Forces

- Newton's Three Laws of Motion
- Types of Forces
- Weight
- Friction
- Terminal Velocity
- Periodic Motion

Forces

Defined as a push or a pull

Types of Forces

1) Gravitational - attractive force that exists between all objects
2) Electromagnetic -determines an objects strength, flexibility
3) Strong Nuclear - holds particles of nucleus together
4) Weak - allows for radioactive decay

Newton's First Law of Motion

Based on the experiments of Galileo, who concluded that a perfectly smooth object moving on a perfectly smooth horizontal surface would travel forever in a straight line.

Newton's Statement: An object with no force acting on it moves with a constant velocity.

Newton's First Law of Motion

- However, many times forces are required to keep an object moving at a constant velocity.
- Therefore, Newton's Law has been altered to say: An object with no net force acting on it remains at rest or moves with constant velocity in a straight line.
- Sometimes called the law of inertia - all objects tend to want to keep doing what they're doing.

Newton's Second Law of Motion

- A massive object's acceleration is directly proportional to the net force placed upon it.
- Equation F= ma
- The net force applied to an object will accelerate that object.
- Forces are measured in Newtons (N)

Weight

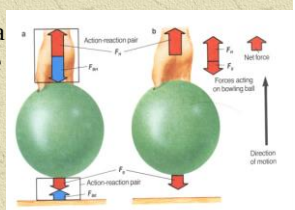
- Weight is the force of gravity applied on an object. The weight of an object can vary from one place to another.
- The calculation for weight is similar to Newton's Second Law:

$$W=mg$$

- Mass and Weight are not the same thing. How do we know?

Newton's Third Law of Motion

When one object exerts a force on a second object, the second exerts a force on the first with equal magnitude in the opposite direction.



Newton's Third Law of Motion

The two forces are considered an action-reaction pair. Those pairs are always equal to one another.

How can objects move then, if forces are always equal? Shouldn't everything just maintain it's current velocity?

Net force is determined by the forces acting on the object, not on the forces the object is applying back on the contact force.

Friction

There are two types of friction

1) Static Friction - force that opposes the start of motion
2) Kinetic Friction - force between surfaces when objects are in relative motion

Coefficient of Friction

- Friction is dependent on the objects and the surface they are moving on. This dependency is considered the coefficient of friction:
  - $F_f = \mu F_N$
- Normal force is the force perpendicular to the surface. On a horizontal surface, it is equal but opposite to the weight.

Air resistance

All falling objects on the moon will fall with the same acceleration.

On Earth, some falling objects will fall at a greater acceleration than others.

The discrepancy is due to air resistance. When an object falls, it collides with air molecules that apply an opposing force against gravity.

Terminal Velocity

Depending on the objects surface area, an object will reach a maximum speed, called the objects terminal velocity. When the speed is constant, no net force is applied to the object. How is this possible?

At terminal velocity, the objects gravitational force is balanced out by the drag force of air.

Simple Harmonic Motion

- A weight suspended from a spring will sit at equilibrium until it is moved.
- When the spring is stretched, the spring exerts a force on the weight to get it back into its equilibrium position.
- However, when the equilibrium point is reached, the weight has inertia, and keeps moving in an upward direction.
- Now, to get back to equilibrium, gravity must pull the weight back down.
- This back and forth movement is called simple harmonic motion.

Pendulums

- Pendulums undergo simple harmonic motion as well.
- The period, or time the bob takes for one complete cycle of movement is dependent on the length of the rod and gravity.

$$T = 2\pi\sqrt{\frac{l}{g}}$$

Review Questions

- A 42.0 kg bag of concrete is dropped from a plane. What is the bag's acceleration through the first 3.0 s, assuming no air resistance? What speed will the bag be traveling after the 3.0 s?
- After a period of time, the bag reaches a constant top speed of 145 mi/hr as it falls? At this speed, what is the force applied by air resistance?

Review Questions

- A 53 kg driver in a 2000 kg race car experiences an uniform acceleration that gets the car to 165 mi/hr in 5.7 s. What force is applied on the driver to push her forward?
- The same car loses control and slides across the grass infield and slows to 25 m/s over a distance of 325 m. What is the coefficient of friction of the car tires against the grass?
- After 325 m, the car slams into the wall. The car is in contact with the wall for 0.30 s. The air bag will deploy if the car fender experiences a force of greater than 1×10^5 N. Will the airbag deploy?

Review Questions

- A 240 N crate is pushed across a floor, and the crate accelerates at 1.9 m/s^2. The floor has a coefficient of friction of 0.20. What force is being applied to the crate?
- The Viking Fury at Kings Island is a pendulum ride where the length of the pendulum is 45 m. What is the period of the ride? On Mars, the period for the ride would be 21.9 s. What is the g on Mars?