UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

1701562327

COMBINED SCIENCE **0653/31**

Paper 3 (Extended) **May/June 2011**

1 hour 15 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 soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
A copy of the Periodic Table is printed on page 20.

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	
5	
6	
7	
8	
9	
Total	

This document consists of **19** printed pages and **1** blank page.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 Dung beetles live in places where large herbivores, such as elephants, buffalo or cattle, also live. The beetles collect dung produced by the herbivores and make it into a ball, which they roll away and bury.

They lay eggs on the buried ball of dung, so that when their larvae hatch they can feed on the dung. The adults also feed on the dung.

Fig. 1.1 shows a dung beetle rolling a ball of dung.

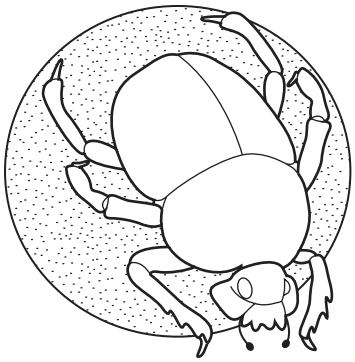

Fig. 1.1

(a) Dung beetles play an important role in the carbon cycle.

Using the information above, suggest how dung beetles can help a carbon atom in animal dung to become part of a carbohydrate molecule within a plant.

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..... [3]

(b) The buried dung adds nitrates to the soil.

Explain how this can help plants to grow better.

.....

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.....

..... [2]

(c) Farmers may use insecticides (pesticides that kill insects) on their land.

For Examiner's Use

(i) Explain why farmers use insecticides.

.....

.....

..... [2]

(ii) Using the information above, explain why using insecticides on land where cattle graze could reduce the growth of grass.

.....

.....

..... [2]

2 The chemical formulae for some compounds (minerals) found in rocks are shown below.

For Examiner's Use

$CaMg(CO_3)_2$	dolomite
$KAlSi_3O_8$	potassium feldspar
$NaAlSi_3O_8$	sodium feldspar
$CaCO_3$	calcite

(a) A white powder is known to be either potassium feldspar or sodium feldspar.

Describe a test and its results which would enable a chemist to find out which of these minerals is contained in the white powder.

.....

.....

..... [2]

(b) Calculate the relative formula mass of calcite.

Show your working.

..... [1]

(c) When dolomite is strongly heated, carbon dioxide gas is given off and a mixture of calcium and magnesium oxides remains.

(i) The symbolic equation for this reaction which is shown below is **not** balanced.

Balance the equation.

$$CaMg(CO_3)_2 \longrightarrow CaO + MgO + CO_2$$

[1]

(ii) Name the type of chemical reaction in **(i)** and state the evidence you have used to decide your answer.

type of reaction .....

evidence .....

..... [2]

(d) A student adds some water to some calcium oxide. She observes that an exothermic reaction occurs and an **alkaline** solution is formed.

(i) State the ion whose concentration increases when calcium oxide reacts with water.

..... [1]

(ii) The student then adds dilute hydrochloric acid to the solution from **(i)**.

Write a **word** equation for the neutralisation reaction which occurs.

..... [2]

For Examiner's Use

3 In an experiment, weights were hung on a spring and the length of the spring measured.

Fig. 3.1 shows a graph of the results.

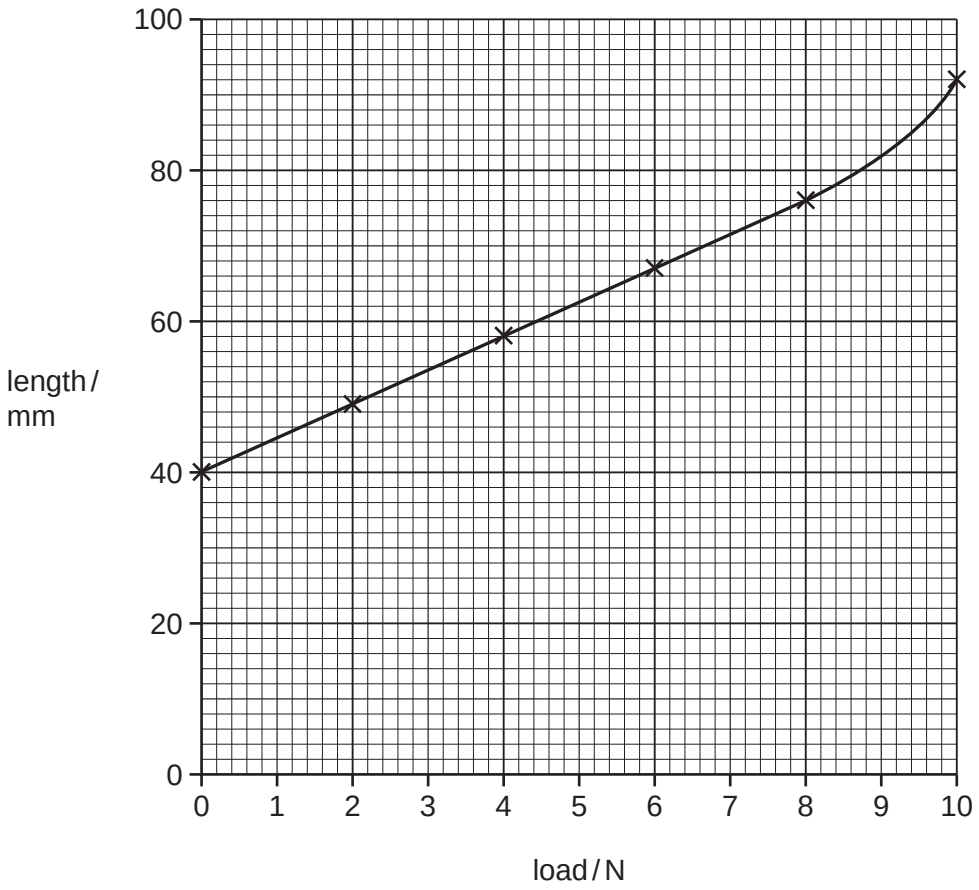


Fig. 3.1

(a) Calculate the **extension** of the spring when a 4 N load is hung from it.

Show your working.

..... [1]

(b) Explain the relationship between the load on the spring and the length of the spring when the load is increased from 0 to 10 N.

.....

.....

.....

..... [3]

(c) Fig. 3.2 shows a wooden bird suspended from an identical spring.

For Examiner's Use

Fig. 3.2

The total length of the spring is 51 mm.

(i) Use the graph in Fig. 3.1 to find the weight of the bird. Show your working.

.....

[1]

(ii) The density of the wood used to make the bird is $0.8\,g/cm^3$.

Use your answer to **(i)** to calculate the volume of the bird in cubic centimetres.

The gravitational field strength of the Earth is 10 N / kg.

State any formula that you use and show your working.

formula used

working

.....

[3]

For Examiner's Use

4 Fig. 4.1 shows a sperm cell.

Fig. 4.1

(a) On Fig. 4.1, use label lines to label and name **two** structures that are found in **all** animal cells. [2]

(b) Name the organ in which sperm are produced. ..... [1]

(c) An investigation was carried out into the oxygen use and energy use of sperm while they were at rest and while they were swimming.

For each measurement, the researchers calculated the amount of oxygen and the amount of energy used by 10^9 (one thousand million) sperm.

The results are shown in Table 4.1.

Table 4.1

	oxygen use / units per 10^9 sperm per hour	**energy use / joules per 10^9 sperm per hour**
resting sperm	24	46
swimming sperm	83	164

(i) Suggest why the researchers measured the oxygen use and energy use for 10^9 sperm, rather than for a single sperm.

.....

..... [1]

For Examiner's Use

(ii) Explain why more oxygen is used when the sperm are using more energy.

.....

.....

.....

..... [2]

(iii) Calculate the total power output of a group of 10^9 swimming sperm.

State the formula that you use and show your working.

formula

working

..... [3]

(iv) In order to reach an egg, a human sperm has to swim from the top of the vagina to an oviduct, through a thin layer of liquid.

Explain how the shape of the sperm, shown in Fig. 4.1, reduces the energy required to swim this distance.

.....

.....

..... [2]

For Examiner's Use

5 **(a)** Nuclear reactors can be used in power stations to produce energy for generating electricity.

(i) Suggest **one** advantage and **one** disadvantage of generating electricity in this way.

advantage .....

.....

disadvantage .....

..... [2]

(ii) Describe what happens to an atom during nuclear fission.

.....

..... [1]

(iii) Below is a newspaper article written by someone who has a poor understanding of radioactivity.

> There was a leak of radiation from our local nuclear power station yesterday.
>
> The radiation blew across farmland.
>
> It emits gamma particles which are harmful to wildlife.

Write down **one** mistake reported in the article. Explain why this is a mistake.

mistake .....

explanation .....

.....

.....

..... [2]

For Examiner's Use

(b) A badge made from photographic film can be used to check the exposure of the workers to radiation. A simple badge has two sections **A** and **B** for the detection of beta and gamma radiation.

Fig. 5.1 shows a worker wearing his badge.

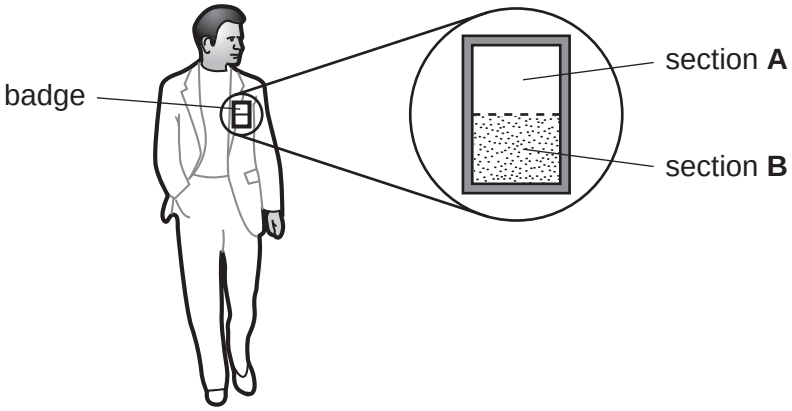


Fig. 5.1

Fig. 5.2 shows the side view through the badge.

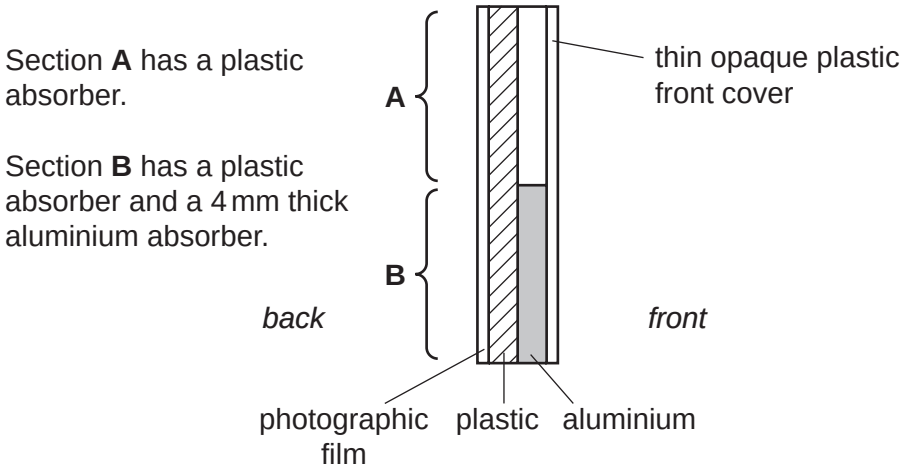


Fig. 5.2

When the photographic film from the badge is developed, it turns black where it has been exposed to radiation.

(i) Complete Table 5.1 to show whether the photographic film will turn black when exposed to beta or gamma radiations.

Table 5.1

radiation	will section A turn black?	will section B turn black?
beta		
gamma	**yes**	

[2]

For Examiner's Use

(ii) Explain why the badge can **not** be used to detect alpha radiation.

.....

..... [1]

(c) Alpha, beta and gamma radiations behave differently when they are passed through an electric field.

(i) Explain why gamma radiation is **not** deflected.

..... [1]

(ii) Explain why alpha and beta radiation are deflected in opposite directions.

.....

..... [1]

For Examiner's Use

6 **(a)** Air is a mixture of elements and compounds. The two main elements in air are nitrogen and oxygen. Nitrogen dioxide, NO_2, is a compound of nitrogen and oxygen.

(i) Complete Table 6.1 by writing **M** in the right hand column if the description refers to a **mixture** of nitrogen and oxygen or **C** if it refers to the **compound**, nitrogen dioxide.

Table 6.1

description	M or C
nitrogen atoms are bonded to oxygen atoms	
relative amounts of nitrogen and oxygen can vary	
little or no energy change when formed from nitrogen and oxygen	
chemical properties are very different from either nitrogen or oxygen	

[2]

(ii) The gases nitrogen and oxygen can be separated by fractional distillation from air which has been cooled and pressurised so that it turns into a liquid.

Explain briefly how fractional distillation separates nitrogen and oxygen from liquefied air.

.....

.....

..... [2]

(b) Nitrogen and hydrogen can be made to react together to form ammonia, NH_3. This reaction requires a solid iron catalyst and a high temperature.

Explain, in terms of molecular collisions, why increasing the temperature increases the rate of reaction.

.....

.....

..... [2]

(c) The diagrams in Fig. 6.1 show the outer electron shells of atoms of the elements hydrogen and sulfur.

For Examiner's Use

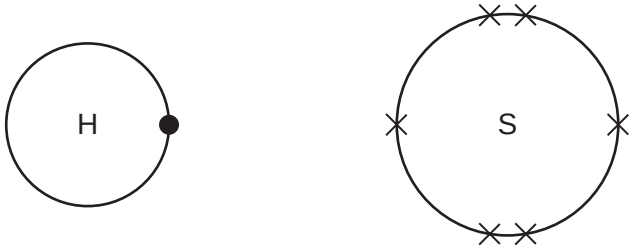


Fig. 6.1

When these atoms bond together, they form a covalent compound whose formula is H_2S.

Use the information shown in these diagrams to explain why the formula of the compound is H_2S.

You may wish to draw a diagram to help your explanation.

.....

..... [2]

7

For Examiner's Use

The smell of food cooking can cause a person's salivary glands to secrete saliva.

(a) (i) Name this type of response to a stimulus. ..... [1]

(ii) Describe how the information about the smell of the food travels from the nose to the salivary glands.

.....

.....

.....

..... [3]

(b) When food has been taken into a person's mouth, it is chewed by teeth and mixed with saliva.

Describe how the molar teeth help in the digestion of food.

.....

.....

.....

..... [3]

(c) Saliva contains the enzyme amylase.

What is an *enzyme*?

.....

.....

..... [2]

For Examiner's Use

8 A student carried out an experiment to find which substances in the environment caused nails made of mild steel to become rusty.

She selected three identical nails and placed them in sealed test-tubes, **A**, **B** and **C**, as shown in Fig. 8.1.

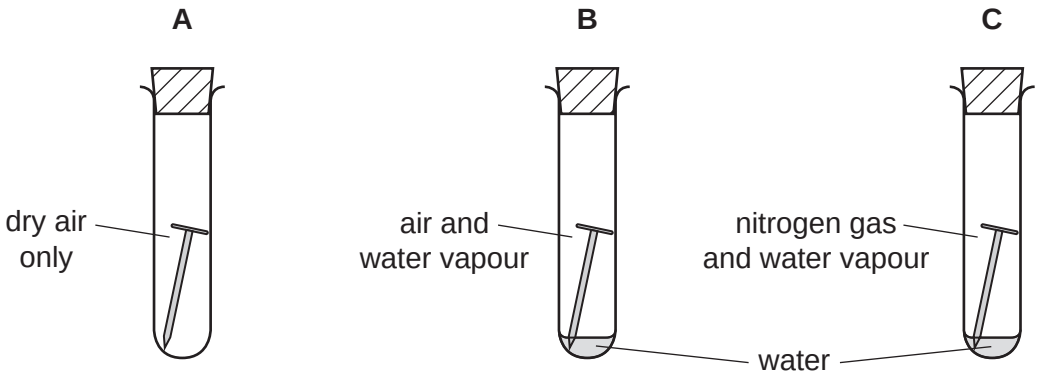


Fig. 8.1

(a) Predict in which tube, **A**, **B** or **C**, the nail became rusty, and explain why the nail did **not** rust in either of the other two tubes.

.....

.....

.....

.....

..... [3]

(b) Stainless steel does not rust because it is protected by a very thin layer which contains chromium oxide.

(i) Chromium oxide contains chromium ions, Cr^{3+}, and oxide ions, O^{2-}.

Deduce the chemical formula of chromium oxide.

Explain how you obtained your answer.

..... [2]

(ii) Explain why an oxide ion carries a double negative (2-) electrical charge.

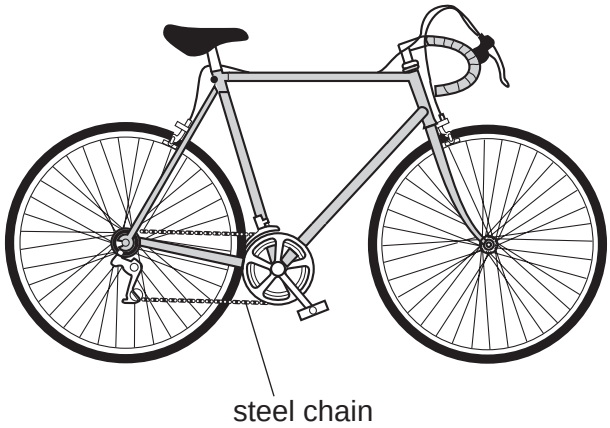
.....

.....

..... [2]

(c) Steel is used to make the chain of a bicycle. To prevent rusting, the chain is covered by oil made of hydrocarbon molecules.

The oil used to protect the bicycle chain contains mainly hydrocarbon molecules which do **not** contain any double bonds.



(i) Describe a chemical test and its result that would show whether or not a hydrocarbon oil contained molecules with double bonds.

.....

.....

..... [2]

(ii) Suggest **one** property of a hydrocarbon oil which makes it suitable for use as a barrier to prevent rusting.

..... [1]

[Turn over

For Examiner's Use

9 The speakers of three MP3 music players are being compared.

(a) The speakers are tested to find the range of frequencies they produce.

Table 9.1 shows the results.

Table 9.1

speaker	range of frequencies / Hz
A	100 to 10 000
B	20 to 25 000
C	20 to 40 000

(i) What is meant by the term *frequency*?

.....

..... [1]

(ii) Use the information in Table 9.1 to suggest why the music played through speaker **A** might not sound as good as the other two speakers.

.....

..... [1]

(iii) Music played through speakers **B** and **C** sounds the same. Suggest a reason for this.

.....

..... [1]

(b) Two speakers each with a resistance of 8 Ω are connected in parallel.

Calculate their combined resistance.

State the formula that you use and show your working.

formula used

working

..... [3]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
							1 **H** Hydrogen 1										4 **He** Helium 2
7 **Li** Lithium 3	9 **Be** Beryllium 4											11 **B** Boron 5	12 **C** Carbon 6	14 **N** Nitrogen 7	16 **O** Oxygen 8	19 **F** Fluorine 9	20 **Ne** Neon 10
23 **Na** Sodium 11	24 **Mg** Magnesium 12											27 **Al** Aluminium 13	28 **Si** Silicon 14	31 **P** Phosphorus 15	32 **S** Sulfur 16	35.5 **Cl** Chlorine 17	40 **Ar** Argon 18
39 **K** Potassium 19	40 **Ca** Calcium 20	45 **Sc** Scandium 21	48 **Ti** Titanium 22	51 **V** Vanadium 23	52 **Cr** Chromium 24	55 **Mn** Manganese 25	56 **Fe** Iron 26	59 **Co** Cobalt 27	59 **Ni** Nickel 28	64 **Cu** Copper 29	65 **Zn** Zinc 30	70 **Ga** Gallium 31	73 **Ge** Germanium 32	75 **As** Arsenic 33	79 **Se** Selenium 34	80 **Br** Bromine 35	84 **Kr** Krypton 36
85 **Rb** Rubidium 37	88 **Sr** Strontium 38	89 **Y** Yttrium 39	91 **Zr** Zirconium 40	93 **Nb** Niobium 41	96 **Mo** Molybdenum 42	**Tc** Technetium 43	101 **Ru** Ruthenium 44	103 **Rh** Rhodium 45	106 **Pd** Palladium 46	108 **Ag** Silver 47	112 **Cd** Cadmium 48	115 **In** Indium 49	119 **Sn** Tin 50	122 **Sb** Antimony 51	128 **Te** Tellurium 52	127 **I** Iodine 53	131 **Xe** Xenon 54
133 **Cs** Caesium 55	137 **Ba** Barium 56	139 **La** Lanthanum 57 *	178 **Hf** Hafnium 72	181 **Ta** Tantalum 73	184 **W** Tungsten 74	186 **Re** Rhenium 75	190 **Os** Osmium 76	192 **Ir** Iridium 77	195 **Pt** Platinum 78	197 **Au** Gold 79	201 **Hg** Mercury 80	204 **Tl** Thallium 81	207 **Pb** Lead 82	209 **Bi** Bismuth 83	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
Fr Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	**Pm** Promethium 61	150 **Sm** Samarium 62	152 **Eu** Europium 63	157 **Gd** Gadolinium 64	159 **Tb** Terbium 65	162 **Dy** Dysprosium 66	165 **Ho** Holmium 67	167 **Er** Erbium 68	169 **Tm** Thulium 69	173 **Yb** Ytterbium 70	175 **Lu** Lutetium 71
232 **Th** Thorium 90	**Pa** Protactinium 91	238 **U** Uranium 92	**Np** Neptunium 93	**Pu** Plutonium 94	**Am** Americium 95	**Cm** Curium 96	**Bk** Berkelium 97	**Cf** Californium 98	**Es** Einsteinium 99	**Fm** Fermium 100	**Md** Mendelevium 101	**No** Nobelium 102	**Lr** Lawrencium 103

Key

a
X
b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).