



Cambridge Assessment International Education
Cambridge International General Certificate of Secondary Education (9–1)

CANDIDATE
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CENTRE
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CO-ORDINATED SCIENCES

0973/42

Paper 4 Theory (Extended)

May/June 2019

2 hours

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 an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

A copy of the Periodic Table is printed on page 28.

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.

This document consists of **27** printed pages and **1** blank page.

1 (a) The graph in Fig. 1.1 shows the effect of temperature on enzyme activity.

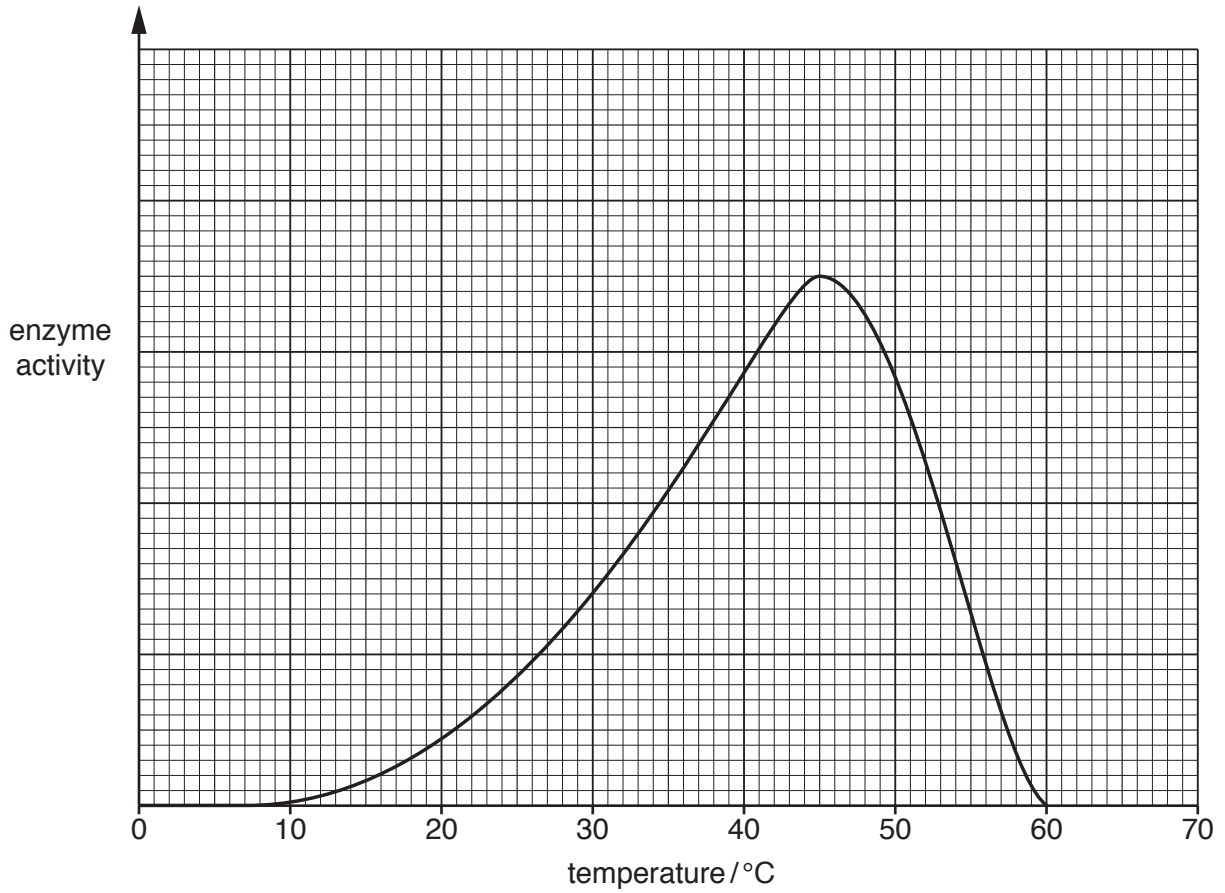


Fig. 1.1

(i) State the optimum temperature of the enzyme in Fig. 1.1.

.....°C [1]

(ii) Explain the results in Fig. 1.1 at 60°C.

.....
.....
.....
..... [2]

(b) Enzyme activity is also affected by pH.

Complete the graph in Fig. 1.2 to show how the activity of a protease enzyme in the stomach is affected by pH.

Include on your graph:

- labels for both axes
- a sketch of a suitable curve.

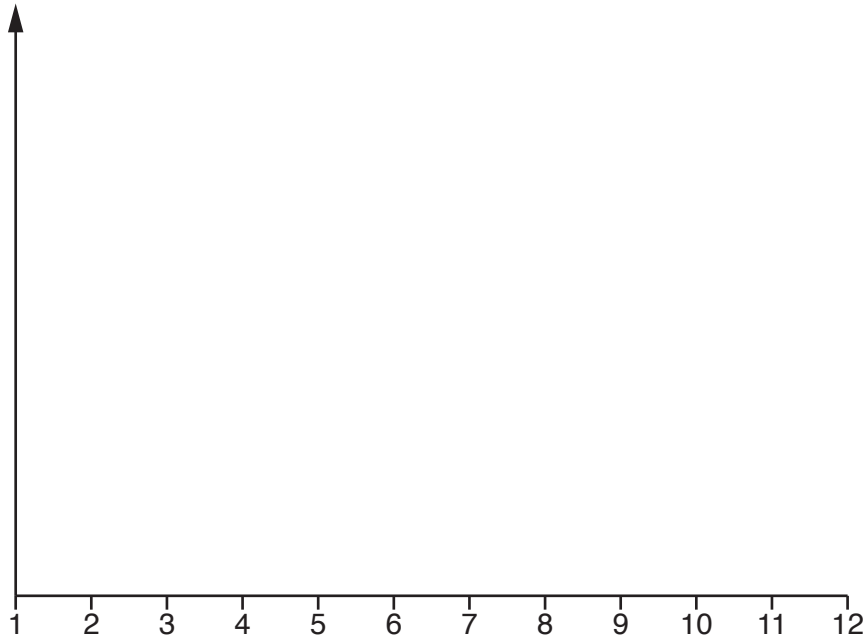


Fig. 1.2

[3]

(c) A solution containing an enzyme is tested with **biuret** solution.

State the colour change you would expect.

Give a reason for your answer.

the colour changes from to

reason

.....

[2]

[Total: 8]

- 2 (a) Fig. 2.1 shows the composition of clean air and of natural gas.

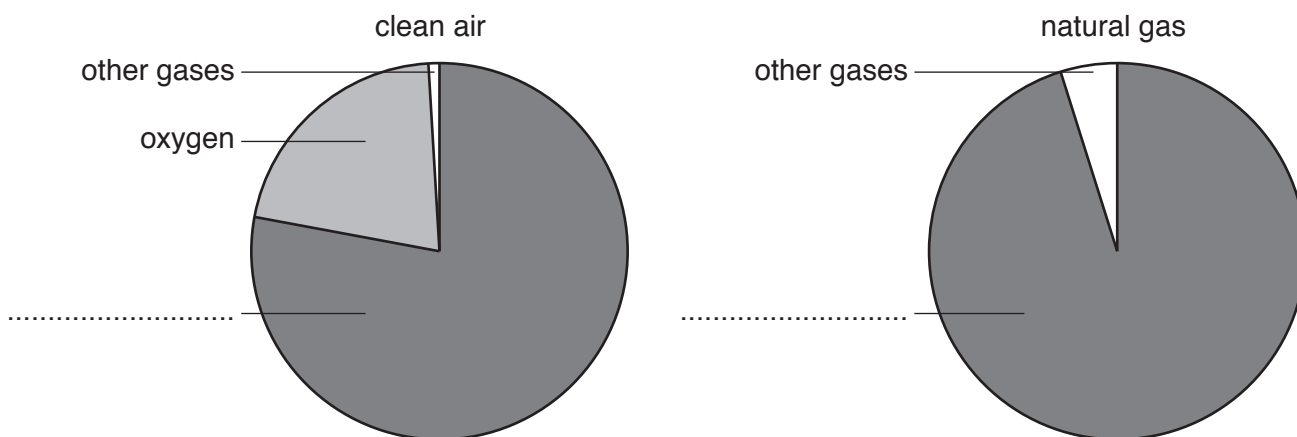


Fig. 2.1

- (i) Complete the labels in Fig. 2.1 to show the main constituent of clean air and of natural gas. [2]

- (ii) One of the other gases in natural gas is ethane.

Name two gases in clean air that are formed by the complete combustion of ethane.

1

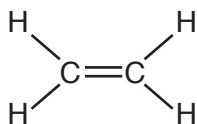
2

[2]

- (b) Name the process used to convert larger alkane molecules into ethene and hydrogen.

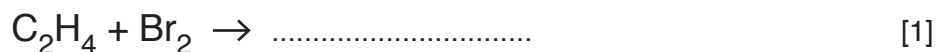
..... [1]

- (c) The molecular structure of ethene is shown below.



The double bond in ethene allows it to undergo addition reactions.

- (i) Complete the equation for the addition reaction between ethene and bromine.



- (ii) Ethene is used to make ethanol in an addition reaction.

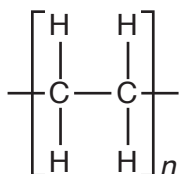
Name the other raw material required in the manufacture of ethanol.

..... [1]

- (d) Ethene is used in the manufacture of poly(ethene).

Propene is used in the manufacture of poly(propene).

- (i) The structure of poly(ethene) is shown by



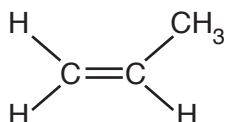
(n is a large number)

Describe the formation of poly(ethene) using the terms *monomer* and *polymer*.

.....

 [2]

- (ii) The molecular structure of propene is shown below.



Suggest the structure of poly(propene). Draw your answer in the space below.

[1]

[Total: 10]

- 3 (a) In 1971, an astronaut hit a golf ball on the surface of the Moon.

The golf ball had a mass of 46 g and initially travelled at 50 m/s.

- (i) Calculate the kinetic energy of the golf ball when travelling at 50 m/s.

Show your working.

kinetic energy = J [3]

- (ii) Describe the difference between the terms *speed* and *velocity*.

.....

 [1]

- (b) On the Moon, an astronaut suspends masses on a spring and measures the extension of the spring in mm as shown in Fig. 3.1

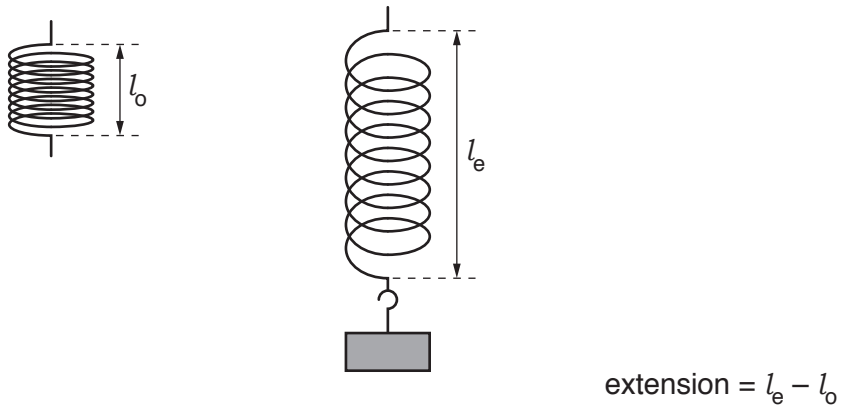


Fig. 3.1

Fig. 3.2 shows the results of the experiment.

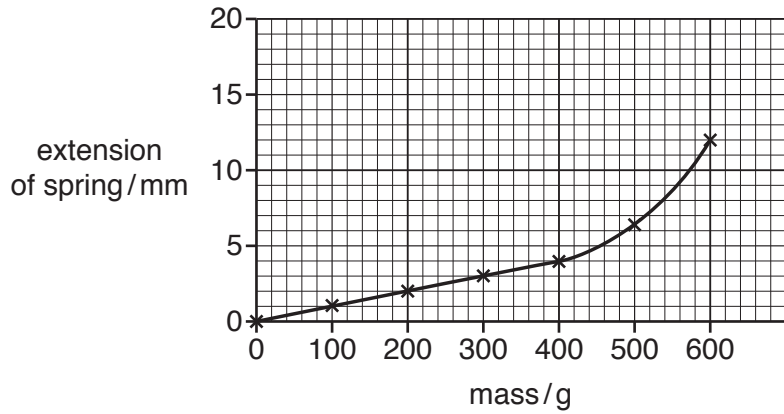


Fig. 3.2

- (i) Use Fig. 3.2 to determine the range of masses where Hooke’s Law is obeyed.

Explain your answer.

range of masses from g to g

explanation [2]

- (ii) The astronaut repeats the experiment with an identical spring on Earth.

Each 100g mass produces a greater extension of the spring on Earth.

Calculate the mass that would need to be used on Earth to obtain the same extension as the addition of 300g on the Moon.

The gravitational field strength on Earth is 10N/kg and on the Moon is 1.6 N/kg.

Show your working.

mass = g [2]

- (c) The astronaut is exposed to infra-red waves that travel from the Sun to the Moon.

- (i) Name this method of energy transfer.

..... [1]

- (ii) Name the type of nuclear reaction taking place in the Sun that releases energy.

..... [1]

4 (a) Fig. 4.1 shows a cross-section through a leaf.

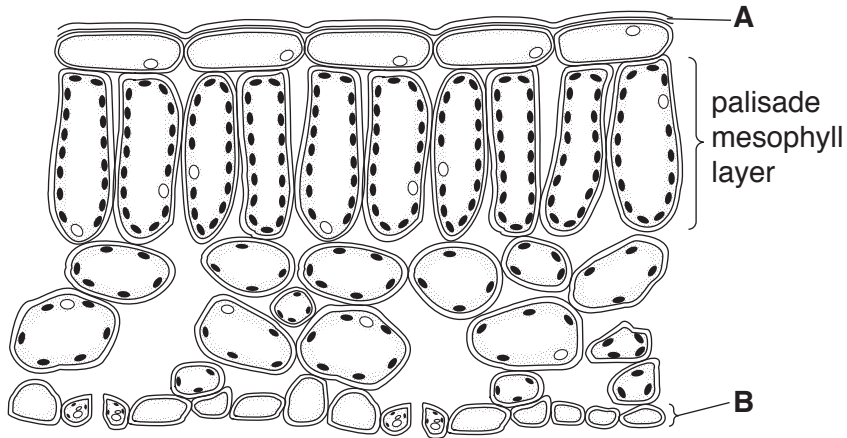


Fig. 4.1

(i) Name the parts **A** and **B**.

A

B [2]

(ii) Draw **one** arrow on Fig. 4.1 to show where carbon dioxide enters the leaf. [1]

(b) Describe two features of the cells in the palisade mesophyll layer that allow efficient photosynthesis to occur.

1

.....

2

..... [2]

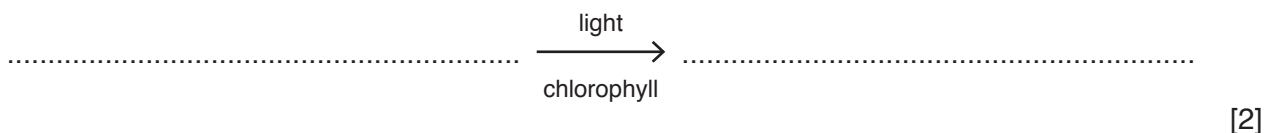
(c) Describe the role of chlorophyll in photosynthesis.

.....

.....

..... [2]

(d) Complete the balanced symbol equation for photosynthesis.



[Total: 9]

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5 A student investigates the colour in a leaf.

He crushes the leaf in a solvent to extract the coloured compounds.

Fig. 5.1 shows the apparatus he uses.

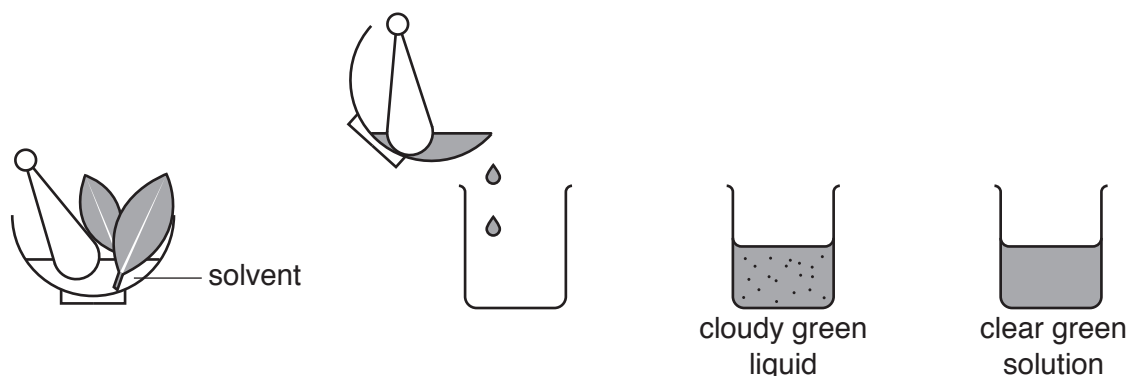


Fig. 5.1

(a) (i) Name the process he uses to remove the solids from the cloudy green liquid to obtain a clear green solution.

..... [1]

(ii) Describe how the process he uses produces a clear green solution.

.....
 [1]

(b) The student uses paper chromatography to separate the compounds which give the solution its green colour.

He draws a pencil line on a strip of chromatography paper and places a drop of the green solution on the pencil line.

He dips the paper into a solvent.

Fig. 5.2 is an incomplete diagram of the apparatus he uses.

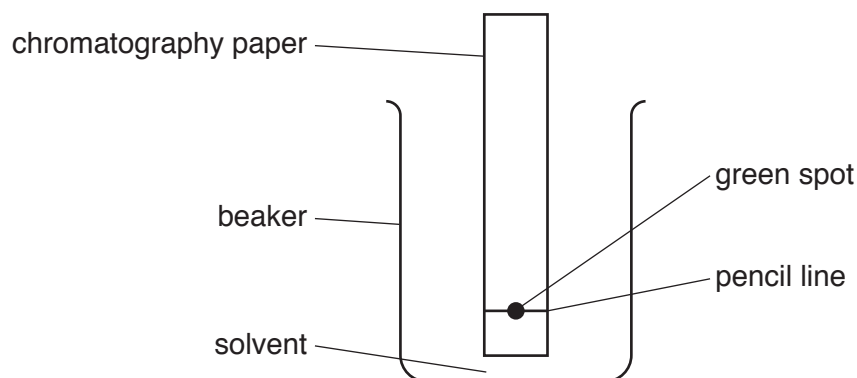


Fig. 5.2

(i) Draw a line on Fig. 5.2 to show the surface of the solvent in the beaker.

[1]

(ii) Fig. 5.3 shows the chromatogram he obtains.

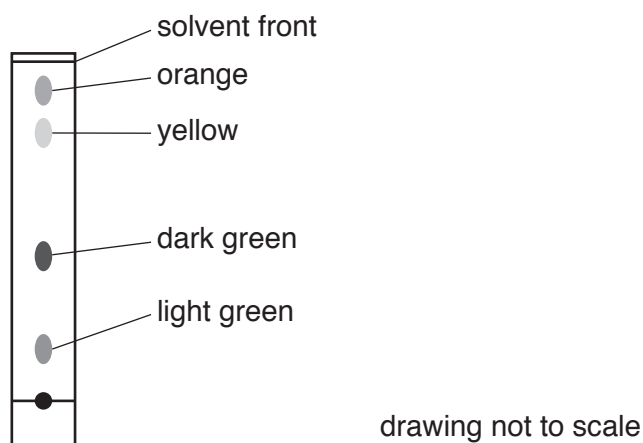


Fig. 5.3

Table 5.1 lists the R_f values of the coloured compounds on the chromatogram.

Table 5.1

coloured compound	R_f
carotene	0.91
chlorophyll A	0.42
chlorophyll B	0.16
xanthophyll	0.77

Use Table 5.1 to identify the yellow compound.

Explain how you obtained your answer.

yellow compound

explanation

..... [2]

(iii) Describe how the student can obtain a pure, dry sample of the orange compound from the chromatogram.

.....

 [3]

[Total: 8]

- 6 (a) Fig. 6.1 shows a car with two rear lamps, **L1** and **L2**.

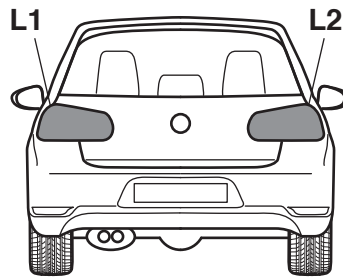


Fig. 6.1

The lamps are connected in parallel and powered by a 12 V battery.

The lamps each have a resistance of $33\ \Omega$.

- (i) Calculate the combined resistance of the two lamps connected in parallel in this circuit.
Show your working.

resistance = Ω [2]

- (ii) Calculate the charge that passes through lamp **L2** in 30 minutes.
State any formula you use and show your working.

charge = C [4]

(b) The air in a car tyre exerts a pressure on the walls of the tyre.

(i) Use ideas about the motion of molecules to describe how the molecules exert a pressure on the walls of the tyre.

.....
.....
..... [2]

(ii) State what happens to the pressure of the air in the tyre if the temperature increases.

.....
..... [1]

(c) Hot exhaust gases from the car engine leave the engine through a steel exhaust pipe.

The steel exhaust pipe transfers thermal energy through the pipe wall by conduction.

(i) Describe the process of conduction in a solid, using ideas about particle vibration and transfer by electrons.

.....
.....
.....
.....
.....
..... [3]

(ii) When heated, the steel exhaust pipe expands.

Explain, in terms of the motion and arrangement of particles, why a solid expands less than a gas when heated.

.....
.....
.....
..... [2]

[Total: 14]

7 Fig. 7.1 shows a cross-section through a human heart.

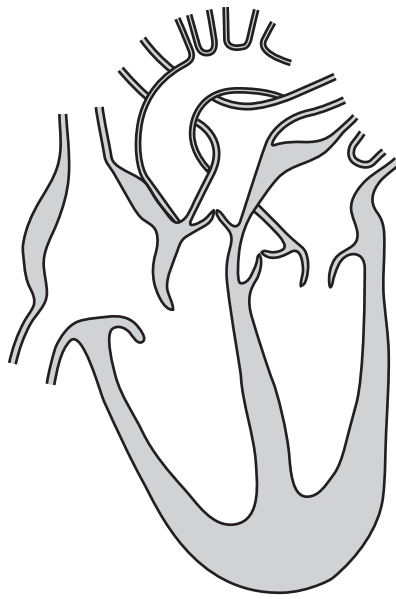


Fig. 7.1

(a) On Fig. 7.1, use a label line and the letter **X** to identify the septum. [1]

(b) The function of the heart is to pump blood around the body.

Describe how the heart pumps blood.

.....
.....
.....
..... [2]

(c) Name the two main **veins** of the heart.

1
2 [2]

- (d) Fig. 7.2 shows a doctor’s note about a patient. It contains information about the patient’s lifestyle.

Patient notes:
Age: 23
Gender: Male

Has an office job.
Plays sport regularly.
Smokes 10 cigarettes a day.
Does not drink alcohol.
Eats large amounts of food high in fat.
Eats small amounts of fruit and vegetables.

Fig. 7.2

Use the information in Fig. 7.2 to answer these questions.

- (i) Describe two ways in which this patient could reduce their risk of developing coronary heart disease.

1

.....

2

.....

[2]

- (ii) State **one non-lifestyle** factor that increases this patient’s risk of developing coronary heart disease.

..... [1]

[Total: 8]

- 8 (a) The thermite reaction is a redox reaction between aluminium and iron oxide, Fe_2O_3 . It produces molten iron and aluminium oxide, Al_2O_3 .

(i) Write a balanced symbol equation for the thermite reaction.

..... [2]

(ii) During the reaction Fe^{3+} ions become Fe atoms and Al atoms become Al^{3+} ions.

Identify the oxidising agent and the reducing agent.

Explain your answer in terms of electron transfer.

oxidising agent

reducing agent

explanation

..... [2]

(b) Fig. 8.1 shows the energy level diagram for the thermite reaction.

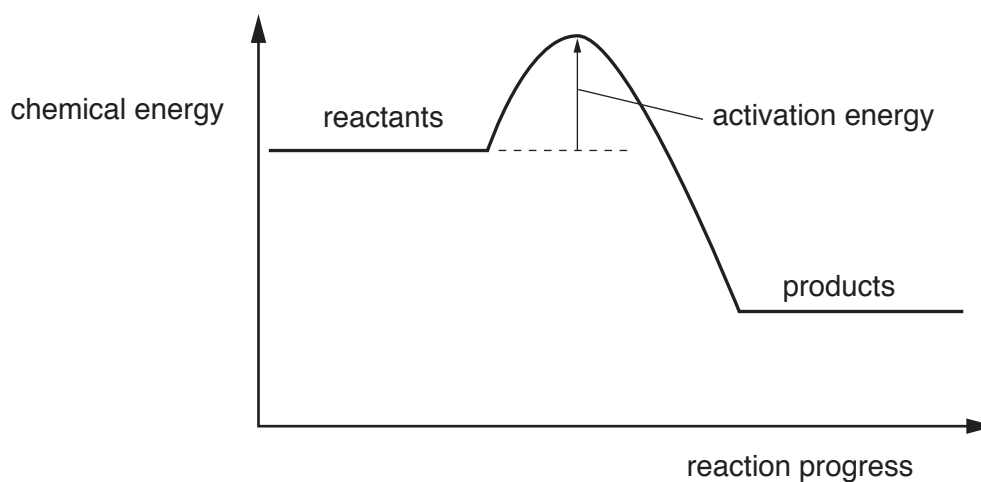


Fig. 8.1

(i) Use the diagram to explain why the reactant mixture must be heated before the reaction starts.

..... [1]

(ii) Use the diagram to explain why the reaction is exothermic.

..... [1]

(c) Steel is an alloy of iron.

(i) Describe the metallic bonding in iron.

You may include a labelled diagram in your answer.

.....
.....
..... [2]

(ii) State the meaning of the term *alloy*.

.....
..... [1]

(iii) Suggest two differences in the physical properties of steel and iron.

1
2 [2]

[Total: 11]

9 (a) Ultrasound waves are used in hospitals to scan unborn babies.

Ultrasound waves have a frequency that is too high for a human to hear.

(i) State, in terms of waves, what is meant by the term *frequency*.

.....
 [1]

(ii) Using your knowledge of the range of audible frequencies for a healthy human ear, suggest a frequency for these ultrasound waves.

frequency = Hz [1]

(iii) Ultrasound waves are longitudinal waves.

Describe what is meant by a longitudinal wave.

.....
 [1]

(b) Endoscopes are used by doctors in hospitals to observe the inside of a patient.

An endoscope uses optical fibres.

Complete Fig. 9.1 to show how a ray of light travels down an optical fibre by total internal reflection.

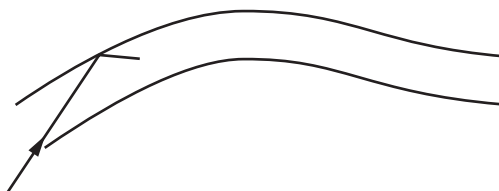


Fig. 9.1

[2]

(c) An isotope of strontium, strontium-89, is used in the treatment of bone cancer in hospitals.

Strontium-89 has a half-life of 50 days. A sample of this isotope contains 4×10^{14} atoms.

Some time later 3×10^{14} atoms have decayed.

Calculate the time needed for this number of atoms to decay.

Show your working.

time = days [3]

[Total: 8]

10 (a) The diagrams in Fig. 10.1 show two cells C and D.

The concentration of carbon dioxide inside and outside the cells is represented by the number of molecules drawn.

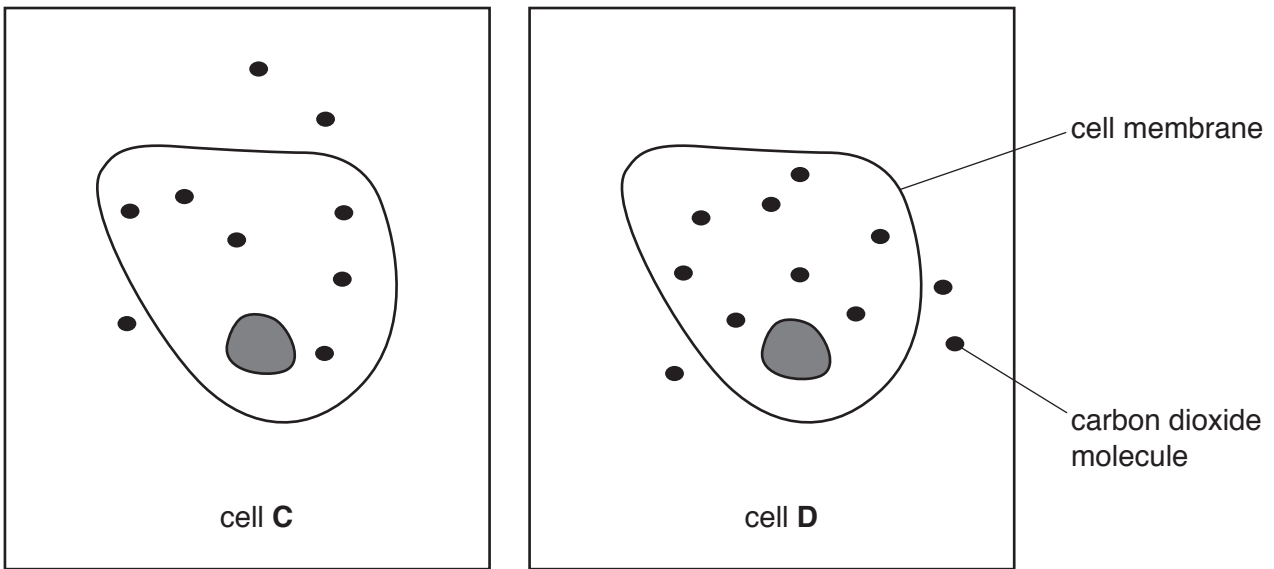


Fig. 10.1

(i) Add **one** arrow to **each** diagram to show the net movement of carbon dioxide molecules across the cell membrane by diffusion. [1]

(ii) State which cell has the greater rate of diffusion.

Give a reason for your answer.

cell

reason

[1]

(b) Humans excrete carbon dioxide.

(i) Define the term *excretion*.

.....

.....

..... [2]

(ii) Describe the pathway of carbon dioxide from the blood to the atmosphere.

.....

.....

.....

.....

..... [3]

[Total: 7]

11 The raw materials needed to make sulfuric acid in the Contact process are air, sulfur and water.

Fig. 11.1 shows the stages in the Contact process.

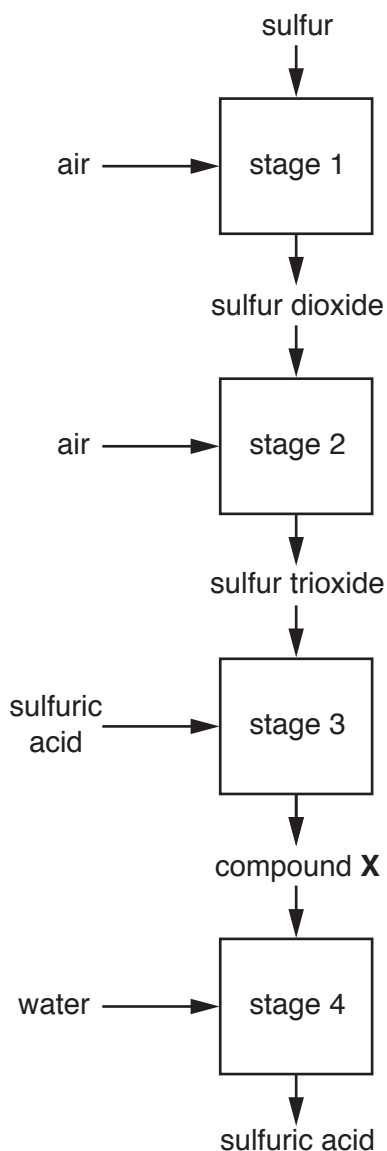
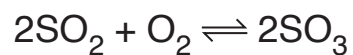


Fig. 11.1

(a) In stage 2, sulfur dioxide reacts with oxygen to make sulfur trioxide.

The equation for this reaction is



State the meaning of the \rightleftharpoons symbol.

..... [1]

- (b) Fig. 11.2 shows the relationship between the temperature of stage 2 and the percentage of sulfur dioxide converted to sulfur trioxide.

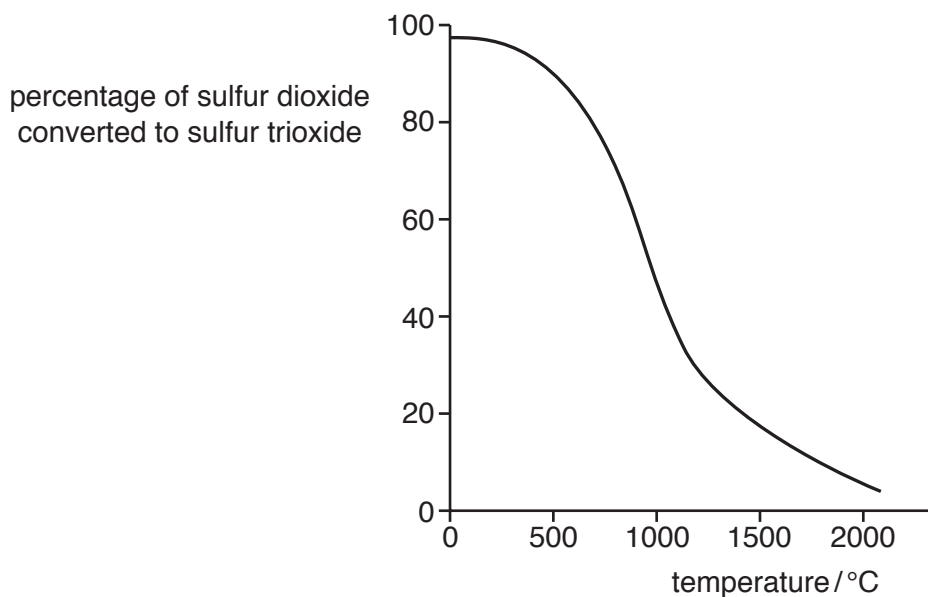


Fig. 11.2

- (i) Suggest the temperature in stage 2 of the Contact process.

..... [1]

- (ii) Use Fig. 11.2 to suggest **one** advantage, other than cost, of using a low temperature in stage 2.

..... [1]

- (iii) State and explain why a low temperature is **not** used in stage 2.

Explain your answer in terms of particle movement in stage 2.

.....

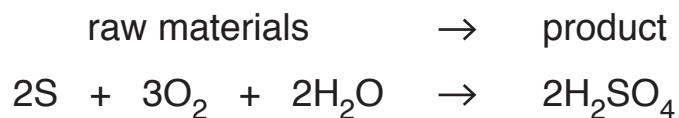
 [3]

- (c) Compound **X**, $\text{H}_2\text{S}_2\text{O}_7$, is formed in stage 3.

Name compound **X**.

..... [1]

(d) The overall equation for the Contact process is



Complete steps 1 to 4 to calculate the mass of sulfuric acid made from 1000g of sulfur.

Show your working.

[A_r : H,1; O,16; S,32]

Step 1

Calculate the number of moles in 1000g of sulfur.

number of moles =

Step 2

Deduce the number of moles of sulfuric acid made from 1000g of sulfur.

number of moles =

Step 3

Calculate the relative molecular mass, M_r , of sulfuric acid.

M_r =

Step 4

Calculate the mass of sulfuric acid made from 1000g of sulfur.

mass = g

[4]

[Total: 11]

12 (a) Fig. 12.1 shows a large snow tractor used by scientists working in the Arctic region.

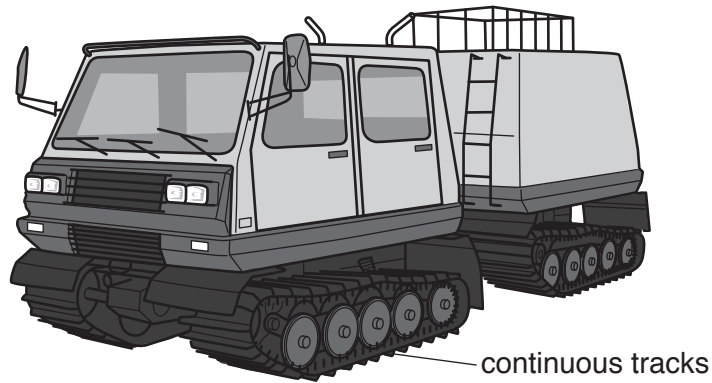


Fig. 12.1

The snow tractor has large continuous tracks (caterpillar tracks), driven by the wheels.

These tracks allow the snow tractor to travel across the soft snow without sinking.

A tractor with four ordinary wheels would sink into the soft snow.

Use ideas about pressure to explain this difference.

.....

.....

..... [2]

(b) The snow tractor has two headlamps.

The headlamps emit visible light of several different wavelengths. One of the wavelengths is 5.01×10^{-7} m. The frequency of this light is 5.98×10^{14} Hz.

Calculate the speed of this light.

Show your working.

speed of light = m/s [2]

- (c) Visible light is part of the electromagnetic spectrum. All electromagnetic waves travel at the same speed in a vacuum.

State **one** other property that is the same for all electromagnetic waves.

.....
 [1]

- (d) Fig. 12.2 shows equipment for measuring wind speed used by Arctic scientists.

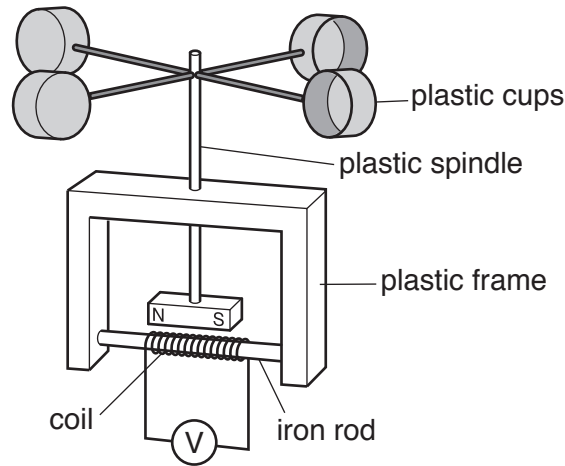


Fig. 12.2

The wind makes the plastic cups move and this causes the spindle and magnet to turn.

Suggest why an alternating voltage is measured on the voltmeter.

.....

 [3]

[Total: 8]

13 (a) Excess use of fertilisers can cause eutrophication. Eutrophication eventually causes organisms in a lake to die.

(i) Explain why producers underneath the surface of the water die.

.....

.....

.....

.....

..... [3]

(ii) Explain why the death of producers eventually leads to the death of the fish in the lake.

.....

.....

.....

.....

..... [3]

(b) Table 13.1 shows some information about two mineral ions found in fertilisers.

Table 13.1

mineral ion	function of mineral ion	effect a deficiency in the mineral ion has on plant
magnesium		yellow leaves
	making amino acids	

Complete Table 13.1. [2]

[Total: 8]

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The Periodic Table of Elements

		Group							
I	II	III	IV	V	VI	VII	VIII		
3 Li lithium 7	4 Be beryllium 9	1 H hydrogen 1	5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20	2
11 Na sodium 23	12 Mg magnesium 24	Key atomic number atomic symbol name relative atomic mass		13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	33 As arsenic 75	34 Se selenium 79
37 Rb rubidium 85	38 Sr strontium 88	43 Tc technetium —	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	51 Sb antimony 122	52 Te tellurium 128
55 Cs caesium 133	56 Ba barium 137	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	81 Tl thallium 204	82 Pb lead 207
87 Fr francium —	88 Ra radium —	89–103 actinoids	104 Rf rutherfordium —	105 Db dubnium —	106 Sg seaborgium —	107 Bh bohrium —	108 Hs hassium —	80 Hg mercury 201	83 Bi bismuth 209
		57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium —	62 Sm samarium 150	84 Po polonium —	85 At astatine —
		63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	86 Rn radon —	
		69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	87 Lv livermorium —	
		75 Rf rutherfordium 261	76 Sg seaborgium 266	77 Bh bohrium 269	78 Hs hassium 270	79 Mt meitnerium 276	80 Ds darmstadtium 285	89–103 actinoids	
		81 La lanthanum 139	82 Ce cerium 140	83 Pr praseodymium 141	84 Nd neodymium 144	85 Pm promethium —	86 Sm samarium 150	87 Eu europium 152	88 Gd gadolinium 157
		89 Ac actinium —	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium —	94 Pu plutonium —	89 Yt yttrium 89	90 Zr zirconium 91
		95 Am americium —	96 Cm curium —	97 Bk berkelium —	98 Cf californium —	99 Es einsteinium —	100 Fm fermium —	91 Sc scandium 45	92 Ti titanium 48
		101 Md mendelevium —	102 No nobelium —	103 Lr lawrencium —	104 Rf rutherfordium 261	105 Sg seaborgium 266	106 Bh bohrium 269	93 Y yttrium 89	94 Zr zirconium 91
		105 Lr lawrencium —	106 No nobelium —	107 Lr lawrencium —	108 Rf rutherfordium 261	109 Sg seaborgium 266	110 Bh bohrium 269	95 Mo molybdenum 96	96 Tc technetium —
		109 Lr lawrencium —	110 No nobelium —	111 Lr lawrencium —	112 Rf rutherfordium 261	113 Sg seaborgium 266	114 Bh bohrium 269	97 Ru ruthenium 101	98 Rh rhodium 103
		113 Lr lawrencium —	114 No nobelium —	115 Lr lawrencium —	116 Rf rutherfordium 261	117 Sg seaborgium 266	118 Bh bohrium 269	99 Pd palladium 106	100 Ag silver 108
		117 Lr lawrencium —	118 No nobelium —	119 Lr lawrencium —	120 Rf rutherfordium 261	121 Sg seaborgium 266	122 Bh bohrium 269	101 Cd cadmium 112	102 In indium 115
		121 Lr lawrencium —	122 No nobelium —	123 Lr lawrencium —	124 Rf rutherfordium 261	125 Sg seaborgium 266	126 Bh bohrium 269	103 Hg mercury 201	104 Tl thallium 204
		125 Lr lawrencium —	126 No nobelium —	127 Lr lawrencium —	128 Rf rutherfordium 261	129 Sg seaborgium 266	130 Bh bohrium 269	105 Pt platinum 195	106 Au gold 197
		127 Lr lawrencium —	128 No nobelium —	129 Lr lawrencium —	130 Rf rutherfordium 261	131 Sg seaborgium 266	132 Bh bohrium 269	107 Ir iridium 192	108 Pt platinum 195
		129 Lr lawrencium —	130 No nobelium —	131 Lr lawrencium —	132 Rf rutherfordium 261	133 Sg seaborgium 266	134 Bh bohrium 269	109 Hg mercury 201	110 Au gold 197
		131 Lr lawrencium —	132 No nobelium —	133 Lr lawrencium —	134 Rf rutherfordium 261	135 Sg seaborgium 266	136 Bh bohrium 269	111 Pb lead 207	112 Pb lead 207
		133 Lr lawrencium —	134 No nobelium —	135 Lr lawrencium —	136 Rf rutherfordium 261	137 Sg seaborgium 266	138 Bh bohrium 269	113 Bi bismuth 209	114 Pb lead 207
		135 Lr lawrencium —	136 No nobelium —	137 Lr lawrencium —	138 Rf rutherfordium 261	139 Sg seaborgium 266	140 Bh bohrium 269	115 Po polonium —	116 Pb lead 207
		137 Lr lawrencium —	138 No nobelium —	139 Lr lawrencium —	140 Rf rutherfordium 261	141 Sg seaborgium 266	142 Bh bohrium 269	117 At astatine —	118 Po polonium —
		139 Lr lawrencium —	140 No nobelium —	141 Lr lawrencium —	142 Rf rutherfordium 261	143 Sg seaborgium 266	144 Bh bohrium 269	119 Rn radon —	120 Po polonium —
		141 Lr lawrencium —	142 No nobelium —	143 Lr lawrencium —	144 Rf rutherfordium 261	145 Sg seaborgium 266	146 Bh bohrium 269	121 Rn radon —	122 Po polonium —
		143 Lr lawrencium —	144 No nobelium —	145 Lr lawrencium —	146 Rf rutherfordium 261	147 Sg seaborgium 266	148 Bh bohrium 269	123 Rn radon —	124 Po polonium —
		145 Lr lawrencium —	146 No nobelium —	147 Lr lawrencium —	148 Rf rutherfordium 261	149 Sg seaborgium 266	150 Bh bohrium 269	125 Rn radon —	126 Po polonium —
		147 Lr lawrencium —	148 No nobelium —	149 Lr lawrencium —	150 Rf rutherfordium 261	151 Sg seaborgium 266	152 Bh bohrium 269	127 Rn radon —	128 Po polonium —
		149 Lr lawrencium —	150 No nobelium —	151 Lr lawrencium —	152 Rf rutherfordium 261	153 Sg seaborgium 266	154 Bh bohrium 269	129 Rn radon —	130 Po polonium —
		151 Lr lawrencium —	152 No nobelium —	153 Lr lawrencium —	154 Rf rutherfordium 261	155 Sg seaborgium 266	156 Bh bohrium 269	131 Rn radon —	132 Po polonium —
		153 Lr lawrencium —	154 No nobelium —	155 Lr lawrencium —	156 Rf rutherfordium 261	157 Sg seaborgium 266	158 Bh bohrium 269	133 Rn radon —	134 Po polonium —
		155 Lr lawrencium —	156 No nobelium —	157 Lr lawrencium —	158 Rf rutherfordium 261	159 Sg seaborgium 266	160 Bh bohrium 269	135 Rn radon —	136 Po polonium —
		157 Lr lawrencium —	158 No nobelium —	159 Lr lawrencium —	160 Rf rutherfordium 261	161 Sg seaborgium 266	162 Bh bohrium 269	137 Rn radon —	138 Po polonium —
		159 Lr lawrencium —	160 No nobelium —	161 Lr lawrencium —	162 Rf rutherfordium 261	163 Sg seaborgium 266	164 Bh bohrium 269	139 Rn radon —	140 Po polonium —
		161 Lr lawrencium —	162 No nobelium —	163 Lr lawrencium —	164 Rf rutherfordium 261	165 Sg seaborgium 266	166 Bh bohrium 269	141 Rn radon —	142 Po polonium —
		163 Lr lawrencium —	164 No nobelium —	165 Lr lawrencium —	166 Rf rutherfordium 261	167 Sg seaborgium 266	168 Bh bohrium 269	143 Rn radon —	144 Po polonium —
		165 Lr lawrencium —	166 No nobelium —	167 Lr lawrencium —	168 Rf rutherfordium 261	169 Sg seaborgium 266	170 Bh bohrium 269	145 Rn radon —	146 Po polonium —
		167 Lr lawrencium —	168 No nobelium —	169 Lr lawrencium —	170 Rf rutherfordium 261	171 Sg seaborgium 266	172 Bh bohrium 269	147 Rn radon —	148 Po polonium —
		169 Lr lawrencium —	170 No nobelium —	171 Lr lawrencium —	172 Rf rutherfordium 261	173 Sg seaborgium 266	174 Bh bohrium 269	149 Rn radon —	150 Po polonium —
		171 Lr lawrencium —	172 No nobelium —	173 Lr lawrencium —	174 Rf rutherfordium 261	175 Sg seaborgium 266	176 Bh bohrium 269	151 Rn radon —	152 Po polonium —
		173 Lr lawrencium —	174 No nobelium —	175 Lr lawrencium —	176 Rf rutherfordium 261	177 Sg seaborgium 266	178 Bh bohrium 269	153 Rn radon —	154 Po polonium —
		175 Lr lawrencium —	176 No nobelium —	177 Lr lawrencium —	178 Rf rutherfordium 261	179 Sg seaborgium 266	180 Bh bohrium 269	155 Rn radon —	156 Po polonium —
		177 Lr lawrencium —	178 No nobelium —	179 Lr lawrencium —	180 Rf rutherfordium 261	181 Sg seaborgium 266	182 Bh bohrium 269	157 Rn radon —	158 Po polonium —
		179 Lr lawrencium —	180 No nobelium —	181 Lr lawrencium —	182 Rf rutherfordium 261	183 Sg seaborgium 266	184 Bh bohrium 269	159 Rn radon —	160 Po polonium —
		181 Lr lawrencium —	182 No nobelium —	183 Lr lawrencium —	184 Rf rutherfordium 261	185 Sg seaborgium 266	186 Bh bohrium 269	161 Rn radon —	162 Po polonium —
		183 Lr lawrencium —	184 No nobelium —	185 Lr lawrencium —	186 Rf rutherfordium 261	187 Sg seaborgium 266	188 Bh bohrium 269	163 Rn radon —	164 Po polonium —
		185 Lr lawrencium —	186 No nobelium —	187 Lr lawrencium —	188 Rf rutherfordium 261	189 Sg seaborgium 266	190 Bh bohrium 269	165 Rn radon —	166 Po polonium —
		187 Lr lawrencium —	188 No nobelium —	189 Lr lawrencium —	190 Rf rutherfordium 261	191 Sg seaborgium 266	192 Bh bohrium 269	167 Rn radon —	168 Po polonium —
		189 Lr lawrencium —	190 No nobelium —	191 Lr lawrencium —	192 Rf rutherfordium 261	193 Sg seaborgium 266	194 Bh bohrium 269	169 Rn radon —	170 Po polonium —
		191 Lr lawrencium —	192 No nobelium —	193 Lr lawrencium —	194 Rf rutherfordium 261	195 Sg seaborgium 266	196 Bh bohrium 269	171 Rn radon —	172 Po polonium —
		193 Lr lawrencium —	194 No nobelium —	195 Lr lawrencium —	196 Rf rutherfordium 261	197 Sg seaborgium 266	198 Bh bohrium 269	173 Rn radon —	174 Po polonium —
		195 Lr lawrencium —	196 No nobelium —	197 Lr lawrencium —	198 Rf rutherfordium 261	199 Sg seaborgium 266	200 Bh bohrium 269	175 Rn radon 	