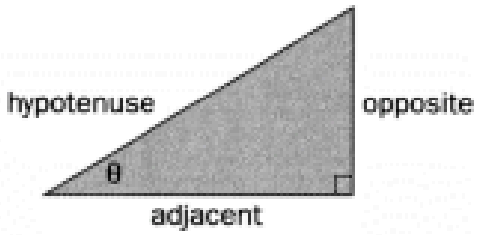
Trigonometry

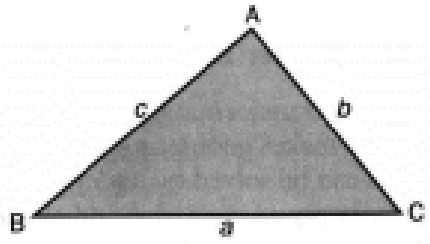
The three Primary Trigonometric Ratios (for Right Triangles) are

$$\sin\theta = \frac{opposite}{hypotenuse}$$

$$\cos\theta = \frac{adjacent}{hypotenuse}$$

$$\tan\theta = \frac{opposite}{adjacent}$$





The Law of Sines states

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

The Law of Cosines states that

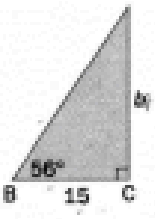
$$a^2 = b^2 + c^2 - 2bc\cos A$$

$$b^2 = a^2 + c^2 - 2ac\cos B$$

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

Find the length of the indicated side

1.



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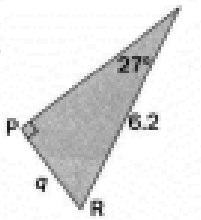

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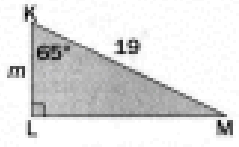

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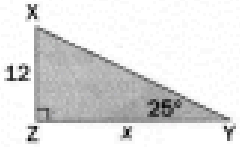

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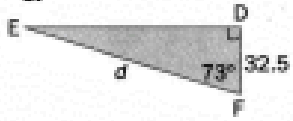

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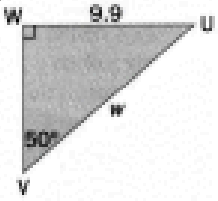
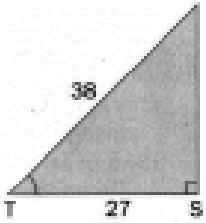


Find the measure of the indicated angle

7.



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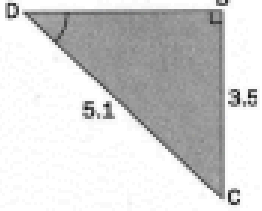

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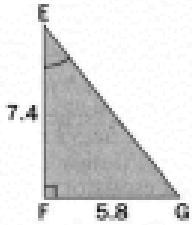

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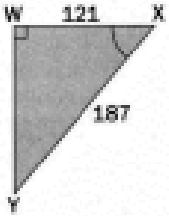

Vectors

1. Determine the displacement between the initial position, *xi*, and the final position, *xf*.

a) xi=3.0 m west;xf=10.0 m westx_i = 3.0 \text{ m west}; \quad x_f = 10.0 \text{ m west}xi=3.0 m west;xf=10.0 m west
b) xi=320 km east;xf=110 km northx_i = 320 \text{ km east}; \quad x_f = 110 \text{ km north}xi=320 km east;xf=110 km north
c) xi=11 m at 32◦ south of east;xf=10.0 m southx_i = 11 \text{ m at } 32^\circ \text{ south of east}; \quad x_f = 10.0 \text{ m south}xi=11 m at 32◦ south of east;xf=10.0 m south
d) xi=550 km at 15◦ west of north;xf=620 km at 40.0◦ north of westx_i = 550 \text{ km at } 15^\circ \text{ west of north}; \quad x_f = 620 \text{ km at } 40.0^\circ \text{ north of west}xi=550 km at 15◦ west of north;xf=620 km at 40.0◦ north of west

2. A car travelling south at 15 m/s is later travelling west at 25 m/s.
What is the change in velocity?

3. An airplane heads due north with an airspeed of 75 m/s. The wind is blowing due west at 18 m/s.
What is the airplane's speed relative to the ground?

4. A girl can swim at 6.2 km/h. She decides to swim across a river heading straight across (east). If the current is 3.0 km/h south:
a) What is her velocity relative to someone sitting on the shore?
b) What is her speed relative to a bird sitting on a free-flowing log next to her?

5. A plane is heading directly south towards a runway at a speed of 210 km/h. Suddenly, the plane experiences a gust of wind 75 km/h due west.
What direction should the pilot aim the plane in order to continue to head directly to the runway?

6. An aircraft heads due south with a speed relative to the air of 56 m/s. Its resultant speed over the ground is 62 m/s. The wind blows from the east.
a) What is the speed of the wind?
b) What is the direction of the aircraft's path over the ground?

Horizontal Projectile

1. A ball rolls off of a table with a speed of 3.2 m/s. The table is 1.5 m high. How far away from the base of the table does the ball travel?

2. A coin rolls off the edge of a table. The coin was travelling with a speed of 0.40 m/s. It lands 0.20 m away from the table leg (which is straight down from the table edge). How high is the table?

3. A car travelling at 72 km/h drives off a cliff 400. m high. How far from the base of the cliff does it hit the ground?

4. A car drives off a 90. m high cliff and lands 72 m from the base of the cliff. At what speed did the car drive off the cliff?

5. A cannon ball is shot horizontally at 30.0 m/s and falls for 5.0 s.

a) How far does it fall vertically?

b) How far does it move horizontally?

6. A baseball is hit horizontally. It leaves the bat with a speed of 40.0 m/s. The batter hit the ball at a height of 1.00 m above the ground. What distance does it travel before it hits the ground?

7. A rock is thrown horizontally from the top of a 12 m high building at a speed of 14 m/s. There is a 8.0 m high tree 11 m from the base of the building. Does the rock make it over the tree?

8. For a horizontally-launched projectile, draw the shape of each of the following graphs (linear, parabolic, exponential, constant, etc.):

a) horizontal displacement vs. time

b) vertical displacement vs. time

c) horizontal velocity vs. time

d) vertical velocity vs. time

e) horizontal acceleration vs. time

f) vertical acceleration vs. time

Projectile Motion at Angles

1. A cannon ball is launched on a flat field at an angle of 30.0° above the horizontal and has an initial velocity of 120 m/s.
a) Draw a vector diagram showing the initial velocity vector and its horizontal and vertical components.
b) What is the time of flight?
c) What is the horizontal range?

2. A soccer ball is kicked from ground level. The ball stays in the air for 4.3 s and the ball hits the field 55 m away from where it was kicked.
a) What is the initial velocity of the ball?
b) What is the velocity upon impact?
c) What maximum height does the ball reach?

3. In a circus, a “human cannonball” is launched from a cannon and lands in a net. The cannon releases him at the same height as the net. His initial velocity is 18.3 m/s in a direction 40.0° above the horizontal.
a) For how much time will he be in the air?
b) How far does he travel horizontally?
c) What is the velocity upon impact?

4. The circus manager from the previous question wants to make the stunt more dramatic by firing the stuntman through a hoop 9.0 m high then land in a safety net at the same height as the cannon. The cannon’s angle is changed to 45.0° and the velocity is increased to 21.0 m/s. The manager needs to know where to place the hoop and safety net.
a) How far from the cannon should the safety net be placed?
b) What is the time required to reach the height of the hoop?
c) How far from the cannon should the hoop be placed?
d) Sketch the setup of the stunt showing the location of the cannon, hoop and net.

5. A catapult flings a rock from a castle wall of height 60.0 m. The initial velocity of the rock is 80.0 m/s at an angle of 25° above the horizontal.

a) What is the horizontal range?

b) What is the velocity upon impact?

c) What maximum height above the ground does the ball reach?

d) If there is a 75 m high tree along the path of the rock's flight, will the rock clear the tree? If so, by how much?