Surname		Other Names	
Centre Number			Candidate Number				
Candidate Signature								

For Examiner's Use

General Certificate of Education
June 2007
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

SCIENCE FOR PUBLIC UNDERSTANDING **SPU2**
Unit 2 Issues in the Physical Sciences

Friday 8 June 2007 9.00 am to 10.15 am

You will need no other materials.
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.
- Answer the questions in the spaces provided.
- 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 2(c)(ii) and 4(c) 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** questions in the spaces provided.

1 It is estimated that 2.4 billion people, more than one third of the world's population, cook with wood or other biomass, often on inefficient and poorly ventilated open fires or stoves. Wood and other biomass provides about 30% of the primary energy sources used in developing countries.

(a) Wood is a renewable fuel.

(i) What does the term *renewable fuel* mean?

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(1 mark)

(ii) The use of wood as a fuel need not contribute extra carbon dioxide to the atmosphere. Sketch a diagram to show how carbon is cycled through the growing and burning of trees.

(2 marks)

(b) For some people a paraffin stove is an alternative to burning wood for cooking.

- A typical wood stove has an efficiency of 4 %.
- Burning 1 kg of wood provides, on average, 16 MJ of energy.
- A paraffin stove has an efficiency of 34 %.
- Burning 1 kg of paraffin provides, on average, 45 MJ of energy.

(i) Use the information above to explain why a woman would have to carry about 25 times more wood, by weight, than paraffin to do the same amount of cooking. Show your working in any calculations.

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(2 marks)

(ii) What happens to the 96 % of the energy from a wood stove that is **not** used for cooking?

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(1 mark)

(c) **Figure 1** compares the average concentration of air pollutants produced by a simple wood stove with the concentration standards set in developed countries.

Figure 1

Pollutant	**Typical concentrations from a simple wood stove (mg/m^3)**	**Typical standards set to protect health in developed countries (mg/m^3)**
carbon monoxide	150	10
small soot particles (PM_{10})	3.3	0.1
benzene	0.8	0.002

(i) Name **one** of the pollutants from **Figure 1** and state what harm it causes.

.....

(1 mark)

(ii) Globally, around 2.1 million children under 5 die of chest infections each year. It is believed that indoor air pollution, mainly from wood burning stoves, is a significant cause of chest disease.

Explain why the data in **Figure 1** make this a reasonable hypothesis.

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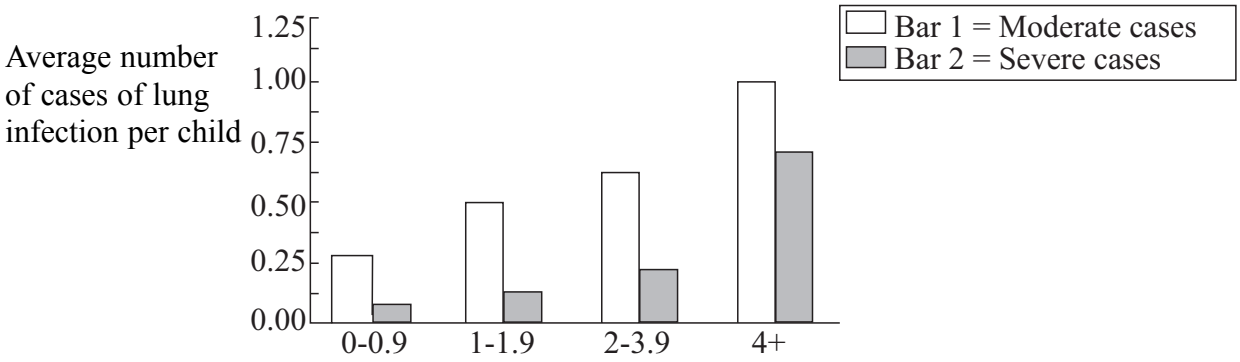
(2 marks)

Question 1 continues on the next page

(d) Several studies have attempted to determine the increase in risk of lung infection caused by wood stoves. **Figure 2** shows the results of one such study involving 250 children in Nepal. The researcher visited their homes every two weeks for six months.

Figure 2



(i) Suggest **one** possible source of inaccuracy in this study.

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(1 mark)

(ii) Do the results in **Figure 2** support the hypothesis that wood fire smoke increases the risk of lung disease in children? Explain your answer.

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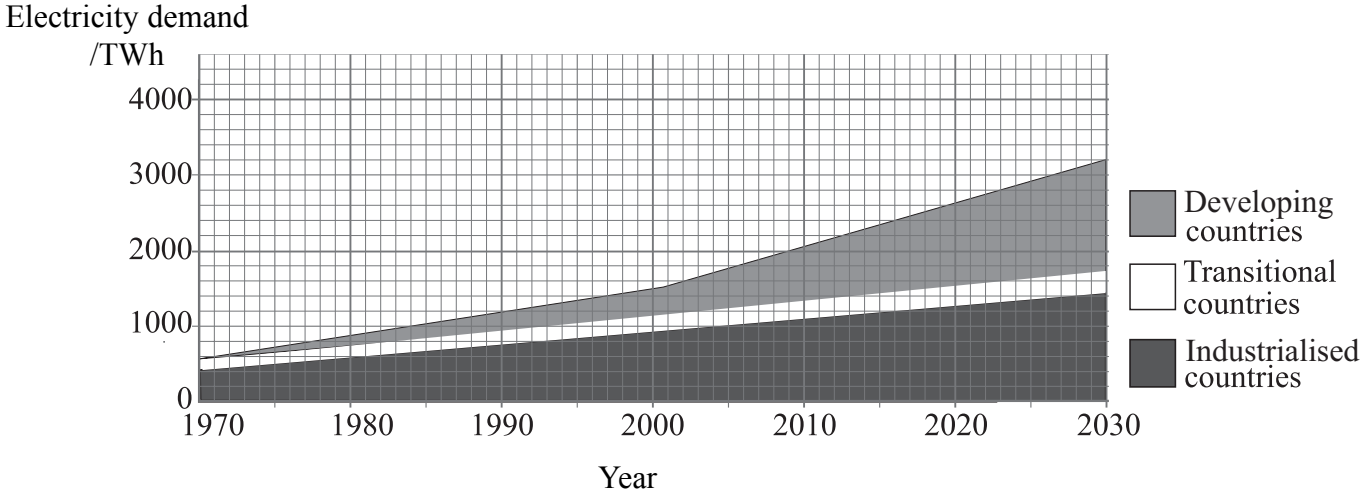
(2 marks)

12

2 Electricity is essential for modern technologies. **Figure 3** shows world-wide demand for electricity since 1970 and predicts demand in the future.

Figure 3



(a) (i) Suggest **two** reasons why the demand is expected to rise so much.

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(2 marks)

(ii) Calculate the percentage increase in world-wide demand predicted between 2000 and 2030.

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(2 marks)

(b) Some people believe that a proportion of this extra demand should be met by building more nuclear power stations. Most of these use the element uranium as a fuel. When the uranium atom splits it releases energy. Two new elements are formed.

(i) What is the characteristic of an atom that determines whether it is uranium or some other element?

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(1 mark)

Question 2 continues on the next page

(ii) Why do the new atoms formed pose a long term risk to humans and the environment?

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(2 marks)

(c) Governments pay for research into better ways of meeting future demand for electricity. **Figure 4** shows research expenditure into different energy technologies between 1980 and 2000 by the governments of industrialised countries.

Figure 4

Energy technologies	**Research expenditure** (£ million adjusted to 2002 prices)		
	1980	**1990**	**2000**
Energy conservation	547	300	708
Fossil fuels	1444	998	236
Renewable energy	1090	317	315
Nuclear energy	4406	2757	1849
Energy storage	913	678	787
Total	8400	5050	3895

(i) Comment on **two** significant features of the ways in which the money for research has been spent on the different energy technologies during this 20 year period.

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(2 marks)

(ii) What is your opinion on the research priorities in the year 2000? You should comment on at least **two** of the technologies, describing the advantages and disadvantages of developing them further.

Two of the 6 marks in this question are available for the quality of your written communication.

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(6 marks)

15

Turn over for the next question

3 In 2001 the IPCC, a United Nations organisation of climate experts, analysed the changes in sea level between 1910 and 1990. They used computer modelling to estimate the influence of three factors affecting sea level:

- expansion of water due to temperature rise
- increasing ice on some land from more snowfall
- decreased ice on other land due to melting.

Sea level rise is likely to be one of the most serious consequences of global warming.

(a) Give **one** reason why rising sea level is a cause for concern.

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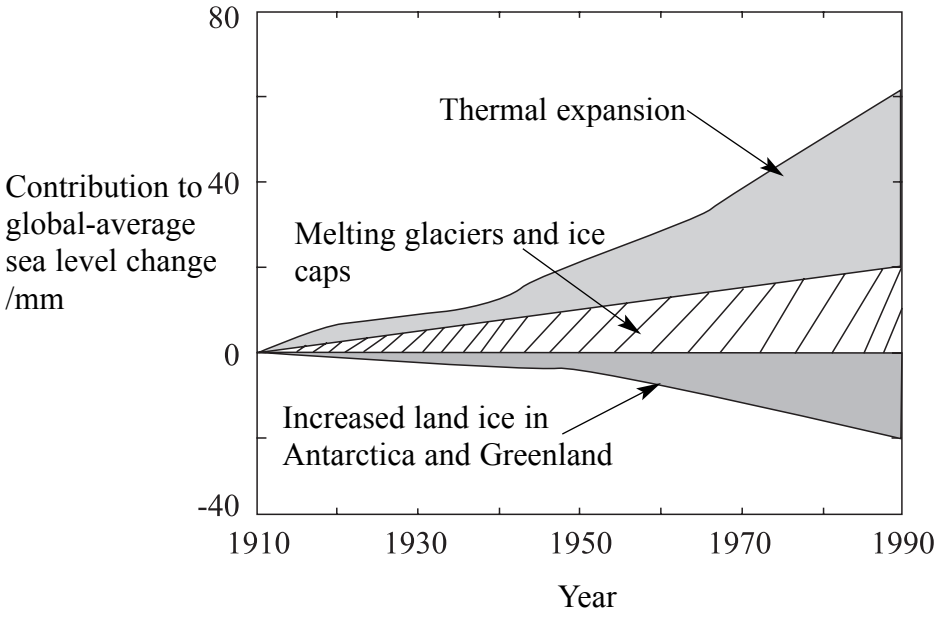
(1 mark)

(b) **Figure 5** shows an IPCC estimate of contributions to a change in sea level from the different factors during this period.

Figure 5



(i) Which factor was assumed to contribute the most to sea level rise?

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(1 mark)

(ii) Which factor was assumed to have reduced sea level rise?

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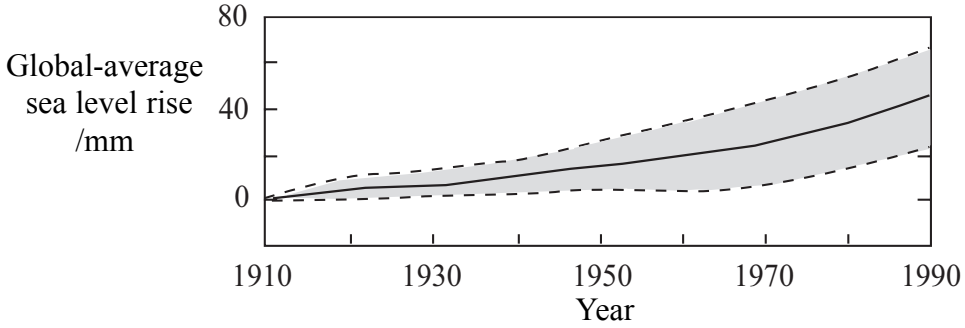
(1 mark)

(c) **Figure 6** shows an IPCC estimate of the overall change in sea level with the uncertainty as a shaded area.

Figure 6



(i) Express the total rise by 1990 as..... ± .....mm. *(2 marks)*

(ii) Suggest **one** reason why there is uncertainty over how much the sea level has risen in the world over the 80 years between 1910 and 1990.

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(1 mark)

(d) The IPCC report in 2001 used computer models to conclude: "Global mean sea level is predicted to rise by between 0.09 and 0.88 metres between 1990 and 2100... Improved models give a smaller contribution (than earlier models) from glaciers and ice sheets."

In the six years since this report was published new information shows that ice is melting much faster than predicted in Greenland and Antarctica. Some scientists are now saying that the sea could rise by as much as 2 metres over the next one hundred years as a result of melting ice.

(i) Suggest **two** kinds of research you would expect scientists to do in response to this new information.

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(2 marks)

(ii) Suggest **two** things that this account tells you about the "advantages and limitations of computer modelling".

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(2 marks)

4 X-rays are widely used in medicine to diagnose cancer and other illnesses. CT scans are a way of using X-rays together with a computer to give much more detailed information, particularly of soft tissue such as lungs or heart. Many doctors are increasingly choosing to use CT scans rather than normal X-rays.

Figure 7 shows the average radiation dose a patient receives from each of the two procedures.

Figure 7

Part of body investigated	Radiation dose/mSv	
	Conventional X-ray	CT scan
Chest	0.02	8
Pelvis	0.70	10
Head	0.03	2

(a) X-rays are a form of ionising radiation and can increase the risk of cancer.

(i) What is meant by *ionising radiation*?

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(1 mark)

(ii) Explain why X-rays increase the risk of cancer when they enter the body.

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(2 marks)

(iii) The lifetime risk of cancer from radiation is assumed to increase by 1 in 20 000 for every 1 mSv of radiation received.

What is the increase in the lifetime risk of cancer due to a CT scan of the pelvis?

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(1 mark)

(b) Recent research has estimated that diagnostic X-rays, including CT scans, increase the risk of cancer in the UK population by about 0.6%. This is about 700 cases of cancer a year.

(i) The report of this research in the medical journal *The Lancet* includes the following information.

The study was paid for by Cancer Research UK.

Cancer Research UK had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Why is it important to include this type of information in reports of research?

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(2 marks)

The researchers say "There is no threshold of radiation dose under which the absence of any cancer risk is proven. On the other hand, there are no reliable data proving that radiation doses as used in diagnostic X-rays do cause cancer."

(ii) Explain why it is so difficult to prove whether low doses of X-rays do or do not cause cancer.

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(2 marks)

Question 4 continues on the next page

(iii) Why do you think the estimate of increased lifetime cancer risk, 1 in 20 000 per mSv, is widely used even though it is not certain that it applies at low doses?

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(1 mark)

(c) In some countries the number of CT scans has been increasing by as much as 30% a year. Doctors are arranging these scans in the hope of detecting a very early cancer or reassuring a patient that there is no cancer. Some doctors suggest that many of these scans are not necessary.

How might you decide whether or not to have a CT scan that had been suggested by a doctor? Discuss what you would want to know and how you might use this information.

Two of the 6 marks in this question are available for the quality of your written communication.

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(6 marks)

15

Turn over for the next question

5 In the 1970s new instruments allowed astronomers to measure the mass of galaxies and their speed of rotation very accurately. The results predicted that galaxies should fly apart; gravity was not strong enough to keep the fast moving stars together. To explain this, astronomers began to adopt the theory of dark matter, matter that exerts a gravitational force but cannot be observed because it does not emit radiation and interacts extremely weakly with 'normal' matter.

Astronomers predicted that gravity due to dark matter would bend light reaching us from distant galaxies. This bending has now been observed. Astronomers are continuing research in an attempt to detect dark matter particles on Earth using very delicate instruments.

(a) What is a galaxy?

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(1 mark)

(b) Explain what is meant by *gravity*.

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(1 mark)

(c) (i) What problem was caused for astronomers by measurements made with new instruments in the 1970s?

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(1 mark)

(ii) Suggest why these astronomers did not abandon the theory of gravity.

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(1 mark)

(iii) Below are two comments on the theory of dark matter.

A
The measurements from the new instruments showed there must be dark matter.

B
Someone had the idea that there might be dark matter which could explain the new measurements.

Which of these better describes where the theory of dark matter came from? Justify your answer.

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(2 marks)

(iv) Why is there increasing confidence in the existence of dark matter?

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(1 mark)

(v) Why do astronomers think it is so important to detect dark matter particles?

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(1 mark)

8

END OF QUESTIONS

There are no questions printed on this page