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Candidate Signature										



General Certificate of Education
Advanced Subsidiary Examination
June 2011

Science in Society

SCIS1

Unit 1 Exploring Key Scientific Issues

Wednesday 18 May 2011

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.

For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



J U N 1 1 S C I S 1 0 1

M/Jun11/SCIS1

SCIS1

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

- 1** *Staphylococcus aureus* (Staph. A) is a type of common bacteria found on the skin and in the nose of about 30% of people. Usually Staph. A causes no ill effects. However, it can lead to serious infections if it gets into open wounds. This presents particular problems in hospitals after operations.

- 1 (a) (i)** Describe how the human immune system responds to infections by bacteria such as Staph. A.

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(2 marks)

- 1 (a) (ii)** Give **one** measure that patients or their doctors in hospitals should take to reduce the spread of Staph. A.

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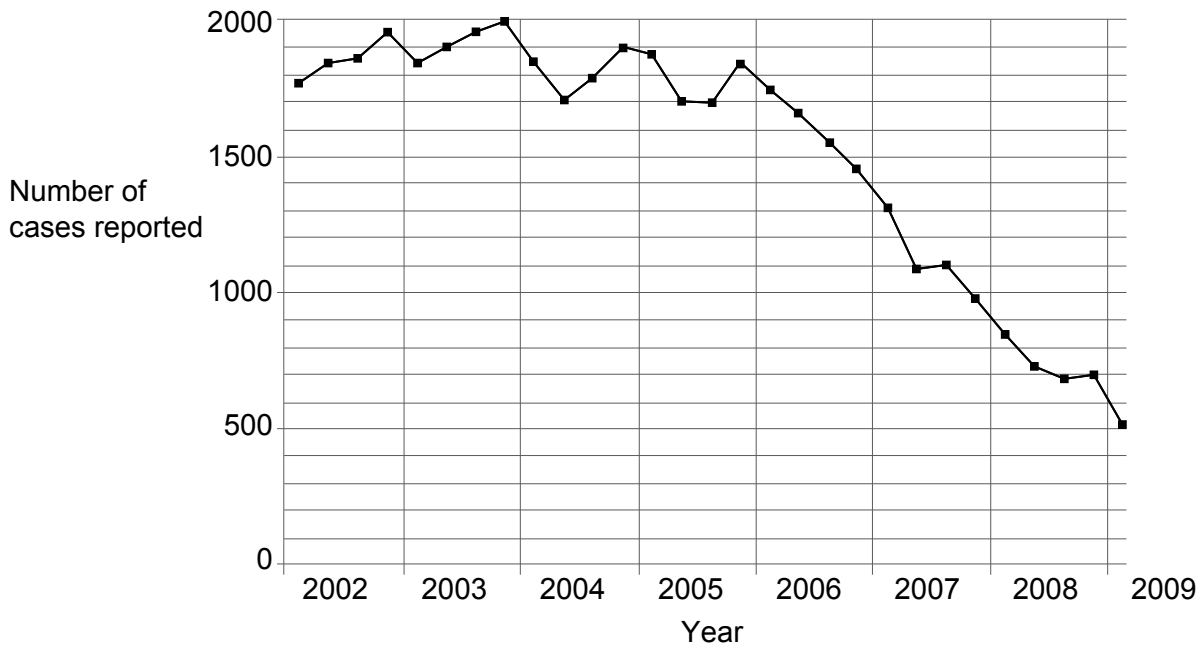
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(1 mark)



- 1 (b)** Normally Staph. A is easily treated with antibiotics. However, some Staph. A has developed resistance to antibiotics making it harder to treat. These resistant bacteria are known as 'MRSA'. Hospitals now have to test for MRSA and report all infections quarterly to the Department of Health. **Figure 1** shows the number of MRSA cases reported by hospitals since January 2002.

Figure 1
Reported cases of MRSA for each quarter since 2002



Source: reproduced by permission of The Health Protection Agency (2009)

- 1 (b) (i)** Explain the process by which a population of bacteria can become resistant to an antibiotic.

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(3 marks)

Turn over ►



- 1 (b) (ii)** In June 2004 the Department of Health set a target to reduce the number of MRSA infections by half by March 2008. Discuss whether this target was met using data from **Figure 1**.

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(2 marks)

- 1 (b) (iii)** Suggest how testing for MRSA and reporting infections to the Department of Health may have helped to reduce the number of infections in hospitals.

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(1 mark)

- 1 (c)** What particular conditions in a hospital favour the development and spread of antibiotic resistant bacteria?

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(2 marks)



2 European and UK legislation sets limits for emissions from vehicle exhausts. The emissions are measured while the car carries out a standard test sequence known as the Vehicle Certification Agency (VCA) 'drive cycle'. This is a series of accelerations, steady speeds, decelerations and periods of idling for a specified amount of time designed to match typical urban driving.

2 (a) Why does legislation require all manufacturers to use the same 'drive cycle' when measuring the CO₂ emissions from new cars?

.....

 (1 mark)

2 (b) Researchers are interested in the effect of driving style on car emissions. To study this they asked two drivers to drive along the same route containing traffic lights, speed limits, busy roads, and single/dual carriageways. Each drive test was carried out five times at different times of day. One driver was asked to drive passively and the other aggressively as shown in **Figure 2**.

Figure 2
Drive characteristics

Drive 1: Aggressive driving	Drive 2: Passive driving
<ul style="list-style-type: none"> • use hard acceleration and heavy braking • keep pace with the vehicle in front at a safe distance • reach driving speed as quickly as possible 	<ul style="list-style-type: none"> • use moderate acceleration and braking • obey the speed limit at all times • overtake as appropriate

Source: Proceedings of the Institution of Civil Engineers -Transport, Felstead et al (2009)

Using data from the test drives, the researchers developed drive cycles corresponding to passive and aggressive driving.

2 (b) Give **two** ways in which the researchers tried to make the drive cycles as realistic as possible.

One:

Two:

(2 marks)

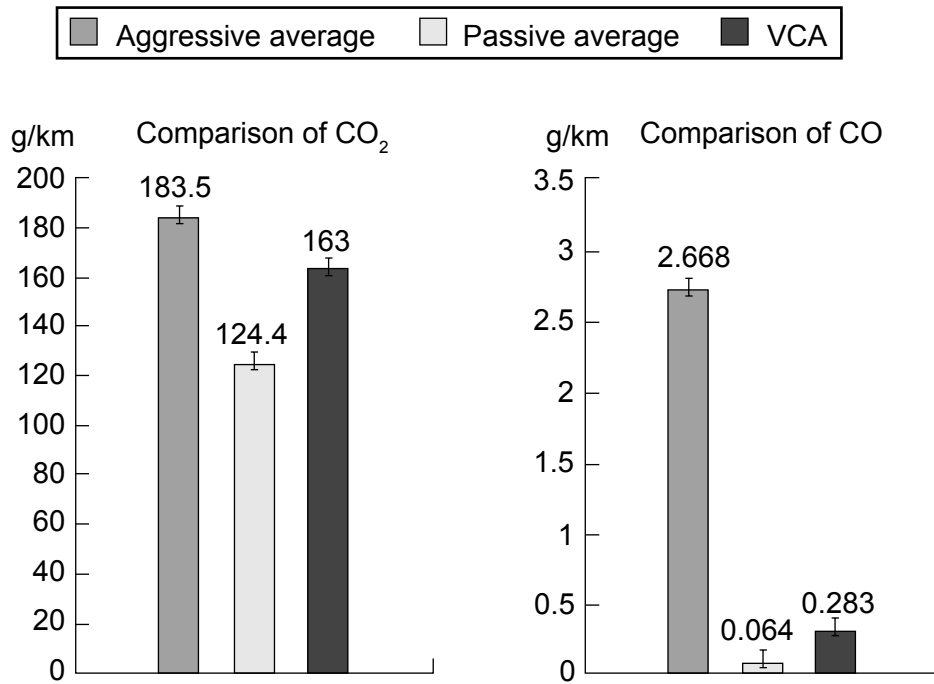
Turn over ►



- 2 (c)** Car emissions are measured in a garage using a chassis dynamometer, which is like a treadmill for cars. This allows measurement of the gases without the car moving.

Figure 3 shows the average emissions in g/km for the official VCA drive cycle and for the aggressive and passive drive cycles developed by the researchers.

Figure 3
Levels of carbon dioxide (CO₂) and carbon monoxide (CO)
for three different drive cycles



Source: Proceedings of the Institution of Civil Engineers -Transport, Felstead et al (2009)

- 2 (c) (i)** Explain how carbon dioxide is produced in car engines.

.....

 (1 mark)

- 2 (c) (ii)** Explain why some carbon monoxide is also produced.

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 (1 mark)



- 2 (c) (iii)** What percentage reduction in carbon dioxide emissions results from driving passively compared with the VCA drive cycle? Show your working.

.....
(2 marks)

- 2 (c) (iv)** Explain how the carbon dioxide data in **Figure 3** provide evidence that your fuel consumption depends on how you drive.

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(2 marks)

9

Turn over for the next question

Turn over ►



3 The risk of developing some non-infectious diseases is increased by unhealthy diet, lack of physical activity, smoking and stress. They are often known as lifestyle diseases.

3 (a) (i) Give **two** examples of lifestyle diseases that can affect people in the UK.

Example 1

Example 2

(1 mark)

3 (a) (ii) Suggest why lifestyle diseases are an increasing problem in developing countries.

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(1 mark)

3 (b) The Isfahan Healthy Heart Programme (IHHP) was a lifestyle intervention trial which was carried out in two districts in Iran: Isfahan and Naaf-Abad. In these areas a number of activities took place depending on the issues and needs identified by a *baseline survey*.

These activities included:

- educating children and adults about healthy cooking methods and good diet
- enforcing no-smoking regulations at worksites
- 'Quit smoking' campaigns
- giving out CDs about exercise in the home and at work.

A third district, Arak, where the IHHP was not used, acted as a control for the trial.

3 (b) (i) Explain what is meant by a baseline survey.

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(1 mark)

3 (b) (ii) Why was it important to have a control district where the IHHP was not used?

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(1 mark)



- 3 (c)** In each year of the study the researchers randomly selected a sample of about 3000 adults living in each district. Each adult answered questionnaires about their diet, physical activity (at work and at home), and smoking behaviour.

Based on data from the questionnaires the researchers identified the individuals with a diet that was judged to be healthy. **Figure 4** shows the percentage of people with a healthy diet, along with data on smoking behaviour and the amount of leisure time spent on physical activities each week.

Figure 4
Data from the IHHP study questionnaires

		Baseline	Annual Evaluation		
			1st	2nd	3rd
Healthy diet (%)					
Intervention areas		16.9	17.7	24.3	31.8
Control area		12.8	14.4	13.9	10.8
Daily smokers (%)					
Intervention areas		14.8	15.0	11.9	13.9
Control area		15.2	16.3	15.3	12.6
Leisure time physical activity (min/week)					
Intervention areas	mean	85	82	104	120
	range	0-176	6-158	30-178	0-280
Control area	mean	84	74	91	106
	range	0-174	11-137	33-149	0-253

Source: Adapted from World Health Organization, (2009)

- 3 (c) (i)** There is a very large range of results for leisure time physical activity. Why is it important for the interpretation of the data to indicate the range of the results as well as the mean?

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(2 marks)

- 3 (c) (ii)** The adults completed questionnaires once a year. Suggest how the accuracy of the data might be affected by only collecting the information yearly.

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(1 mark)

Turn over ►



3 (d) Write a short report for the Iranian government **evaluating** the effects of the IHHP. You should refer to the following factors in your report:

- diet
- smoking
- physical activity.

The quality of your written communication will be assessed in your answer.

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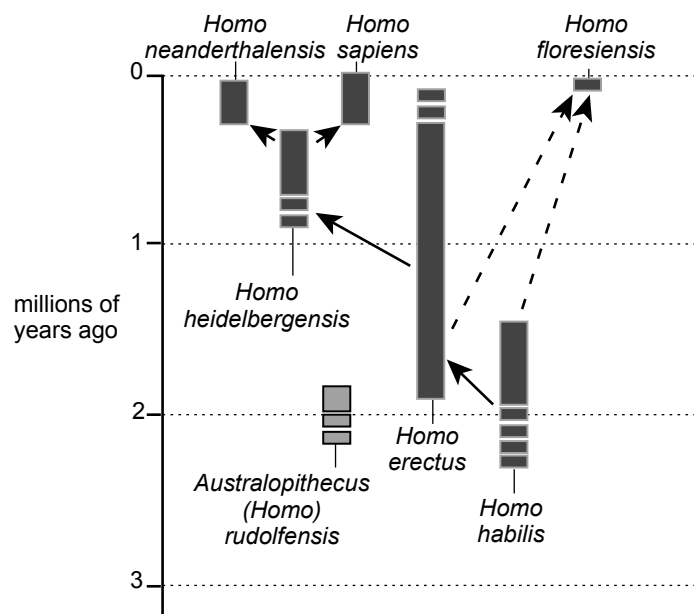
(6 marks)



- 4 Flores is an island in Indonesia. In 2004 the well preserved skeleton of a 1 m tall woman was found in a cave on the island. The scientists who found it claimed that this was a new species of hominin – the group of species that includes humans and their ancestors – and more closely related to humans than to chimpanzees and other apes. They called the species *Homo floresiensis*.

Figure 5 shows a possible relationship between different hominin species. Relationships that scientists are fairly confident about are indicated by solid arrows; relationships that they are less sure about are indicated by dotted arrows. Broken vertical bars indicate uncertainties about when species evolved or became extinct.

Figure 5
Current view of the relationships between different species of hominin



Source: Reprinted by permission from Macmillan Publishers Ltd: Nature, (2009)

- 4 (a) (i) Estimate how long ago *Homo heidelbergensis* became extinct.

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 (1 mark)

- 4 (a) (ii) Which of the species shown in **Figure 5** is the earliest ancestor of *Homo sapiens* (humans)?

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 (1 mark)

Turn over ►



- 4 (a) (iii) Suggest **one** reason why there may be uncertainty about when a species, such as *Homo habilis*, evolved.

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(1 mark)

- 4 (a) (iv) Suggest **one** reason why there is uncertainty about which species *Homo floresiensis* evolved from, as indicated in **Figure 5**.

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(1 mark)

- 4 (b) Summarise how Darwin's theory of evolution by natural selection could explain the development of a new species on Flores.

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(3 marks)



- 4 (c)** In 2006, some researchers published a paper which suggested that *Homo floresiensis* was not a new species. They said that the remains were of a group of people who suffered from a brain disease called microcephaly which leads to very small heads.

In 2009 more research about the Flores remains was published. One research group had investigated the structure of the foot. They found that it lacked an arch, and looked remarkably primitive. A second research study also looked at the anatomy of the body, and suggested that *Homo floresiensis* could have evolved from *Homo habilis*.

A comment posted on a website about *Homo floresiensis* said:

“Scientists are always changing their minds. They should all agree and get their ideas right first time.”

Do you agree with this comment? Using the information in the question to help you, explain your answer.

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(3 marks)

Turn over for the next question

10

Turn over ►



- 5** Lymphoma is a type of cancer which affects part of the body's immune system. In lymphoma abnormal lymphocytes are produced which are not able to function correctly.

Researchers, funded partly by Cancer Research UK, have carried out a phase 1 clinical trial of a potential new treatment for lymphoma. They have identified a protein found on the surface of lymphocytes called IL-2. There are more of these proteins produced in some lymphomas. The treatment uses radioactive antibodies known as CHT25. The radioactive antibodies attach to the IL-2 proteins and irradiate the cancerous cells.

- 5 (a)** The radioactive isotope used in the research was iodine-131, which has a half-life of eight days. The *activity* of the iodine-131 is measured in becquerel (Bq).

- 5 (a) (i)** How can the iodine-131 kill the cancerous cells?

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 (1 mark)

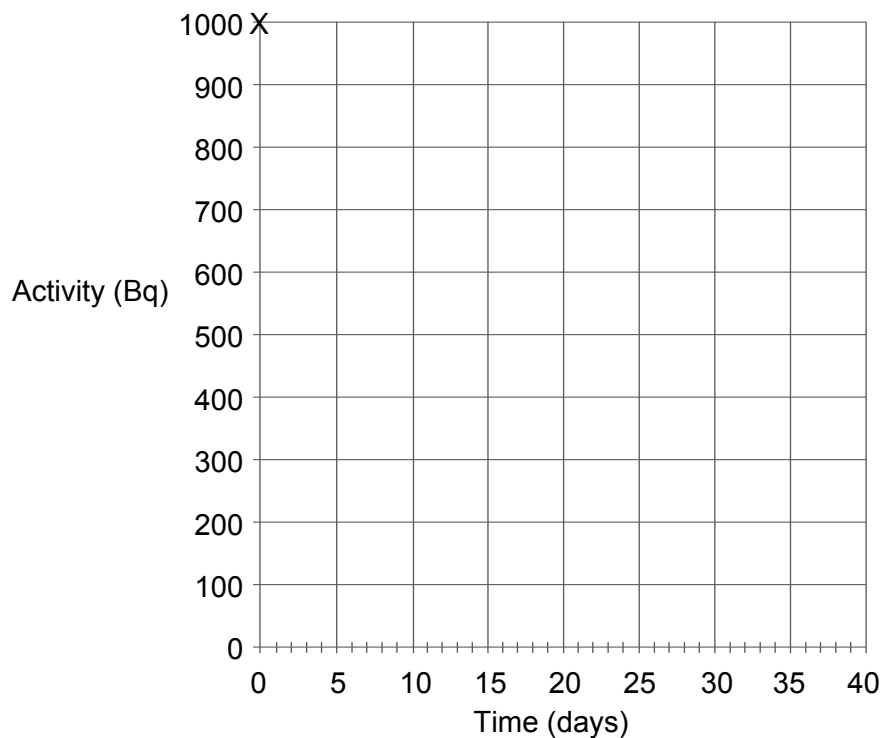
- 5 (a) (ii)** What is meant by the activity of a radioactive isotope?

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 (1 mark)

- 5 (a) (iii)** Sketch a graph showing the decrease in activity of a sample of iodine-131 using the axes below. The initial activity of the sample was 1000 Bq. The first point (X) has been drawn for you.

Activity of iodine-131



(3 marks)



- 5 (a) (iv)** Iodine also exists in a non-radioactive form, iodine-127. How are the atoms of these two isotopes of iodine different?

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(1 mark)

- 5 (b)** The researchers wanted to carry out a study to find out:
- what dose of CHT25 could be given before there were serious blood problems
 - what dose of CHT25 caused adverse effects in half of the patients
 - what happened to the CHT25 as it travelled through the body during treatment.

The researchers chose 15 patients whose lymphoma had been treated by other methods. In these patients the cancer was no longer responding to the treatments. These patients all had lymphomas which had the IL-2 protein in excess. The researchers selected patients with at least a 3-month life expectancy and no other serious illnesses.

Each patient was given information about the study before they were asked to agree to being included. This is known as informed consent.

- 5 (b) (i)** What information should patients be given before they gave their consent?

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(2 marks)

- 5 (b) (ii)** Describe the key features of further trials which would be needed before CHT25 could be accepted as a general treatment for lymphoma.

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(2 marks)

Turn over ►



- 5 (c)** The current treatment for some lymphomas is radiotherapy. A beam of X-rays is directed at the site of the tumour from outside the body.

Give **two** possible advantages of the CHT25 treatment compared with the current treatment.

Advantage 1

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Advantage 2

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(2 marks)

12



- 6** *In vitro* fertilisation (IVF) can often lead to multiple births. Researchers in Western Australia wanted to find out if twins born as a result of IVF were as healthy as naturally conceived (NC) twins.

They investigated how often twins were admitted into hospital in the first three years of life. They compared naturally conceived (NC) twins with all twins born as a result of IVF.

- 6 (a)** Explain briefly how IVF works.

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(2 marks)

- 6 (b)** The researchers used medical records to see if the children went into hospital, why, and for how long. **Figure 6** shows some data from the study.

Figure 6
Comparison of twins born by IVF and by natural conception (NC)

	IVF Twins	NC Twins
Number of children	700	1240
Average length of pregnancy (weeks)	34.7 ± 3.3	35.8 ± 2.8
Average birthweight (g)	2276 ± 634	2486 ± 584
Major birth defect		
Yes	48	63
No	652	1177
% Children admitted to hospital – year 1	35.5%	25.8%
% Children admitted to hospital – year 2	18.9%	14.2%
% Children admitted to hospital – year 3	13.7%	12.1%

Source: Adapted from, Human Reproduction Vol 24, Hansen et al (2009)

- 6 (b) (i)** Do the data provide clear evidence that there is a difference between the birthweight of IVF and NC twins? Explain your answer.

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(2 marks)

Turn over ►



6 (b) (ii) Explain if an IVF or NC twin is more likely to be born with a major birth defect.

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(3 marks)

6 (c) In the discussion section of their paper the researchers wrote:
“In this study 35.5% of IVF and 25.8% of NC twins were admitted to hospital in their first year... The increase was no longer statistically significant after adjustment for other factors...”

6 (c) (i) What do the researchers mean when they say that the results are not statistically significant?

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(1 mark)

6 (c) (ii) Suggest **one** reason why a higher percentage of IVF twins is admitted to hospital in their first year of life.

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(1 mark)

6 (c) (iii) Give **two** reasons why the researchers adjusted the results for other factors when comparing the health and hospital admissions of the IVF and NC twins.

Reason 1

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Reason 2

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(2 marks)



7

Scientists are interested in knowing how much mass is contained in the Universe. The total mass of the Universe will affect the way in which the universe will end.

Astronomers are able to calculate the mass of individual galaxies in two ways. The first is by looking at how fast they spin. The faster a galaxy spins the more mass it must contain. The second method is to add up the masses of all the visible objects in the galaxy.

In the 1930s an astronomer, Fritz Zwicky, used both of these methods to calculate the mass of galaxies in the Coma cluster. The two methods led to very different results. There was far too little visible matter to account for the rate at which the galaxies were spinning. Zwicky concluded that there was something there which was exerting gravitational attraction but which could not be seen.

Zwicky's findings were mostly ignored for the next 40 years. However, other astronomers also found that there were other measurements that could not be explained by the mass of the visible universe. The 'missing' mass was named dark matter because it does not emit electromagnetic radiation and could not be detected by telescopes. It is now calculated that only about 5% of the mass of the universe comes from visible matter such as stars and planets.

Scientists using the Large Hadron Collider (LHC) will recreate the conditions in the universe just after the '*Big Bang*'. They are hoping that they will be able to create and study dark matter particles. This will allow them to develop a better description of the way in which the Universe began, and what it is made from.

7 (a) (i) What is a galaxy?

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 (1 mark)

7 (a) (ii) Give **two** examples of electromagnetic radiation that can be used by astronomers to study galaxies.

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 (1 mark)

7 (a) (iii) Explain why astronomers rely on electromagnetic radiation to investigate galaxies.

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 (1 mark)

7 (a) (iv) Describe briefly what scientists mean by the '*Big Bang*'.

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 (2 marks)

Turn over ►



- 7 (b) (i)** Suggest why Zwicky thought that it was worthwhile to use two different methods to work out the mass of galaxies?

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(1 mark)

- 7 (b) (ii)** Give **two** ways you would expect scientists to respond when two ways of calculating a quantity disagree?

One

.....

Two

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(2 marks)

- 7 (b) (iii)** Suggest why it took a long time for other astronomers to accept Zwicky's theory.

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(1 mark)

- 7 (c)** The Large Hadron Collider (LHC) has been built by CERN – a multinational collaboration between 20 European countries. The money to build and run the experiments that will be carried out using the LHC is being provided by many other nations including Brazil, USA, India, Morocco and Australia.

Suggest **two** reasons why so many scientists and countries are involved in building and running the Large Hadron Collider.

Reason 1

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Reason 2

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(2 marks)



8

Passage 1

Extract from *Statistics of Scientific Procedures on Living Animals in Great Britain (2008)*

The use of animals in scientific research and experimentation in the UK is regulated by the Animals (Scientific Procedures) Act 1986. In order to carry out research using animals the researcher must apply for a licence from the Home Office, which acts as the *regulatory body*.

Once a project has a licence the researchers must follow a strict code of conduct which sets the minimum standards for the care of the animals. The researchers must also report the number, and species, of animals they have used, along with the type of procedure that was carried out.

Some animal species have diseases similar to those found in humans, often caused by a harmful genetic defect. Some human diseases have no counterpart in animals. Scientists have used *genetic modification* to create animals which *show symptoms similar to the human disease*. They can then use these animals to carry out research.

The proportion (values rounded up) of animal types used in research across the whole of the UK in 2008, was:

- mice, rats and other rodents: 78%
- fish, birds and reptiles: 21%
- large mammals (eg cows, sheep, pigs): 0.5%
- small mammals (eg rabbits, ferrets): 0.4%
- dogs and cats: 0.1%

Great apes are no longer used in research.

Source: © Crown Copyright material is reproduced with the permission of the Controller of HMSO and Queen's Printer for Scotland (2007)

Passage 2

Adapted from The Cystic Fibrosis Trust website

The Cystic Fibrosis Trust acknowledges the concern of some people about the use of animals in medical research. However, we recognise that research using animals has made, and continues to make, a vital contribution to the understanding and treatment of a range of major health problems including cancer, heart disease, diabetes and cystic fibrosis - as well as to the health and welfare of animals.

Most research is carried out on cells in a laboratory, with computers or on patients; however, these methods cannot yet always replace research involving animals.

All new medicines are required by law to use animals during development and safety testing.

Source: by kind permission of Cystic Fibrosis Trust (2009)

8 (a) (i) What do you understand by the term regulatory body?

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(1 mark)

Turn over ►



8 (a) (ii) What do you understand by the term genetic modification?

.....

.....

(1 mark)

8 (a) (iii) Suggest why scientists use genetic modification to create animals which show symptoms similar to the human disease in their research.

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(2 marks)

8 (b) (i) Animals that breed quickly, such as mice and fish, are used extensively in research. Suggest **one** reason why this characteristic is useful to researchers.

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(1 mark)

8 (b) (ii) Do the data given in **Passage 1** suggest that public opinion affects the number and type of species used in research? Explain your answer.

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(2 marks)



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13



There are no questions printed on this page

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