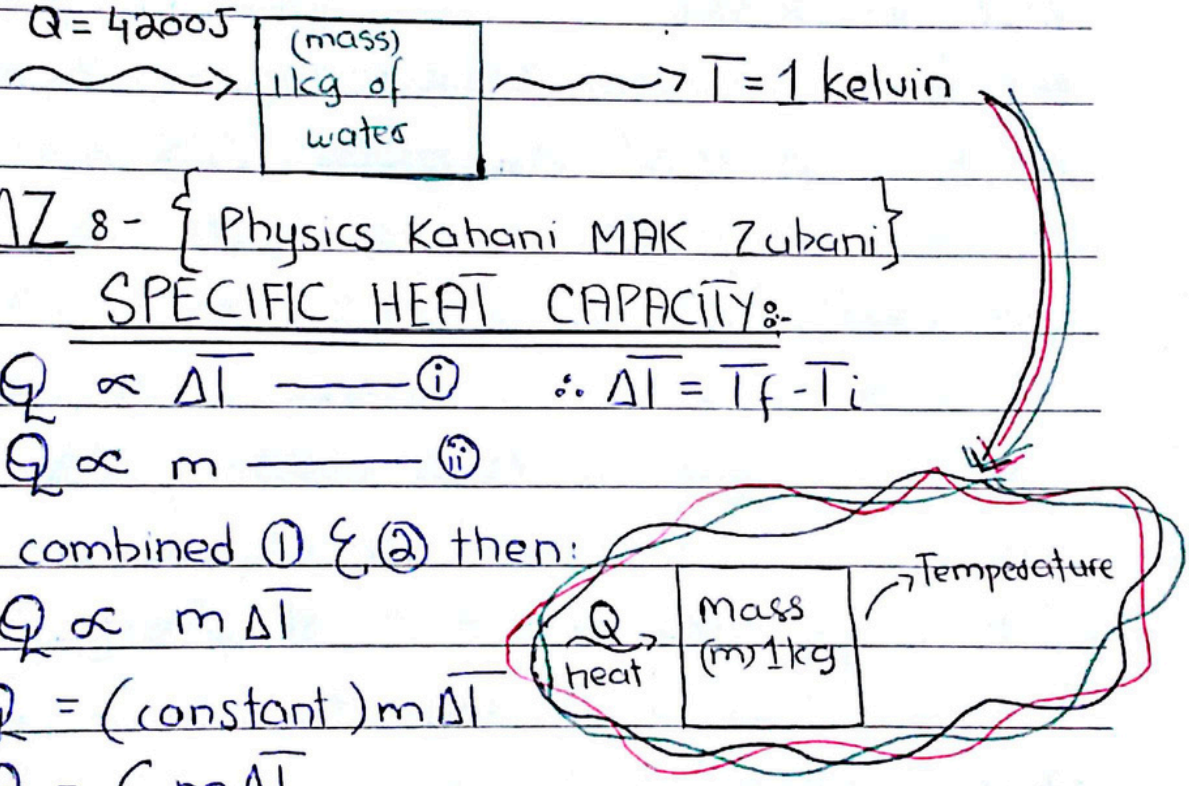
HEAT CAPACITY & HEAT TRANSFER :-

SPECIFIC HEAT CAPACITY :-

Specific heat capacity or specific heat of a material is the amount of heat absorbed or lost to change the temperature of 1kg of its substance by 1 keluin or 1 degree celsius.



PKMZ :- { Physics Kahani MAK Zubani }

SPECIFIC HEAT CAPACITY :-

$\Rightarrow Q \propto \Delta T$ ——— (i) $\quad \therefore \Delta T = T_f - T_i$

$\Rightarrow Q \propto m$ ——— (ii)

By combined (i) & (ii) then:

$\Rightarrow Q \propto m\Delta T$

$\Rightarrow Q = (\text{constant})\, m\Delta T$

$\Rightarrow Q = Cm\Delta T$

$\Rightarrow \therefore C$ = specific heat capacity constant

$$\frac{Q}{m\Delta T} = C \Rightarrow \boxed{C = \frac{Q}{m\Delta T}} \text{ formula}$$

Where 'c' is the specific heat of the materials,

'Q' is the amount of heat absorbed or lost,

'm' is the mass of the substance,

$T_{final} - T_{initial}$ [ΔT] is the change in temperature.

$c = \frac{Q}{m\Delta T}$ => $c = \frac{\text{heat}}{\text{mass(Temperature)}} = \frac{\text{Joule}}{kg \cdot K} = \frac{J}{kg \cdot K}$

SI unit of specific heat capacity is $J kg^{-1} k^{-1}$

=> SLO BASED:-

① State specific heat capacity with the help of mathematical derivation

② Why the dessert are hot & in day time & cool at night?

=> Some materials have to require lessed amount of heat like metals (Aluminium), so, they get hotter quickly & get cooler also quickly (s.p.c of Al = 910, Steel = 412)

=> On the other hand, materials like water have high specific heat capacity :(Water = 4200 $J kg^{-1} k^{-1}$) so they absorb heat less quickly & also release heat slowly.

-> POINTS TO PONDER:

Heat is Energy.

Temperature shows how hot or cool smthg is.

Materials with low heat capacity heat up & cool down quickly eg Deserts get hot in the day & cold at night because sand has low capacity.

RECAP:-

Heat capacity is the total amount of heat energy required to change the temperature of a substance by given amount.
Specific Heat Capacity is the amount of heat energy required to change the temperature of unit mass (1kg or 1g) by 1C° or 1K.
Heat capacity depends on the substance
Specific heat capacity is property of a substance

SPECIFIC HEAT CAPACITY OF DIFFERENT REGIONS:-

- COASTAL AREAS:-

Water has high s.p.c., so it heats up & cools down quickly? No! Slowly. This moderate climate of the coastal regions — keeping them cooler in summer & warmer in winters. As a result, coastal areas experience mild & stable temperature

- INLAND AREAS:-

Land has low heat capacity means it heats & cools quickly. Inland areas, have more extreme temperature.

with hot days & cold nights in winters, unlike the steady climate near the coast.

• DESERT REGIONS:-

Desserts are usually inland withy dry, sandy soil & little water. The low specific heat capacity of sand & lack of moisture cause rapid heating in day & fast cooling at night, leading to extreme temperature variations.

=> SLO BASED QNA:-

Q: What is the role of specific heat capacity in human body temperature regulation?

The body is made mostly of water, which has high specific heat capacity so it helps maintain a stable internal temperature.

When the body gets too hot, it produce sweat. Sweating cools the body as the sweat absorbs heat & evaporates.

This process remove excess heat & prevents overheating.

Q: How does water helps regulates a vehicles engine temperature?

HOW WATER COOL ENGINE:-

Absorb Heat:

Water in the radiator absorbs heat

from the engine.

Carries Away Heat:-

The hot water circulates through hoses to the radiator.

Cools Down:-

In the radiator, air cools the water, often with the helps of a fan

Repeats Cycle:

The cooled water goes back to the engine to absorbed more heat.

Q: How water is used in Central cooling & heating systems in buildings?

Water is commonly used in central cooling & heating systems in buildings due to its excellent ability to absorb & transfer heat. (1) In a central heating system, hot water is generated by a boiler & circulated through pipe to radiators or underfloor heating systems, releasing warmth in the room. (2) In cooling systems, such as chilled water air conditioning, cold water is produced by a chiller & pumped through coils in air handling units or fan coil units. As warm air from the building pass over those cold coils, heat is absorbed by the water, cooling the air before it is distributed.

throughout the building. The warmed water is then returned to the chiller to be cooled again, creating a continuous cycle.

Q: Role of specific heat capacity in cooking?

Water is an excellent conductor of heat, making it ideal for cooking methods like boiling, steaming, & poaching.

It helps to distribute heat evenly, preventing food from burning or sticking to the bottom of the pan.

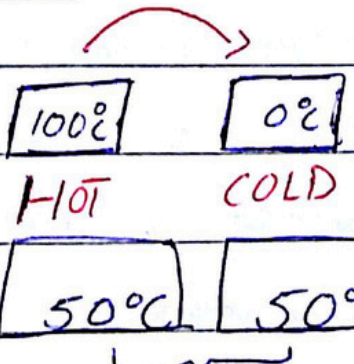
In methods like steaming, the waters, vapor carries heat to cook the food, allowing for gentle & even cooking.

TRANSFER OF HEAT:-

→ THERMAL EQUILIBRIUM:-

(PKMZ:)

Thermal equilibrium ⟶



DEFINATION:-

Thermal equilibrium is when 'two or more object at different temperature come into contact & even

eventually reach the same temperature, so no heat flow between them anymore.

HOT PARTICLES: particles move faster.

COLD PARTICLES: particles move slower.

When they touch, fast particles transfer energy to slower ones.

Over time both reach the same avg K.E → same temperature.

=> THE ZEROTH LAW OF THERMODYNAMICS

If A is in thermal equilibrium with object B, & object B is with C, then A is in thermal equilibrium with C.

Examples-

A hot cup of tea left on the table eventually cools to match temperature — reaching thermal equilibrium with its surroundings.

Conduction :-

Conduction is the transfer of heat through a solid without the movement of the material Heat travels from the hotter part of the object to cooler part.

/ /

> It happens due to the vibration & collision of particles (atom or molecules)
> Best conductors are metal like copper, aluminum & rod
> Poor conductors are {insulators} like wood, plastic & rubber.
> No material moves — only energy is transformed.
> It occurs when objects are in direct contact.
Example:- A metal spoon in hot soup gets hot because of conduction.
> Conduction is one of the three methods of heat transfer.

metals:-

Metals are good conductors because:-
1: Free Electron:- Metal have free electrons that can move freely, allowing them to transfer heat energy quickly & efficiently.
2: Close-PACKED STRUCTURE:- Metal atoms are closely packed, enabling effecient transfer of vibration & electrons.

insulators:-

Insulators are poor conductors because :-

1: TIGHILY BOUND ELECTRONS:-

Insulators have electrons that are tightly bound to their atoms, limiting the flow of electrons & heat.

2: GAPS BETWEEN PARTICLES:-

Insulators often have a more open structure or gaps between particles, reducing the effeciency of heat transfer.

[important mcq]

Water:-

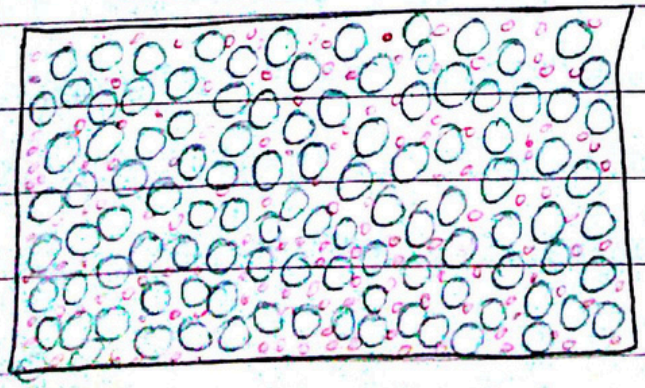
Wleter is not good conductor cuz:-

1:- Wlater has low thermal conductivity.

2:- It does not transfer heat as effeciently as metals.

3:- Heat transfer in water often relies on convection rather than conductors.

4: MOST IMPORTANT IT HAS HIGH SPECIFIC HEAT CAPACITY.!!!!



• Electron
• Free elction

Metal Diagram

[important]

Convection:-

> The method of flow of heat in liquid due to bulk movement of liquid is called..... "Convection".

> Example:- When you heat water in a pot, the hot water at the bottom rises & the cooler water moves down. This movement spreads heat — thats convection.

=> HOW IT WORKS:-

Fluids near a heat source become less dense due to increased kinetic energy in its particles. This less dense fluid rises, while denser fluid sinks, As, the less dense fluid moves away from the heat source, it cools & sinks, while the denser fluids heats up & rise. It is the cycle called Convection.

KEY POINTS:-

{KINETIC MOLECULAR THEORY}

KMT is a scientific theory that explains the behavior of gases based on the idea that particles are always in constant,

random motion & that their energy depends on temperature.

Everyday Example:

- Boiling water in a pot.
- Wind pattern in the atmosphere.
- Ocean pattern.
- Heatings systems using radiators or air veints.
- Heated room.
- Sea breeze.
- Boiling water.

QUESTIONS:

Q: Why does convection not occur in solids?
Q: How does the density of a fluid affect convection currents?
Q: Why do hot fluid rise & cold fluids sinks during convection?
Q: How would the rate of convection change if gravity did not exsist?
Q: What roles does convection play in ocean currents & climate system?

Convection & MARINE LIFE :-

> Convection helps in the distribution of food, oxygen, & heat in oceans.

> Warm water rises, cold water sinks, creating currents that move nutrients & oxygen through the water.

> This supports marine life by maintaining a balanced environment.

=> KEY POINTS :-

- Distribution of food: Nutrients from deep are brought to the surface.
- Distribution of oxygen: Surface oxygen mixes with deeper layers
- Distribution of heat: Heat is spread from the surface to deeper ocean layers.

distribution of food:

A standard way of giving food is that upwellings brings nutrient rich water from the deep ocean to the surface.

These nutrients feed phytophlakton, the base of the marine food chain

Currents & waves then spread nutrients across ocean regions.

WHY IT MATTERS:-

Supports the entire food web [zooplankton → fish → larger predators]

distribution of oxygen:

In upwelling, deep cold water rises to the surface, bringing less oxygen but supporting high marine life to nutrients. In down-welling, oxygen rich surface sinks, carrying oxygen to deeper layers, helping deep-sea organisms survive. Together, they maintain the balance of oxygen throughout the ocean.

distribution of heat:

The sun heats the ocean surface. Convection currents move warm water toward the poles & cold water toward the equator (global ocean circulation)

Wind, tides & currents help mix surface

& deeper layers

WHY IT MATTERS:

Regulates global climate.

keep ocean temperatures stable for marine life.

KEY POINTS:- {important!!!}

= upwelling:-

- Brings cold water to surface.
- Cools the surface area.
- Helps balance ocean temperature.

= downwelling:-

- Pushes warm water downward.
- Warms deeper ocean layers.
- Maintains heat flows in ocean.

= latent heat:-

Heat absorbed or emitted to change the phase of matter is called latent heat.

Hurricanes:-

A hurricanes is a large, powerful storm system that forms over warm ocean water & strong winds, heavy rain & a spinning motion.

-> MECHANISM:-

1:- Warm ocean water evaporates.

2:- Moist air rises & cools, forming clouds.

3:- More warm air rises -> causes low pressure.

4:- Air spins due to Earths rotation

5:- Systems grows into a spiraling storm -> A hurricanes

(RKMZ) Physics kahani MAK zubani:-

HOW HURRICANE FORM:-

Step 1:- gharam pani wala samandar

Step 2:- samandar ke upar ki hawa geeli ho jaye gee.

step 3:- moist air upar ki taraf jata hai [height par]

step 4:- upar badal ban jaye gen

step 5:- latent heat extract hogaya.

Step 6:- Hurricanes form!!

/ /

SLO BASED:-

Q1: Why hurricanes are mostly form on ocean water ?

Q2: How convection help in hurricanes?

radiation:-

Radiation is the transfer of heat through electromagnetic wave without needing any medium (like air, liquid or solid). It can occur in a vaccum.

KEY POINTS:-

=> Don't need any medium

=> Travels in electromagnetic waves

=> Faster than conduction or convection

=> Can absorbed, reflected, transmitted.

=> All object emit radiation, especially hotter.

Example:-

> Heat reaching from the Sun.

> Feeling warm near a campfire

> Heat emitted from a heater or bulb.

effect of different surface:

Surface of object :-

It's like Newton 3rd law :-

EVERY REACTION HAS EQUAL OPPOSITE / EQUAL REACTION :-

BLACK :

=> when heat given, absorbs heat.

=> when heat removed, reflect heat.

WHITE :

=> Since, it does not absorb heat so is the case it ultimately does not emit heat even.

Texture of object :-

The texture of a surface can impact.

> Heat transfer: Rough surface can increase convective heat transfer.

> Emissivity: Surface texture can influence emissivety, effecting thermal radiation.

> Thermal imaging: Surface texture can effect thermal imaging accuracy.

Texture of surface: dull, rough, dark
Good absorbers & emitters

Texture of surface: Smooth, shiny
Bad absorbers & emitters.

Leslie Cube:-

It is a scientific instrument [cube] used to study the emission of thermal radiation from different surface.

A leslie cube is a hollow, metal cube [often aluminium or copper] with different surface, each with a different texture or color. It is filled with hot water to warm the side.

THE SURFACE TYPICALLY INCLUDE:-

1: Matte Black

2: White

3: Shiny (polished metal)

4: Dull metal (:grey or unpolished)

PURPOSE:-

To show how surface color & texture affect the emission of infrared radiation.

HOW IT WORKS:-

1:- Fill the cube with hot water.

2:- Use an infrared detetor or thermopile to

to measure the heat emitted from each face.

3:- Observe & record which side emits the most & least radiation

OBSERVATION :-

Surface	RADIATION EMITTED
MATTE BLACK	HIGHEST
DULL METAL	MODERATE
WHITE	LESS
SHINY METAL	LEAST

Important SLO based Questions:-

Q1:- What is the effect of temperature on the rate of radiation?

Q2:- How leslie cube helps in determining the behavior of surfaces for radiating & absorbing radiation.

COOKING IN A PAN:

Conduction:- Heat moves from the pan to the food by direct contact.

Convection:- Hot liquid or air moves, cooking food evenly.

Radiation:- Heat from the flame or stoves reaches the pan through infrared eyes.

Q: WHY NON-METALS ARE NOT USED IN COOKING?

POOR CONDUCTORS:-

Non-metals do not conduct heat well, so they cannot transfer heat effeciently to food.

LOW MELTING POINTS:

Many non-meltings melt or burn at low temperatures, making them unsafe for cooking.

BRITLE NATURE:

Non metals like sulphur or phasphorus are brittle & can easily break or crumble.

CAN BE TOXIC:

Some non-metals (like chlorine or iodine) are toxic & not safe for food contact.

Q2: WHY THE FREEZER COMPARTMENT IS AT THE TOP REFRIGATORS?

COLD AIR SINKS:-

Cold air is denser, & heavier, so it naturally sinks down from the top, cooling the entire fridge evenly.

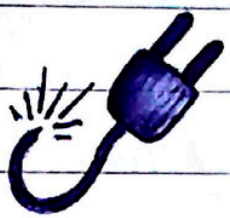
EFFICIENTLY COOLING:-

Placing the freezer at

the top allows cold air to flow downward, helping the lower refrigerator section stay cool with less energy.

FASTER FREEZING:- Heat rises, so the top stays cooler & is better for quick freezing of items.

electric heater



- Very efficient at delivering radiant heat.
- Provides instant warmth, like sunlight.
- Ideal for spot heating or open areas.

Gas heater

- Primarily heats air a using convection, not radiation.
- Some models emit radiant heat, but less efficiently.
- Slower warmth, as air must heat up first.
- Better for heating, entire enclosed rooms.

SLO BASED QEUSTION:-

Q: Application of heat transfer in daily life?

Q: Explain conduction, convection, radiation?

Q: Explain process of heating room?

Q: Explain mechanism of hot water in heater?

REDUCING THERMAL ENERGY TRANSFER IN BUILDINGS:-

To keep buildings warm in winter & cool in summer, we reduce heat transfer by the process of conduction, convection, radiation.

> INSULATION:-

[fibre glass or foam] in walls, roofs & floors trap k air, reducing conduction & convection.

> DOUBLE GLAZED WINDOW :-

They have 2 glass layers with air between, reducing heat loss & gain.

> REFLECTIVE SURFACES:-

Shiny roofs, reflextive foils) reduce heat transfer by radiation.

> SEALINGS GAP:-

Around the doors & windows [draught proofing] prevents warm air from escaping, reducing convection.

> THICK WALLS:-

Made of concrete or bricks slow down heat transfer.

HOW MUD HOUSES STAY COOL?

= Mud houses stay cool in sumeer & warm in winter:-

- High thermal mass:

Thick mud walls absorb heat & release it gradually, stabilizing temperature

- Porosity:

Mud allows moisture to evaporate, creating a natural cooling effect.

- Design:

Thick walls & thatched roofs insulate well.

IMPOPORTANT SLO BASED QNA:-

Q:- How false ceilings help houses to be cold?

Ans:- A false ceiling (also called drop ceiling or suspended ceiling) is a secondary ceiling installed below the main roof or ceiling of a room.

=> It does not hold the structure but is mainly for:-

PURPUSE OF FALSE CEILING:-

INSULATION:- Traps hot air above, keeping room cooler in summer & warmer in winter.

measuring temperature with Infrared thermometer:-

PRINCIPLE:-

- All objects emit infrared radiation if warm.
- Infrared thermometer detect this radiation to measure temperature.

USES:-

- During pendamic (e.g covid 19) to measure without contact.
- Industrial, medical, food storage & hazardous applications.

STEPS TO USE:-

- Read device manual.
- Power on & adjust scale.
- Aim sensers at target.
- Press button, wait for stable reading.
- Release button to note temperature.

IMPORTANT TIPS:-

- Maintain proper distance-to-distance ratio.
- Avoid use on wer, reflective of moving surface.

• Compare readings with mercury thermometers for accuracy.

Global Warming :-

Rise in Earth's average temperature due to increased greenhouse gases. Increase in Earths average temperature due to excessive GHGs. It is caused by human activities & it leads to climate change, rising sea level, & extreme weather events

=> Major Cause :- Greenhouse Effect.

=> Effect:

- Melting of glaciours & polar ice caps.
- Rising sea levels
- Extreme weather event (flooding, storms, drought)
- Loss of biodiversity.

=> Human effect:

- Health risks
- reduced crop yeilds
- water shortage

Greenhouse Effect:-

Natural process that traps some of the sun's heat in Earth's Atmosphere. Caused by greenhouse gases (GHGs) like CO_2, methane, & water vapor. Natural process essential for life, on Earth.

Consequences:-

- Climate change
- Rising sea levels
- Extreme weather

SIMPLE DEFINATION:-

>Greenhouse Effect:-

Radiation come to earth & cannot go making the earth hot.

>Global Warming:-

Temperature increased by green house effect is called global warmings.

FLOW OF HEAT IN GEOTHERMAL ACTIVITIES:-

Thermal The Earths structure was primarily discovered by studying seismic waves of earth quakes & explosions the refraction & reflection of waves provided a sketch for the structure.

>Crust:- Thin, rocky skin where all life exists, just 1% of Earths mass.

>Mantle:-Semi solid rock layer that flows slowly & powers plate ~~tectn~~ tectonics.

>Outer Mantle:- Liquid metal (iron & nickel) that create Earth's magnetic field.

>Inner core:-Solid iron ball hotter than the surface of the sun (~5,700°C)

HOW IT FLOWS:-

=> Heat from earths core moves upward through rocks.

=> This heat is transferred by conduction & convection.

=>Convection in Magma & Water : Heated ~~Magma~~ magma & water circulated, carrying heat to the surface

=> Hot rocks & magma heat underground water.

=> This forms heat steam or hot springs on the surface.
=> Can cause geysers, volcanoes.

Brief for Earths structure:-

Crust → Lithosphere → Asthenosphere (very important for techtonic plate) => Mantle → Outer core → Inner core

SLO BASED QNA:-

Q:- How does heat flows from Earths core to the surface?
Q:- What role does conduction & convection play in geothermal heat flow.
Q:- How is geothermal heat used to produce energy.

=> MAGMA:-

- Magma is a burning hot liquid & semi-liquid rock situated under Earths surface.
- Found below the Earths crust.
- The term magma has an ancient greek origin.
- Magma fluctuates in between a general temperature of 1300 to 2400 degrees Farenheit.

LAVA :-

- Lava is the magma that erupts out of a volcano vent onto the surface of the Earth
- Reaches the Earths surface.
- The term lava is of a Latin derivation
- Lava fluctuates in between 1300 & 2200 degree Fahrenheit.

VOLCANIC ERUPTION :-

It is a natural event where magma (molten rock), gases & ash escape from beneath the Earths surface through a volcano, often violently, reshaping the landscape & affecting the environment.

SLO BASED QNA :-

Q :- Differentiate between Magma & lava?

Q :- How lava erupts out of volcano?

MOVEMENT OF TECTONIC PLATES :-

= Defination :-

Technotic plates are large, rigid slabs of the Earth's lithosphere that move relative to each other. Their movement is driven by convection currents in the Earths mantle.

= MOVEMENT OF TECTONIC PLATE :-

Earths crust is broken into large pieces called techtonic plates. These plates floates on the semi-molten mantle (asthenosphere) beneath them. Heat from the Earths core causes convection current in the mantle. These convection currents push & pull the plates, causing them to move slowly (about a few cm per year)

= EFFECTS OF PLATE MOVEMENT :

1. EARTHQUAKES :-

Sudden releases of energy at plate boundaries cause seismic activity.

2. VOLCANIC ACTIVITY :-

Subdde Subduction zones & divergent boundaries often lead to volcanic eruptions.

3. MOUNTAIN BUILDING :

The collision of plates can form mountain ranges.

= FACTS :-

Valdivia earthquake, named after the town ~~closets~~ closest to its epicenter, was roughly a magnitude 9.5, the largest ever recorded.

= MAJOR TECTONIC PLATES:

1. Pacific Plates
2. North American Plate
3. Eurasion Plate
4. African Plate
5. Antartic Plate
6. Indo - Australian. Plate
7. South American Plate

HOW THE EARTH MAINTAINS ITS TEMPERATURE :-

1. The Sun gives heat to the Earth.
2. The atmosphere traps some heat using gases like CO_2 — this is called greenhouse effect.
3. Clouds & ice reflects some heat back into space, keeping Earth cool.
4. Oceans & forests absorb heat & help balance the temperature.
5. This systems helps Earth stay neither too hot nor too cold for living things.

SLO QNA:-

Q1: Describe the movement of tectonic plates?

Q2: Major techtonic plate sites?

Q3: How does Earth trap heat??

THE END !! <33 :D