Fizix Of Phun

RCS Sr High
Lab Day
Support Pack

In Conjunction with THE GREAT ESCAPE & SPLASHWATER KINGDOM

Student Name	

Uniform Motion

For uniform motion, the forces are in balance. There are no net or resulting forces. Under these conditions, calculating the velocity of an object is straight forward.

$$\bar{v} = \frac{d}{t}$$

Accelerated Motion

When an unbalanced force acts on an object, am acceleration is produced.

$$a = \frac{F}{m}$$

Acceleration occurs anytime there is a change in velocity. For objects moving in a curved path velocity is changing even though speed may be constant. Velocity is a vector and therefore must have speed and direction. If your direction is changing, like on a rotor, then there is an acceleration towards the center of the rotor. this acceleration is called centripetal acceleration.

$$a_c = \frac{v^2}{r} = \frac{4\pi^2 r}{T^2}$$

In the case of an object spinning in a circle, the magnitude of the velocity (speed) is calculated by measuring the time for one complete spin and dividing this into the circumference of the circle.

If there is an acceleration there must be an unbalanced force producing it. The force causing the circular motion is called centripetal force (F_c). This force causes the object to change direction thereby creating the acceleration in the same direction (toward the center).

Newton's 2nd Law of Motion must also apply to circular motion.

$$F_c = ma_c$$

$$F_c = \frac{mv^2}{r} = \frac{4m\pi^2 r}{T^2}$$

This force is easy to see and understand if you swing a rubber stopper on the end of a string. You can see your hand is producing the force which is transferred through the string to make the stopper follow the circular path. So your hand produces the force which causes the centripetal acceleration.

On the Canyon Blaster, the track produces the centripetal force. This force keeps you moving in a circular path by providing an acceleration on you toward the center. You on the other hand have the impression that there is a force throwing you toward the outside of the train's car. This is very similar to being in an automobile at rest and the driver pushes the accelerator to the floor. **If** the car has a lot of horsepower you feel like you are being pushed back in the seat. In reality the seat is accelerating you forward. This "force" you feel back against the seat does not really exist, its your inertia trying to keep you at rest.
The only force is the seat accelerating you. So on the Canyon Blaster the force you feel out against the car's wall, called centrifugal force, is a fictitious force. You are reacting to the wall pushing in on you. Think of centripetal force as the action force and centrifugal force is the reaction force. Remember centrifugal force is considered to be fictitious.

Gravity and G-Forces

Gravity refers to the force of attraction between objects. All objects exert a gravitational force. The larger or more massive the object the greater the force.

We are accustom to the gravity of the earth. When you are standing still the force exerted on you by the earth produces your weight. This is also referred to as one "g". When you feel heavier than normal you are experiencing a force greater than 1 g. When you feel lighter than normal you are experiencing a force less than 1 g. You are weightless when you feel no forces, (free fall).

On the roller coaster, when you go down a steep hill, you will get that "light stomach feeling" and will notice yourself lifting off the seat. You have just experienced weightlessness (you and the seat are falling at the same rate so you no longer feel pressure from the seat). Imagine the shuttle astronauts having this same feeling continually for several days. This may give you an idea of why many astronauts have what's known as space or motion sickness.

G-Force Information

The ratio of the force felt by an object and its weight is the G-Force.

Examples:

Shuttle in Orbit	0 g's
The Moon	0.165 g's
Mars	0.38 g's
Shuttle Lift Off	3.0 g's
Sun	28 g's

Energy Transformations

There are many energy transformations that occur at the Great Escape amusement park. The main energies used to make calculations involve gravitational potential energy and kinetic energy. Potential energy is energy that is stored. Kinetic energy is energy of motion.

When an object is lifted from the ground or rest position it acquires potential energy. The amount of energy can be expressed as;

$$PE = mgh$$

Energy is measured in units called Joules.

When this object is dropped the potential energy that it has is changed to kinetic energy as the object falls. At the bottom of its fall the object is moving at its fastest velocity which indicates it has its maximum kinetic energy. This kinetic energy can be expressed as;

$$KE = \frac{1}{2}mv^2$$

Conservation of energy requires that the total potential at the top must be equal to the total kinetic at the bottom. If you calculate the potential energy at the top and set it equal to the kinetic energy at the bottom of the hill, the maximum velocity at the bottom can be calculated.

But remember, the rides are not friction free!!!

Work

Work is produced by a force acting on an object over a distance.

$$W = Fd$$

Notice the unit for work (Joules) is the same as the units for energy. energy is the ability to do work. If work is done to lift an object, that work tells the increase in potential energy of the object.

Power

Power is the rate at which work is done (and is measured in Watts)

$$P = \frac{W}{t} = \frac{Fd}{t}$$

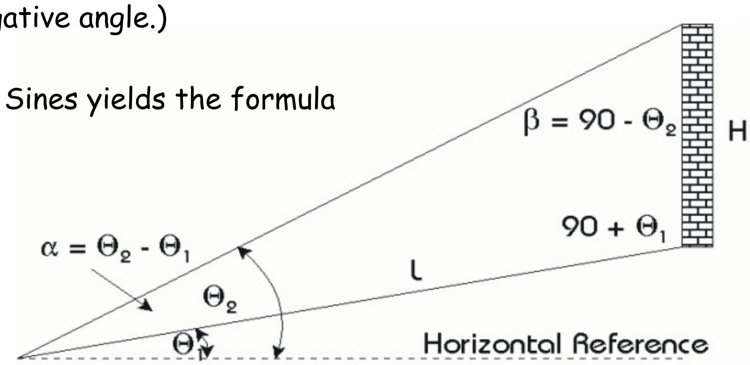
An Angle on Distance

To determine the height of an object, use a simple “protractor elevation finder.”

After pacing off a distance from the base of the object who’s height you need (L), use the “protractor elevation finder” to find the elevation of the base and top of the object. (Note: measuring a downhill angle yields a negative angle.)

Some simple geometry and the Law of Sines yields the formula

$$H = \frac{L \sin\alpha}{\sin\beta}$$



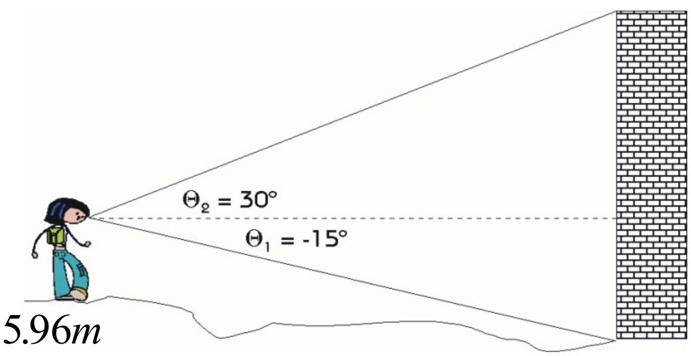
Example 1

$$L = (23 paces)\left(\frac{0.85m}{pace}\right) = 19.55m$$

$$\alpha = \Theta_2 - \Theta_1 = 30 - (-15) = 45^{\circ}$$

$$\beta = 90 - \Theta_2 = 90 - 30 = 60^{\circ}$$

$$H = \frac{L \sin\alpha}{\sin\beta} = \frac{(19.55m)(\sin 45)}{\sin 60} = 15.96m$$



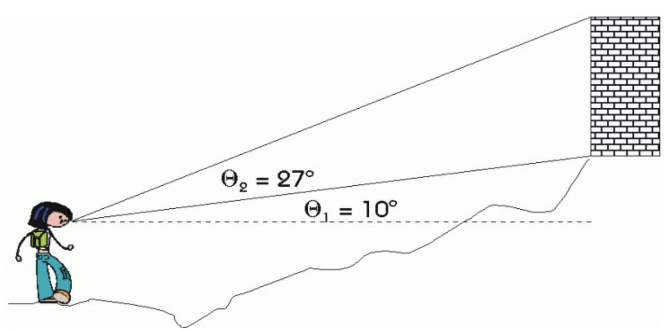
Example 2

$$L = (45 paces)\left(\frac{0.85m}{pace}\right) = 38.25m$$

$$\alpha = \Theta_2 - \Theta_1 = 27 - 10 = 17^{\circ}$$

$$\beta = 90 - \Theta_2 = 90 - 27 = 63^{\circ}$$

$$H = \frac{L \sin\alpha}{\sin\beta} = \frac{(38.25m)(\sin 17)}{\sin 63} = 12.55m$$



Conversions, etc

Force	1 lb = 4.448 N
"Mass"	2.2 lbs = 1 kg
Length	1 in = 0.0254 m 1 ft = 0.3048 m 1 mi = 1609.3 m
Speed	1 mph = 0.447 m/s
Volume	1 liter = 10^{-3} m^3 1 gal = 231 in^3
Power	1 hp = 746 W 1 hp = 550 ft-lbs/sec
Energy	1 kwhr = 3.6×10^6 J

10 paces = ________________ m

1 Arm Span = ______________ m

Average Mass of a student = 70 kg