

# States of Matter

Solids, Liquids and Gases

Changing State

Density

Diffusion

Gas and water pressure





## Notes:



CuO is a "BASE"

"BASE" A chemical that neutralises an acid



BASE + ACID  $\rightarrow$  SALT + WATER

# Solids, Liquids and Gases

## Atoms

## The kinetic theory

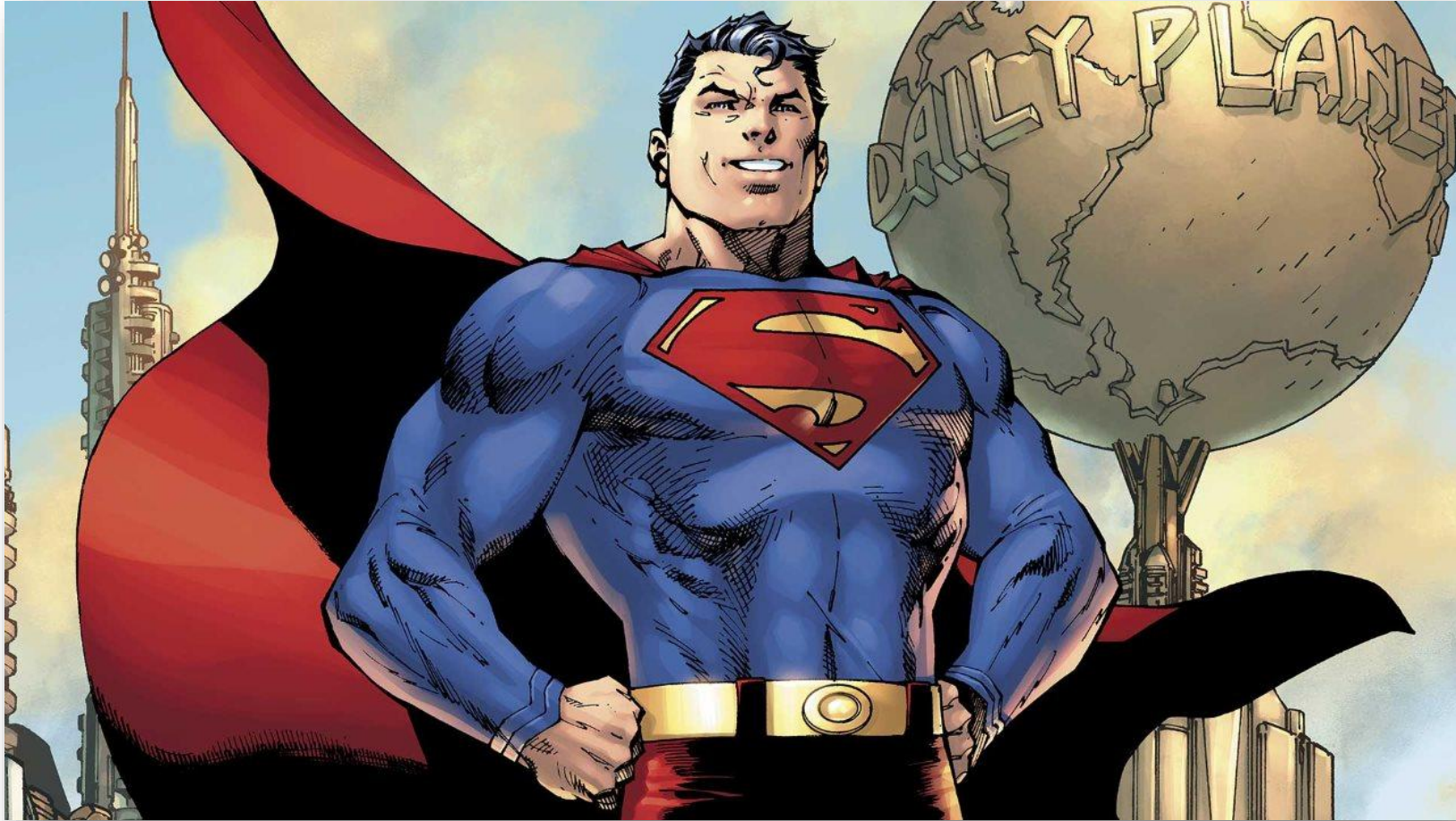
## Atoms in a solid

## Atoms in a liquid

## Atoms in a gas

## Non-Newtonian liquids

(Very good eyesight!)



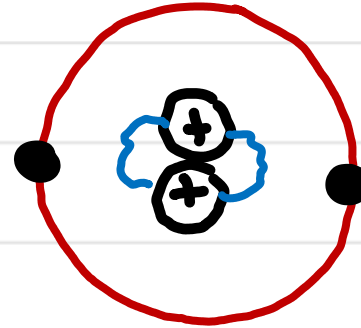
# Atomos



The term Atom comes from Atomos which means uncuttable

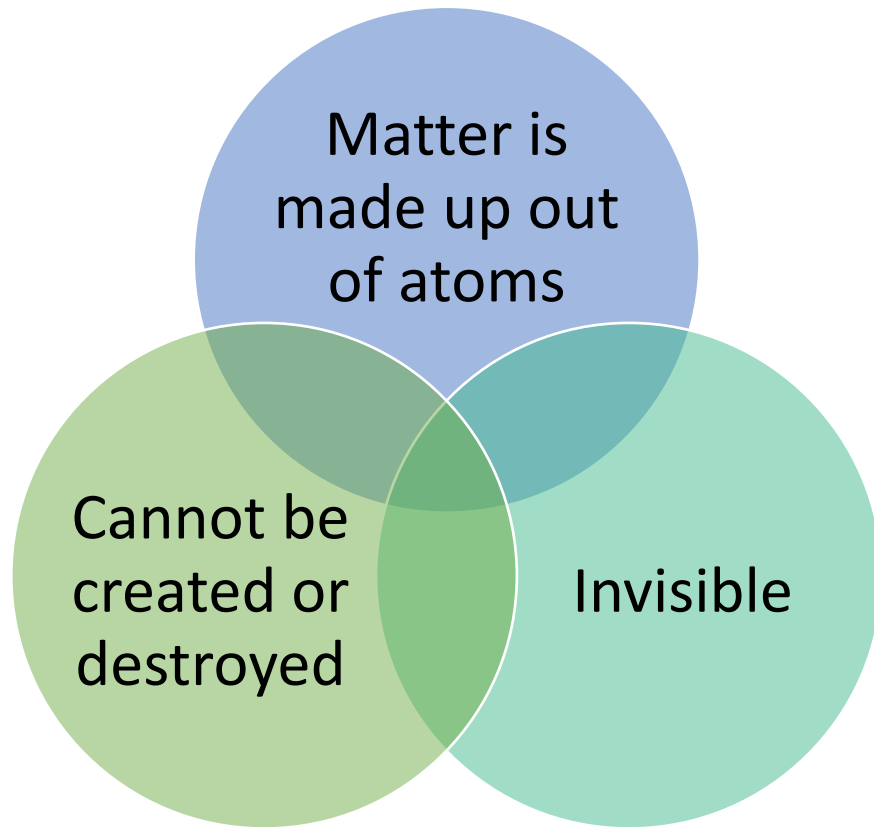
Helium

NUCLEAR MODEL

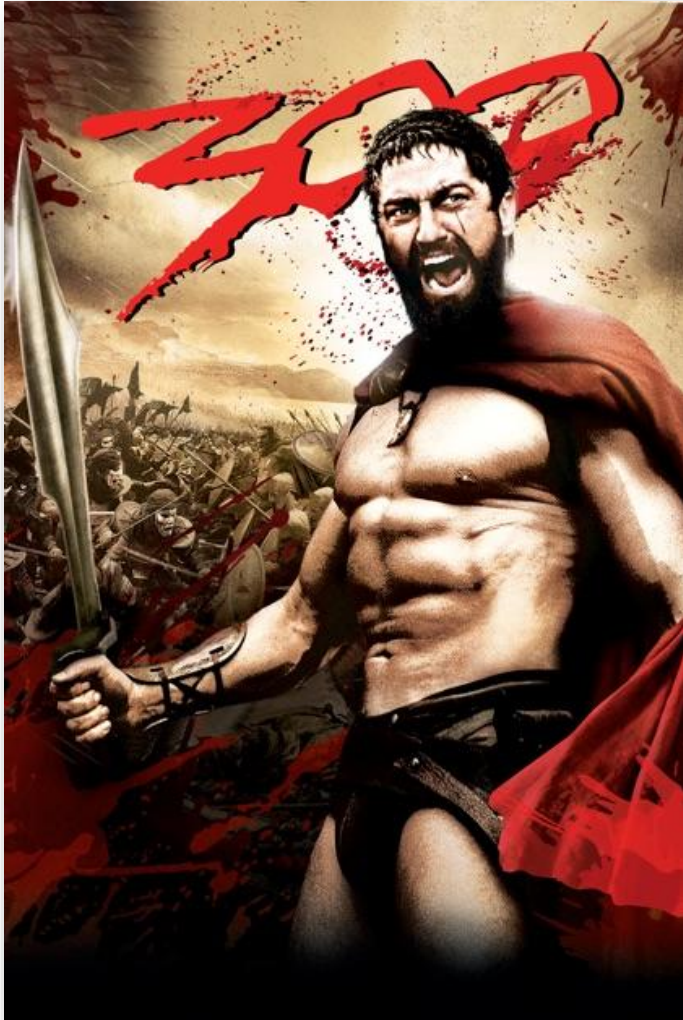


99% "SPACE"

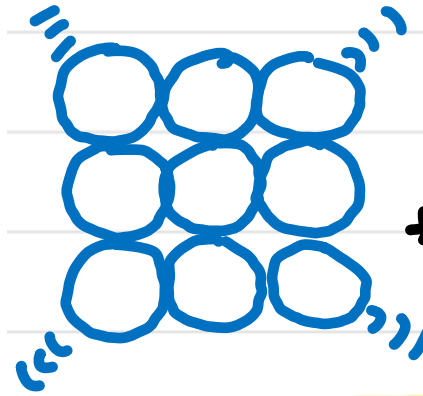
# Leucippus 2500 Years ago



# Ancient Greece



## KINETIC THEORY

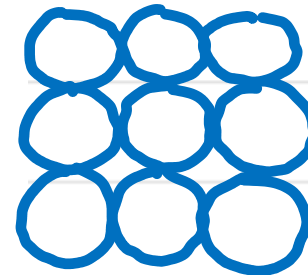


+298K — 25°C

+273K

0°C

DALTON  
MODEL

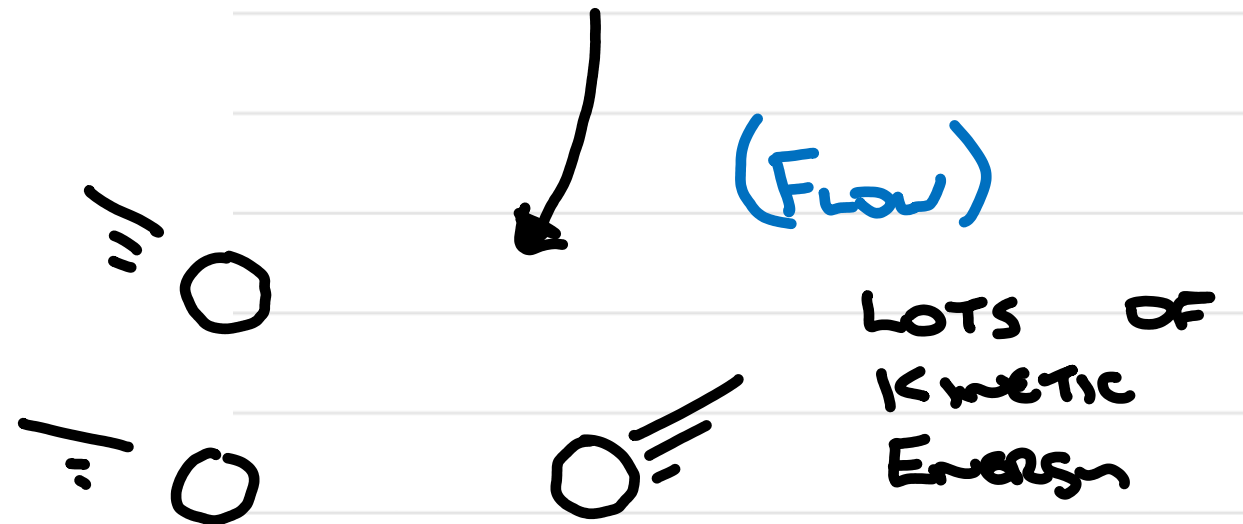
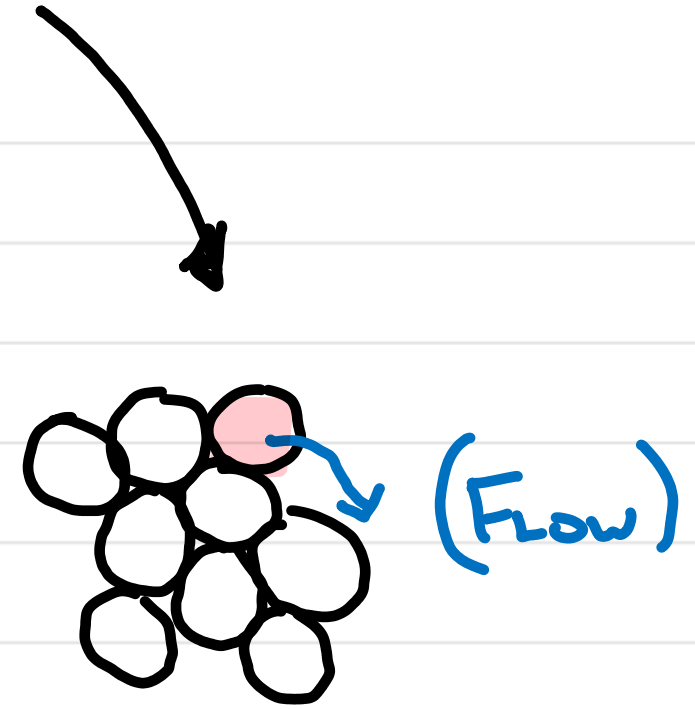
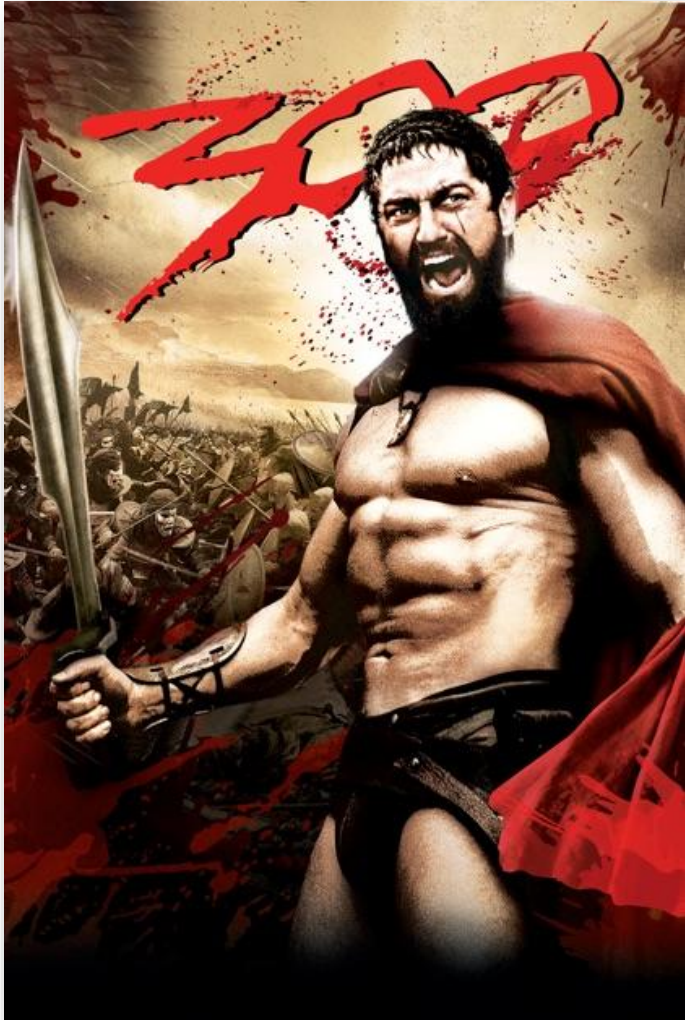


ABSOLUTE  
ZERO

0 KELVIN

— -273°C

# Ancient Greece



# The microscopic world



ant  
length  
3 mm



hair  
diameter  
100  $\mu\text{m}$



leaf cell  
length 70  $\mu\text{m}$



red blood cell  
diameter 7  $\mu\text{m}$



bacterium  
length 1  $\mu\text{m}$



virus  
100 nm



DNA  
diameter  
2.5 nm

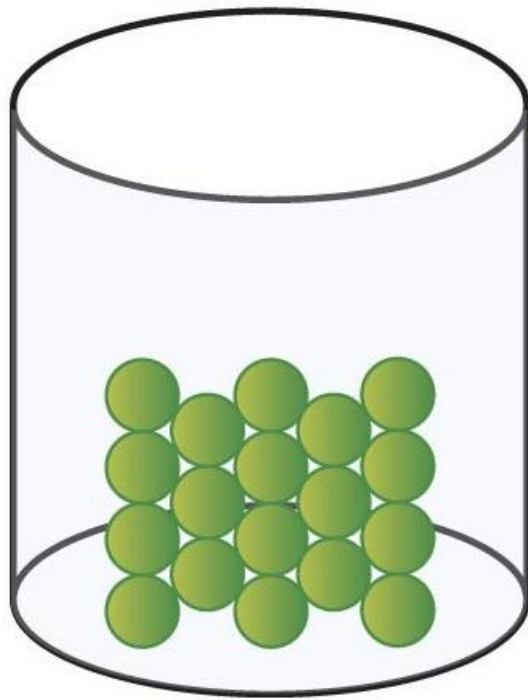


carbon atom  
0.34 nm

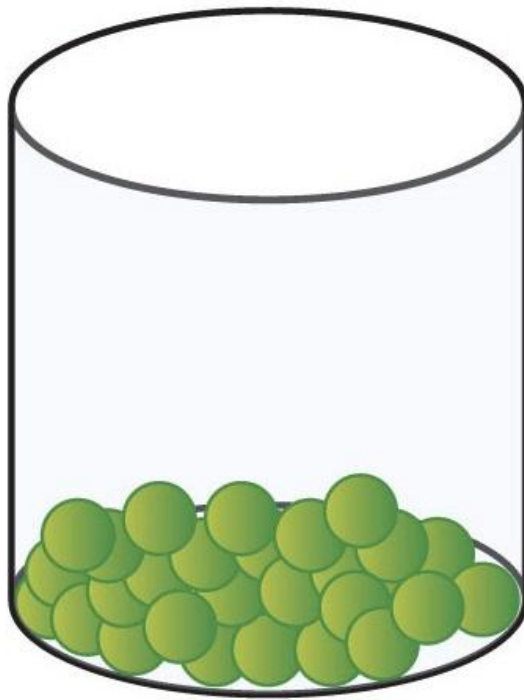


\* 0 0 0 0 0 0 0 3 4 metres!

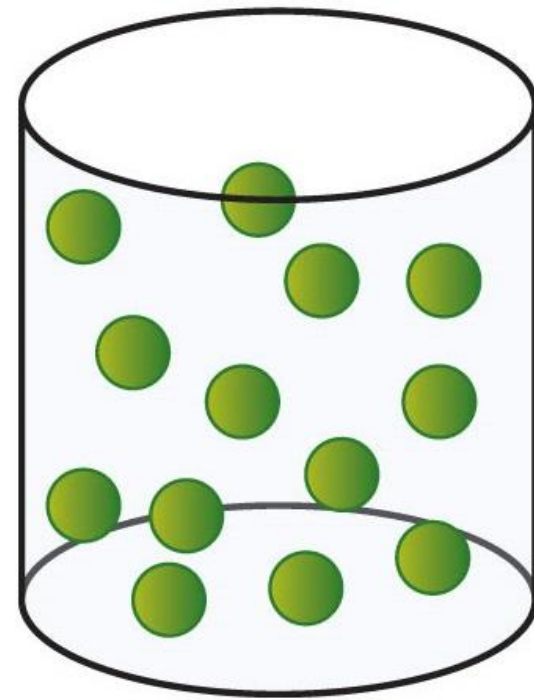
# The Kinetic Theory



Solid

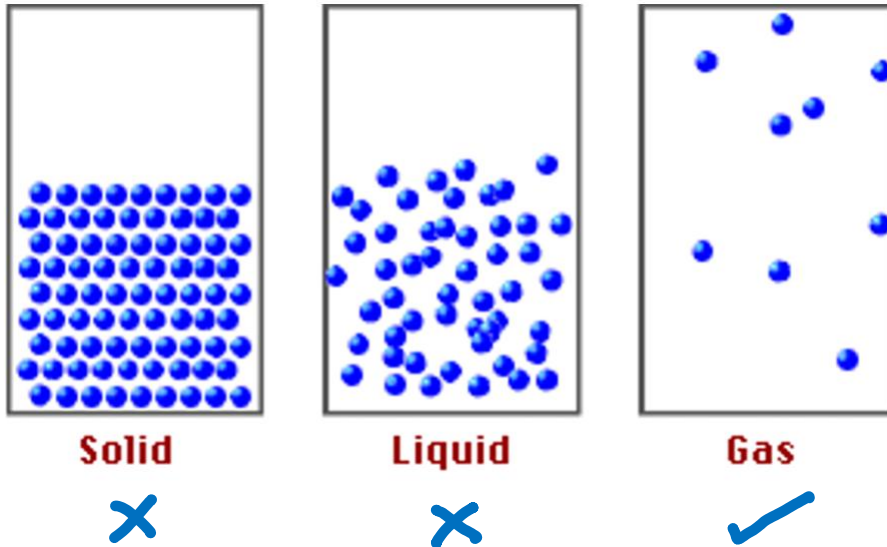


Liquid



Gas

# How atoms move



Can you see where these diagrams are wrong?

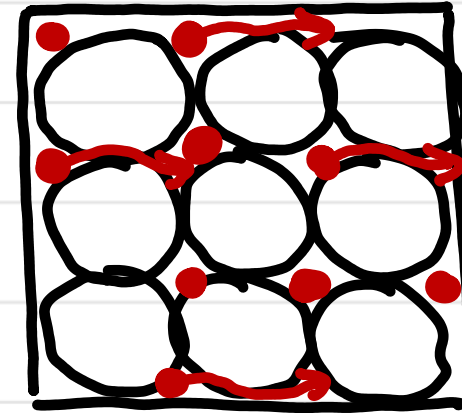
X = shouldn't be  
GAPS

# Atoms in a solid



## METALS

HAVE METAL "IONS"  
ALL TOUCHING AND  
ELECTRONS THAT FLOW  
BETWEEN THEM

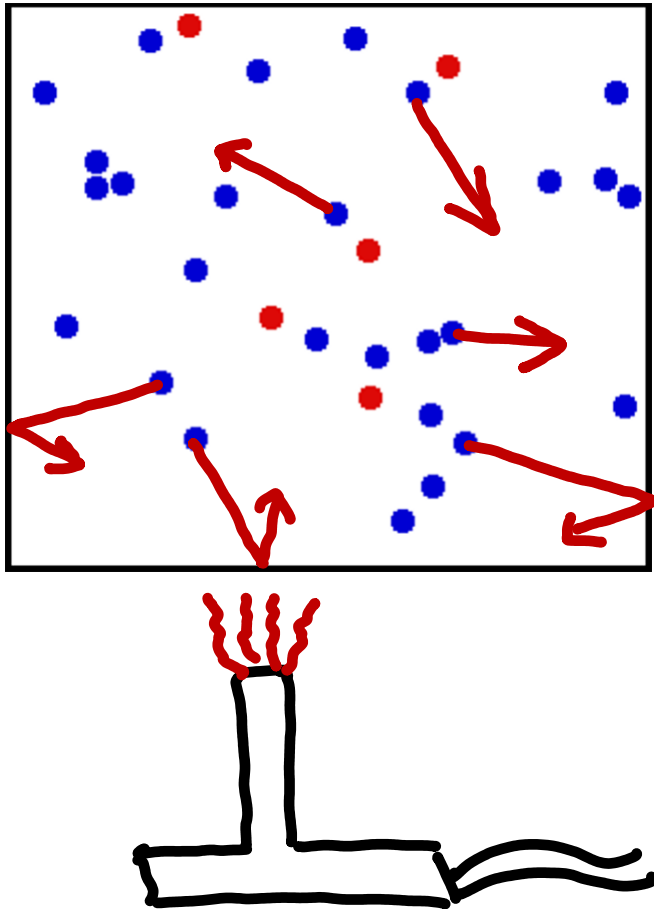


# Atoms in a liquid



- Particles Flowing.

# Atoms in a gas



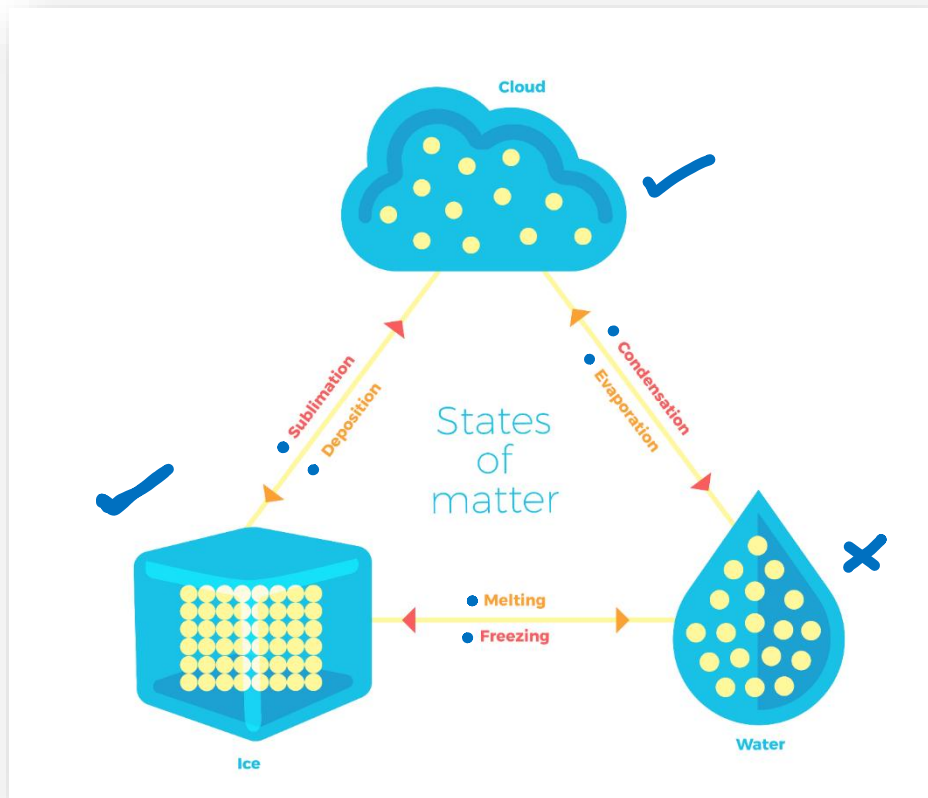
- LOTS OF ENERGY

- PUSHING AGAINST SIDES

# Particle arrangement in matter

| State of matter | Distance between molecules | Particle arrangement | Movement of particles |
|-----------------|----------------------------|----------------------|-----------------------|
| Solid           | Close together             | Fixed                | Vibrating             |
| Liquid          | Touching                   | Random               | Flowing               |
| Gas             | Gaps                       | Random               | Flowing               |

# Spot the mistake!!



Another mistake by the publisher.

Can you spot it?

- GAPS (ASAIN)

Is sand a solid or a liquid?



→ NON-NEWTONIAN  
FLUID

# Wet custard

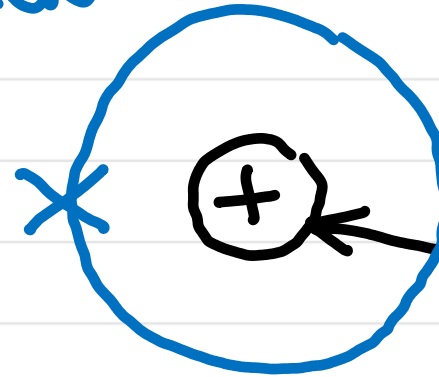


Is wet custard a solid or liquid?

Notes:

## HYDROGEN ATOM

Electron



Proton



## HYDROGEN ION



ION = CHARGED  
PARTICLE

# Changing State

Melting

Freezing

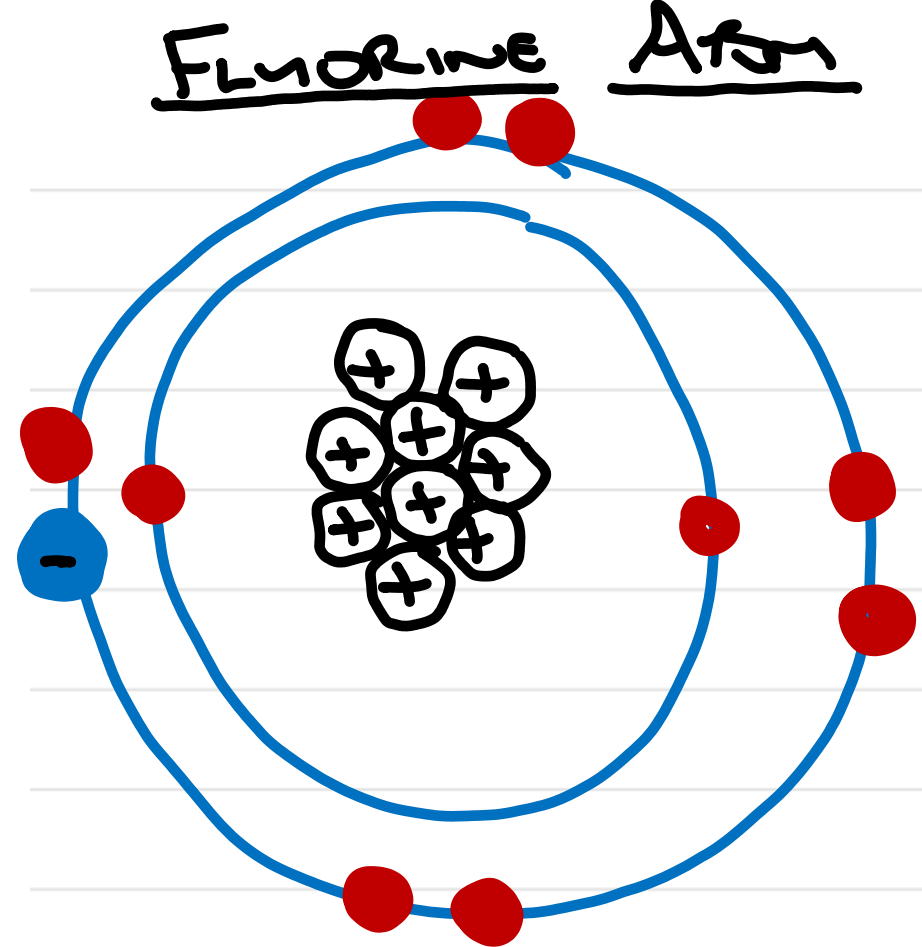
Evaporating

Condensing

Subliming

Deposition

Comets



$$9p - 10e = "-1"$$

# Melting



ICE  $\xrightarrow{0^{\circ}\text{C}}$  WATER

PHYSICAL

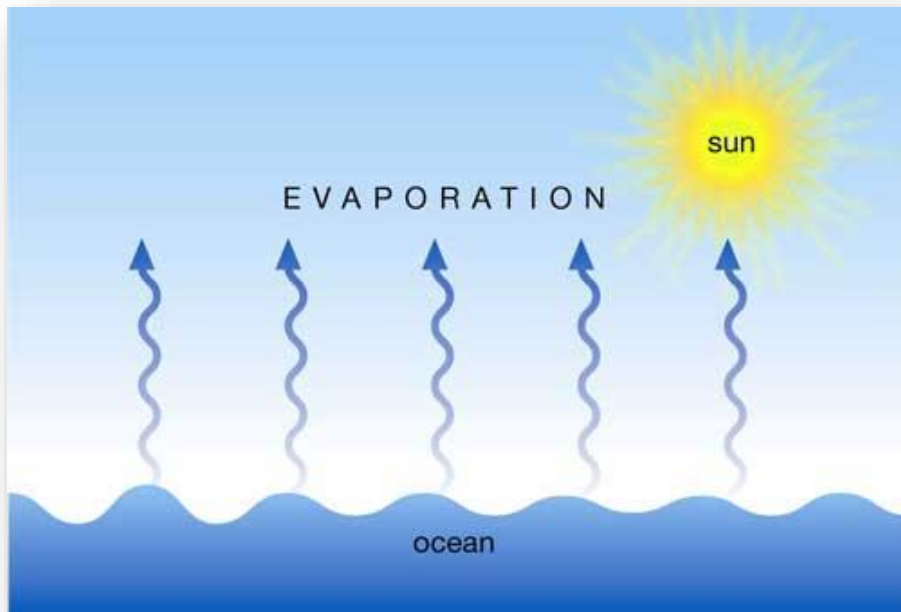
CHANGE

# Freezing



- Physical Change
- Crystal Formation
  - ↳ increase in volume

# Evaporating



The process of turning from liquid into vapor

... AT ANY Temp.

- ONLY HAPPENS ON THE SURFACE OF A LIQUID

# Making clothes evaporate faster



- Windy conditions

- Increase surface area

- When water evaporates off your skin you will feel cold

$43^{\circ}\text{C} \Rightarrow 316 \text{ KELVIN}$

# Boiling



WATER  $\xrightarrow{100^{\circ}\text{C}}$  WATER  
VAPOUR

- ONLY HAPPENS AT  
ONE TEMPERATURE

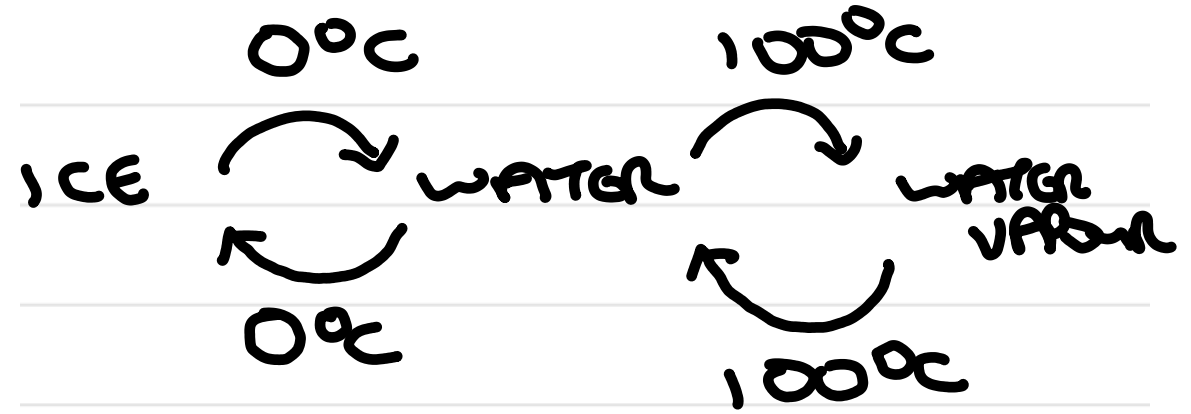
# Condensing



GAS  $\longrightarrow$  LIQUID

WATER  
VAPOR  $\xrightarrow{100^{\circ}\text{C}}$  WATER  
LIQUID

# Condensation on a cold day



A CHANGE OF STATE  
OCCURS AT 1 TEMP.

# Subliming



Solid → Gas



# Spooky



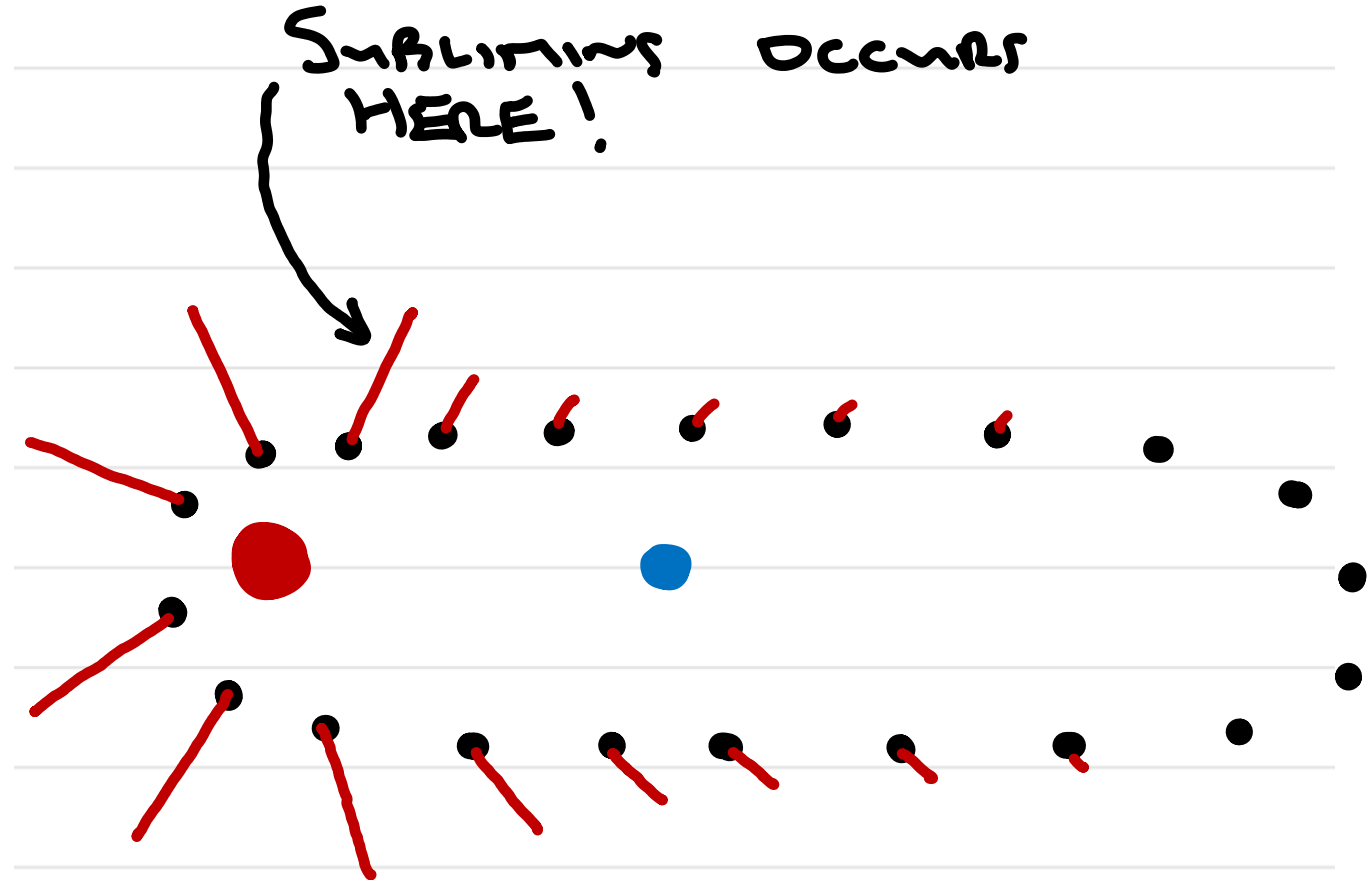
- Dry Ice

# Comets



In a vacuum, liquids do not exist so only subliming and deposition occur

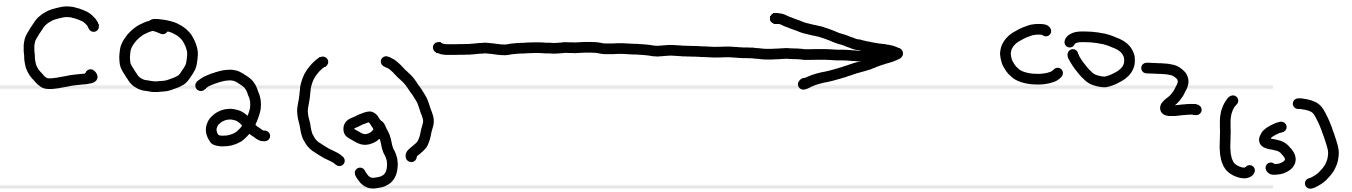
Comets have a tail because ice turns straight into water vapour



# Deposition



Gas → Solid



(aq) = WHAT DOES  
THIS MEAN.

# Change of State

# Density

## What is density?

## Calculating density

Eureka can

## Archimedes

## Icebergs

## Hot air balloons

# What is density?



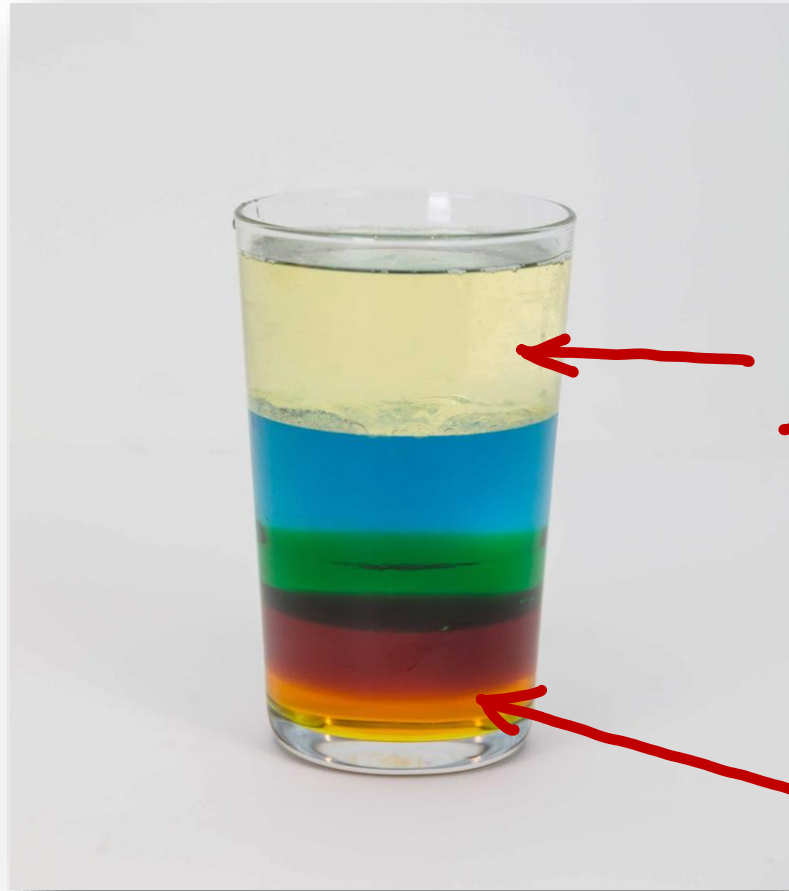
VS



**Density:** THE MASS  
OF A SUBSTANCE  
RELATIVE TO ITS  
VOLUME



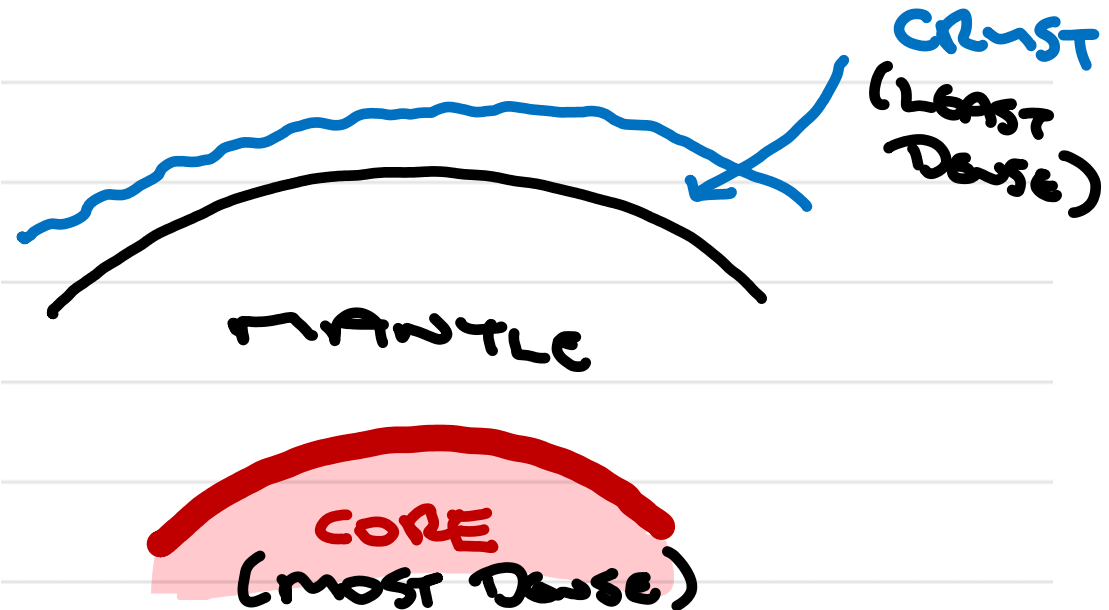
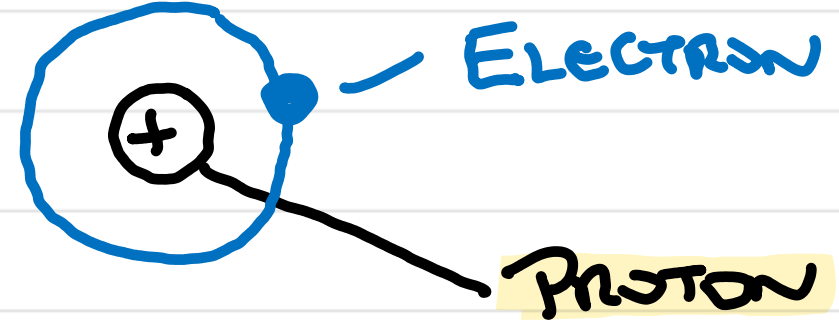
# What is density?



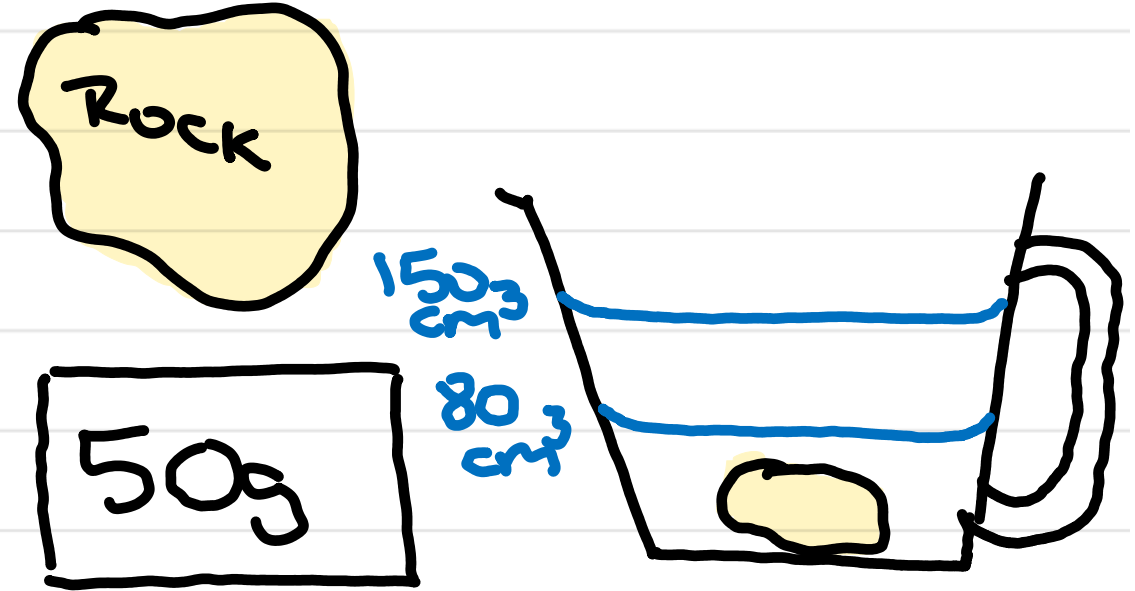
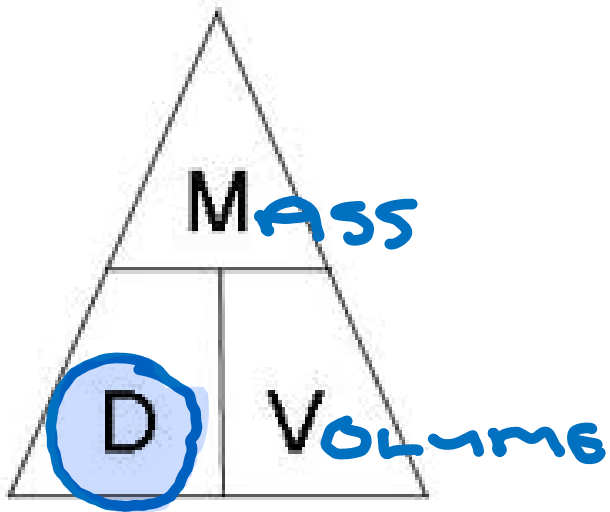
← LEAST  
Dense

→ MOST  
Dense

## HYDROGEN



# Calculating density



$$\begin{aligned}\text{Volume of Rock} &= 150 - 80 \\ &= 70 \text{ cm}^3\end{aligned}$$

# Density calculation

$$\text{Density} = \frac{\text{mass (g)}}{\text{volume (cm}^3\text{)}} = \frac{50 \text{ g}}{70 \text{ cm}^3}$$

$$= \underline{0.7143 \text{ g/cm}^3}$$

$$= 0.71 \text{ g/cm}^3$$

(2 sig figs)

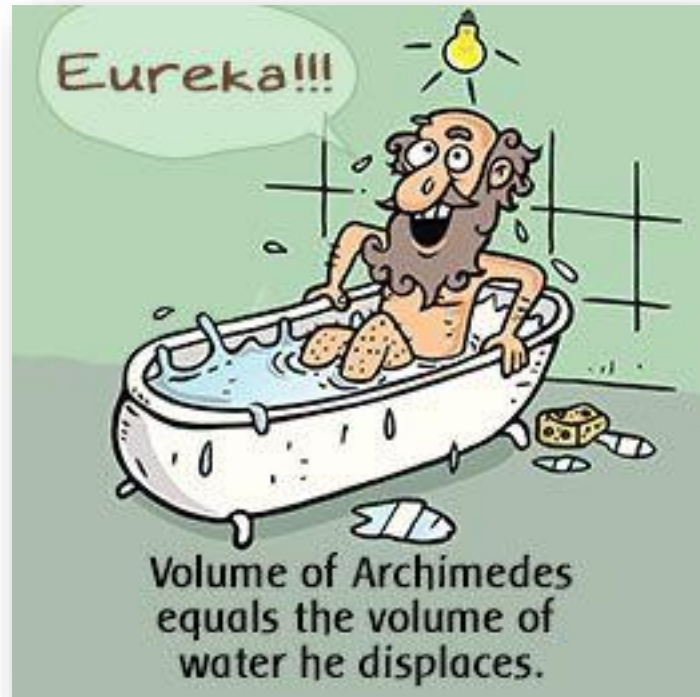


56 PROTONS

56 NEUTRONS

# Archimedes

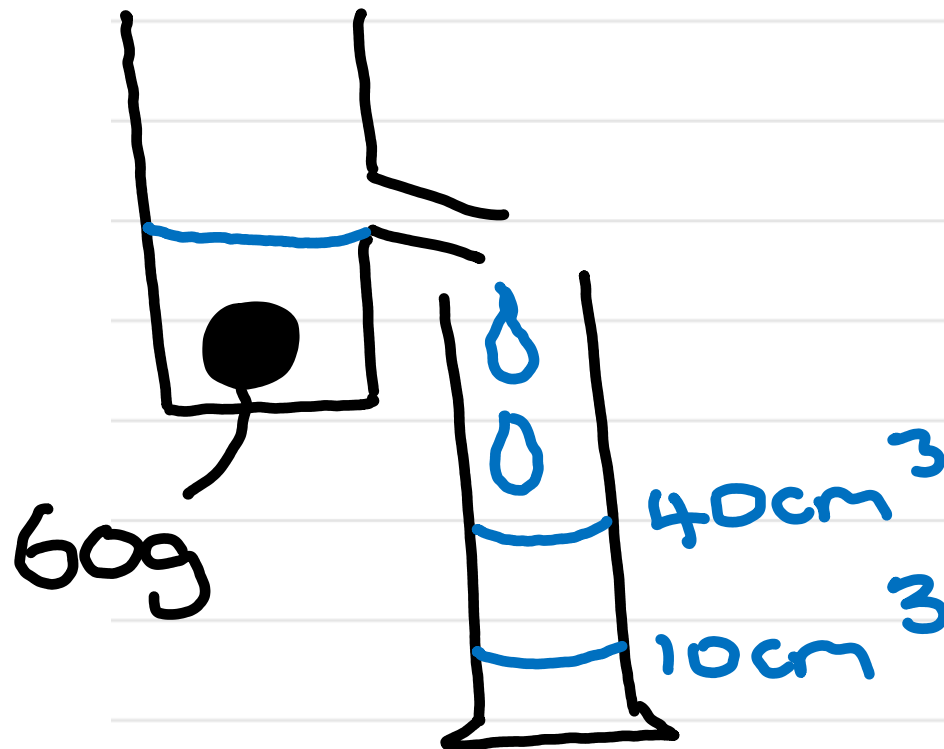
(287bc-212bc)



Discovered the principle of displacement!!

DISPLACEMENT: TAKING THE  
PLACEMENT OF  
SOMETHING ELSE

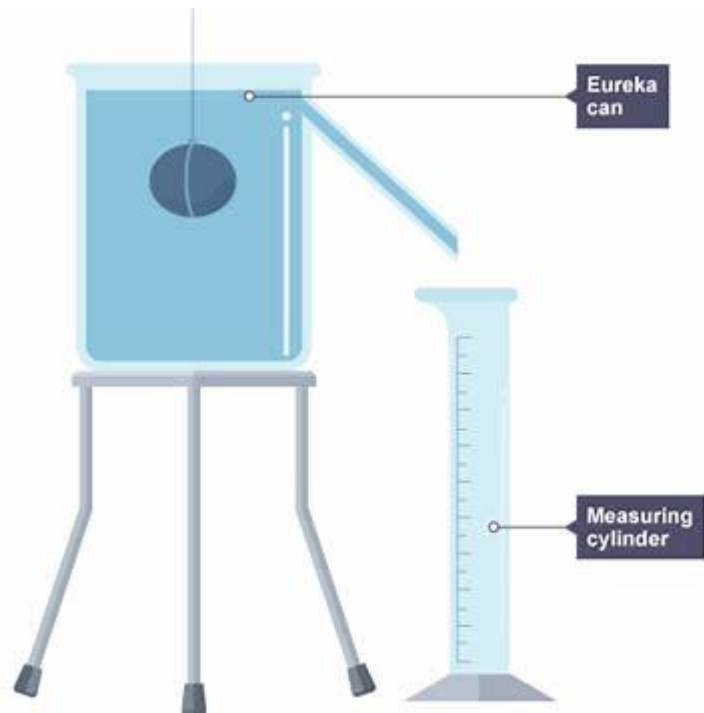
# Eureka Can



$$\text{Volume} = 40 - 10 = 30\text{cm}^3$$

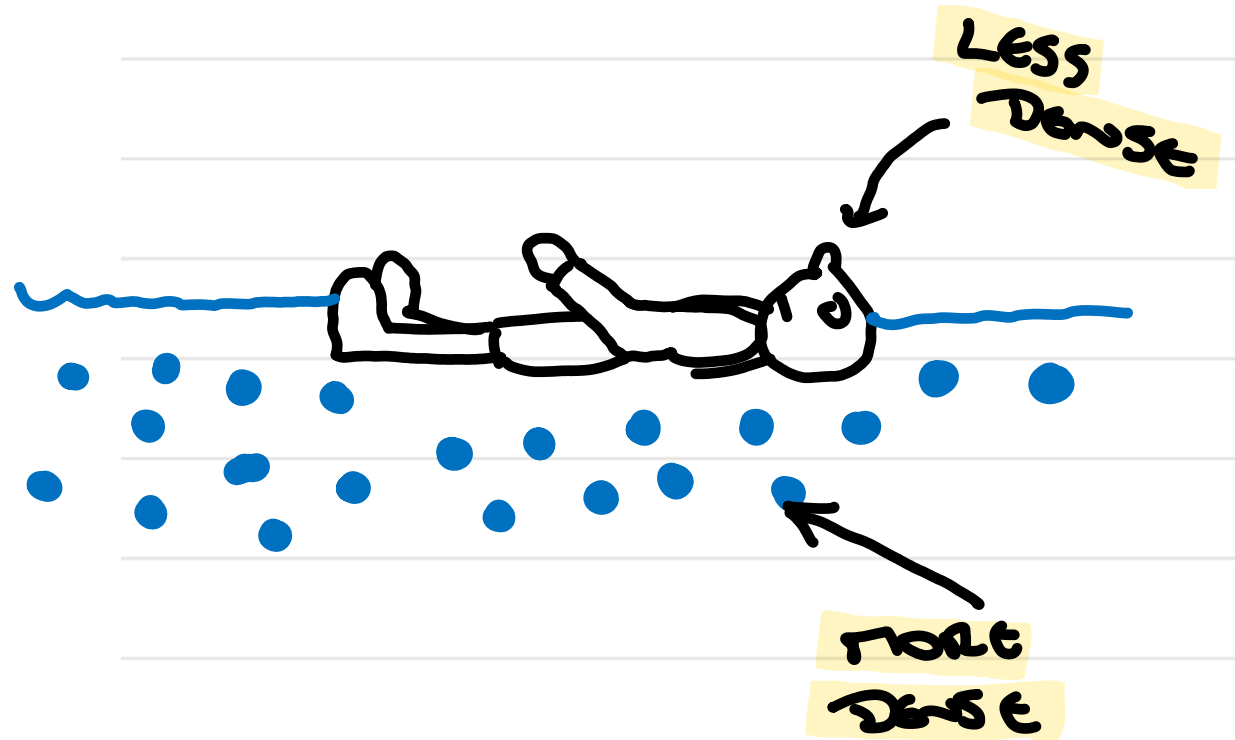
$$\text{Density} = \frac{60\text{g}}{30\text{cm}^3} = \underline{2\text{g/cm}^3}$$

# Eureka can calculation



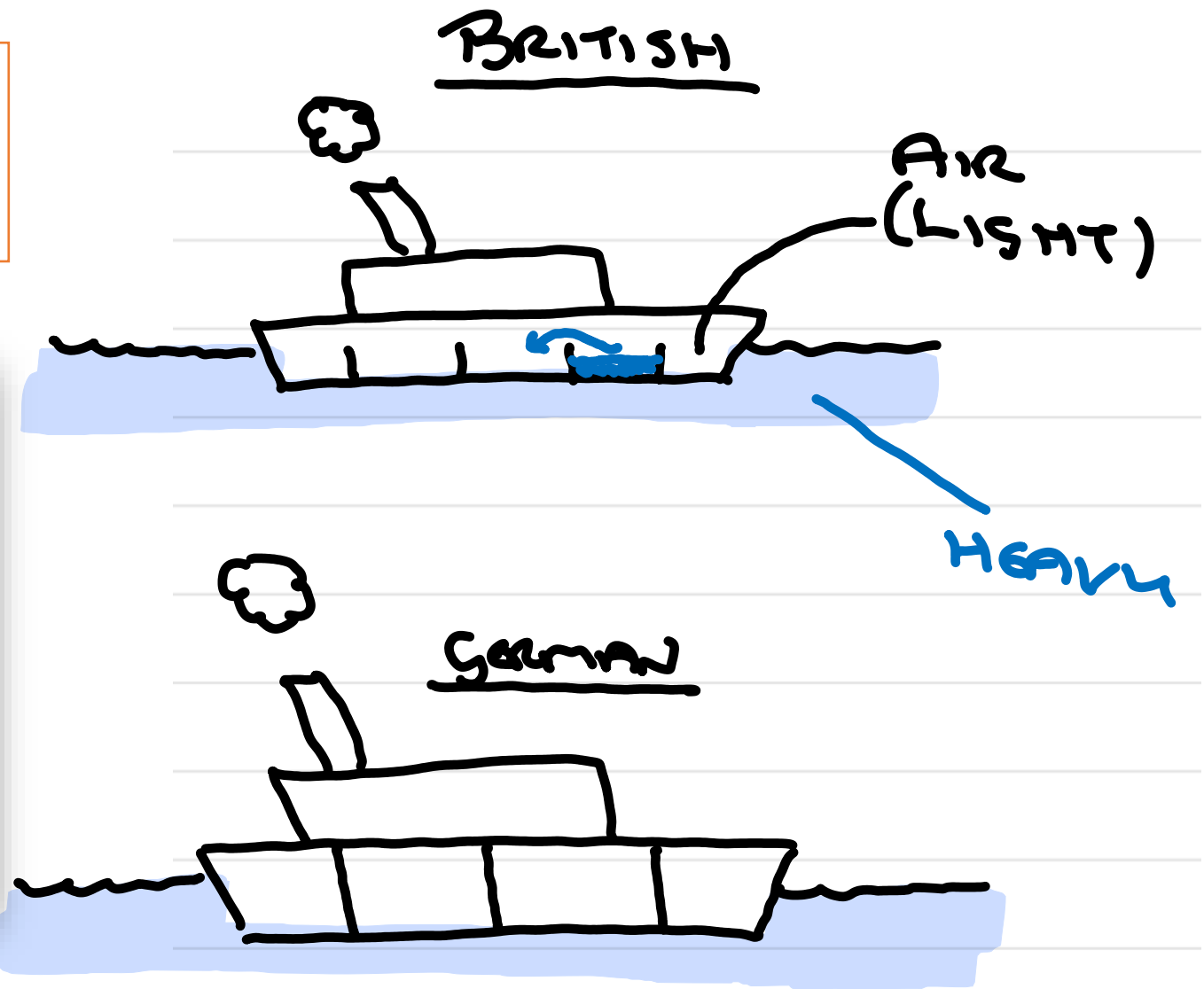
Pure water: Density = 1

# The Dead Sea



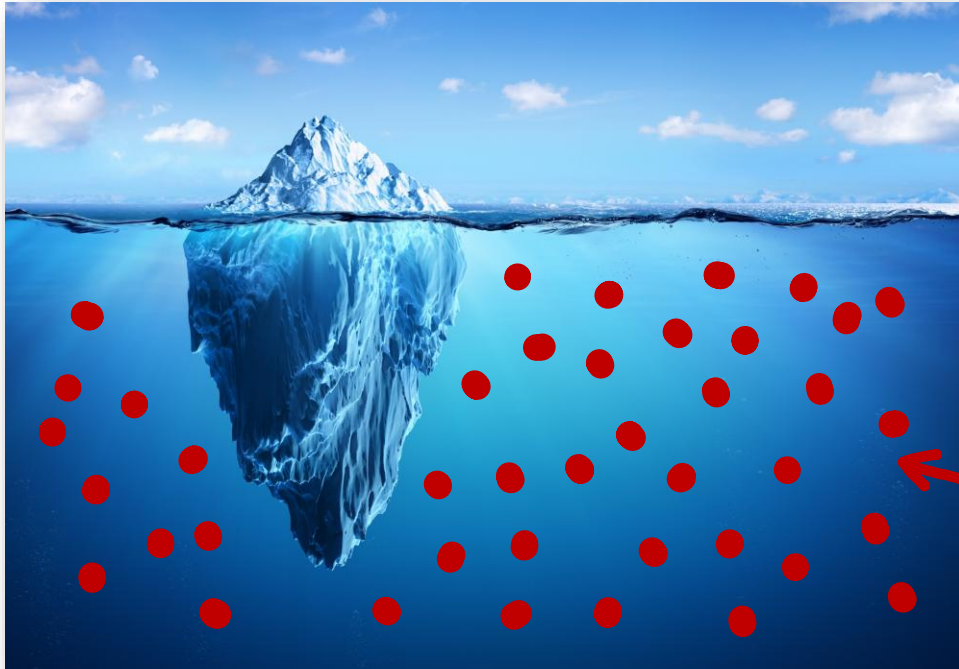
# The Titanic

(1912)



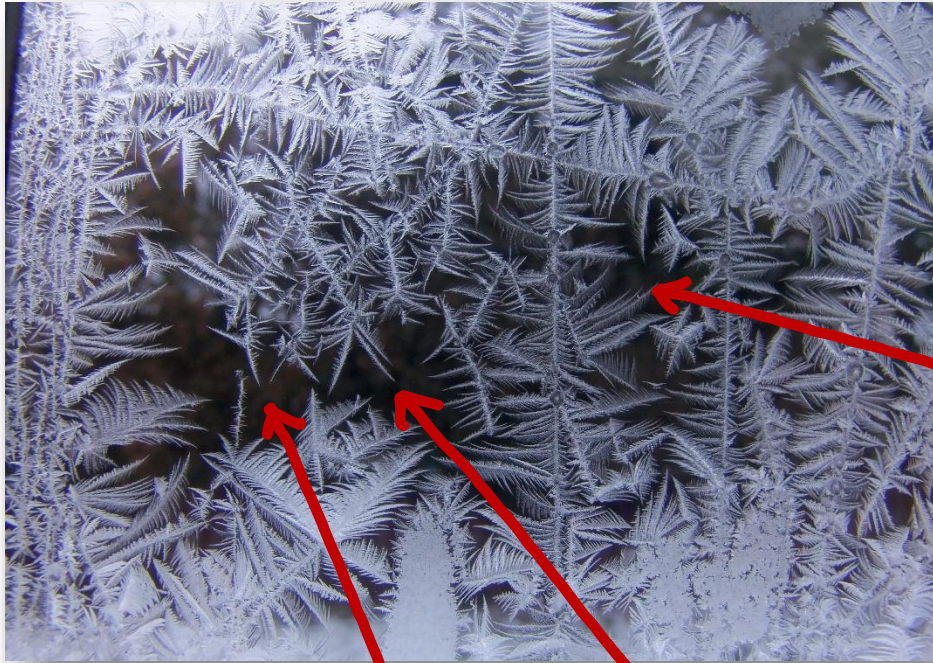
# The density of ice

ICE IS LESS DENSE  
THAN SEA WATER



SALTY  
WATER  
(more  
dense)

# Ice crystals

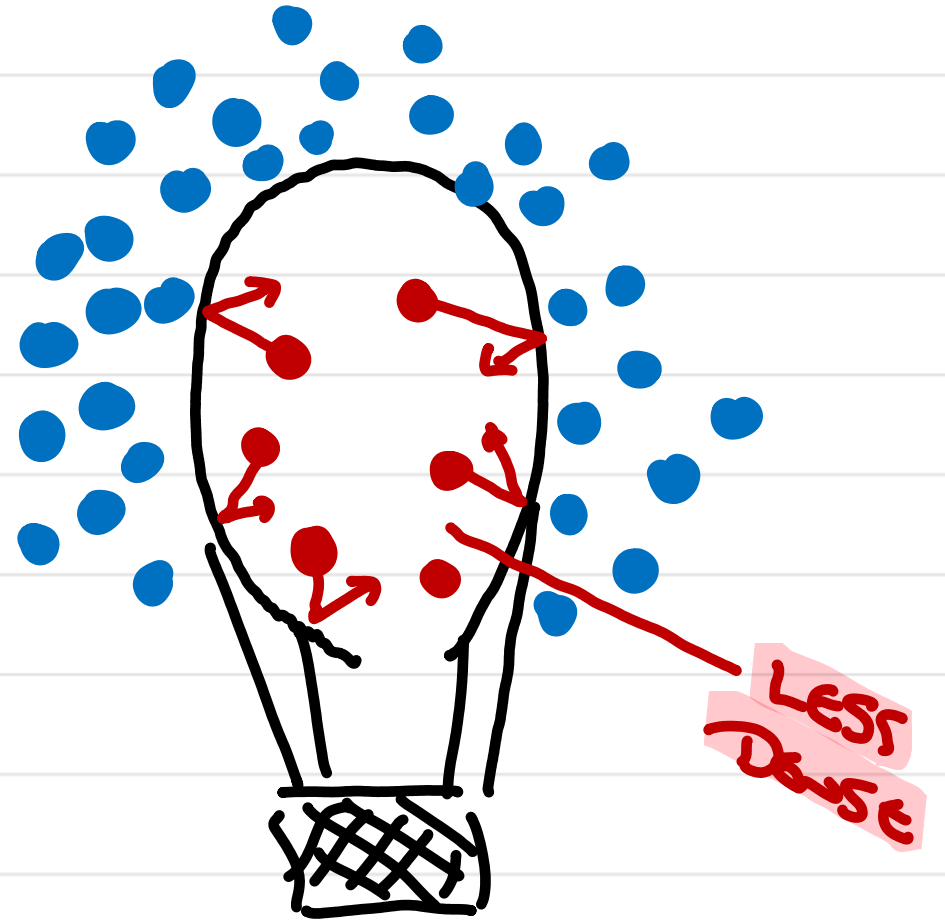


THE CRYSTALS HAVE  
LOTS OF GAPS  
IN THEM WHICH  
MAKE THEM LESS  
DENSE.

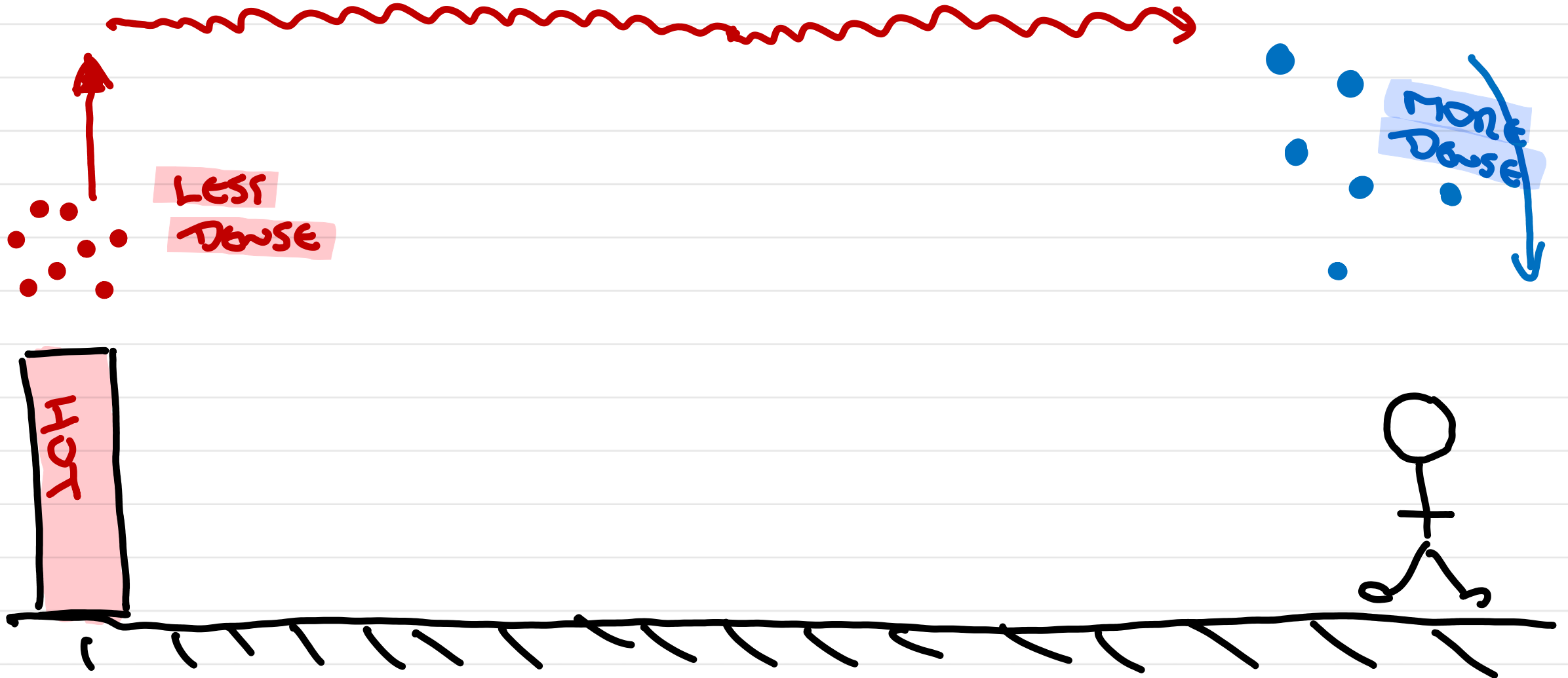
# Hot air balloons



MORE  
Dense



# Notes:



# Diffusion

How does smell spread?

What is diffusion?

Diffusion in liquids

Diffusion in gases

Brownian motion

Robert Brown

- Temperature

( MOVE  
FASTER  
MORE  
Energy

OSMOSIS

# How does the smell spread?

\* INCREASE TEMP

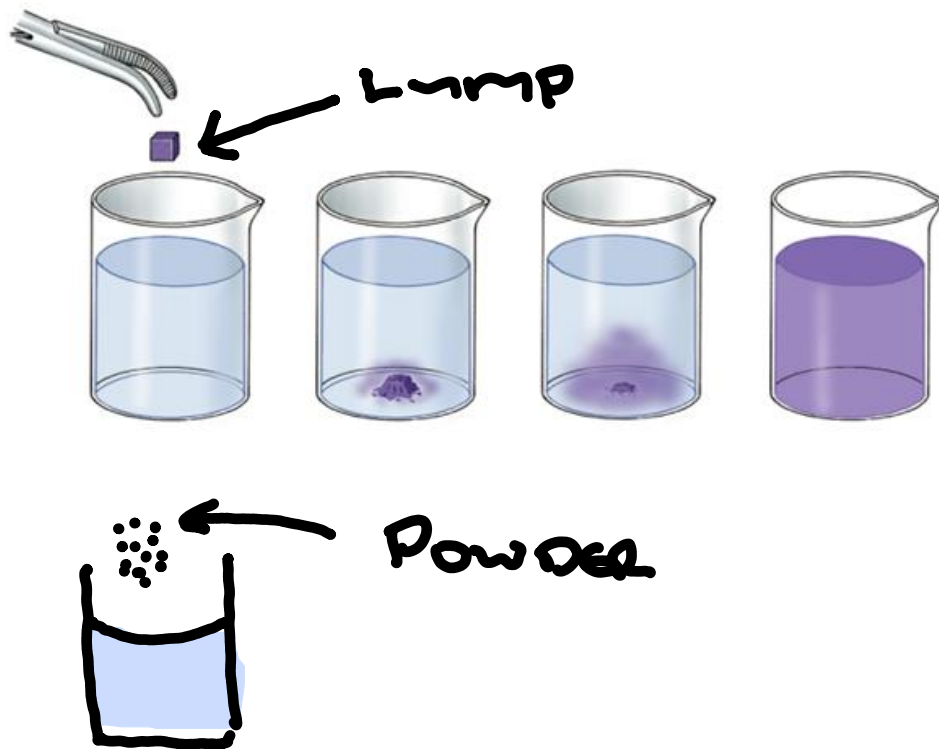


High [ ]

Low [ ]

# What is diffusion?

- SPREADING OUT FROM HIGH  $[ ]$  TO LOW  $[ ]$



As you increase the surface area the speed of diffusion increases.

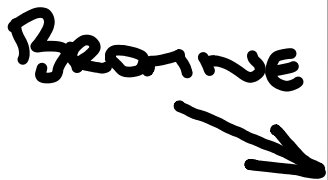
# Diffusion in liquids



# How can you increase the rate of diffusion?



# Diffusion in gases

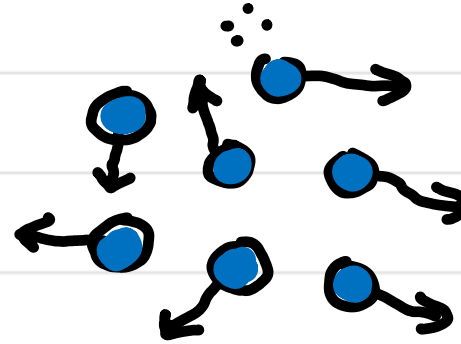


# Robert Brown

(1773-1858)

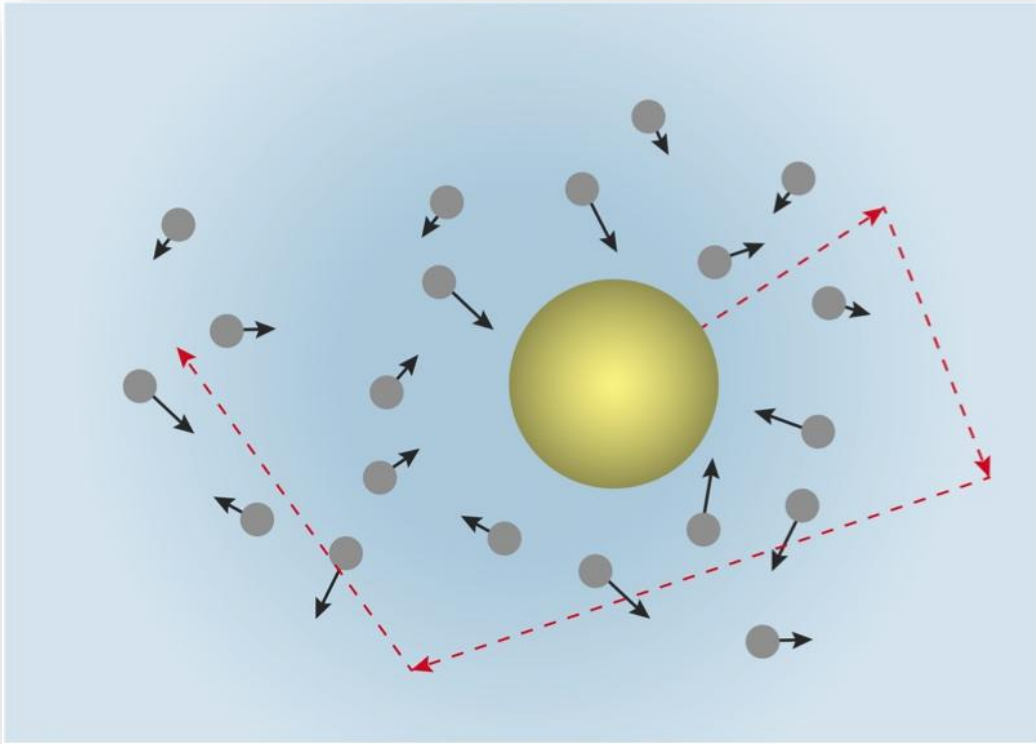


When dust flakes are moved around randomly by things that you cannot see like air it is called Brownian Motion



# Brownian motion

The random movement  
is called **Brownian**  
**motion**



Notes:

# Gas and water pressure

The collapsing can

Why would the balloon expand?

Water pressure

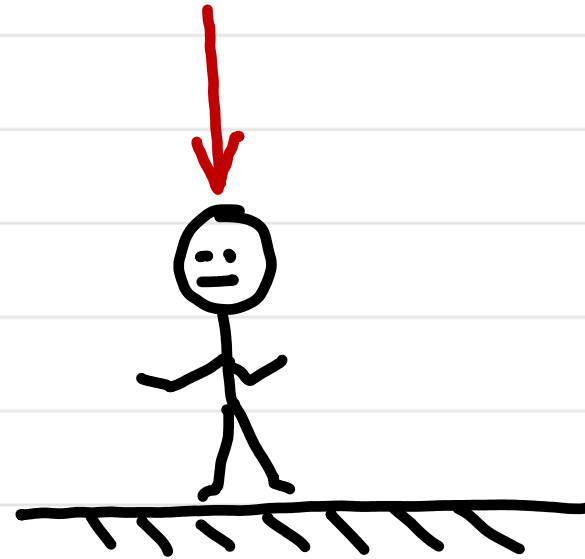
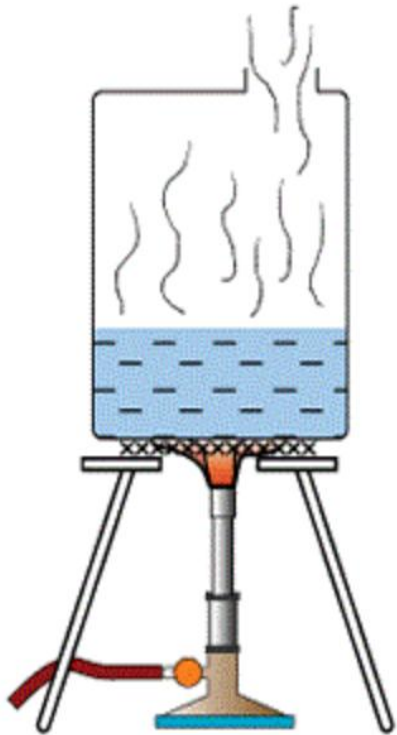
Deep sea fish

WHAT HAPPENS TO  
AIR PRESSURE AS  
WE GO AWAY ALTITUDE?

# The collapsing can

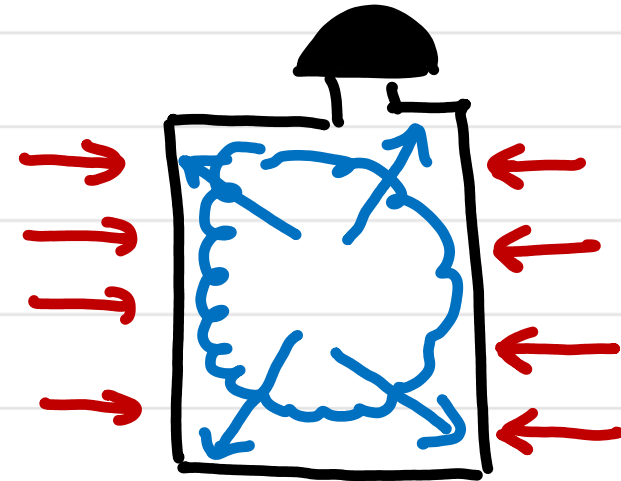
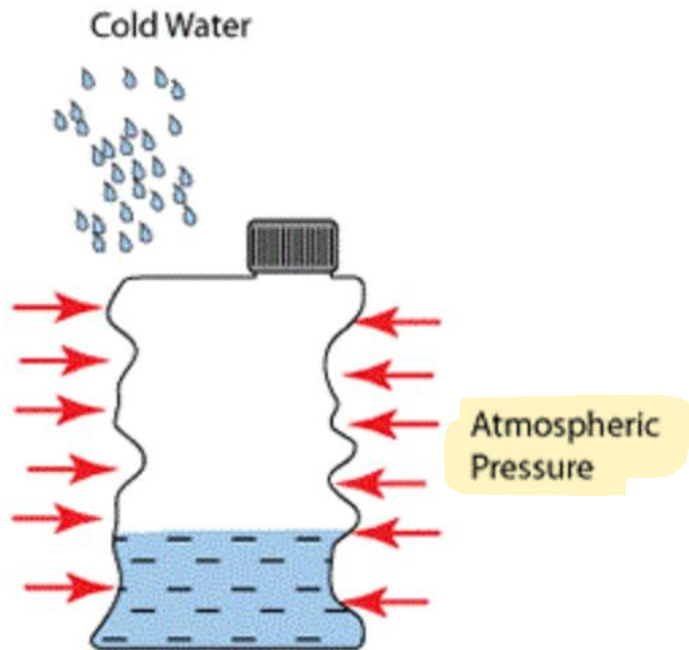
# Collapsing can

(heating water)

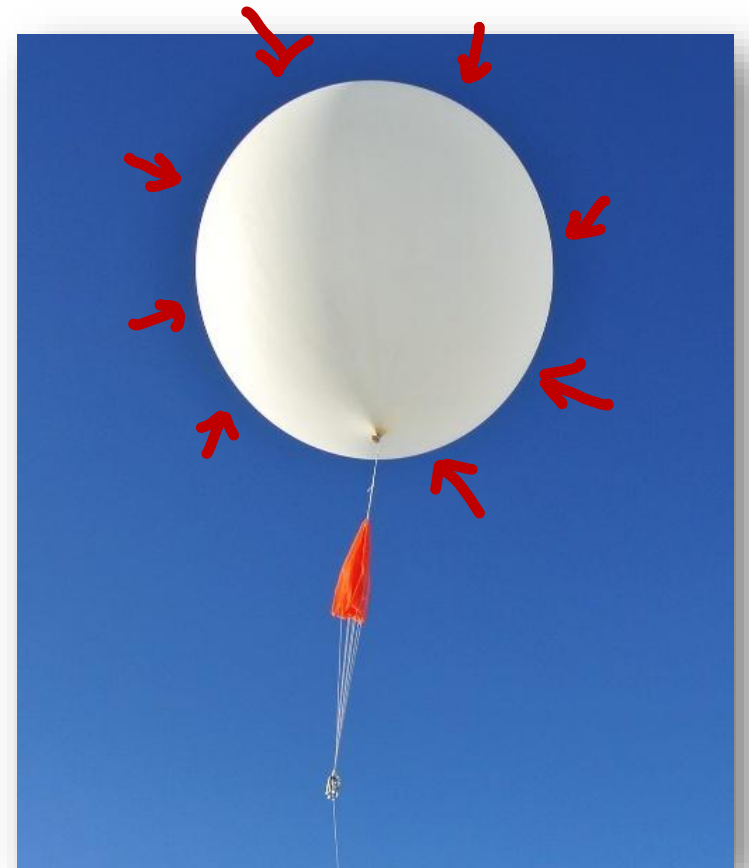
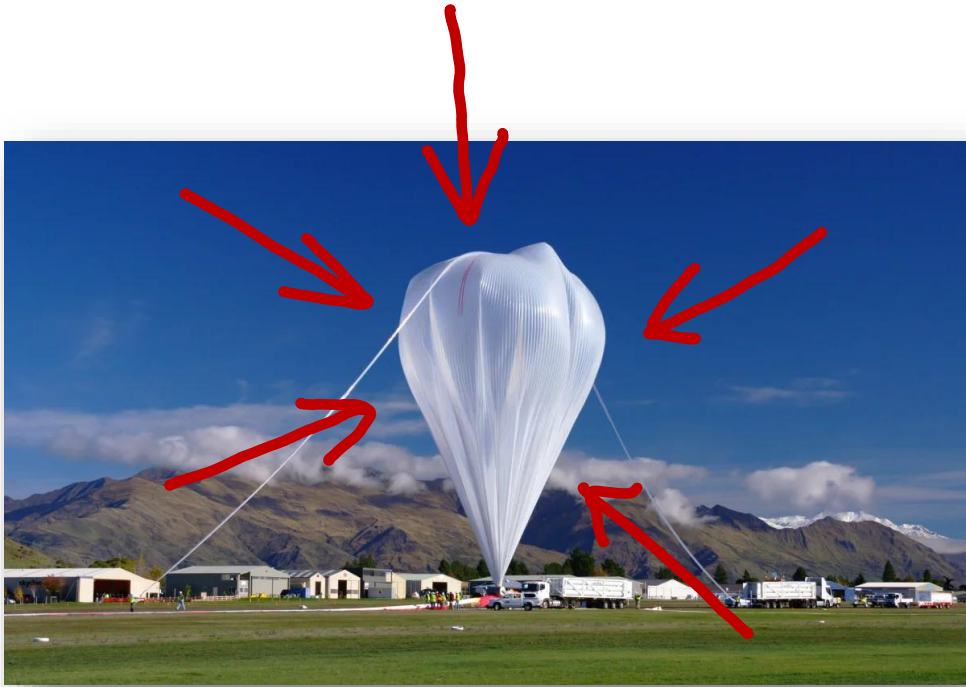


# Collapsing can

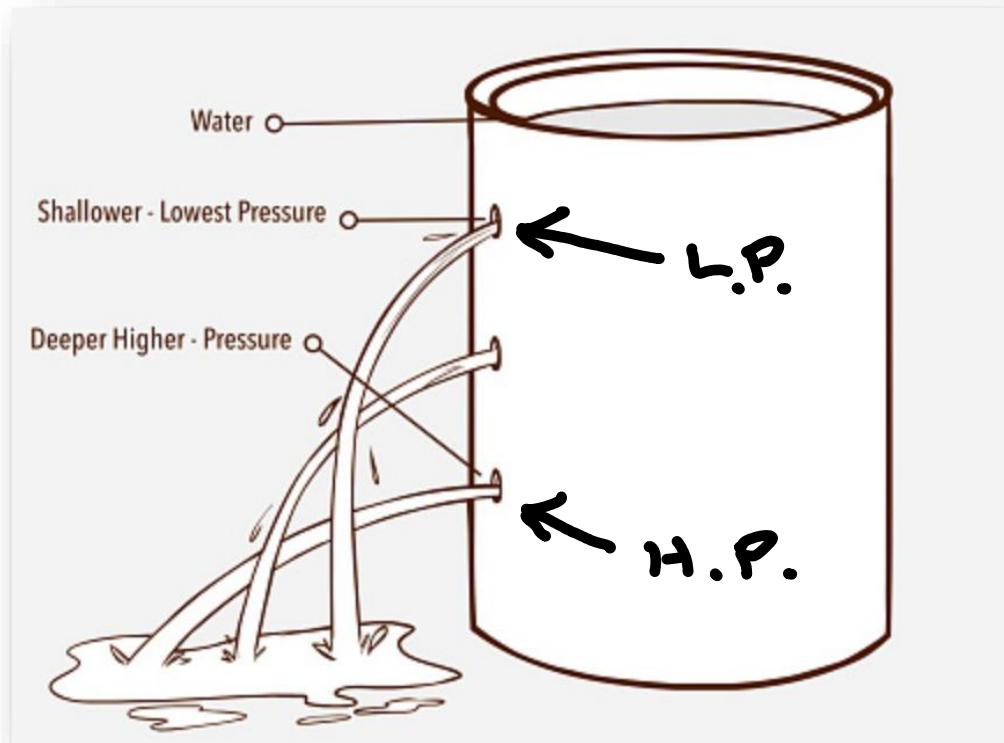
(why is it collapsing??)



# Why does the balloon expand?



# What is happening here?

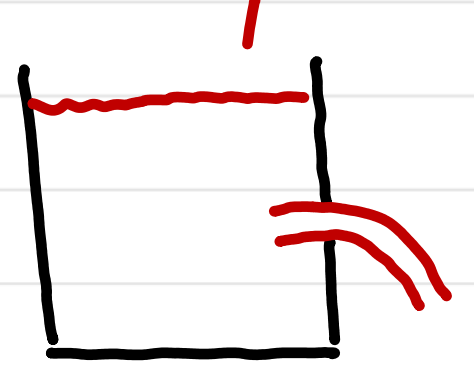


WATER



DENSITY "1"

PETROL



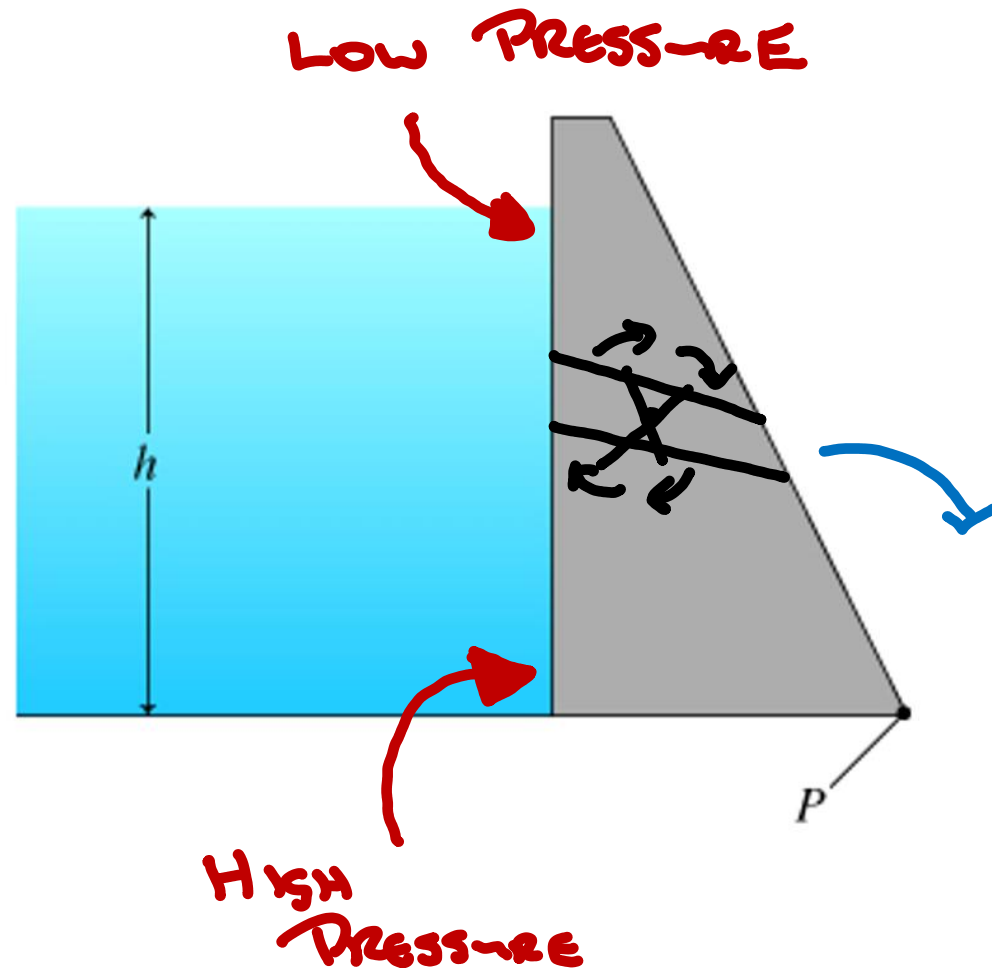
PETROL "0.7"

MERCURY



DENSITY "13.5"

Why is the dam thicker at the bottom?

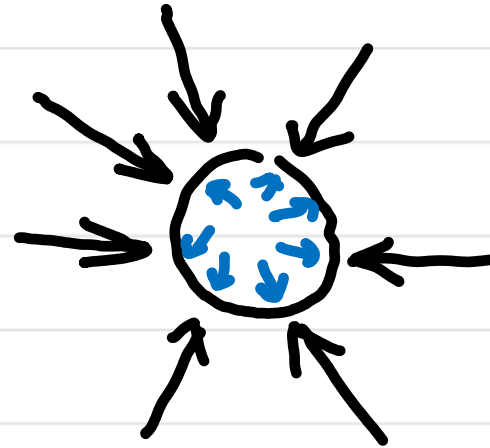
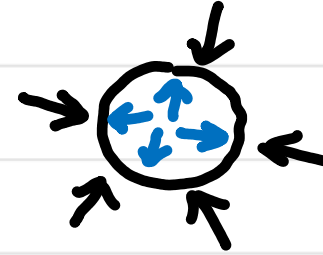
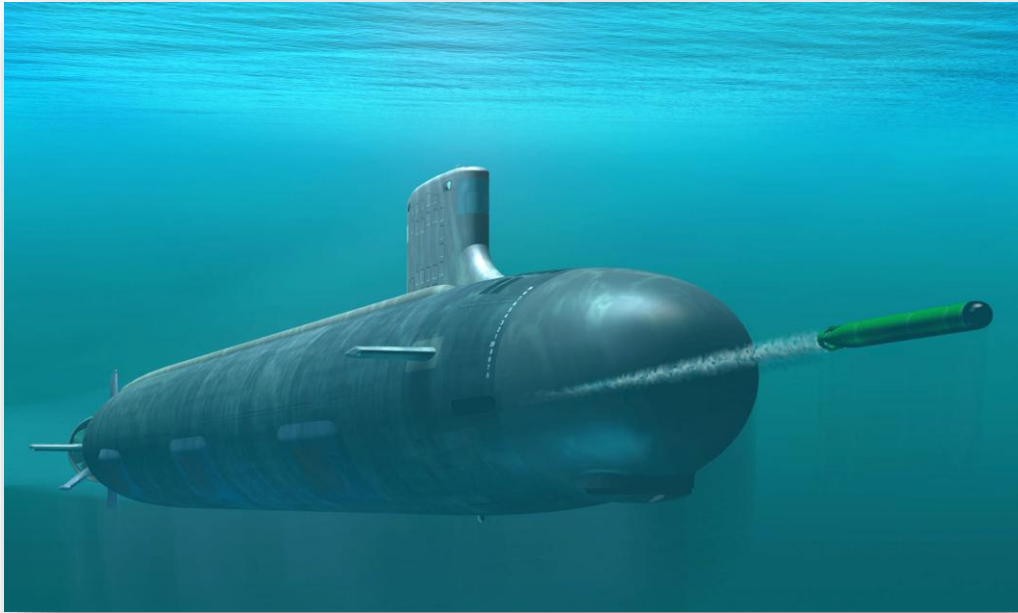


KINETIC ENERGY → ELECTRICAL ENERGY

# Humpback angler fish

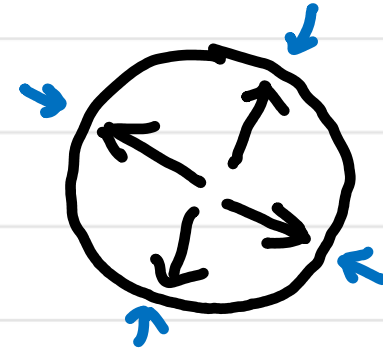
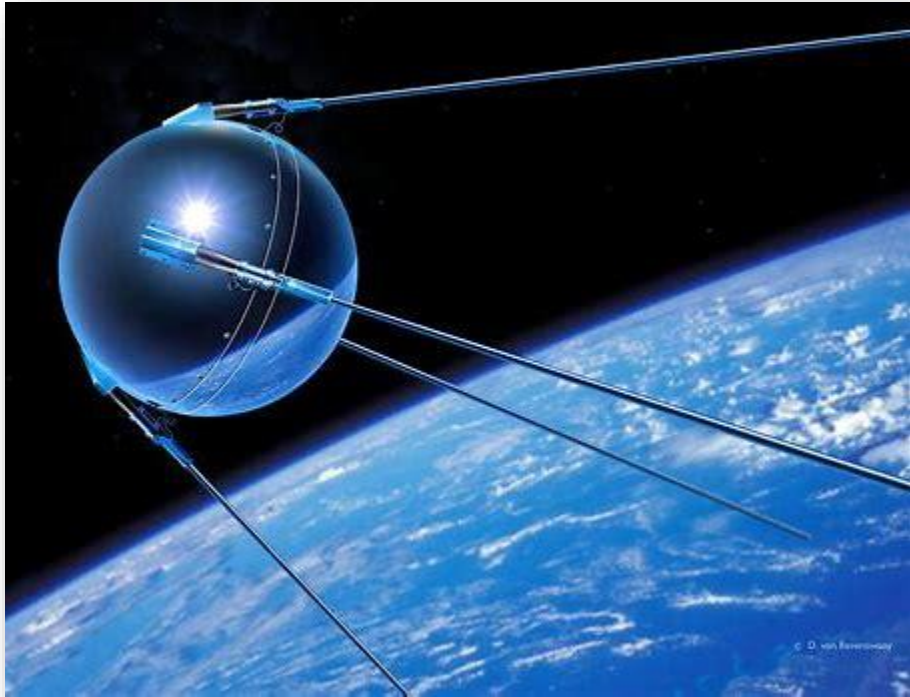


# Submarines



# Sputnik 1

(1957)



Notes:

# Practice Questions

| Question                                          | Answer                             |
|---------------------------------------------------|------------------------------------|
| What does evaporate mean?                         | LIQUID TO GAS                      |
| Define subliming                                  | SOLID TO GAS                       |
| Explain the term density                          | MASS RELATIVE TO VOLUME            |
| What is Brownian motion?                          | RANDOM MOTION OF GAS PARTICLES     |
| Why does a balloon expand when it gains altitude? | INSIDE PRESSURE > OUTSIDE PRESSURE |

Notes:

Why can't solids be compressed?

What does subliming mean?

What happens to temperature during a change of state?

What does the term gas pressure mean?

Why would a balloon get bigger at higher altitude?

What does the term density mean?

What will happen to the volume of a liquid as it turns into a solid?

What does diffusion mean?

# States of matter

What happens to particles in a solid as it melts?

Why doesn't diffusion happen in solids?

What happens to pressure as temperature increases?

Why do hot gases diffuse faster than cold gases?