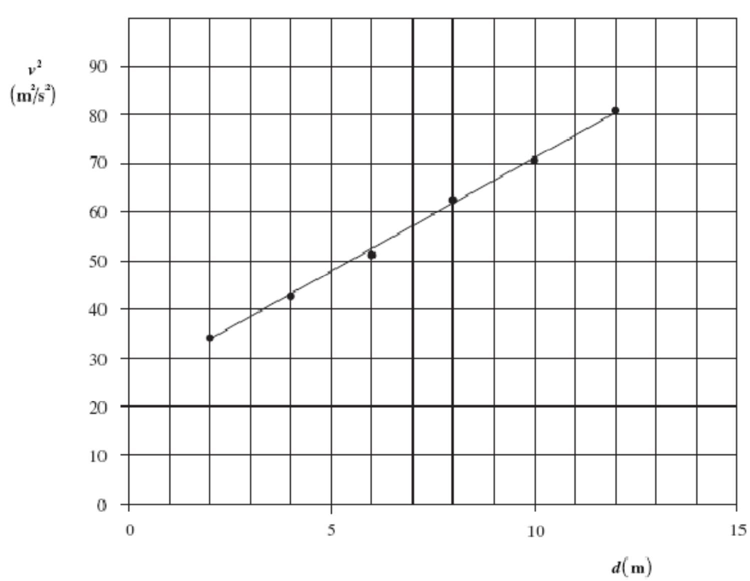
5. **(5 marks)**

A student measures the final speed of an accelerating car at various displacements. The data collected is shown below.

FINAL SPEED (m/s)	v^2	DISPLACEMENT (m)
5.9	**34.8**	2.0
6.5	**42.3**	4.0
7.2	**51.8**	6.0
7.9	**62.4**	8.0
8.4	**70.6**	10.0
9.0	**81.0**	12.0

Plot a graph of the final speed squared, v^2, versus the displacement, d, of the car on the graph below.

Graph of v^2 vs d



Determine the slope of the line of best fit to the data and state what the slope represents. Extend the line to the y-axis and use the y-intercept to determine the initial speed of the car.

Slope calculation:

$$m = \frac{\Delta v^2}{\Delta d}$$

$$= \frac{81 - 42}{12 - 4.0}$$

$$= 4.8\text{ m/s}^2$$

Slope $= 2 \times$ acceleration of the car $\leftarrow$ **2 marks**

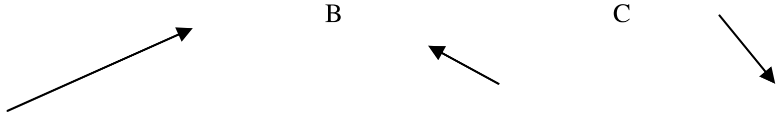
$y - \text{intercept} = 24\text{ m}^2/\text{s}^2$

$\therefore v_i = (24)^{\frac{1}{2}} = 4.9\text{ m/s}$ $\leftarrow$ **1 mark**

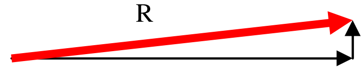
Worksheet 1.4

1) $x = 63$; $y = 30$. 2) $R = 7.6$; $\theta = 23^o$ 3) $R_1 = 4.47$; $R_2 = 3.16$ 4) $R_{resultant} = 10.0$
1) $R_x = 1.7$ cm; $R_y = 9.8$ cm 2) $R_x = 3.4$ cm; $R_y = 9.4$ cm 3) $R_x = 5.0$ cm; $R_y = 8.7$ cm 4) $R_x = 7.1$ cm; $R_y = 7.1$ cm
5) $R_{para} = 2$ cm; $R_{perp} = 3.5$ cm 6) $R_{para} = 3.5$ cm; $R_{perp} = 2$ cm

Vector Addition by Components
1) A B C



2) Ax = 5.17 cm; Ay = 1.88 cm; Bx = -1.69 cm; By = 0.62 cm; Cx = 1.05 cm; -2
3) 4.53 cm 4) 0.5 cm 5) R



6) R = 4.6 cm $\theta = 6.0^o$

Draw and Add Vectors
1) 11.3 m 22^o E of N 2) 188 m/s 23^o W of S

Change in Quantity
1) 10 m/s^2 53^o W of S 2) 15 m/s^2 68^o E of S 3) 9.8 m/s^2 down 4) 367m/s^2 back
6) 9.7 m/s^2 30^o S of E

Across the River Problem
1) a. 2.7 m/s 33^o b. 33^o c. 21.6 m d. 41^o

Vector Problems(Trig)
1) 148 m 3) 67^o 5) 23.6^o
7) swimmer 5: 494 s, ends up 693 m downstream, swimmer 6: 545 s
9) 587 km E and 749 km N

Vector Problems (Component or Sine/Cosine Law)
1) 9.5 km/h 30^o E of N
3) 267 km/h 14.6^o W of N; 2.1 h
5) 288 km/h 8^o E of N

Worksheet 1.5

1) Vx = 36.8 m/s; Vyo = 30.8 m/s
3) a. Vx = 30.8 m/s; Vyo = 36.8 m/s b. 7.50 s c. 231 m d. 30.8 m/s horizontal
5) a. 10.0 s b. 279 m c. Oh Yeah!
7) a. Vx = 20.8 m/s; Vyo = 12 m/s b. 2.45 s c. 50.9 m d. 7.34 m e. 24 m/s 30^o below horiz
9) 11 m High
11) 1.28 s
13) 17.9 m/s 33^o above horiz