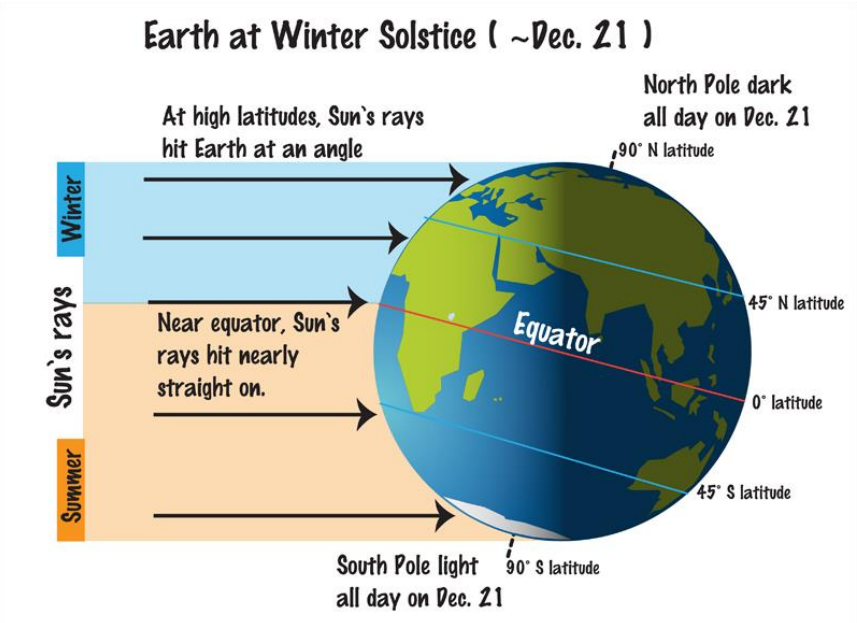
WEATHER AND CLIMATE	
Weather	Condition of atmosphere of a particular place and specific time
Climate	Average condition of atmosphere of a particular place over a long period of time
C.L.A.P factors (influencing temperature)	
Cloud cover	GENERAL IDEA: **Day with cloud cover: cooler → Night with cloud cover: warmer** **Day with no cloud cover: warmer → Night with no cloud cover: cooler** • Cloud cover **acts as shield**, deflecting away incoming insolation in the day • Cloud cover **acts as a blanket** in the night, trapping outgoing solar radiation, **retaining heat** at night. • At night when there is no cloud cover, the warm generated in the day is allowed to be re-radiated back into space, resulting in lower temperature. Example: **Sahara Desert** with not much cloud cover.
Latitude	GENERAL IDEA: **Nearer the equator: higher temperature** **Further from equator: lower temperature** • At lower latitude, **distance away from the sun** is shorter, thus **angle of incidence** of Sun's rays and the **concentration of heat over the area** on Earth's surface are greater, resulting in less **solar energy being lost to space**. This is due to the **curvature of Earth on its axis** and the **titillation of the Earth**, resulting in higher temperature. NOTE: *Singapore is near the equator, thus it experiences negligible temperature difference. Places further away from the equator like China will experience higher temperature in June (summer) as the earth tilts in a way that more sun's rays hit towards China.* 

Altitude	GENERAL IDEA: **Higher altitude: lower temperature** • Lesser air particles at higher altitude to trap heat as air particles move to Earth's surface due to gravity • Longer time for longwave radiation to reach higher altitudes and conduct warmth, thus lower temperature. Example: **Genting Highlands** vs **City area in Kuala Lumpur**
Proximity to Sea	GENERAL IDEA: **Nearer to water bodies: warmer temperature (small temp range)** **In land area: heats and cools faster than sea (large temp range)** • **Sea has higher specific heat capacity**, thus requiring more heat energy to raise the temperature by 1℃ • **Sea heats and cools slower than land** • Due to the difference in temperature, there is an exchange of air at coastal area, leading to **moderating effect** • Inland areas experience **continental effect** • Sea experience **maritime influence** • In the day, inland area has a higher temperature than coastal area / water bodies.

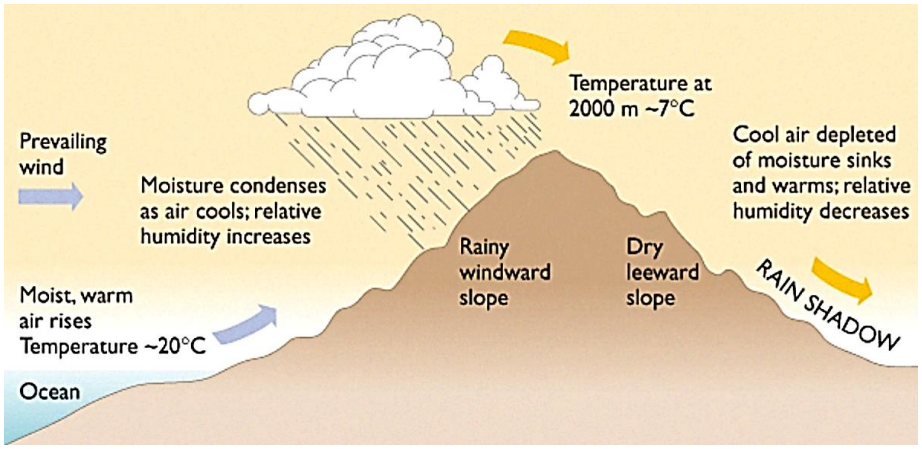
CONVECTIONAL RAINFALL

- Sun's rays heat up the Earth's surface
- Air expands and rises, carrying moisture within them
- Temperature drops at higher altitudes and air cools to dew point temperature
- Condensation occurs and clouds are formed,
- Rain falls

RELIEF / OROGRAPHIC RAINFALL

- Insolation heats up sea, evaporation occurs, water vapour forms
- Huge mass of moist warm air forms above sea
- Prevailing wind pushes air towards land, forced to rise against obstacles (mountain)
- At higher altitude, temperature is lower, dew point is met and hence
- Condensation occurs and form clouds from water droplets
- Too heavy to hold, falls as rain over windward side of mountain
- At leeward side, little moisture left thus air is dry

NOTE: Windward side has moisture and rainfall; Leeward side is dry and no rainfall



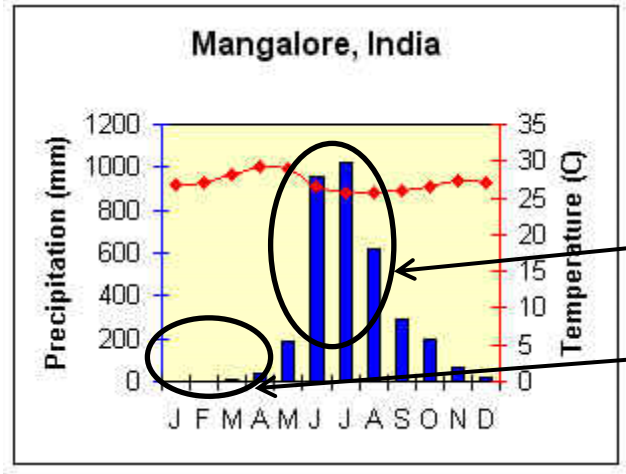
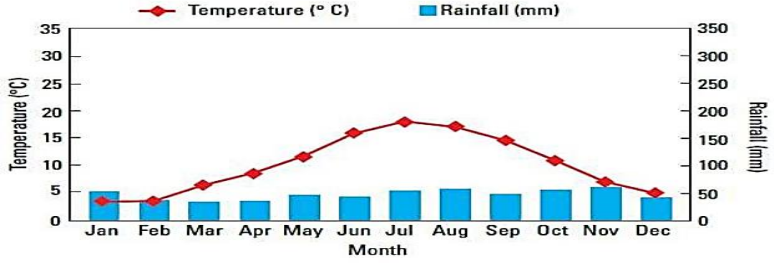
Natural / Physical Causes (of climate change)	
Climate Change	Refers to substantial change in state of the climate that can be identified by change in variability of atmospheric conditions and that persists for an extended period of time, typically decades or longer
Solar Variations in solar output	• Magnetic activity of Sun has a cycle that lasts for 11 years • Sunspots from Sun increase when solar activity is high as areas surrounding the sunspots radiate more energy which compensate for lower temperatures of sunspot areas
Volcanic eruptions [O level 2017]	• Gradual reduction in amount of sunlight reaching Earth's surface • Sulfur dioxide reacts with water vapour and other chemicals to form sulfur-based particles • Dust particles from eruption form condensation nuclei, creating more cloud cover • Dust and ash reflect away incoming solar radiation back to space • Lesser incoming solar radiation, lower temperature, global dimming occurs •
Earth's orbital changes	• Earth's orbit around the sun is elliptical, not perfectly circular. • The earth makes one full orbit around the sun each year. Changes in the tilt of the earth can lead to small but climatically important changes in the strength of the seasons over tens of thousands of years. • More tilt means warmer summers and colder winters; less tilt means cooler summers and milder winters. • Therefore, leading to climate change.
Unnatural / Human Causes (of climate change)	
Burning of fossil fuels	• Fossil fuels are formed from decomposition of dead organic matter over millions of years which contain carbon • Combustion of fossil fuels can release huge concentration of CO2, trapping heat and leading to enhanced greenhouse effect and global warming
Deforestation	• Loss of forests due to removal of trees • Forests are natural carbon sinks • Forest absorbs CO2 and releases O2 but deforestation leads to less intake of CO2 and increasing concentration of CO2 • Carbon oxidation is where carbon in soil reacts with O2 in atmosphere to form CO2 • Deforestation exposes soil to sunlight, increasing temperature of soil and rate of carbon oxidation • Releasing more CO2 that traps heat and lead to global warming Example: Honduras with 37% of deforestation in 1990-2005.
Agriculture	• Greater demand for food • Intensification of food production leads to cattle ranching • Releases millions of tonnes of methane annually from cattle's digestive system • Methane is a greenhouse gas that traps heat and leads to global warming

Industries	• Refer to production of goods and services within a country • Rice cultivation requires use of machineries such as tractors running on fossil fuels, producing CO2. In China, use of inorganic fertilisers increases amount of nitrous oxide in soil which is released when soil is ploughed or when rain flows through soil

SEA BREEZE

- Blows from sea to land in the day
- Differences in air pressure
- Sea heats up and cools slower than land
- Land has higher temperature and lower pressure while sea has lower temperature and high pressure
- Pressure moves from high to low

NOTE: Land breeze has the opposite concept and occurs at night.

Monsoon winds	• At northern hemisphere → wind deflect to right • At southern hemisphere → wind deflect to left • Due to coriolis effect, wind picks up moisture and dissipates
Tropical Equatorial climate [O level 2017]	• Small temperature range / similar temperature all year round • Located near equator • Dominantly convectional rain with large cloud
Tropical Monsoon climate [O level 2017]	• High temperature, small annual range • High rainfall and high humidity all year round but distinct wet and dry seasons  *Distinct wet season at June* Distinct dry season at January Conclusion: Located at northern hemisphere
Cool temperature climate (Marine west coast)	• Large temperature range • Rainfall evenly distributed but total annual rainfall lower than in places with equatorial and monsoon climates. 

Impacts of climate change	
Sea level rise	• Increase in mean height of sea's surface between high and low tide relative to land • Increase temperature in atmosphere, causing water bodies to expand and melting of ice shelves, adding meltwater to sea • Threatening low-lying areas and islands submerged in water • Increases risk of damage to homes and buildings and disintegration of communities • Affects and contaminates coastal aquifers (groundwater) and agricultural soil • Seawater inundation (surface flow of seawater onto unconfined aquifers) and seawater intrusion occur where salt water encroach through subsurface, threatening freshwater supply to farmers Example: Maldives 1880 reported to have 8 inches of flood
Frequent extreme weather events	• Results in significant economic losses and loss of lives • Hotter days and stronger hurricanes • More money needed to monitor and predict extreme weather events and rebuilding after Example: Europe 2015 suffered a severe drought in summer with high heat, causing soils and plants to dry out, leading to spread of wildfires and agricultural and hydropower production reduced
Spread of infectious insect-borne diseases	• Increased rainfall and temperature are favourable for breeding of mosquitoes • Greater chance of spreading malaria and dengue fever, causing income loss due to loss of work hours, affecting productivity and increase in public health expenditure • Social impact as cost due to medical and healthcare bills are expensive • Economic impact as strain of financial resources on healthcare Example: healthcare in Singapore costs $220 million in 2007 due to dengue fever.
Lengthening of growing season in certain regions	• Higher temperatures lead to longer growing seasons for some regions • Advantage is that higher latitudes are that cold regions are now warmer, more conducive for crop growth • Increase in types of crops grown such as potatoes and wheat in Canada • Farmers can earn more income as crop yields increase • Disadvantage is that lower latitudes are that warmer regions are now hotter and less conducive for crop growth, causing food shortage and hence, malnutrition. Example: Apples and cherries production in Yunnan is reduced as they need cool conditions.
Responses / Strategies to climate change	
INTERNATIONAL MEASURES [O level 2017]	
Kyoto Protocol	• Linked to United Nations framework convention on climate change in 1997 • Different countries have different targets to hit and progress of carbon emissions will be tracked and reported for review

	Success: • Greece and finland met or exceeded targets • Creates platforms for LDCs and DCs to collaborate to encourage sustainable carbon reduction development Example: CDM (Clean Development Mechanism) / Carbon Credits Trading Scheme / Tianjin Dagang Mapengkou Wind Power Project that uses cleaner source of energy via wind Limitations: • Countries like Denmark and Sweden didn't meet targets and not all countries have same targets • Not compulsory and not many countries like China signed up and contributed • Countries who didn't sign up contribute to greater carbon emissions • Countries are not restricted to withdraw from the protocol Example: Canada and Australia withdrawn from Kyoto Protocol in 2011 and 2014 respectively
Copenhagon Conference	• Held in Denmark, 2009. Hosted to build upon measures developed in previous conferences for addressing climate change • Engages with heads of government in the topic of climate problems. Success: • Sets tangible and realistic targets • Allows countries to discuss measures to deal with climate change effectively, including improvements to CDM (Clean Development Mechanism) Limitations: • Lacks of concrete plans on how to reduce greenhouse gases • Countries did not agree on how to reduce greenhouse gases • Not adopted by all countries. No countries will be punished if they do not fulfil their pledges Example: 8 countries didn't engage with the accord and represents 2.09% of global emissions.
NATIONAL MEASURES [O level 2017]	
Green Plan 2012	• Launched in 2002 by Ministry of Environment to reduce greenhouse gases by using natural gas as energy source • To generate 60% of local energy with natural gas by 2012 • Success is that by 2010, 79% of local electricity was generated from natural gas, exceeding target ahead of schedule Limitations: • High maintenance costs as pipelines are laid underground and requires regular checks for leakage • Complex treatment plants needed to process and transport natural gas
Green Mark Scheme	• Launched by Building Construction Authority in 2005 to evaluate and certify buildings according to how energy efficient and environmentally friendly they are • To encourage more green buildings that run partly on solar energy • Buildings which are energy efficient use less energy provide the same service with lesser energy

	• Success is that some green buildings are National Library Board and Plaza by the Park • These buildings have been reported to have 15% to 35% of energy savings compared to conventional buildings • This cuts down greenhouse gas emissions by reducing the use of fossil fuels to generate electricity Limitations: • Costly as green materials are expensive • Construction companies are too conservation to adopt new ideas and materials to build green buildings
Plant-A-Tree Programme	• Launched in 1971 as Tree Planting Day by the Garden City Fund and Singapore Environmental Council • Residents are encouraged to donate money to buy a tree or take part in tree planting events that occur monthly throughout Singapore • Success is that the programme has contributed to an estimated 60000 trees being planted yearly as reported by the National Parks Board • Trees are carbon sinks that reduce carbon dioxide levels in atmosphere Limitations: • Takes many years for trees to mature and effect is not immediate • For example. Trees such as angsana and raintrees that 25 years to reach their full height • With growing demand for land for human activities and commercial purposes, the sustainability of such programmes in the long run is being questioned
WEATHER AND CLIMATE FIELDWORK: WEATHER INSTRUMENTS	
Maximum-minimum thermometer OR Six's thermometer [Note: Temperature is drawn as line graphs]  	HOW TO CARRY OUT: MEASURE TEMPERATURE • Read the temperature every 24 hours • Read the maximum and minimum temperatures from the bottom of metal indices • Read at eye level • (use magnet) reset the indices ENSURING ACCURACY: • Stevenson screen is used for storing the thermometer. Must be above 1.2m to prevent excessive absorption of heat radiated from the ground • Stevenson screen is white as it is a poor absorber of infrared radiation • Stevenson screen has louvers to allow air circulation BENEFITS OF DIGITAL MAX-MIN THERMOMETER: • Easy to read / convenient to read or use • Instant measurement / quick / saves times • Portable / easy to carry • Accurate / gives decimal point reading / exact / precise • Robust / strong / won't break easily • Easy to reset
SLING PSYCHROMETER OR Wet and dry bulb thermometer OR Hygrometer	HOW TO CARRY OUT: MEASURE RELATIVE HUMIDITY • Identify suitable location • Swing psychrometer for 1 minute • Record wet and dry bulb reading • Calculate difference and identify relative humidity using humidity table • Total of 3 intervals in a day, preferably in morning, afternoon and night ENSURING ACCURACY: [O level 2017]

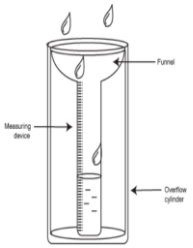
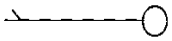
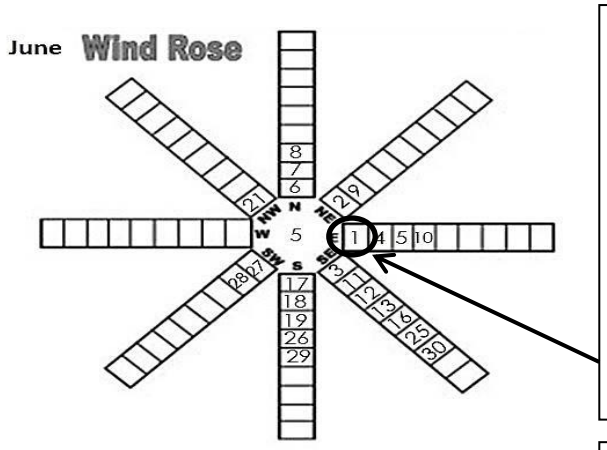
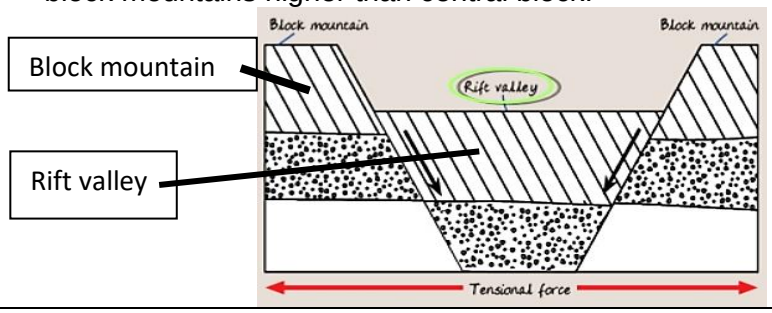
[Note: Relative Humidity is drawn as line graphs]	• Ensure that only distilled water is used for the container for the wick for wet bulb • As any impurities can affect rate of evaporation, affecting accuracy • Never touch wick with oily hands as impurities or oil can affect rate of evaporation • Stretch out at arm's length before start to prevent excessive radiation of heat from body to the instrument
RAIN GAUGE [Note: Rainfall in diagrams are drawn as bar graphs] 	HOW TO CARRY OUT MEASURE RAINFALL • Identify suitable location. Place rain gauge sunken 1/3 into the ground • Record start of placing, return and record reading after 24 hours • Empty container after use ENSURING ACCURACY: • Place rain gauge away from buildings or trees to prevent excessive collection of rainfall due to leaf drip • Do not place on concrete ground to prevent excessive collection of rainfall as water droplets rebounce into the rain gauge • Use appropriate material such as copper for the casing to prevent excessive conduction of heat, causing loss of rainfall collected due to evaporation
ANEMOMETER [Symbol of wind speed is known as wind barbs as shown below] 	HOW TO CARRY OUT: MEASURE WIND SPEED • Place at high grounds, unobstructed by buildings or physical barriers • Has cups / spoons that revolve in the wind • Connected to meter which counts number of revolutions per minute • Record wind speeds at different timing over a day from screen • Calculate average wind speed
WIND VANE [Represented by a wind rose] 	HOW TO CARRY OUT: MEASURE WIND DIRECTION • Arrow points the direction the wind is coming from • Horse provides large surface area to catch the wind • Compass N, S, E, W to allow direction to be worked out  The circle in the wind rose (middle) represents the number of days that has no wind. The numbers show the wind direction at certain days in June. For example, the wind direction for 1st June is in the East.
Barometer 	HOW TO CARRY OUT MEASURE AIR PRESSURE • Identify suitable location and read off at appropriate intervals • Remember to adjust the knob of the movable pointer to coincide with current reading of the measuring hand as a form of reset ENSURING ACCURACY: • Parallex error • Damage of intended vacuum within the barometer

PLATE TECTONICS	
Divergent Plate Movement	**Constructive plate boundary** • Magma cools and spreads, dragging along plates and move away from each other
Convergent Plate Movement	**Destructive plate boundary** • Magma cools and sinks, pulling the plates along, moving towards each other
Transform Plate Movement	**Strike-slip fault** **Conservative plate boundary** • Plates move past one another at opposite directions
Slap-pull force	Oceanic plate subducts less dense plate
Ridge push	Cooling rocks exert force on spreading lithosphere plats, helping to drive their movements.
DIVERGENT OCEANIC – OCEANIC	
Landforms: **1.** Mid-oceanic ridge (eg *mid-Atlantic ridge*) **2.** Volcanic islands	• **Tensional force** on oceanic crust, forming faultlines • Magma rises from mantle layer, cools and solidifies and **fills faultlines** • Forms new seafloor known as **seafloor spreading** • Magma rises at **spreading zone** to form a new mid-oceanic ridge
DIVERGENT CONTINENTAL – CONTINENTAL	
Landforms: **1.** Rift valley (eg *Great rift valley at East Africa*) **2.** Block mountains	• **Tensional force** on continental plates results in **breakup of continents**. • **Rocks are displaced**, **steep sides are formed along faultlines**. • Rising convection currents drag lithosphere apart, forming normal faults • Drop in central block or parts of crust will sink in relation to the adjacent highlands, forming rift valley. • Block mountain is a **block of land with steep sides**. It is formed when **sections of crust extend along fault lines** and **rock masses surrounding a central block sink due to tensional forces**, leaving block mountains higher than central block. 
CONVERGENT OCEANIC – OCEANIC	
Landforms: **1.** A chain of arc of	• Plates converge by **slab-pull force** • Subduction of denser oceanic plate under less dense continental plate • **Subduction zone forms deep oceanic trench**

islands **2.** Deep oceanic trench **3.** Volcanoes	• Subduction of oceanic plate causes **solid mantle material to melt** and form magma, rising through faultlines, cools and solidifies to form volcanoes eg *mariana trench from Phillipines and Pacific plates*

CONVERGENT CONTINENTAL – CONTINENTAL [O level 2017]

Landforms: **1.** Fold mountains	• Plates converge by **slab-pull force** • Due to **similar densities**, continental plates **do not subduct** each other • They experience **compressional force** • **Buckle and fold** to form fold mountains eg *Himalayas mountain from Eurasian and Indian plates*

CONVERGENT OCEANIC – CONTINENTAL [O level 2017]

Landforms: **1.** Fold mountains **2.** Deep oceanic trench **3.** Volcanoes	• Plates converge by **slab-pull force** • Subduction of denser oceanic plate under less dense continental plate • **Subduction zone forms deep oceanic trench** • Subduction of oceanic plate causes **solid mantle material to melt** and form magma, rising through faultlines, cools and solidifies to form volcanoes • Continental plate experiences **compressional force**, **buckles and folds** to form fold mountains.

Features to describe landforms

- Upfold / Anticline
- Downfold / Syncline
- Uneven slopes
- Pyramid peaks
- Deep valleys
- …etc

VOLCANOES FORMATION

Shield Volcano	• Occurs when rising magma seeps into mantle layer through faultlines • Accumulating a reservoir of volcanic materials, forming magma chamber • Kept under immense pressure, magma rises to surface through vent • Magma forced to release when pressure is released • Violent eruption of magma occurs • Successive layers of lava cools and solidifies, forming a volcano.
Stratovolcano	• Occurs when rising magma seeps into mantle layer through faultlines • Accumulating a reservoir of volcanic materials, forming magma chamber • Kept under immense pressure, magma rises to surface through vent • Magma forced to release when pressure is released • Violent eruption of magma occurs • Successive layers of lava cools and solidifies, forming a volcano. • Due to nature of lava being high silica content and high viscosity, viscous lava blocks central pipe, preventing magma and trapping gases from escaping. Pyroclastic materials settle and form alternating layers. • Crater is blocked, magma has to escape via secondary cones and secondary vents.

	• Pressure builds up and when pressure is released, there is a volcanic eruption of ash and cinders, forming a stratovolcano.
Differences between shield and strato volcanoes	

Shield	Strato
Low viscosity	High viscosity
Low silica content	High silica content
One conical shape vent	Secondary cones and vents
Wide base	Narrow base
Gentle slope / gradient	Steep slope / gradient
Lower in height	Taller in height

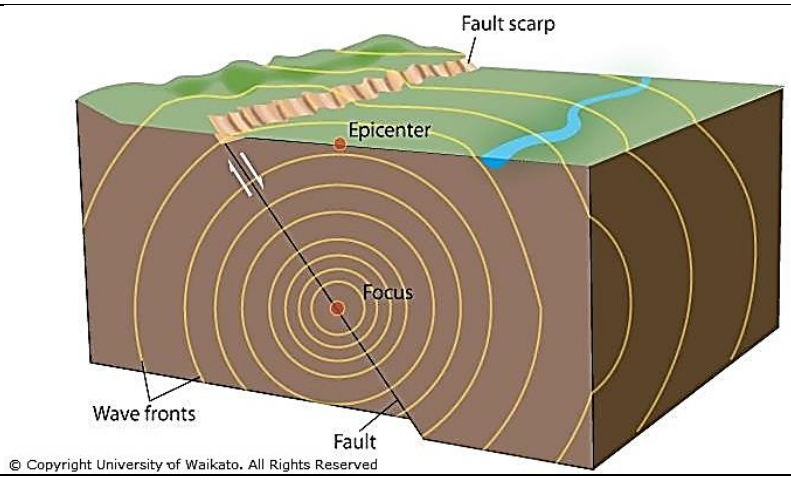
IMPACTS OF LIVING NEAR VOLCANOES [O level 2017]

BENEFITS	
Fertile volcanic soil	• Shortens fallow period • Used for farming or agriculture • Saves costs from fertilisers, higher productivity of food
Precious stones and minerals	• Lava and materials from pyroclastic flow are weathered to form medicine (health) • Employment generated for both mining and health sectors Example: extracting sulfur from Ijen volcano in East Java, Indonesia
Tourism	• More people will be engaged in activities like camp / hiking • People engage in such activities to get away from the hectic lives
Geothermal energy	• Obtained from heat in Earth's crust • When groundwater from precipitation comes into contact with hot rocks beneath the surface, water heats up, expands and erupts as steam • Escaping through bore holes and energy from steam drives turbines for electricity
RISKS	
Destruction of properties	• Buildings and roads destroyed by lava and pyroclastic flows • Buildings collapse when enough ash falls on them • Economic impact from loss of jobs and destroyed buildings • Social impact from loss of homes
Landslides	• Structural collapse of volcanic cone • Obstruct flow of rivers which causes flood • Destabilisation of water table, thus unstable ground causes landslides
Death toll	• High temperature of the lava kills people
Pollution	• Ash particles may block sunlight, affecting airline industries. Example: *When Eyjafjallajokull in Iceland erupted in April 2010, residents had to **wear masks** to prevent them breathing in the ash from the volcano. People living near it had to be **evacuated to shelters**. They tried to **seal their homes from the ash** and got their cattle inside to protect them. Much of European **air space was closed as the impacts on jet engines could lead to crashes**. This caused chaos as all flights within countries like England were cancelled and passengers were stranded. **It caused enormous disruption to air travel across Western and Northern Europe for (about) 6 days.***

	• Suffocate crops and cause severe respiratory problems • Release harmful gases like sulfur dioxide that dissolves in rainwater which leads to acid rain
Effects on weather	• Sulfur dioxide reacts with water vapour and other chemicals in atmosphere to form sulfur-based particles which reflect Sun's heat back into space • Causing global dimming and possibly food shortage Example: Mount Pinatubo cools the Earth's surface by 1.3 degree Celsius by releasing 20 million tonnes of sulfur dioxide.

EARTHQUAKES

- Plates encounter jam-locked situation
- Building up immense energy
- Plates jerk free, thus there is a sudden release of energy, producing earthquakes
- Sending seismic waves and strong tremors

Earthquakes	Vibration in earth's crust caused by sudden release of stored energy in the rocks along fault lines [Measured by a Richter scale of magnitude]
Focus	Point of sudden energy released by earthquakes
Labelling of earthquakes	

Detecting earthquakes by a seismometer

Seismometer	• Placed at mountainous areas or region among rocks • Sensitive and picks up tectonic activities • Transmit information to relevant authorities to respond evacuation • Lowers death toll • However, landslides may occur instead of earthquakes, sending false signals / alarms.

DAMAGES / IMPACTS OF EARTHQUAKES

DAMAGES / IMPACTS	
Disruption of services	• Disrupt supply of electricity, gas and water Example: Kobe Japan, 1995 which affected 1.4 million residents due to disrupted supply of electricity, gas and water
Loss of lives	• Buildings collapse and kill people • Falling objects obstruct emergency services, slowing down rescues, causing higher death toll

Destruction of properties	• Violent vibration causes buildings to fall and collapse, causing economic loss. • People may be jobless or homeless and die from potential dangers
Landslides	• Resulted from liquefaction when vibrations from earthquake causes • Watertable to be destabilised • Unsaturated soil to flow like liquid • Ground becomes unstable and causes landslides Example: Mexico City in 1995
Destruction of infrastructure	• Cracks in infrastructure like roads and bridges • Unsafe and accentuate / delay rescue efforts • Increasing death toll
Fires	• Ruptures gas pipes • Provides fuel to start a fire Example: Kobe Japan in 1995
Tsunamis [O level 2017]	• Seismic waves to seabeds, resulting in displacement of large water mass • Seabeds create huge waves to radiate violently from epicentre • When shallow, wave increases in size but at high speed • Wave gets bigger as water piles up behind it • When reaching shore, due to greater friction, waves are forced to slow down but increase in height • Sea often recedes from its shore, as water rushes to fill the void caused by movement of seafloor before tsunami hits • When tsunami hits, waves are taller but have slowed down significantly Example: 2004 Indian Ocean tsunami kills 230000 people, 1.7million lost homes
Severity / Extent of Earthquake	
SEVERITY / EXTENT	
Proximity to epicentre	• More damage from shockwaves • Stronger tremors Example: Christchurch, New Zealand in 2011
Population density	• Higher death toll in populated areas
Level of preparedness	• DCs usually more prepared • Have evacuation plans, trained and professional rescue workers • Have emergency drills and quake-resistant buildings • Have better economic means to reduce severity Example: Japan students are taught to practise earthquake drills under tables during warning systems.
Type of soil	• Softer soil, stronger earthquakes • Amplify effects of earthquakes
Magnitude	• Stronger magnitude, stronger tremors and stronger shockwaves

	Example: Haiti Earthquake in January 2010, Japan has a 13km of focus and 7.2 magnitude, killing 230,000 people, affecting 3 million people.
Depth of focus	• Shallow depth results in stronger tremors Example: Haiti Earthquake in January 2010, Japan has a 13km of focus and 7.2 magnitude, killing 230,000 people, affecting 3 million people.
Time of day	• Affects people's chances of survival • Insufficient time to escape and trapped in houses when sleeping at night • Caught off guard and less prepared at night compared to in the day when people are out for school or work
MEASURES TO MINIMISE DAMAGE	
Building design	• Shear walls to reduce effect of earthquakes • Buildings with shock absorbers • Walls strengthened by cross-bracing methods • Quake-proof and base isolation made of rubber or cushion dampens vibrations • Reducing collapse of buildings with steel and reinforced concrete Limitations: • Costly; for example: San Francisco Transamerica pyramid costs $75 millions • May not withstand greater magnitude as predicted
Infrastructure development	• Infrastructure can be strengthened by wrapping steel frames round pillars and bridges and placing steel rods in existing structures • Minimise death toll and people would not be buried under fallen debris • Smooth emergency Limitations: • Costly • Water pipes can be ruptured, affecting cleanwater suppy For example: Christchurch New Zealand, 2011: shortage of water supplies and contamination of water
Level of preparedness	• DCs usually more prepared • Have evacuation plans, trained and professional rescue workers • Have emergency drills and quake-resistant buildings • Have better economic means to reduce severity Example: Japan students are taught to practise earthquake drills under tables during warning systems.
Land use regulation	• Set of rules implement to restrict developments in certain areas • Infrastructure built further away from epicentre • Lowers death toll • Through legislature can effectively control land use in quake proof areas • Example: In California, USA, all new building developments are not built across fault lines or places risk of liquefaction. Limitations: • Costly and control of land use is difficult in places with slums and squatters

Emergency drills	• Familiarise people what to do in event of an earthquake • People are more vigilant and aware, reducing death toll • People will be more educated • Have technology such as seismometer to reduce death toll and provide and plan evacuation before earthquakes hits Limitations: • People may be complacent and not treat drills seriously • Earthquake may not occurred in the region for a very long time, thus people may not be serious • Technology can have its flaws, for instance, seismometer can send false signals when it picks tectonic activities such as landslides instead of earthquakes
RESPONSES TO MINIMISE DAMAGE	
SHORT – TERM RESPONSES	
Providing medical aid, food and water	• Minimise impacts such as famine • Help survivors cope with disaster to receive timely medical help Limitations: • May not be sufficient, countries may not have the economic means to provide extensive aid • May not be accessible to remote and mountainous areas Example: April 2015, Nepal (inaccessible by road and impossible for helicopters to land due to thick vegetation and steep terrain)
Emergency shelters	• Provide shelters for homeless • Effective as it is essential to house and protect victims from elements • For example: 2008, temporary tentages were sent to Sichuan quake hit zones Limitations: • May be subjected to cramped and unhygienic conditions which are not comfortable • For example, the 2010 January Haiti Earthquake results in lack of clean water due to cholera crisis which claims the lives of 6700 people being homeless in the quake • May be used as an excuse for governments to delay recovery in terms of rebuilding proper homes
Humanitarian aid	• Humanitarian assistance is aimed at providing rapid, life-saving support in settings of high population vulnerability, such as earthquake • Financial support to rebuild devastated areas • Experienced rescues teams can better manage and coordinate the rescue effort Example: In 2010, United Nations (UN) sent food supplies into Haiti after a devastating earthquake occurred. Limitations: • Complicated by severe access restrictions, large-scale emergency needs and displaced populations, and complex political and social settings

	• Aid might be looted • Difficulty reaching quake-hit regions • May be rejected due to political or social setting Example: Nepal rejected Taiwanese offer for 'search and rescue' teams in April 2015 earthquake as many suspected that the rejection is due to the awkward relationship between Taiwan and China.
Rescue and recovery	• To save people who are still trapped in buildings • Minimise death toll • Allow the country and people to return to normalcy and for economic activity to resume swiftly Limitations: • Only have limited time to save people • Disruption of infrastructure like roads and bridges can hamper access of rescue efforts • Limited resources hamper rescue efforts, especially LDCs Example: In April 2015, Nepal has only nine working helicopters.
LONG – TERM RESPONSES	
Provision of healthcare	• To help injured victims or psychologically disturbed victims restore their livelihoods • Essential to look after post-trauma incidence amongst survivors Limitations: • May be challenging if healthcare facilities are badly hit • Difficult to provide healthcare if these facilities are badly hit Example: April 2015, Nepal earthquake, World Health Organisation (WHO) estimated that 1059 health facilities damaged and 402 being completely damaged.
Infrastructure improvement	• Stricter building codes ensures higher safety levels • For example: The post-earthquake examination in Kobe, Japan 1995 saw that building codes can then be modified so that still-to-be constructed buildings will not include designs that are inadequate for earthquake resistance. Limitations: • Not fully protected from all hazards • May be resistant against tremors but not other weather elements such as storm surge from tsunamis Example: in 2011, Great Tohoku earthquake in Japan, Fukushima prefecture was badly hit by tsunami and nuclear meltdown instead
Compensation	• To allow victims to cope with losses and restore their livelihoods Limitations: • Insufficient funds by government • Meagre amount do little to help Example: Nepal's government would only pay US$1000 to the families of those who lost their lives in the earthquake, US$50 for every home that was destroyed and US$20 to every injured person

End