Assessment Schedule – 2016

Earth and Space Science: Demonstrate understanding of processes in the atmosphere system (91414)

Evidence Statement

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
ONE	**Climate and Weather** Climate is the average weather pattern in a place or region over many years, including averages of precipitation, temperature, humidity, sunshine, etc. Weather is a mix of events that happen over a day or series of days in a locality, including temperature changes, precipitation, wind, brightness, humidity, etc. **Factors affecting climate** • Latitude – sun heats the Earth unevenly, being greatest at the Equator and weakest at the poles. • Earth's tilt – leads to different parts of Earth receiving more solar energy at different times of the year. • Altitude – decrease in air pressure leading to decrease in air temperature. • wind formation – differences in solar heating cause temperature differences which form convection cells e.g. sea breeze, Hadley Cell. • pressure differences – pressure differences caused by solar heating which which create winds e.g. trade winds, equatorial heating. • Coriolis Effect – affects the rising and falling air masses, dragging them with the spin, causing air in the northern hemisphere to be deflected towards the right, and in the southern towards the left. • Ocean currents – movement of large bodies of warm or cold surface waters. e.g Bay of Plenty, Gulf Stream. • Greenhouse gases – creating a warmer climate through heating of the atmosphere by re-radiation of infra red. **Role of landforms** Mountains affect weather due to orographic lifting. As air moves up a mountain or ridge it is cooled. This happens due to the pressure difference. If the rising air gets cooled enough to reach the dew point, condensation begins, causing clouds and precipitation. The air descending on the other side of the mountain / ridge has lost its moisture, making it dry, and it warms as it descends, causing warm, dry air on the leeward side, forming a rain shadow. The air heats due to adiabatic heating. When the air mass descends in the atmosphere as it moves down the leeward side of the range, the air encounters increasing atmospheric pressure. The compression of the air mass causes the air mass to increase in temperature.	To demonstrate understanding of processes, the candidate: • Explains the difference between climate and weather. • Explains the effect of ONE factor affecting climate. • Gives a description of the effect of mountains on weather. • Gives a description of the effect of coastal areas on weather. • Describes one reason why NZ has different climates. • Gives a simple explanation of ONE climate within New Zealand e.g. Wellington is windy because the westerly winds are funnelled between the two islands.	To demonstrate in-depth understanding of processes, the candidate: • Explains in detail at least two factors that affect climate. • Explains orographic lifting. • Explains ONE reason for NZ's climates. • Explains in detail the climate in a named NZ location.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion of the reasons for different climate and weather conditions around NZ, using at least two different named locations.

	Reasons for regional different climates in NZ • the length of the country extending from latitude 34° to 47° south • positioned in the Ferrel circulation cell, leading to the prevailing westerly winds (roaring forties, furious fifties, and screaming sixties) • mountain chains running from north to south, which provide a barrier for the prevailing westerly winds • proximity of the locality to the ocean. **Examples may include ideas from the following:** Climates vary from warm subtropical in the far north to cool temperate in the far south, with severe alpine conditions in the mountainous areas. The temperature range at any time of year becomes more extreme as you go inland, where there are lower minimum temperatures and higher maximum temperatures – for instance at Alexandra in Central Otago and Ohakune in the central North Island. The moderating influence of the oceans means there are relatively small variations between summer and winter temperatures (mostly less than 10°C), although inland and to the east of the ranges the variation is greater (up to 14°C). For example: • Nelson (at the top of the South Island) is unusually warm because it is protected by mountain ranges to the south and west. • Wellington is very windy because it is exposed to the westerly winds that are funnelled through Cook Strait. • West coast of the South Island (Hokitika to Milford Sound) has the highest precipitation levels due to the orographic lifting of moisture laden westerly winds over the southern alps. • East coast of the South Island is in a rain shadow due to the Southern Alps leading to hot, dry north westerly winds which cause droughts.			

Not Achieved			**Achievement**		**Achievement with Merit**		**Achievement with Excellence**	
NØ = no response or no relevant evidence	N1 = 1 point from Achievement	N2 = 2 partial points from Achievement	A3 =2 points	A4 = 3 points	M5 = 1 points	M6 = 2 points	E7 = Discusses reasons but with minor omissions	E8 = full discussion

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TWO	**Temperature** Temperature within the atmosphere varies due to the source of its heat energy. The boundaries between the four layers of the atmosphere are defined by abrupt changes in temperature, and include respectively the tropopause, stratopause, and mesopause. In the troposphere and mesosphere, temperature generally falls with increasing altitude, whilst in the stratosphere and thermosphere, temperature rises with increasing altitude. The **troposphere** is mostly heated by **infra-red energy** transfer from the surface of the Earth, so temperature is highest at the lowest point and decreases with increasing altitude. The **stratosphere** defines a layer in which temperatures rise with increasing altitude. At the top of the stratosphere the thin air may attain temperatures close to 0°C or 270K. This rise in temperature is caused by the **absorption of ultraviolet (UV) radiation from the Sun by the ozone layer**. Such a temperature profile creates very stable atmospheric conditions. The **mesosphere** has the coldest temperatures in the atmosphere because **very little solar radiation** is absorbed here and the air is very thin, with air particles far apart making it difficult for heat transfer. Temperatures in the mesosphere drop with increasing altitude to about –100°C or 180K. Within the **thermosphere temperatures rise continually to well beyond 1000°C**. The few molecules that are present in the thermosphere **receive extraordinary amounts of energy from the Sun**, causing the layer to warm to such high temperatures. Air temperature, however, is a measure of the kinetic energy of air molecules, not of the total energy stored by the air. Therefore, since the air is so thin within the thermosphere, such temperature values are not comparable to those of the troposphere or stratosphere. Although the measured temperature is very hot, the thermosphere would actually feel very cold to us because the total energy of only a few air molecules residing there would not be enough to transfer any appreciable heat to our skin. **Density** Atmospheric density is the mass of air molecules per unit of volume. **Air density decreases with increasing altitude because there are fewer air particles the higher you go in the atmosphere.** The highest density of gases in the atmosphere is at the surface of Earth at sea level, within the troposphere. The troposphere is denser than the layers of the atmosphere above it (because of the weight compressing it), and it contains up to 75% of the mass of the atmosphere. **Pressure** Atmospheric pressure is the force per unit of area exerted on a surface by the weight of air above the surface. The force exerted on the air is due to gravity. Air pressure depends on the	To demonstrate understanding of processes, the candidate: • Describes the changes in temperature in the troposphere and why it changes. • Describes the temperature changes in the stratosphere and why it changes. • Describes the main reason for the differences in temperature within different layers. • Describes why there is change in atmospheric density. • Describes why there is change in atmospheric pressure.	To demonstrate in-depth understanding of processes, the candidate: • Explains the reason for temperature differences between two layers. • Explains why the density changes between the layers of the atmosphere. • Explains the pressure changes between the layers of the atmosphere.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion of the reasons for the differences in temperature, density and pressure within and between the layers of the atmosphere.

	temperature and density of the air mass. Temperature affects air pressure by causing the air to either become more or less dense. Warm, less dense air has low pressure, while cold, more dense air has high pressure. The molecules that make up the atmosphere are pulled close to the Earth's surface by gravity. This causes the atmosphere to be concentrated at the Earth's surface and thin rapidly with height. Air pressure is a measure of the weight of the molecules above you. As you move up in the atmosphere, there are fewer molecules above you, so the air pressure is lower.			

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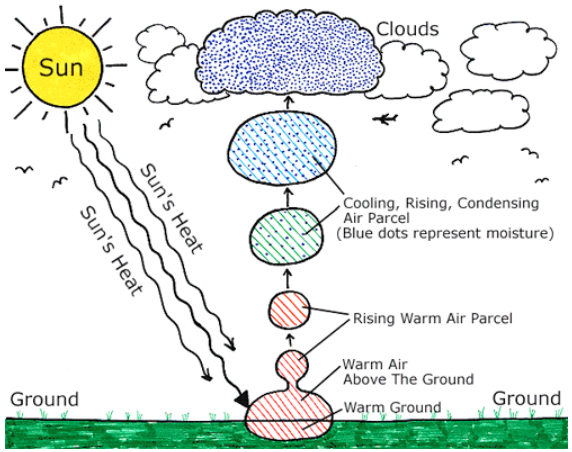
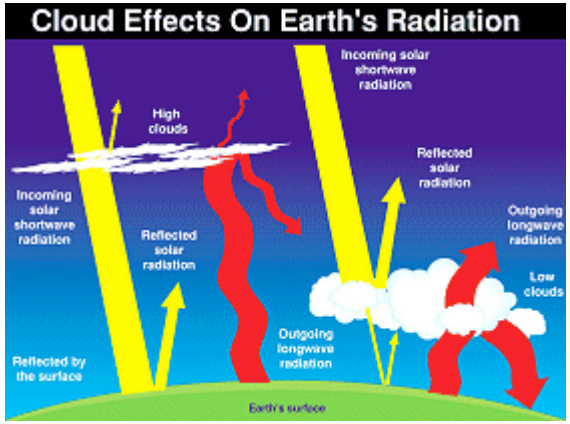
THREE	**Cloud formation (and role of water vapour)** Clouds form when air containing water vapour rises and then cools to its dew point, the temperature at which air becomes saturated, and vapour condenses around small particles in the air called seeds. The moist air may originate over the ocean or inland e.g. evapotranspiration. **Role of aerosols in cloud formation** Aerosols are tiny particles such as dust, sulfates, sea salt and ammonium salts, that act as tiny seeds for the water vapour and are known as cloud condensation nuclei. The water vapour in the air condenses around these seeds. When the seed becomes too heavy, it will fall as precipitation. **Role of temperature and air pressure in formation** The uneven heating of the Earth's surface leads to warm air masses forming near the surface of the Earth in certain areas. Warm air is less dense than cool air and so it rises. As it rises, the temperature and air pressure decrease, causing the water vapour to cool and contract until it reaches the dew point where condensation begins to occur, forming clouds. This is observed in low pressure areas around the Earth e.g. the Equator.  **Why clouds are in the troposphere** Clouds predominantly form in the troposphere because nearly all of the Earth's water vapour and aerosols are found there.	To demonstrate understanding of processes, the candidate: • Explains simply how clouds form. • Explains simply the role of aerosols in cloud formation. • Gives a description of the role of temperature and / or pressure on cloud formation. • Describes why clouds form predominantly in troposphere. • Describes one way clouds affect the Earth's heat exchange. • Gives a description of how low level OR high level clouds affect heat exchange.	To demonstrate in-depth understanding of processes, the candidate: • Explains how clouds are formed (referring to either dew point / saturation). • Explains the role of aerosols in cloud formation. • Explains the role of temperature and / or pressure in cloud formation. • Explains how low level or high level clouds affect heat exchange. • Explains one way clouds affect the Earth's heat exchange.	To demonstrate comprehensive understanding of processes, the candidate: • Gives a comprehensive discussion of how clouds are formed (discussion should include the role of water vapour, aerosols, temperature, and pressure) and how both low and high level clouds affect the Earth's heat exchange.

Role of clouds in Earth's heat exchange
Cloud cover affects the surface temperature of the Earth in four ways:

- they carry heat energy from the warmer tropics to cooler climates
- when water vapour condenses to form clouds, it releases **latent heat** into the atmosphere. The latent heat then warms the surrounding air around the new cloud droplet
- clouds **reflect** radiation from the Sun back into space preventing it from reaching Earth's surface
- clouds **trap** long-wavelength radiation from the Earth's surface and **re-radiate** it back to Earth.

Effect of low and high clouds on Earth's radiation
Low level clouds tend to be thick and reflect much of the short-wavelength radiation coming from the Sun back into space. Also because of their low altitude, they will absorb long wave radiation from Earth's surface, which may then be re-radiated back to Earth or into space. On balance more of this long wave radiation is re-radiated back into space creating a cooling effect.

High clouds tend to be thin and virtually transparent. They reflect very little short-wavelength radiation from the Sun, and emit only small amounts of long-wavelength radiation towards space, so most of the radiation reaches the Earth and increases its temperature, creating a warming effect. High clouds also will re-radiate some long wave radiation back to Earth enhancing their warming effect.



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Cut Scores

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0 – 6	7 – 13	14 – 19	20 – 24