Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
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TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2015

Science in Society SCIS1

Unit 1 Exploring Key Scientific Issues

Thursday 14 May 2015 9.00 am to 11.00 am

For this paper you must have:
- a calculator
- a ruler.

Time allowed
- 2 hours

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.
- Show all your working.
- Do all rough work in this book. Cross through any work you do not want to be marked.

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.

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

1 In the UK, concentrations of pollutants emitted by road traffic are regulated by law. This is because there is concern about the health effects of pollutants. **Table 1** shows the permitted concentrations of two pollutants: nitrogen dioxide and particulates.

Table 1

Pollutant	Permitted concentration	Measured as
Nitrogen dioxide, NO_2	200 µg/m^3 Not to be exceeded more than 18 times per year	1-hour mean
	40 µg/m^3	Annual mean
Particulates, PM_{10}	50 µg/m^3 Not to be exceeded more than 35 times per year	24-hour mean
	40 µg/m^3	Annual mean

1 (a) (i) Explain what is meant by the phrase **1-hour mean**.

[1 mark]

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1 (a) (ii) Suggest why the annual permitted mean concentration for a pollutant is lower than the 1-hour mean or 24-hour mean.

[1 mark]

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1 (a) (iii) Why are fossil fuels still used in the majority of vehicles, even though they produce pollutants?

[2 marks]

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1 (b) The M1 is a large motorway from London to the north of England. It is often very congested.

The Highways Agency has proposed that, in some places, the hard shoulder could be used by vehicles to make the motorway four lanes wide and improve the flow of traffic.

However, this might also lead to an increase in the amount of traffic using the motorway. This would increase the concentrations of pollutants in areas near the motorway.

Suggest what data researchers would need to collect in order to investigate the impact of more traffic on people's health.

[3 marks]

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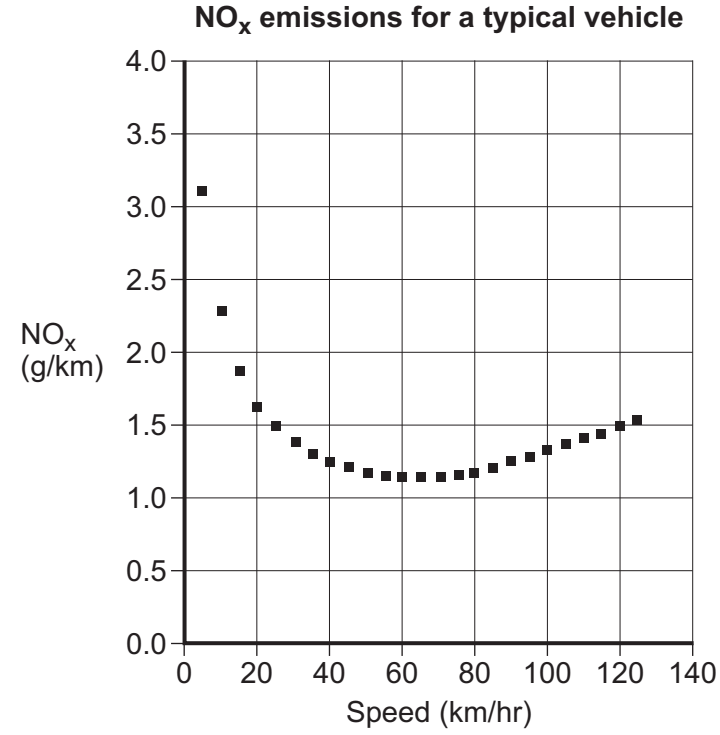
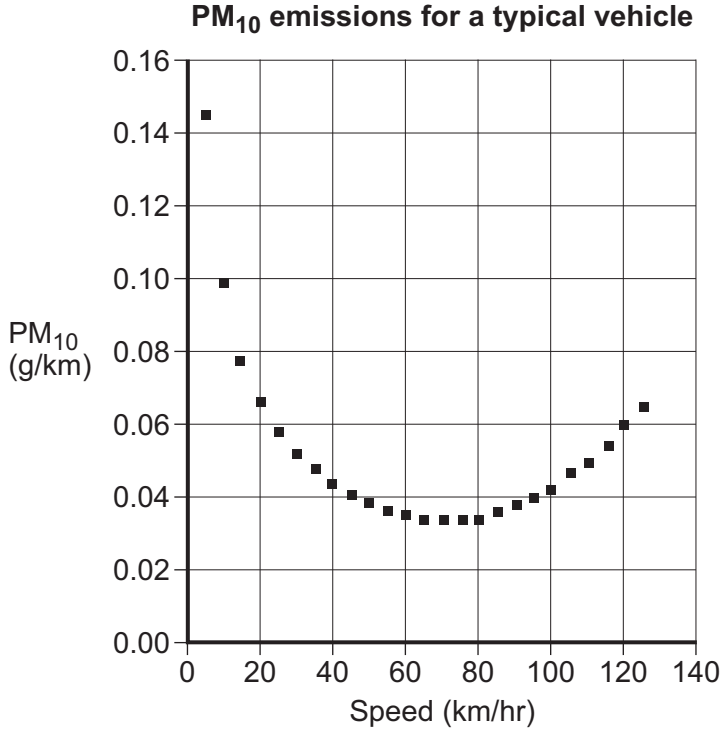
Question 1 continues on the next page

1 (c) Researchers calculated how emissions for a typical vehicle vary for different travel speeds. The results for nitrogen oxides (NO_x) and for PM_{10} emissions are shown in **Figure 1**.

Figure 1





To reduce air pollution, the Highways Agency has also proposed that the speed limit on the M1 should be reduced where the motorway is four lanes wide.

- The current speed limit on the M1 is 112 km/hr (70 mph).
- The proposed speed limit would be 95 km/hr (60 mph).

1 (c) (i) Use the data in **Figure 1** to identify what range of speeds would lead to the least pollution from the pollutants shown.

[1 mark]

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1 (c) (ii) Suggest reasons why the Highways Agency has proposed 95 km/hr as the new speed limit on the four-lane section of the M1. Use the data in **Figure 1** to support your answer.

[4 marks]

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Turn over for the next question

2 A database, known as the Cooper Centre Longitudinal Study, contains medical information from over 100 000 individuals who have visited the Cooper Centre medical clinic since 1970. The information in the database is used by many researchers studying health and disease.

One group of researchers used data taken from the Cooper Centre Longitudinal Study to look at the links between regular physical activity, weight and cardiovascular disease (CVD). Their research used a cohort study design.

2 (a) (i) Explain why data from databases of this kind are needed for a cohort study.

[2 marks]

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2 (a) (ii) Suggest why a clinical trial would be unsuitable for this study.

[2 marks]

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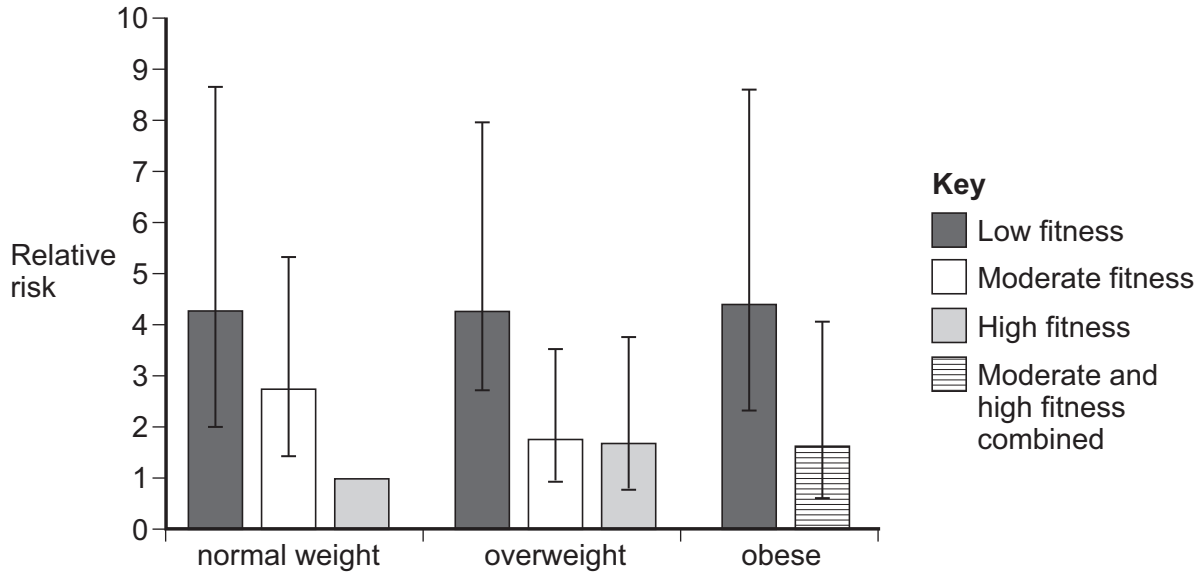
2 (b) From the Cooper Centre Longitudinal Study the researchers identified 2316 men who had been diagnosed with diabetes, but not with strokes or heart disease. The researchers followed each of these patients from the time when they were diagnosed with diabetes until 1998 and recorded how many of them died of CVD in that time.

The researchers categorised the men into three groups according to their weight. These groups were normal weight, overweight, obese. They then subdivided each group into three fitness levels.

The rate of death in men of normal weight and high fitness was used as the baseline rate, which gave this sub-group a relative risk of 1.

The researchers calculated the relative risk of death from CVD for the men in the other sub-groups compared with the baseline, as shown in **Figure 2**.

Figure 2



2 (b) (i) Use the data in **Figure 2** to compare the relative risk of death from CVD for men with different weight and fitness levels.

[2 marks]

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2 (b) (ii) Discuss whether the data in **Figure 2** provide evidence of a causal link between weight, fitness level and the risk of death from CVD.

[2 marks]

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Question 2 continues on the next page

2 (c) The UK Government provides guidelines about the amount of physical activity that different age groups should do each week.

For adults (ages 18 to 65) the guidelines are:

- adults should aim to be active daily. Over a week, activity should add up to at least $2\frac{1}{2}$ hours of moderate-intensity activity
- all adults should minimise the amount of time spent sitting for extended periods.

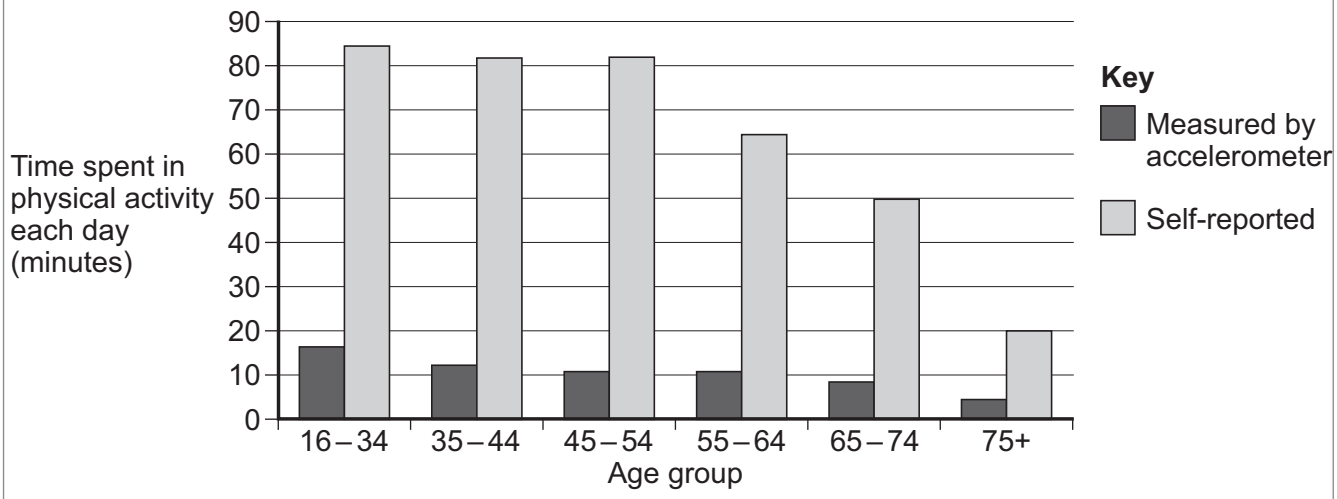
In the UK, the National Health Service carried out a survey about the physical activity of UK adults. They were asked how much, and what type of, physical activity they had done in the past four weeks.

The adults taking the survey were also given an accelerometer to wear for a week. This device measured the actual amount of physical activity that week.

The results of the work are shown in **Figure 3**.

Figure 3

Amount of physical activity reported and measured for different age groups of men



Discuss whether the Government should do more to encourage adults to increase the amount of exercise they do.

Use the data in parts (b) and (c) to support your answer.

[4 marks]

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Turn over for the next question

3 After publishing 'On the Origin of Species', Charles Darwin continued to think about how variation and the development of new species might occur. He studied the effect of selective breeding on pigeons. As part of his studies, Darwin kept and bred pigeons and joined a pigeon club.

Selective breeding occurs when animals or plants are bred by people for particular characteristics. It has been used by people to develop desired characteristics in domesticated animals and plants.

Figure 4 shows a rock pigeon, and two breeds of pigeons which have been selectively bred from rock pigeons.

Figure 4

Rock pigeon | English carrier | English fantail

3 (a) (i) Identify **one** of the main differences between selective breeding and natural selection.

[1 mark]

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3 (a) (ii) Suggest how selective breeding might be used to develop different breeds of pigeons, such as those shown in **Figure 4**, starting from the rock pigeon species.

[3 marks]

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3 (b) One reason why Darwin's theory of natural selection came to be widely accepted was that it provided a mechanism for evolution.

Explain why it is important for scientists to suggest a mechanism which could explain their observations.

[2 marks]

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3 (c) In 2013 a paper was published which reported research into the genes that determine the shape and colour of the head feathers in pigeons.

Researchers used pigeon blood samples and DNA from feathers to identify a single genetic mutation which was responsible for the diversity of the head feathers. They used this to suggest how selective breeding might work in this case.

Why do scientists continue to research aspects of evolution today, even though the theory of evolution by natural selection is widely accepted?

[3 marks]

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4 A computerised tomography (CT) scan is used in diagnostic medicine. It uses X-rays to create an image of the internal organs of a patient. CT scans expose patients to a radiation dose of up to 50 times greater than when a single X-ray photograph is taken.

4 (a) (i) X-rays are a type of ionising radiation.

In the list below, tick the **two** types of radiation that are also ionising.

[1 mark]

gamma rays	☐
microwaves	☐
radio waves	☐
UV	☐
visible light	☐

4 (a) (ii) State **one** way that ionising radiation damages human tissue.

[1 mark]

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4 (a) (iii) Why do scientists use a measure of equivalent dose when discussing the effect of different ionising radiations on the human body?

[2 marks]

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Question 4 continues on the next page

4 (b) Researchers in Australia wanted to investigate the effect of having CT scans during childhood. They thought that there might be a greater risk of developing cancer if a child had more CT scans.

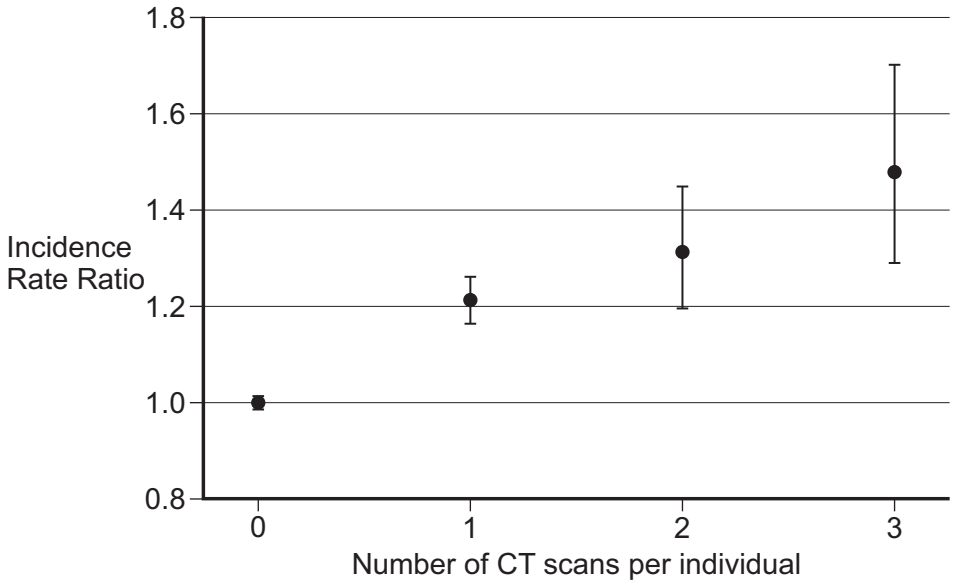
The researchers used the complete health records of 10.9 million people made between 1985 and 2007. These records included details of medical treatments, including CT scans. They categorised the records into two groups:

- group **A** had no CT scans during childhood
- group **B** had at least one CT scan.

The researchers calculated an Incidence Rate Ratio to compare the rate of cancer diagnosis in group **B** with group **A**. The results of this calculation are shown in **Figure 5**.

Figure 5

Rate of cancer diagnosis for people who had CT scans in childhood compared with people who did not have a scan



4 (b) (i) Why did the researchers use group **A** as a control group during their research?

[1 mark]

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4 (b) (ii) What conclusion can be drawn from the data in **Figure 5**?

[2 marks]

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4 (c) Much of the early scientific evidence about the dose-effect relationship for ionising radiation comes from survivors of the atomic bombs dropped on Japan in the Second World War and others who were exposed to high doses of ionising radiation.

The researchers who did the study into CT scans said about their findings:

'Our study…provides more information about low-dose exposures than was available from the study of Japanese atomic bomb survivors.'

Discuss why it is difficult to obtain evidence about the health effects of exposure to low doses of radiation.

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Turn over for the next question

5

The Personal Genome Project (PGP) aims to sequence the genomes of volunteers using a cheek-cell swab and blood sample.

All the genetic information from the samples will be available freely online to anyone who wants to use it. Although the genetic information of each person will not be linked to their name, it will be possible to work out who they, or their relatives, are from the genetic and medical data.

The PGP makes it very clear to volunteers that there may be no benefits to them from sharing their genetic information and that it might reveal that they are at risk of a disease for which there is no effective treatment. Volunteers must pass an online test of their knowledge of genetic science and complete an informed consent form which is 19 pages long.

The consent form highlights some of the worst case scenarios that might arise from sharing genetic data. It is possible that other people could use the information to:

- provide evidence that a person was the parent of a child
- identify statistical risks of disease that might affect employment or insurance
- link a person or their relatives to a criminal
- create synthetic DNA and 'plant it' at a crime scene
- clone human organs.

Participants will provide a sample of cheek cells and a blood sample.

Although there may be no health benefits to the volunteers, the PGP suggests that there will be a longer term benefit to medical research, which may lead to improved personal health care. However, it has been suggested that the PGP is supported by companies which would like to use the data provided for commercial reasons.

Although over 3000 people had registered with the PGP worldwide by January 2014, only 176 of those people had their genetic information sequenced at that point.

5 (a) (i) Explain why a single cell, such as a cheek cell, provides the entire genetic information for a person.

[1 mark]

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5 (a) (ii) The PGP will not sequence the genetic code of one identical twin unless the other twin also gives consent to participate.

Suggest why the consent of the second twin is needed.

[1 mark]

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5 (a) (iii) Explain how a volunteer's genetic information can be used to provide evidence that they are the parent of a child.

[2 marks]

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5 (a) (iv) The genetic test will provide information about susceptibility to a range of diseases such as cystic fibrosis and heart disease.

Explain why a volunteer should interpret the genetic information differently for these two diseases.

[2 marks]

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Question 5 continues on the next page

5 (b) Would you be willing to volunteer to have your genome sequenced by the PGP?

Explain your answer.

[6 marks]

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6 Ceres is a dwarf planet. It is the largest object in the asteroid belt which is between Mars and Jupiter in the solar system.

There is a force of attraction which causes Ceres to orbit the Sun in an elliptical orbit.

6 (a) (i) State the relationship between the force of attraction and the distance between Ceres and the Sun.

[1 mark]

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6 (a) (ii) This force of attraction is calculated using Newton's law of gravitation.

Explain what is meant by the term **law** in science.

[1 mark]

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6 (b) Between 1990 and 2013, astronomers used three telescopes at different times to observe Ceres. Some details about the telescopes are given in **Table 2**.

Table 2

Telescope name	**Type (average orbit)**	**Region of spectrum observed**	**Dates when in use**
International Ultraviolet Explorer (IUE)	satellite (42×10^3 km)	ultraviolet	1978–1995
Very Large Telescope (VLT)	ground based	visible, near infrared	1998–ongoing
Herschel	satellite (1.5×10^6 km)	far infrared	2009–2013

Give **two** reasons why astronomers have used different types of telescope to observe Ceres.

[2 marks]

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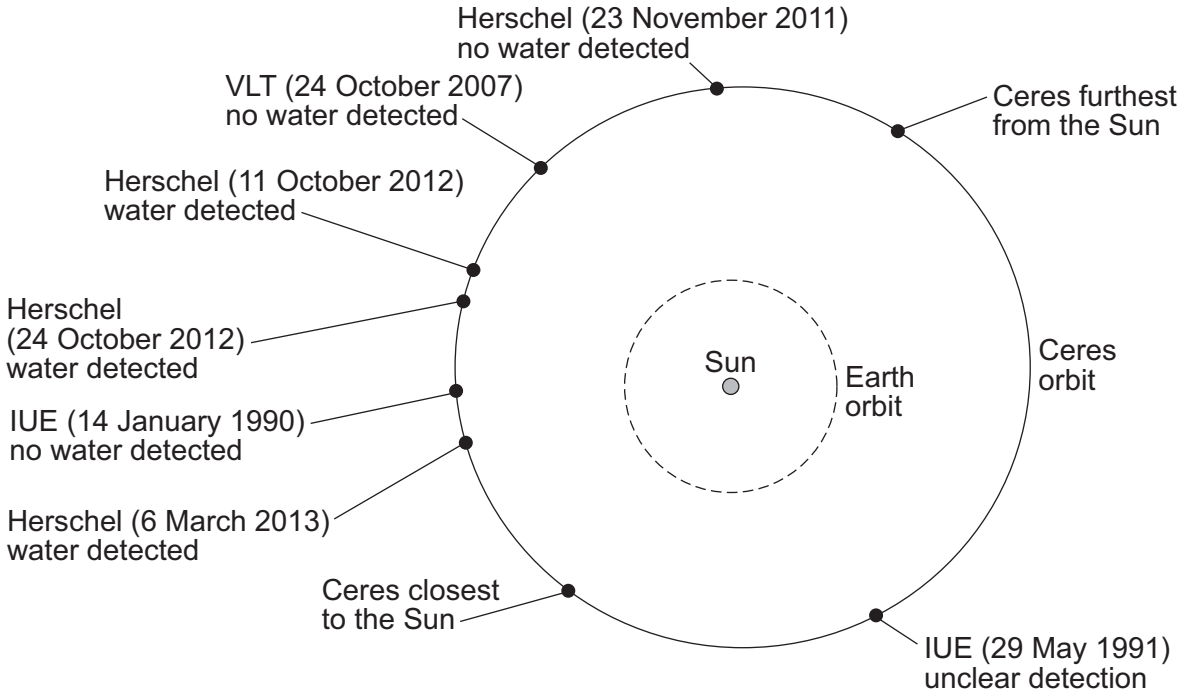
6 (c) Using the telescopes, the astronomers were able to detect water vapour being released from regions of Ceres' surface. **Figure 6** shows the orbit of Earth, the position of Ceres and the dates when the observations of Ceres were made. It also indicates whether water vapour was detected during the observations.

Figure 6

Positions of Ceres when water vapour was detected



One hypothesis to explain the release of water from Ceres is that:

- as Ceres gets closer to the Sun, some of the ice that it contains is released as water vapour.

To what extent do the data in **Figure 6** support this hypothesis?

Explain your answer.

[3 marks]

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6 (d) Suggest why scientists are very interested in finding out if there is water on objects, such as Ceres, in the solar system.

[2 marks]

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Turn over for the next question

7 Cohort studies on people have shown a correlation between a father's diet and the health of his children.

One group of researchers has used mice to investigate this correlation further.

The researchers investigated the effect of folic acid (also known as vitamin B9) eaten by male mice on the health of the offspring of those mice.

Two groups of male mice were used. One group of mice were fed a diet which had plenty of folic acid. The other group were fed a diet that was low in folic acid.

7 (a) (i) The diets for both groups were equally nutritious and both groups of mice had access to as much food and water as they wanted.

Explain why this high level of animal care is good scientific practice.

[2 marks]

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7 (a) (ii) Discuss the advantages and disadvantages of animal studies, such as this one on mice, when investigating the role of diet in human health.

[3 marks]

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7 (b) The male mice were mated with healthy female mice. At 18 days after mating, the researchers looked at the health of the embryos which had been fathered by the male mice in each group. **Table 3** shows some of the characteristics of embryos fathered by mice on diets with different levels of folic acid.

Table 3

Diet of father	Mean embryo mass (g)	Mean embryo length (mm)	Total number of embryos	Number of malformed embryos
Sufficient in folic acid	1.38 ± 0.02	24.17 ± 0.02	285	3
Lacking in folic acid	1.40 ± 0.02	24.18 ± 0.15	328	14

7 (b) (i) In their paper the researchers state:

'Embryo weight and length were not affected by paternal diet.'

Suggest why it is important for researchers to publish results which show no effects.

[1 mark]

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7 (b) (ii) Calculate, and compare, the percentage of embryo malformation in embryos fathered by mice from each diet group.

[2 marks]

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7 (b) (iii) The researchers stated that the increase in the number of malformed embryos was statistically significant.

Explain what is meant by this statement.

[1 mark]

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7 (c) This research paper on mice was published in Nature Communications, a peer-reviewed journal. One newspaper reported the research as follows.

Eating habits of future fathers can affect their children

Dads who tuck into junk food could be harming their future child, a study by Canadian McGill University claims.

It urges men to pay as much attention to lifestyle before conception as mothers do.

A lack of vitamin B9 – in vegetables and fruit – raises risks to an unborn child's health, says the research, published in Nature Communications.

Discuss how accurately this article represents the research into the effects of folic acid (vitamin B9).

[4 marks]

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Passage 1

Key facts about polio.

- Polio is a highly infectious disease caused by a virus. The virus enters the body through the mouth and multiplies in the intestine. Many people who are infected with polio do not show any signs of the disease.
- Polio mainly affects children under five years of age.
- One in 200 infections leads to irreversible paralysis. Among those paralysed, 5% to 10% die when their breathing muscles become immobilized.
- Worldwide polio cases have fallen by over 99% since 1988, from an estimated 350 000 cases, to 223 reported cases in 2012.
- As long as a single child remains infected, children in all countries are at risk of contracting polio.
- In most countries, the global effort [to eliminate polio] has expanded capacities to tackle other infectious diseases by building effective surveillance and immunization systems.

adapted from materials produced by the World Health Organization (WHO)

Passage 2

The World Health Organization (WHO) has confirmed 10 cases of polio in war-torn Syria – the first outbreak in the country in 14 years. The UN body says a further 12 cases are still being investigated. Most of the 22 people who have been tested are babies and toddlers.

Before Syria's civil war began in 2011, some 95% of children were vaccinated against the disease. The UN now estimates 500 000 children have not been immunised.

Polio has been largely eradicated in developed countries but remains endemic in Nigeria, Pakistan and Afghanistan.

The BBC's Imogen Foulkes in the Swiss city of Geneva says there has been speculation that foreign groups fighting in Syria may have imported it.

A WHO spokesman said the source of the virus had to be one of the endemic areas. "That's from where it would have always spread, and that's why it is so important to eradicate in those areas, because otherwise you are going to keep seeing polio in polio-free areas," he told the BBC.

Source: BBC News website 29/10/13

Question 8 continues on the next page

Turn over ▸

8 (a) (i) Explain how vaccination protects children from polio infection.

[3 marks]

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8 (a) (ii) Suggest why 'As long as a single child remains infected, children in all countries are at risk of contracting polio.'

[2 marks]

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8 (a) (iii) Suggest what sort of surveillance systems, mentioned in **Passage 1**, might be needed to monitor disease outbreaks.

[2 marks]

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8 (b) The World Health Organization (WHO) is the organising body for health matters within the United Nations. It currently has 194 member states which provide financial support for a variety of health programmes. One of those programmes is the vaccination of every child in the world against polio.

Why is it valuable to have an international body such as the WHO to deal with diseases like polio, rather than relying on individual government provision?

Use information from the passages to support your answer.

[6 marks]

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END OF QUESTIONS

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Question 3: John van Wyhe, ed. 2002 – The Complete Work of Charles Darwin Online (http://darwin-online.org.uk).

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Question 8, passage 2: www.bbc.co.uk, 29 October 2013.