**Name :_____ Date: _____ Per: ____ Mr. Ahearn**

# Motion & Forces

**Objectives:**

1. Define distance, speed, and velocity.
2. Graph Motion
3. Define acceleration.
4. Predict what effect acceleration will have on motion.
5. Explain Newton's three laws of motion
6. Explain friction.
7. Explain the difference between mass and weight.
8. Define momentum.
9. Explain why momentum might not be conserved after a collision.
10. Predict motion using the law of conservation of momentum.

**Newton's First Law of Motion**

- An object at rest will remain at rest and an object in motion will continue moving at a constant velocity unless acted upon by a net force.

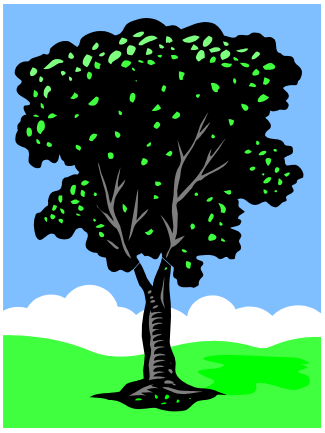
**Problem:**

- Is your desk moving?

- We need a **reference point**...
  - Non-moving point from which motion is measured

**Motion**

Change in position in relation to a reference point



**Problem:**

- You are a passenger in a car stopped at a stop sign. Out of the corner of your eye, you notice a tree on the side of the road begin to move forward.
- You have mistakenly set yourself as the reference point.

## Speed & Velocity

**Speed**

- rate of motion
- distance traveled per unit time

$$speed = \frac{distance}{time}$$

**Instantaneous Speed**

- speed at a given instant

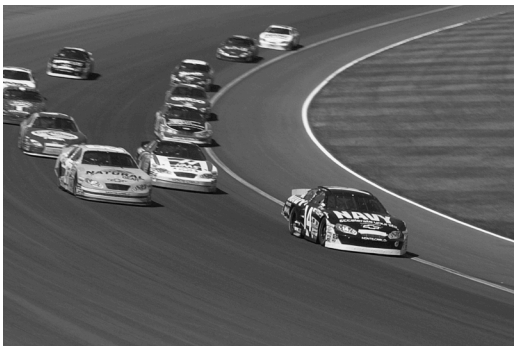
**Average Speed**

$$avg.\ speed = \frac{total\ distance}{total\ time}$$

**Problem:**

- A storm is 10 km away and is moving at a speed of 60 km/h. Should you be worried?

**Velocity**
- speed in a given direction
- can change even when the speed is constant!



## Acceleration
- the rate of change of velocity
- change in speed or direction

$a$: acceleration
$v_f$: final velocity
$v_i$: initial velocity
$t$: time

$$a = \frac{v_f - v_i}{t}$$

Positive acceleration→ "speeding up"  Negative acceleration→"slowing down"

## Practice

Your neighbor skates at a speed of 4 m/s. You can skate 100 m in 20 s. Who skates faster?

| Given | Work |
|---|---|
| | |

A roller coaster starts down a hill at 10 m/s. Three seconds later, its speed is 32 m/s. What is the roller coaster's acceleration?

| Given | Work |
|---|---|
| | |

| | |
|---|---|
| | |

Sound travels 330 m/s. If a lightning bolt strikes the ground 1 km away from you, how long will it take for you to hear it?

| Given | Work |
|---|---|
| | |

How long will it take a car traveling 30 m/s to come to a stop if its acceleration is -3 $m/s^2$?

| Given | Work |
|---|---|
| | |

## Graphing Motion

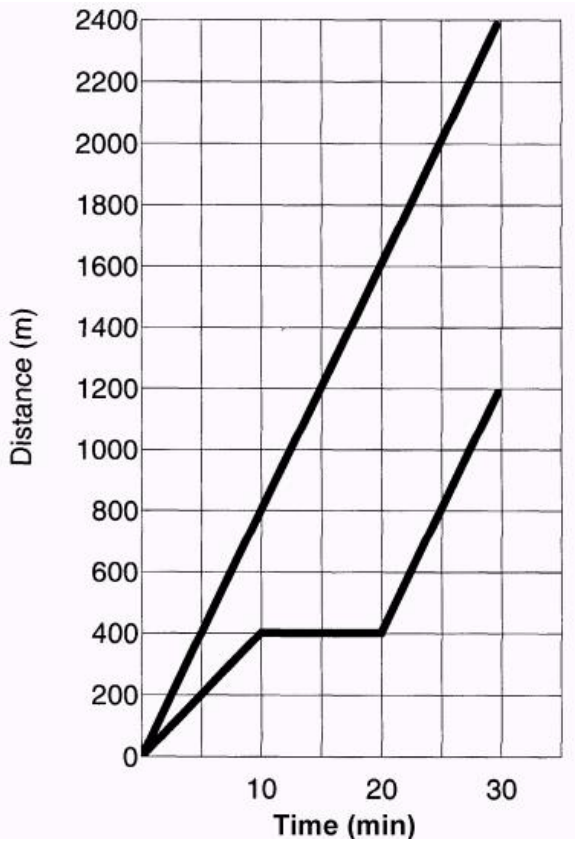
- Slope= Speed
- Steeper line→ Faster Speed
- Straight line → Constant speed
- Flat line → No Motion

1. Who started out faster?

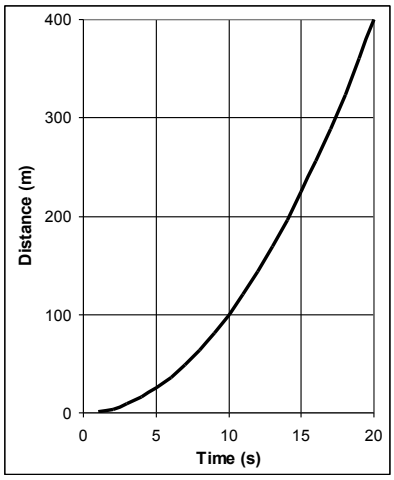
2. Who had a constant speed?

3. Describe B from 10-20 min.

4. Find their average speeds.



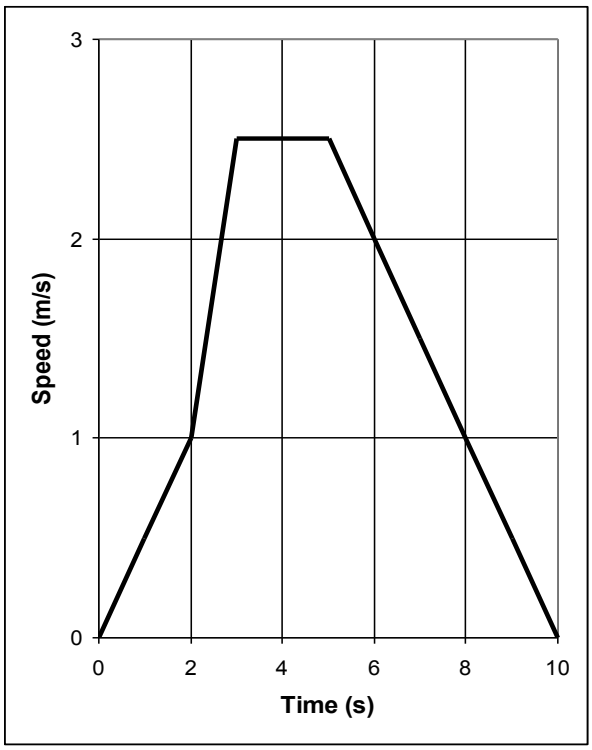
Acceleration is indicated by a curve on a Distance-Time graph.
Changing slope = changing velocity




Slope =acceleration
+ve = speeds up
-ve = slows down

Straight line= Constant acceleration

Flat line = No acceleration




Specify the time period when the object was:

1. slowing down

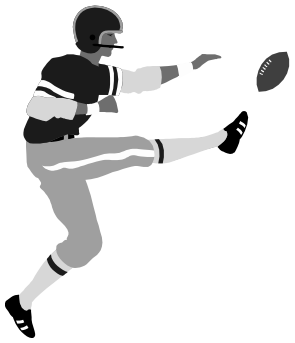
2. speeding up

3. moving at a constant speed

4. not moving

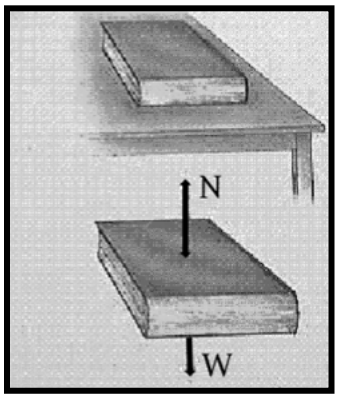
**Force**

- a push or pull that one body exerts on another
- What forces are being exerted on the football?



**Balanced Forces**

- Forces that are opposite in direction and equal in size
- No change in velocity




**Net Force**

- unbalanced forces that are not opposite and equal
- velocity changes (object accelerates)

**Newton's First Law of Motion**

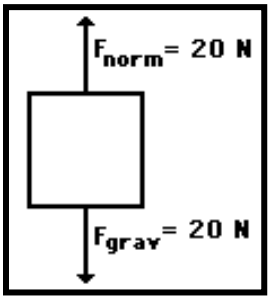
An object at rest will remain at rest and an object in motion will continue moving at a constant velocity unless acted upon by a net force. "Law of Inertia"

**Inertia**

- tendency of an object to resist any change in its motion
- increases as mass increases

**TRUE or FALSE?**

The object shown in the diagram must be at rest since there is no net force acting on it.



You are a passenger in a car and not wearing your seat belt. Without increasing or decreasing its speed, the car makes a sharp left turn, and you find yourself colliding with the right-hand door.

Which is the correct analysis of the situation?

1. Before and after the collision, there is a rightward force pushing you into the door.

2. Starting at the time of collision, the door exerts a leftward force on you.

3. Starting at the time of collision, the door exerts a leftward force on you

**<u>Friction</u>**

Force that opposes motion between 2 surfaces

Depends on the: 1. Types of surfaces 2. Forces between the surfaces

**Friction is greater…**

- between rough surfaces
- when there's a greater force between the surfaces (e.g. more weight)

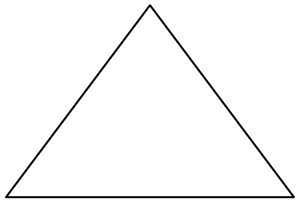
- **Pros and Cons?**

**<u>Newton's Second Law</u>**

The acceleration of an object is directly proportional to the net force acting on it and inversely proportional to its mass. ***F = ma***

*F*: force (N)
*m*: mass (kg)
*a*: accel ($m/s^2$)

$1\ N = 1\ kg \cdot m/s^2$



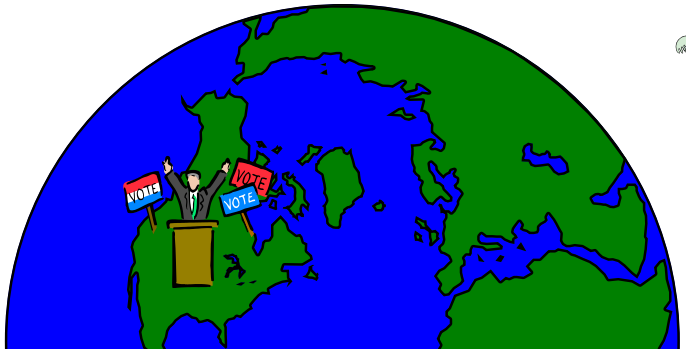
## Gravity

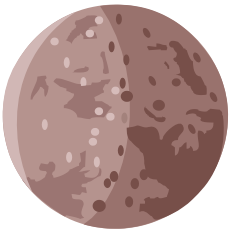
Force of attraction between any two objects in the universe

Increases as... mass increases distance decreases

Who experiences more gravity - the astronaut or the politician?

Which exerts more gravity: Earth moon



**Weight**- the force of gravity on an object

$$W = mg$$

*W*: weight (N)
*m*: mass (kg)
*g*: acceleration due to gravity ($m/s^2$)

**MASS →** *always the same(kg)* **WEIGHT→** *depends on gravity(N)*

Would you weigh more on Earth or Jupiter?

## Acceleration due to gravity *(g)*

- In the absence of air resistance, <u>all</u> falling objects have the same acceleration!
- On Earth: $g = 9.8\ m/s^2$

**Air Resistance** (a.k.a. "fluid friction" or "drag")

Force that air exerts on a moving object to oppose its motion

Depends on:

speed surface area shape density of fluid

**Terminal Velocity**

- maximum velocity reached by a falling object
- reached when…

  $\mathbf{F_{grav} = F_{air}}$
- no net force

  ⇒ no acceleration

  ⇒ constant velocity

- increasing speed ⇒ increasing air resistance until…

  $\mathbf{F_{air} = F_{grav}}$

**Falling with Air Resistance**

- heavier objects fall faster because they accelerate to higher speeds before reaching terminal velocity
- $\mathbf{F_{grav} = F_{air}}$
- larger $F_{grav}$

  ⇒ need larger $F_{air}$

  ⇒ need higher speed

**<u>Problems</u>**

What force would be required to accelerate a 40 kg mass by 4 $m/s^2$?

| Given | Work |
|---|---|
| | |

A 4.0 kg shotput is thrown with 30 N of force. What is its acceleration?

| Given | Work |
| --- | --- |
| | |

A jockey weighs 557 N. What is his mass?

| Given | Work |
| --- | --- |
| | |

**Is the following statement true or false?**
An astronaut has less mass on the moon since the moon exerts a weaker gravitational force.