Twenty First Century Science

PILOT
Examination Questions

GCSE Science Jan 2005

Air quality, You and your genes, Earth in the Universe (Higher Tier)

Please note:

- **These questions are <u>not</u> Sample Assessment Materials (SAMs) for the new specification (teaching from Sept 2006).**
- **The style of question varies from that used for the new specifications.**
- **For up to date SAMs see www.gcse-science.com.**
- **These questions are provided for classroom use by teachers, to help develop students understanding of Ideas about Science.**
- **Some of the material covered in these questions is no longer part of GCSE Science specification. Teachers should check their specification document before using these questions.**

Answer **all** the questions.

1 Not everyone agrees about the age of the Earth. Read this story of how ideas changed and then answer the questions.

How old is the Earth?

James Ussher was Archbishop of Armagh.

In 1645, he followed family histories in the Bible back in time.

He calculated that the Universe was created in the year 4004 BC, on October 23.

By the late 1700s, it was known that rocks eroded.

James Hutton, a Scottish farmer, noticed that Hadrian's Wall had not been eroded very much.

It was made from stone and had been there for over 1000 years.

He said that the Earth must be older than Ussher suggested.

By 1897, many people were studying science.

William Thompson suggested that the Earth had once been a ball of molten rock.

He said that it was cooling down gradually by conduction and radiation.

He worked out that it must be between 24 million and 400 million years old.

Radioactivity was discovered in 1896.

In 1905, Ernest Rutherford used radioactive decay of minerals to work out the age of the Earth. He said it was 500 million years old.

Today scientists estimate the age of the Earth as being much older.

(a) Ussher's announcement that the Universe was created in 4004 BC was not challenged by many people in Britain in 1645.

Suggest why.

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..... [2]

(b) James Hutton thought that Hadrian's Wall showed that the Earth must be much more than 5 000 years old.

Explain why.

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..... [2]

(c) William Thompson did not know about radioactive decay. Radioactive decay releases heat energy.

Explain why Thompson's cooling model gave too low a value for the age of the Earth.

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(d) The information in the question describes how estimates about the age of the Earth have changed.

Use your ideas about how science theories are developed to explain how this happened.

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[Total: 9]

2 Nepal is a small country, high in the Himalaya mountains. 90% of its population work in agriculture, yet it is threatened with air pollution.

Nepal is building big concrete dams to supply hydroelectric power. Concrete manufacture is a dusty business.

Cement is used to make concrete.

Cement is made by mixing chalk and clay and heating to very high temperatures in a coal-fired furnace. The coal forms soot and ash.

The chalk (calcium carbonate) decomposes to form lime (calcium oxide) and carbon dioxide.

The calcium oxide then reacts with the clay to form calcium silicate. The small lumps of calcium silicate are ground to a very fine powder – cement powder.

(a) Write the word equation for the decomposition of calcium carbonate when it is heated.

[1]

(b) Suggest **one** cause of dust from the manufacture of cement.

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..... [1]

(c) The coal used to heat the furnace contains sulfur, which forms sulfur dioxide when coal burns.

Describe what happens to sulfur dioxide when it is released into damp air.

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..... [2]

(d) There is a large concrete factory near Kathmandu, the capital of Nepal. Every year, this factory alone puts 6 000 tonnes of dust into the air around Kathmandu.

Suggest an experiment that could be done to compare the amount of dust in the air at different places around Kathmandu.

One mark will be for a clear, ordered answer.

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[Total: 8]

3 This newspaper article refers to a study of genes, environment and health.

Gene study will provide 30 years of Human Data

Manchester-based UK Biobank to monitor health of 500,000

In one of the largest studies of human health, researchers will look at the genes, lifestyle and health of 500,000 volunteers for the next 30 years.

Many disorders are caused by both our genes **and** our lifestyle. This includes cancer, heart disease and diabetes.

Researchers will use the UK Biobank to uncover the genetic and environmental triggers for these common conditions.

(a) **(i)** Describe where in cells genes are found.

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..... [1]

(ii) Describe the function of genes.

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..... [2]

(b) This article refers to some disorders that are "caused by both our genes **and** our lifestyle."

(i) Write down the name of **one** disorder that is caused **only** by one gene.

..... [1]

(ii) Describe the symptoms of this disorder.

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..... [2]

(c) A representative from UK Biobank suggests that the data will only be available to researchers from pharmaceutical companies, universities, medical charities and the National Health Service.

(i) Suggest how researchers might use this data.

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(ii) It is unlikely that the UK Biobank will allow the data to be made available to others such as insurance companies or employers.

Suggest **and** explain one argument for and one argument against the data being made available to other people.

one argument for .....

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one argument against .....

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..... [4]

[Total: 11]

4 Some cars now have two fuel tanks. They are called 'dual fuel' cars and can either burn liquefied petroleum gas (LPG) or normal petrol. The extra cost compared to a normal petrol car is £1800.

LPG is a 'cleaner' fuel than petrol. Unlike petrol, it contains no sulfur. When it burns, it makes less carbon monoxide, much less nitrogen oxides and fewer solid particles of soot. It also costs about half as much as petrol.

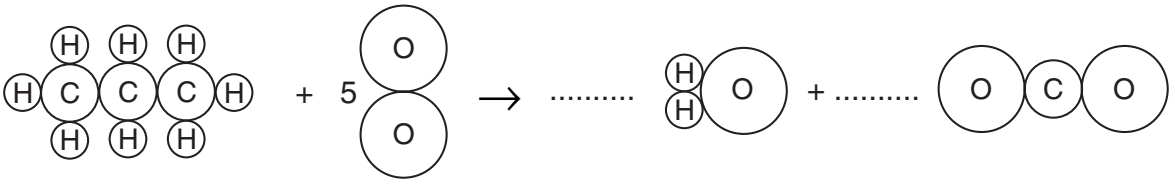
Not all garages sell LPG, so these cars have two fuel tanks, one for each fuel. This makes little difference to the performance of the car, but it takes up extra space, so usually the boot will be smaller.

Drivers usually use LPG, and the car will automatically switch to petrol when the gas tank is empty.

(a) LPG is mainly propane, C_3H_8. Propane burns in air to produce water and carbon dioxide.

propane + oxygen $\longrightarrow$ water + carbon dioxide

Complete the diagram below to show how many water molecules and carbon dioxide molecules are produced when propane burns.



[2]

(b) An average family car covers 12 000 miles each year.

If it ran on petrol for all of the year, it would give out 3 tonnes of carbon dioxide.

If the car ran on LPG for the same distance, it would use 0.6 tonnes of LPG.

Each tonne of LPG which is burned gives out 3 tonnes of carbon dioxide.

(i) Calculate the mass of carbon dioxide given out by burning 0.6 tonnes of LPG.

mass = ... tonne [1]

(ii) Calculate how much **less** carbon dioxide is released into the atmosphere as a result of burning LPG instead of petrol.

mass = ... tonne [1]

(c) When running on LPG, the car does 6 miles to the litre. A litre of LPG costs 36 p.

Calculate the fuel cost per mile when using LPG.

fuel cost = ... pence per mile [1]

(d) Using LPG saves 3 p per mile compared with using petrol.

(i) Calculate the money saved in fuel costs if all 12 000 miles each year were fuelled by LPG, rather than petrol.

savings = ... [1]

(ii) Calculate the number of years it would take to recover the £1800 cost of installing a dual fuel system if all 12 000 miles each year were fuelled by LPG, rather than petrol.

time = ... years [1]

(e) Describe the advantages **and** disadvantages of running a dual fuel car.

advantages .....

.....

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disadvantages .....

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..... [4]

[Total: 11]

5 Genetic engineers have found a way to make human proteins using yeast.

> **Researchers tweak yeast DNA to produce human protein**
>
> "For the first time, we have shown that yeast can be used to produce a complex human glycoprotein".

(a) The diagram shows part of a DNA molecule.

DNA has a double helix structure and is made up of four different bases.

In the diagram, the four bases are represented by the letters: **A**, **C**, **G** and **T**.

Finish the diagram by writing in the correct letter for each missing base.

[2]

(b) The yeast DNA is used to produce human protein.

Explain how a section of DNA produces a specific protein.

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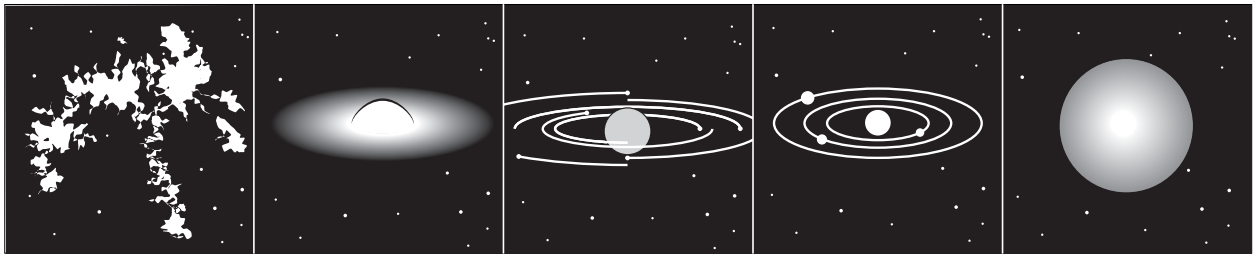
[Total: 5]

6 **(a)** The diagrams show some of the stages in the life of the Sun and solar system.



Use the diagrams to help you tell the life story of the Sun.

One mark will be for a clear, ordered answer.

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(b) Betelgeuse, a bright star in the constellation Orion, is 600 light years away from Earth.

People say that when we look at a star we are **looking back in time**.

Use Betelgeuse as an example to explain what this means.

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..... [2]

(c) The Milky Way is one of many galaxies in the Universe. Astronomers have observed that the galaxies are moving.

Describe this movement **and** explain what this suggests about the beginning of the Universe.

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..... [3]

[Total: 11]

7 Chris has diabetes.

In the future, gene therapy may cure diabetes.

(a) Here are five sentences describing the process of gene therapy.

They are in the wrong order.

A Put normal gene into cells of person with diabetes.

B Find a person without diabetes to donate some cells.

C Identify the gene that causes diabetes.

D Cells follow instructions on normal gene, curing the diabetes.

E Take normal gene from donated cells.

Fill in the boxes to show the correct order. The first one has been done for you.

C				

[3]

(b) Chris reads that gene therapy could be used on human embryos, to prevent genetic conditions. He has mixed views about this.

Suggest one argument **for** and one argument **against** using gene therapy on human embryos.

one argument for .....

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one argument against .....

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..... [2]

[Total: 5]

END OF QUESTION PAPER