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Centre Number		Candidate Number	
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For Examiner's Use

General Certificate of Education
 June 2008
 Advanced Subsidiary Examination



SCIENCE FOR PUBLIC UNDERSTANDING
Unit 2 Issues in the Physical Sciences

SPU2

Friday 6 June 2008 9.00 am to 10.15 am

<p>You will need no other materials. You may use a calculator</p>

Time allowed: 1 hour 15 minutes

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Answer the questions in the spaces provided. Answers written in margins or on blank pages will not be marked.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- Show your working in **all** calculations.

Information

- The maximum mark for this paper is 60.
- The marks for questions are shown in brackets.
- Questions 1(c) and 2(c)(ii) should be answered in continuous prose. In these questions you will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

For Examiner's Use			
Question	Mark	Question	Mark
1			
2			
3			
4			
5			
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			



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

- 1 **Figure 1** shows the average annual carbon dioxide emissions per person in a range of countries in 2003.

Figure 1

Carbon dioxide emissions in different countries

Country	CO ₂ tonnes per person each year
USA	19.5
UK	9.1
China	3.2
India	1.0

- 1 (a) (i) The UK government has set a target to significantly reduce greenhouse gas emissions by the year 2010. This will require a reduction of about 10% on 2003 emissions.
By how many tonnes of carbon dioxide would an average family of 4 in the UK have to reduce their annual emissions to achieve the target?

.....
(1 mark)

- 1 (a) (ii) Name **two** probable features of this family's lifestyle that would explain why its carbon dioxide emissions are so much higher than those of an average Indian family.

Feature 1

.....

Feature 2

.....

(1 marks)



- 1 (b) Specialist companies offer people the chance to purchase ‘carbon offsets’ to compensate for the carbon dioxide released by a flight or some other consumption of fossil fuel. They encourage people to pay an offset fee which is spent on reducing carbon dioxide emissions in a developing country. **Figure 2** shows some of the offset projects offered.

Figure 2

Carbon offset projects

Offset projects	Tonnes of CO ₂ saved	Time over which this saving made
providing more efficient light bulbs for homes in a poor community in South Africa	0.1/light bulb	1 year
providing more efficient wood burning stoves in India	3.0/stove	1 year
planting trees in a national park in Uganda	400 tonnes/hectare	lifetime of tree
fitting solar panels on homes in Nigeria	0.13/m ²	1 year

- 1 (b) (i) Explain how using a light bulb that still consumes electricity can be said to ‘save’ carbon dioxide emissions.

.....

.....

.....

(2 marks)

- 1 (b) (ii) Explain how planting a tree can be said to ‘save’ carbon dioxide emissions.

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(2 marks)

Question 1 continues on the next page

Turn over ▶



2 Coal is an abundant and relatively cheap fuel. It is used to generate electricity and for heating. Unfortunately coal contains sulfur as an impurity. Other fossil fuels contain much less sulfur.

2 (a) Explain why burning coal produces the pollutant gas sulfur dioxide.

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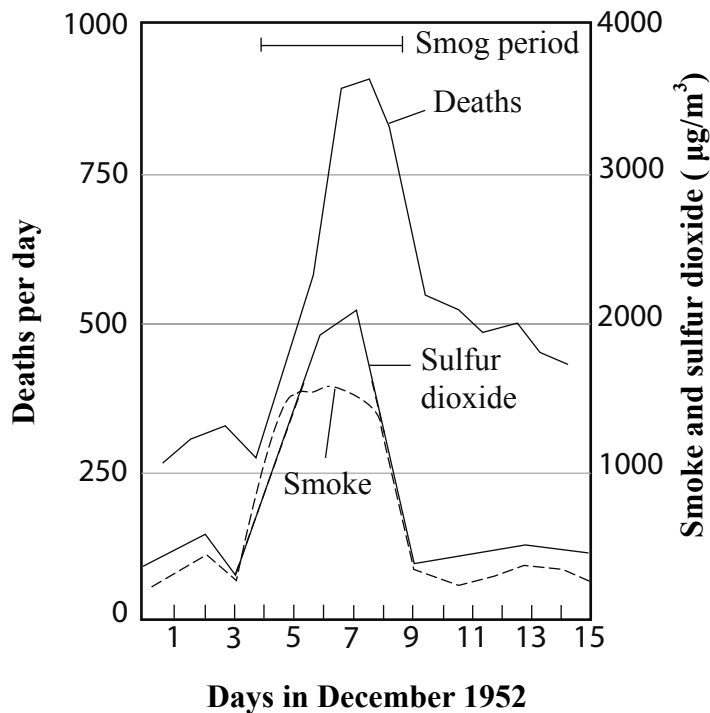
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(2 marks)

2 (b) **Figure 3** shows data collected in London in December 1952 during a serious pollution incident called a smog. The main source of pollutants at this time was the use of coal fires to heat homes.

Figure 3

Deaths per day and pollution levels during the 1952 London smog



2 (b) (i) What does **Figure 3** suggest was the 'normal' level of sulfur dioxide in London at this time?

.....

(1 mark)

Turn over ▶



2 (b) (ii) There were at least 4000 extra deaths over the period of the smog. What conclusions can you draw from **Figure 3** about the causes of these excess deaths?

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(2 marks)

2 (c) Since 1952 average concentrations of sulfur dioxide in Europe have continued to fall and are now about $20 \mu\text{g}/\text{m}^3$. Since 2006 international guidelines have recommended an average of $20 \mu\text{g}/\text{m}^3$ to prevent increased risk of illness and death from respiratory disease.

2 (c) (i) Suggest **two** factors that led to the fall in emissions of sulfur dioxide in Europe.

Factor 1

.....

Factor 2

.....

(2 marks)



- 3 In 1986 a massive nuclear accident destroyed a nuclear power station at Chernobyl in the Ukraine, at that time part of the Soviet Union. There was a huge release of *radioactive isotopes* into the atmosphere. Now, more than 20 years later, scientists are trying to assess the increased risk of cancer caused by the accident.

The main risks are associated with the radioactive isotopes iodine-131, with a half-life of 8 days, and caesium-137, with a half-life of 30 years.

- 3 (a) (i) What is meant by the term isotopes?

.....

.....

(1 mark)

- 3 (a) (ii) What is meant by the term radioactive?

.....

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(1 mark)

- 3 (a) (iii) People are still excluded from the 4000 km² area around the damaged reactor. Which of these two radioactive isotopes is the reason for the continued risk in the area? Explain your answer using the idea of half-life.

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(2 marks)

- 3 (a) (iv) In the days after the accident, contamination from radioactive isotopes in milk was the main risk. Suggest a route by which radioactive isotopes sent up into the atmosphere could end up in milk.

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(2 marks)



- 3 (b) Scientists estimate the risk of cancers caused by exposure to ionising radiation by using studies of survivors of the atomic bombs dropped on Hiroshima and Nagasaki in 1945. Victims were exposed to different doses of radiation depending on their distance from the explosions. The data suggest that risk is proportional to dose. Most scientists assume that this relationship also holds for doses lower than those experienced by the atom bomb survivors.

The data in **Figure 4** show one set of risk estimates, based on this method.

Figure 4

The number of extra cancer deaths expected as a result of the Chernobyl accident.

Groups affected by Chernobyl radiation	Number of people in this group	Average dose/mSv	Normal number of deaths from cancer in this group	Extra deaths from cancer (in this group) due to Chernobyl radiation
People working on the damaged reactor	240 000	100	41 000	2000
People evacuated from the immediate area	116 000	33	21 500	150
People living in high contamination area	270 000	50	43 500	1500
People living in low contamination area	5 000 000	10	800 000	4600

- 3 (b) (i) Explain **one** of the important sources of error in these estimates of extra risk.

.....

(2 marks)

- 3 (b) (ii) Some researchers are measuring how many **extra** deaths from cancer have in fact occurred over the last 20 years in populations exposed to radiation from the accident. What information do they need to collect to do this?

.....

(1 mark)

Turn over ►



3 (b) (iii) What particular difficulties would the researchers face in finding out how many extra deaths there have been in the low contamination area?

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(2 marks)

3 (c) Different groups of scientists have come up with very different estimates of the total deaths to be expected, as the quotes below show.

“The UN study predicts the real number that will die from long-term cancers caused by the radiation to be about 3940.”

International Atomic Energy Association and World Health Organisation

“Cancer deaths caused by Chernobyl will be between 30 000 and 60 000”

Radiation experts employed by Green group in European Parliament

Suggest an explanation for the fact that different experts can come up with such different predictions.

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(2 marks)

3 (d) One researcher writing in a newspaper, has made the claim

“Risks are probably no greater than those posed by obesity or smoking”

Even though this claim may be correct, many people living in areas affected by the accident are much more anxious about the risks to their health posed by the radiation than about the risks posed by obesity or smoking. Suggest why the risks are viewed differently.

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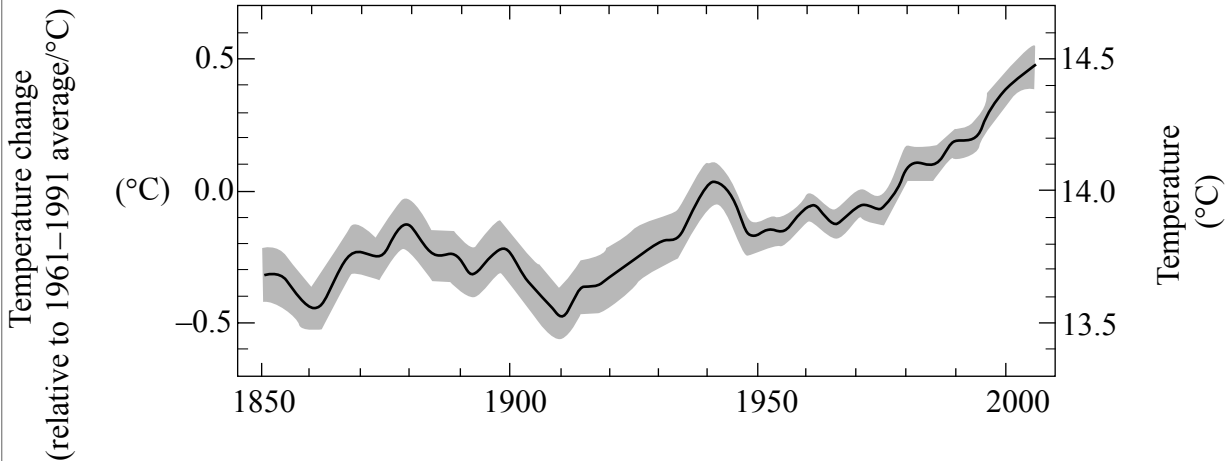
(2 marks)



- 4 In 2007 the IPCC, a United Nations group of 600 climate scientists, produced its fourth report on climate change.
- 4 (a) **Figure 5** shows the observed change in global average temperatures since 1850. The change is relative to the 1961–1991 average. The averages are derived from many temperature measurements all over the world.

Figure 5

Global Average Temperature Since 1850



- 4 (a) (i) The uncertainty in the temperature data in **Figure 5** is represented by the shaded area. Why is there uncertainty in the data?

.....

 (1 mark)

- 4 (a) (ii) Suggest **one** reason why the uncertainty in the temperature data in **Figure 5** has decreased since the 1950s.

.....

 (1 mark)

- 4 (a) (iii) Describe **one** other feature of the data in **Figure 5** that gives the IPCC confidence to say that there is now no doubt that the climate is warming.

.....

 (1 mark)

Turn over ▶



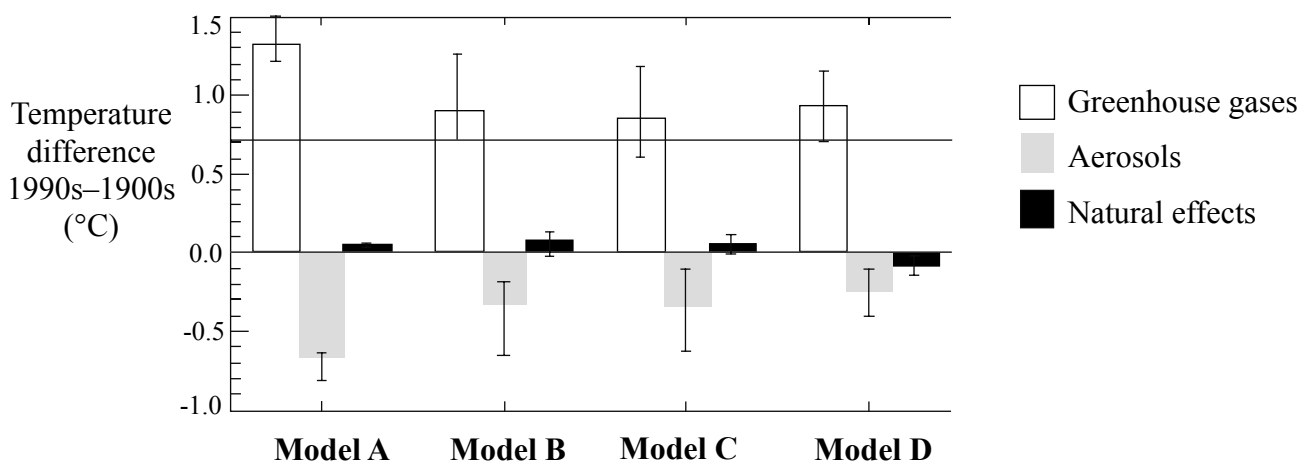
- 4 (b) IPCC reports make use of models to analyse the causes of past climate change and to predict the future.

Figure 6 shows the estimates, made by four different climate models, of contributions to the observed temperature change by three main factors:

- greenhouse gases generated by human activity
- aerosols (airborne solid or liquid particles) caused by human activity
- natural effects such as changes in the Sun's output.

Figure 6

Estimated contribution to changes in the observed global mean surface temperature from greenhouse gases, aerosols and natural effects.



- 4 (b) (i) In the space below sketch a diagram to explain how greenhouse gases and aerosols each influence the temperature of the Earth in the ways shown in **Figure 6**.

(3 marks)



4 (b) (ii) The IPCC report concludes that ‘most of the observed increase in globally averaged temperatures since the mid-20th century is *very likely* (90% likelihood) due to the observed increase in greenhouse gas concentrations due to human activity.’

Describe **two** features of the information in **Figure 6** that support confidence in the conclusion that human activity has caused the temperature rise.

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(2 marks)

4 (b) (iii) Some features of the Earth’s climate system are not yet understood well enough to be taken fully into account by climate models.
Describe **one** feature of the climate system that is still not well understood.

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(2 marks)

10

Turn over for the next question

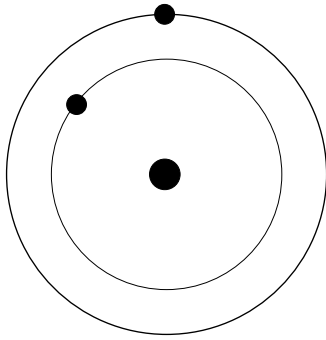
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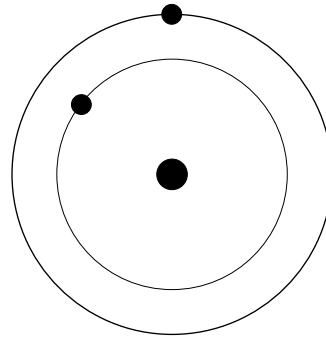
5 The change from Ptolemy’s geocentric theory to a heliocentric theory of the solar system took over 100 years to become accepted from the time it was first proposed by Copernicus.

5 (a) Label the diagrams in **Figure 7** in a way that explains the important difference between the two theories.

Figure 7



Geocentric model



Heliocentric model

(2 marks)

5 (b) Give **two** pieces of evidence that made scientists like Copernicus feel that the geocentric model needed change.

1.....

2.....

(2 marks)

5 (c) Galileo made several important contributions towards the acceptance of the new theory.

5 (c) (i) He made new observations that did not agree with predictions made by Ptolemy’s theory.

Describe **one** of these observations and explain why it does not agree with Ptolemy’s model.

.....

(2 marks)



5 (c) (ii) Give **two** reasons why Galileo’s writings about the heliocentric model of the solar system got him into trouble with the authorities.

Reason 1

.....

Reason 2

.....

(2 marks)

5 (d) Newer scientific theories, such as relativity or the Big Bang, have been accepted much more quickly than the 100 years it took to accept the heliocentric model. Suggest **two** reasons why this is so.

Reason 1

.....

Reason 2

.....

(2 marks)

10

END OF QUESTIONS



There are no questions printed on this page

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