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General Certificate of Education
 June 2004
 Advanced Subsidiary Examination



SCIENCE FOR PUBLIC UNDERSTANDING
Unit 2 Issues in the Physical Sciences

SPU2

Monday 14 June 2004 Morning Session

No additional materials are required.
 You may use a calculator.

Time allowed: 1 hour 15 minutes

Instructions

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** 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 60.
- Mark allocations are shown in brackets.
- In your answers to Question 3(d) and Question 4(d) you will be assessed on your ability to use an appropriate form and style of writing, to organise relevant information clearly and coherently, and to use specialist vocabulary, where appropriate. The degree of legibility of your handwriting and the level of accuracy of your spelling, punctuation and grammar will also be taken into account.

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

- 1 (a) We cannot continue to rely on oil as a transport fuel indefinitely. Give **two** reasons why this is so.

Reason 1.....

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Reason 2.....

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(2 marks)

- (b) The use of hydrogen gas as a fuel to replace oil is being actively researched by car manufacturers. It can be stored relatively easily and used in a fuel cell, where the hydrogen combines with oxygen from the air to generate electricity. The only waste product is water. Hydrogen gas does not occur naturally; it has to be produced by passing an electric current through water. The flow diagram in **Figure 1** shows the whole process of hydrogen production and use, starting with four different possible primary energy sources.

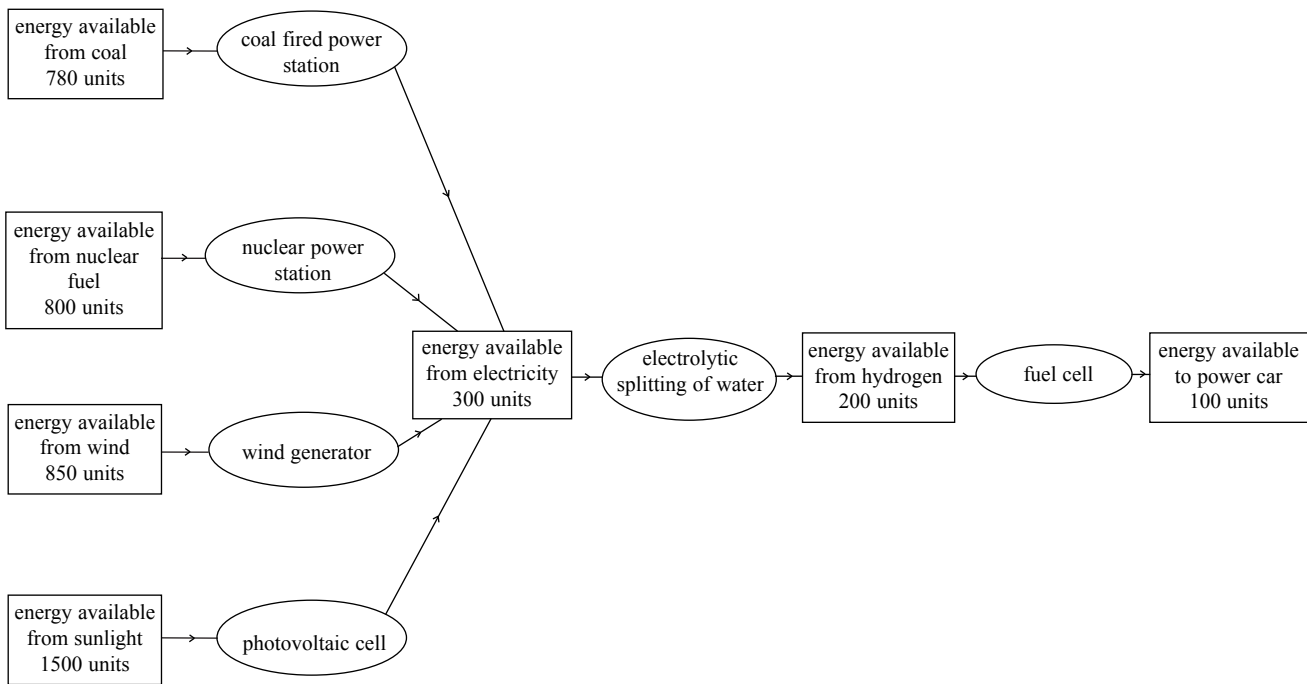


Figure 1

- (i) The flow diagram shows four different ways of generating 300 units of electricity. Which of the four is the most efficient?

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(1 mark)

(ii) A car is run on hydrogen made by electricity from a coal fired power station. Calculate the overall efficiency of this process, showing your working.

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(2 marks)

(iii) Choose **one** of the less efficient ways of generating electricity in **Figure 1** and give **two** reasons why it might be chosen despite this.

Method.....

Reason 1

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Reason 2

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(2 marks)

(c) The President of the United States has been quoted as saying "Cars powered by hydrogen will be pollution-free". Explain why this is not necessarily the case.

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(2 marks)

(d) One commentator wrote "Hydrogen can burn explosively. It must not be used in cars unless it is 100% safe". Discuss whether you think 100% safety is the relevant safety standard to use in making a decision on the choice of fuel.

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(2 marks)

- 2 Over the last 100 years the average temperature of the Earth has been rising. Two hypotheses have been put forward to account for this:
 - 1 It is due to increased concentrations of carbon dioxide and other greenhouse gases in the atmosphere.
(It is known that carbon dioxide concentrations in the atmosphere remained almost constant over the last 1000 years at about 280 ppm until they started rising in the 1800s to the current level of about 360 ppm.)
 - 2 It is due to natural variations in the Sun's output.
(These variations are thought to occur about every 200 - 500 years.)

Most scientists agree with hypothesis 1.

Figure 2 is based on data published by the Intergovernmental Panel on Climate Change (IPCC), a United Nations body made up of 2500 scientists. It shows the estimate, made by one group of scientists, of average Northern Hemisphere temperatures over the last 1000 years, relative to the average temperature 1961-1990. Other groups of scientists within the IPCC have produced very similar graphs.

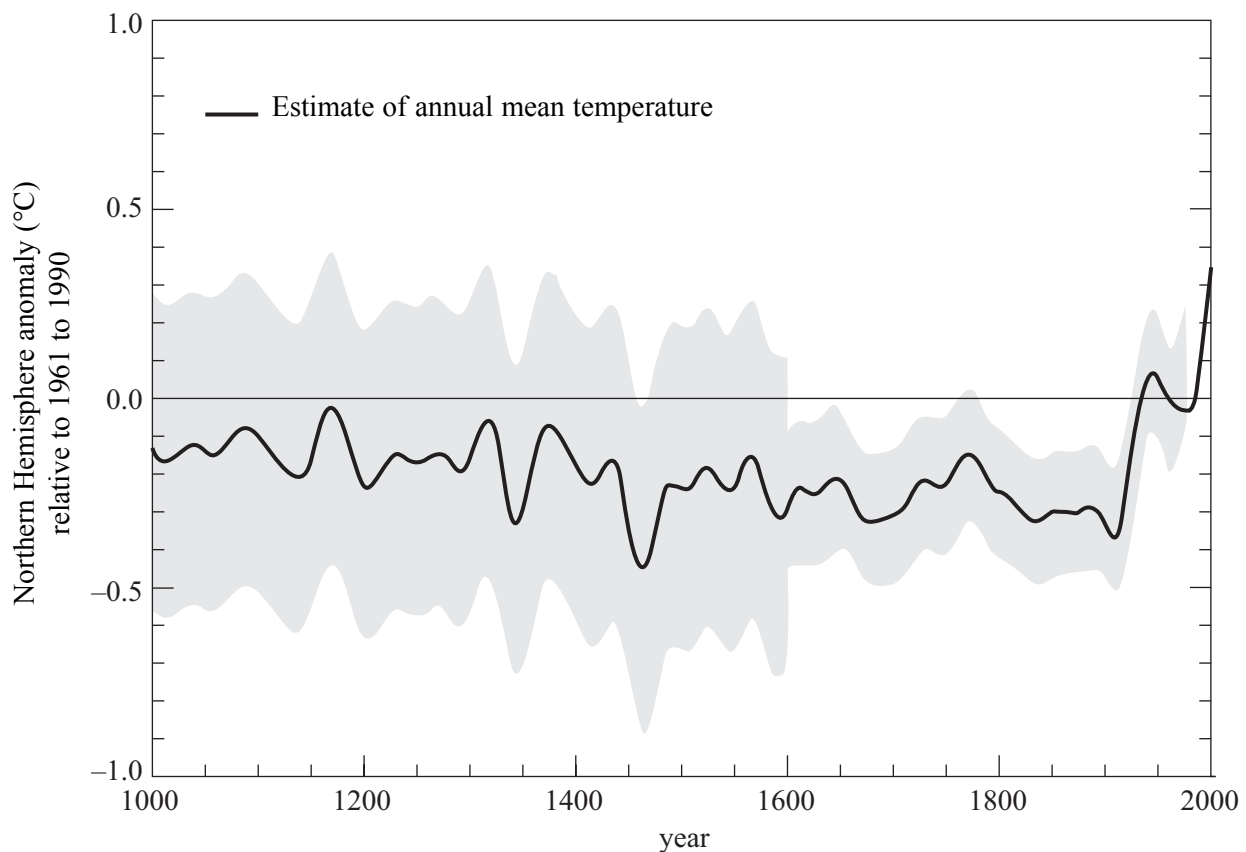


Figure 2

- (a) (i) Describe the main trends in temperature change over the last 1000 years as shown in **Figure 2**.

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(2 marks)

- (ii) Which of the two hypotheses do these trends support? Explain your answer.

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(2 marks)

- (b) The range of uncertainty in the values plotted in **Figure 2** is shown by the grey shaded area on the graph.

- (i) Why is there uncertainty in the data?

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(1 mark)

- (ii) Suggest a reason why the uncertainty is so much greater in the period 1500-1600 than the period 1900-2000.

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(2 marks)

QUESTION 2 CONTINUES ON THE NEXT PAGE

Turn over ▶

- (c) Another research group has used slightly different techniques to estimate past temperatures and has concluded that:
- the period 800 - 1300 AD was at least as warm as the present;
 - the period 1300 - 1900 AD was exceptionally cold;
 - the current rapid change in temperature is "neither unusual nor unprecedented" for the past 1000 years.

These scientists are astronomers who work at Harvard, a prestigious university in the United States. The information was published in peer-reviewed journals. The research was part-funded by the American Petroleum Institute. Two of the scientists also have positions with an institute funded by an oil company.

- (i) Explain how data from the Harvard group supports hypothesis 2.

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(2 marks)

- (ii) From the information you have about the IPCC study and about the Harvard group, give **two** reasons why you would be likely to trust one set of data more than the other.

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(2 marks)

- (d) Do you think it is a good thing or not for the progress of science that some scientists are publishing ideas which contradict widely held theories? Explain your answer.

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(2 marks)

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

- 3 The article below is adapted from a feature in a national newspaper.

Asthma in children: deadly link to car fumes confirmed

Alarming official research provides the first evidence that British schoolchildren are getting asthma from exhaust fumes, dramatically increasing pressure on the government to cut traffic pollution.

Research showed that primary schoolchildren were 6% more likely to wheeze when breathing for every 30 metres closer they lived to a main road. In secondary schoolchildren the rate was 16%. The study of nearly 10 000 schoolchildren was carried out by Nottingham University with the support of the Department of Health

and the National Asthma Campaign. The research report says these findings "support a causal effect of exposure to road-traffic pollution on wheezing illness in children." The effects are likely to have been caused by emissions such as nitrogen dioxide or small soot particles.

The study undermines the Government's position that "there is no firm evidence" that pollution has caused asthma. This newspaper has for more than eight years been identifying car fumes as a likely cause of asthma.

- (a) (i) Nitrogen dioxide is identified as a possible cause of asthma. It is a compound of oxygen and nitrogen, both of which are harmless to humans and together make up over 99% of air. How would you answer someone who said that nitrogen dioxide must therefore also be harmless?

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(2 marks)

- (ii) The diagram below represents the particles involved in the chemical reaction that produces nitrogen dioxide.



What does the symbol \circ represent?

What does the symbol $\circ\circ$ represent?

(2 marks)

(b) (i) What evidence is presented in the article to support its headline assertion that the causal link between traffic fumes and asthma has been “confirmed”?

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(2 marks)

(ii) What features of the research study reported in this article might persuade us to take its findings seriously?

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(2 marks)

(c) Suggest **two** reasons why, on the basis of this article, we might not yet be quite so sure that traffic fumes cause asthma.

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(2 marks)

(d) Do you think the newspaper is right to present scientific results under headlines making such strong and definite claims? Explain your answer.

You will be awarded up to 2 additional marks for the quality of written communication in your answer to this question.

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(3 marks)

Quality of Written Communication

(2 marks)

- 4 Radon is a radioactive gas which decays by emission of α particles. It is released naturally by certain types of rock. In Britain these are found mainly in Devon and Cornwall, and in parts of Scotland.

A resident of the UK receives an average dose of ionising radiation of 2.6 mSv a year. It has been calculated that this dose gives a lifetime risk of cancer of 1 in 300. 50% of this average dose is from radon, by far the largest single contribution.

- (a) (i) State what happens during radioactive decay.

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(1 mark)

- (ii) Explain why α particles emitted by radon increase the risk of lung cancer.

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(2 marks)

- (b) The International Commission on Radiation Protection has published two principles to guide policy on intervention to protect people from radiation.

- 1 The intervention should do more good than harm.
- 2 The dose should be reduced to a value as low as reasonably achievable. This principle is known as ALARA, and implies that the cost of this reduction should also be considered.

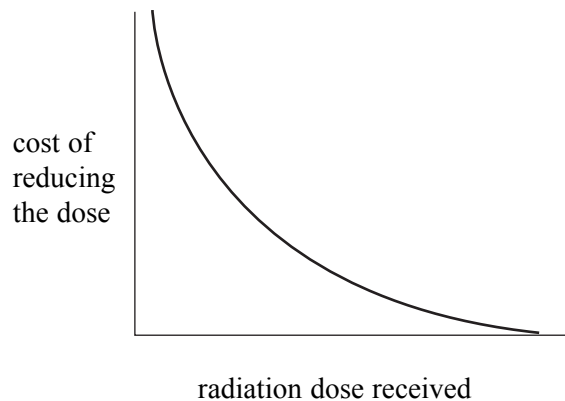


Figure 3

What does the graph in **Figure 3** show about the relationship between radiation dose and the cost of reducing the dose?

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(2 marks)

(c) In Britain the limit for radon exposure has been set at 10 mSv a year. Householders in high radon areas can modify their homes to prevent radon build up. Intervention to reduce the dose to the 10 mSv level costs about £ 800, with further running costs of about £ 75 a year.

(i) Estimate the lifetime risk of cancer for someone who receives 10 mSv annually. Assume that the risk is proportioned to the dose and that the UK average dose of 2.6 mSv gives a lifetime risk of 1 in 300.

(1 mark)

(ii) Use the ALARA principle and **Figure 3** to explain why you think the limit has been set at 10 mSv despite the fact that there is still a risk of cancer at this level.

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(2 marks)

(d) Only about 10% of those living in the 40 000 homes identified as above the action level have actually undertaken the necessary work to reduce radon levels.

How do you account for the apparent willingness of many people to accept this relatively high risk when many are unwilling to accept much lower risks, such as those from mobile phone masts or power lines?

You will be awarded up to 2 additional marks for the quality of written communication in your answer to this question.

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(3 marks)

Quality of Written Communication

(2 marks)

5 (a) The Earth is a planet and the Sun is a star.

(i) State **two** differences between a star and a planet.

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(2 marks)

(ii) The Earth is moving in orbit round the Sun at an average speed of 30 km per second. Explain why the Earth moves around the Sun and does not fly off into space as it moves at this high speed.

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(2 marks)

(b) When the planet Uranus was discovered in 1781, scientists found that its motion did not fit with the predictions made from their current theory of the solar system. Explain why, despite this difficulty, most scientists continued to accept the theory.

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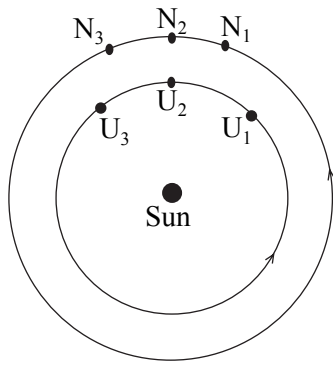
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(2 marks)

(c)



N_1/ U_1 position of Neptune and Uranus at time 1

N_2/ U_2 position of Neptune and Uranus at time 2

N_3/ U_3 position of Neptune and Uranus at time 3

Figure 4

Use **Figure 4** to explain how Adams and Leverrier solved the difficulty in explaining the motion of Uranus.

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(2 marks)

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END OF QUESTIONS

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