MODULE 3: WHAT EVIDENCE DO WE HAVE OF CLIMATE CHANGE?

ANSWER SHEET

ACTIVITY ONE

The graphic shows what has happened to the world's air temperatures over time and the temperature anomalies (variation from the average) over time. The answers to the questions are

1. This graphic shows the average temperature of the Earth's surface from 1850-2008.
2. Other elements of climate include precipitation (rain and snow), wind direction and strength and air pressure.
3. The horizontal, x, axis shows time in years from 1850-2008.
4. The vertical, y, axis shows how different the temperature is from the average of 1961-1990.
5. Each of the bars shows the average air temperature element of the world's 'weather' for that year. The black line shows the changing 'climate' over time. Climate is usually taken to be a 30 year average (running mean).
6. The climate has been getting warmer since 1900,. The climate warmed most at the beginning of the 20th century and then from the 1970s onwards.
7. This overall warming has not occurred evenly across the world's surface and different places, because of their location and geography, are affected in different ways.

ACTIVITY TWO

Answers to the quiz

STATEMENT	'TRUE' ANSWER	'FALSE' ANSWER
Without the natural Greenhouse Effect, our planet would be much warmer than it is now.	Well done! As I'm sure you know, without the Greenhouse Effect the Earth would be, on average, about 33°C colder than it is now.	I'm afraid the opposite is true. Without the Greenhouse Effect the Earth would be, on average, about 33°C colder than it is now.
The greenhouse gases which absorb heat coming from the earth's surface are mainly methane and ozone.	I'm afraid you've got your gases mixed up! The correct answer is water vapour and carbon dioxide.	You're right! As you probably know, the correct answer is water vapour and carbon dioxide.
Over the last 50 years, global warming has been caused by changes in the sun's energy.	Think again! Over the last 50 years, global warming has been caused by increases in the levels of	Well done! Over the last 50 years, global warming has been caused by increases in the levels of

	greenhouse gases in the atmosphere. These gases trap in heat escaping from the earth's surface.	greenhouse gases in the atmosphere. These gases trap in heat escaping from the earth's surface.
Dark surfaces absorb more of the Sun's energy than light surfaces.	You're right! Darker surfaces such as land and water absorb the sun's energy, causing more warming, whereas lighter surfaces such as glaciers and ice caps reflect a large amount of the sun's energy.	No, the opposite is true! Light surfaces such as glaciers and ice caps reflect a large amount of the sun's energy rather than absorbing it. Dark surfaces such as land and water absorb the sun's energy causing more warming.
Climate is the day-to-day condition of our atmosphere, for example how warm, cold, dry or wet each day is.	No, I'm afraid you've mixed up weather and climate. Weather is the day-to-day condition of our atmosphere, whereas climate is the average weather we might expect over (a period of) 30 years or more.	Well done. As you probably know, weather is the day-to-day condition of our atmosphere, whereas climate is the average weather we might expect over (a period of) 30 years or more.
High clouds tend to warm the climate, low clouds tend to cool the climate.	Yes, you're right. High clouds can absorb infrared radiation (heat) and warm the earth, whereas low clouds can reflect away solar energy (sunlight), cooling the Earth.	I'm afraid you've got your clouds muddled! High clouds can absorb infrared radiation (heat) and warm the earth, whereas low clouds can reflect away solar energy (sunlight), cooling the Earth.
Since the 1970's global warming has been greater over the oceans than over the land.	No, the opposite is true. Since the 1970s warming has been greater over land than oceans, especially over Asia and northern North America.	Yes, well done! Since the 1970s warming has been greater over land than oceans, especially over Asia and northern North America.

Global temperatures are likely to rise 2-4°C by the end of the 21st century.	Yes, although we cannot say exactly what will happen to the climate in the future, this is what the world's leading scientists (IPCC) think is likely to happen. The actual temperature rise depends on how much greenhouse gas is emitted over the next 80 years.	You're wrong I'm afraid! Although we cannot say exactly what will happen to the climate in the future, this is what the world's leading scientists (IPCC) thinks is likely to happen. The actual temperature rise depends on how much greenhouse gas is emitted over the next 80 years.
Global warming means that every country will get hotter and drier.	No, the effects of global warming will be different in different regions. For example there might be increased drought in Australia, Africa and Southern Europe, and increased flooding in South Asia. *	There's no catching you out! The effects of global warming will be different in different regions. For example there might be increased drought in Australia, Africa and Southern Europe, and increased flooding in South Asia.*
Over the past 150 years global temperatures have fallen.	I'm afraid the opposite is true! Over the past 150 years the average temperature of the Earth's surface has risen. In fact, current global temperatures are warmer than they have been for the past five centuries.	Well done. As I'm sure you know, over the past 150 years the average temperature of the Earth's surface has risen. Current global temperatures are warmer than they have been for the past five centuries.
Changes in the concentration of greenhouse gas in the atmosphere is the main reason for global warming in the past 50 years.	You're right! Over the last 50 years, global warming has been caused mainly by increases in the levels of greenhouse gases in the atmosphere. These gases trap in heat escaping from the earth's surface.	You're wrong I'm afraid! Over the last 50 years, global warming has been caused mainly by increases in the levels of greenhouse gases in the atmosphere. These gases trap in heat escaping from the earth's surface.

The only way to predict the climate for the next 100 years is to use very complex mathematical models.	Yes this is true. Some of the biggest models contain 10 million lines of computer code! They can tell us what the climate is most likely to do and what it probably won't do.	No, this is true. Some of the biggest models contain 10 million lines of computer code! They can tell us what the climate is most likely to do and what it probably won't do.
A sustained rise in local temperatures of about 6°C would melt the Greenland Ice Sheet.	No, I'm afraid you've got your temperatures mixed up! A sustained local rise of about 3°C (that's global warming of about 1.5°C) would melt the Greenland Ice Sheet, although this would probably take a few thousand years.	There's no fooling you! A sustained local rise of about 3°C (that's global warming of about 1.5°C) would melt the Greenland Ice Sheet, although this would probably take a few thousand years.
Temperatures over the ocean are likely to rise twice as fast as temperatures over the land.	No, the opposite is true! Temperatures over the land are likely to rise twice as fast as temperatures over the ocean.	Well done! Temperatures over the land are likely to rise twice as fast as temperatures over the ocean.
If we stop emitting greenhouse gases now, the climate will stop warming.	I'm afraid you're wrong. The climate will not stop warming immediately. Although the levels of some greenhouse gases, such as methane, will decrease almost immediately, CO_2 can remain in the atmosphere for up to 200 years.	Correct answer! The climate will not stop warming immediately. Although the levels of some greenhouse gases, such as methane, will decrease almost immediately, CO_2 can remain in the atmosphere for up to 200 years.
It's much easier to forecast the weather for next month, than it is to predict changes in the climate.	Surprisingly enough, you're wrong! Weather is a short-term, local phenomenon. To predict the weather you need to know exactly what is happening in the atmosphere down to the smallest scale. Climate is the average weather pattern of a region over many years. I may not be able to predict the weather in Beijing on May 20 2009, but I can predict with confidence that it will be hotter than it is today, in mid-July.	Well done! Weather is a short-term, local phenomenon. To predict the weather you need to know exactly what is happening in the atmosphere down to the smallest scale. Climate is the average weather pattern of a region over many years. I may not be able to predict the weather in Beijing on May 20 2009, but I can predict with confidence that it will be hotter than it is today, in mid-July.

Tipping points refer to abrupt climate change	Yes, you're right. An example of abrupt climate change would be the rapid loss of the Greenland Ice Sheet. However, abrupt changes like this are not likely to occur in the 21st century.	You're wrong, I'm afraid. An example of abrupt climate change would be the rapid loss of the Greenland Ice Sheet. However, abrupt changes like this are not likely to occur in the 21st century.
Abrupt climate change has never happened before.	I'm afraid you're wrong. Abrupt climate change has occurred naturally in the past. A gigantic release of methane from below the ocean bed 56 million years ago led to a sudden warming of 6°C in the climate. This was at a time when global temperatures were much higher than now.	There's no catching you out! Abrupt climate change has occurred naturally in the past. A gigantic release of methane from below the ocean bed 56 million years ago led to a sudden warming of 6°C in the climate. This was at a time when global temperatures were much higher than now.

SOURCE *IPCC Fourth Assessment Report - Climate Change: impacts and adaptation by Ms Lucka Kajfez Bogataj, Former IPCC WG II Vice-chair (see http://www.ipcc.ch/graphics/presentations.htm)

ACTIVITY THREE

- There was no accurate measurement of air temperature until the 17th Century. To know what was happening before 1850, we have to rely on what things like tree rings, fossils, and the gases trapped in ice cores tell us about local temperatures. This information is much less precise, and much less global, than for example the satellite data we have nowadays. There is no single thermometer measuring the global temperature. Instead, individual thermometer measurements taken every day at several thousand stations over the land areas of the world are combined with thousands more measurements of sea surface temperature taken from ships moving over the oceans. These produce an estimate of global average temperature every month. It is now possible to use these measurements from 1850 to the present, and although coverage is much less than global in the second half of the 19th century, it is much better after 1957 when measurements began in Antarctica, and best after about 1980, when satellite measurements began.
- There has been a rapid rise in temperature since 1950.

ACTIVITY FOUR

- During the 20th century there have been two 'warming phases' the first from the 1910s to the 1940s (0.35°C),
- The most significant has been from the 1970s to the present (0.55°C).

ACTIVITY FIVE

There are many sources of information about extreme weather conditions. http://www.rgs.org/NR/rdonlyres/32634944-D055-4B94-9C89-1686645C794D/0/Bangladeshfloods.pdf is a case study of flooding in Bangladesh and the measures taken to try to minimize the effects of future flooding