Chp 2 Gateway 1 – Different places experience different weather and climate

Subject content:

Learning Outcomes	Content	Main Terms
Key Question 1: Why do different places experience different weather and climate?		

Students will be able to:
• Differentiate between weather and climate
• Explain the daily and seasonal variations in temperature at a particular location
• Compare and explain the variations in temperature between different locations
	A) <u>Knowledge</u>
	• Definition of weather
	• Definition of climate
	• Elements of weather
	  – Temperature
	  – Relative humidity, clouds and rainfall
	  – Pressure and winds
	• Temperature
	  – Factors influencing the temperature of locations
	    ○ Latitude
	    ○ Altitude
	    ○ Distance from the sea
	    ○ Cloud cover
		• Weather
		• Climate
		• Weather elements
		• Temperature
		• Latitude
		• Altitude
		• Continental effect
		• Maritime effect
		• Cloud cover

• Explain the differences in relative humidity in different locations
• Explain the formation of convectional rain and relief rain
	• Relative humidity, clouds and rainfall
	  – Relative humidity
	  – Formation of rain
	    ○ Convectional rain
	    ○ Relief rain
		• Relative humidity
		• Evaporation
		• Condensation
		• Saturation
		• Clouds
		• Precipitation
		• Convectional rain
		• Relief rain

• Explain how coastal temperatures are moderated by land and sea breezes
• Explain the formation of monsoon winds
	• Pressure and winds
	  – Pressure and movement of air
	  – Wind systems
	    ○ Land and sea breezes
	    ○ Monsoon winds
		• Air pressure
		• Wind
		• Land breeze
		• Sea breeze
		• Coriolis effect
		• Deflection
		• Monsoon winds

<table>
<tr><th>Learning Outcomes</th><th>Content</th><th>Main Terms</th></tr>
<tr><td>Describe and explain the distribution and characteristics of equatorial, monsoon and cool temperate climates
Describe and explain the weather and climate of Singapore with reference to rainfall, relative humidity and temperature</td><td>Equatorial climate
Monsoon climate
Cool temperate climate: Marine west coast climate</td><td>Equatorial climate
Monsoon climate
Cool temperate climate
Marine west coast climate
Annual range
Diurnal range
Prevailing wind
Wind speed
Wind direction</td></tr>
<tr><td></td><td>B) <u>Skills</u>
Use of appropriate instruments to gather weather data
– Temperature
– Rainfall
– Air pressure
– Wind
– Relative humidity
Make calculations of the following weather data:
– Annual range
– Diurnal range
– Mean monthly
– Relative humidity
Use appropriate graphs and diagrams to present weather data</td><td></td></tr>
</table>

<u>Weather & climate</u>

Aspect	**Weather**	**Climate**
Definition	condition of atmosphere at <u>particular place & time</u> (day to day changes)	average condition of atmosphere of specific place over <u>long period of time</u> (30 years)
Difference	a point in time	long period of time

Elements of weather

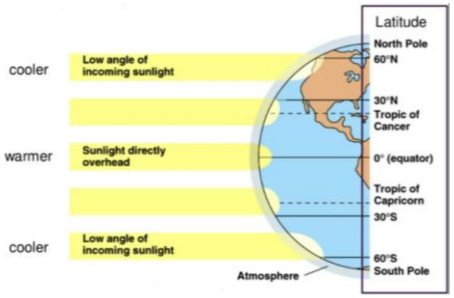
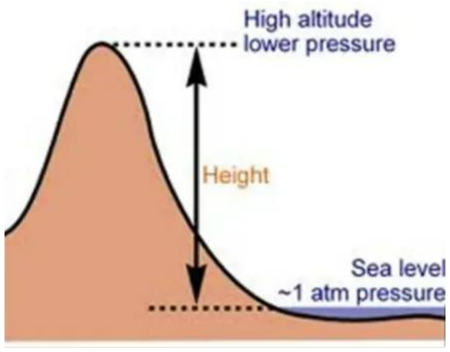
<u>Elements of weather:</u>

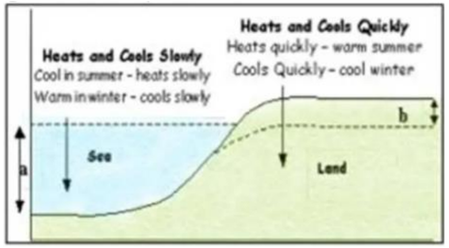
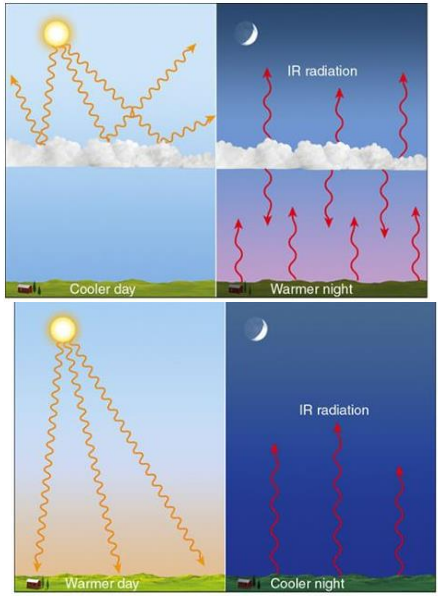
1. **Temperature**
2. **Relative humidity, clouds and rainfall**
3. **Pressure and winds**

<u>Temperature</u>

Factors affecting temperature:

1. **Latitude**
2. **Altitude**
3. **Distance from sea**
4. **Cloud cover**

<table>
<tr><th>Factor</th><th>Explanation</th><th colspan="2">Factor</th><th>Figure</th></tr>
<tr><td rowspan="2">1. Latitude</td><td rowspan="2">Latitude ↑ temperature ↓
● Earth tilts at angle of 23.5° on axis</td><td>Higher latitude</td><td>Lower latitude</td><td rowspan="2">
</td></tr>
<tr><td>● Lower solar angle
● Solar energy spread out over larger area</td><td>● High solar angle
● Solar energy concentrated on smaller area</td></tr>
<tr><td rowspan="2">2. Altitude</td><td rowspan="2">Altitude ↑ temperature ↓
● Temp decreases 6.5°C every 1000 m</td><td colspan="2">Higher altitude</td><td rowspan="2">
</td></tr>
<tr><td colspan="2">1) Radiation
● Shortwave radiation: heat up earth surface
● Longwave radiation: emitted by surface
● Air further away from surface → heat up later
2) Density of air
● Air less dense
● Lower ability to absorb heat from longwave radiation</td></tr>
</table>

3. **Distance from sea**	Distance ↑ : warm summer & cold winter Distance ↓ : cool summer & warm winter ● Land: gain & lose heat faster (lower *c*) ● Sea: gain & lose heat slower (higher *c*)	Coastal area	Inland area	
		Maritime effect	**Continental effect**	
		<u>Summer</u> Low summer temp ● Sea heat up slowly ● Sea remain cool	<u>Summer</u> High summer temp ● Land heat up quickly ● Land hot	
		<u>Winter</u> High winter temp ● Sea lose heat slowly ● Sea remain warm	<u>Winter</u> Low winter temp ● Land lose heat quickly ● Land cold	
4. **Cloud cover**		Tropical area	Desert area	
		High amount of cloud cover Smaller diurnal temp range	Low amount of cloud cover Large diurnal temp range	
		<u>Day</u> Air near surface: cool ● Cloud reflect sun energy back to space ● Cloud absorb heat radiated from surface	<u>Day</u> Air near surface: warm ● Large amt of sun energy reach earth ● Surface heat up quickly	
		<u>Night</u> Air near surface: warm ● Cloud absorb heat radiated from surface → X escape into space	<u>Night</u> Air near surface: cool ● Large amt of heat radiate from surface → escape into space	

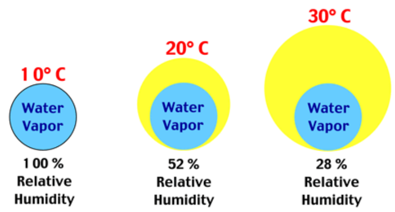
c: specific heat capacity

Relative humidity

Equation

$$\text{Relative humidity (\%)} = \frac{actual\ amount\ of\ water\ vapour\ in\ the\ air (g/m^3)}{maximum\ amount\ of\ water\ vapour\ the\ air\ can\ hold\ (g/m^3)} \times 100\%$$

Factors affecting RH:



Factor	Explanation	RH
1. **Amount of water vapour**	More water vapour present in fixed mass of air	↑
2. **Temperature**	Warm air hold more water vapour	↓

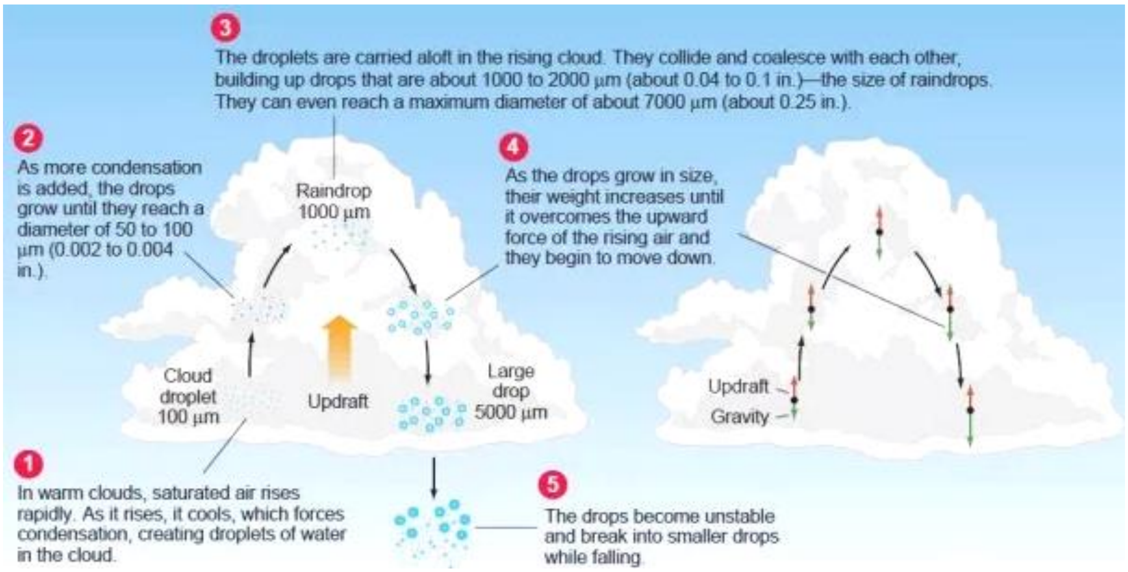
Saturation : Air hold max amt of water vapour, RH = 100%
Dew point temperature : temperature where saturation occurs
Condensation : water vapour → liquid (cooling), occur at dew point temperature

Rainfall

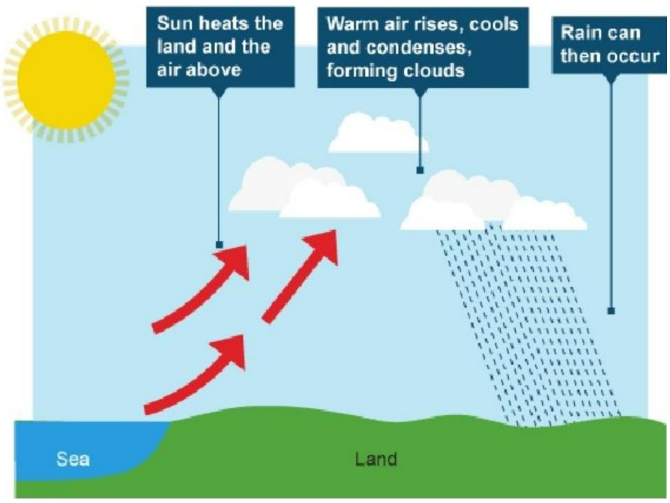
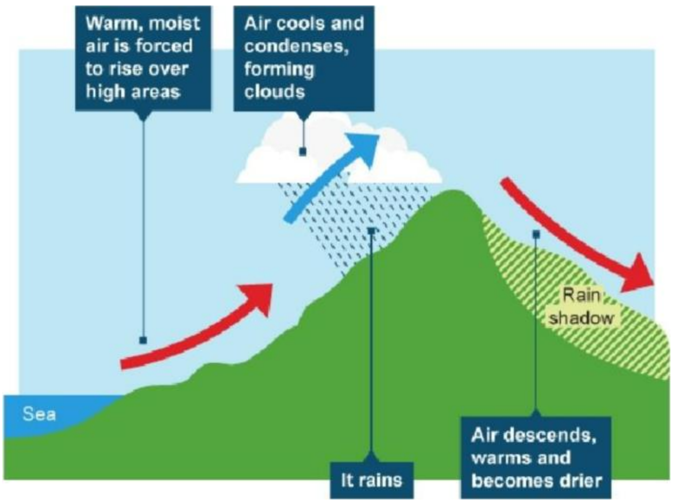
Cloud: visible mass of water droplets / ice crystals suspended in atm
→ due to condensation of water vapour

Precipitation: water in any form that falls from atm to surface
1. rain
2. hail (balls of ice)
3. snow (white / translucent ice crystals)
4. sleet (mixture of rain + snow)

Formation of rainfall
- Earth surface heated up, liquid water <u>evaporate</u> → water vapour
- Water vapour rise, cool to <u>dew point temperature</u>
- Water vapour <u>condense</u> on condensation nuclei (e.g. dust)
- Water droplets in air <u>coalesce</u> → clouds
- Water droplets grow large enough → fall to surface as precipitation



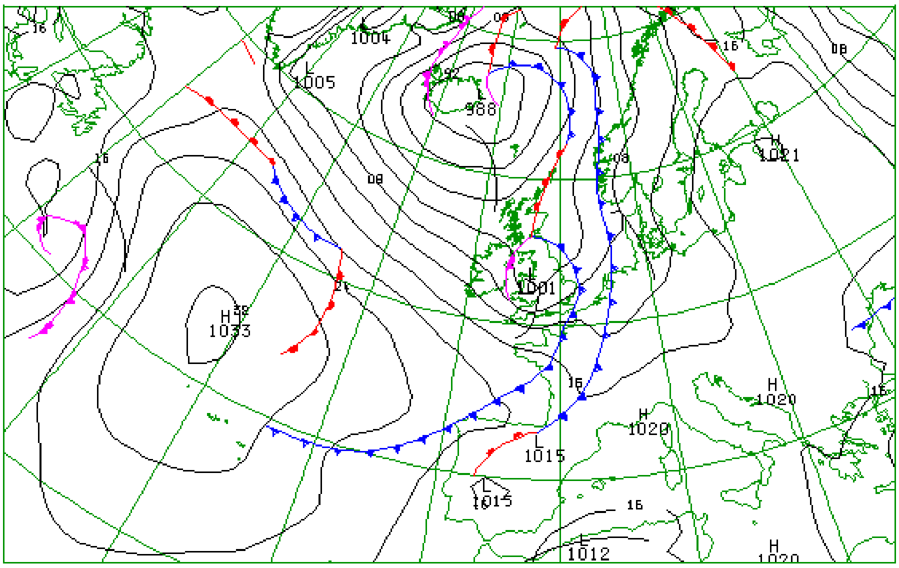
Types of rain:

Convectional rain	Relief rain
1. Sun energy heat up surface 2. Warm surface heat up air 3. Air become unstable → expand → rise → temp drop 4. Air cool to dew point temperature → condense 5. Water droplets coalesce → clouds 6. Saturation point reached + water droplets large enough: fall to ground as rain 7. Rain is short-lived but very intense and usually accompanied by lightning + thunder	1. Warm moist air pass over water body (sea) 2. Air rise up windward side of mountain → temp drop 3. Air cool to dew point temperature → condense → clouds 4. Water droplets large enough: fall as rain on windward side 5. Leeward side dry (most rain fall on windward side)
	

Air pressure

Air pressure: force exerted on unit area of surface by weight of column of air above it
Average sea level value of air pressure: 1013 millibars (mb)

Synoptic chart:



Altitude ↑ air pressure ↓
- air <u>less compressed</u> at high elevations (small overlying mass exert small gravitational force)
- air less dense at high altitude

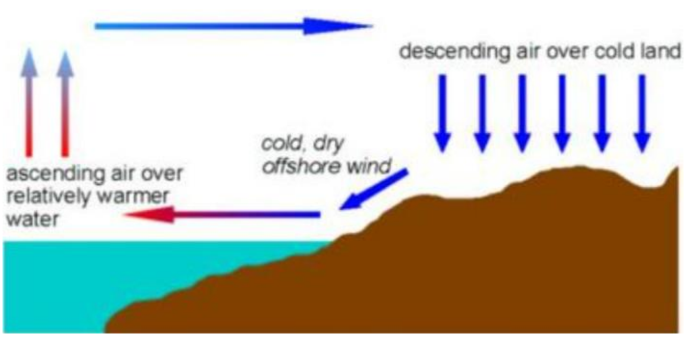
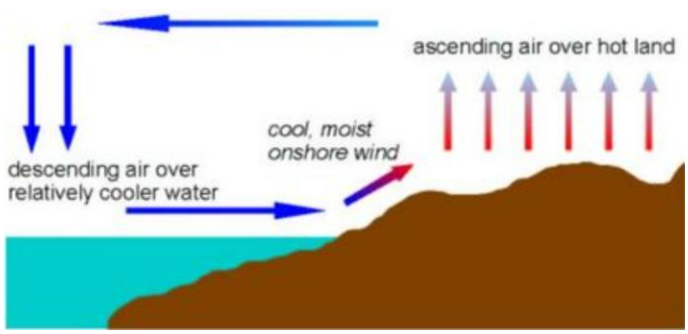
<u>Wind</u>

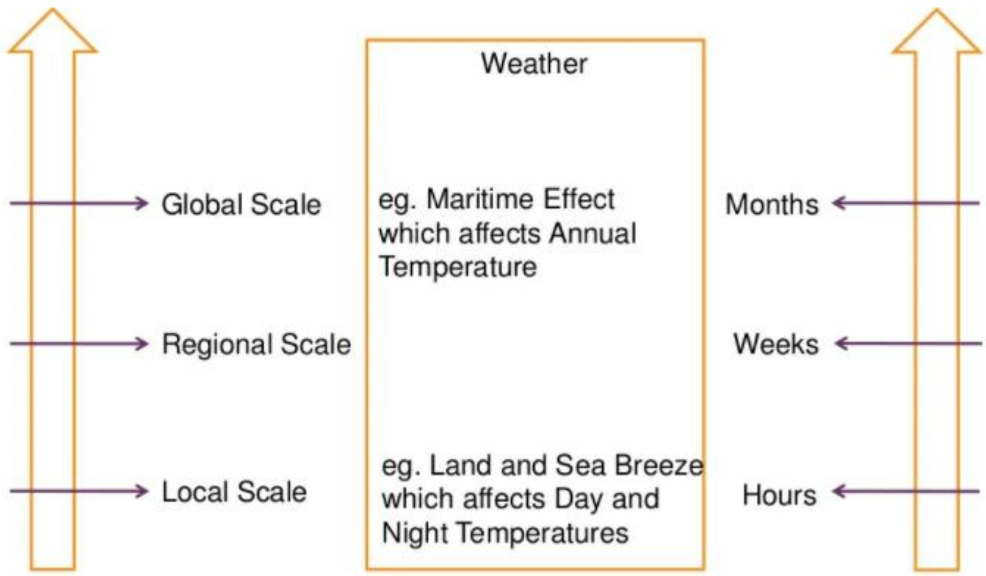
Wind: movement of air (high → low pressure)
Pressure gradient: difference in air pressure b/w 2 locations

Steeper pressure gradient, faster wind speed

<u>Wind systems</u>

Land & sea breezes (small-scale local winds occurring in coastal areas)

Land breeze (night)	**Sea breeze** (day)
L: Lose heat faster → cool → high pressure	L: Heat up faster → warm → low pressure
S: Lose heat slower → warm → low pressure	S: Heat up slower → cool → high pressure
Wind: high (land) → low (sea)	Wind: high (sea) → low (land)
	


Weather
Global Scale
eg. Maritime Effect which affects Annual Temperature
Months
Regional Scale
Weeks
Local Scale
eg. Land and Sea Breeze which affects Day and Night Temperatures
Hours

Monsoon winds: large-scale regional winds that change directions according to seasons (seasonal winds)

1. bring large amount of rain → <u>wet</u> season
2. bring small amount of rain → <u>dry</u> season

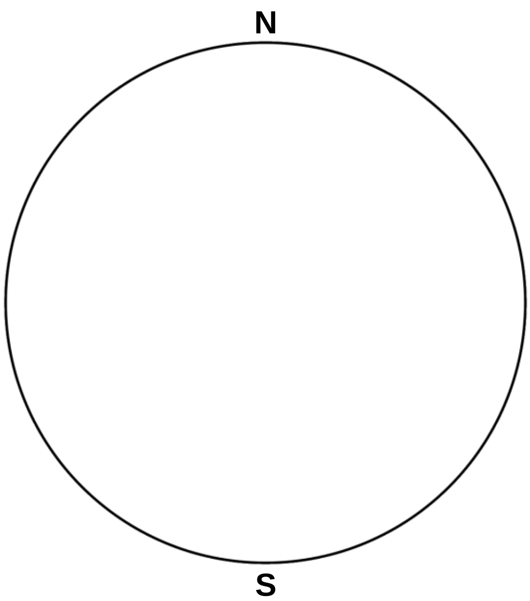
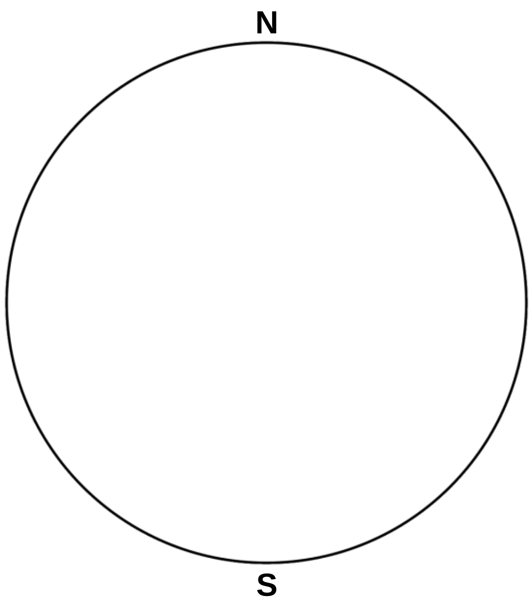
Coriolis effect: force produced when earth rotate in anti-clockwise direction

- Deflect & bend moving air (winds)
- Effect

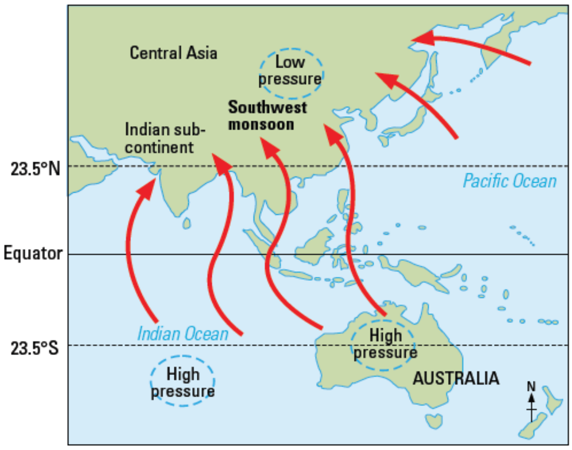
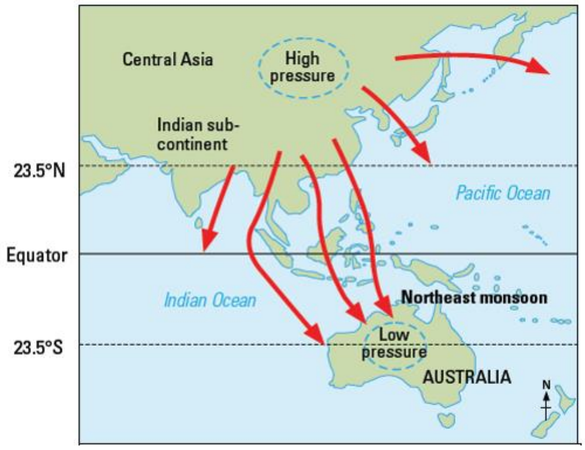
Area	Effect
poles	strongest
tropics	weak
equator	not discernible

Northern hemisphere: Central Asia
Southern hemisphere: Australia

- Monsoon winds

Months	10 ~ 2	6 ~ 9
Season	N: winter → cool → air more dense S: summer → hot → air less dense	N: summer → hot → air less dense S: winter → cool → air more dense
Direction	N → S	S → N
Globe		
Northern hemisphere	**Northeast** monsoon (deflected to right)	**Southwest** monsoon (deflected to right)
Southern hemisphere	Northwest monsoon (deflected to left)	Southeast monsoon (deflected to left)

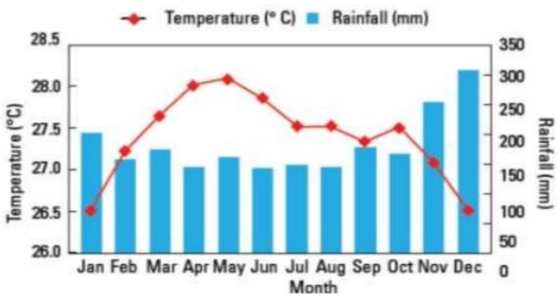
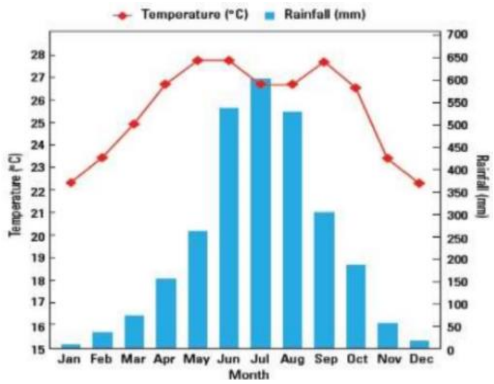
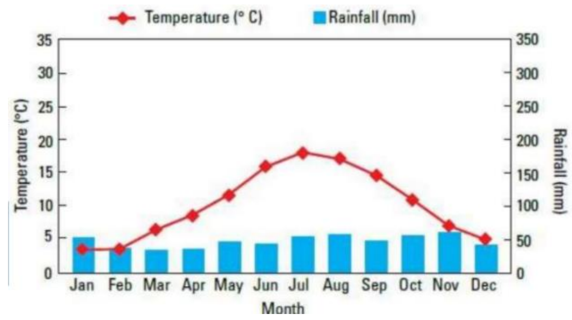
Monsoon winds

Aspect	**Southwest monsoon**	**Northeast monsoon**
Months	June ~ Sep	Oct ~ Feb
Process	**S** hemisphere: <u>winter</u> ● low temp → air cool down + shrink + sink → <u>denser</u> ● high pressure **N** hemisphere: <u>summer</u> ● high temp → air heat up + expand + rise → <u>less dense</u> ● low pressure	**N** hemisphere: <u>winter</u> ● low temp → air cool down + shrink + sink → <u>denser</u> ● high pressure **S** hemisphere: <u>summer</u> ● high temp → air heat up + expand + rise → <u>less dense</u> ● low pressure
	Air: **S** → **N** (difference in air pressure)	Air: **N** → **S** (difference in pressure)
	Wind cross Equator, Coriolis effect deflect wind → right	Wind cross Equator, Coriolis effect deflect wind → left
Figure		

Climatic types

Describe + explain characteristics of climate types:

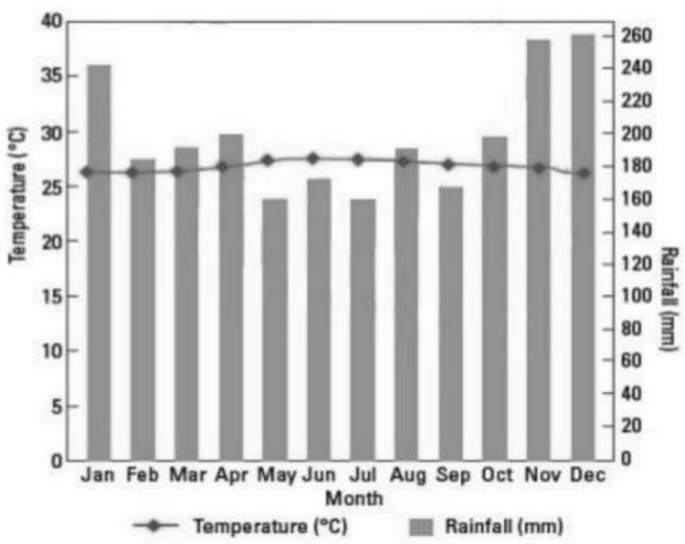
1. **Temperature**
2. **Annual temperature range**
3. **Total annual rainfall / precipitation**
4. **Distribution of rainfall / precipitation**

Aspect	**Equatorial** climate	**Monsoon** climate	**Cool temperate** climate (Marine west coast climate)
Distribution	Between **<u>10</u>**°N and S of equator ● Singapore ● Johor (Malaysia)	Between **<u>5 ~ 25</u>**°N and S of equator ● Mumbai (India) ● Chittagong (Bangladesh)	Between **<u>40 ~ 60</u>**°N and S of equator ● London (UK) ● Vancouver (Canada)
Climograph			
1. **Mean annual temp**	**<u>High</u>** Low latitude	**<u>High</u>** Relatively low latitude	**<u>Moderate</u>** High latitude 4 distinct seasons → tilt of earth + revolution around sun
2. **Annual temp**	**<u>Small</u>**	**<u>Small</u>**	**<u>Large</u>**

range	2 ~ 3°C	6°C Hot season: high temp (midday sun overhead at Tropic of Cancer) Cool season: low temp	25°C Distance from sea: maritime effect → mild winter + cool summer
3. **Annual rainfall**	**<u>High</u>** > 2000 mm High temp: high evaporation rate → high rainfall → more convectional rain	**<u>High</u>** > 2000 mm Monsoon winds: bring heavy rain during wet season	**<u>Low</u>** 300 ~ 900 mm Low temp: low evaporation rate → low rainfall → less convectional rain
4. **Rainfall distribution**	**<u>Evenly distributed</u>** No distinct wet or dry seasons ● NE monsoon: bring more rain → wet (pick up moisture when crossing South China sea) [Nov – Jan]	**<u>Unevenly distributed</u>** Distinct wet and dry seasons ● NE monsoon: bring less rain → dry [Oct – May] ● SW monsoon: bring heavy rain → wet (pick up moisture when crossing Indian Ocean) [June – Sept]	**<u>Evenly distributed</u>** No distinct wet or dry seasons ● X influenced by monsoon patterns

<u>How to describe climographs</u>

Refer to the climograph of Singapore below.



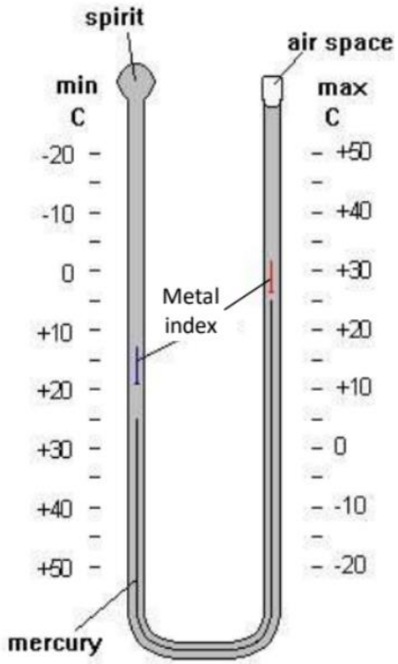
(a) Describe the temperature in Singapore.

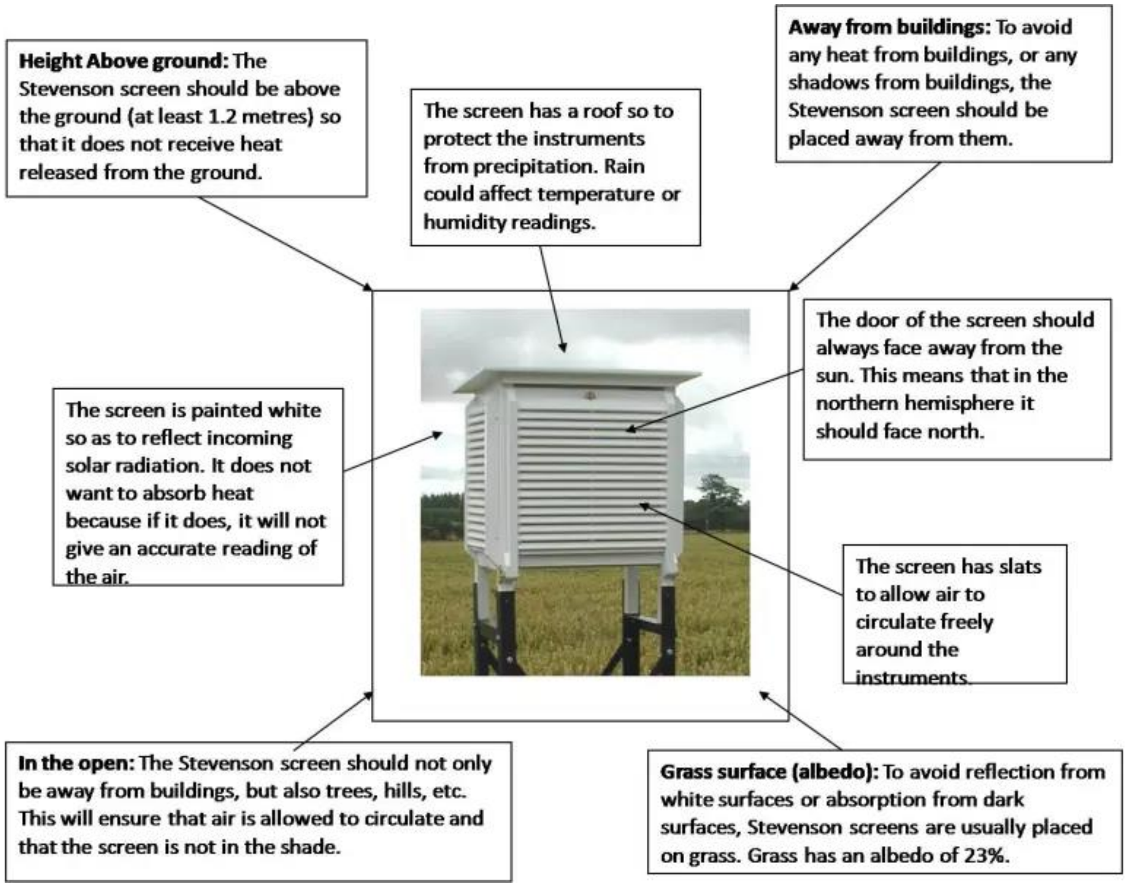
Mean annual temperature is high at 26.9°C. Annual temperature range is small at 2°C.	1. **<u>Mean annual temperature</u>** + state if it is <u>high / low</u> + quote **DATA** 2. **<u>Annual temperature range</u>** + state if it is <u>large / small</u> + quote **DATA** 3. Months with lowest + highest temperatures + quote **DATA**

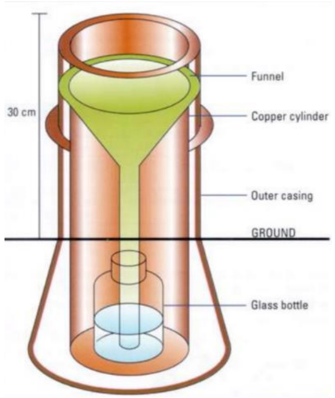
(b) Describe rainfall in Singapore.

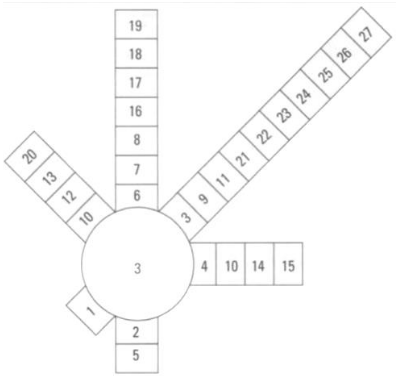
Total annual rainfall is high at 2275mm. Rainfall is evenly distributed throughout the year, with a maximum rainfall of 260mm in December and minimum rainfall of 160mm in May and July.	1. **<u>Total annual rainfall</u>** + state if it is high / low + quote **DATA** **2. <u>Rainfall distribution</u>** ● Distinct wet and dry season (very high ⇔ very low amount of rainfall) + quote **DATA** ● Rainfall evenly distributed (relatively equal amount of rainfall every month) + quote **DATA** 3. Months with maximum + minimum amount rainfall + quote **DATA**

FIELDWORK: Weather instruments (REFER TO OTHER SCHOOL PAST YR PAPER) → ans technique

Instrument	Measure	Description
Six's thermometer (max and min thermometer)  	maximum and minimum temperatures	Steps 1. Read the temperature every 24 hours 2. Read the maximum and minimum temperatures from the bottom of metal indices 3. Read at eye level 4. (use magnet) reset the indices Accuracy ● Stevenson screen is used for storing the thermometer. Must be above 1.5 m 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 version ● 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 How should you go about reading the max and min temperature of the day? • Take the reading from the lowest point of each metal index.

		
Rainfall gauge	amount of rainfall	Steps 1. Select an appropriate location (an open area, preferably a grass patch, away from obstructions, such as buildings or under a tree). 2. Prevent the rain gauge from falling over by SINKING the rain gauge into the ground with 30 cm protruding above the ground. WHY? 3. Record the time at which the rainfall events start and end. 4. Pour collected water into measuring cylinder. Read and record water level. 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 (P173, 175)
Sling psychrometer	relative humidity	Steps 1. Dip the wick of wet bulb thermometer in water. 2. Swing the psychrometer at a steady & comfortable pace. Hold the psychrometer far from your body. WHY? 3. Read & record temperature on the wet bulb thermometer after 1 minute of swinging. 4. Continue swinging sling psychrometer for another minute. Read and record temperature on wet bulb thermometer again. 5. If the 2 temperatures recorded are different, repeat steps 2 and 4 until same temperature is recorded consecutively. 6. Read and record the temperature on the dry bulb thermometer 7. Calculate the difference between the wet & dry bulb temperature to obtain the wet bulb depression 8. Use conversion table to determine the relative humidity by locating the value where the wet bulb depression intersects the dry bulb temperature Accuracy ● 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

Wind vane 	wind direction	Steps 1. Place the wind vane in an open area, away from obstruction where the wind is blowing directly at it & hold it above your head. 2. Use a compass to determine how the wind vane should be positioned. Turn the wind vane so that its direction mark labelled ‘N’ matches the compass arrow pointing north. 3. Record the direction the wind vane points to. This is the direction the wind is blowing FROM.
Anemometer 	wind speed	Steps 1. Go to an open area, away from obstruction (where air flows freely). 2. Hold up the anemometer. 3. Read the wind speed off the display on the anemometer.
Wind rose 	wind direction	Steps 1. Measure wind direction using a wind vane 2. Draw a square in the direction of the wind 3. Write the dates in the rectangles 4. Write the number of calm days in the circle Numbers in the rectangles = dates in the month in which the wind is blown from a particular direction. Number in the circle = number of calm days without wind 8 compass directions are used to show where the wind is blowing FROM for each day of the month.

Barometer

	air pressure	Steps
		1. Step 1: Check that the moveable pointer is arranged over the measuring hand to mark the current pressure.
		2. Step 2: The moveable pointer will move to the left when pressure falls and to the right if pressure increases.
		    1) An increase in the pressure reading above the average barometric pressure for your area is an indicator of high pressure or mild weather.
		    2) A decrease in the millibar reading indicates that rainy or stormy weather is approaching.
		
		Accuracy
		● Parallax error
		● Damage of intended vacuum within the barometer

Typical questions

Structured questions

1 Describe how seasonal temperatures vary in cool temperate climates. [3]
(N2014/P2/Q3b)

Cool temperate climates experience seasonal weather, where there are four seasons each year: spring, summer, autumn and winter. Temperatures will be highest during summer and lowest during winter.

- Areas with temperate climates receive less sunlight during winter, resulting in lower temperatures.
- They receive more sunlight during summer, resulting in higher temperatures.

2 Explain how weather differs from climate. [3]
(N2014/P2/Q4b)

- Weather and climate differ in that weather measures short term atmospheric conditions while climate measures it in the long term.
- Weather refers to the atmospheric condition at a specific point in time. However, climate refers to the atmospheric condition for an extended period of time.

3 Explain how annual temperature range is affected by distance from the sea. [4]
(N2018/P2/Q3a)

- Coastal areas or areas nearer to the sea have smaller annual temperature range compared to those further inland due to the maritime effect. The sea tends to heat up much slower than land. For this reason, the sea takes a longer time to heat up during summer, which contributes to a cooling effect on nearby land and coastal areas.
- Similarly, since the sea loses heat much slower than land during winter, its retained heat contributes to milder, warmer winters in coastal areas. As such, the change in annual temperature range remains significantly smaller compared to inland areas, which cannot benefit from the moderating influence of the sea. This results in greater annual temperature range in land further away from the sea.

4 Explain how latitude affects temperature. [4]
(N2019/P2/Q4a)

Temperatures at lower latitudes and higher latitudes differ because the earth tilts at 23.5° on its own axis and this causes the sun's rays to strike various parts of the earth at different angles, thereby influencing the amount of solar energy a particular location receives.

- Higher latitudes: temperatures are lower because lower solar angle causes sun rays to strike at a lower angle, so solar energy is spread out over a wider area.
- Lower latitudes: temperatures are higher because higher solar angle causes sun rays to strike at a higher angle, so solar energy is concentrated at a smaller area.

5 Explain briefly **one named** way in which rainfall occurs. [4]
(N2016/P2/Q4a)

Convectional rain:

- When the earth's surface is heated by conduction (primarily by the sun), the surrounding air warms up, expands and rises. Moisture on Earth also rises as water vapour.
- As the water vapour rises higher into the atmosphere, it coolds, reaches dew point temperature and condenses to form large cumulonimbus clouds, which are characterised by their great vertical extent.
- The hot air rising into the atmosphere holds up the moisture and the clouds.
- When saturation point is reached and water droplets in the clouds can no longer be suspended in the atmosphere, convection rain occurs, usually in the form of torrential downpours with thunder and lightning.

6 Explain why the rainfall distribution throughout the year differs between an equatorial climate and a tropical monsoon climate. [4]
(N2017/P2/Q4a)

Equatorial climate	Tropical monsoon climate
● Countries lie in latitudes between 10 degrees north and south of the equator, ● such as Singapore, Malaysia and Indonesia	● Countries lie in latitudes between 5 and 25 north and south of the equator ● such as Mumbai in India
High temperatures throughout the year as they are located near the equator.	Relatively lower average annual temperature compared to the equatorial climate.
This contributes to a high evaporation rate, resulting in relatively high rainfall throughout the year, much of it being convectional rain.	Characterised by distinct wet and dry seasons resulting from monsoon winds. Monsoon winds are formed because of the changes in air pressure over the northern and southern

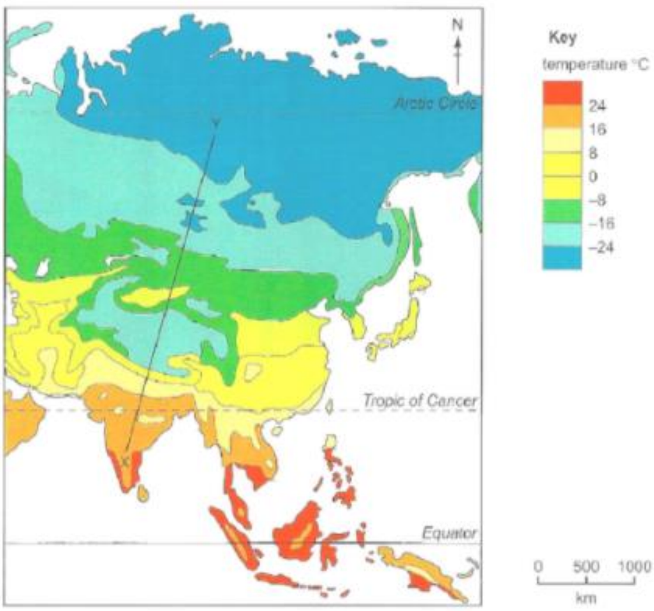
	hemispheres due to the change in temperature. Winds blowing across the equator carry water droplets, which then fall as precipitation during the wet seasons of the tropical monsoon climate.

7 Explain how relief affects rainfall. [4]
(N2019/P2/Q3a)

Relief, which is the variations in elevation and slope of an area of the Earth's surface, can affect the amount of rainfall an area receives.

- Mountains receive more rainfall than low lying areas because when air is forced to rise over higher grounds, it cools and the moisture within it condenses to form clouds and produce orographic rain mostly on the windward slopes.
- As the air moves over the mountain range and starts to descend on the leeward side of the slope, it becomes warm and dry.
- As a result, rainfall is usually low on the leeward side of the mountain range.

8 The figure below shows the January temperatures over Asia.



Describe and explain the variations in temperature along the line X-Y. [7]

<u>Description: [3]</u>

- Generally, temperature decreases from X in India to Y in Russia decreasing from about 16°C ~ 24°C to – 24°C and below. [**general statement**]

- However, at about 1000 km from X, there is a sharp decrease of temperature from – 16°C to – 24°C for about 600 km. After which, temperature continues to decrease consistently towards Y in the north.

Explanation: [4]

Factor 1: **Latitude**

- The variation in temperature from X-Y is largely due to latitude. X is nearer to the Equator / at a lower latitude where the solar angle is higher and solar energy is concentrated on a smaller area, thus temperatures are higher.
- At higher latitudes where Y is, solar angle is lower and solar energy is spread out over a wider area, thus temperatures are lower.
- In addition, Sun's rays travel a greater distance through the atmosphere to reach Y than X due to the curvature of the Earth. Hence, more heat is lost which results in lower temperature at Y. (optional)

Factor 2: **Distance from the sea**

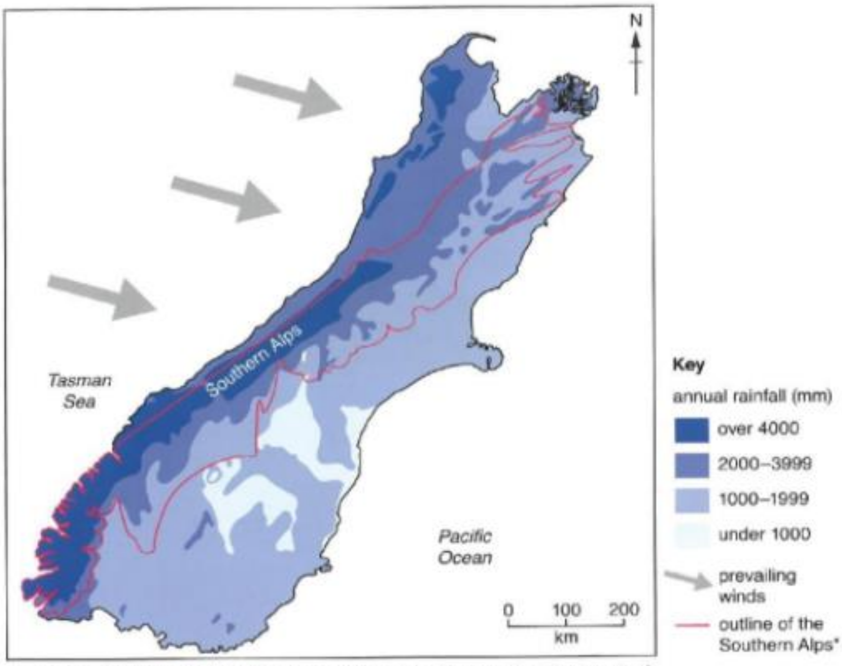
- In January, the Northern Hemisphere experiences winter and Y experiences the continental effect. Being further inland, Y is not influenced by the moderating effects of large ocean bodies.
- However, temperature is higher at X which is near to the Indian Ocean. As the sea loses heat more slowly, the air over the sea remains relatively warm compared to the air over land. The warmer air over the sea helps to raise the temperature of coastal areas.

Factor 3: **Altitude**

- At about 1000 km from X, the temperature drops sharply due to the high altitude of the area, which is the Himalayas / Tibetan Plateau. Air at such higher altitudes is less dense and is unable to absorb heat as effectively hence causing temperatures to be much lower.
- Moreover, heat is emitted in the form of longwave radiation from the earth's surface. Hence, air at high altitude absorbs less heat as it is further from the surface.

9 Describe and give reasons for the annual rainfall distribution over the Southern Alps. [5]

Annual rainfall over South Island, New Zealand



* The Southern Alps is a mountain range extending along much of the length of New Zealand's South Island.

Describe:

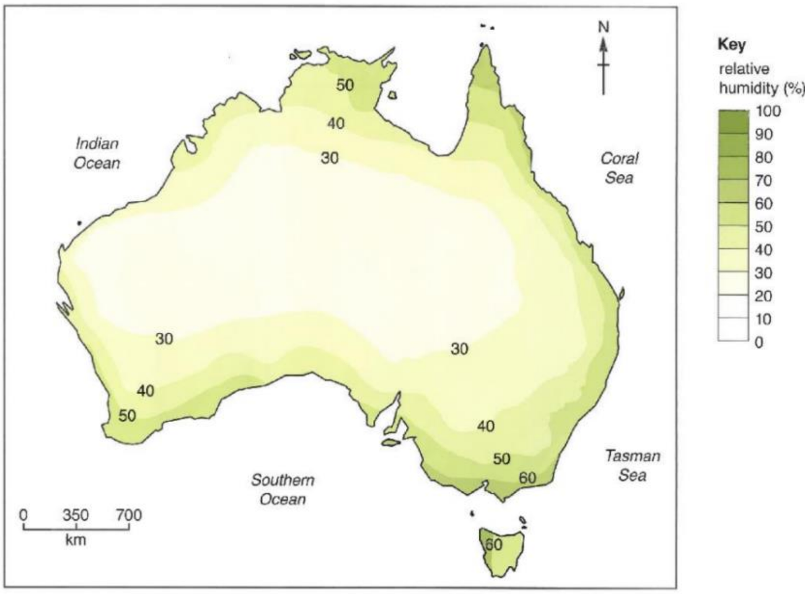
- The highest amount of rainfall of over 4000 mm occurs along the south-western part of the Southern Alps. This is also the windward side of the mountain range.
- The annual rainfall on the northwestern part of the Southern Alps is lower at 2000 to 3999mm.
- The lowest annual rainfall occurs as one crosses over to the eastern part of the Southern Alps from 1000 to 1999mm.

Explain: (*relief rain*)

- This is due to the prevailing winds from the west which brings a lot of moisture from the Tasman Sea to the western coast.
- The moisture-laden air is forced to rise up the windward side of the Southern Alps and is forced to cool as it reaches higher altitude.
- When temperature reaches dew point, condensation occurs, forming water droplets which coalesce to form clouds.
- As the water droplets get too heavy, relief rain falls on the windward side. The air continues to flow down the leeward side bringing less rain as the air is dry.

10 Study the figure below, which shows the average daily relative humidity in Australia at 15:00.

Average daily relative humidity in Australia at 15:00



Describe and suggest reasons for the pattern of relative humidity in Australia shown on the figure above. [5]

Describe:

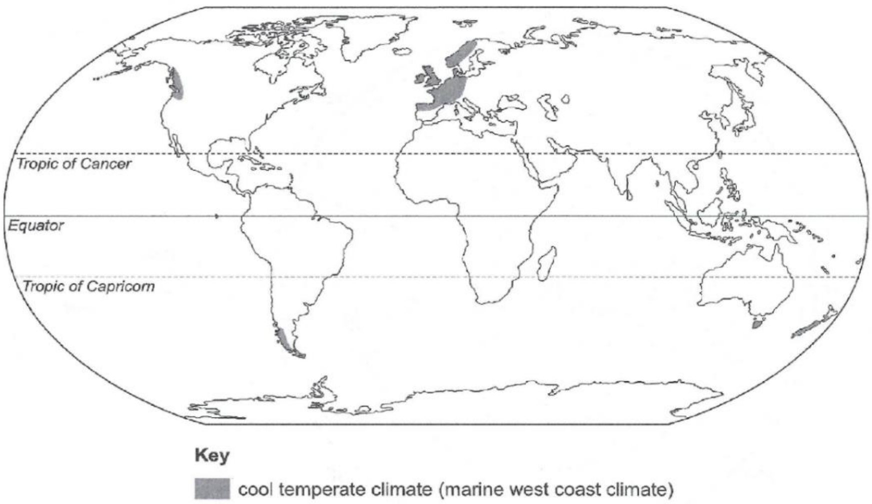
- Relative humidity at the coastal areas is higher as compared to the inland areas.
- The highest relative humidity is at 60% at the south-eastern coast of Australia and at Tasmania. Other coastal regions at the northern and southern parts of Australia had higher humidity at 50%.
- Relative humidity decreases inland towards the central part of Australia to less than 30%.

Suggest reasons: (2 factors affecting RH – *temperature* and *amount of water vapour*)

- The reason for the highest relative humidity at the south and at Tasmania could be due to a **lower temperature**. As these parts of Australia are at lower latitudes compared to the other parts of Australia, they will have lower temperatures which could account for the highest relative humidity.
- Other coastal parts of Australia with 50% of relative humidity could be due to their proximity to the sea. Being near the sea would have **a lot of water vapour** evaporating from the sea.

11 Study the figure below, which shows the distribution of areas experiencing a cool temperate climate (marine west coast climate).

Areas with a cool temperate climate (marine west coast climate)



Using the figure above, account for the characteristics of areas experiencing a cool temperate climate (marine west coast climate). [5]

1. Places with a cool temperate climate experience **four distinct seasons** of spring, summer, autumn and winter in a year
    - as they are located in areas of latitude 40° to 60° North and South of the equator such as Western Europe.
    - This results in them experiencing 4 seasons in a year due to the tilt of the earth and its revolution around the sun.

2. **Annual mean temperature** is moderate compared to other areas.
    - This is because at such high latitudes,
    - sun rays strike at a lower solar angle, so solar energy is spread out over a large area.

3. They have **mild winters** and **cool summers**.
    - This is because they are mostly found near coastal areas
    - and would experience the moderating effects of the sea (maritime effect) which result in cooler summers and milder winters.

4. **Rainfall is evenly distributed** throughout the year.
    - Rainfall is not influenced by monsoon patterns
    - and neither are they located at equatorial regions where evaporation rates are high (which can contribute to high rainfall).

5. **Total annual rainfall** is low, between 300 - 900mm with no distinct wet – dry seasons.
    - This is because in these areas the rate of evaporation is not high and there is less moisture in the air.

Open-ended questions

12 ‘Distance from the sea is the most important factor affecting temperature at a location.’
To what extent is this true? Support your answer with evidence. [8]
(N2014/P2/Q4)

…

I believe that latitude is the most important factor that affects temperature at a location. (Comparison criterion: **scope of impact**) While altitude and distance from the sea also affect temperature, they do not affect as many locations and as wide of an area as latitude. Therefore, I believe that latitude is the most important factor.

13 ‘The factors which contribute to the formation, speed and direction of monsoon winds and land and sea breezes are the same.’
How far do you agree with this statement? Give evidence to support your answer. [8]
(N2016/P2/Q4)

Fieldwork questions

14 A group of students in Kuala Lumpur thought that the forested area at the side of the Lake garden (photograph below), was less windy and had a smaller temperature variation than the open land in other parts of the park. They measured temperature and wind speed at 4 times of the day for each of the 3 locations (figure below). The tables below show their results.

Temperature and wind speed in Lake Garden

23 March – temperatures °C				
	8:00 am	11:00 am	2:00 pm	5:00 pm
A – short grass	25	30	33	29
B – long grass and shrubs	25	29	31	29
C – dense woodland	25	27	28	28
23 March – wind speed kph (all were SW)				
	8:00 am	11:00 am	2:00 pm	5:00 pm
A – short grass	2	3	8	11
B – long grass and shrubs	2	2	5	8
C – dense woodland	0	1	2	2

(N2014/P2/Q2)

(a) Suggest how the changes in temperature at the 3 locations could be shown on 1 graph. [2]

Use a **<u>line graph</u>**

- X-axis indicates the time, Y-axis indicates the temperature.
- Different lines are plotted for the different locations.
- Different symbols are used to represent the different lines, which are labelled at the side of the graph.

(b) One student thought that the results could be explained by the amount of sunlight reaching the ground. Suggest how this might be related to the results obtained. [4]

The results show a definite trend in that the thicker the vegetation, the lower the temperature. It is possible that the level of vegetation affected the amount of sunlight reaching the ground, hence affecting the temperature.

At 2:00 p.m., the area with least vegetation, A, experiences the highest temperature, 33°C; the area with the most vegetation, C, experiences the lowest temperature, at 28°C. Furthermore, the average temperature of A throughout the day is 29.25°C; the average temperature of B and C is 28.5°C and 27.0°C respectively. This shows that the thicker the vegetation, the higher the temperature.

Since A only contains short grass, a large amount of sunlight is unblocked, resulting in the high temperature. However, C is made up of dense woodland, which provides shade and blocks out sunlight. Therefore, it does not experience as high a temperature as compared to A.

(c) The students thought that the vegetation cover might influence how much rain reached the ground during a storm. Suggest a suitable hypothesis to test this and name an instrument which would be used to gather data. [2]

Hypothesis: The denser the vegetation, the lesser the rainfall that reaches the ground.
Instrument: Rain gauge

(d) Describe the steps that the students would need to take to ensure that their rainfall records were as accurate as possible. [4]

- Students need to ensure that their rain gauge is not affected by other factors such as being obstructed by any structures.
- The students also have to make sure that the rain gauge is on the ground so that the amount of water reaching the ground is accurately measured.
- Students also have to take note to record the water collected in the rain gauge at eye level to prevent misreading of the scale.

15 A group of students wanted to investigate how relative humidity (RH) changed before, during and after a rain storm. They could not predict exactly when it was likely to rain, so they left a data logger recording relative humidity and checked a rain gauge every hour during two consecutive school days when rain storms had been forecast. Their records are shown in the tables below.

	day 1						
	0800 - 0859	0900 - 0959	1000 - 1059	1100 - 1159	1200 - 1259	1300 - 1359	1400 - 1459
rainfall (mm)	0	6	54	12	0	0	0

RH %	84	86	91	92	93	88	85

	day 2						
	0800 - 0859	0900 - 0959	1000 - 1059	1100 - 1159	1200 - 1259	1300 - 1359	1400 - 1459
rainfall (mm)	0	0	0	14	61	5	0
RH %	82	82	85	88	82	94	89

(N2015/P2/Q2)

(a) Describe a suitable method to show how both rainfall and relative humidity can be shown on one bar graph. [3]

Use a **<u>comparative bar graph</u>**

- Rainfall and RH should be labelled on the left and right side of the Y-axis respectively.
- The scales used should accommodate both the largest and smallest values.
- The x-axis should be labelled as the progress of time.
- Two separate categories can be added to the graph representing rainfall and RH; the two bars can be shaded in different colours to better differentiate them.

(b) One student thought that there was a relationship between rainfall amounts and relative humidity. State a suitable hypothesis to describe the relationship. Explain how the data from the tables or other data could be used to test the hypothesis. [4]

Hypothesis: The amount of rainfall and RH are directly correlated.

The data from the tables and other sources can be used to see if a higher RH relates to higher amounts of rainfall. If the data shows this trend, the hypothesis is correct; if it does not, it is wrong.

(c) Name **one** instrument, other than a data logger or rain gauge, used to record the information shown in the tables above. [1]

Sling psychrometer (measures RH)

(d) Describe and explain the steps the students could take to ensure that their relative humidity measurements were as accurate as possible. [4]

- To ensure that their RH measurements were as accurate as possible, the students could conduct the experiment more often over a longer period of time. By taking the average of the findings, their data will be more accurate and better represented.
- The students could also take extra care when using the sling psychrometer by making sure that it is not affected by their own body heat.
- In addition, the students could swing the sling psychrometer for about a metre before reading and taking down the temperature reading.
- Furthermore, the students could also make sure that they record the data off the data logger accurately.

16 A group of students were interested in relationships between temperature, relative humidity and cloud cover. They were able to obtain details of temperature and humidity from a data logger within the school grounds, and at the same time measured cloud cover by observing how many oktas (eights) of the sky were covered in cloud. The extent of cloud cover was recorded by using the symbols shown below.

They took measurements between 07:00 and 19:00 for one day in January and for one day in April. The results obtained are shown below.

(N2017/P2/Q2)

(a) Using the key provided, complete the top data logger results for 16:00 when cloud cover was 5 oktas (eights). [1]

(b) State the temperature range over the hours shown for January. [1]

4°C

(c) One student thought that the amount of cloud cover might have an influence on temperatures. Suggest the guiding question to investigate this and show how the data in the figures above could be presented to help answer the question. [3]

How does the amount of cloud cover affect the temperatures throughout the day?

(d) One student stated that temperature and relative humidity might be inversely related. How far does the information confirm this? Use evidence from the figures above to support your answer. [3]

- The data from the figures above generally confirm the student’s statement.
- Based on the information from the upper figure, the relative humidity is logged at 93% at 07:00 when the temperature is 25°C. As the temperature increases with time, the

relative humidity decreases. This happens until 14:00, when both readings almost coincide.

- Similarly, this trend is also observed in the bottom figure. At 07:00, the temperature is recorded to be 27°C, while the relative humidity was at 88%. As the day continues and the temperature rises slowly, relative humidity decreases correspondingly. At 10:00, the relative humidity becomes lower than the temperature, and the inverse relationship continues.

(e) In their evaluation, the students reflected that they could use a wet-and-dry bulb thermometer to record temperature and relative humidity. Describe and explain the steps taken to ensure accurate readings. [5]

- To begin, the students would have to calibrate the wet-and-dry bulb thermometer to ensure that the instrument is in proper working order. They could do this by holding the thermometer in front of a moderate speed fan for a couple of minutes before recording the readings.
- Next, the students would have to set up the instrument by suspending the thermometer on a hanging platform, as well as ensure that it is not placed directly in the sun.
- Then, the students would need to record the initial temperature of the two thermometers before starting on the experiment proper. Readings could be taken at regular intervals (for example, 5 minutes).
- To obtain the data for relative humidity, the student would then have to subtract the values of the wet-bulb readings from those of the dry bulb.

17 A group of students visited the coastline of the Tulun National Park, Mexico, to investigate how wind direction varies along the coast.
They collected wind direction data for one week in May 2017 as shown in the table below.

They presented their data using a wind rose as shown in the figure below.

(N2019/P2/Q2)

(a) Identify **one** error made by the students in the figure above. [1]

They incorrectly shaded one rectangle for NE.

(b) Describe the steps taken to minimise errors when collecting the data in the table above. [3]

1. Check that the wind vane is in good working condition.
2. Hold the wind vane away from the body slightly above the head.
3. Ensure that the wind vane is not obstructed by obstacles such as buildings.

(c) Some students were interested in how wind speed varies with distance from the sea at the Tulun National Park. They were divided into two groups to collect wind speed data at locations X and Y.

(i) Suggest a hypothesis the students could use to investigate the relationship between wind speed and distance from the sea. [1]

The further the distance from the sea, the higher the wind speed.

(ii) To test their hypothesis, the students collected wind speed data at multiple sites at locations X and Y. The data was collected at the same time of day at all sites.
Using the figure above, explain why this data collection method is reliable. [4]

- By collecting wind speed data at multiple sites, the students have a larger sample size. Hence, there is a higher likelihood of the data collected being more representative and hence more reliable.
- In addition, by collecting the data at the same time of day at all the sites, the students ensure conditions for comparison are consistent, and thereby ensure fair comparison and reliability.

(d) Some students decided to extend their investigation to find out whether there was a relationship between humidity and distance from the sea. At each location, the students recorded measurements from three attempts using a log as shown in the tables below.

Location X

attempt	wet bulb temperature (°C)	dry bulb temperature (°C)
1	25	30
2	26	31
3	24	30

Location Y

attempt	wet bulb temperature (°C)	dry bulb temperature (°C)
1	24	28

2	26	29
3	24	28

What conclusions can the students draw from the tables above? [4]

As less humidity results in a greater difference between wet bulb and dry bulb thermometers, the students can conclude that the further the distance from the sea, the lower the relative humidity.

- In Location X (inland), the temperature difference of 5°C to 6°C between the wet bulb and dry bulb thermometers compared to Location Y's (beach) difference in temperature of between 3°C to 4°C indicates that more water vapour evaporates from the wet cloth of the wet bulb thermometer in Location X, which lowers the temperature of the wet bulb thermometer.
- As less humidity results in a greater difference between a wet and dry bulb thermometer, the higher wet bulb temperature of Location X indicates that water vapour that evaporates from the wet cloth has lowered the temperature of the wet bulb thermometer.