Physical Science EOCT Review
and
GHSGT Review

Domain 3: Physics- Energy, Force, and Motion

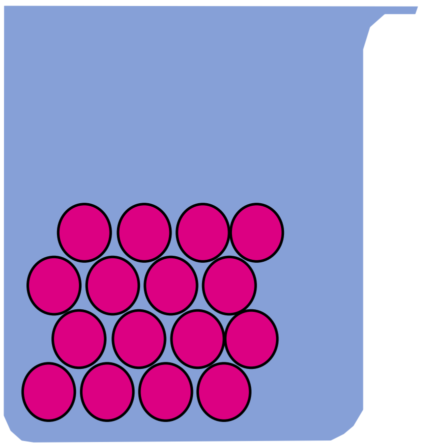

Domain 3: Physics- Energy

Kinetic Theory

- Kinetic means motion
- Three main parts of the theory
  - All matter is made of tiny particles
  - These particles are in constant motion and the higher the temperature, the faster they move
  - At the same temperature, heavier particles move slower.

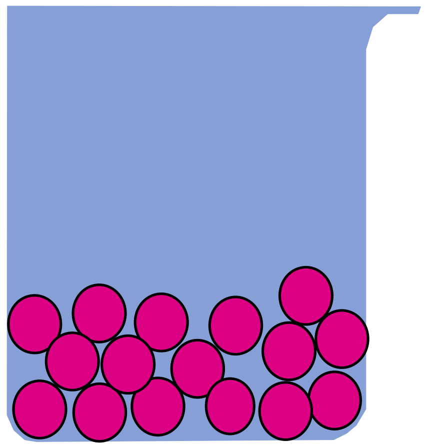
States of Matter

- Solid
- Particles are tightly packed
- Stuck to each other in a pattern
- Vibrate in place
- Can't flow
- Constant volume



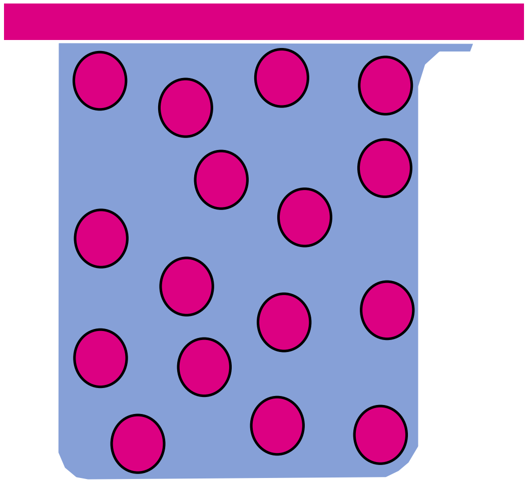
States of Matter

- Liquid
- Particles are tightly packed
- Able to slide past each other
- Can flow
- Constant volume



States of Matter

- Gas
- Particles are spread out
- Flying all over the place
- Can flow
- Volume of whatever container their in



In a state: Particles everywhere!

Solid: particles close together, vibrating in fixed places

Liquid: particles close together, but they can move past each other

Gas: particles far apart, moving quickly

System vs Surroundings

- In studying heat changes, think of defining these two parts:
  - the ***system*** - the part of the universe on which you focus your attention
  - the ***surroundings*** - includes everything else in the universe

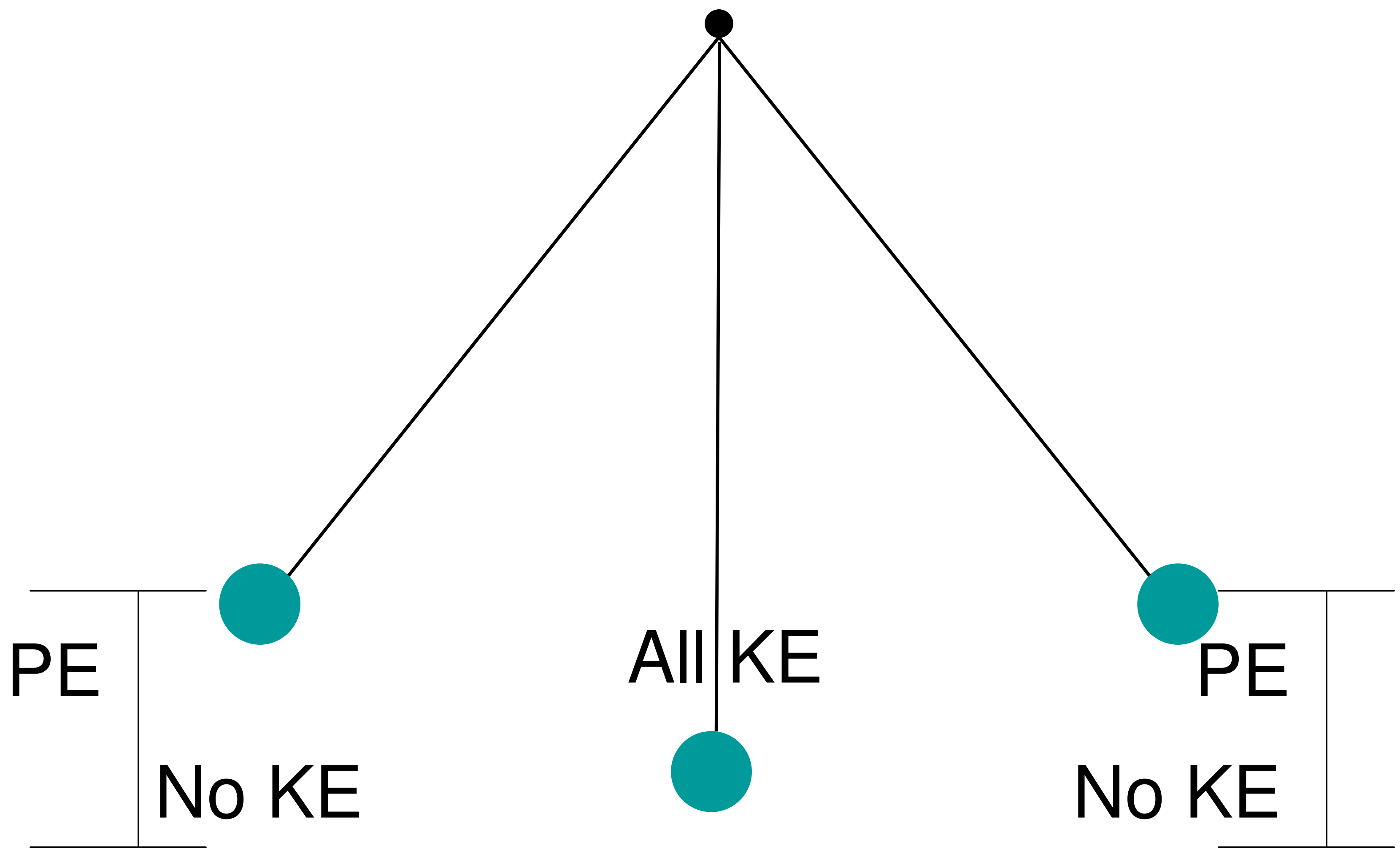
Solids, liquids and gases

	Solid	Liquid	Gas
Squash?	No	No	Yes
Fixed shape?	Yes	No	No
Can be poured?	No	Yes	Yes
Hard?	Yes	No	No

Conservation of energy

- Energy can’t be created or destroyed but it does change from one form to another.
  - The total energy remains constant, it just changes its form

Example: A Pendulum



Energy is transformed

- Potential to kinetic
- But the pendulum will stop eventually.
- Where does the energy go
- Into moving the air
- Some energy is always changed into a form you don't want
- Friction turns motion to heat.
- Electric cords get hot

Types of energy and Sources

• Chemical	Chemical Bonds
• Mechanical	Kinetic + Potential
• Thermonuclear	Nuclear Fission
• Photoelectric	Electricity from Light
• Electromagnetic	Sun / Radio $\rightarrow$ Gamma

Energy and Uses

- All Energy can be **converted** to usable forms such as
  - Electricity
  - Light
  - Mechanical
  - Heat

Energy is Conserved

- All the energy can be accounted for
- It can be hard to conserve
- Two types of systems
  - Closed system does not let energy in or out
    - Used by scientists to limit variables
  - Open system does let energy in or out
    - Much more common

Efficiency

- Not all the work done is useful work
  - Some gets turned into other forms
    - Often heat (the least organized of all types of energy)
- Efficiency = $\frac{\text{Useful work or Work Output}}{\text{Work Input}}$

- Or % Efficiency = $\frac{\text{Useful work or Work output}}{\text{Work input}} \times 100\%$
  - Always less than 100% efficient

Perpetual Motion Machines

- Machines that would run forever without energy input
- Or machines that put out more energy than you put in.
- They don't exist.
- Would require a complete absence of friction.
- They would break the law of conservation of energy

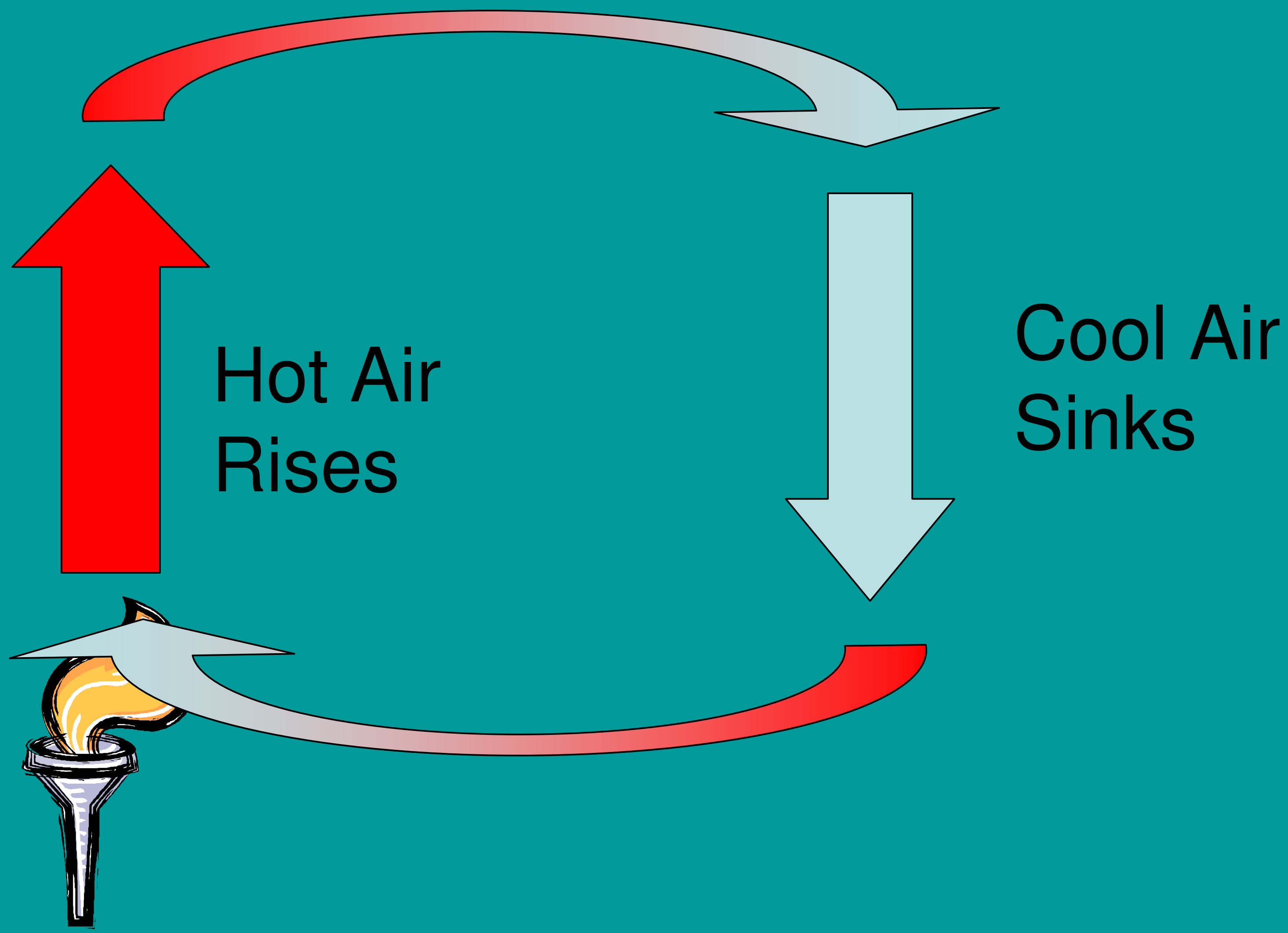
Energy Transfer

- Conductors- materials that allow heat to pass through them
- Most metals
- Insulators- materials that don't let heat through them well
- Rubber, plastics, glass
- Insulation traps air in pockets.
- Still air makes a good insulator.

Energy Transfer

- Convections- transferring energy by moving fluids
- Liquids and gases are fluids
- When heated they expand, become less dense
- They rise, replaced by cooler denser fluids
- Make a circular flow called a convection current

Convection Current



Energy Transfer

- Radiation- Energy transferred by electromagnetic waves
- Can travel through empty space
- When wave hit object they make the molecules move faster.

Units of Energy

- Energy is the capacity to do work, or to produce heat.
- Energy can also be measured, and two common units are:

1) Joule (J) = the SI unit of energy, named after James Prescott Joule
2) calorie (cal) = the heat needed to raise 1 gram of water by 1 ºC

Units of Temperature

- Temperature is a measure of how hot or cold an object is. **(Measured with a <u>thermometer</u>.)**
- Heat moves from the object at the higher temperature to the object at the lower temperature.
- We use two units of temperature:
  - Celsius – named after Anders Celsius
  - Kelvin – named after Lord Kelvin

Units of Temperature

- Celsius scale defined by two readily determined temperatures:
  - Freezing point of water = 0 ºC
  - Boiling point of water = 100 ºC
- Kelvin scale does not use the degree sign, but is just represented by K
  - absolute zero = 0 K (thus no negative values)
  - formula to convert: K = ºC + 273

SAMPLE PROBLEM 3.4 - Page 78

Converting Between Temperature Scales

Normal human body temperature is 37°C. What is that temperature in kelvins?

1 Analyze *List the known and the unknown.*

Known

- Temperature in °C = 37°C

Unknown

- Temperature in K = ? K

Use the known value and the equation K = °C + 273 to calculate the temperature in kelvins.

Exothermic and Endothermic Processes

- Heat flowing <u>into</u> a system from it's surroundings:
  - defined as positive
  - q has a positive value
  - called <u>endothermic</u>
    - system ***gains heat*** as the surroundings cool down

Exothermic and Endothermic Processes

- Heat flowing <u>out of</u> a system into it's surroundings:
  - defined as negative
  - q has a negative value
  - called <u>exothermic</u>
    - system ***loses heat*** as the surroundings heat up

Units for Measuring Heat Flow

1) A calorie is defined as the quantity of heat needed to raise the temperature of 1 g of pure water 1 ^{o}C.
   - Used except when referring to food
   - a Calorie, (written with a capital C), always refers to the energy in food
   - 1 Calorie = 1 kilocalorie = 1000 cal.

Heat Capacity and Specific Heat

- **Specific Heat Capacity** - the amount of heat it takes to raise the temperature of *1 gram* of the substance by 1 ^{o}C (abbreviated "C")
  - often called simply "Specific Heat"
  - Note Table 17.1, page 508
- Water has a **HUGE** value, when it is compared to other chemicals

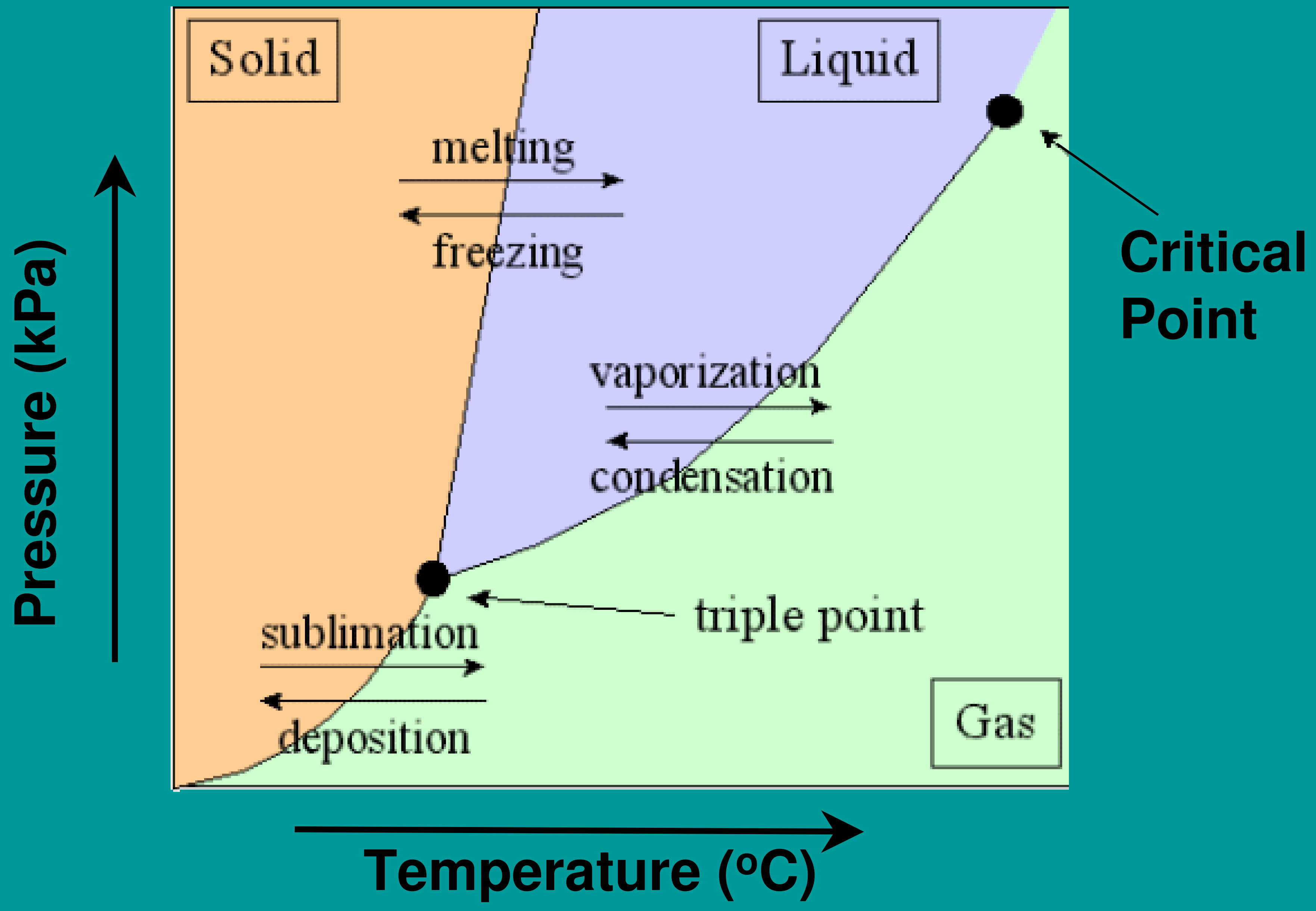
TABLE 17-1 Specific Heats of Some Common Substances at 298.15 K

Substance	Specific heat J/(g·K)
Water (*l*)	4.18
Water (*s*)	2.06
Water (*g*)	1.87
Ammonia (*g*)	2.09
Benzene (*l*)	1.74
Ethanol (*l*)	2.44
Ethanol (*g*)	1.42
Aluminum (*s*)	0.897
Calcium (*s*)	0.647
Carbon, graphite (*s*)	0.709
Copper (*s*)	0.385
Gold (*s*)	0.129
Iron (*s*)	0.449
Mercury (*l*)	0.140
Lead (*s*)	0.129

Changes of State

- The relationship among the solid, liquid, and vapor states (or phases) of a substance in a sealed container are best represented in a single graph called a phase diagram
- Phase diagram- gives the temperature and pressure at which a substances exists as solid, liquid, or gas (vapor)

Phase changes by Name



Changes in State (phase changes)

1. Melting - solid to liquid

   a. Particles get more kinetic energy and begin rotating around each other.

   b. There isn't enough energy to break the inter-particular attractions, so the particles remain close (liquid).

   c. The energy required to melt a solid is called the *heat of fusion*.

2. Freezing - liquid to solid

a. Particles lose kinetic e
and slow down.

b. Attractive forces between par
become stronger than the particles' motion, so the particles begin merely vibrating in place.

c. The amount of heat the particles must lose to turn into a solid is called the *heat of fusion*.

- 3. Vaporization - liquid to gas
- a. Types:
- 1) Boiling - rapid; gas bubbles are produced throughout.
- 2) Evaporation - slow; occurs at the surface.
- b. Liquid particles gain enough kinetic energy to overcome forces between the particles and they begin translational motion; this energy is called the *heat of vaporization*.

4. Evaporation is a cooling process.

a. Particles in a liquid gain kinetic energy.

b. They leave as gas particles (taking the energy away with them).

c. This leaves less energy in the liquid, therefore cooling down what is left.

5. Condensation - gas to liquid

a. Particles lose
energy, slow
come

b. Inter-particular forces become strong enough to make particles merely rotate around each other.

c. The energy they lose to turn into a liquid is the *heat of vaporization*.

Domain 3: Physics- Force and Motion

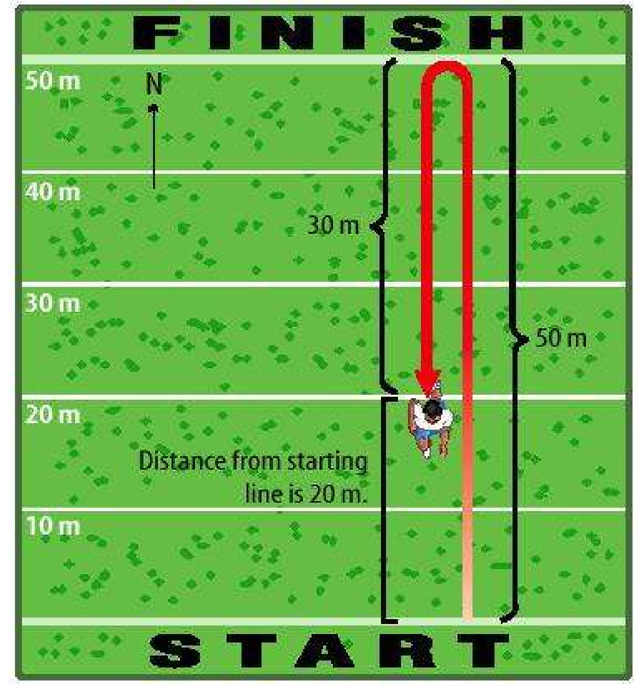
B. Speed

1. The rate of change in position
2. Types of speed:
   a. Instantaneous
   b. Constant
   c. Average
3. Speed = Distance / Time

5. Displacement vs. distance

a. Distance – how far something moves

b. Displacement – the distance and direction of an object's change in position from its starting point



Displacement = 20 m north of starting line
Distance traveled = 50 m + 30 m = 80 m

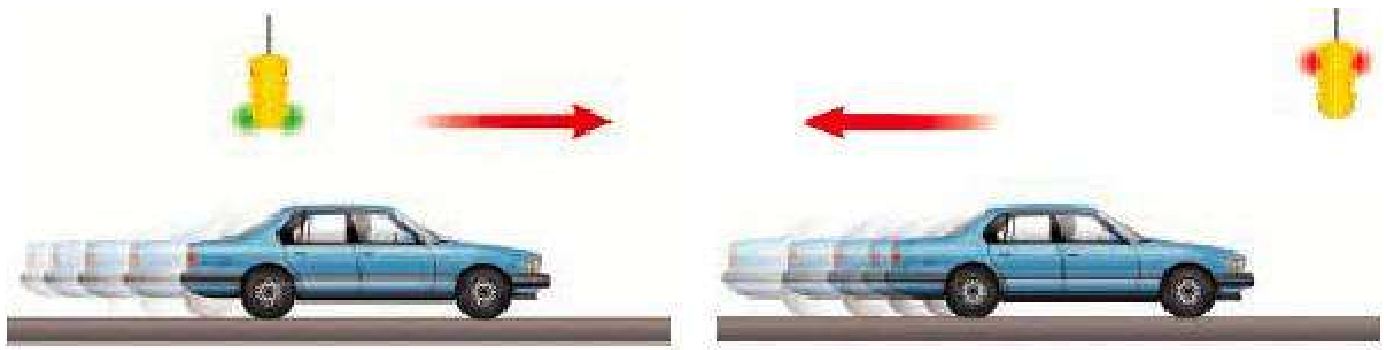
C. Velocity

1. Speed in a defined direction
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.

D. Acceleration

1. The rate of change of velocity
2. $a = (v_f - v_i) / t$ or $a = \Delta v / t$
3. Units are m/s/s
4. +a = speeding up; -a = slowing down

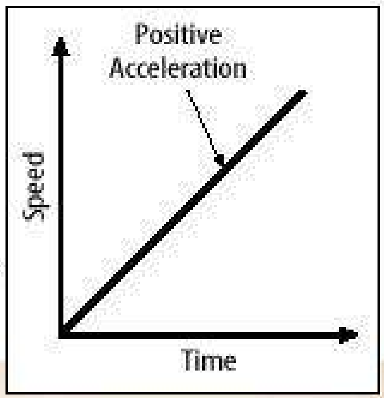


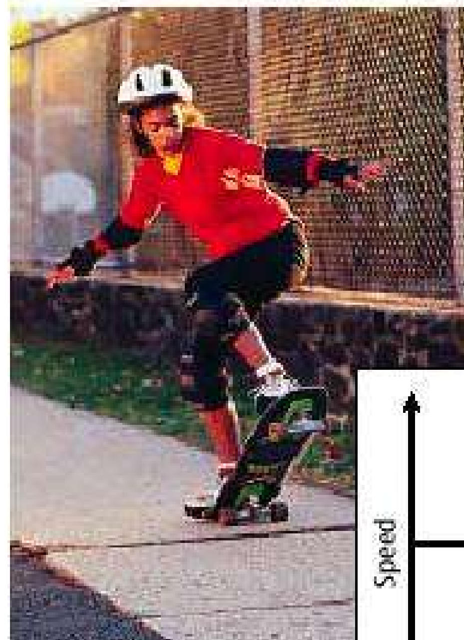
A The speed of this car is increasing. The car has positive acceleration.

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

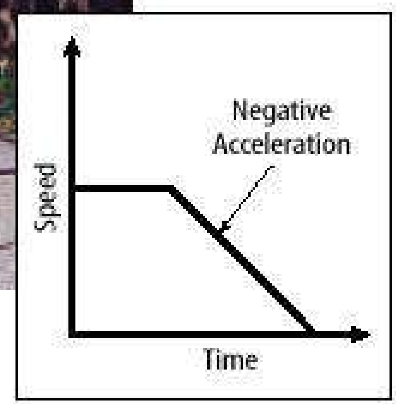
Graphing Acceleration

A If accelera-
tion is a positive
number, the line
slopes upward to
the right.

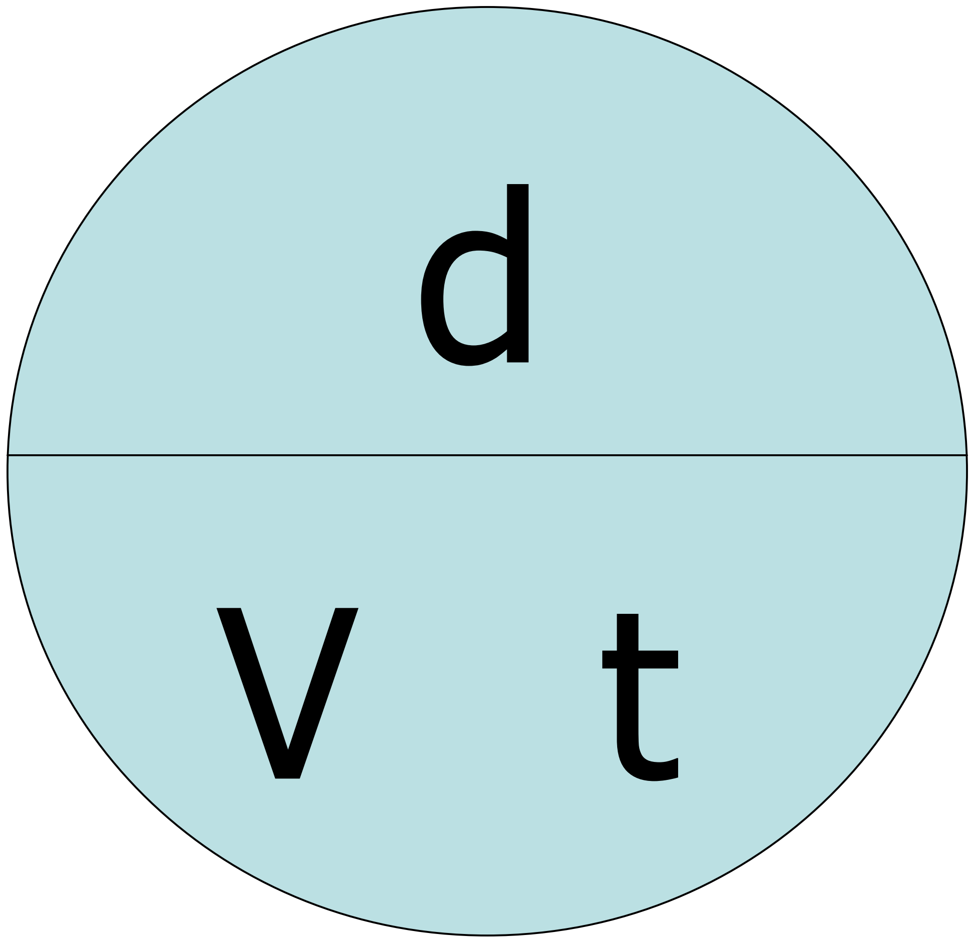




B If accelera-
tion is a negative
number, the line
slopes downward
to the right.



Cover the one you’re looking for



Newton’s First Law: Inertia

- An object at rest stays at rest until an outside force causes it to move.
- An object in motion continues to move in the same direction until a force stops it or changes its direction.
- So, an object at rest will stay at rest, and an object in motion will remain in motion unless acted by an outside force.

Inertia

- Inertia: the tendency of an object to remain at rest or in motion until acted upon by an external force.
- Friction is an outside force that resists motion when two surfaces come in contact.
- The surfaces can be between two objects or between an object and air or water.

Newton's Second Law of Motion: Force

- Acceleration depends on the mass of the object and the unbalanced force applied
- F = m x a
- more mass, harder to accelerate
- more force, faster acceleration
- Newton is the unit of force
- equal the force needed to change the velocity of a 1 kg mass by 1 m/s^2

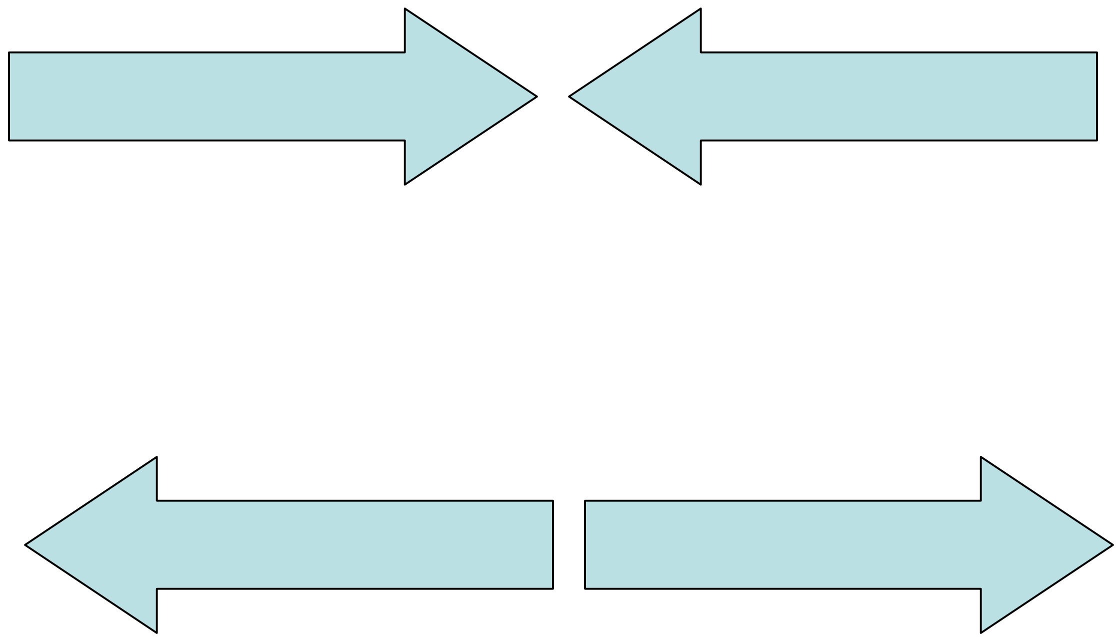
Force

- A push or a pull
- Can cause a change in motion
- Can cause a change in velocity
- Can cause acceleration
- There can be no acceleration without a force

Net Force

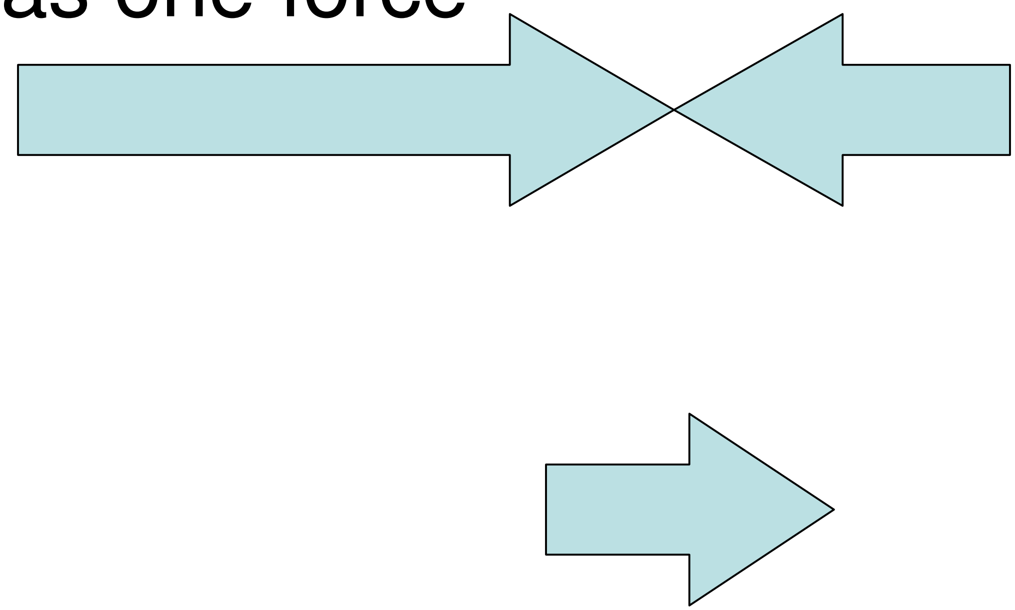
- Usually many forces are acting at the same time
- Have to add up these forces to see whether they add up or cancel out.
- Balanced Forces cancel out and give a net force of zero
- Balanced forces can not cause a change in motion
- Like a tug of war

Balanced Forces



Unbalanced Forces

- The forces don't cancel out
- Cause a change in motion
- Act as one force



Newton's Third Law of Motion: Equal But Opposite Forces

- For every force, there is an equal and opposite force
- For every action there is an equal and opposite reaction.
- Rockets
  - Action: gases get pushed out
  - Reaction: Rocket moves forward

Friction

1. Force that opposes motion between two surfaces in contact.

2. Amount depends on:

   a. Kinds of surfaces in contact.

   b. Amount of force pressing surfaces together. Something that weighs more will have greater friction.

Facts about Friction

- Friction can keep an object from moving
- Rougher surfaces have greater friction
- Smoother surfaces have less friction
- Larger surface area has more friction
- Greater weight has more friction
- Sliding friction is greater than rolling friction.

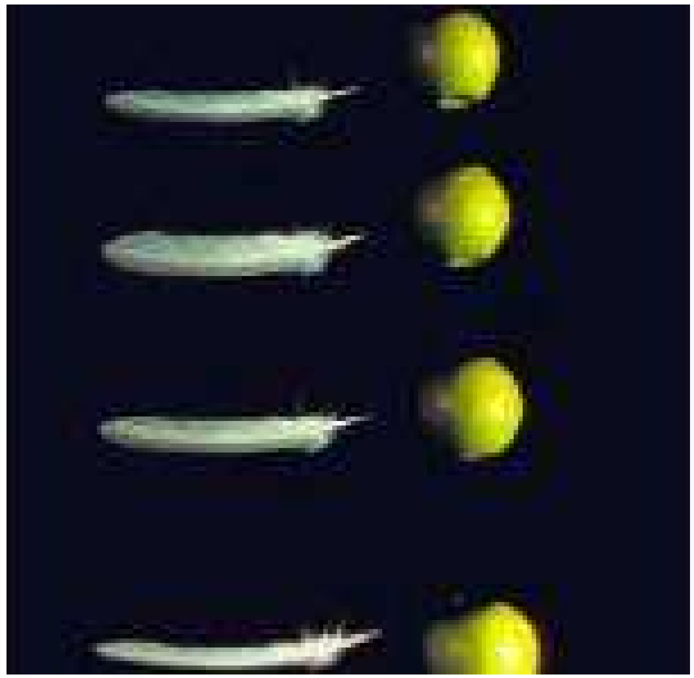
C. Air resistance (drag force)

1. Force that opposes motion of objects through air

2. Pushes up on falling objects

3. Affected by object’s speed, size, shape

4. Without drag force, all objects fall at the same rate



5. Terminal velocity is the max speed at which an object can fall

Mass vs Weight

- **Mass** is anything that has mass and takes up space
  - Not dependent on location
  - Is constant
- **Weight** is the affect of gravitational force on mass
  - Is dependent on location
  - May vary

D. Gravity

1. Attraction between objects
2. Weakest force in universe
3. Farthest range
4. Directly proportional to the masses of the objects
5. Inversely proportional to the squares of the distance between

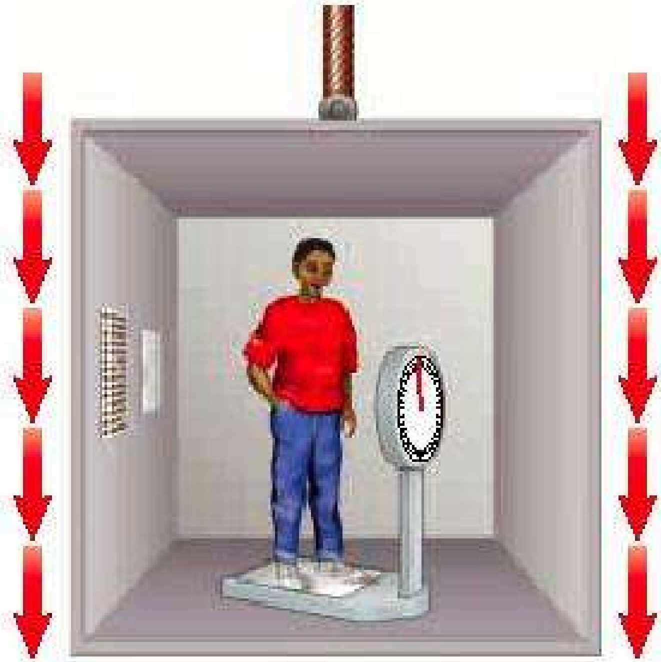
If distance between two bodies … gravity…

- Doubles… decreases by 1/4
- Triples… decreases by 1/9
- Increases 4 times… decreases by 1/16
- Increases 5 times… decreases by 1/25

E. Gravitational Acceleration

1. $g = 9.8$ m/s/s on Earth
2. $F_{WEIGHT} = m \times g$
3. All objects fall with the same g
4. Weight is NOT the same as mass

A When the elevator is stationary, the scale shows the boy's weight.



B If the elevator were falling, the scale would show a smaller weight.

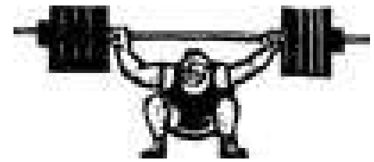
F. Free Fall (Weightlessness)

1. As long as an object is free falling, nothing exerts an upward force

2. With no upward force, F_W = 0 N

Domain 3: Physics- Work and Machines

Work and Machines



A. Work

1. The transfer of energy when a force makes an object move.

2. W = f ·d (Unit is a joule or N ·m)

3. Energy is transferred between objects when work is done.

Box being given energy

C. Using Machines

1. A machine makes doing work easier.

2. They may multiply the applied force.

The car may weigh a lot, but you don't have to use nearly that much force to lift it with a jack.

D. Important terms for machines

1. Resistance – the force being moved (F_R)

2. Effort – the force being used to move a resistance (F_E)

3. Effort Distance – the distance the effort force moves through (d_e)

4. Resistance Distance – how far the resistance moves (d_r)

E. Work Calculations

1. Work Input – the amount of work done on a simple machine.

2. $W_{in} = F_E \cdot d_e$

3. Work output – the amount of work the machine actually does.

4. $W_{out} = F_R \cdot d_r$

G. **Mechanical Advantage**

1. **MA** is the number of times a machine multiplies the effort force.

2. **MA** = F_R / F_E & **MA** = d_e / d_r

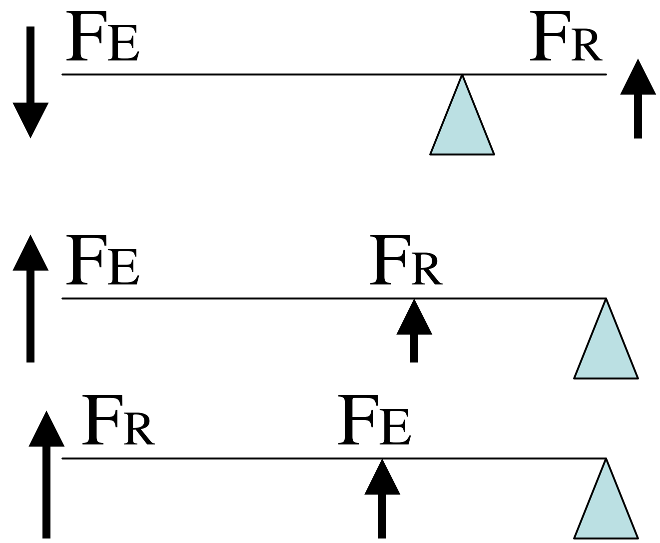
H. Efficiency

1. Measures how much of the work input is changed into useful output

2. Efficiency = (W_{out} / W_{in}) x 100%

I. The Simple Machines

1. Levers



a. 1st class:

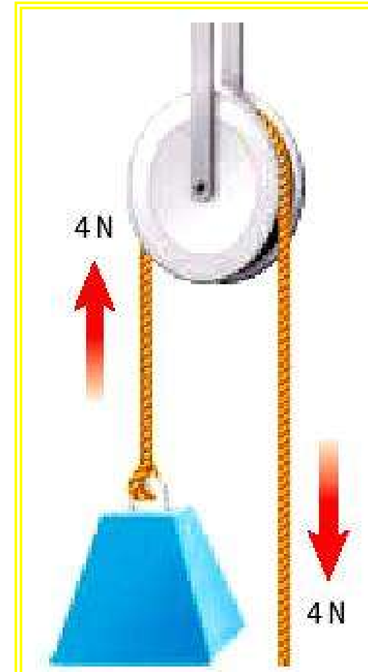
b. 2nd class:

c. 3rd class:

d. IMA = effort arm / resistance arm

2. Pulleys

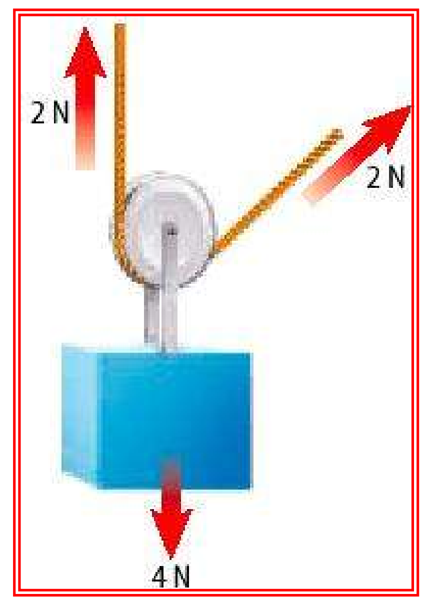
a. Fixed pulley



1) changes only the direction of a force

2) always has IMA = 1

b. Movable pulley



1) attached to object

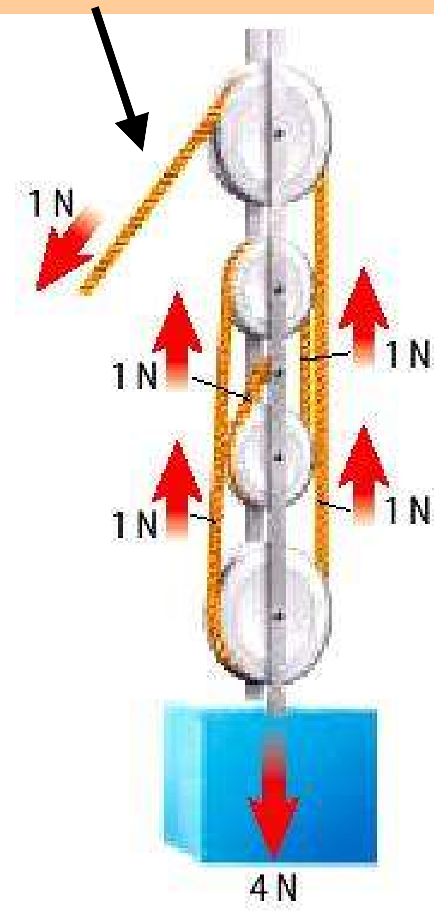
2) IMA = 2

c. Block and Tackle

1) system of fixed and movable pulleys

2) IMA = number of strands supporting the resistance

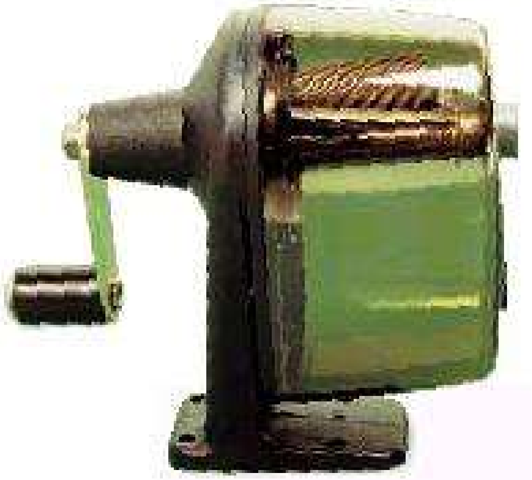
This strand does not count toward the IMA

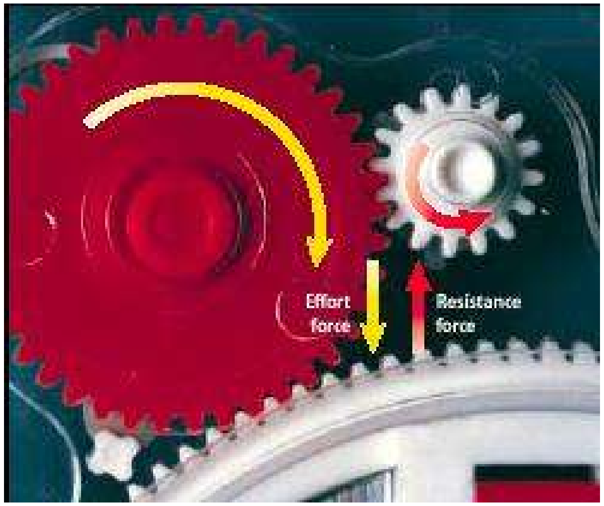


3. Wheel and Axle

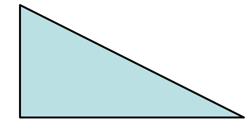
a. IMA = r_w / r_a

b. Gears are modified forms of the wheel and axle



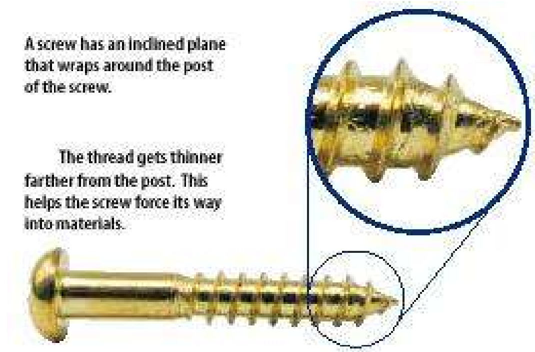


4. Inclined Planes: IMA = L_s / L_h



5. The Screw

a. Modified inclined plane wrapped around a cylinder



b. The pitch of the threading determines the IMA

6. The Wedge: two inclined planes back-to-back