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# AS SCIENCE IN SOCIETY

## Unit 1 Exploring Key Scientific Issues

Thursday 19 May 2016

Morning

Time allowed: 2 hours

### Materials

For this paper you must have:

- a pencil
- a ruler
- a calculator.

### Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show the working of your calculations.

### Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 90.
- You will be marked on your ability to:
  - use good English
  - organise information clearly
  - use specialist vocabulary where appropriate.
- You are expected to use a calculator where appropriate.



Answer **all** questions in the spaces provided.

**1 (a)** Cryptococcal meningitis (CM) is a fungal infection that causes inflammation of the membrane that covers the brain inside the skull.

CM is a common illness for patients infected with HIV. It is the second most common cause of death for HIV patients in parts of Africa.

**1 (a) (i)** Describe how the immune system responds to infection by a microbe, such as the CM fungus.

**[2 marks]**

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**1 (a) (ii)** Suggest why patients with HIV are at greater risk from CM.

**[1 mark]**

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**1 (b)** A group of researchers from the UK, Zambia and Tanzania studied the effect of providing infection screening for CM and home visits in the first few weeks after a patient was diagnosed with HIV.

Patients were recruited from six clinics: three in Zambia and three in Tanzania. Each patient was asked to provide written informed consent before they were enrolled on the study.

Once enrolled, each patient was randomly put into one of two groups. The two groups were:

- standard care: patients treated with the current best practice for the clinic they attended
- care+support: in addition to being treated with the current best practice, patients received weekly home visits from a trained non-medical clinic worker for 4 weeks. Patients were also screened for CM and offered antifungal treatment if they tested positive. The home visits were to make sure that patients took the correct medicines to treat their illnesses.



- 1 (b) (i)** Suggest what information should have been given to patients before they gave consent to be in the study.

**[2 marks]**

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- 1 (b) (ii)** To prevent bias, the random grouping was done by a researcher who had no contact with the patients.

Describe **one** way that non-random allocation of patients could be biased and suggest the effect that this bias might have on the outcomes of the study.

**[2 marks]**

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- 1 (b) (iii)** Suggest why six clinics in two different countries were involved in the study.

**[2 marks]**

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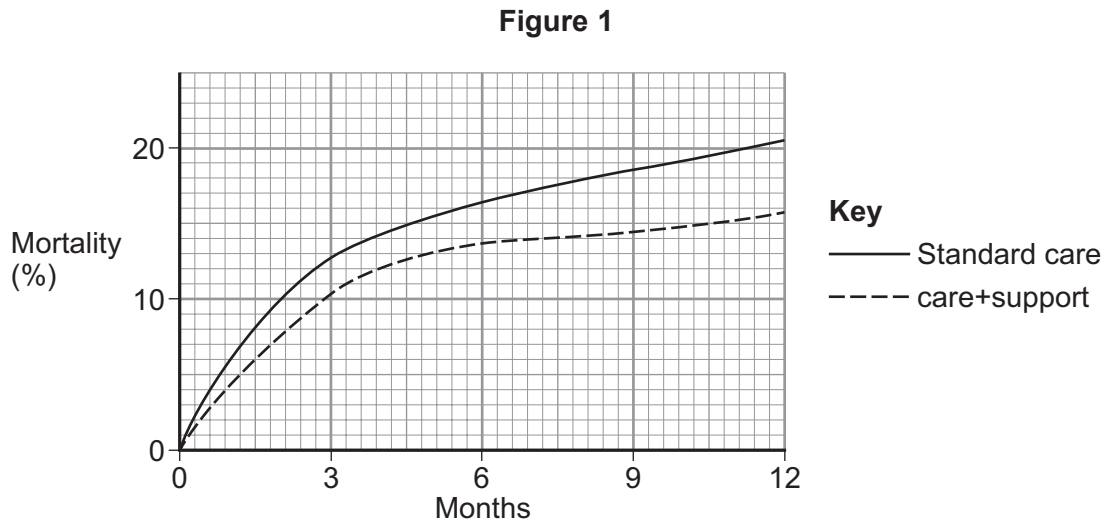
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- 1 (c)** The researchers monitored the patients in the trial for 12 months. During that time, they recorded the number of patients in each group who were still alive and calculated the percentage of patients in each group who had died.

**Figure 1** shows the cumulative percentage of patients who had died (mortality) during the 12 months of the study.



- 1 (c) (i)** Describe the trends shown in the data in **Figure 1**.

**[3 marks]**

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**1 (c) (ii)** The mortality was approximately 22% lower in the care+support group than in the standard care group.

By comparing the percentage of patients in the two groups who died by the end of the 12-month period (**Figure 1**), show how this value for reduction in mortality was obtained.

**[2 marks]**

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**Turn over for the next question**

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- 2 Electric cars are vehicles with a battery and motor instead of a combustion engine. In the UK the battery is charged by plugging the car into a charging point as shown in **Figure 2**.

**Figure 2**



One advertisement for an electric car said:

‘Cars are a vital part of our lives. The environment is a vital part of our lives. You shouldn’t have to choose between the two. We’ve designed our electric cars to be eco-friendly, so that you don’t have to make that choice. Our state-of-the-art engines provide the best performance around. Quick and agile about town: kinder to the environment.

With no CO<sub>2</sub> emissions, all you have to think about is the ride.’

- 2 (a) The advertisement claims that electric cars are better for the environment.

A combustion engine produces carbon dioxide (CO<sub>2</sub>).

- 2 (a) (i) Name **two** emissions, other than CO<sub>2</sub>, that a combustion engine produces.

**[2 marks]**

1 \_\_\_\_\_

2 \_\_\_\_\_



**2 (a) (ii)** Explain why switching to electric vehicles can improve human health.

**[2 marks]**

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**2 (a) (iii)** Is the advert correct to claim that the use of electric cars does not give rise to emissions of CO<sub>2</sub> to the atmosphere? Explain your answer.

**[2 marks]**

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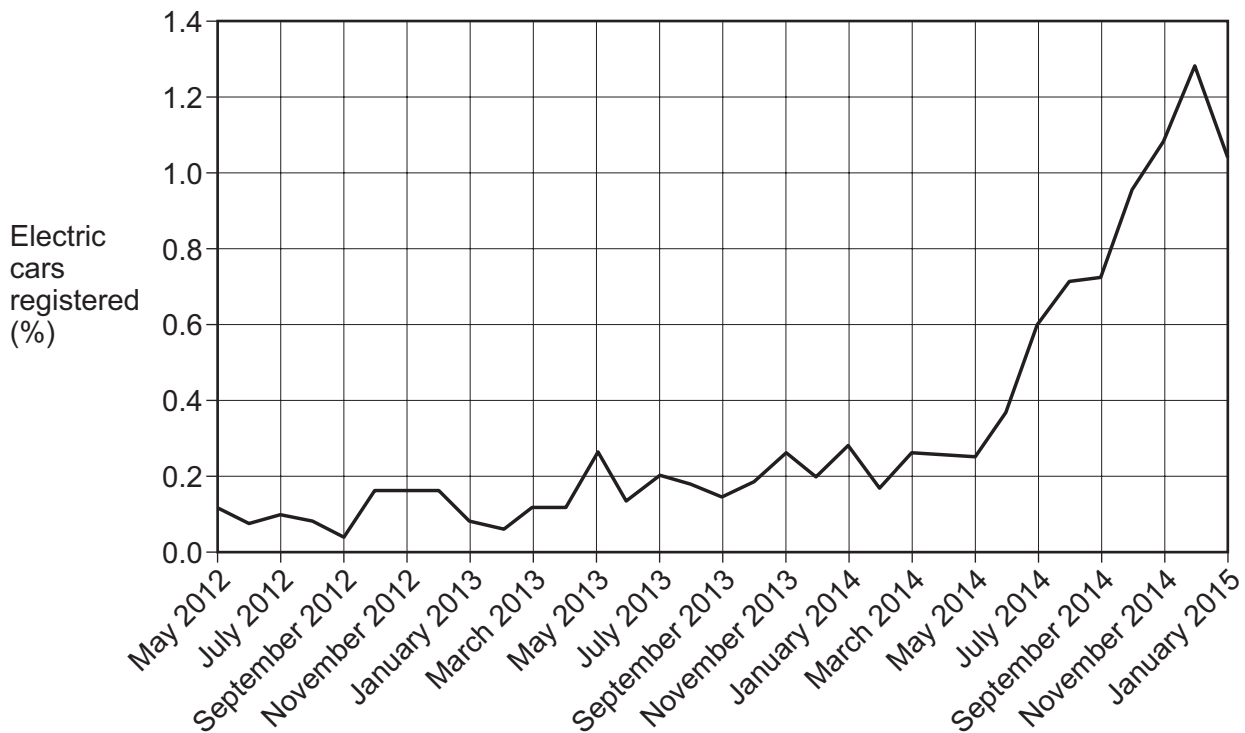


**2 (b)** In June 2011, the UK Government decided to support Low Emission Vehicles (LEV). The aim was to reduce transport emissions while still allowing mobility for motorists. Actions included:

- providing a grant of up to £5000 for people who bought an LEV
- reducing the cost of car tax for LEVs
- supporting pilot projects to install charging points in different areas.

**Figure 3** shows electric car registrations as a percentage of all new car registrations from May 2012.

**Figure 3**





**2 (b) (i)** Do the data in **Figure 3** suggest that the government's actions on LEVs caused a reduction in emissions from transport? Explain your answer.

**[3 marks]**

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**2 (b) (ii)** Do you think that the government should provide financial incentives to motorists to encourage them to buy electric vehicles? Explain your answer.

**[2 marks]**

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- 3** In 1983 the UK Government introduced dietary guidelines aimed at reducing coronary heart disease (CHD). The guidelines suggested that people reduce the amount of fat they ate to 30% of their calorie intake, and reduce saturated fat to 10% of their calorie intake.

In 2014, some researchers published a review of all the randomised control trials that had been reported before the UK Government introduced the guidelines in 1983.

The researchers identified seven relevant randomised control trials. These looked at the relationship between saturated fat and death from coronary heart disease. Brief details of each trial are given in **Table 1**.

All the trials recruited men who had suffered at least one heart attack. Trial **D** also recruited some men who had not had a heart attack.

**Table 1**

<b>Trial</b>	<b>Gender of participants</b>	<b>Age / years</b>	<b>Length of trial / years</b>	<b>Number of patients (treatment / control)</b>
<b>A</b>	Male	Under 70	2	28 / 26
<b>B</b>	Male	Under 70	2	26 / 26
<b>C</b>	Male	Under 65	3	123 / 129
<b>D</b>	Male	Under 60	3.4	199 / 194
<b>E</b>	Male	55+	8	424 / 422
<b>F</b>	Male	30–64	11	206 / 206
<b>G</b>	Male	30–59	5	221 / 237

- 3 (a) (i)** Suggest **one** reason why researchers in the trials recruited male participants who had already had a heart attack.

**[1 mark]**

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- 3 (a) (ii)** Explain why the choice of participants in all these trials could make the findings less widely applicable.

[2 marks]

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- 3 (b)** The randomised control trials were all dietary interventions that either substituted vegetable oil for other types of fat, or limited the amount of fat (and other foods) that participants in the treatment group ate.

Cohort studies have also been used to study the effect of saturated fat on coronary heart disease.

Complete **Table 2** to give **one** benefit and **one** disadvantage of randomised control trials and cohort studies for finding out about the link between diet and health.

[4 marks]

**Table 2**

	<b>Benefit</b>	<b>Disadvantage</b>
Randomised control trials		
Cohort studies		

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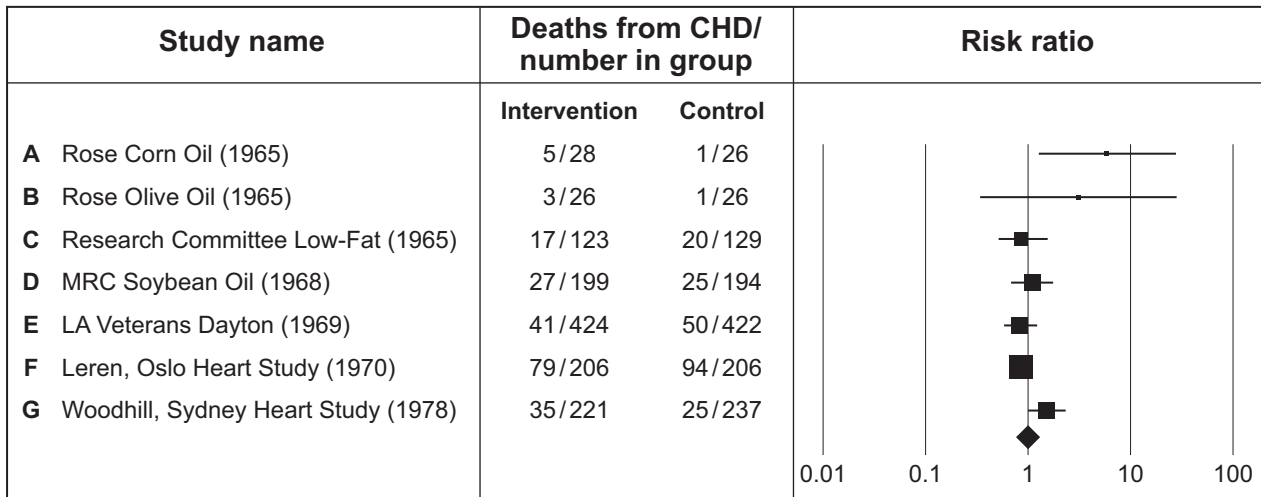
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**3 (c)** For each of the seven trials, the researchers who published the review compared the number of deaths in the intervention group with the number of deaths in the control group. They also combined the data to produce an overall risk ratio for the dietary interventions.

**Figure 4** shows the risk ratio for each of the seven trials. A risk ratio below 1 shows a lower risk of death for the men who were given the changed diet compared with those whose diet was not changed. The diamond mark represents the overall risk ratio for the seven trials. Larger squares represent better quality studies.

**Figure 4**



A number of newspapers reported the findings of the comparison of trials. One headline is shown below.

‘Fat is the key to living longer: previous diet advice was **wrong**, say experts’

Use the data in **Figure 4** to discuss whether the headline is justified.

**[3 marks]**

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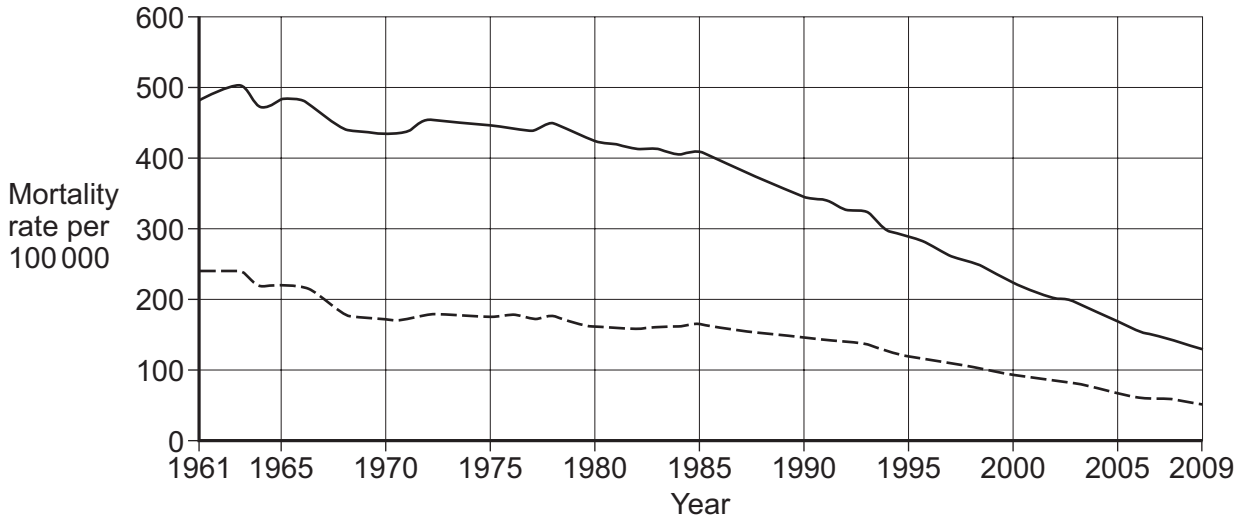


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**3 (d)** The mortality rate of a disease is the number of people who die from that disease for a given size of population. **Figure 5** shows the change in the mortality rate from CHD per 100 000 of the UK population from 1961 to 2009.

**Figure 5**



**Key**  
—— Men  
----- Women

Do the data provide evidence that the UK Government's guidelines about fats given in 1983 were effective?

**[3 marks]**

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**3 (e)** A researcher not involved in the review wrote:

“Understanding the true relationship between diet and our health is not simple... That’s why guidance in the UK is based on an agreement between the evidence available, not just on randomised controlled trials.”

Explain why it is difficult to show a causal link between the amount of fat a person eats and their likelihood of coronary heart disease.

**[3 marks]**

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<b>16</b>



**4 (a)** Fluoroscopy is a medical technique that uses X-rays to give a moving image of changes inside the human body. It allows real-time monitoring of surgical operations and other treatments.

Fluoroscopy is often used for the diagnosis and treatment of heart problems. When fluoroscopy is used during operations, the patient and the doctors are exposed to X-rays.

**4 (a) (i)** What are X-rays?

**[1 mark]**

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**4 (a) (ii)** State **two** effects that X-rays can have on living tissue.

**[2 marks]**

1 \_\_\_\_\_

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2 \_\_\_\_\_

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- 4 (b)** Doctors, and other medical personnel who use fluoroscopy, aim to reduce their exposure to X-rays. They also wear radiation badges which monitor their exposure levels to X-rays. These badges are sent to be developed, usually monthly, and the exposure levels can be measured.

A company has developed a monitoring device, called Bleeper Sv. Bleeper Sv makes different noises in response to the level of radiation it is exposed to. The device also measures the cumulative radiation dose received. **Table 3** shows the radiation dose equivalent per hour and the different noises made by the device.

**Table 3**

Radiation dose equivalent per hour	Noise
Background radiation	1 bleep every 15 minutes
0.01 mSv / h	1 bleep every 20 seconds
Above 1 mSv / h	Continuous sound

- 4 (b) (i)** Suggest **two** ways that medical personnel can reduce their exposure to X-rays during fluoroscopy.

**[2 marks]**

1 \_\_\_\_\_  
\_\_\_\_\_

2 \_\_\_\_\_  
\_\_\_\_\_

- 4 (b) (ii)** Suggest why it is important that the Bleeper Sv device measures the cumulative radiation dose as well as the current exposure.

**[1 mark]**

\_\_\_\_\_  
\_\_\_\_\_





- 4 (b) (iii)** The acceptable cumulative radiation dose limit for medical personnel is set at a higher level than for the general public.

Why is it acceptable to have different limits?

**[2 marks]**

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- 4 (c)** Researchers wanted to test whether the use of Bleeper Sv affected the radiation doses that the doctors received. They recruited 505 patients who were due to have fluoroscopy for heart problems, and put them into two different groups.

In the control group, the doctors used the best standard procedure for fluoroscopy. In the other group, the doctors used the best standard procedure and wore a Bleeper Sv. Before the study began, all the doctors received a talk about equipment use and radiation safety.

- 4 (c) (i)** Why was it necessary to have a control group?

**[1 mark]**

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- 4 (c) (ii)** Suggest why doctors in both the control and the Bleeper Sv groups were given a safety talk.

**[1 mark]**

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**4 (d)** After the operations, the researchers measured the radiation exposure of the doctors and the patients. The researchers concluded that the radiation exposure for the doctors was significantly lower in the Bleeper Sv group compared with the control group.

**4 (d) (i)** When analysing the data for the Bleeper Sv group and the control group, the researchers checked that the observed differences were statistically significant.

Explain why it was important to do so.

**[1 mark]**

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**4 (d) (ii)** The doctors in the Bleeper Sv group were not told to make changes to how they did the fluoroscopy during operations. They were simply made aware of the level of radiation that they were being exposed to, as they were exposed to it.

Suggest reasons why the radiation exposure of the doctors in the Bleeper Sv group was less than in the control group.

**[3 marks]**

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- 5 Hominin is the name given to all the species in the genus which includes humans (*Homo sapiens*) and their ancestors. Scientists' understanding of how the genus developed is limited because there are not many hominin fossils dated between 2–3 million years ago.

In 2013, part of a fossilised jawbone containing five teeth was found at a fossil excavation in Ethiopia. **Figure 6** shows a photograph of the fossil, where the small white bar represents a distance of 1 cm.

**Figure 6**



- 5 (a) (i) Estimate the length of the fossil jaw in **Figure 6**.

[1 mark]

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- 5 (a) (ii) Suggest why hominin fossils are rare.

[2 marks]

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- 5 (b)** The jawbone was dated to between 2.8–2.75 million years old. The jawbone is a transitional fossil. It has some features which are similar to older hominin fossils from the genus *Australopithecus* and some features which are similar to younger *Homo* fossils.

The scientists think that this bone is from a member of the genus *Homo*, although there is not enough evidence to identify the exact species. The jawbone is 0.4 million years older than previously found fossils of the genus *Homo*.

- 5 (b) (i)** Describe how the theory of evolution can be used to explain the emergence of new species of hominin.

**[3 marks]**

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- 5 (b) (ii)** Suggest why transitional fossils are important to the study of evolution of humans.

**[2 marks]**

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- 5 (c)** A reporter, talking about the research, said “With the discovery of this fossil jawbone, scientists have found the first human.”

Explain why this statement is **incorrect**.

**[2 marks]**

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6

In March 2014 a group of astronomers gave a press conference. The astronomers worked on a telescope at the South Pole known as BICEP2. At the press conference they claimed that their experiments provided direct evidence of conditions just after the Big Bang.

Inflation is used to explain the structure of the visible universe. Inflation suggests that for a fraction of a second after the Big Bang, the universe grew very fast and at an exponential rate. This would explain why the cosmic microwave background radiation appears quite similar no matter in what direction of the sky we look.

The BICEP2 astronomers observed patterns in the cosmic microwave background radiation. These patterns could be caused by inflation. However, the patterns could also be produced by space dust in the Milky Way. In order to increase the sensitivity of their measurements, BICEP2 astronomers used only one frequency of microwaves. They also used preliminary data taken from the Planck space telescope to estimate the effect of dust on their measurements.

Immediately after the press conference, other astronomers began looking at the data and carried out their own analysis. Many thought that the BICEP2 astronomers had underestimated the effect of dust and misinterpreted the Planck data.

The Planck telescope took measurements at nine different frequencies of microwaves which meant that it could distinguish the effects of space dust more easily.

Researchers using BICEP2 and Planck agreed to work together and share data. In January 2015 they published a joint paper which showed that the direction that BICEP2 observed was dustier than originally thought. The patterns observed by BICEP2 were mostly caused by this dust.

One BICEP2 astronomer said "Obviously, we're not exactly thrilled, but we are scientists and our job is to try and uncover the truth. In the scientific process, the truth will emerge."

6 (a) (i) What is meant by the term **the Big Bang**?

[1 mark]

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6 (a) (ii) How many years ago do astronomers think that the Big Bang occurred?  
Tick the correct box.

[1 mark]

3.5 billion	<input type="checkbox"/>
4.6 billion	<input type="checkbox"/>
13.7 billion	<input type="checkbox"/>
137 billion	<input type="checkbox"/>

Turn over ►



**6 (a) (iii)** The BICEP2 astronomers gave a press conference **before** they had published their paper in a peer-reviewed journal.

Suggest why they did this.

[1 mark]

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**6 (b)** In the passage identify **one** example of:

**6 (b) (i)** a scientific theory

[1 mark]

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**6 (b) (ii)** data (observations or measurements)

[1 mark]

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**6 (b) (iii)** alternative explanations for the same observation.

[1 mark]

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**6 (c)** The BICEP2 telescope is based at the South Pole. The Planck telescope is a space telescope.

Suggest **two** advantages for astronomers of using different methods to investigate the condition of the Universe just after the Big Bang.

**[2 marks]**

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**6 (d)** An astronomer said “our job is to uncover the truth”.

Discuss whether the scientific process allows scientists to uncover the truth.

**[3 marks]**

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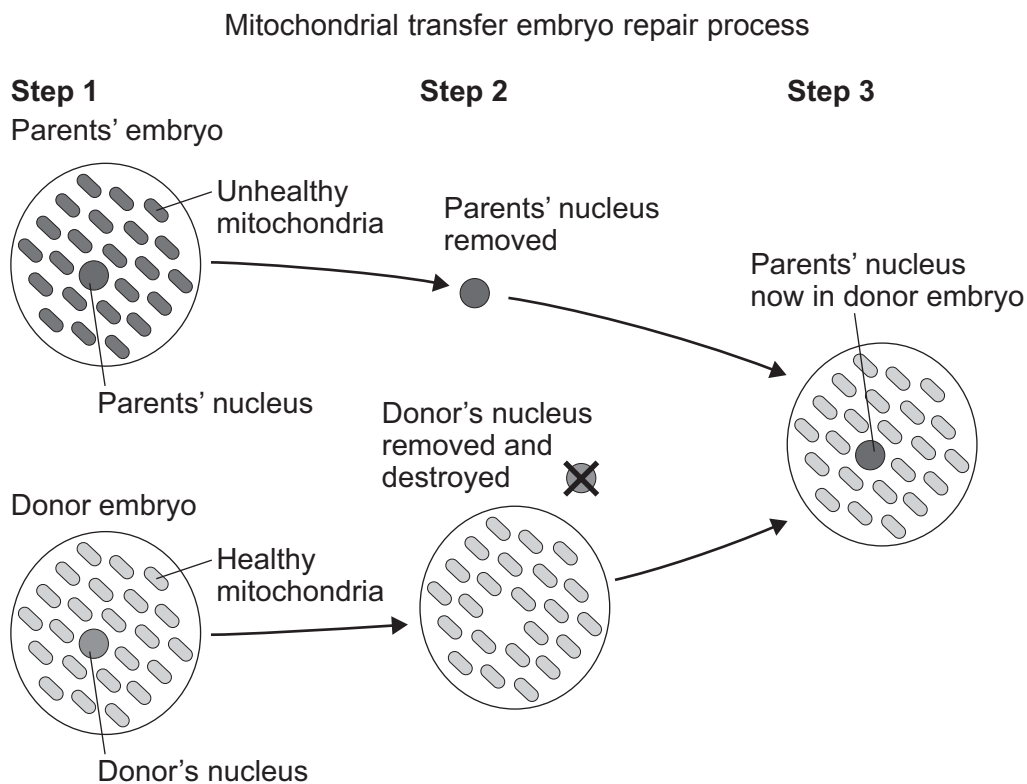


7 In vitro fertilisation (IVF) is a process used to allow infertile couples to have children. IVF involves the fertilisation of eggs outside the body. It can use eggs and sperm from the couple, or use donated sperm or eggs. After fertilisation, one or two embryos are placed into the womb, and the pregnancy continues normally.

Mitochondria are structures in a cell that carry out essential processes. Mitochondria contain a small number of genes which are not shared with the nucleus of the cell. Around 1 in 6500 children have genetic diseases which mean that the mitochondria do not work correctly. These mitochondrial diseases can affect different organs and, in the most severe cases, can cause early death.

Researchers in the UK have developed IVF techniques which transfer the nucleus from an embryo containing faulty mitochondria into an embryo containing healthy mitochondria, but which has had its nucleus removed. This process is called mitochondrial transfer and **Figure 7** shows the steps involved.

**Figure 7**



In February 2015, the UK Government passed legislation that allows the use of mitochondrial transfer. The procedures will be regulated by the independent Human Fertilisation and Embryology Authority (HFEA). Any clinic wanting to use mitochondrial transfer IVF will have to apply for a licence.





**7 (a)** Describe what happens to the genes contained in the egg and sperm before fertilisation and explain how this leads to a variety of characteristics in the children that are born. **[3 marks]**

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**7 (b)** Some groups, including religious leaders, have spoken out against these new mitochondrial IVF treatments.

Suggest what ethical arguments these groups might have used.

**[3 marks]**

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**7 (c)** The government set up the Human Fertilisation and Embryology Authority to regulate procedures such as IVF and mitochondrial transfer.

Suggest why.

**[2 marks]**

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