OXFORD CAMBRIDGE AND RSA EXAMINATIONS

GCSE

A214/01

TWENTY FIRST CENTURY SCIENCE

SCIENCE A

Unit 4: Ideas in Context (Foundation Tier)

INSERT

THURSDAY 24 MAY 2012: Morning

DURATION: 45 minutes
plus your additional time allowance

MODIFIED ENLARGED

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

- **Do not send this insert for marking; it should be retained in the centre or destroyed.**

INSTRUCTIONS TO CANDIDATES

- **This insert contains the three articles required to answer the questions.**

DC (CW/JG) 12MEP06083 62277

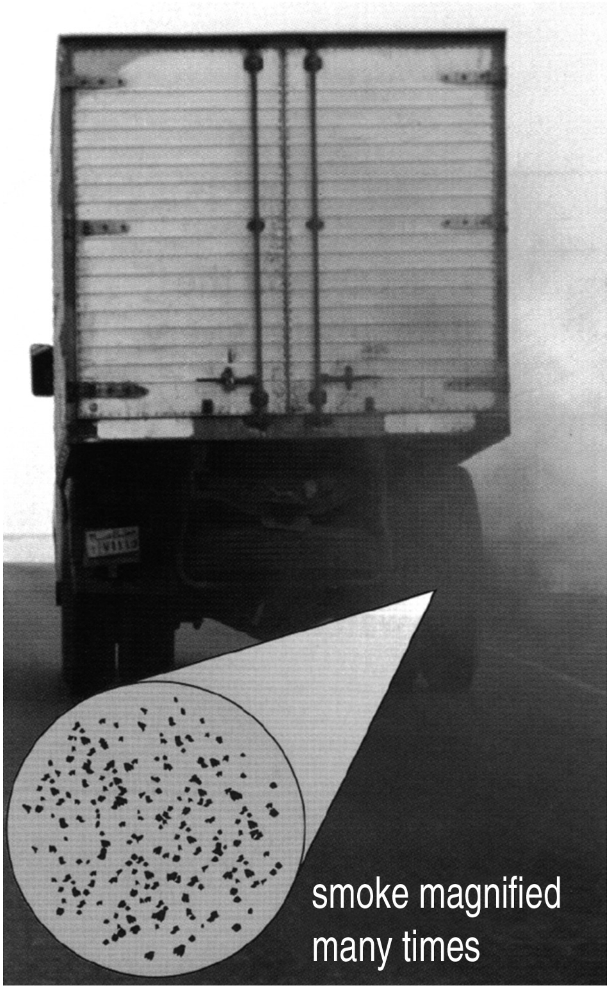
Particulate perils

What are particulates?

Particulates are small bits of solid or liquid. They are tiny enough to stay floating in the air for several weeks. Particulates less than 10 micrometres in diameter are known as PM_{10}. This is about 1/7th of the thickness of a human hair.

Where do particulates come from?

More than 90% of particulates in the air result from natural sources such as volcanoes, pollen and moulds. The other 10% of particulates are caused by human activity, mostly from burning fossil fuels. When fossil fuels burn completely in a plentiful supply of air they make carbon dioxide and water. But when they burn in a limited supply of air they also make carbon particulates. This air pollution is often called ‘black carbon’ and is released in the exhaust gases of motor vehicles.



How do particulates affect the climate?

Particulates in the air can both scatter and absorb solar radiation.

The result of the scattering of solar radiation is an increase in the amount of radiation reflected back into space. This means that less solar radiation reaches the Earth's surface.

Particulates also absorb some of the solar radiation directly and, depending on the size and concentration of the particulates, can contribute to global warming.

Particulates do not remain in the air forever, and eventually settle on solid surfaces such as glaciers. If a glacier becomes coated with a black layer of particulates,

this will absorb solar radiation. Therefore the ice melts faster. So there may be a link between particulate pollution and a rise in sea level.

Particulates can also cause a decrease in rainfall. Water condenses onto them forming very small droplets that do not fall as rain.

How do particulates affect health?

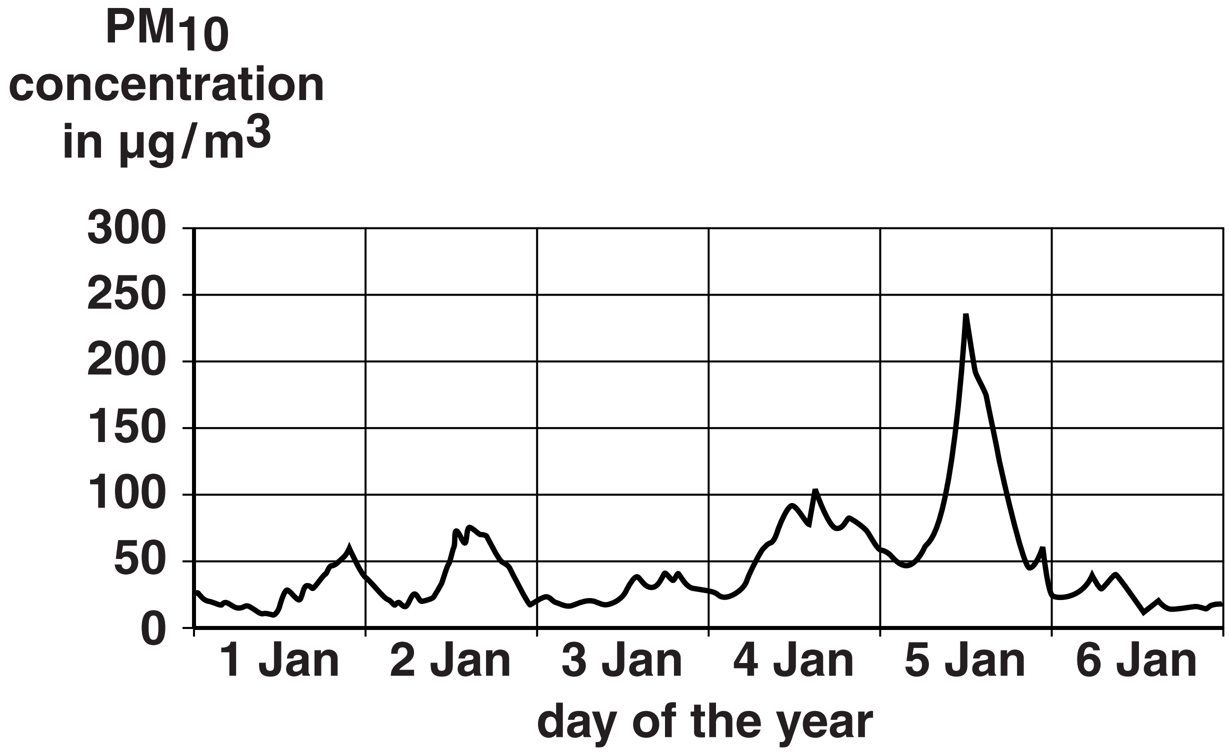
The effects of inhaling particulates have been widely studied in humans and animals. These effects include asthma, lung cancer, and cardiovascular disease, all of which can cause premature death. Because of their very small size, particulates with a diameter of 10 micrometres or less can penetrate the deepest part of the lungs and cause health problems.

Are there limits for particulate concentration?

Limits for PM_{10} in the air have been set for Europe. From 1 January 2010 the maximum yearly average must not be greater than 20 $\mu g/m^3$ and the daily (24 hour) average must not be greater than 50 $\mu g/m^3$.

Scientists measured the PM_{10} concentration in a European city centre on each of the first six days in January 2010.

Their results are shown in the graph.



Scientists also found that the highest number of hospital admissions for asthma in the city during this time was on 5 January.

Boston study

Researchers studied the 107 925 deaths in the residential area of Boston USA from 1995 to 2002. They found that increases in particulate concentration in the air were linked with a rise in deaths on the next day. The researchers think that particulates may cause deaths. They need to carry out further research to support this theory.

Scientist knows his own future

Forty-year-old scientist Professor Stephen Quake may know his own future. He has had his genes mapped. This allows scientists to predict some of the diseases that Stephen may get in the future. Even though he is healthy at the moment, he was told that he was at increased risk of diabetes, cancer and a rare heart condition that ran in his family. This condition could cause sudden cardiac death or "sudden death syndrome". He was also at much greater risk of becoming obese and developing coronary heart disease.

The good news for Stephen was that he was at a much lower risk of developing Alzheimer's disease in his later life.

Stephen volunteered to have all of his genes mapped and compared against genetic variations known for 55 different genetic conditions. The total cost for the procedure was £33 000. The cost of gene mapping is falling.

The procedure was possible because of the Human Genome Project, which was completed in 2003. Following this, it has been possible to catalogue individual genetic

variations that are associated with different genetic conditions, in computer databases. The databases are continually updated. Stephen's genes were compared with these databases. A computer then calculated Stephen's risk of certain genetic conditions based on his age and sex.

Before taking the test, Stephen was given counselling, so that he was prepared for any bad news.

After the test, Stephen said: "It's certainly been interesting. I was curious to see what would show up. But it's important to recognise that not everyone will want to know the intimate details of their genome, and it's entirely possible that this group will be the majority. There are many ethical, educational and policy questions that need to be addressed."

Scientists say that although the study ushers in a new era of personalised medicine, it raises ethical dilemmas. Scientists believe that a similar test could be on offer to everyone in about ten years' time.

Professor Henry Greely of Stanford Law School in California said that doctors are about to be hit by a "tsunami" of genome sequence data. He said: "The experience with Steve Quake's genome shows we need to start thinking – hard and soon – about how we can deal with that information".

Observing the night sky

People have always looked up at the night sky and tried to make sense of what they see. From very early times, people observed the regular movements of the Sun and Moon across the fixed pattern of the stars. The stars themselves are tiny, fixed points of light which all seem to move together around the Earth. There are also some bright star-like objects – the planets – which seem to wander about.

From the earliest times, however, observers also saw blurry smudges of light in the night sky. Some quickly became brighter, grew tails and moved about between the stars: these are comets. Others seemed fixed among the stars and were called 'nebulae', which means 'clouds'.

The invention of the telescope in the early 17th century showed a lot of detail in the night sky. Galileo turned his telescope on the Milky Way, also called the Galaxy, a white band stretching across the night sky. He saw for the first time that it is made of many thousands of stars.

In 1781 William Herschel, a keen comet observer, spotted a round, blurry shape. He thought at first it was a comet, but careful observations of its movement proved that it was in fact a planet, later named Uranus.

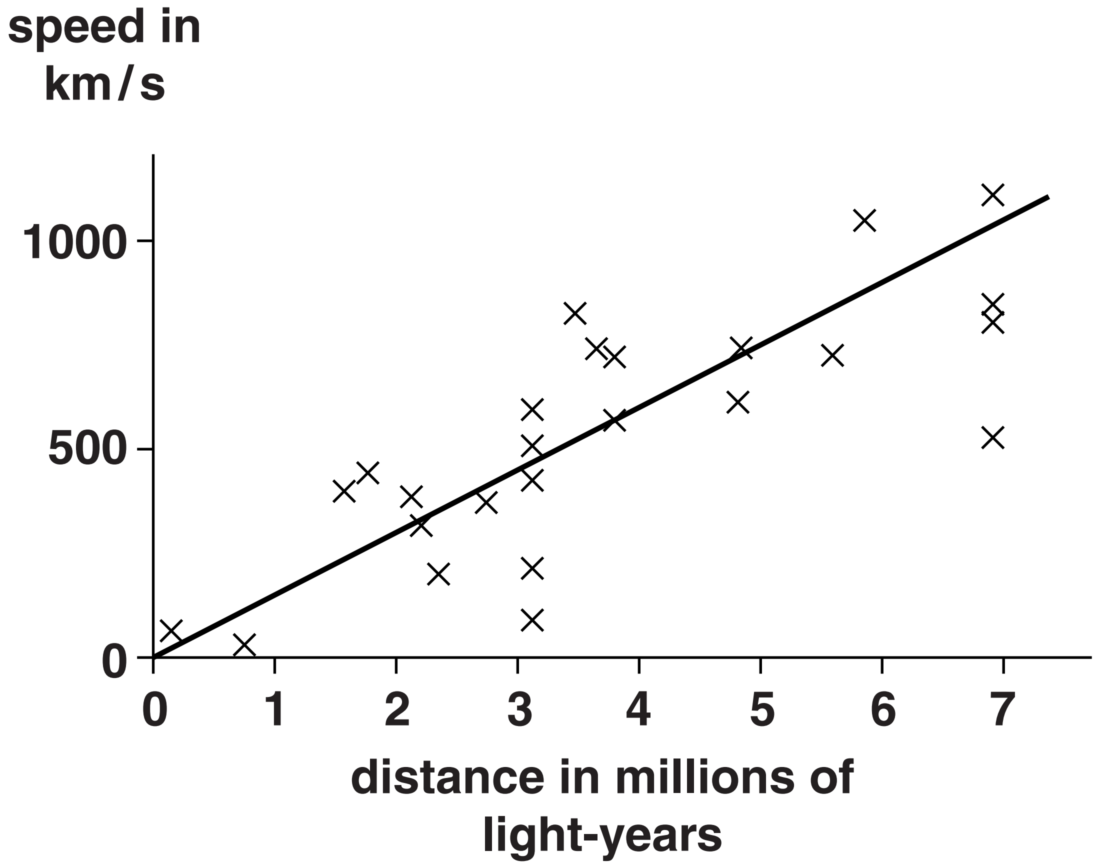
William Herschel

Other astronomers looked in detail at nebulae. Powerful telescopes soon showed that some of these nebulae are clouds of matter, where new stars are being created. Most of the nebulae, however, are made up of large numbers of stars. But how far away are these starry nebulae?

In a famous debate about the starry nebulae in 1920, two points of view were expressed by leading American astronomers. Harlow Shapley claimed that the starry nebulae were inside our Galaxy, and the Milky Way was the entire Universe. Heber Curtis claimed that the Universe was much bigger than Shapley thought, and that the starry nebulae were outside the Milky Way.

More observations were needed before any judgement could be passed on the two theories. Within three years of the debate, Edwin Hubble measured the distance to one of the starry nebulae in the constellation of Andromeda. He showed that the Andromeda nebula is far outside the Milky Way. All starry nebulae are galaxies, just like the Milky Way.

Over the next decade, Hubble measured the distances and speeds of a number of distant galaxies. He plotted his data and obtained this graph:



His data supported the idea that the Universe started with a big bang. Recent data obtained in the same way showed that this happened nearly 14 thousand million years ago. Satellite measurements of microwave radiation support this finding. However, detailed observations of galaxies show that they do not move exactly as theory predicts. This suggests that there is a lot that we do not yet understand about the early Universe.

BLANK PAGE