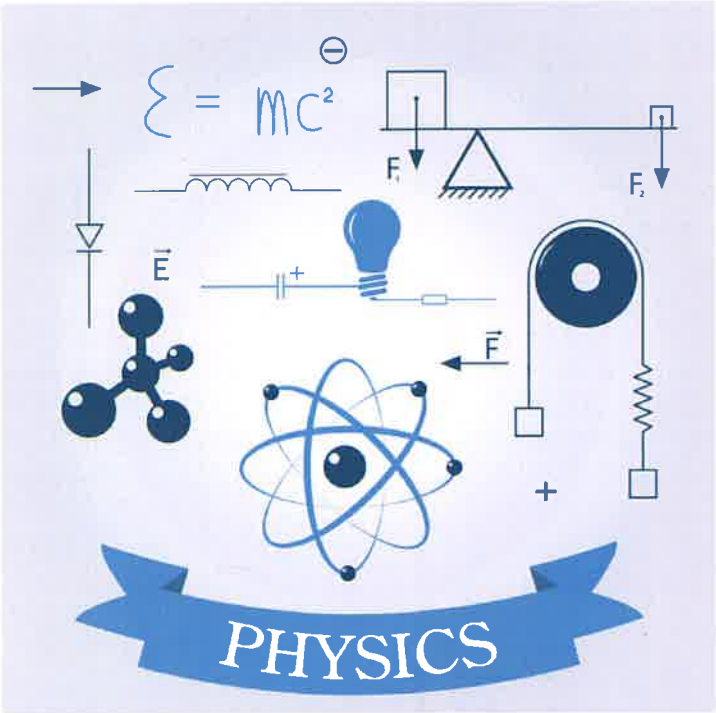
AP PHYSICS 1



2020 SUMMER ASSIGNMENT PROBLEMS

VECTOR ALGEBRA

RULES:

1. 0° = same direction: ADD (maximum resultant)

2. 180° = opposite direction: SUBTRACT (minimum resultant)

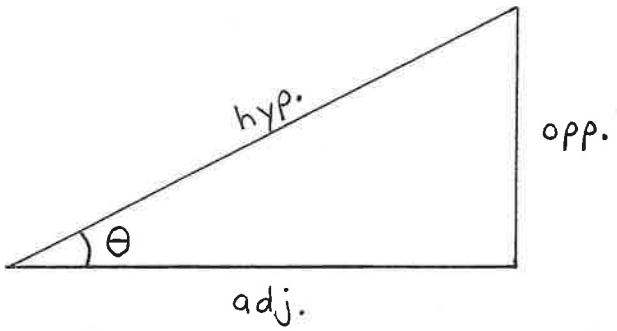
3. Vectors at right angles (90°): use the pythagorean theorem & SOHCAHTOA

$$a^2 + b^2 = c^2$$

$$\cos\theta = \frac{ADJ}{HYP}$$

$$\sin\theta = \frac{OPP}{HYP}$$

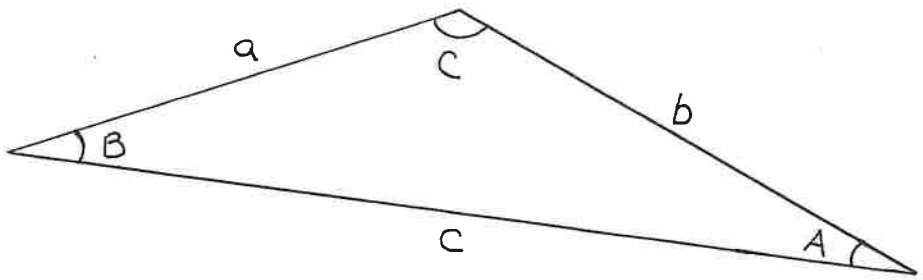
$$\tan\theta = \frac{OPP}{ADJ}$$



4. Vectors at "other" angles: use Laws of sines and cosines:

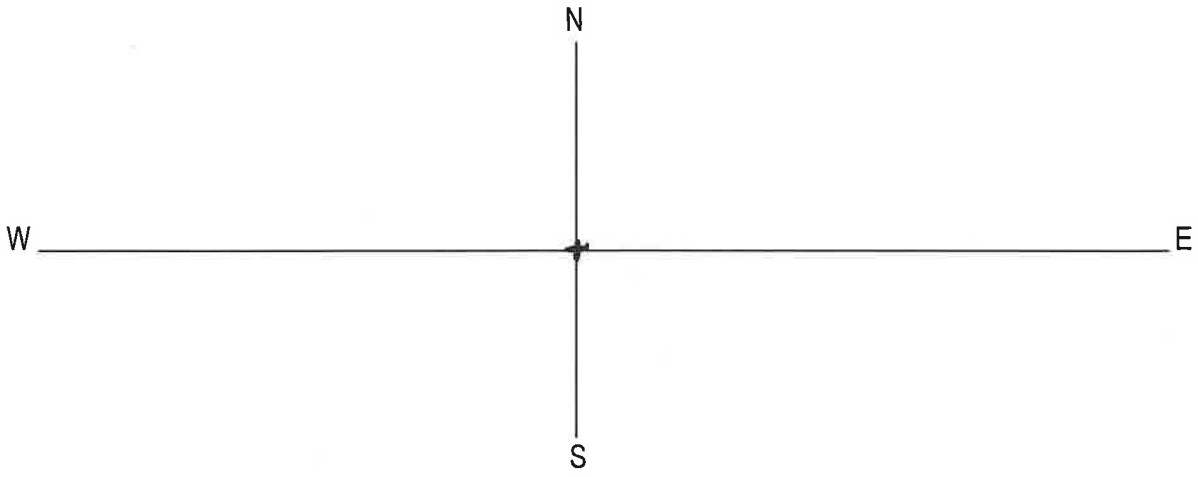
$$c^2 = a^2 + b^2 - (2ab\cos C)$$

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

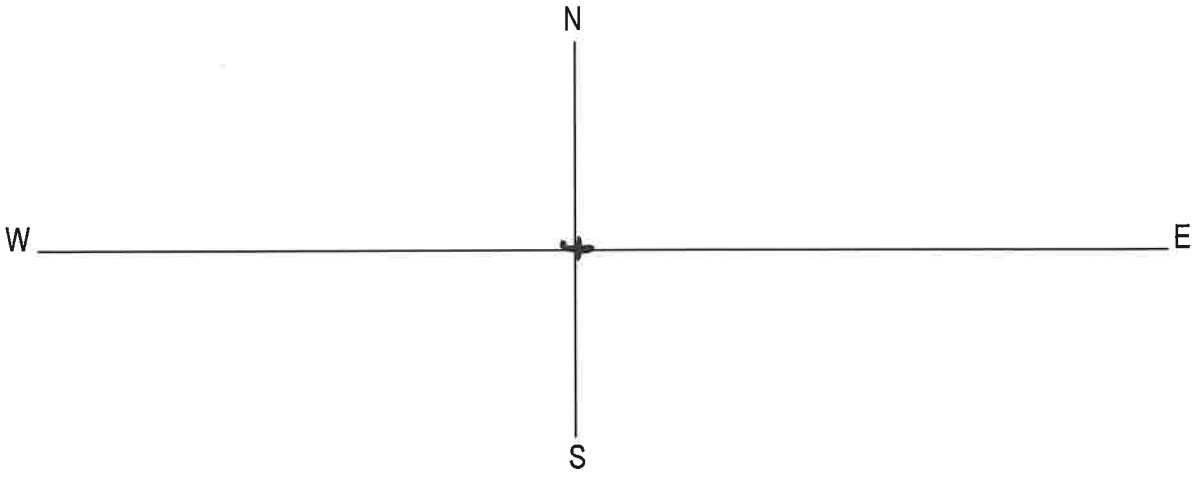


For each of the following problems, **show all work**, including the equation and substitution with units.

1. A small plane flies due west with a speed of 86 m/s while a tailwind blows due west at 28 m/s. Using a scale of **1.0 cm = 20 m/s**, draw and label a vector diagram (including the resultant) on the axis below and calculate the magnitude and direction of the plane's resultant velocity.

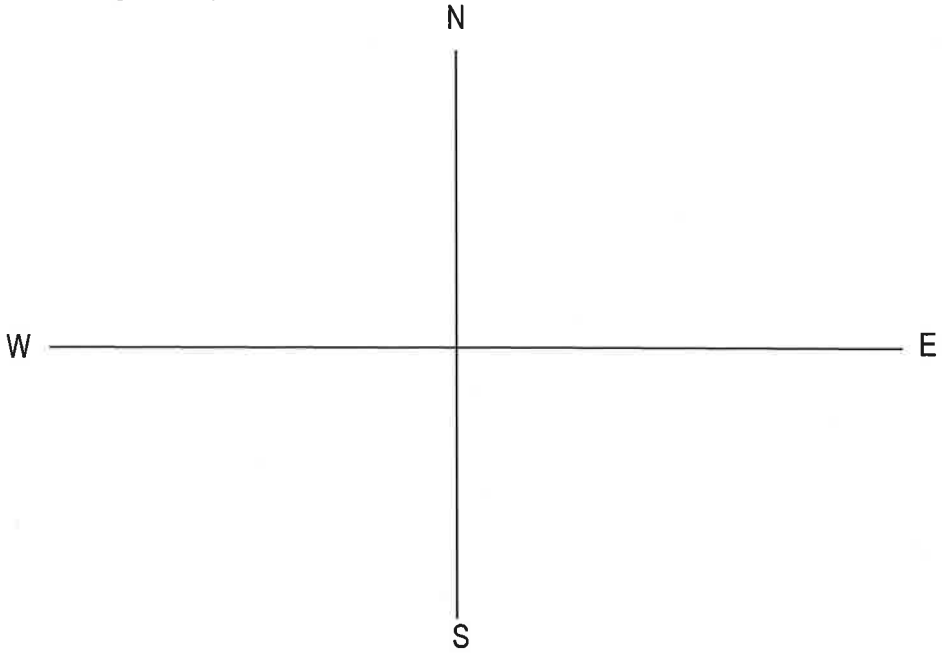


b. On the trip back, the plane flies due east at 78 m/s while the wind now blows due west at 36 m/s. Using the same scale as part (a), draw and label a vector diagram (including the resultant) on the axis below and determine the magnitude and direction of the plane's resultant velocity.

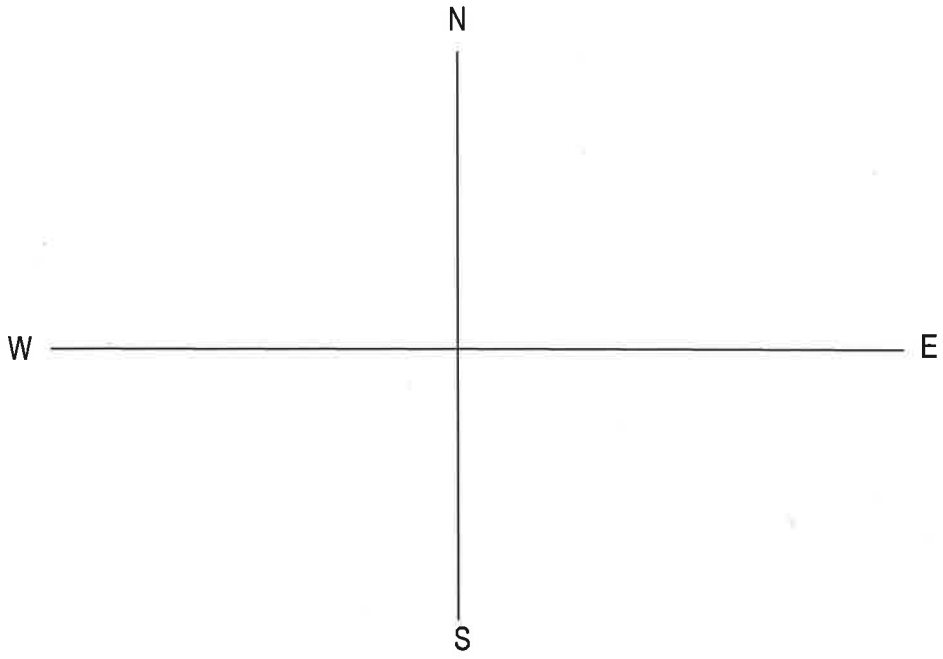


2. Force **A** has a magnitude of 45 N and is directed due east. Force **B** has a magnitude of 39 N and is directed due north.

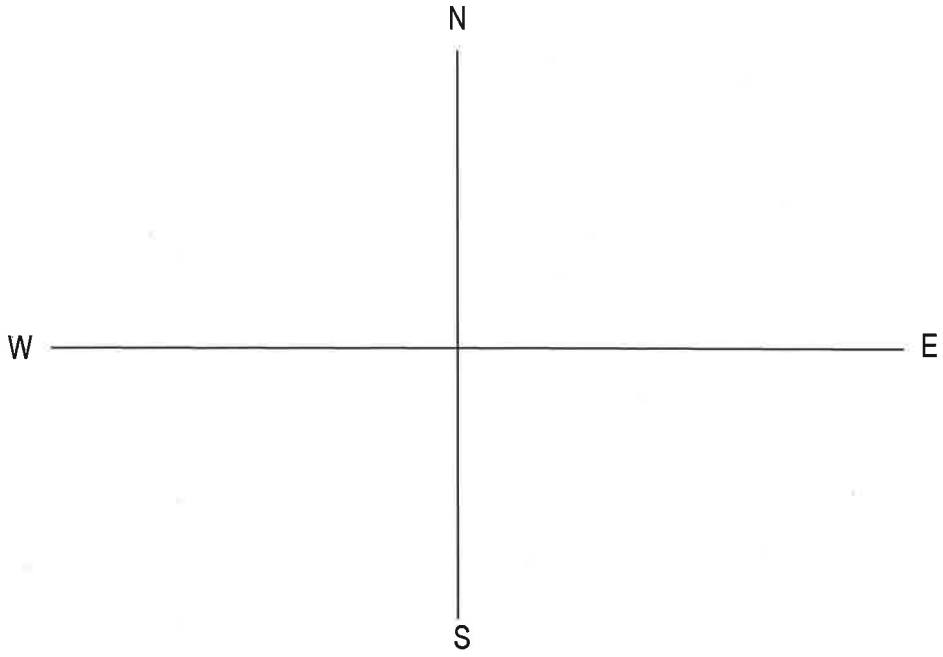
(a) Calculate the magnitude and direction (including a specific directional angle θ) of **A + B**. Include a labeled vector diagram in your solution.



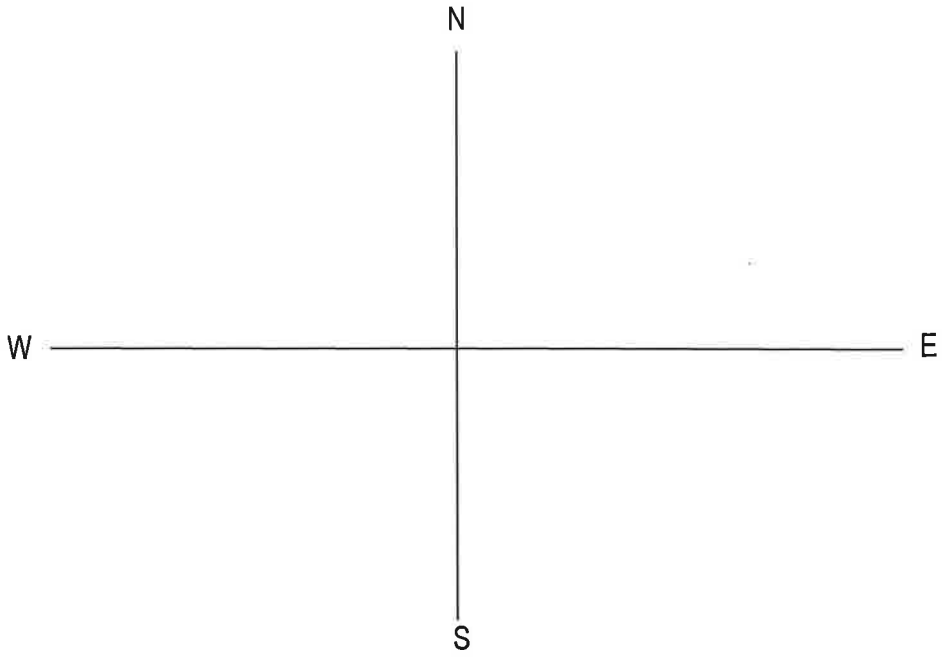
(b) Calculate the magnitude and direction (including a specific directional angle θ) of **A – B**. Include a labeled vector diagram in your solution.



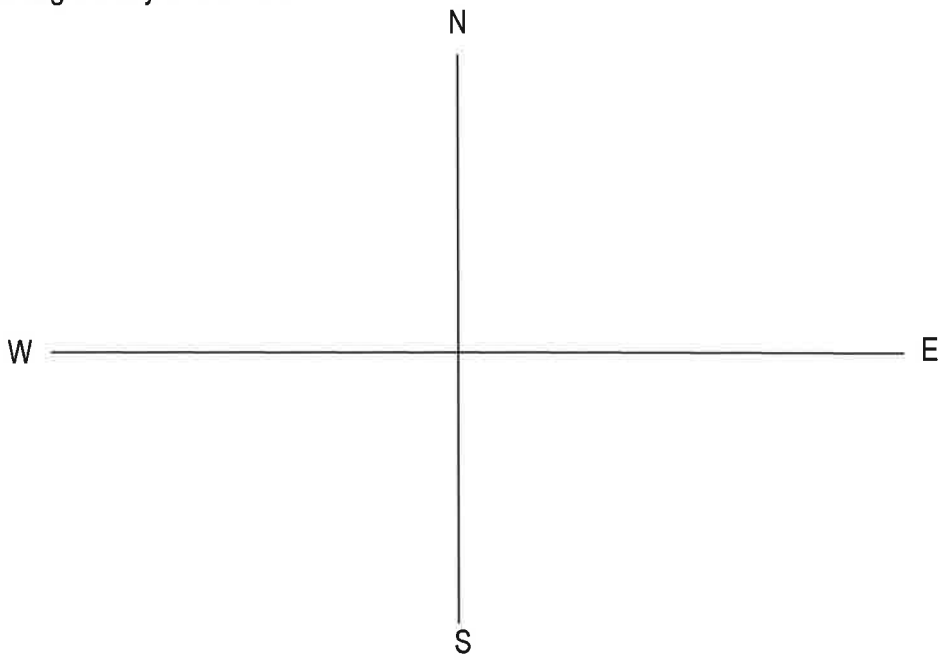
3. A woman hikes 1850 meters due east, then 650 meters due west, and finally 2120 meters due south. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction (including a specific directional angle, θ) of the woman's resultant displacement, relative to her starting point.



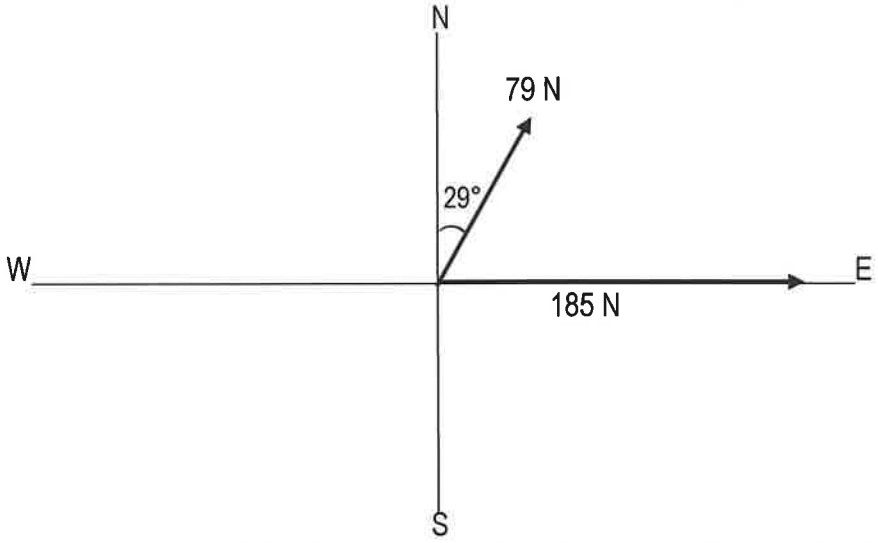
4. A bug crawls 22 cm due north, then 15 cm due west, the 7 cm due south and finally 12 cm due west. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the bug's resultant displacement. Include a specific directional angle θ in your answer.



5. A ship traveling at a velocity of 38 m/s at an angle of 32° south of west is acted on by a wind blowing at a velocity of 15 m/s at an angle of 26° east of north. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the ship's resultant velocity. Include a specific directional angle θ in your answer.



6. Two forces of 79 N and 185 N act on an object, as shown in the diagram below.



Calculate the magnitude and direction (measured from the x axis) of the resultant force **and** the equilibrant force.

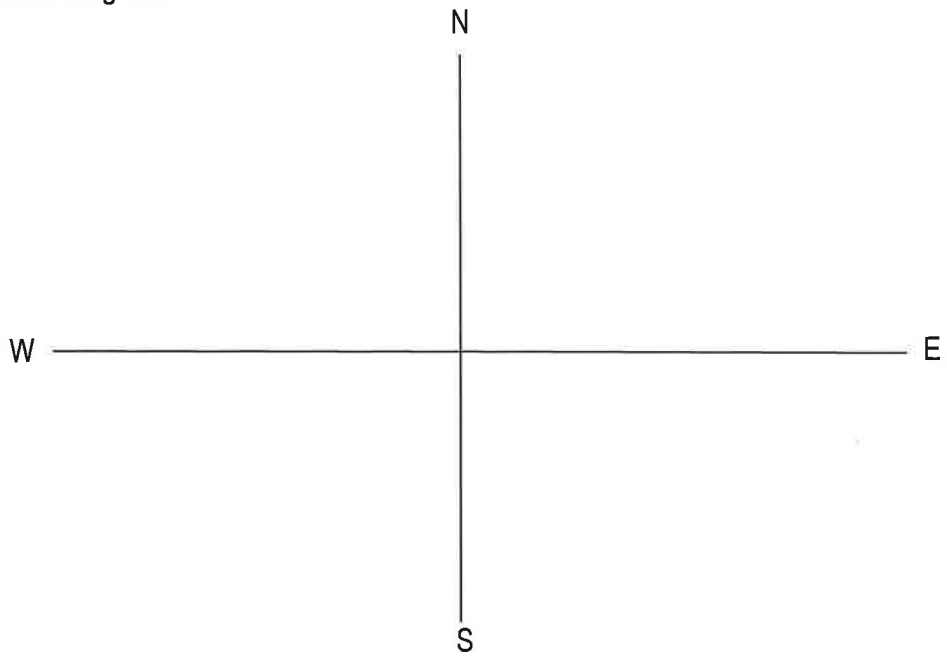
Resultant force = _____

Equilibrant force = _____

7. Two forces act on an object.

   Force **A** = 46 N due west
   Force **B** = 163 N directed 56° east of north

   Calculate the magnitude and direction (including a specific angle θ) of **A + B**. Include in your answer a labeled vector diagram.



VECTOR COMPONENTS

EQUATIONS:

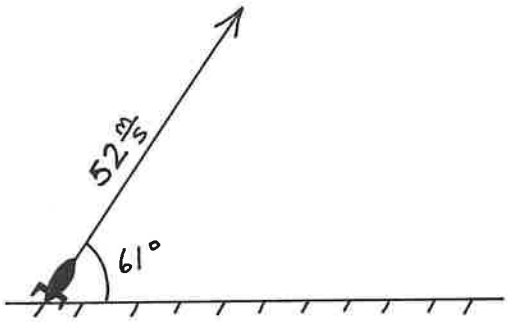
$A_x = A \cos \theta$

$A_y = A \sin \theta$

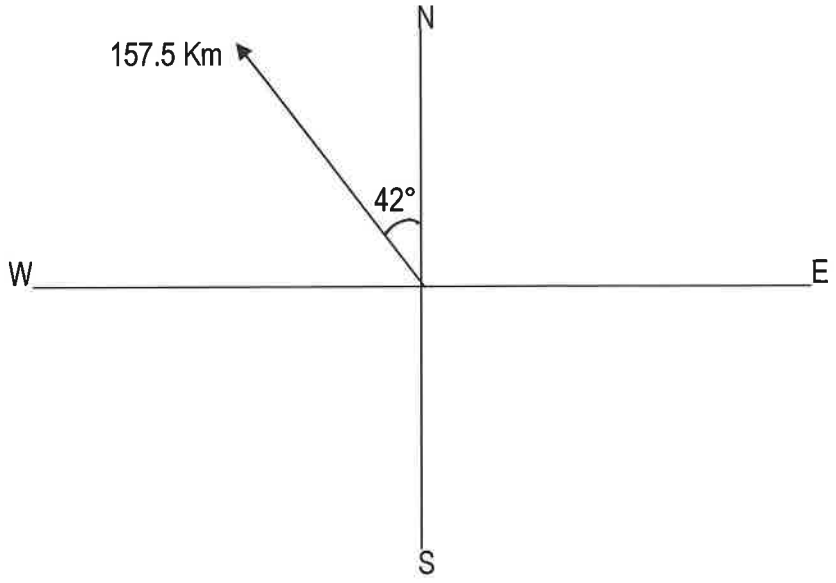
} **These equations are valid if θ is measured from the x axis!**

PROBLEMS: For each of the following problems, **show all work**, including the equation and substitution with units.

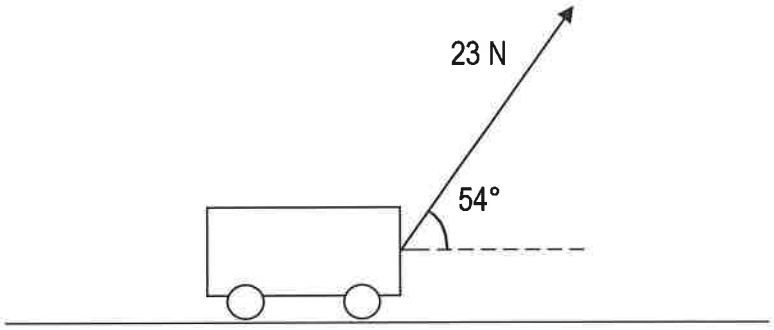
1. A toy rocket is launched upward at a velocity of 52 m/s at an angle of 61° relative to the level ground. Draw and label the components on the diagram below and calculate the magnitudes of the vertical and horizontal components of the velocity.



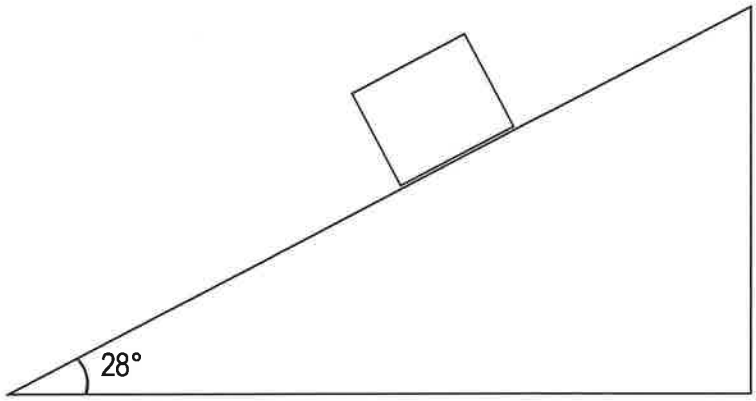
2. A plane is flown 157.5 km in a direction 42° west of north. Draw and label the components on the diagram below and calculate the magnitudes of the western and northern components of the plane's displacement.



3. A wagon is pulled by a 23 N force applied to the handle, which makes an angle of 54° with respect to the ground. Draw and label the components on the diagram below and calculate the magnitudes of the vertical and horizontal components of the applied force.



4. A block whose weight is 85 N is placed on a 28° incline, as shown below.



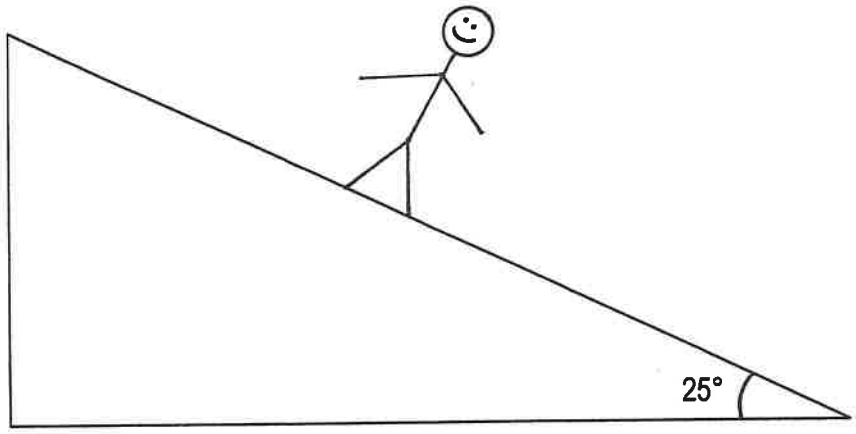
(a) Draw and label the components of the block's weight that are parallel and perpendicular to the incline and calculate the magnitude of each component.

(b) If the angle of the incline is increased, how would the magnitudes of the parallel and perpendicular components be affected, if at all? (increases, decreases, remains the same)

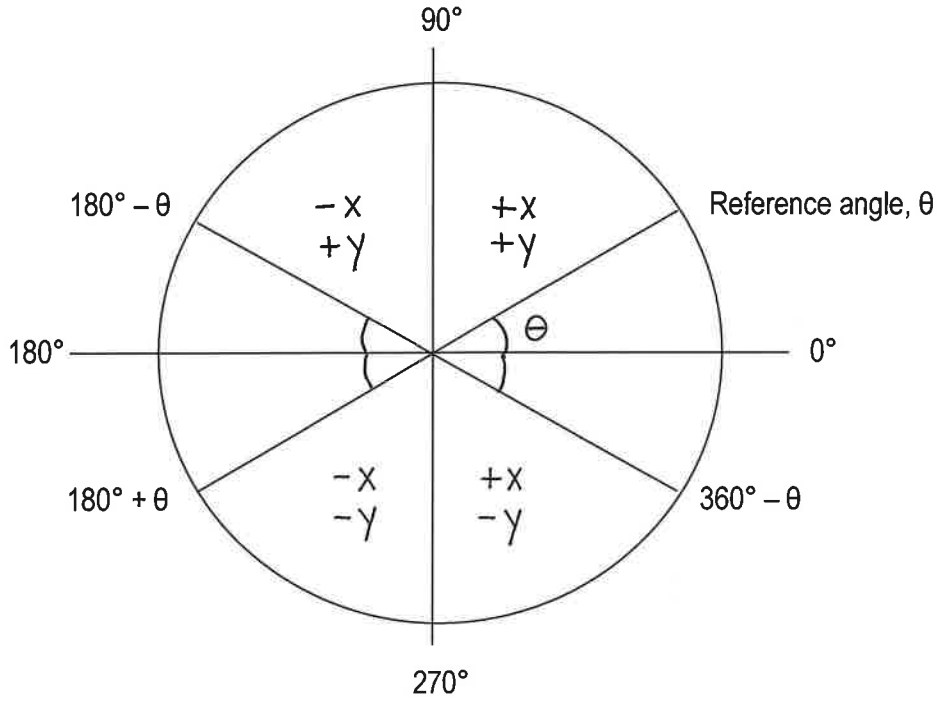
Parallel Component _____

Perpendicular Component _____

5. A person weighing 752 N stands on a 25° incline, as shown below. Draw and label the components of the person's weight that are parallel and perpendicular to the incline and calculate the magnitude of each component.



TRIG REVIEW



PROBLEMS:
For each of the following pairs of components, determine the magnitude and direction (θ) of the resultant vector.

1. $A_x = -7$, $A_y = +3$

2. $A_x = +9$, $A_y = +14$

3. $A_x = -5$, $A_y = -7$

4. $A_x = +6$, $A_y = -13$

COMPONENTS METHOD PROBLEMS

1. A person drives 12.6 Km in a direction 51° west of north, then 4.7 Km due south and finally 8.2 Km at 33° north of east. Calculate the magnitude and direction of the person's resultant displacement. Include a specific directional angle in your answer.

2. Three forces act on a body. The magnitudes and directions are as follows:

Force A = 55 N, 49° west of south
Force B = 26 N, 28° west of north
Force C = 84 N, 33° south of east

(a) Calculate the magnitude and direction of **–A + B + C**. Include a specific directional angle in your answer.

(b) Calculate the magnitude and direction of **+A – B + C**. Include a specific directional angle in your answer.

3. A man jogs 935 meters at 26° south of west, then 662 meters due west and then 730 meters at 41° south of east. The fourth part of his jog is unknown. The man ends up back at his starting point. Calculate the magnitude and direction of the fourth part of the man's jog.

4. A woman bikes 2.3 Km due east, then 1.6 Km at 35° east of north and continues for an unknown distance in an unknown direction. She ends up in a location that is 1.2 Km at 10° west of south of where she started. Calculate the magnitude and direction of the third part of her bike trip. Include a specific directional angle in your answer.

UNIT CONVERSIONS

1 mile = 1.609 km	**1 mile = 5280 feet**
1 km = 0.6214 mile (mi)	**1 Newton (N) = 0.2248 lbs**
1 meter (m) = 3.281 ft	**1 lb = 4.448 Newton (N)**
1 inch = 2.54 cm	**1 kg = 0.0685 slug**
1 m^3 = 1000 L	**1 ton = 2000 lbs**

PROBLEMS: Using the factor-label method (dimensional analysis) and the given conversion factors (and any others you may know), convert the following quantities. Be sure to **show all work**, including how the units canceled out!

1) 1,760,000 inches = _____ km

2) 885 N = _____ lbs

3) 5500 inches/sec = _____ km/hr

4) 66,000,000 m/week = _____ ft/sec

5) 2.44×10^{-2} km/hr = _____ in/sec

6) 3.0×10^{8} m/s = _____ mi/hr

7) 1.44×10^{3} lbs/ft^2 = _____ N/m^2

8) 2.55×10^{-3} slugs/m^3 = _____ g/ft^3

9) 6.27×10^4 in^2 = _____ km^2

10) 0.00225 km^3 = _____ ft^3

ANSWER KEY

Vector Algebra

1. a) R = 114 m/s west
   b) R = 42 m/s east
2. a) R = 59.55 N, 40.9° N of E (or 40.9° cc)
   b) R = 59.55 N, 40.9° S of E (or 319.1° cc)
3. R = 2436.06 m, 60.5° S of E (or 299.5° cc)
4. R = 30.89 cm, 60.9° W of N (or 150.9° cc)
5. R = 26.5 m/s, 14.5° S of W (or 194.5° cc)
6. R = 233.75 N, 17.2° N of E (17.2° cc)
   E = 233.75 N, 17.2° S of W (or 197.2° cc)
7. R = 127.49 N, 45.6° N of E (45.6° cc) or 44.4° E of N

Vector Components

1. A_x = 25.21 m/s, A_y = 45.48 m/s
2. Western component (A_x) = 105.39 Km
   Northern component (A_y) = 117.05 Km
3. A_x = 13.52 N, A_y = 18.61 N
4. a) Perpendicular component = 75.05 N, Parallel component = 39.91 N
   b) Parallel component increases, perpendicular component decreases
5. Perpendicular component = 681.54 N, Parallel component = 317.81 N

Trig Review

1. R = 7.62, 23.2° above –x axis (or 156.8° cc)
2. R = 16.6, 57.3° above +x axis (or 57.3° cc)
3. R = 8.6, 54.5° below –x axis (or 234.5° cc)
4. R = 14.3, 65.2° below +x axis (or 294.8° cc)

Components Method

1. R = 8.23 Km, 69.3° N of W (or 110.7° cc)
2. a) R = 100.63 N, 7.6° N of E (or 7.6° cc)
   b) R = 112.58 N, 68.6° S of E (or 291.4° cc)
3. 1301.99 m, 43.1° N of E (or 43.1° cc)
4. 4.24 Km, 36° S of W (or 216° cc)

Unit Conversions

1. 44.7 Km
2. 199 lbs
3. 502.9 Km/hr
4. 358 ft/sec
5. 2.67×10^{-1} in/sec
6. 6.71×10^{8} mi/hr
7. 6.9×10^{4} N/m^2
8. 1.05 g/ft^3
9. 4.05×10^{-5} Km^2
10. 7.9×10^{7} ft^3