UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

21ST CENTURY SCIENCE **0608/05**

Paper 5 **May/June 2009**

1 hour 30 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
1	
2	
3	
4	
Total	

This document consists of **15** printed pages and **1** blank page.

UNIVERSITY of CAMBRIDGE International Examinations

Section A

For Examiner's Use

Read this newspaper article.

Biodegradable Packaging

Plastic packaging provides excellent protection for many products. It is cheap to manufacture and seems to last forever. Lasting forever, however, means that plastics are causing a major environmental problem. This packaging may cause litter, harm wildlife and take up space in landfill. Another problem is that traditional plastics are manufactured from non-renewable resources such as crude oil. Their production is therefore not sustainable in the long term.

For many years scientists have been trying to develop cheap plastics that biodegrade into chemicals that do not pollute the environment, and that are made from renewable resources such as chemicals obtained from plants.

The term biodegradable means that a substance can be broken down into simpler substances by the activities of living organisms such as bacteria. The intention is that discarded packaging made from these new plastics would quickly decompose.

The reason traditional plastics are not biodegradable is because their long polymer molecules are too large and too tightly bonded together to be broken apart by decomposer organisms. Examples are poly(ethene), used to make most supermarket carrier bags, and poly(propene), used to make bottles.

Biodegradable plastics

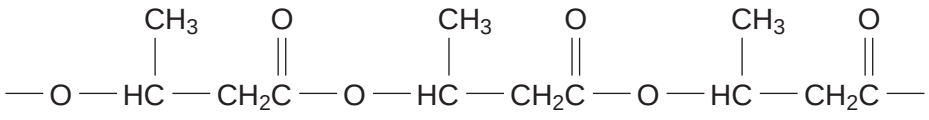
Many supermarkets have begun to offer customers biodegradable carrier bags.

One type of bag uses a plastic similar to poly(ethene), but it is made from 70% ethene, which is obtained from crude oil, and 30% vegetable starch. Bacteria digest the starch in these new bags, starting the process of breaking down the hydrogen and carbon chains that make up the plastic.

It is also possible to make biodegradable plastics from chemicals obtained from plant sources only. These plastics have molecules that are readily broken down by micro-organisms.

Poly(hydroxybutyrate) is a plastic made from plant material only. It has physical properties similar to those of poly(propene). This polymer is now being used to make bottles for water and soft drinks.

Part of the structural formula for a poly(hydroxybutyrate) molecule is shown in the diagram.



poly(hydroxybutyrate)

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Do they decompose?

Some environmental scientists say that biodegradable plastic bags and bottles are not much better than those made from normal plastics.

Although supermarket bags made from biodegradable plastics decompose quickly under ideal conditions, they take far longer to decay if they are exposed to cold or wet conditions. Even after decomposition they may still leave behind some harmful breakdown products.

Rubbish deposited in landfill is compressed and sealed under tonnes of soil. This reduces the available oxygen and moisture, which are essential for the growth of micro-organisms. This means that packaging made from biodegradable plastics may require specialist treatment rather than being used as landfill.

Another problem is that biodegradable bags use material from crops such as maize. This may lead to a shortage of these food crops and an increase in their price.

Recycling

Normal polymers such as poly(ethene) and poly(propene) can be recycled but biodegradable plastics made using plant materials cannot. So a greater use of biodegradable plastics could lead to more material being sent to landfill. Some scientists think it is better to recycle more of the normal plastics rather than using biodegradable plastics.

Polymer testing

Scientists tested a new biodegradable polymer to compare its properties with those of poly(ethene).

They measured the force needed to break identical sized strips of each polymer. The results of this investigation are shown in the table.

	force needed to break plastic strip (kN)						
	sample 1	sample 2	sample 3	sample 4	sample 5	sample 6	average
new polymer	87	92	89	91	135	91	
poly(ethene)	85	83	87	85	86	84	85

Use information from the article 'Biodegradable Packaging' to help you answer question 1.

For Examiner's Use

1 **(a)** What is meant by the term biodegradable?

.....

..... [1]

(b) Life Cycle Assessments for each type of polymer can be compared.

(i) Biodegradable bags can be made from a polymer produced using ethene and corn starch.

Why are these biodegradable bags **not** a sustainable development?

.....

.....

..... [2]

(ii) Using poly(hydroxybutyrate) to make plastic bottles is more sustainable than using poly(propene).

Explain why.

.....

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..... [2]

(iii) Other than sustainability, outline **two** arguments for, and **two** arguments against the use of biodegradable plastics.

for .....

.....

.....

.....

against .....

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..... [4]

(c) Some scientists think that using biodegradable plastics is better for the environment than using normal plastics.

Other scientists disagree.

Suggest why scientists often disagree on environmental issues.

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..... [2]

(d) **(i)** Write an equation for the formation of poly(propene) by the polymerisation of propene, C_3H_6.

Use structural formulae in your answer.

[3]

(ii) As monomer molecules join together to make poly(hydroxybutyrate), water is also produced.

Draw the structural formula of the monomer used to make poly(hydroxybutyrate).

Use the diagram of poly(hydroxybutyrate) in the article to help you.

[2]

[Turn over

(iii) Describe **two** ways in which the Life Cycle Assessment of a soft drink bottle made from poly(hydroxybutyrate) differs from that of a similar bottle made from poly(propene).

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..... [2]

(e) **(i)** Traditional plastics are not biodegradable because their molecules are not broken apart by decomposer organisms.

Use ideas about forces and energy to explain why these molecules are not easily broken apart.

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..... [3]

(ii) It is possible to change the properties of a polymer to make it more suited to a particular job.

Describe **two** ways that the properties of a polymer can be changed.

1 .....

.....

2 .....

..... [2]

(f) The article shows results from an investigation to compare the properties of a new biodegradable polymer with those of poly(ethene).

(i) The scientists used the same sized pieces of polymer for each sample.

Explain why they did this.

.....

.....

..... [2]

(ii) What is the range for the measurements taken for poly(ethene)?

range = ... to ..... [1]

(iii) There is an outlier in the results obtained for the new polymer.

For which sample is this outlier?

..... [1]

(iv) Find a best estimate for the force needed to break the new polymer.

best estimate = ... kN [2]

(v) The scientists decide that there is a **real difference** between the force needed to break the new polymer and that needed to break poly(ethene).

Explain how the results show that there is a real difference.

.....

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..... [1]

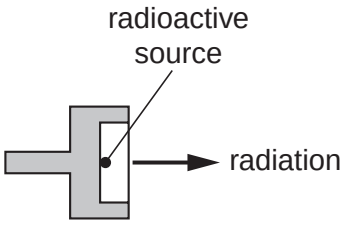
[Total: 30]

Section B

For Examiner's Use

2 Radioactive materials in schools must be handled with care. This is because ionising radiation can damage living cells.

The radioactive sources used give out most of their ionising radiation from one end.



(a) The photograph shows a radioactive source ready for use.

Suggest **two** ways in which the teacher should use the radioactive source safely.

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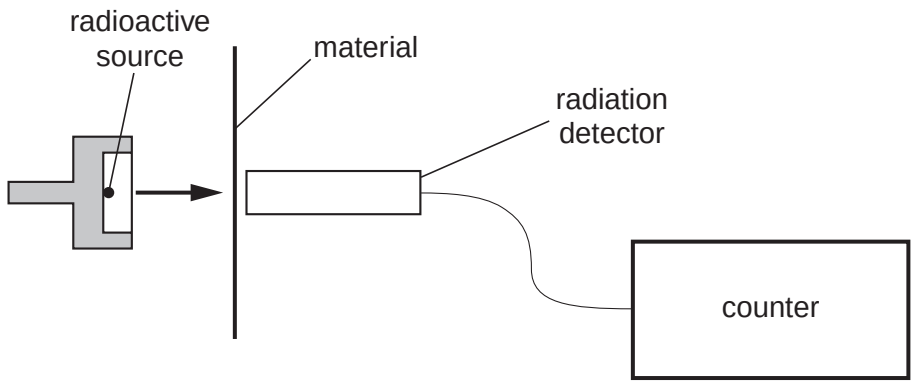
..... [2]

(b) The teacher uses two different sources to see how much radiation is absorbed by different materials.



The experiment is to compare the count rate when different materials are put between the source and the radiation detector.

Explain how you would make these measurements.

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..... [2]

(c) The results are shown in the table.

	count (counts / second)		
source	without any material	with one sheet of paper	with 2 mm thick aluminium
X	25	3	3
Y	500	480	3

(i) Explain what these results show about source **X**.

.....

.....

..... [2]

(ii) Explain what these results show about source **Y**.

.....

.....

..... [2]

[Turn over

(d) The teacher tries the same experiment with a third source.

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She says, 'This source is not as strong as it used to be. When I bought it, ten years ago, it was **four** times as strong.'

Explain this using the idea of **half-life**.

.....

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..... [2]

[Total: 10]

3 Ellie and Harry are investigating their reaction times.

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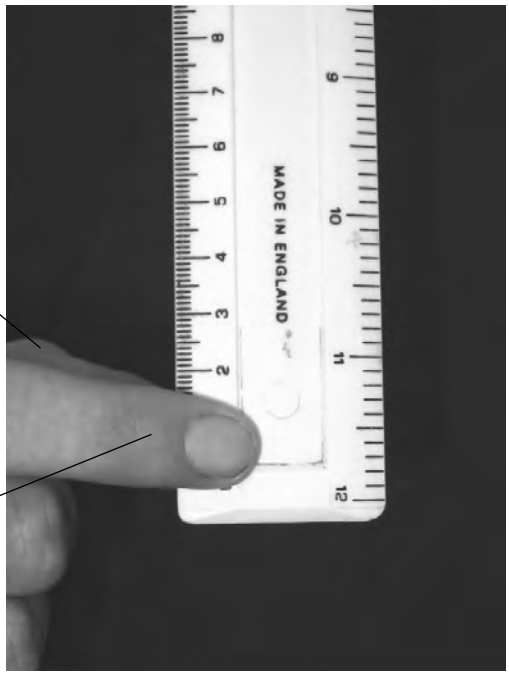
Ellie holds a ruler between Harry's thumb and finger as shown in the picture.



Ellie lets the ruler drop and Harry catches the ruler between his thumb and finger as quickly as he can. Ellie measures the distance the ruler has travelled before it is caught. She measures to the bottom of Harry's finger.

(a) What does the distance the ruler travels before it is caught show about Harry's reactions?

.....

.....

..... [1]

(b) Harry and Ellie repeat the experiment.

This time Harry lets the ruler drop so that Ellie can catch it.

Ellie and Harry use their results to compare their reactions.

Suggest two variables that must be controlled in the experiment so that a comparison can be made.

.....

.....

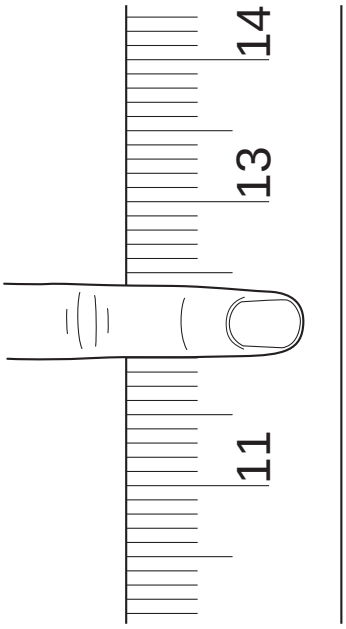
..... [2]

(c) The diagram shows the results of the two experiments.

(i) Under each diagram, write down the results in cm.

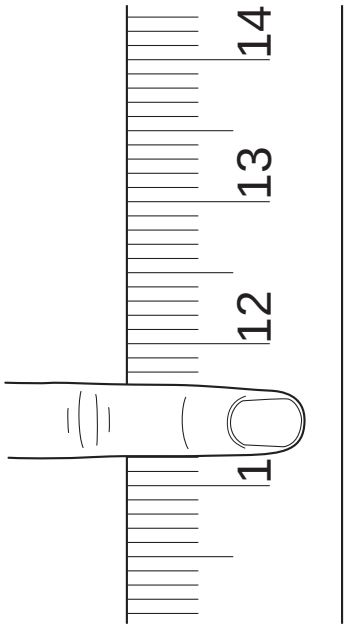
Use the reading from the bottom of each finger.

Harry



..... cm

Ellie



..... cm

[2]

(ii) Ellie and Harry carry out this experiment four more times.

They use their results to calculate mean (average) distances.

Suggest why they do this.

..... [1]

(d) Harry suggests that the measurements made in this experiment are not very accurate.

Suggest **two** ways in which the experiment is not very accurate.

.....

.....

.....

..... [2]

(e) Ellie and Harry carry out another similar experiment. Sam measures the time taken for the ruler to drop.

For Examiner's Use

Sam uses a stopwatch to make this measurement.

(i) Why will the time measurements made by Sam be inaccurate?

.....

..... [1]

(ii) Suggest what apparatus Sam can use to make a more accurate measurement.

..... [1]

[Total: 10]

4 Scientists test a new additive that can be used in the manufacture of poly(ethene).

They make batches of the polymer containing different amounts (%) of the new additive.

They test equal sized samples by hanging a 2000 N weight on the end of each one. They then measure how much the length of the sample has increased.

For each batch of the polymer several samples are used and an average calculated.

Results are shown in the table below.

	increase in length (cm)						
% additive	sample 1	sample 2	sample 3	sample 4	sample 5	sample 6	average
1.0	1.9	2.1	2.1	2.0	2.3	2.2	2.1
2.0	2.6	2.7	2.7	3.3	2.5	2.5	2.6
4.0	3.8	3.7	3.6	3.7	3.8	3.6	3.7
5.0	4.1	4.2	4.4	4.4	4.3	4.4	4.3
6.0	5.0	4.8	4.7	4.9	4.7	4.7	

(a) In addition to the 2000 N weight, suggest one other piece of apparatus that the scientists use in this investigation,

..... [1]

(b) **(i)** Calculate the average increase in length for the polymer with 6.0% additive.

average increase in length = ... cm [1]

(ii) When calculating the average for 2.0% additive, the scientists did **not** use the value for sample 4.

Suggest and explain why.

.....

.....

..... [2]

(c) **(i)** Use the grid to plot values for % additive against average increase in length. [2]

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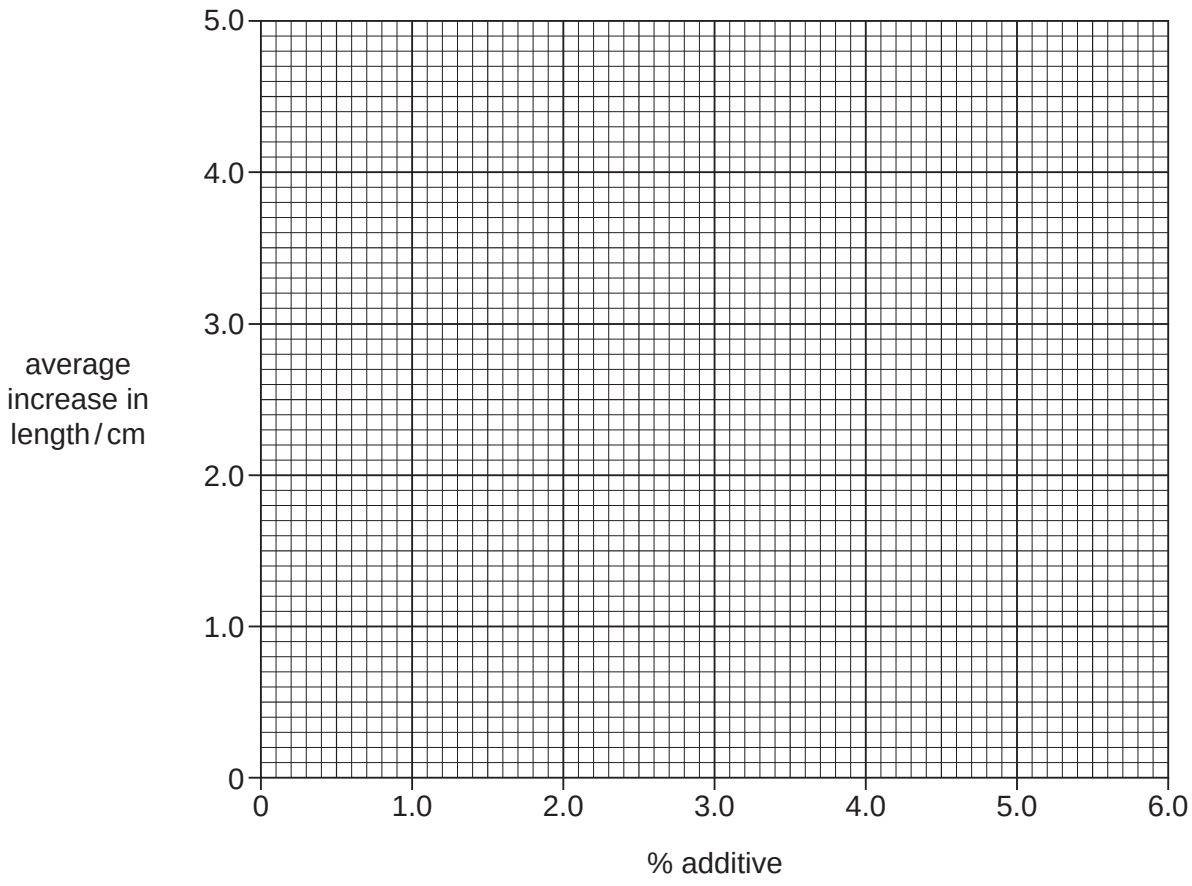
(ii) Draw a best fit line for your graph. [1]



(d) Use your graph to estimate the increase in length for poly(ethene) containing

(i) 3.0% additive,

increase in length = ... cm [1]

(ii) no additive.

increase in length = ... cm [1]

(e) The graph shows a correlation between amount of additive in the polymer and how much the polymer stretches.

Describe this correlation.

.....

..... [1]

[Total: 10]

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