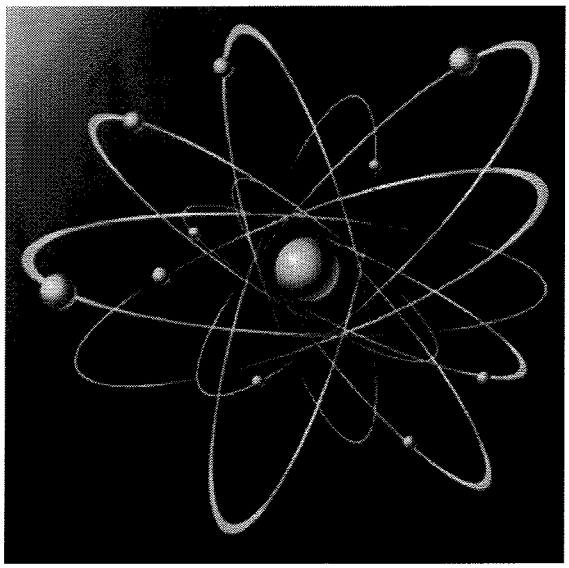
AP PHYSICS 1



SUMMER ASSIGNMENT PROBLEMS

VECTOR ALGEBRA

RULES:

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

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

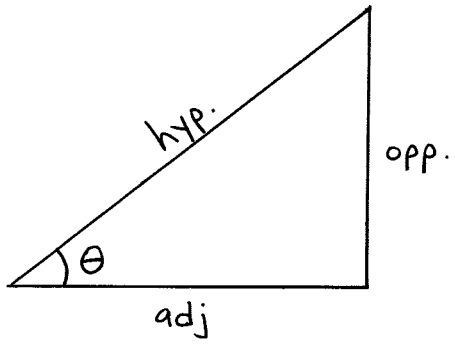
3. Vectors at right angles (90°): use the pythagorean theorem & SOHCAHTOA

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

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

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

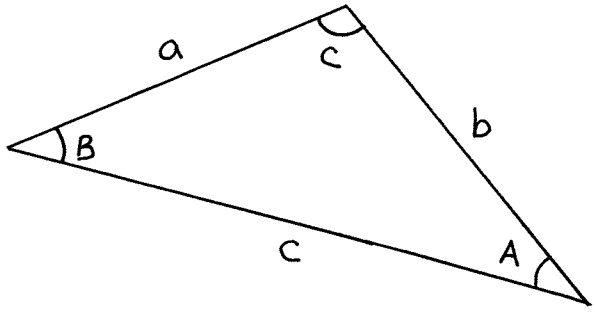
$$\tan\theta = \frac{OPP}{ADJ}$$



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

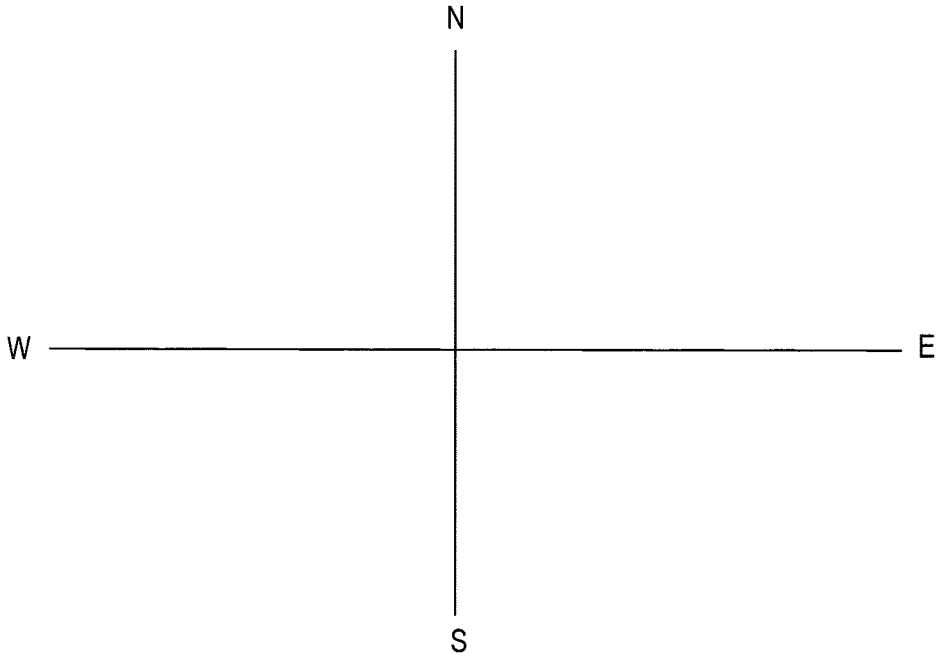
$$c^2 = a^2 + b^2 - (2ab\cos C)$$

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

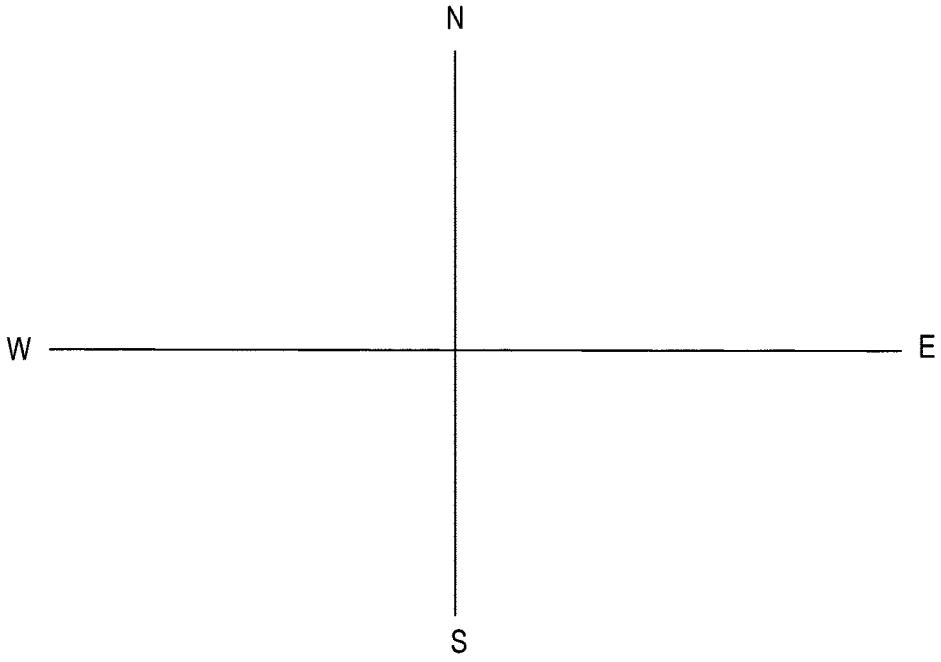


PROBLEMS: For each of the following problems, **show all work**, including the equation and substitution with units.

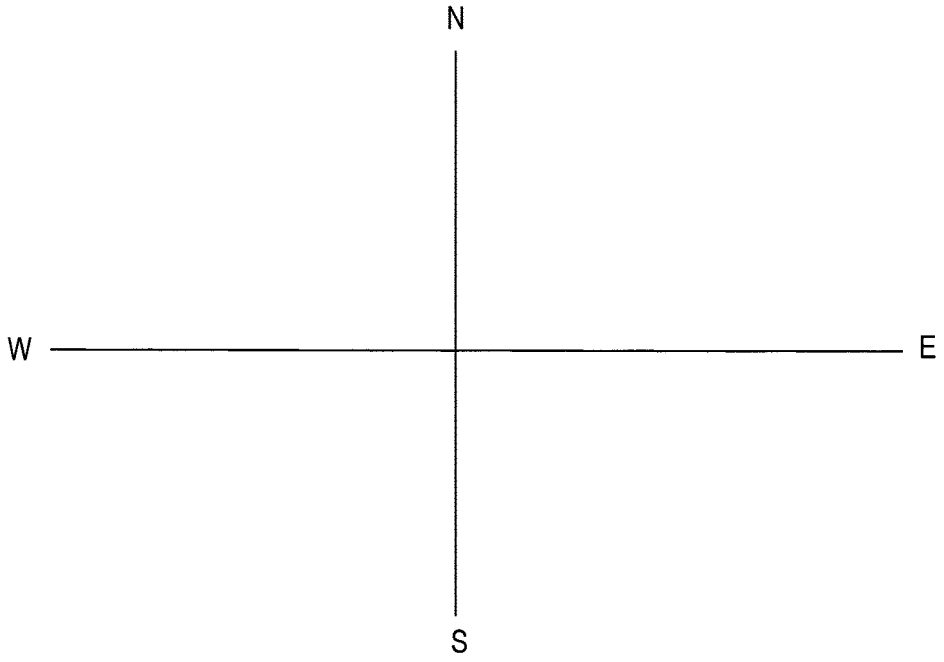
1. A helicopter flies due north at a velocity of 115 m/s while a tailwind blows due north at 34 m/s. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the helicopter's resultant velocity.



2. Two forces act on an object. Force **A** equals 13 Newtons directed due east and force **B** equals 22 Newtons due east. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the resultant force.



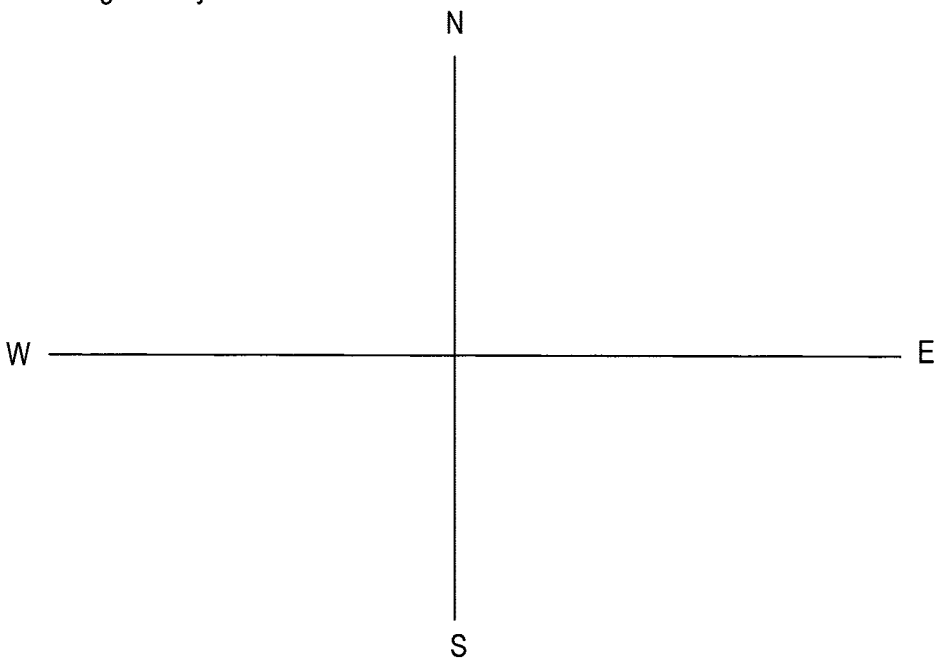
3. A woman hikes 2500 meters due west, then 1200 meters due east, and finally 1875 meters due north. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction (including a specific directional angle, θ) of the woman's resultant displacement, relative to her starting point.



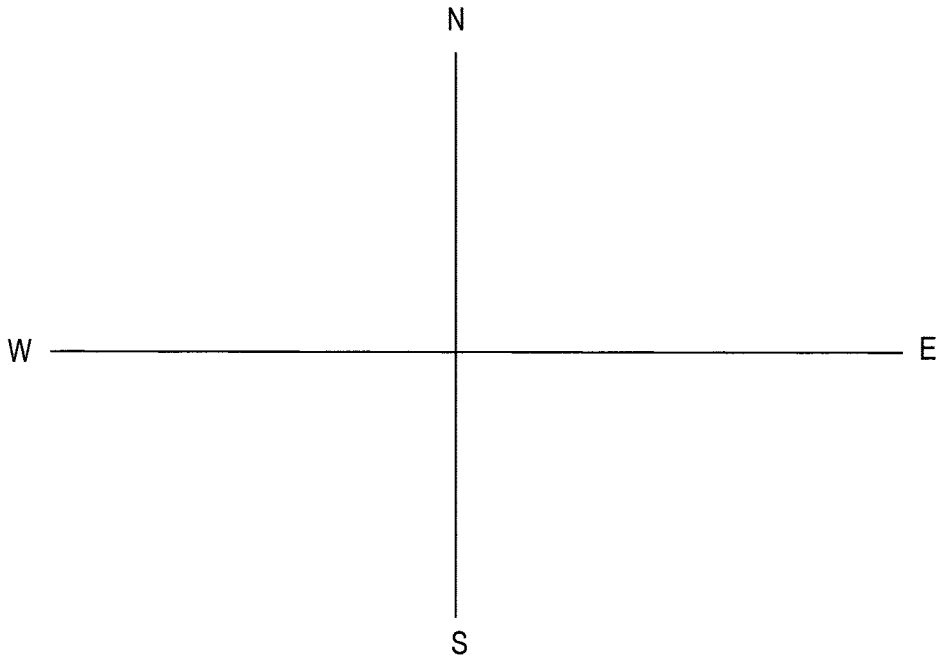
4. Two concurrent forces of 68 N and 52 N act on a body. Determine the magnitudes of the maximum and minimum resultant forces that could be produced from these two forces.

5. Force **A** has a magnitude of 30 Newtons and is directed due south. Force **B** has a magnitude of 42 Newtons and is directed due west.

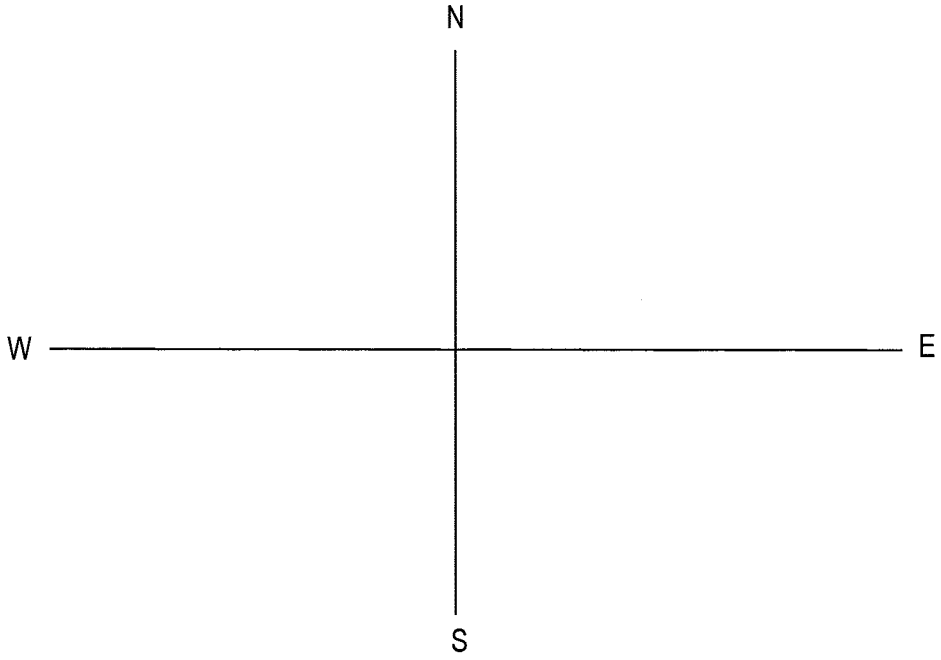
(a) Calculate the magnitude and direction (including a specific directional angle, θ) of **A – B.** Include a labeled vector diagram in your solution.



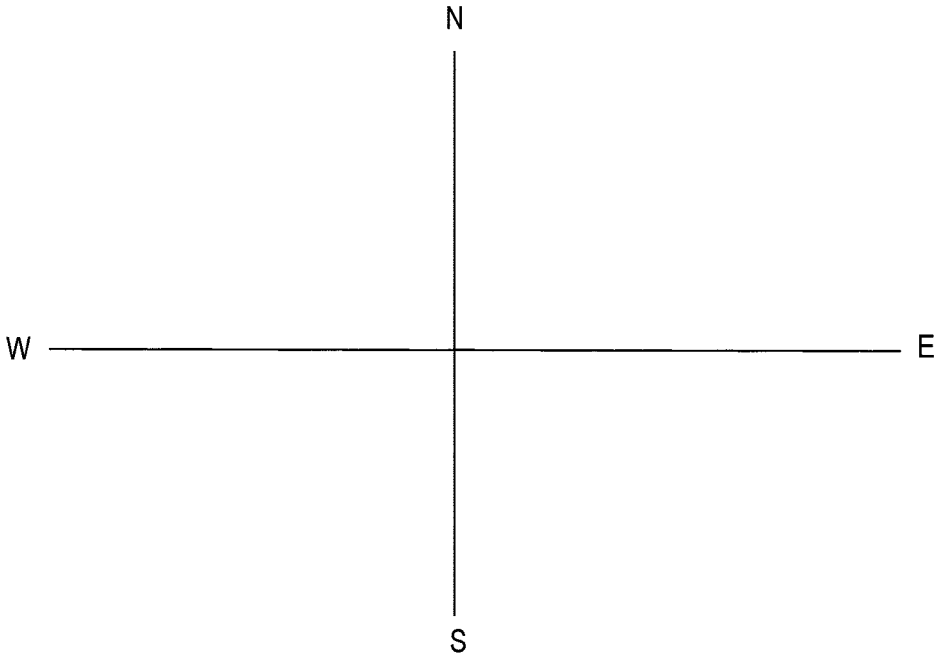
(b) Calculate the magnitude and direction (including a specific directional angle, θ) of **A + B.** Include a labeled vector diagram in your solution.



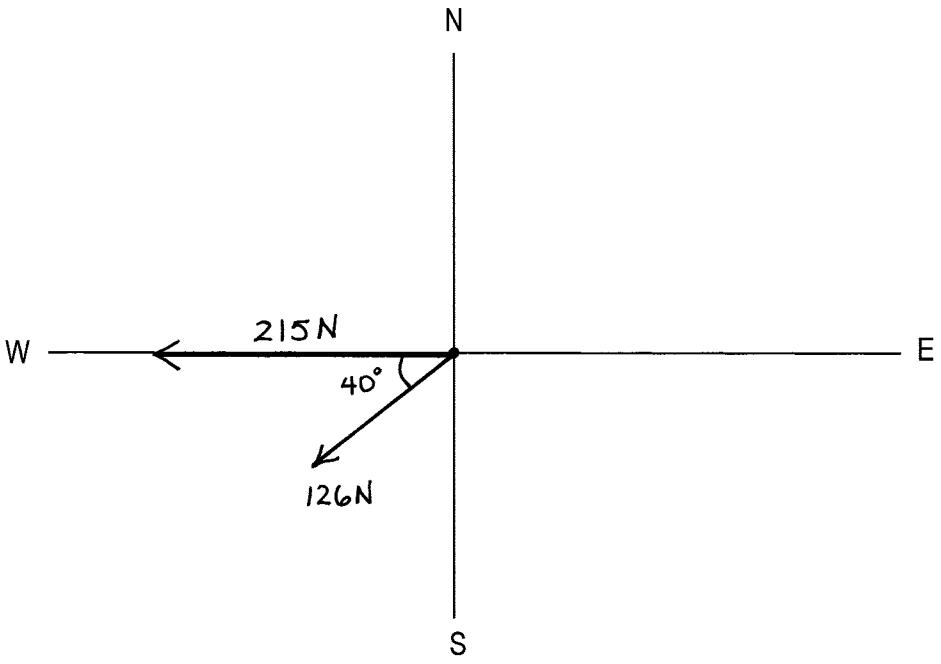
6. A bug crawls 16 cm due east, then 12 cm due north, then 4 cm due west and finally 9 cm due north. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the bug's resultant displacement. Include a specific directional angle, θ, in your answer.



7. A ship traveling at a velocity of 47 m/s at an angle of 20° north of east is acted on by a wind blowing at a velocity of 10 m/s at an angle of 30° north of west. 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.

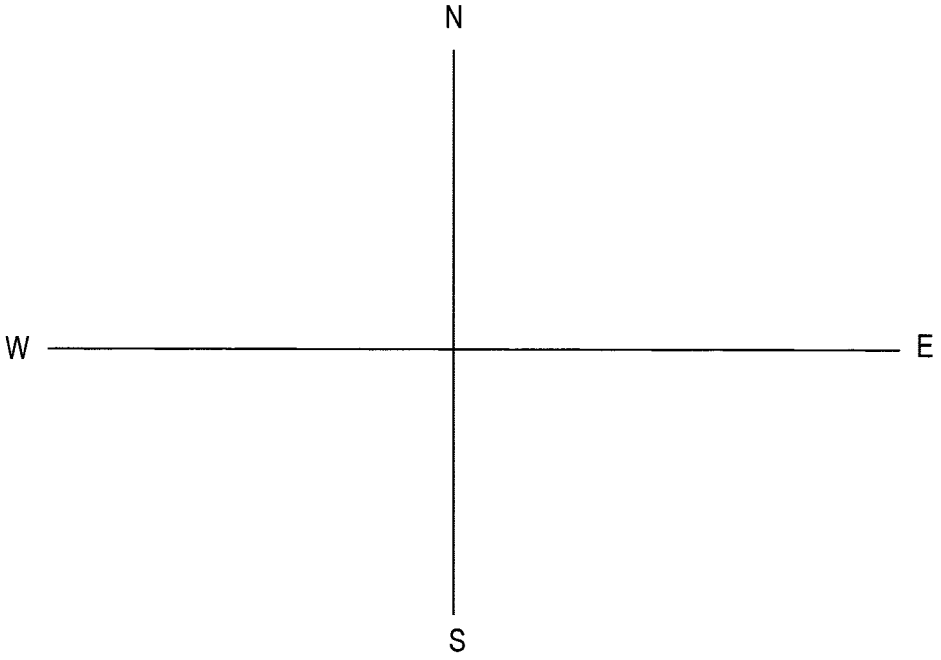


8. Two forces of 126 Newtons and 215 Newtons act on an object, as shown in the diagram below.



Calculate the magnitude and direction (including a specific angle, θ) of the resultant force and the equilibrant force.

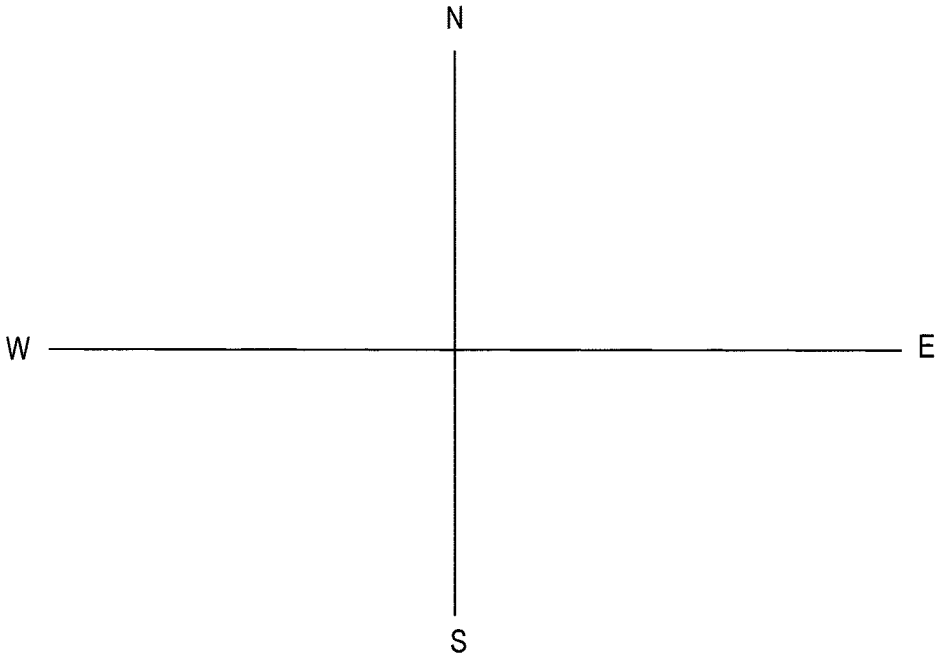
9. A student walks 400 meters due south, then 260 meters due west, then 120 meters due north and lastly 395 meters due east. Draw and label a vector diagram (including the resultant) and calculate the magnitude and direction of the student's resultant displacement. Include a specific directional angle, θ, in your answer.



10. Two forces act on an object.

Force **A** = 120 Newtons due north
Force **B** = 38 Newtons directed 25° south of east

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



VECTOR COMPONENTS

EQUATIONS:

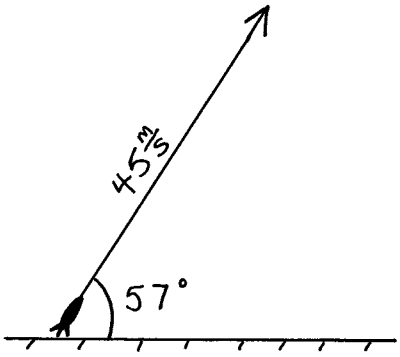
$A_x = A \cos \theta$

$A_y = A \sin \theta$

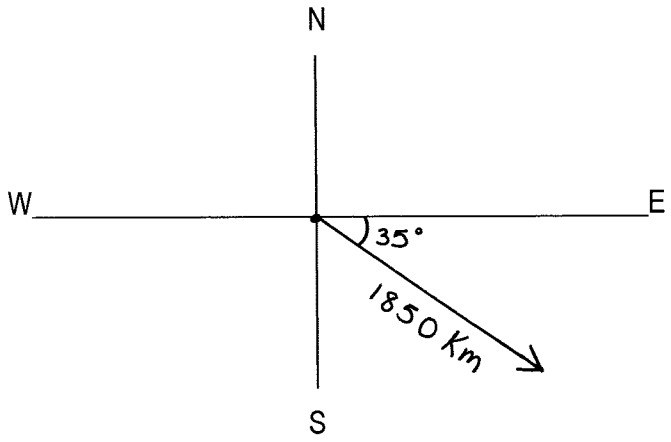
These equations are valid if θ is measured from the x axis!

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

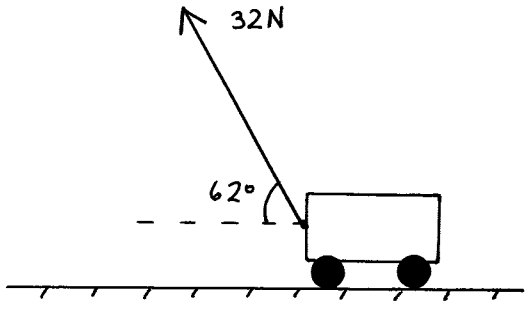
1. A toy rocket is launched upward at a velocity of 45 m/s at a 57° angle relative to the ground. Draw and label the components on the diagram below and calculate the magnitudes of the vertical and horizontal components of the velocity.



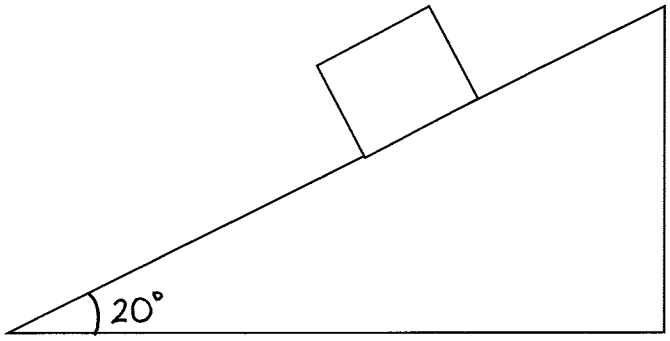
2. A plane is flown 1850 Km in a direction 35° south of east. Draw and label the components on the diagram below and calculate the magnitudes of the eastern and southern components of the plane's displacement.



3. A wagon is pulled by force of 32 N force applied to the handle, which makes an angle of 62° 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 70 Newtons is placed on a 20° incline, as shown below.



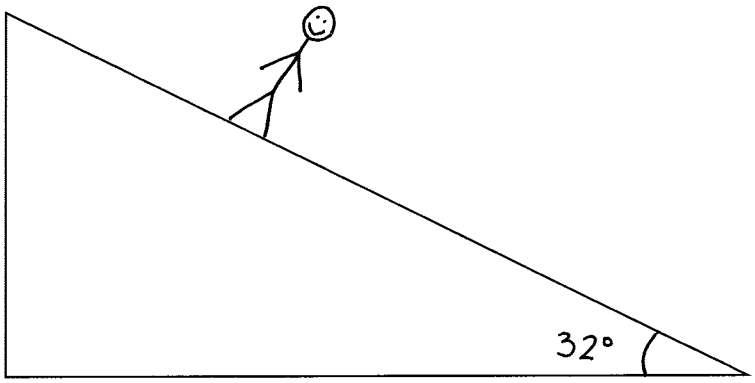
(a) Draw and label the components of the block's weight that are parallel and perpendicular to the incline and calculate the magnitude of each component.

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

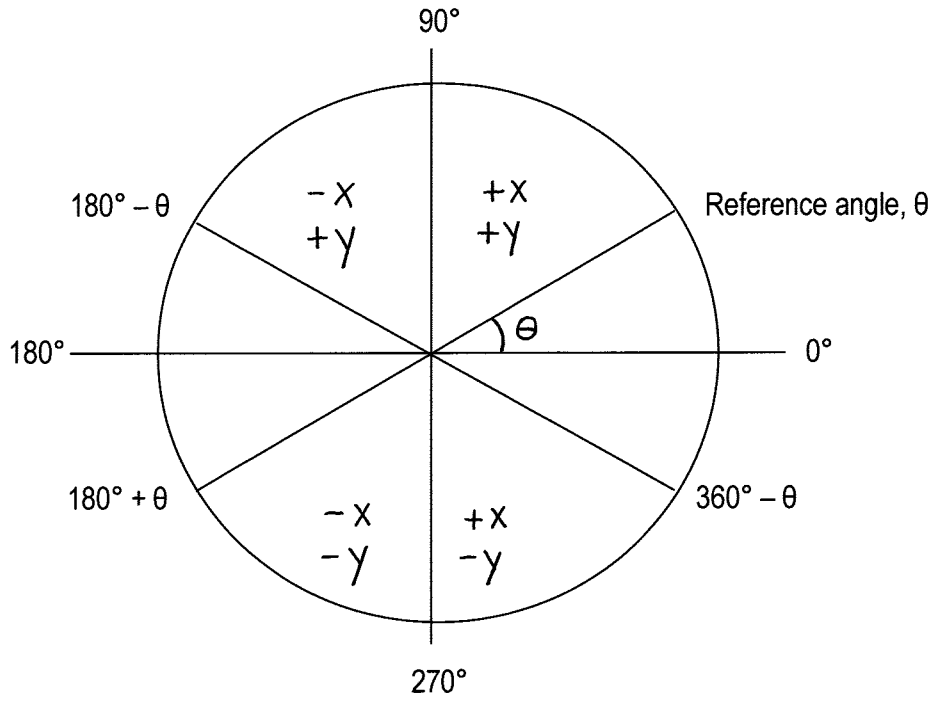
Parallel component _____

Perpendicular component _____.

5. A person weighing 874 N stands on a 32° 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.



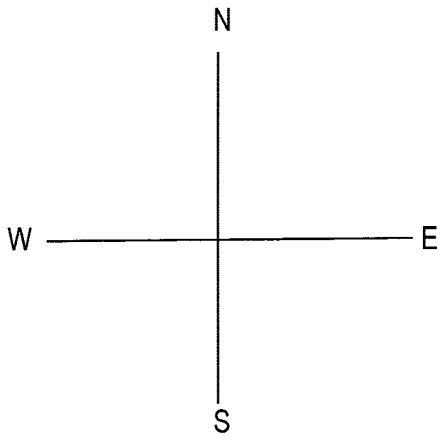
TRIG REVIEW



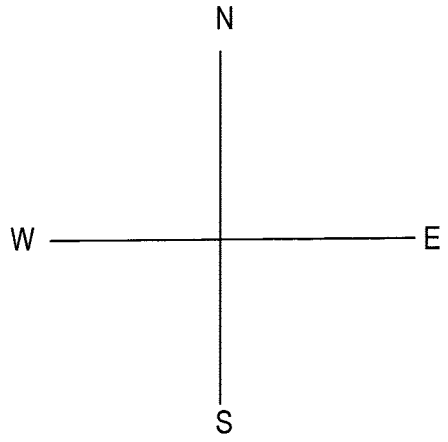
PROBLEMS:

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

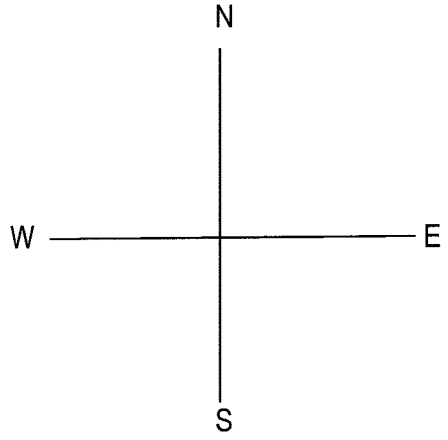
1. A_x = **-4**, A_y = **-8**



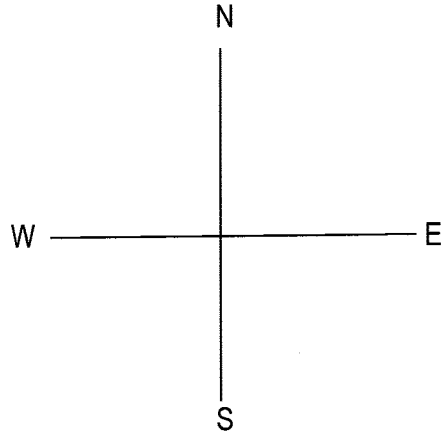
2. A_x = **+12**, A_y = **-9**



3. A_x = **-6**, A_y = **+11**



4. A_x = **+10**, A_y = **+4**



COMPONENTS METHOD PROBLEMS

1. A person drives 5.2 Km in a direction 32° north of west, then 11.4 Km due east and finally 3.8 Km at 26° south of east. Calculate the magnitude and direction of the person's resultant displacement. Include a specific directional angle in your answer. (No diagram is necessary.)

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

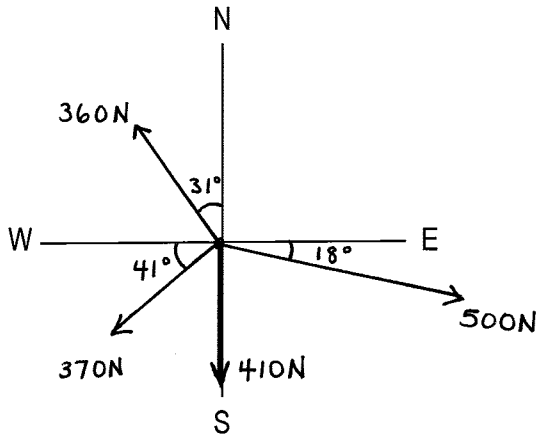
Force A = 94 N, 24° south of west
Force B = 70 N, 40° north of east°
Force C = 110 N, 36° west of north

(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 520 meters at 50° north of west, then 450 meters due west and then 615 meters at 18° north 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. Four forces act on point **P**, as shown below. Calculate the magnitude and direction of the resultant force and the equilibrant force.



5. A woman bikes 1.2 Km due north, then 2.4 Km at 10° south of east and continues for an unknown distance. Her final location is 0.75 Km, 43° north of west of where she started. Determine the magnitude and direction of the third part of her bike ride. Include a specific directional angle (θ) in your answer.

UNIT CONVERSIONS

1 mile = 1.609 Km

1 Km = 0.6214 mile (mi)

1 meter (m) = 3.281 ft

1 inch = 2.54 cm

1 ton = 2000 lbs

1 mile = 5280 feet

1 Newton (N) = 0.2248 lbs

1 lb = 4.448 Newton (N)

1 kg = 0.0685 slug

PROBLEMS: Using the factor-label method 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) 12.6 miles = _____ Km

2) 160 lbs = _____ N

3) 250 ft/sec = _____ Km/hr

4) 100 Km/min = _____ ft/sec

5) 7.75×10^2 m/s = _____ in/min

6) 12.7 slugs = _____ Kg

7) 52 N/cm^2 = _____ lbs/ft^2

8) 5.4×10^3 Kg/m^3 = _____ g/in^3

9) 4.1×10^2 meters/min = _____ cm/hr

10) 590 m^2 = _____ Km^2

11) 5.7×10^5 mm^3 = _____ in^3

VECTORS ANSWER KEY

Vector Algebra

1. R = 149 m/s north
2. R = 35 N east
3. R = 2281.6 m, 55.3° north of west (or 124.7° cc)
4. Maximum force = 120 N, Minimum force = 16 N

5a. R = 51.6 N, 54.5° east of south (or 324.5° cc)

b. R = 51.6 N, 54.5° west of south (or 215.5° cc)

6. R = 24.2 cm, 60.3° north of east (or 60.3° cc)
7. R = 41.3 m/s, 30.7° north of east (or 30.7° cc)
8. R = 321.9 N, 14.6° south of west (or 194.6° cc)

   E = 321.9 N, 14.6° north of east (or 14.6° cc)

9. R = 310.8 m, 25.7° east of south (or 295.7° cc)
10. R = 109.5 N, 18.3° east of north (or 331.5° cc)

Vector Components

1. A_x = 24.5 m/s, A_y = 37.7 m/s
2. A_x = 1515.4 m/s (east), A_y = 1061.1 Km (south)
3. A_x = 15.0 N, A_y = 28.3 N

4a. $A_{\parallel}$ = 29.3 N, $A_{\perp}$ = 65.8 N

b. Parallel component increases, perpendicular component decreases

5. A = 463.1 N, A = 741.2 N

Trig Review

1. R = 8.9, 63.4° below –x axis (or 243.4° cc)
2. R = 15, 36.9° below +x axis (or 323.1° cc)
3. R = 12.5, 61.4° above –x axis (or 118.6° cc)
4. R = 10.8, 21.8° above +x axis (or 21.8° cc)

Components Method

1. R = 10.5 Km, 6.0° north of east (or 6.0° cc)

2a. R = 204.3 N, 1.6° north of west (or 178.4° cc)

b. R = 204.3 N, 1.6° south of east (or 358.4° cc)

3. 621.1 m, 71.3° south of east (or 288.7° cc)

4. R = 498.7 N, 88.7° south of east (or 271.3° cc)

   E = 498.7 N, 88.7° north of west (or 91.3° cc)

5. 2.92 Km, 5.3° south of west (or 185.3° cc)

Unit Conversions

1. 20.3 Km
2. 711.7 lbs
3. 274.3 Km/hr
4. 5468.3 ft/sec
5. 1.83×10^6 in/min
6. 185.4 Kg
7. 1.08×10^4 lb/ft^2
8. 88.5 g/in^3
9. 2.46×10^6 cm/hr
10. 5.9×10^{-4} Km^2
11. 34.8 in^3