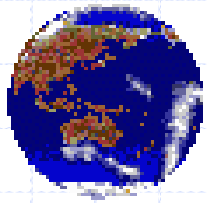
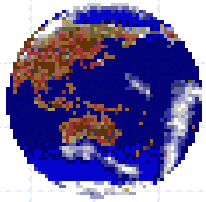
Motion & Forces

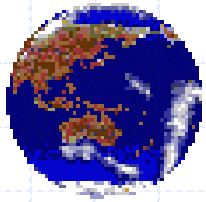
What is motion?



Motion is a change in position, measured by distance and time



Are you moving right now?



- **Earth rotates on its axis at 1,100 mph**
- **Earth orbits the Sun at 68,000 mph**

- **The whole galaxy rotates at 490,000 mph**

Motion

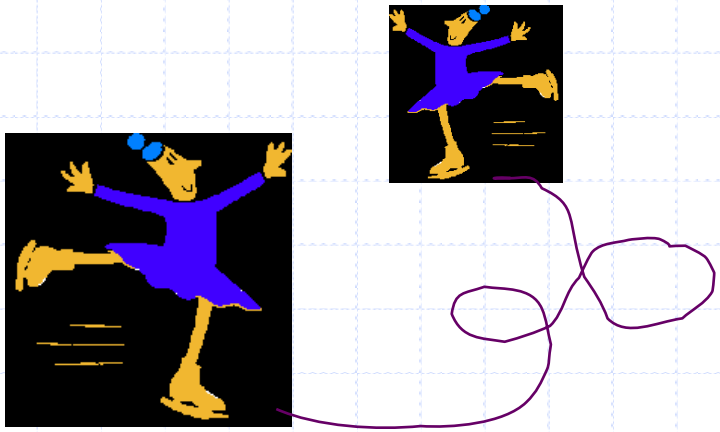
- Speed has two parts
  - Distance - change of position relative to something else
  - Time - seconds

SPEED

- Speed is change in position ÷ change in time
- Changing Speed
  v=d/t

These are your formulas-

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$



$$\text{Velocity} = \frac{\text{Displacement}}{\text{Time}}$$

Three Main Types of Speed

- Instantaneous Speed - at any give moment
- Constant speed
  - When speed doesn't change
- Average speed = total distance/total time
  Graphing speed

Some things move extremely slow

- Earth's Crust
  - California moves 2 cm/year
  - Australia 17 cm/year

Velocity

1. **Speed is distance, direction and time**
    1. **Speed can be in a circle**
2. **Velocity can change even if speed is constant as long as direction changes**

The speed of this car might be constant, but its velocity is not constant because the direction of motion is always changing.

Constant Velocity Motion – No Forces

- If no external forces are acting, velocity is constant
- Position changes, at a steady (constant) rate

t=0 sec 1 sec 2 sec 3 sec 4 sec 5 sec 6 sec

x =1 m 2 m 3 m 4 m 5 m 6 m 7 m

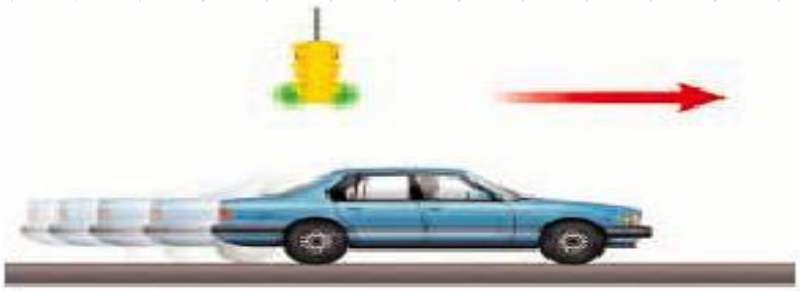
v= 1 m/s 1 m/s 1 m/s 1 m/s 1 m/s 1 m/s *to right*

How does determination of velocity depend on choice x=0 and t=0?


Acceleration

Acceleration

- Velocity is both speed and direction
- Acceleration
  - Change in Velocity
  - Calculation of acceleration
    - a = (Vf-Vi)/t ,
    - a = Δv/t
    - **Units are m/s/s**
    - Deceleration is just negative acceleration
    - +a = speeding up; -a = slowing down



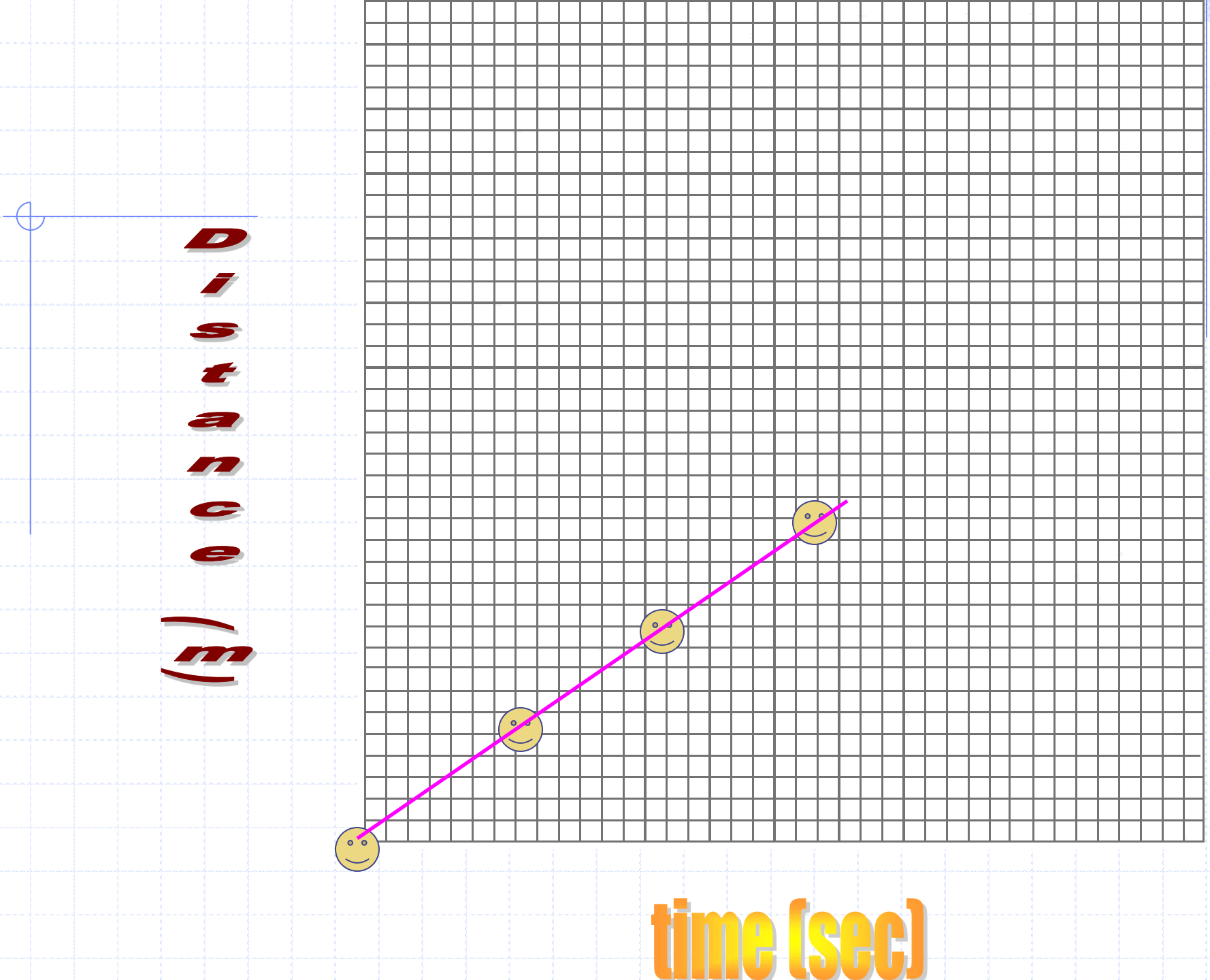
A The speed of this car is increasing. The car has positive acceleration.

B The speed of this car is decreasing. The car has negative acceleration.

Distance-time graphs

- On your paper, graph the following:

D (m)	T (sec)
0	0
5	7
10	14
15	21

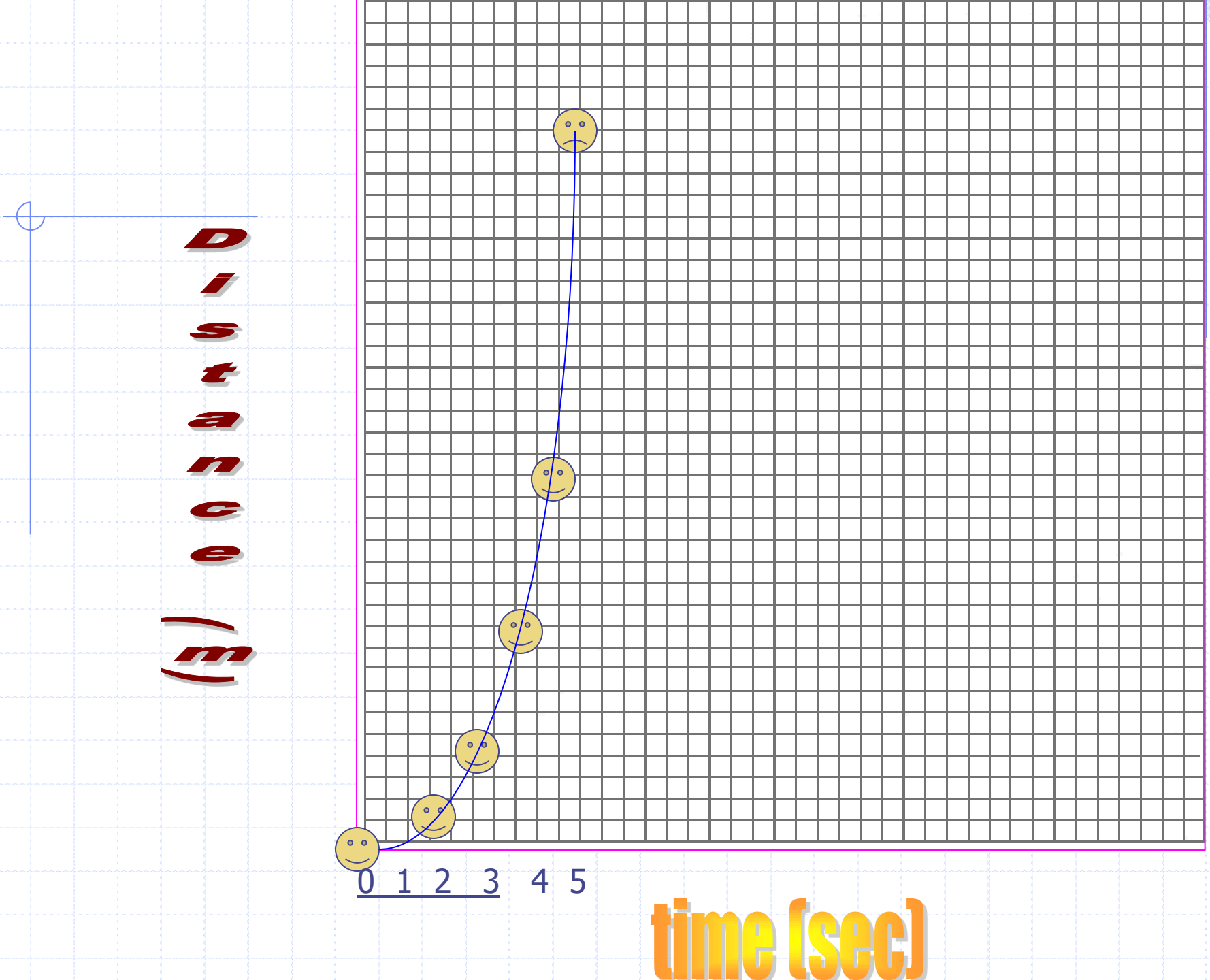

Distance (m)
time (sec)

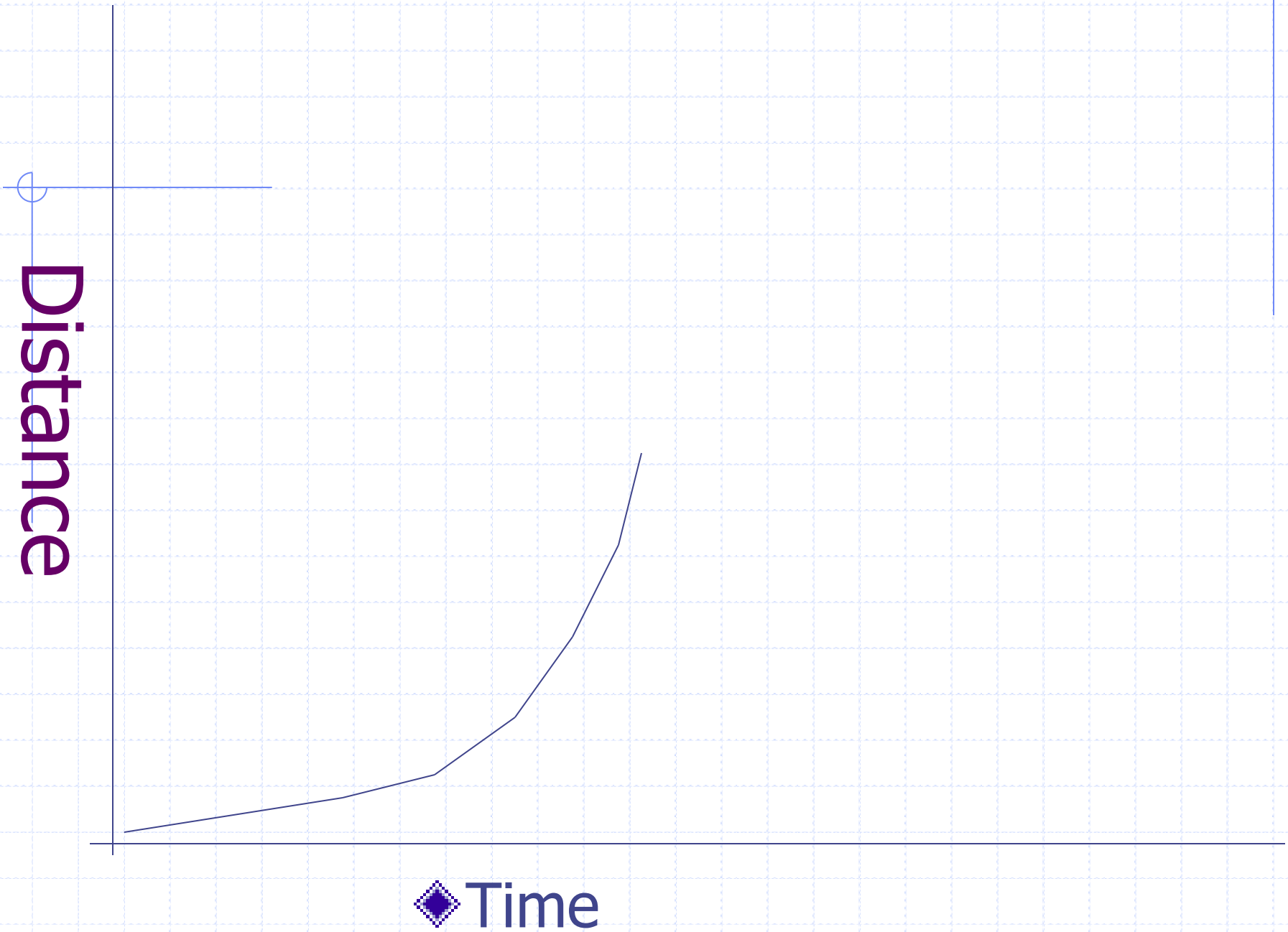
Was your graph a straight line?

- A distance-time graph which is a straight line indicates constant speed.
- In constant speed, the object does not speed up or slow down. The acceleration is zero.

Graph the following on a distance-time graph:

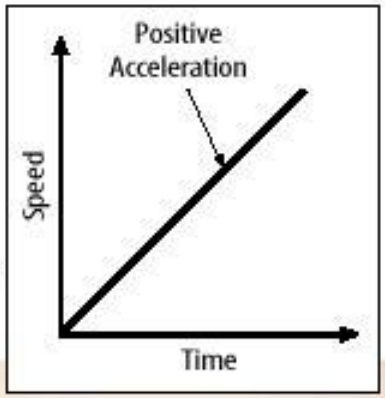
D (m)	T (s)
0	0
5	1
20	2
45	3
80	4
125	5

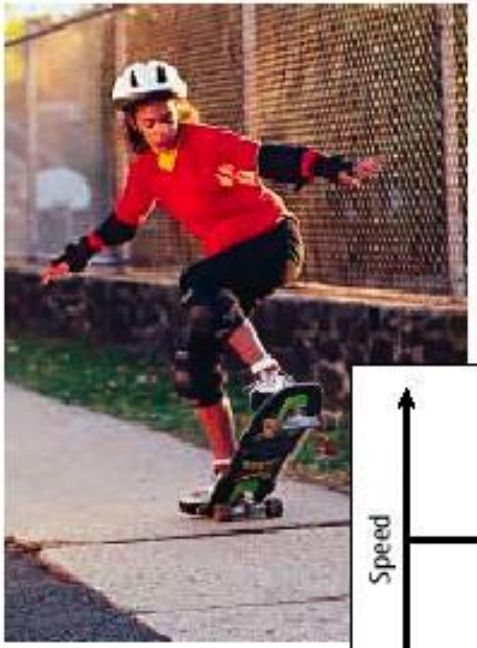

Distance (m)
0 1 2 3 4 5
time (sec)


Distance
Time

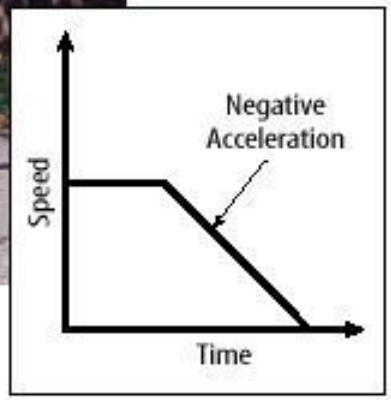
Graphing Acceleration

A If acceleration is a positive number, the line slopes upward to the right.





B If acceleration is a negative number, the line slopes downward to the right.



Quiz

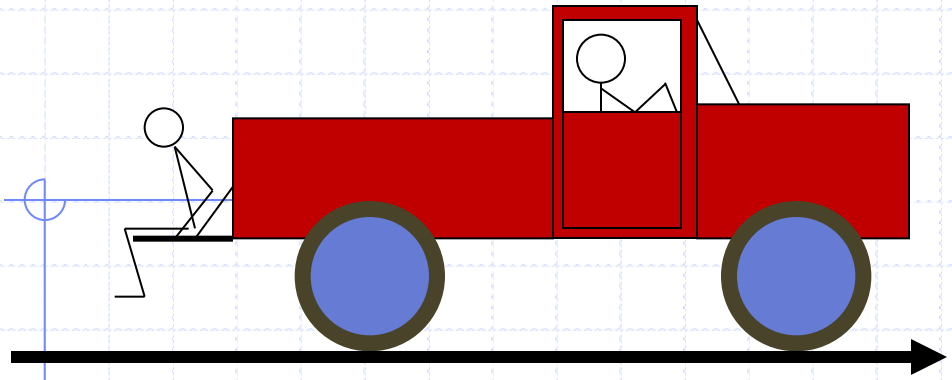
1. If an object travels 120 meters in 8 seconds what is the speed of the object?
2. What is required for an object to accelerate?
3. Explain the difference between instantaneous speed and average speed?
4. What is acceleration?
5. What is the rate of acceleration due to gravity near the earth's surface?
6. If something fell for 5 seconds, how fast will it be going when it hits the earth?
7. Why must there be a frame of reference when speed is calculated?

Prior Knowledge

- Review of ideas:
  - Motion
    - Velocity
    - Acceleration
  - Mass
  - Rest
  - Force

My experience

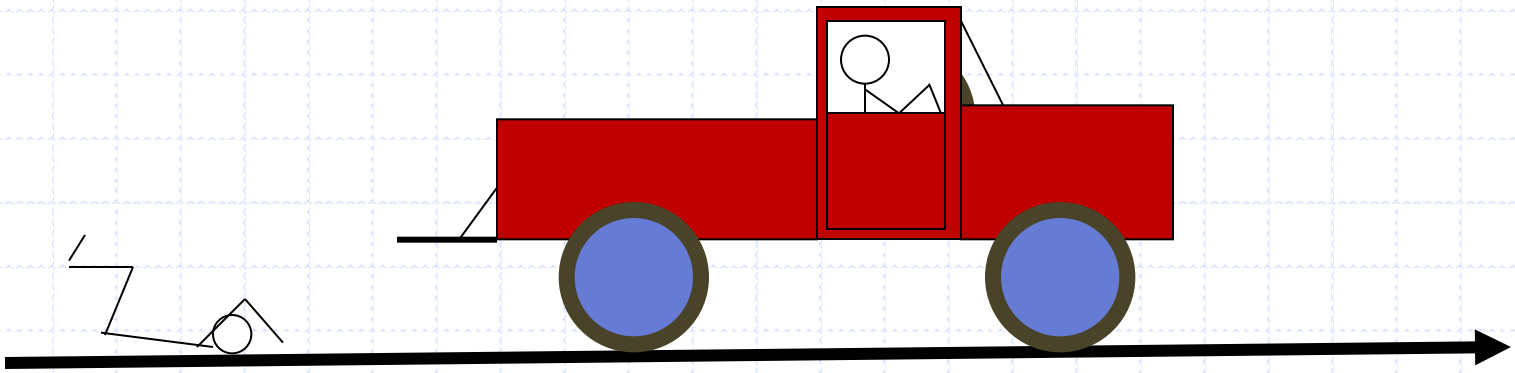
- Getting wood w/my dad
- One of my first realizations about a property of all moving object that we are going to discuss.
- I was riding on the tailgate of the truck and thought that the pickup really wasn't going all that fast
- So what do you think I did?
- Yes I decided I could jump out



Before jumping out of the pickup moving less than 5 mph.

- I had jumped out of the pickup many times when it wasn't moving
- How is jumping out of the moving truck different?
- Do you think this is a good idea?
- What do you think happened?

After jumping out of the pickup moving at about 5 mph



What do you think caused me to fall down on my back and hit my head?

Why was this different than when the pickup was stationary (just sitting in the yard)?

What would have happened if:

- The truck was traveling faster?
- I was heavier?

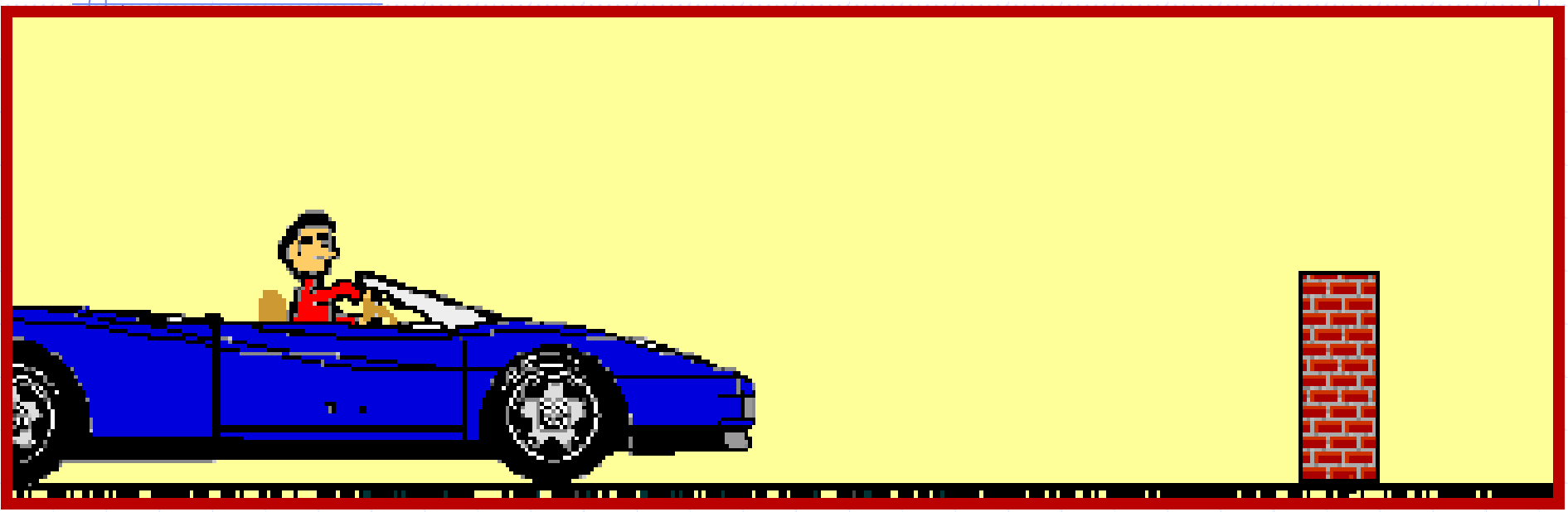
Is there a word in science we us for this tendency for a mass to maintain its velocity?

Inertia

Watch the following video

http://www.youtube.com/watch?v=T1ux9D7-O38
http://www.youtube.com/watch?v=ZqV-raQXTzE

Inertia



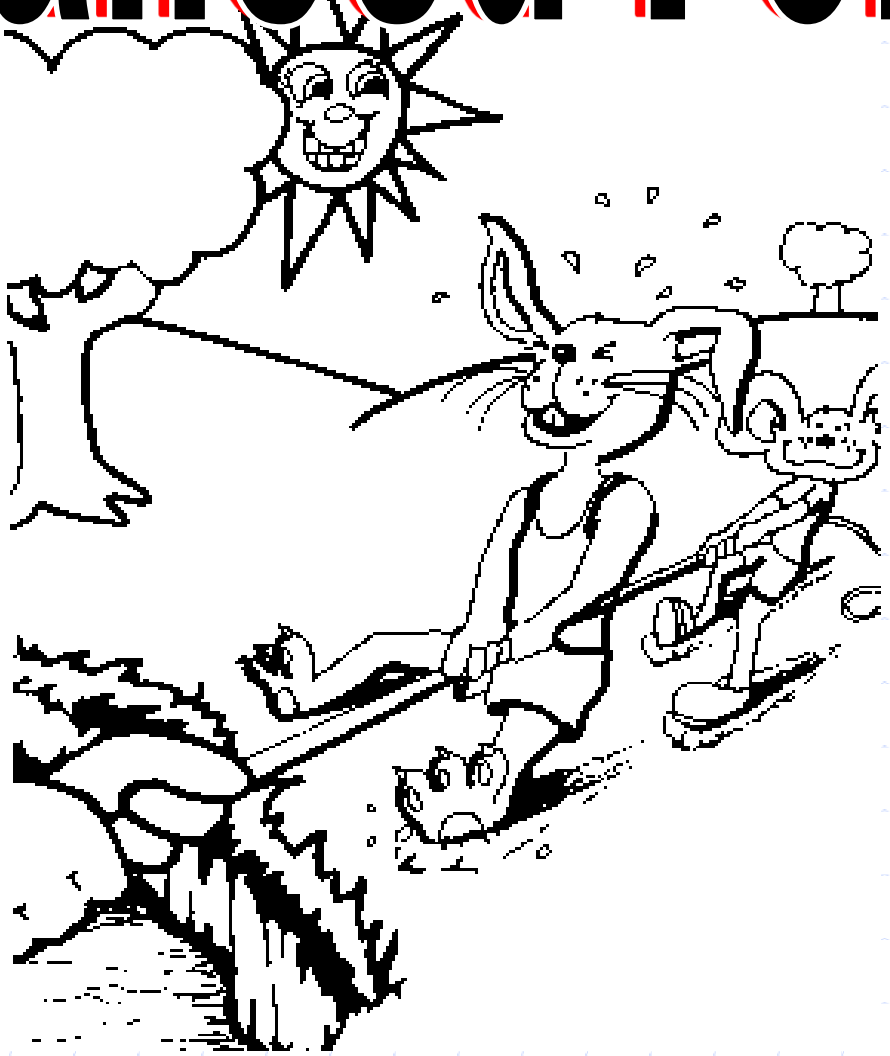
- Is there anything wrong with this picture?

- In your own words describe inertia

Force causes motion

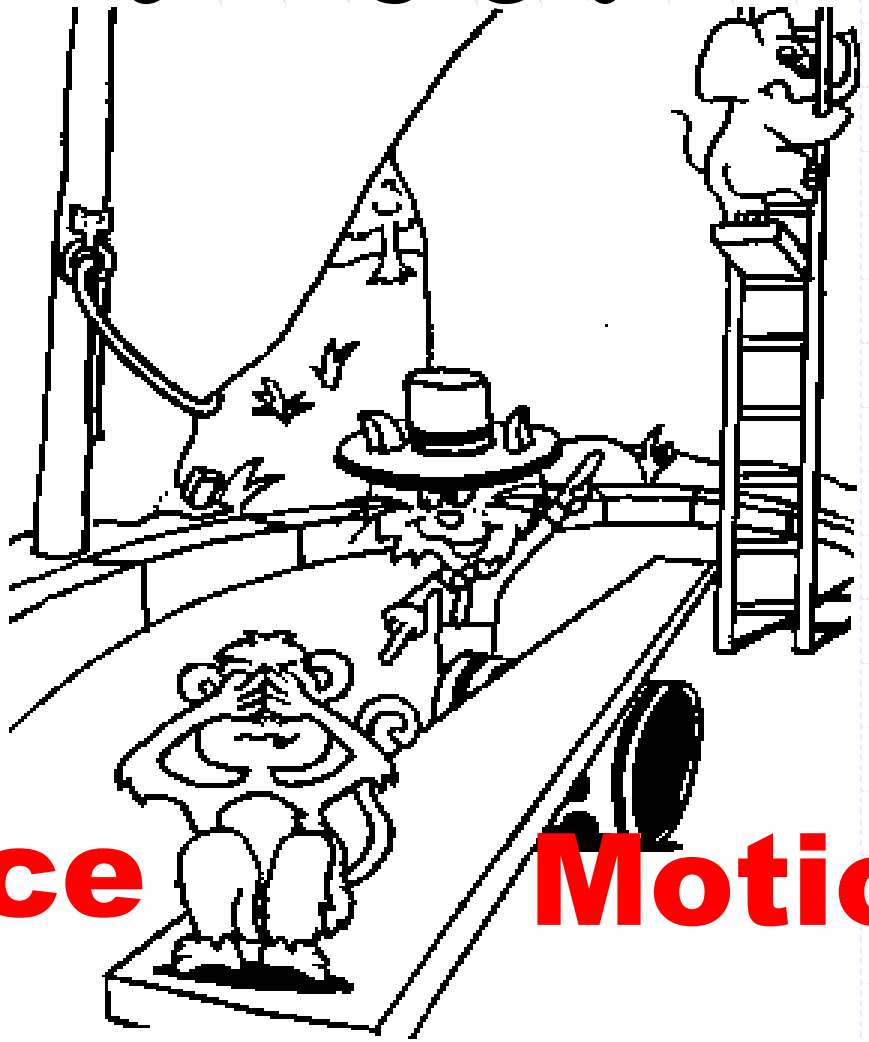
- Force
  - Push or a pull
  - Acceleration is caused by an unbalanced force
  - Constant velocity is the result of balanced forces
  - Unbalanced forces cause acceleration in the direction of the net force

Balanced Forces



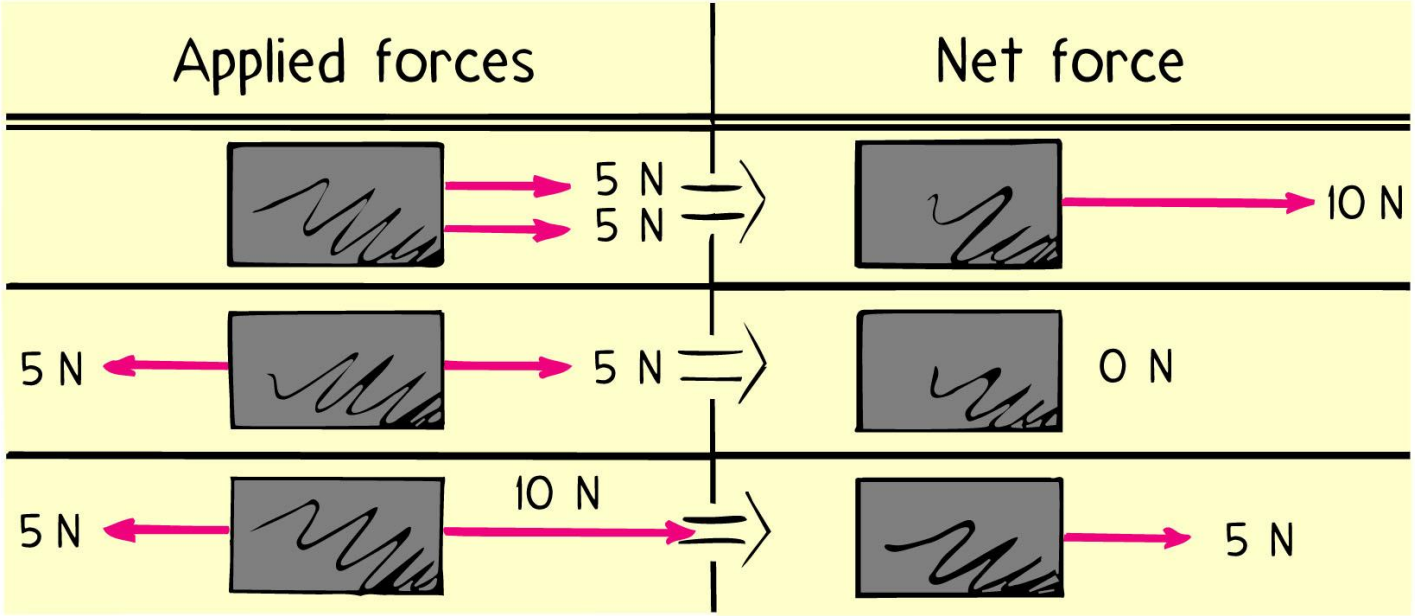
Produce NO Motion

Unbalanced Forces



Produce Motion

Net Forces



Newton's Laws

Newton

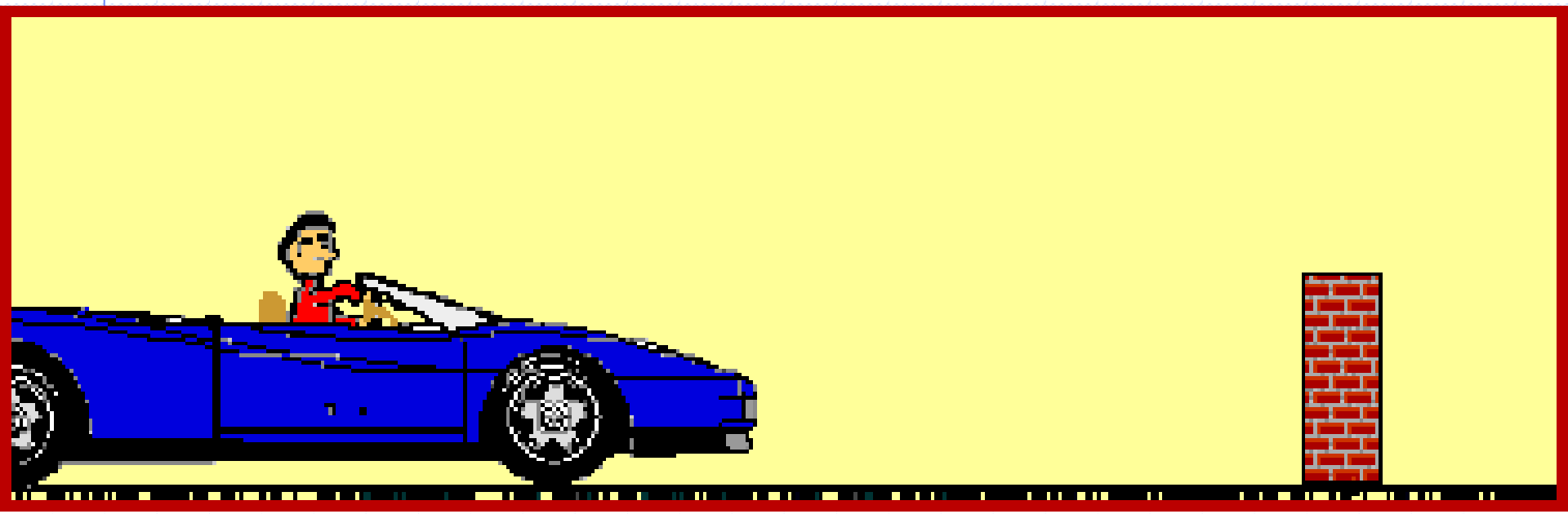
First Law of Motion

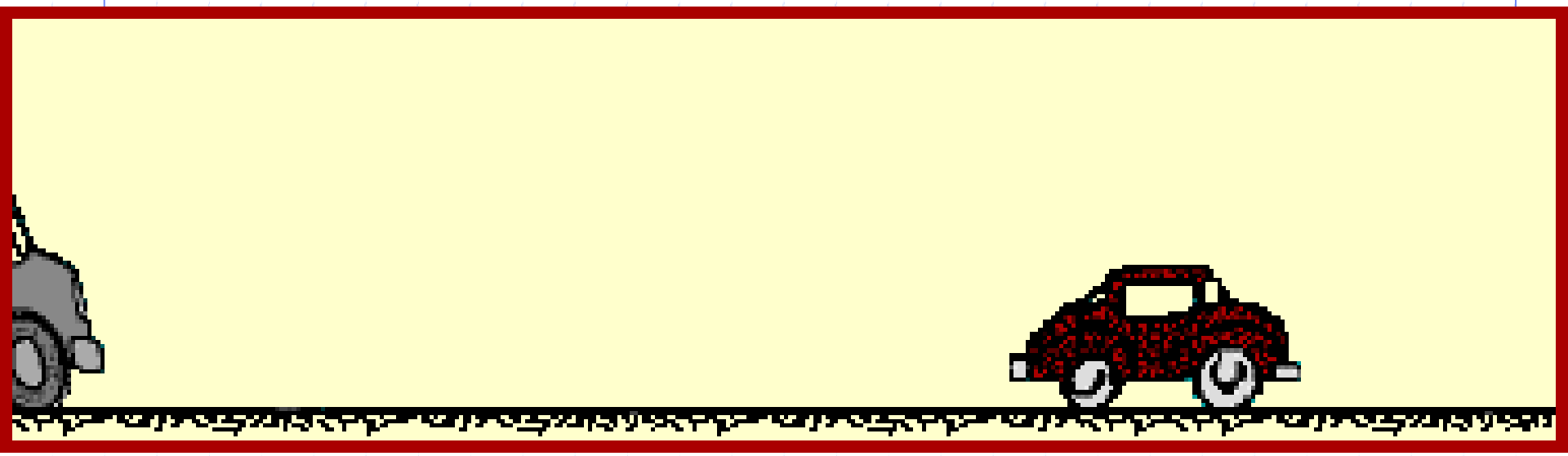
An object at rest will remain at rest, and a moving object will remain at a constant velocity unless acted on by unbalanced forces.

Newton's first law of motion

- An object will maintain its present velocity until acted on by an unbalanced force
  - Inertia - the tendency of an object to resist a change in motion
  - Increase mass causes an increase of inertia
  - Increase in velocity causes an increase of inertia

Please Newton Stop Your Law!





Inertia

Inertia

Friction

A force that opposes motion

Friction

- the force that opposes motion
- Friction,
  - good or
  - bad?

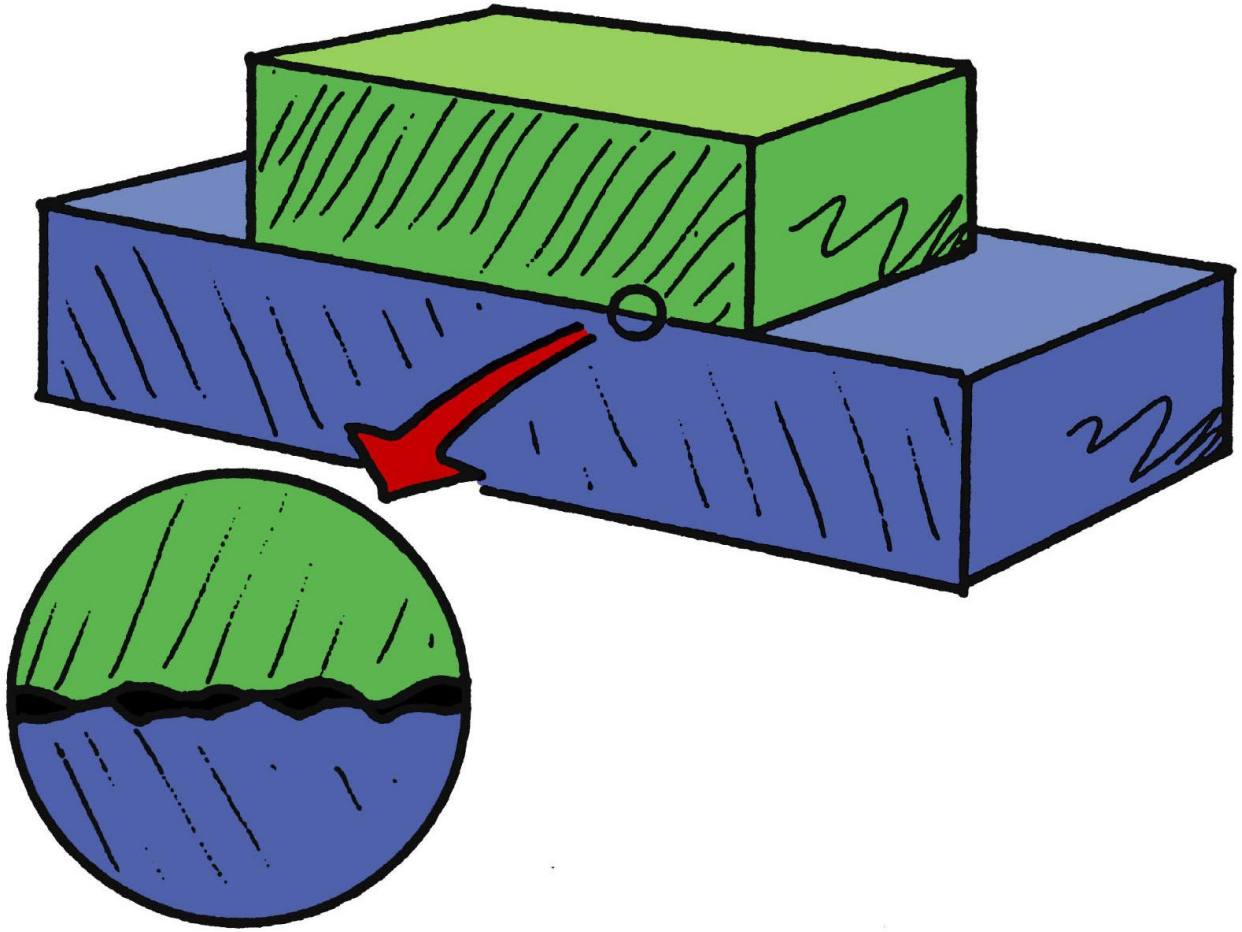
Types of Friction

Sliding - two solid surfaces rubbing against each other.

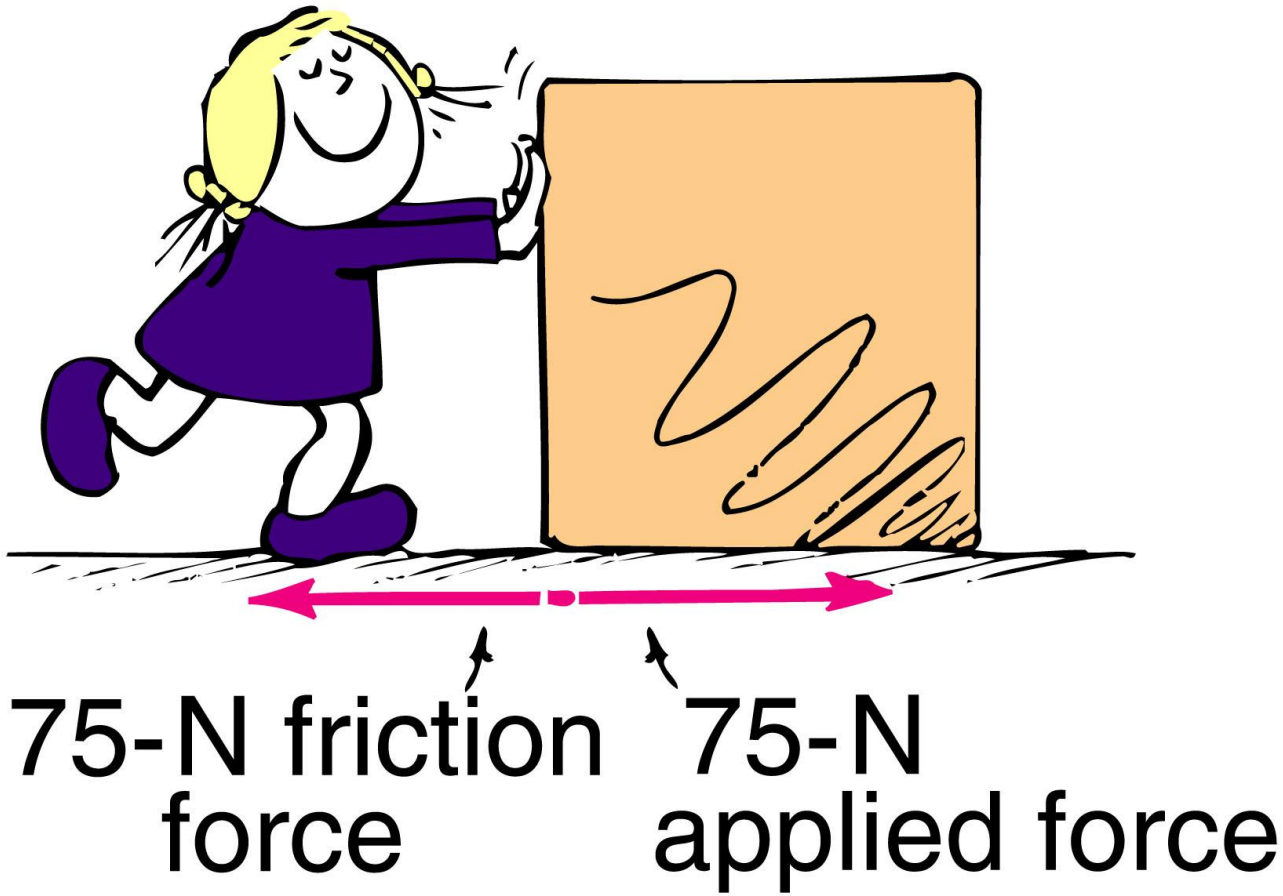
Rolling - an object rolling over a surface.

Fluid - an object moving through a fluid.

Frictional Forces



Frictional Forces



Mass

- The property of an object that tells us how much force must be applied to cause a particular change in motion
- Measured in kilograms
- Mass is NOT the same as weight
- Weight is a measure of gravitational force on an object
- Mass and Weight are related by an equation

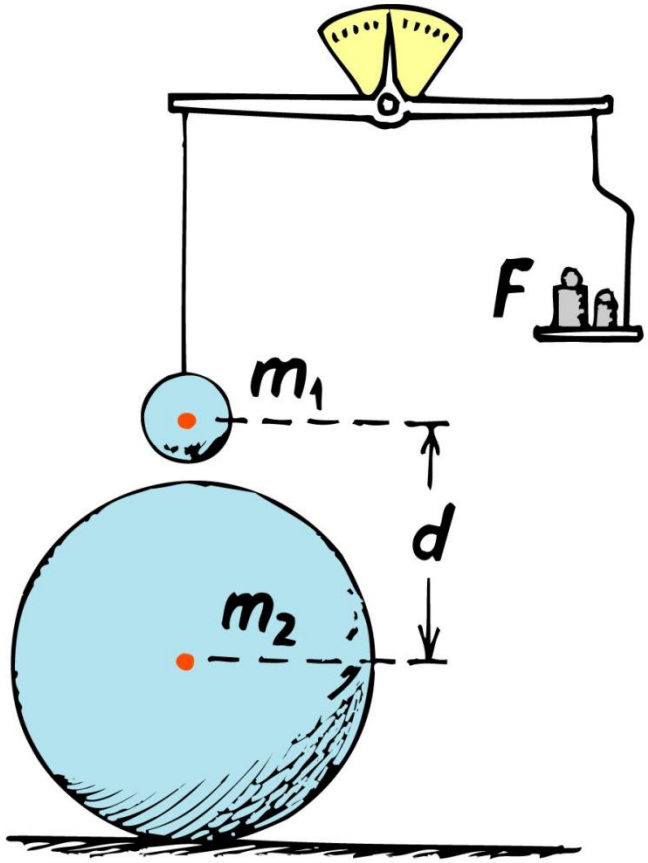
Universal Gravitation (Newton)

- Every mass attracts every other mass with a force that is proportional to the product of the two masses divided by the square of the distance between the masses
- For distances, calculate from the CENTER OF MASS
- For the earth, that is at the center of the earth

Gravity

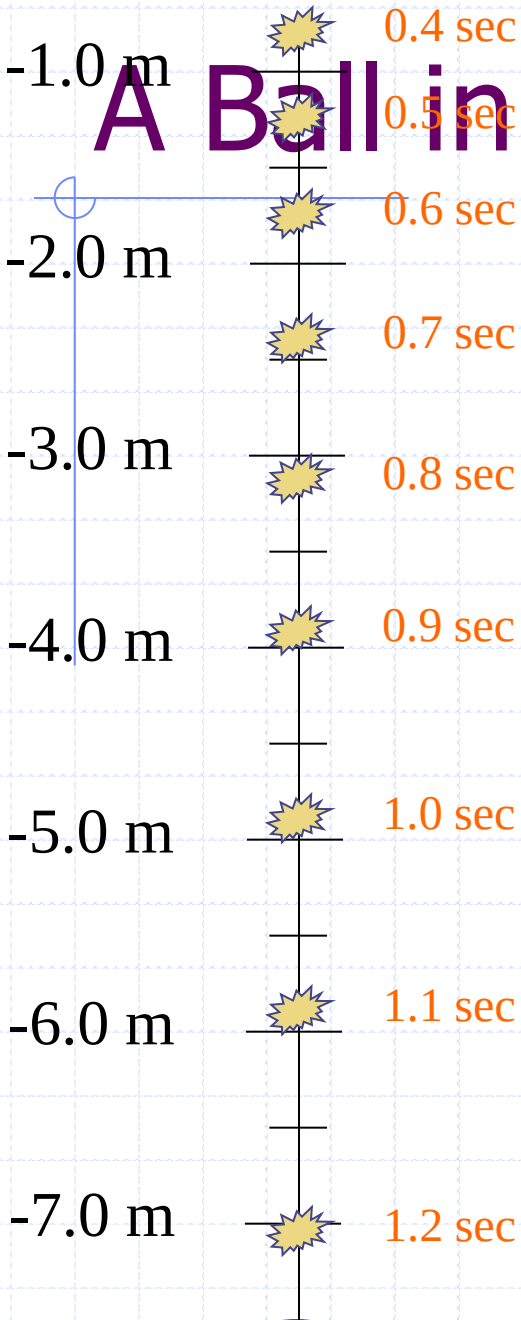
- The force on mass exerts on another mass
- Everything that has mass has gravitational pull
- The attraction due to gravity decreases as the distance increases between the two masses
- Force of gravity is $1/d^2$
  - When the distance is doubled the force is ¼ as much
- gravity due to the earth's gravity is 9.8 m/s^2 (or approximately 10 m/s^2
- Weight is the force gravity exerts on an object

Universal Gravitation

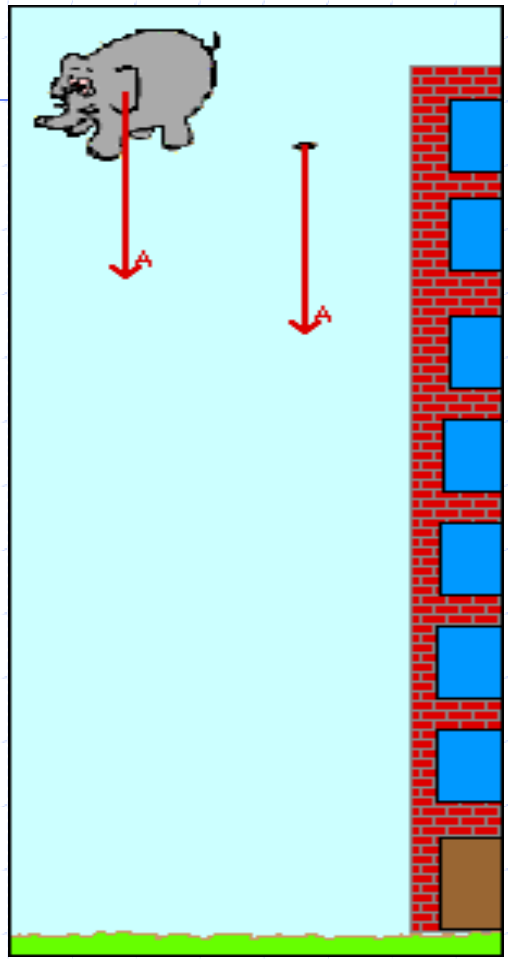


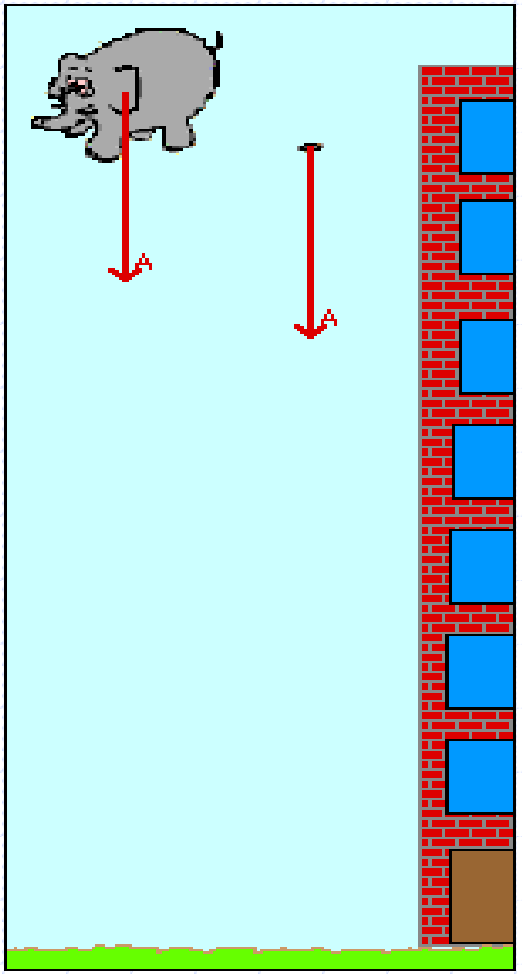
$$F = G\frac{m_1 m_2}{d^2}$$

A Ball in Free Fall



- Is the ball's *direction* of velocity constant?
- Does it travel equal distances in equal times?
- Is the ball accelerating?
- What is the direction of the acceleration vector?
- What is the direction of the force ($\boldsymbol{F} = m\boldsymbol{a}$)?
- What's responsible for the force on the ball?


A
A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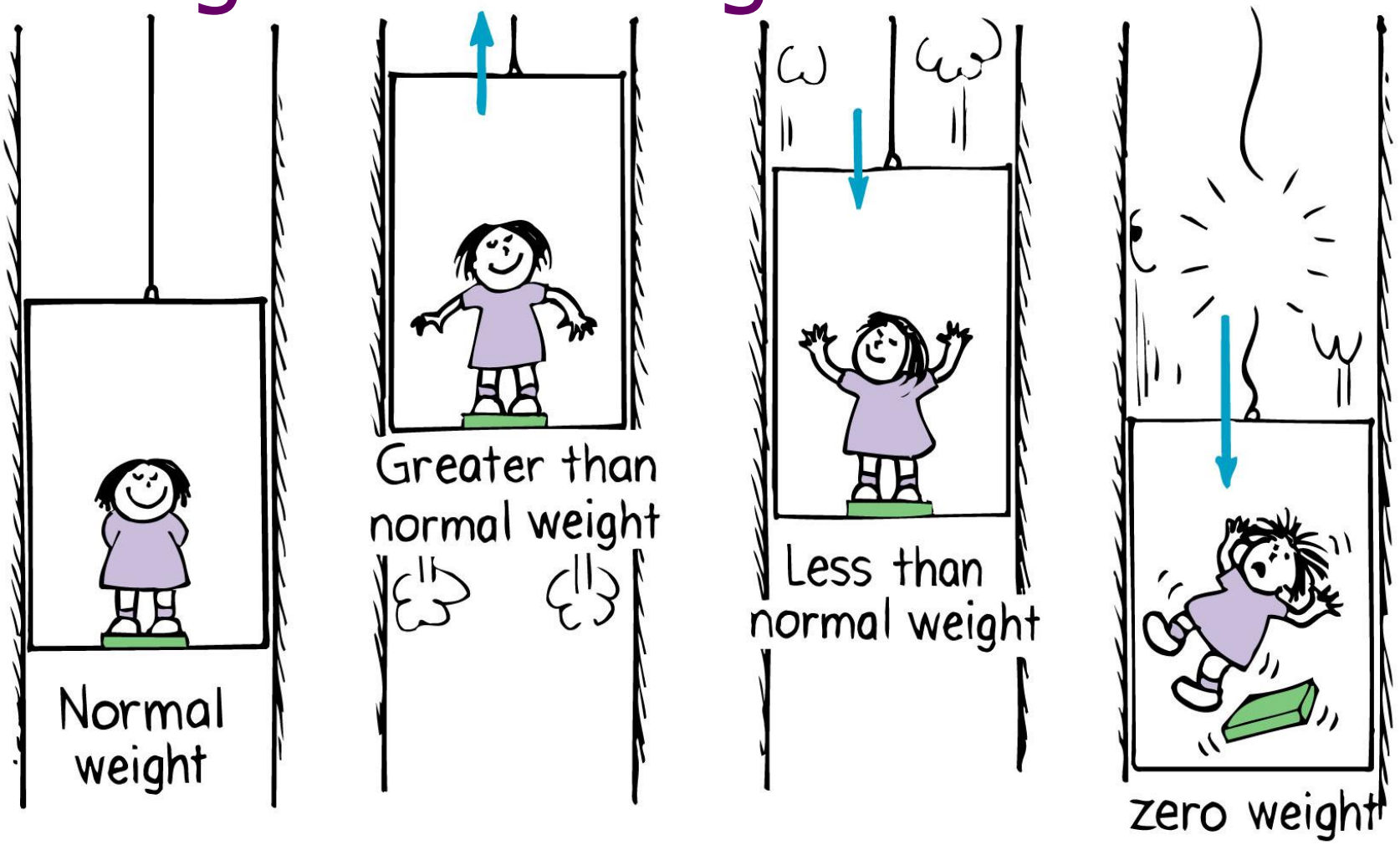
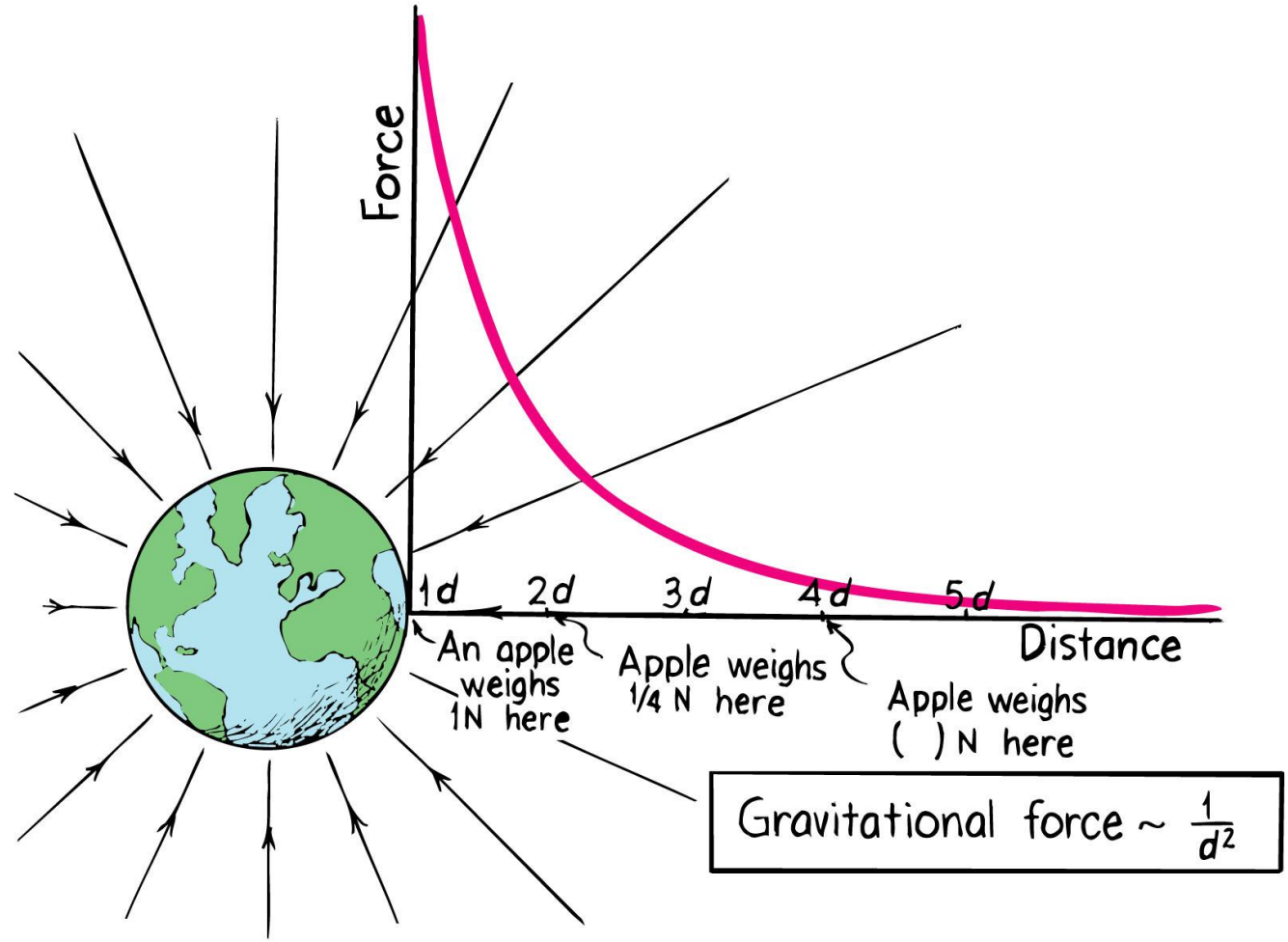
Weight and Weightlessnes



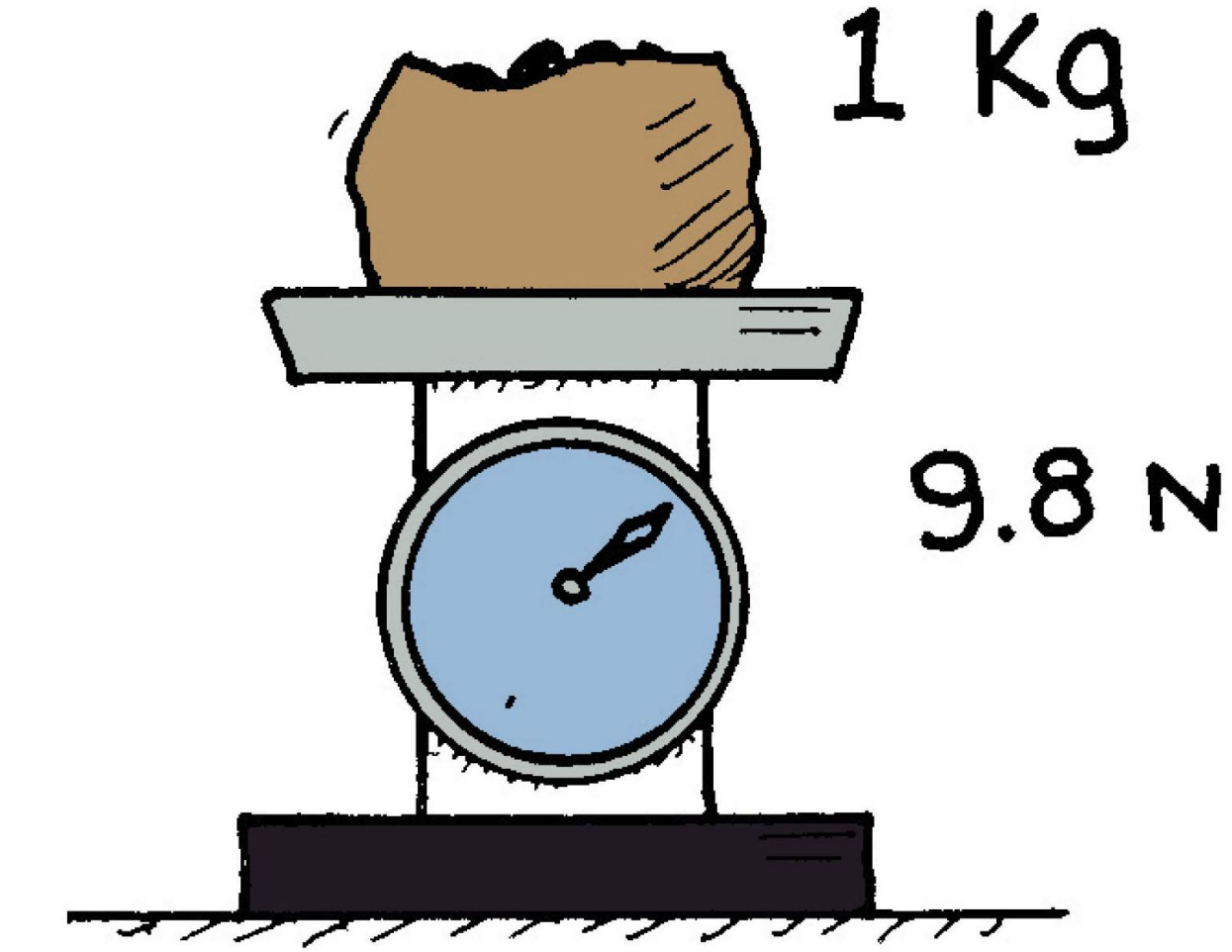
Inverse Square Law



The unit of force is the Newton

- The Newton is the amount of force that is required to accelerate a one kilogram object 1 m/s^2
  - F=ma

Mass and Weight



Measuring forces

- Spring scale or elastic device
  - Does a bathroom scale measure mass or weight?


"That's all Folks!"