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 2014

Science in Society SCIS1

Unit 1 Exploring Key Scientific Issues

Friday 23 May 2014 1.30 pm to 3.30 pm

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.

There are no questions printed on this page

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ANSWER IN THE SPACES PROVIDED

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

1 Rotavirus is a virus that causes severe diarrhoea in very young children.

In 2007, Mexico introduced a national vaccination programme against rotavirus. The aim was to vaccinate all babies between 2 months and 4 months old.

1 (a) (i) Describe how a virus reproduces.

[2 marks]

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1 (a) (ii) Explain how vaccination prevents babies from becoming ill if they are infected with rotavirus.

[3 marks]

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1 (a) (iii) Explain why antibiotics were **not** used to reduce the number of deaths due to rotavirus.

[1 mark]

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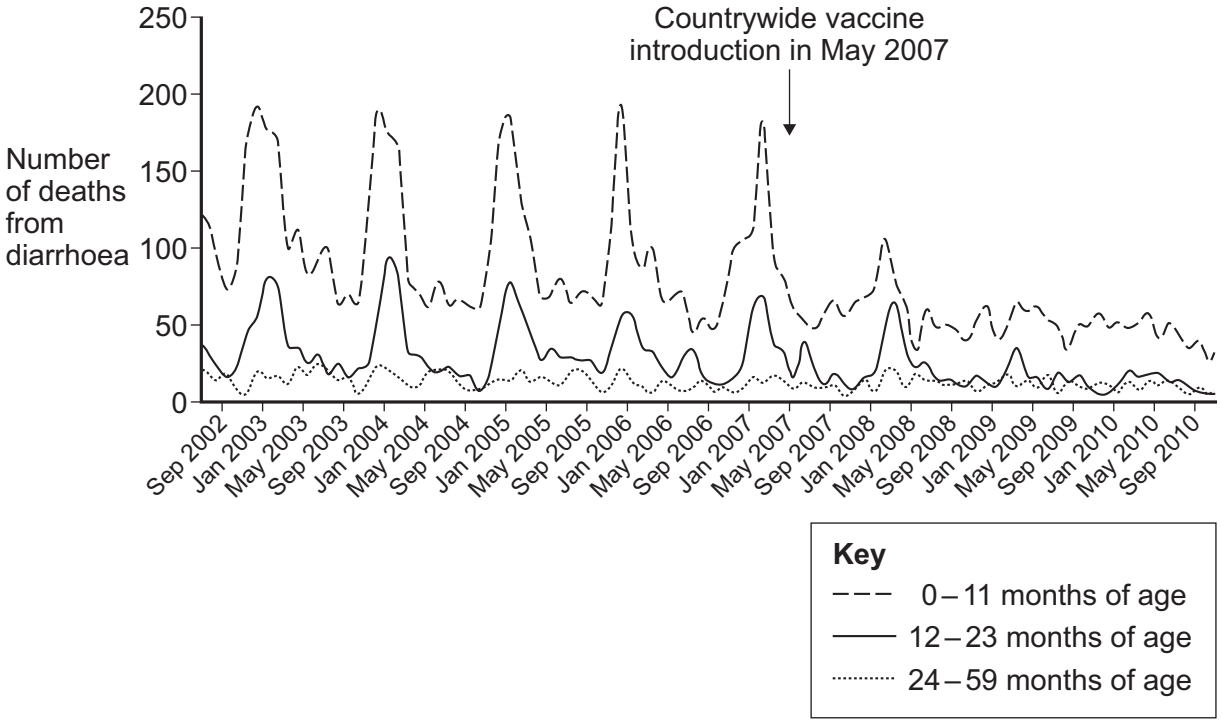
Question 1 continues on the next page

1 (b) Researchers monitored the number of diarrhoea-related deaths in children each month. The researchers did this from 2002, before the vaccination programme was introduced, until 2010, several years after it was introduced.

Figure 1 shows the number of deaths from diarrhoea each month for three different age groups of children between 2002 and 2010.

Figure 1 Number of diarrhoea-related deaths among children in Mexico, according to age group, from July 2002 to December 2010.



1 (b) (i) Why was it important to monitor deaths before the introduction of the vaccination programme?

[1 mark]

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1 (b) (ii) Describe the seasonal pattern in diarrhoea-related deaths before 2007 shown in **Figure 1**.

[1 mark]

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1 (b) (iii) The researchers concluded that the introduction of rotavirus vaccination was effective in reducing deaths from diarrhoea in children 23 months of age or younger.

Use the data in **Figure 1** to explain why they came to this conclusion.

[3 marks]

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Turn over for the next question

2 Ultrasound scans were first used on pregnant women in the 1970s. Women who had an ultrasound scan between 16 and 20 weeks were found to be less likely to lose their fetus due to death in the womb. This is because problems were identified earlier and could sometimes be treated.

2 (a) Explain why it would be reasonable to claim that there is a causal link between the use of ultrasound and the reduction in fetal death, rather than just a correlation between them.

[1 mark]

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2 (b) Researchers thought that having more than one ultrasound scan might reduce the number of babies born early and the number of days that the babies had to stay in hospital after birth.

In 1989 nearly 3000 pregnant Australian women were enrolled on a randomised controlled study to test this hypothesis.

The pregnant women in the study were put randomly into one of two groups as shown in **Table 1**.

Table 1 Ultrasound treatment for each group

	Number of women	**Treatment**
Regular group	1419	Ultrasound scan at 18 weeks (normal care)
Intensive group	1415	Five ultrasound scans at 18, 24, 28, 34 and 38 weeks

2 (b) (i) Problems in pregnancy are relatively rare.
Explain why the researchers enrolled as many women as possible into the study.

[1 mark]

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2 (b) (ii) Suggest why the researchers used randomisation to put the women into two groups.
[2 marks]

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2 (c) When the researchers analysed their results they found that their initial hypothesis was wrong.

More ultrasound scans did not lead to a reduction in the number of babies born early, or in the number of days that the babies stayed in hospital after birth. The results were similar in both groups.

The researchers also said:

> The mean birth weight in the intensive group was 25 g less than in the regular group, although this difference was not statistically significant.

2 (c) (i) What do the researchers mean by the phrase **not statistically significant**?
[1 mark]

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Question 2 continues on the next page

2 (c) (ii) The researchers obtained permission for this research from the Human Ethics committee at the hospital where the women went for pregnancy care. They also obtained written informed consent from each woman before they had any ultrasounds.

At the start of the study the researchers did not know if there would be any benefits or risks due to the use of additional ultrasound scans.

Do you think that it was right to carry out the research? Justify your answer.

[6 marks]

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3 Each year since 1988, the Department for Transport has carried out a national travel survey. The overall aim of these annual surveys is to find out short-term and long-term trends in travel.

In 2002 the number of people sampled in the survey was increased. The survey in 2011 included over 18 000 people in 7700 households. This was three times larger than the number of people used before 2002.

3 (a) (i) Give **one** advantage of using a larger sample size in the national travel survey.

[1 mark]

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3 (a) (ii) Suggest why the Department for Transport is interested in knowing the trends in travel over time.

[2 marks]

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3 (a) (iii) The 2011 survey found that, on average, people made 23% of all journeys by walking. However, walking only contributed 3% to the total distance travelled.

Suggest **one** reason for the difference between the two percentages.

[1 mark]

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Question 3 continues on the next page

3 (b) In 2011 the transport sector was responsible for 26% of UK carbon dioxide (CO_2) emissions.

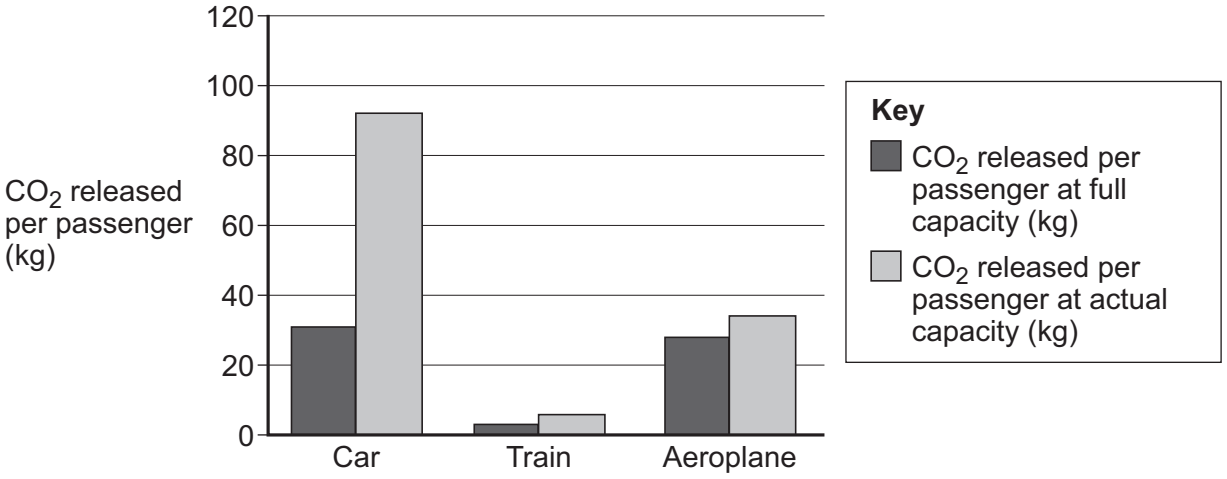
A researcher calculated the amount of CO_2 emissions for the 480 mile journey between Glasgow and Plymouth. She did this for three different types of transport.

She calculated the amount of CO_2 released per passenger in kilograms (kg) for the journey when the vehicle being used was:

- carrying the maximum number of passengers (full capacity)
- carrying the most likely number of passengers (actual capacity).

Figure 2 shows the calculated amount of CO_2 released for the 480 mile journey made using a car, a train or an aeroplane at full and actual capacity.

Figure 2 Comparison between the amount of CO_2 released per passenger for car, train and aeroplane at full and actual capacity for a 480 mile journey



3 (b) (i) How is CO_2 produced in a car engine?

[1 mark]

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3 (b) (ii) Why is the quantity 'CO_2 released per passenger' useful when comparing the amount of CO_2 produced by the three different types of transport?

[1 mark]

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3 (b) (iii) At full capacity the car and aeroplane produce a similar amount of CO_2 per passenger.

Suggest why the CO_2 released per passenger at actual capacity is much larger for the car than for the aeroplane.

[1 mark]

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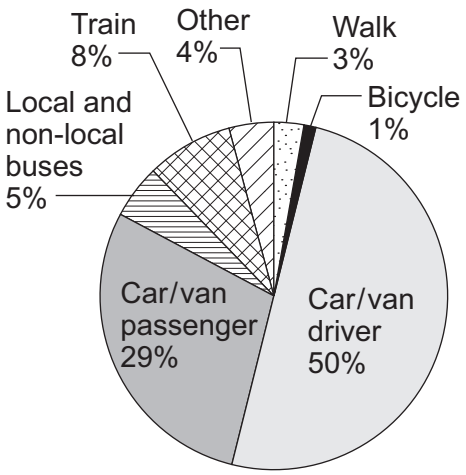
3 (c) **Figure 3** shows the percentage that different modes of transport contributed to the total distance travelled in the UK in 2011. Aeroplane journeys are included in the category labelled 'other'.

Figure 3 Percentage contribution from different types of transport to the total distance travelled by people in the 2011 National Travel Survey.



Suggest why it is difficult for the government to reduce the amount of CO_2 produced by the transport sector in the UK. Use information from **Figure 2** and **Figure 3** in your answer.

[3 marks]

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Turn over ▶

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4 Croatia is a European country with a long coastline on the Adriatic Sea. Since the Chernobyl nuclear accident in 1986, researchers from Croatia have been monitoring the concentrations of different radioactive isotopes in the Adriatic Sea, and in animals and plants that live in the sea.

4 (a) The researchers measured the concentrations of two isotopes of caesium, Cs-134 and Cs-137, in the sea water. **Table 2** compares the half-life of Cs-134 and Cs-137.

Table 2 Half-life of two caesium isotopes

Isotope	Half-life (years)	Type of radiation produced
Cs-134	2.1	Beta and gamma
Cs-137	30.2	Beta and gamma

4 (a) (i) What is an **isotope**?

[1 mark]

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4 (a) (ii) What measurements do researchers need to take to measure the half-life of a radioactive isotope?

[2 marks]

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4 (a) (iii) Give **one** difference between beta and gamma radiation.

[1 mark]

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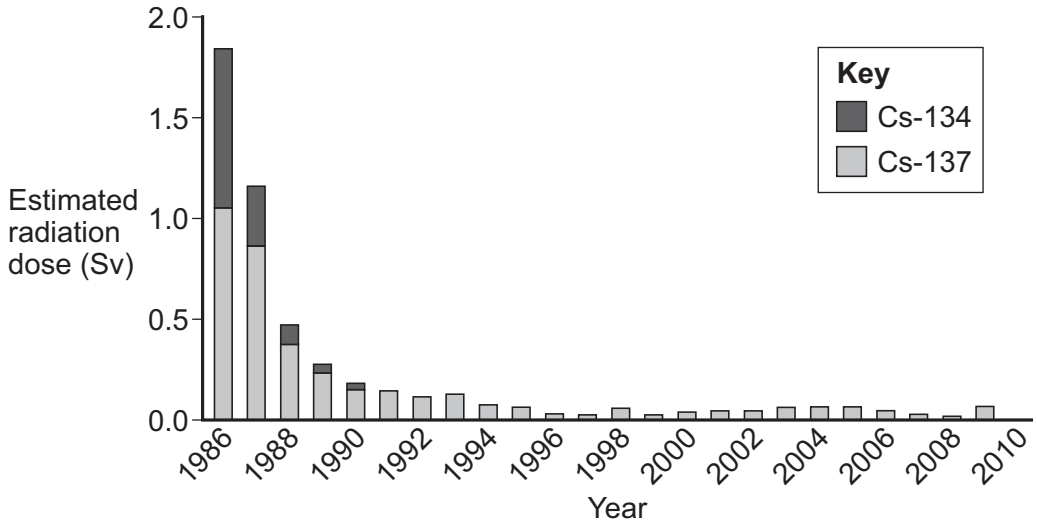
Question 4 continues on the next page

4 (b) The researchers have been monitoring the concentrations of the caesium isotopes in Adriatic Sea pilchards. These fish are caught along the coast, and eaten by Croatians.

Each year the researchers obtained 5 kg of pilchards, dried them, and measured the activity due to Cs-134 and Cs-137 in the sample. They then used a simple mathematical model to estimate the radiation dose to humans from eating pilchards with that level of activity.

Figure 4 shows the estimated radiation dose to the whole population of Croatia due to Cs-134 and Cs-137 in pilchards between 1986 and 2009.

Figure 4 Estimated radiation dose to the whole population of Croatia due to two isotopes of caesium in pilchards



4 (b) (i) What is the difference between the **activity** of an isotope and the **radiation dose** from an isotope?

[1 mark]

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4 (b) (ii) Explain why the proportion of the estimated radiation dose due to Cs-134 and Cs-137 changes, as shown in **Figure 4**.

[2 marks]

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4 (b) (iii) The population of Croatia was approximately 4.5 million during the years that the researchers collected their data.

Use data from **Figure 4** to calculate the average dose to a person in Croatia caused by eating pilchards in 1986. Show your working.

[2 marks]

Average dose = ...

4 (b) (iv) For most people in Europe the background radiation level is approximately 0.0028 Sv (2.8 mSv).

In 1986, what advice should scientists have given to the population of Croatia about the risks from eating pilchards from the Adriatic Sea?

[2 marks]

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Turn over for the next question

5 Some researchers thought that plant-eating insects in the environment would influence the evolution of plants by natural selection. They decided to study this idea using evening primrose plants. The study lasted for 5 years.

5 (a) Explain what is meant by the term **natural selection**.

[3 marks]

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5 (b) The researchers chose one species of evening primrose to study.

There are 18 varieties of this species containing different combinations of alleles.

What are **alleles**?

[1 mark]

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5 (c) Evening primrose plants grow and die in one year. They do not need to be pollinated by insects, and each plant can produce seeds on its own.

At the start of the study the researchers prepared 16 plots in the same field. There was the same mixture of the different varieties in each plot.

The plots were far enough apart to prevent the population of plants in one plot fertilising the plants in another. Each year new plants grew from the seeds produced by the previous year's plants. The researchers did not add any more plants.

5 (c) (i) Why was it necessary to isolate each population of plants in this way to observe natural selection?

[1 mark]

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5 (c) (ii) Why was it necessary to use a mix of varieties in each plot to observe natural selection?

[1 mark]

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5 (d) To investigate the effects of the plant-eating insects the researchers sprayed water on eight of the plots and sprayed the other eight plots with insecticide. The effect on the insects in the two types of plot is shown in **Table 3**.

Table 3 Watering conditions and insect numbers

Condition	Treatment	Effect on insects
A	8 plots sprayed with water every 2 weeks	No effect
B	8 plots sprayed with insecticide every 2 weeks	Fewer insects than usual

5 (d) (i) Suggest why the researchers used several identical plots for each condition.

[1 mark]

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5 (d) (ii) Suggest why the researchers sprayed half of the plots with water.

[1 mark]

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Question 5 continues on the next page

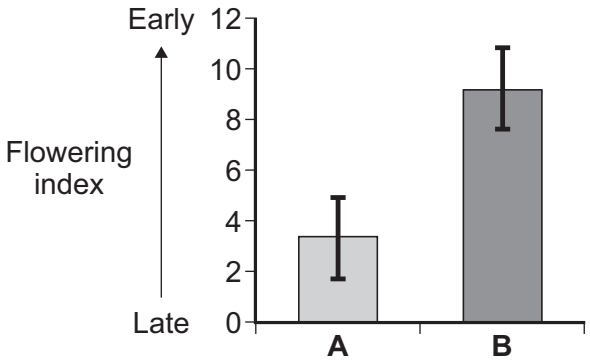
5 (e) One characteristic affected by the different alleles is how early in the year the plants produce flowers.

Time of flowering was one of the characteristics the researchers measured each year to see whether natural selection had taken place. They calculated an average flowering date for each plot.

The flowering index is a measure of how much earlier, on average, the plants in each plot flowered in the final year compared with the first year.

Figure 5 shows the mean value and the range of the flowering index in the final, fifth, year of the experiment, in plots sprayed with water (**A**) and with insecticide (**B**).

Figure 5 Flowering index for evening primrose plants in plots sprayed with water (**A**) or insecticide (**B**) after five generations



Do the data in **Figure 5** suggest that natural selection took place in the plots where the insects were killed? Explain your answer.

[2 marks]

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5 (f) This research has been used by some people as evidence to contradict the theory of evolution. On a website they made the following statement:

> If you remove the insects from an evening primrose population, the plants will adjust, and adjust fast... In other words, remove a threat that the plant had to defend against, and the plant population immediately exploits the opportunity.

This passage shows an incorrect understanding of the mechanism of natural selection. Explain why it is incorrect.

[2 marks]

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Turn over for the next question

6 Ultraviolet (UV) radiation is one type of electromagnetic wave emitted by the Sun.

When UV radiation is absorbed by skin it may be absorbed by pigments in the skin, such as melanin, or it may cause ionisation.

6 (a) (i) What is **ionisation**?

[1 mark]

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6 (a) (ii) Infrared radiation is another type of electromagnetic wave. It does not cause ionisation when absorbed by skin.

What difference between UV and infrared explains this observation?

[1 mark]

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6 (b) Exposure to UV is a risk factor in developing skin cancer. This exposure is often due to sunbathing or using tanning sunbeds.

In 2010 the rate of skin cancer diagnosis in the UK was 17 per 100 000 of the total UK population.

Why is it better to report the **rate** of skin cancer diagnosis rather than the total **number** of people diagnosed with skin cancer?

[2 marks]

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6 (c) Over the past 30 years, 32 research studies have been published which have looked at the link between the use of tanning sunbeds and skin cancer.

Recently, a group of researchers analysed the results from 13 of these studies. People in all these studies reported that they had first used sunbeds before they were 35 years old.

The authors rated the studies in terms of quality and strength of evidence that they provided.

Give **two** features that might be found in a good quality research study.

[2 marks]

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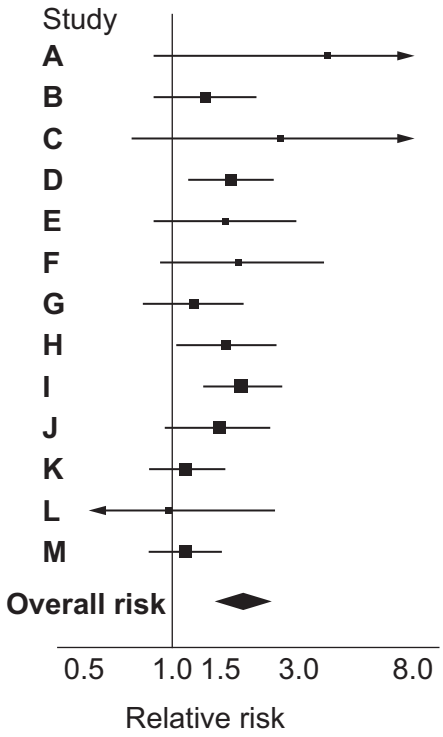
Question 6 continues on the next page

6 (d) For each study, **A**–**M**, the researchers calculated the relative risk of skin cancer from the use of sunbeds. They also calculated an overall relative risk which combined the results of all 13 studies. **Figure 6** shows the results.

A relative risk value above 1 shows a greater risk of diagnosis of skin cancer for a person who has used a sunbed compared with someone who has never used a sunbed. In **Figure 6**, larger squares represent better quality studies.

Figure 6 Relative risk of skin cancer associated with use of sunbeds, starting before age 35.



Study **D** and Study **I** both provide strong evidence that using sunbeds starting before 35 years increases the risk of skin cancer.

Use information from **Figure 6** to explain why.

[2 marks]

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6 (e) The researchers estimated that approximately 5% of skin cancer diagnoses were due to sunbed use.

In 2011, people under the age of 18 in England and Wales were banned from using sunbeds in tanning salons.

The researchers said:

> If sunbed use by teenagers and young adults does not decrease by a large amount soon, then there should be a nationwide ban of the public use of tanning devices.

Discuss whether you think the data in **Figure 6** justify a decision to ban everybody from using sunbeds and other tanning devices. Explain your view.

[4 marks]

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Turn over for the next question

7 There have been over 100 searches for extraterrestrial intelligence (SETI) since 1960. These have been carried out by many different groups of scientists, such as:

- universities
- government-funded organisations, eg NASA
- private companies.

Most of the searches have used telescopes which detect electromagnetic waves, such as visible light and radio waves, to look for signals which may have been produced by intelligent life.

7 (a) (i) Give **one** advantage and **one** disadvantage of having many different scientists working separately on a research problem such as SETI.

[2 marks]

Advantage.....

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Disadvantage.....

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7 (a) (ii) So far no one has detected a signal thought to be produced by intelligent extraterrestrial life.

One reason for this may be that intelligent extraterrestrial life does not exist so there is no signal to detect.

Discuss other possible reasons why SETI experiments have not detected a signal.

[4 marks]

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7 (a) (iii) Suggest why scientists continue to carry out SETI experiments even though no signal from intelligent extraterrestrial life has yet been detected.

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7 (b) Is the view that life exists elsewhere in the universe a scientific theory? Explain your answer.

[2 marks]

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Turn over for the next question

Passage: extract from Daily Mail article, 21.12.12

Half the impact of sleeping pills 'is due to placebo effect'

Around half the benefit of taking sleeping pills comes from the placebo effect – where people get better even when they are taking a 'dummy' drug, according to a study.

The placebo effect produced around 50 per cent of the benefits, with the active ingredient in the sleeping pills – known as Z-drugs – making up the rest.

Widely prescribed since the 1990s, the drugs have been criticised for having too many side-effects – such as memory loss, extreme tiredness and balance problems – compared with their benefits.

One in three Britons are believed to suffer insomnia, with older people at greater risk.

Around 10 million NHS prescriptions for sleeping pills are issued each year – but guidelines say the drugs should only be for short-term use, usually for two weeks and for a maximum of four weeks at a time.

A research team from the University of Lincoln, Harvard Medical School and the University of Connecticut looked at trials in which the effects of sleeping pills were compared with placebos, non-active substances which supposedly have little effect on the condition.

Altogether they analysed 13 clinical trials containing 65 different comparisons and more than 4300 participants, according to a report in the British Medical Journal.

They looked at the difference between the drug response and placebo response, as well as the change which occurs after administration of a placebo – which includes factors such as improvement over the natural course of the condition.

Lead author Professor Niroshan Siriwardena, from the University of Lincoln, said: 'Psychological treatments for insomnia can work as effectively as sleeping tablets in the short term and better in the long term, so we should pay more attention to increasing access to these treatments for patients who might benefit.'

8 (a) (i) What is a **drug**?

[1 mark]

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8 (a) (ii) Suggest why a placebo effect might occur when a patient is taking 'dummy' drugs.

[2 marks]

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8 (a) (iii) Using information from the passage, suggest why guidelines say that sleeping pills should be for short-term use only.

[1 mark]

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8 (b) The University of Lincoln used a press release to give information about the findings of the research paper to the media. This information helped the Daily Mail journalist to produce a newspaper report which described the research accurately.

Describe some of the main differences between a research paper and the newspaper report.

[3 marks]

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8 (c) An elderly relative is not sleeping well and is considering taking sleeping pills.

Having read this passage, what would you suggest that your relative discusses with the doctor?

[6 marks]

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Question 8 continues on the next page

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END OF QUESTIONS

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Figure 1 From The New England Journal of Medicine; V. Richardson, U. Parashar, M. Patel; Childhood Diarrhea Deaths After Rotavirus Vaccination in Mexico; Volume 365, Issue 8, pp. 772-773. Copyright © 2011 Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society.
Figure 2 Herring, *The Plymouth Student Scientist*, 2012, 5 (1) 203-252
Figure 3 Department for Transport
Question 3 Are Prenatal Ultrasound Scans Associated with the Autism Phenotype? Follow-up of a Randomised Controlled Trial. Stoch et al., J Autism Dev Disord (2012) 42:2693–2701. National Library of Medicine.
Figure 4 Franic et al, Post-Chernobyl Investigations of Radiocaesium activity concentrations in Adriatic Sea Pilchards, Radiation Protection Dosimetry (2012), Vol. 151, No. 2, pp. 314–322, by permission of Oxford University Press.
Figure 5 Anurag A. Agrawal et al. Insect herbivores drive real-time ecological and evolutionary change in plant populations, Science 338, 113 (2012). Reprinted with permission from AAAS.
Figure 6 Reproduced from BMJ, Boniol et al, Cutaneous melanoma attributable to sunbed use: systematic review and meta-analysis, volume 345, pp. 1-12, 2012, with permission from BMJ Publishing Group Ltd.
Question 8 Daily Mail