Assessment Schedule – 2014

Earth and Space Science: Demonstrate understanding of physical principles related to the Earth system (91193)

Evidence Statement

QUESTION ONE			
Expected Coverage	**Achievement**	**Merit**	**Excellence**
Heat energy is transmitted through space (vacuum) and Earth's atmosphere by radiation, which is the transmission of energy by electromagnetic waves. As heat passes through particles in the atmosphere, the particles absorb the energy and so the air temperature increases as a result. Around 10% of the Earth is covered by polar ice, which acts as huge mirrors reflecting a lot of the heat energy from the Sun back out into space. This acts to reduce the overall effect of radiation on the Earth and means that with polar ice acting as a reflector of heat due to its high reflective ability (albedo), Earth's temperature is not increasing as fast as it would otherwise. If the polar ice were to reduce in size, it would mean that the energy from the Sun would not be getting reflected back out into space to the same extent as it is now. More heat energy would be absorbed into the darker oceans now exposed by the melted ice. This would lead to a rise in temperature and a further decrease in the amount of polar ice, which would then lead to an even faster rise in the Earth's temperature. Ie, when the polar ice reduced in size, more of the darker, less reflective ocean surface is exposed; the ocean reflects less heat energy back to space and therefore, more heat energy would be absorbed, causing a rise in temperature.	Describes: • transfer of heat energy from Sun to Earth by radiation, transmitting energy through a space (vacuum) by electromagnetic waves • transfer of heat energy from Earth's surface, and upwards in the atmosphere by conduction, convection and radiation • ice reflects more energy back into space than oceans / land • ice albedo / reflectivity of radiation leads to maintaining a temperature balance • the polar ice caps help reduce any increase in Earth's atmospheric temperature • water absorbs more radiation / heat than ice due to non reflectivity • water has a high heat capacity.	Explains: • transfer of heat energy is explained, eg from the Sun is by radiation and back through the atmosphere is by convection and radiation • ice is a reflector of solar heat back into space, which means less heat is absorbed by the land and ocean and therefore the earth does not heat up as much • if ice disappears less heat energy will be reflected back into the atmosphere / space and ocean temperatures / atmospheric temperatures will rise.	Comprehensively: • compares ocean vs ice as a regulator of temperature due to different reflective abilities of ice compared with ocean • explains how reducing the reflective ability of the Earth (the polar ice caps diminishing) will lead to an increase in temperature of the Earth over time.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	One point partially described.	Describes ONE point.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Comprehensively explains ONE point.	Comprehensively explains BOTH points.

QUESTION TWO			
Expected Coverage	**Achievement**	**Merit**	**Excellence**
The Earth is heated by the Sun releasing energy due to nuclear fusion reactions of hydrogen into helium. The Sun is full of hydrogen gas that is colliding and making heat energy by nuclear fusion. Nuclear fusion is where two small atoms combine to form a larger element and release energy ($E = mc^2$). Once in the Earth's atmosphere the infrared radiation is directly absorbed by the Earth's surface making it become hotter. When the surface is heated up, the heat energy is transferred by conduction to the atmosphere, with the vibrating hotter particles passing on their heat energy to the cooler particles sitting next to them. The Earth is tilted 23.5℃, which means that one of the Earth's poles is tilted towards the Sun for half the year and the other pole is tilted away from the Sun for the same amount of time. When the Earth's pole that is tilted towards the Sun, the heat energy that arrives from the Sun is concentrated over a small area of land and so this land is heated to a higher temperature, which means summer is hotter than winter. In winter, the pole is tilted away from the Sun and the heat energy that arrives from the Sun is spread out over a greater area of land, and so the temperature of the land cannot reach the same temperature as summer because the same amount of heat energy is heating a bigger area of the Earth.	Describes: • source of Sun's heat energy • main methods of heat transport of infrared radiation from the sun to the land • that land temperature depends on the amount of heat energy transferred from the sun • heating effect / temperature in relation to the surface area • heating effect in relation to the rotation of the Earth around the sun • heating effect in relation to the Earth's tilted rotational axis.	Explains: • main methods of heat transport of infrared radiation from the Sun to the land • link between the Earth's rotation around the Sun and Earth's tilt with exposure to the sun • how tilt of Earth leads to uneven heating of land surface,	Comprehensively: • explains in detail how heat energy from the sun can heat particles on the surface of the land • links land temperature to the same amount of heat energy arriving from the Sun but that in winter this heat energy hits more of the land area (angle of Earth), so temperature rise is less.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	One point partially described	Describes ONE point.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Comprehensively explains ONE point.	Comprehensively explains BOTH points.

QUESTION THREE			
Expected Coverage	**Achievement**	**Merit**	**Excellence**
The heat energy is absorbed by the Earth, then released out to the atmosphere by conduction. Usually the air closest to the ground is the hottest due to conduction, and the air temperature decreases the higher you are from the ground, as convection makes the hot and cold air particles mix. In an inversion layer, the air temperature actually increases with height for a variable distance from the ground. This is because the air is held in place by surrounding hills and it cannot move and so cannot mix via convection. In winter, the Sun heats the Earth up via infrared radiation but as the Sun sets, the Earth's temperature drops. The warm air that is already above the ground because it has been heated by the Earth earlier in the day is still and doesn't move, trapping the cold air below and making two distinct layers that don't mix due to the lack of convection. The cold layer contains trapped air pollution from the activities of the residents in the location and so causes winter air pollution. ie during inversion, temperatures increase with increasing altitude. The warm inversion layer acts as a cap and stops atmospheric mixing, thereby trapping pollutants.	Describes: • that the ground absorbs the heat energy during the day and releases heat energy later in the day • conditions needed for an inversion layer to occur (cold ground; still, trapped air above) • how pollution is trapped in the lower layer and unable to escape • how normally air temperature decreases with height • how convection currents form.	Explains: • that usually the air temperature decreases as height increases due to convection • how the atmosphere is heated by land mass • how an inversion layer acts as a "ceiling / trap" to convection currents • how inversion layer means that air temperature increases as height increases.	Comprehensively: • explains in detail how the air temperature gradient is reversed for inversion layer • explains in detail how air particles are trapped in lower cooler layer to form smog / air pollution • explains in detail how the temperature gradient operated through the day and the effect of the inversion layer.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; no relevant evidence.	Partially describes one point	Describes ONE point.	Describes TWO points.	Describes THREE points.	Explains ONE point in detail.	Explains TWO points in detail.	Comprehensively explains ONE point.	Comprehensively explains TWO points.