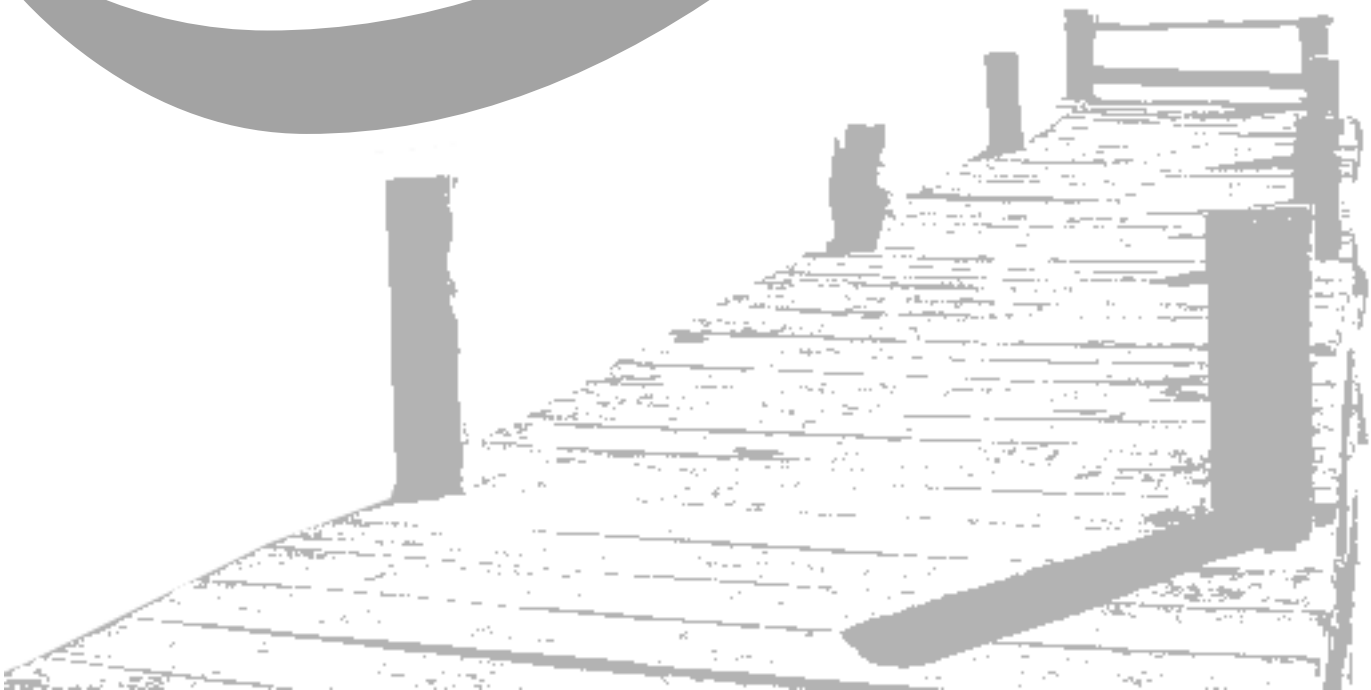
GCE
AS and A Level

Science in Society

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 1: Approved specimen question paper

Version 1.1



version: 1.1

GENERAL CERTIFICATE OF EDUCATION
SPECIMEN

SCIENCE IN SOCIETY UNIT 1: AS EXPLORING KEY SCIENTIFIC ISSUES

No additional materials are required
You may use a calculator

Time allowed 2 hours

Instructions

- Use black ink.
- Answer **all** questions in the spaces provided.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.
- Show your working in **all** calculations.

Information

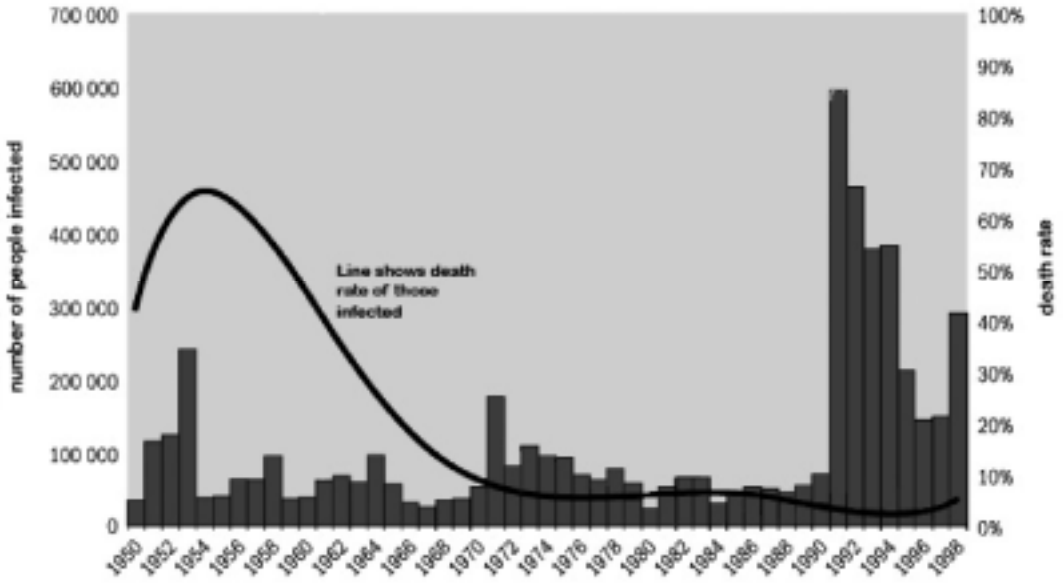
- The maximum mark for this paper is 90.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers. Questions 3(c) and 8(e) should be answered in continuous prose. Quality of Written Communication will be assessed in these answers.

1 Cholera is a serious infection of the digestive tract. Symptoms include diarrhoea. It is one of many infectious diseases that are transmitted in drinking water.

Figure 1 shows trends in the number of cholera cases in the world since 1950.

Figure 1

Cholera, reported number of people infected and death rates of those infected, 1950-1998



(a) Explain what is meant by an infectious disease.

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(2 marks)

(b) (i) Describe the main changes in the numbers of people infected, shown in **Figure 1**, over the period 1950 to 1998.

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(2 marks)

(ii) Use the data in **Figure 1** to calculate the number of people who died of cholera in 1974.

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(2 marks)

(iii) In the 1970s a new treatment was introduced for those infected with cholera. It is called Oral Rehydration Therapy, ORT. Does the data in **Figure 1** provide evidence that ORT treatment saved lives? Explain your answer.

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(2 marks)

(iv) Almost all the cases shown in **Figure 1** were in low income countries. Suggest and explain **one** possible reason for this.

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(2 marks)

Total 10 marks

2 (a) During treatment for thyroid cancer the patient is given a drink containing a radioactive isotope of iodine. In the body, iodine concentrates in the thyroid. The radioactive iodine has a half-life of 8 days and emits beta and gamma radiation. Before the treatment patients are given the following information about what to expect.

- The doctors and staff on the ward will only stay in your room for short periods at a time.
- Visitors will be restricted and only allowed to stay in the room for a short time, if at all. Visitors will be able to talk to you from outside the room through an intercom.
- An instrument called a Geiger counter can be used to monitor the level of radiation in the room.
- Children and women who are pregnant will not be allowed to visit.

(i) Ionising radiation can harm living cells. Explain in what way the radiation causes long term damage to cells.

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(2 marks)

(ii) How would you explain to a visitor why the hospital has these restrictions on the time they can spend with the patient?

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(2 marks)

(iii) Explain why these restrictions only last for about 2 weeks.

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(2 marks)

(iv) Why is it acceptable to expose the patient to a dose hundreds of times higher than that permitted for the public?

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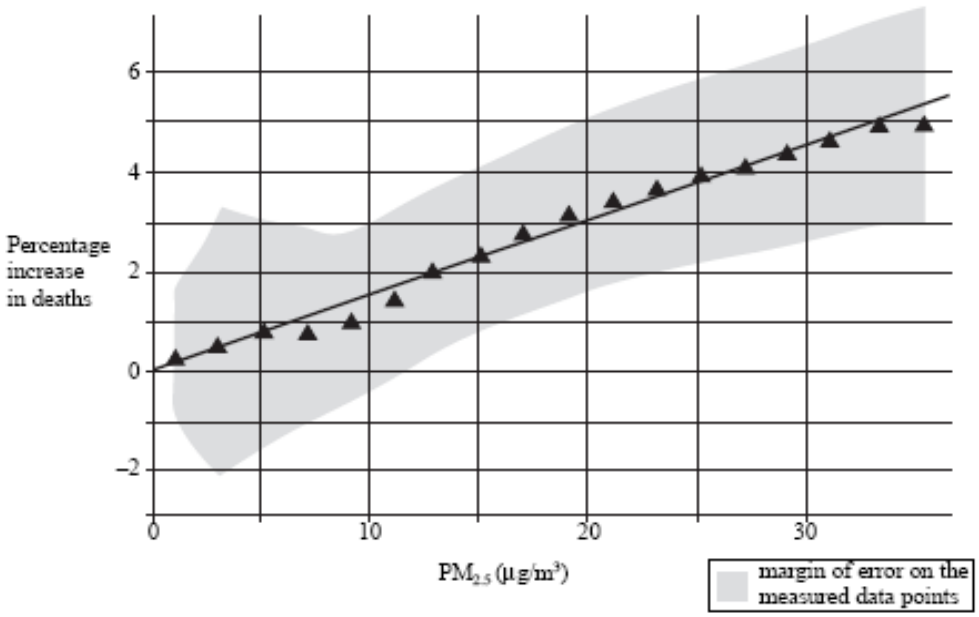
(2 marks)

Total 8 marks

3 Air pollution caused by small particles is a major cause of ill health. The average level of the very small particles ($PM_{2.5}$) in the air in British cities is now about 20 micrograms per cubic metre ($\mu g/m^3$). Most of these particles come from the exhausts of diesel vehicles.

Figure 2

The relationship between the change in daily death rate and the level of $PM_{2.5}$ particles in a US city



(a) **Figure 2** shows how daily deaths vary with the level of PM2.5 particles, based on data from one study in the U.S. The shaded area shows the margin of error on the measured data points.

(i) Complete this sentence:

When the level of $PM_{2.5}$ particles is 20 $\mu g/m^3$ daily deaths are increased by ..... ± ..... percent, compared with daily deaths when there is no pollution.

(2 marks)

(ii) Give **two** reasons why it is difficult to measure the 'true' concentration of $PM_{2.5}$ particles in a city.

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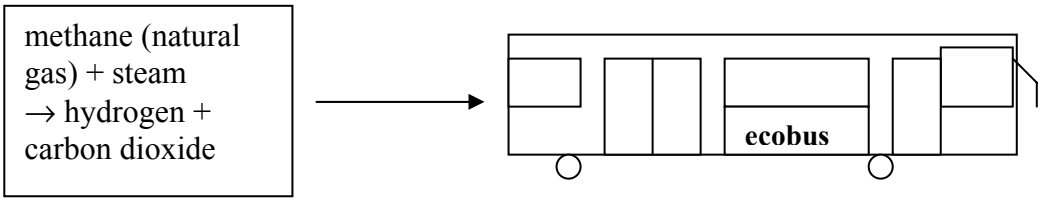
(2 marks)

(b) One way of reducing air pollution from city traffic is to use hydrogen as fuel.
Figure 3 represents the production and use of hydrogen.

Figure 3

Hydrogen transport and storage



centralised hydrogen production bus running on hydrogen fuel cells

(i) 1000 MJ of energy available to move the bus is produced from the processing of 2400 MJ available in the methane.
Calculate the efficiency of the process.

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(1 mark)

(ii) Using a diagram or words summarise the chemical change that takes place when hydrogen reacts to release energy.

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(2 marks)

(c) Planners have to make choices about the fuels and technologies that should be used to improve air quality in a large city. Describe some of the factors they will need to consider and give your own opinion on how the problem should be tackled.

Quality of written communication will be taken into account in awarding marks.

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(6 marks)

Total 13 marks

4 Chlorine is used to treat drinking water. It is a cheap and effective way of killing microbes that can cause disease. However chlorine reacts with impurities in the water to form compounds called trihalomethanes, (THMs).

There have been persistent fears that THMs in treated water may cause cancers. Evidence for this comes from two sources: animal studies and epidemiological studies.

Animal studies
Studies in rats, mice and dogs all gave similar results. They showed that THMs given over a long period cause cancer, but only when given in very high doses. The animals who developed cancer had received more than 10mg of THM per kg body weight every day. The normal human dose from water is about 10 000 times less than this.

(a) (i) Why do scientists repeat such tests on several different animal species?

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(2 marks)

(ii) Do the results of animal studies suggest that THMs in drinking water are likely to cause cancer in humans? Explain your answer.

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(2 marks)

Epidemiological studies
One very large study in the US compared the rate of cancer in different areas:

- areas where the water supply was treated with chlorine,
- areas where the water supply was not treated with chlorine.

It found that the risk of bladder cancer was 1.2 times higher in the areas with chlorine treated water, relative to areas with untreated water.
Similar epidemiological studies by other scientists have indicated risks ranging between 1.0 – 2.0 times higher.

(b) (i) Explain what is meant by an epidemiological study.

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(2 marks)

(ii) Bladder cancer is found to occur at a rate of 14 per 100 000 in those who drink untreated water. How many extra cases would be expected in a sample of 100 000 people drinking chlorine treated water if their risk is 1.2 times higher?

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(1 mark)

(iii) Suggest **two** reasons why the epidemiological study described does not, on its own, confirm that THMs in drinking water cause cancer.

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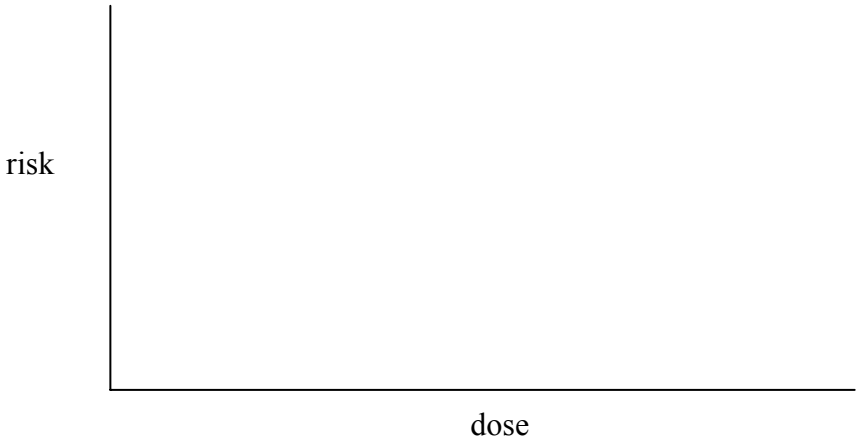
(2 marks)

(c) It is accepted that high doses of THMs cause cancer. At lower doses, such as those received from drinking water, there are two possible relationships between dose and risk.

A - the risk of cancer is proportional to the dose even at low doses

B - there is a safe threshold below which there is no risk

Sketch two graphs on the axes below to show the shape expected for A and B, labelling each line.



(2 marks)

(d) Even though there may be a risk of harm from THMs in water most governments continue to treat drinking water with chlorine.
What factors might they have taken into account in making this decision?

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(3 marks)

Total 14 marks

5 Mice can be bred so that they lack light sensitive cells in the retina of their eyes. These mice are blind. Scientists have attempted to cure such blindness by transplanting cells into the defective eyes. They have used:

- stem cells
- cells from the retina of adult mice

Neither approach improved vision.

(a) What is a stem cell?

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(1 mark)

In another study scientists transplanted precursor cells for light sensitive cells, taken from normal three-to-five-day-old mice. Precursor cells are cells that have already differentiated so that they can only go on to develop into a very limited range of cell types.

After the transplant the blind mice were able to react to bright lights.

(b) The publicity surrounding the success of the research claimed that it will lead to a cure for some forms of human blindness.

Suggest **two** further investigations that the scientists would need to undertake before this technique could be ready to trial in humans.

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(2 marks)

(c) When scientists announce the results of new biological research they often mention the promise of a cure for a human disease.

(i) Why might they do this?

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(2 marks)

(ii) Many patients, hearing about this research, may have their hopes raised. Give **two** questions they should ask about the research which would help them assess whether to trust the publicity.

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(2 marks)

(d) Further research may show that transplanting suitable precursor cells is likely to restore human sight in some conditions. These cells will have to be derived from either human embryos or maybe from the patient's own eye. Research on humans will require the approval of an Ethics Committee.

State and explain **two** conditions that would need to be met before you, as a member of such a committee, could recommend approval.

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(4 marks)

Total 11 marks

6 In 1915 Einstein used his theory of General Relativity to try to understand what the cosmos was like. His calculations led to the conclusion that the universe could not be stable; it should be either expanding or collapsing. As Einstein believed the universe was stable, he modified his equations to produce that result. He thought he was improving his theory, to make it match better to reality – but he later described this as 'the biggest blunder of my life'.

In 1929, the American astronomer Edwin Hubble made measurements that allowed him to estimate the speed at which galaxies were moving away from the Earth. His calculations indicated that the further away a galaxy was, the faster it was moving away from us. This implied that the universe was expanding. Hubble and other astronomers proposed that the universe had originated in a 'Big Bang'.

Some other astronomers were not convinced. Their research led them to think that matter was distributed uniformly throughout the universe – and did not get more spread out with time. They proposed an alternative theory, the Steady State theory, which proposed that matter was constantly being produced to keep the average density of the universe constant as it expanded.

By the 1950s there were still two competing theories on the origin of the universe: the Big Bang theory and the Steady State theory. One of the predictions of the Big Bang theory was that radiation produced in the Big Bang should still be detectable. This radiation was found in 1964 by Penzias and Wilson. This is one of the reasons why most astronomers now accept the Big Bang theory.

(a) Explain briefly what is meant by the Big Bang theory.

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(2 marks)

(b) From the account above briefly identify an example of each of the following

(i) An observation

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(1 mark)

(ii) A correlation between two variables

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(1 mark)

(iii) An explanation that involved conjecture and creative imagination

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(1 mark)

(iv) A second explanation that also involved conjecture and creative imagination

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(1 mark)

(v) A testable prediction from a theory

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(1 mark)

(vi) The use of observation to increase confidence in an explanation or theory

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(1 mark)

(vii) The way a person's views can influence their interpretations.

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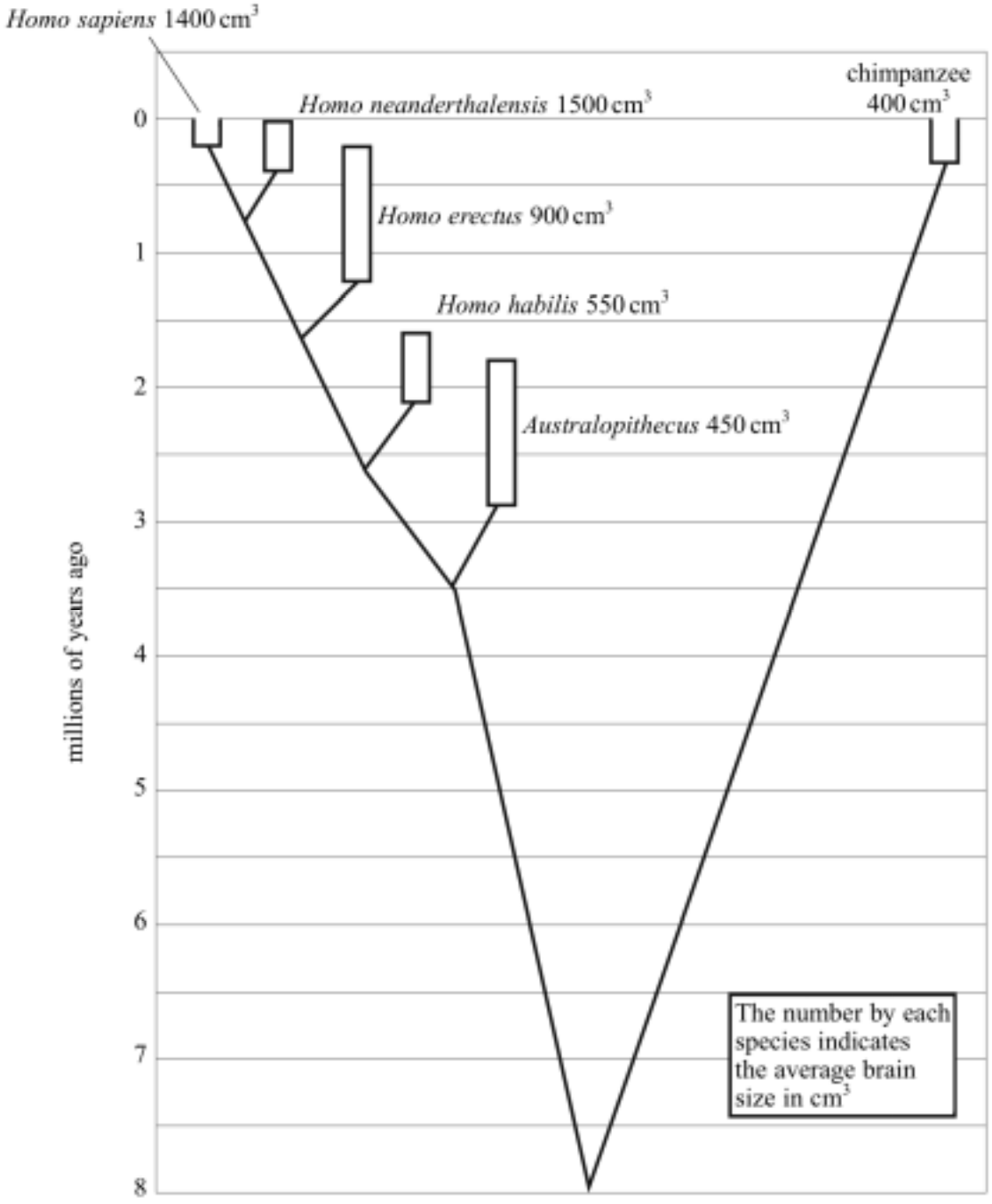
(1 mark)

Total 9 marks

7 Humans and chimpanzees are both primates. Many other primate species are now extinct. **Figure 4** shows one suggested relationship between modern humans, some of the other extinct human-like species and chimpanzees. The number by each species indicates the average brain size in cm.

Figure 4



(a) On **Figure 4** shade in the rectangles representing two homo species that became extinct less than 1 million years ago.

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(1 mark)

(b) Suggest how some of the information in **Figure 4** can be explained by Darwin's theory of natural selection.

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(4 marks)

(c) (i) The information in **Figure 4** is derived from fossils. Scientists agree on most dates and the overall pattern. They disagree on some of the evolutionary relationships between one species and another. Explain why these disagreements do not lead most people to doubt the evolutionary origins of humans.

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(2 marks)

(ii) Suggest **two** reasons why some people find it hard to accept that humans have evolved from other species.

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(2 marks)

9

8 Read the article below and answer the questions that follow.

Should parents be free to decide what is acceptable?

A 66-year-old woman gives birth

Children are born selected as tissue donors for sick siblings

Women give birth to their own grandchildren, or to their nephew or niece

Children are conceived with the sperm of dead men.

All these things have happened, and might even become routine. Before long we may be able to screen embryos not just for disease-causing mutations, but also for desirable genetic characteristics. Egg freezing will allow women to delay having children until their forties or later.

These rapid advances in technology are making it hard for us to properly weigh up the ethical, social and biological consequences. The many reproductive choices available already raise difficult questions. Governments have responded to them in two ways: either by banning "undesirable" applications, as in the UK and Australia, or by leaving prospective parents to make up their own minds with the help of their doctors, as in the US.

Should governments intervene given the issues that reproductive science is raising? The answer is far from straightforward. One good reason for banning certain reproductive practices is to protect the health of the resulting children. There is, for instance, clear evidence of the dangers of implanting more than one in vitro fertilisation (IVF) embryo, as this results in more twins and triplets who generally face greater health risks than singletons. Limiting the number of embryos that can be transferred, as many European countries do, is undoubtedly improving the prospects of children conceived by IVF. On the other hand, is it right to deny twins to parents who want them?

In the UK, the government regulator goes further. Until recently, would-be parents in the UK could use pre-implantation genetic diagnosis (PGD) to screen only for fatal childhood diseases. The restrictions have now been relaxed, but parents are still denied the option of screening out many known disease-causing gene variants. It is also illegal in the UK to select an embryo on the basis of its sex, while in the US PGD can be used for whatever parents want and doctors will agree to, from sex selection to choosing deaf embryos.

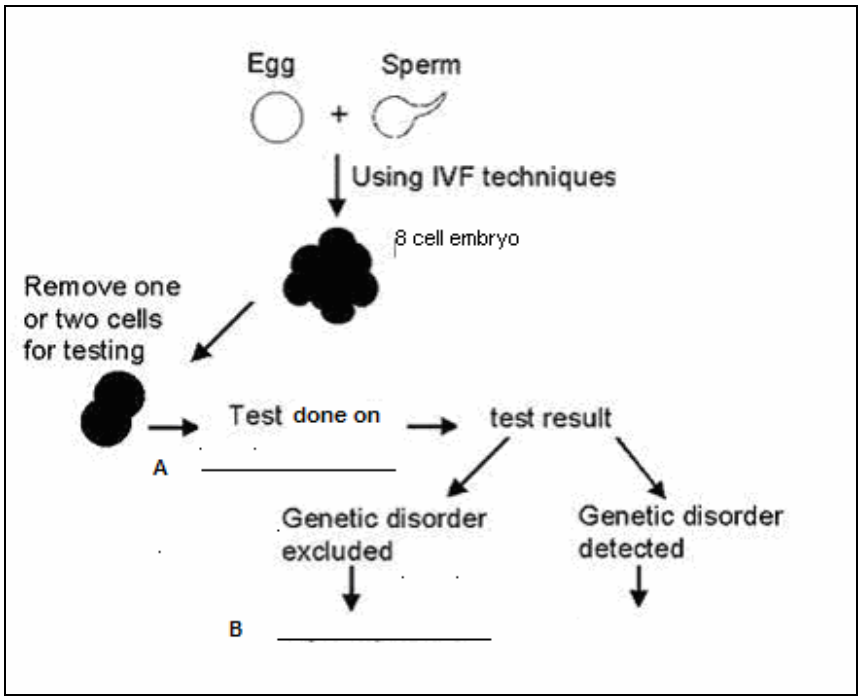
Should governments intervene in these sensitive issues? Heavy handed legislation is never likely to be the best answer. For example, if parental choice is skewing the balance of the sexes, a suitable system of incentives could be used to restore it.

The majority of these advances are beneficial, and promise people a better quality of life than their grandparents could have dreamed of. We should not reject them simply because they are novel. Deciding what is acceptable will, however, take thoughtful policy-making at every step, and open, informed public debate.

Source: adapted from *New Scientist,* 21 October 2006, p5

(a) **Figure 5** represents the process of IVF and how it can be combined with PGD.

Figure 5



Add two labels to the diagram on the solid lines A and B.

(2 marks)

(b) The process shown in **Figure 5** is normally used to ensure that a couple who are at risk of having a child with a genetic disorder can select an unaffected embryo. However, as the cases described in italics at the start of the article show, it can be used in other ways.

(i) Indicate on **Figure 5** how the process would be different for the *66-year old woman*.

(1 mark)

(ii) What extra tests would need to be done if children are *selected as tissue donors for sick siblings*?

(1 mark)

(c) Describe the differences in the way that IVF and PGD are regulated in the US and the UK.

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(2 marks)

(d) The article says that it is hard to *weigh up the ethical, social and biological consequences* (paragraph 2*)*.

Explain what is meant by *ethical* and describe how the process of attempting to weigh up ethical consequences would be different from the process needed to weigh up biological consequences.

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(4 marks)

(e) The article ends with hope for open, informed public debate on which of these technologies are acceptable and which should be controlled by regulation. People have a very wide range of opinions on the issue.

Explain what you would want to say if you were asked to give and justify your opinion as part of this debate. You can discuss the issues in general or focus on just **one or two** of the applications mentioned in the article.

Quality of written communication will be taken into account in awarding marks.

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(6 marks)

Total 16 marks