First name:	**Surname:**

Current School:

SHREWSBURY SCHOOL

SIXTH FORM ENTRANCE EXAMINATION 2016

CHEMISTRY

(1 hour)

Instructions to candidates:

Answer **ALL TWENTY** questions from SECTION A on the grid provided on **page 18**

and

Answer **THREE questions ONLY** from **SECTION B** in the spaces provided

Section A is worth **20 marks** and **Section B 30 marks**. 50 marks in total.

You may use a calculator.

You are provided with a **copy of the Periodic table** at the **end of Section B.**

SECTION A

Answer **ALL** questions from **SECTION A** on the grid provided on **page 18.**

Question 1

What is always true for a pure substance?

A It always boils at 100 °C.

B It contains only one type of atom.

C It has a sharp melting point.

D It is solid at room temperature.

Question 2

At room temperature, in which substance are the particles furthest apart?

A H_2 **B** H_2O **C** Mg **D** MgO

Question 3

What is the relative molecular mass, M_r, of butanol?

A 15 **B** 37 **C** 74 **D** 148

Question 4

What is the concentration of a solution containing 1.0 g of sodium hydroxide in 250 cm^3 of solution?

A 0.025 mol / dm^3

B 0.10 mol / dm^3

C 0.25 mol / dm^3

D 1.0 mol / dm^3

Question 5

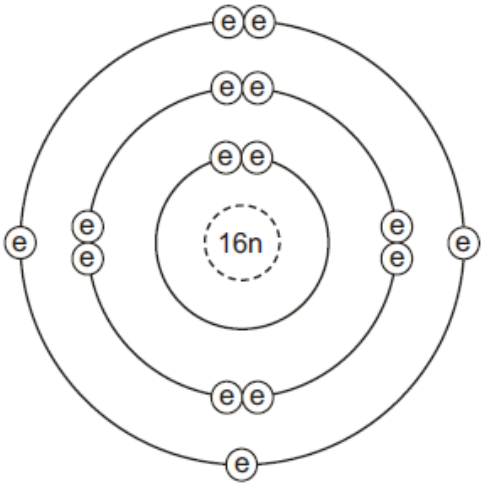
The nucleon number and proton number of the lithium atom are shown by the symbol $^{7}_{3}Li$.

What is the correct symbol for the lithium ion in lithium chloride?

A $^{6}_{2}Li^-$ **B** $^{6}_{3}Li^+$ **C** $^{7}_{3}Li^+$ **D** $^{7}_{3}Li^-$

Question 6

Which element has the atomic structure shown?



key

e electron

n neutron

nucleus

A Al **B** P **C** S **D** Si

Question 7

The table shows the structure of different atoms and ions.

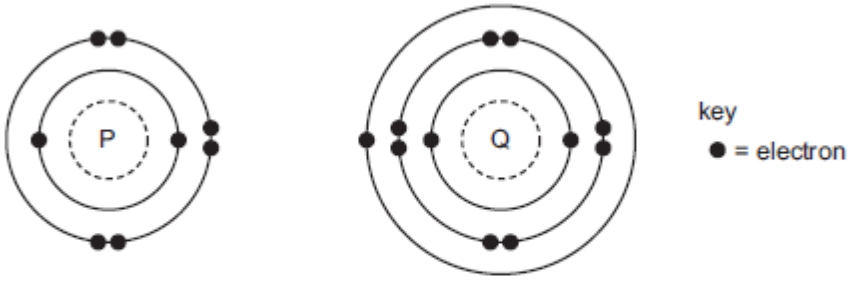
particle	proton number	nucleon number	number of protons	number of neutrons	number of electrons
Mg	12	24	12	W	12
Mg^{2+}	X	24	12	12	10
F	9	19	9	Y	9
F^-	9	19	9	10	Z

What are the values of W, X, Y and Z?

	W	X	Y	Z
A	10	10	9	9
B	10	12	10	9
C	12	10	9	10
D	12	12	10	10

Question 8

The electronic structures of atoms P and Q are shown.



P and Q react to form an ionic compound.

What is the formula of this compound?

A PQ_2 **B** P_2Q **C** P_2Q_6 **D** P_6Q_2

Question 9

A solution contains barium ions and silver ions and one type of anion.

What could the anion be?

A chloride only

B nitrate only

C sulfate only

D chloride or nitrate or sulfate

Question 10

A mixture containing two anions was tested and the results are shown below.

test	result
dilute nitric acid added	effervescence of a gas which turned limewater milky
dilute nitric acid added, followed by aqueous silver nitrate	yellow precipitate formed

Which anions were present?

A carbonate and chloride

B carbonate and iodide

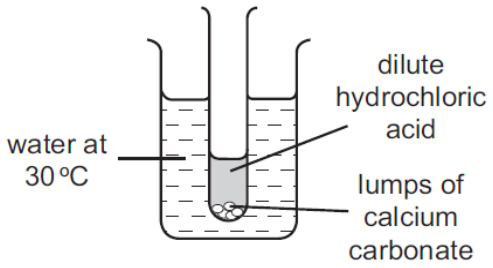
C sulfate and chloride

D sulfate and iodide

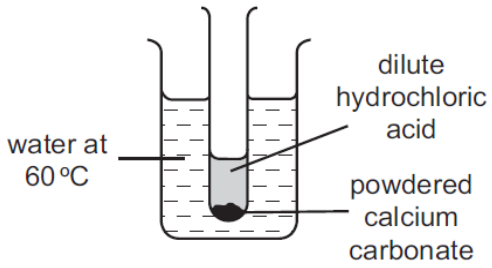
Question 11

In which experiment is the rate of reaction between hydrochloric acid and calcium carbonate **slowest**?

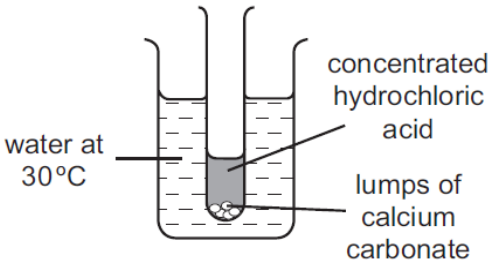
A



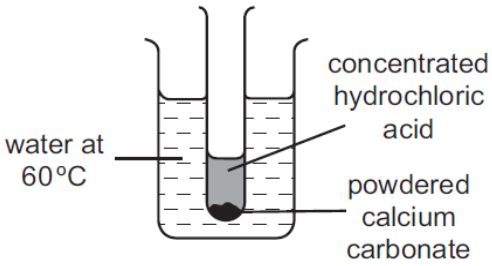
B



C



D

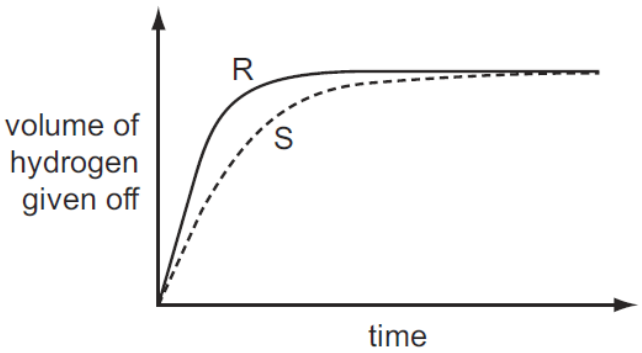


Question 12

A student investigates the rate of reaction between magnesium and excess sulfuric acid.

The volume of hydrogen given off in the reaction is measured over time.

The graph shows the results of two experiments, R and S.



Which change in conditions would cause the difference between R and S?

A A catalyst is added in S.

B The acid is more concentrated in R than in S.

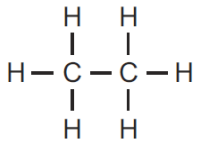
C The magnesium is less finely powdered in R than in S.

D The temperature in R is lower than in S.

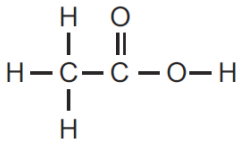
Question 13

Which structure is **incorrect**?

A



B



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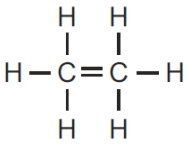

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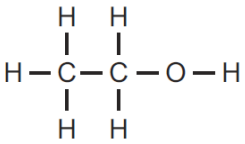
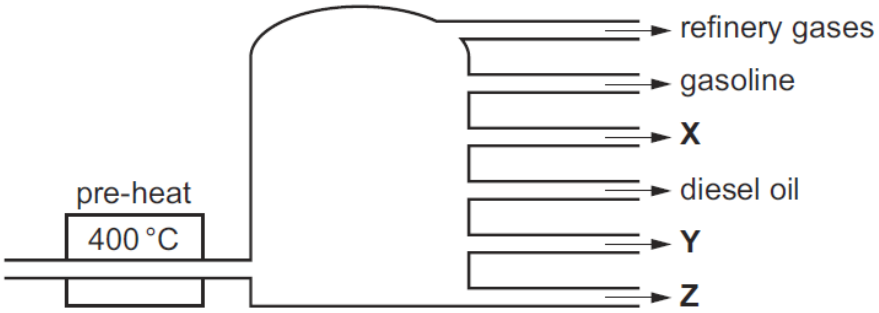


Question 14

In an oil refinery, petroleum is separated into useful fractions.

The diagram shows some of these fractions.

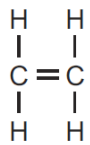


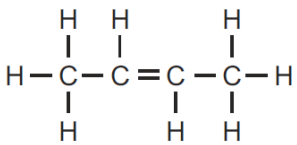
What are fractions X, Y and Z?

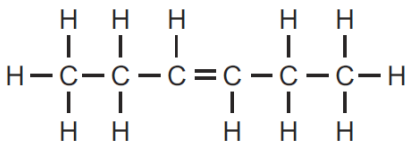
	X	Y	Z
A	fuel oil	bitumen	paraffin (kerosene)
B	fuel oil	paraffin (kerosene)	bitumen
C	paraffin (kerosene)	bitumen	fuel oil
D	paraffin (kerosene)	fuel oil	bitumen

Question 15

The structures of three compounds are shown.







Why do these substances all belong to the same homologous series?

A They all contain an even number of carbon atoms.

B They all contain the same functional group.

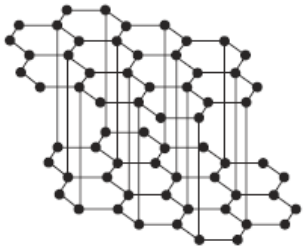
C They are all hydrocarbons.

D They are all saturated.

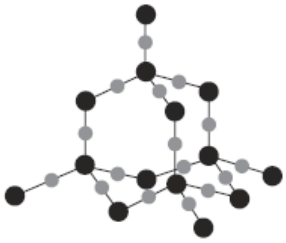
Question 16

Which structure represents a polymer?

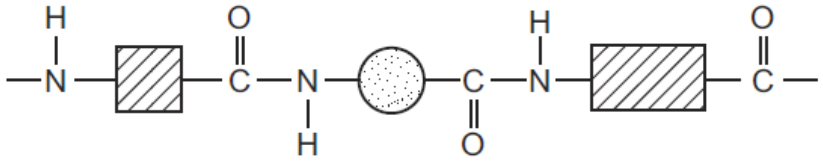
A



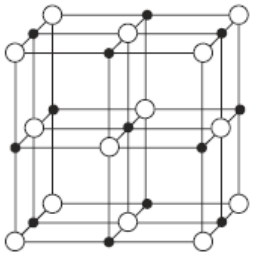
B



C



D



Question 17

Which equation shows an oxidation reaction?

A $C + O_2 \rightarrow CO_2$

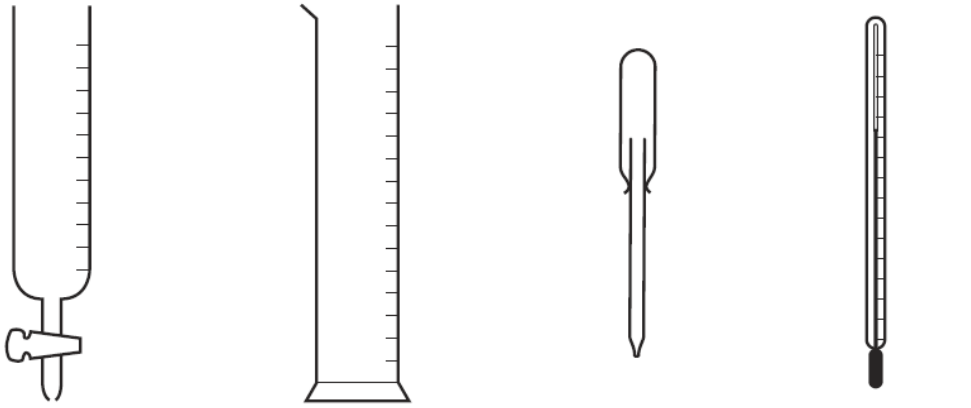
B $CaCO_3 \rightarrow CaO + CO_2$

C $CaO + 2HCl \rightarrow CaCl_2 + H_2O$

D $N_2O_4 \rightarrow 2NO_2$

Question 18

The four pieces of apparatus shown below are used in chemical experiments.



burette | measuring cylinder | pipette | thermometer

Which statement about the apparatus is correct?

A The burette measures the volume of liquid added in a titration.

B The measuring cylinder measures the mass of a substance used in an experiment.

C The pipette measures the volume of gas given off in a reaction.

D The thermometer measures the density of a solution.

Question 19

Solutions of two chemicals are mixed.

A reaction occurs and the temperature change is measured.

Which statement is correct?

A If the reaction is endothermic, the temperature decreases and energy is taken in.

B If the reaction is endothermic, the temperature increases and energy is given out.

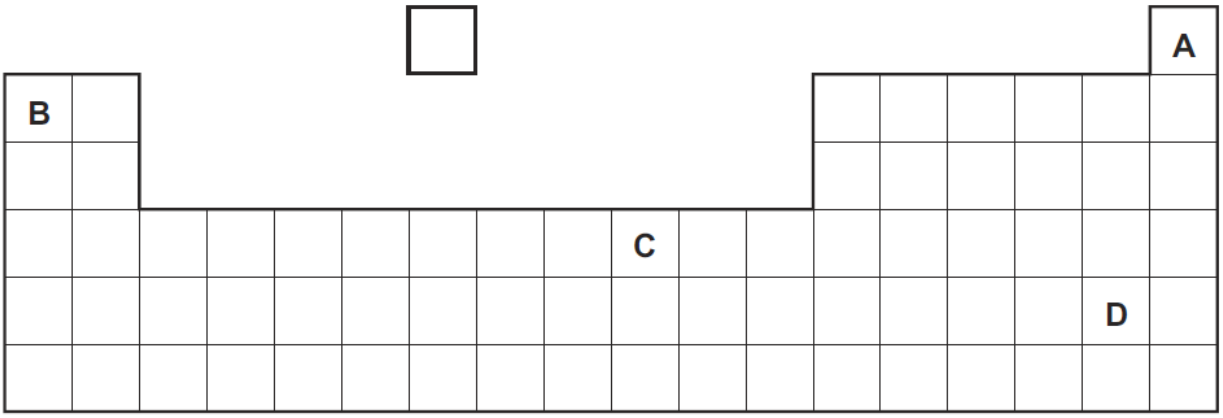
C If the reaction is exothermic, the temperature decreases and energy is given out.

D If the reaction is exothermic, the temperature increases and energy is taken in.

Question 20

An element melts at 1455 °C, has a density of 8.90 g / cm^3 and forms a green chloride.

Where in the Periodic Table is this element found?



END OF SECTION A

SECTION B

Answer THREE of the following FOUR questions

Question 1

Iron from the blast furnace contains about 5% impurities, which are mostly made up of carbon and silicon dioxide. Most of the resulting iron is used to make steels, such as mild steel.

(a) Calcium oxide and oxygen are used to remove the impurities from the iron produced in the blast furnace.

(i) State how these chemicals are manufactured.

calcium oxide .....

.....

oxygen .....

.....

[3]

(ii) Describe how these two chemicals remove the impurities; carbon & silicon dioxide. You should include equations in your answer and the type of reaction that is occurring in each case.

.....

.....

.....

.....

.....

.....

..... [5]

(b) (i) Describe the structure of a typical metal such as iron. You may include a diagram.

.....

.....

[2]

TOTAL: 10

Question 2

The alkanes are a family of saturated hydrocarbons. Their reactions include combustion, cracking and substitution.

(a) (i) What is meant by the term *hydrocarbon*?

.....

[1]

(ii) What is meant by the term *saturated*?

.....

[1]

(b) (i) What is the general formula for the homologous series of alkanes?

.....

[1]

(ii) Calculate the mass of one mole of an alkane with 14 carbon atoms.

.....

.....

[2]

(c) The complete combustion of hydrocarbons produces carbon dioxide and water only.

(i) Write the equation for the complete combustion of nonane, C_9H_{20}.

.....

[2]

(ii) 20 cm^3 of a gaseous hydrocarbon was mixed with an excess of oxygen, 200 cm^3. The mixture was ignited. After cooling, 40 cm^3 of oxygen and 100 cm^3 of carbon dioxide remained. Deduce the formula of the hydrocarbon and the equation for its combustion. All volumes were measured at r.t.p..

.....

.....

.....

.....

.....

[3]

TOTAL: 10

Question 3

Part (a)

One way of establishing a reactivity series is by displacement reactions.

(a) A series of experiments was carried out using the metals lead, magnesium, zinc and silver. Each metal was added in turn to aqueous solutions of the metal nitrates.

The order of reactivity was found to be:

magnesium	most reactive
zinc	↓
lead	
silver	least reactive

(i) Complete the table.

✓ = reacts
✗ = does not react

	metal			
aqueous solution	lead Pb	magnesium Mg	zinc Zn	silver Ag
lead(II) nitrate		✓	✓	✗
magnesium nitrate				
zinc nitrate				
silver nitrate				

[3]

(ii) Displacement reactions are redox reactions.
On the following equation, draw a **ring** around the reducing agent and an **arrow** to show the change which is oxidation.

$$Zn + Pb^{2+} \rightarrow Zn^{2+} + Pb$$

[2]

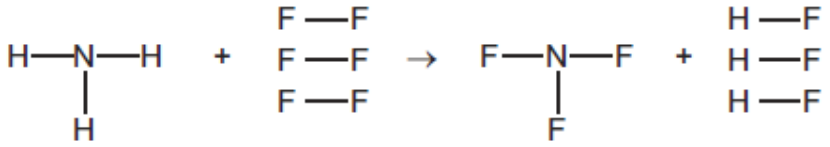
(iii) Complete the following ionic equation.

$$Zn + 2Ag^{+} \rightarrow \text{.....} + \text{.....}$$

[1]

Part (b)

Ammonia is used to make nitrogen trifluoride, NF_3.
Nitrogen trifluoride is essential to the electronics industry. It is made by the following reaction.



Use the table below to calculate the energy change in KJ/mole for this reaction.

bond	bond energy in kJ / mole
N – H	390
F – F	155
N – F	280
H – F	565

Energy change = ……KJ/Mol

[3]

Comment on whether this reaction is endothermic or exothermic.

…….. [1]

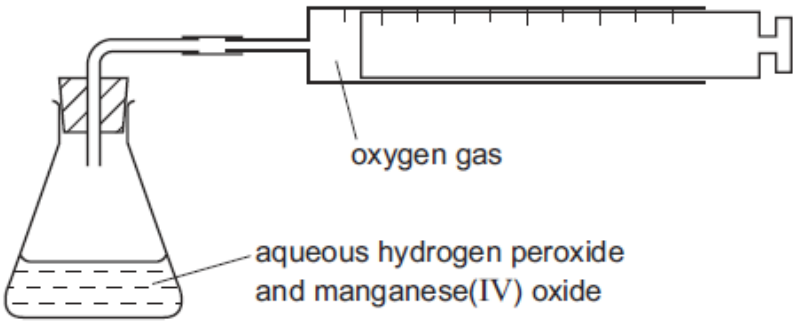
Total: 10

Question 4

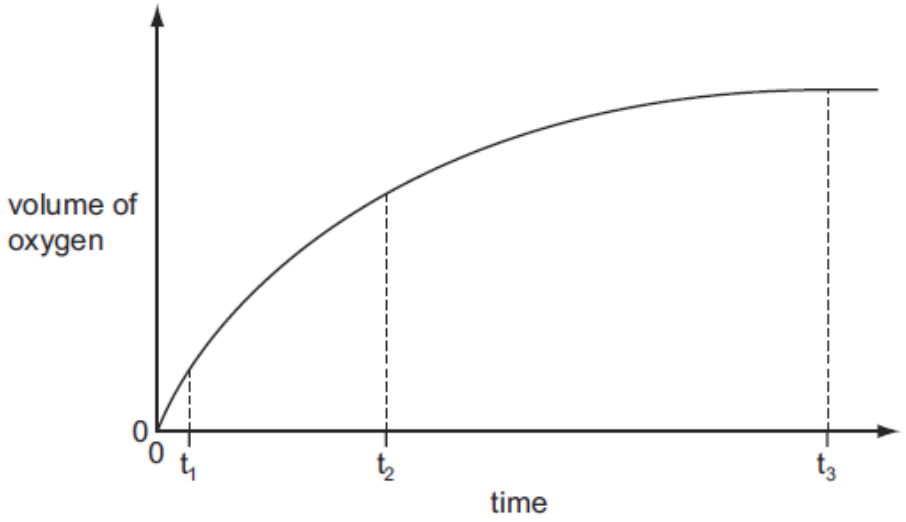
Hydrogen peroxide decomposes to form water and oxygen. This reaction is catalyzed by manganese(IV) oxide.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

The rate of this reaction can be investigated using the following apparatus.



40 cm^3 of aqueous hydrogen peroxide was put in the flask and 0.1 g of small lumps of manganese(IV) oxide was added. The volume of oxygen collected was measured every 30 seconds. The results were plotted to give the graph shown below.



(a) (i) How do the rates at times t_1, t_2 and t_3 differ?

.....

..... [2]

(ii) Explain the trend in reaction rate that you described in **(a)(i)**.

.....

.....

..... [2]

(c) Describe how you could show that the catalyst, manganese(IV) oxide, was not used up in the reaction. Manganese(IV) oxide is insoluble in water.

.....

.....

.....

.....

..... [4]

(b) The experiment was repeated using 0.1 g of finely powdered manganese(IV) oxide. All the other variables were kept the same.

(i) On the axes opposite, sketch the graph that would be expected. [2]

(ii) Explain the shape of this graph. .....

.....

.....

..... [2]

Total: 10

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 †															

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

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

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.).

Name: .....

Answer all questions – circle the correct letter for each question below.

1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D