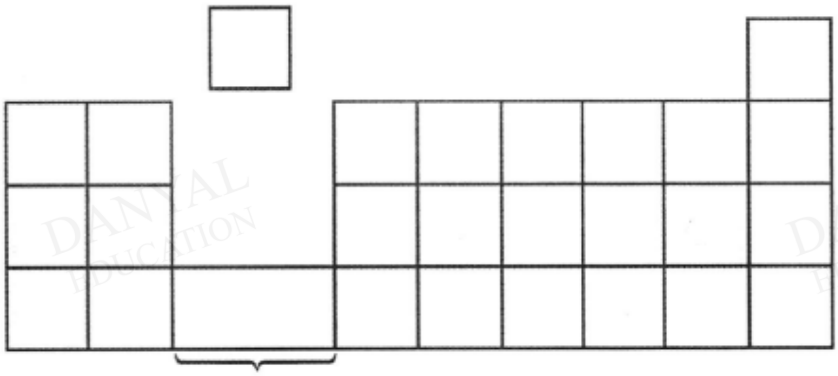
O Level Pure Chemistry Structured

Periodic Table Test 2.0

Q1

The diagram below shows a simplified version of the Periodic Table.



Use the information below to place the elements in their correct position in the Periodic Table above. (The letters do **not** represent the chemical symbols of the elements.)

(a) P has an electronic configuration of 2, 2.

(b) Q has only two electrons.

(c) R is a non-metal that forms a strong acid with Group VII elements.

(d) S forms an ion, S^{3-}, with an electronic configuration of 2, 8, 8.

[Total: 4]

Q2

The Periodic Table shows trends down each group and across each period.

(a) Which trends are only true down a group, which trends are only true across a period, which trends are true for both, and which trends are not true for both?

Put a tick (✓) in **one** box in each row.

trend	only true down a group	only true across a period	true for both	not true for both
The mass number increases.				
The atomic radius increases.				
The melting point increases.				
There is a change in the character of the oxides from basic to amphoteric to acidic.				

[2]

(b) Group I and Group VII show different trends in their properties.

Group I	Group VII
Li	F
Na	Cl
K	Br
Rb	I

(i) Explain the trend in reactivity down each group.

.....

.....

.....

..... [3]

(ii) Hydrogen is not placed in any group of the Periodic Table though it shares some similar properties with the elements in Group I and the elements in Group VII.

Give reasons to explain why hydrogen can be placed in either Group I or Group VII of the Periodic Table.

Group I .....

.....

Group VII .....

.....

[2]

(c) Persulfate ions, $S_2O_8^{2-}$ oxidise iodide ions according to the following equation.

$$S_2O_8^{2-}(aq) + 2I^-(aq) \rightarrow 2SO_4^{2-}(aq) + I_2(aq)$$

The reaction occurs very slowly at room temperature, so a catalyst of Fe^{2+} ions is used.

The reaction involving the Fe^{2+} catalyst takes place in two steps:

$$2Fe^{2+}(aq) + S_2O_8^{2-}(aq) \rightarrow 2Fe^{3+}(aq) + 2SO_4^{2-}(aq)$$

$$2Fe^{3+}(aq) + 2I^-(aq) \rightarrow 2Fe^{2+}(aq) + I_2(aq)$$

(i) With reference to the collision of particles, suggest why the reaction between persulfate ions and iodide ions is very slow at room temperature.

.....

..... [1]

(ii) Using the above equations, explain how the Fe^{2+} ion displays one of the characteristics of a catalyst.

.....

..... [1]

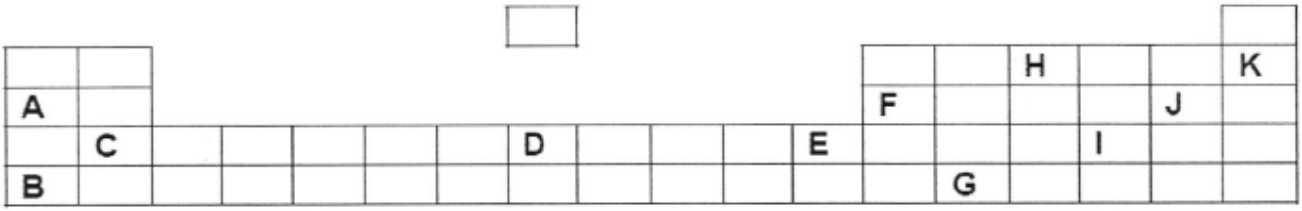
(iii) Using information from the above equations, suggest the property of transition metals that allow Fe^{2+} to act as a catalyst in this reaction.

.....

..... [1]

Q3

In the Periodic Table below, the letters **A** to **K** represent some elements but not the symbols of the respective elements.



Use the letter(s) to identify and answer the following questions.

(a) A metal that sinks in and reacts vigorously with water

_____ [1]

(b) An oxidising gas.

_____ [1]

(c) A monoatomic element.

_____ [1]

(d) An element which forms an ion with charge +2 and +3.

_____ [1]

(e) The formula of the compound formed between **H** and **J**.

_____ [1]

Q4

Read the information about the oxides of elements in Period 3 of the Periodic Table.

The formulae and the chemical properties of the oxides and chlorides of the elements change across Period 3.

element	metal/non-metal	formula of main oxide	bonding in oxide	formula in chloride	bonding in chloride
Na	metal	Na_2O	ionic	NaCl	ionic
Mg	metal	MgO	ionic	$MgCl_2$	ionic
Al	metal	Al_2O_3	ionic	$AlCl_3$	covalent
Si	non-metal	SiO_2	covalent	$SiCl_4$	covalent
P	non-metal	P_4O_{10}	covalent	PCl_3	covalent
S	non-metal	SO_3	covalent	S_2Cl_2	covalent
Cl	non-metal	Cl_2O_7	covalent	Cl_2	covalent

Electronegativity refers to the tendency of an atom to attract electrons to itself.
Metals tend to have low electronegativities while non-metals have high electronegativities.
The electronegativity values of Period 3 elements are shown in the table below.

element	electronegativity of each element
Na	0.9
Mg	1.2
Al	1.6
Si	1.8
P	2.1
S	2.5
Cl	3.0

Oxygen has electronegativity of 3.5.

The difference in the electronegativities between each element and oxygen can be calculated.
Some examples are shown the table below.

formula of oxides	difference in electronegativities between each element and oxygen
Na_2O	2.6
MgO	2.3
Al_2O_3	2.1

(a) Describe the pattern for the difference in electronegativities between each element and oxygen across Period 3.

[2]

(b) With reference to atomic structure, give reason(s) why the electronegativity of oxygen is higher than that of any element in Period 3.

[2]

(c) A student wrote the following conclusion by studying the results.

> "The bonds in the oxides and chlorides are covalent when the difference in electronegativities is less than 2.0."

Do you agree with this conclusion?
Use the results to explain your reasoning.

[4]

(d) The electronegativity of beryllium is 1.57. Predict the bonding in beryllium chloride and beryllium oxide.
Explain your answer.

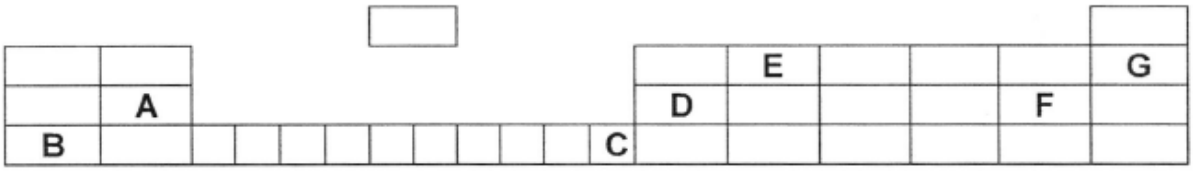
[2]

(e) Suggest, with reason(s), an electronegative value for argon.

[2]

Q5

The positions of six elements, represented by letters, **A**, **B**, **C**, **D**, **E**, **F** and **G** are shown in the Periodic Table below. These letters **A**, **B**, **C**, **D**, **E**, **F** and **G** **are not** symbols of elements in the Periodic Table.



Use the letters **A**, **B**, **C**, **D**, **E**, **F** and **G** to answer the following questions. You may use each letter once, more than once or none at all.

(a) An element which combines with **F** to form a very volatile compound. [1]

_____

(b) An element which has an insoluble hydroxide that is soluble in excess sodium hydroxide to form a colourless solution. [1]

_____

(c) An element which is the strongest reducing agent. [1]

_____

(d) An element which is chemically unreactive. [1]

_____

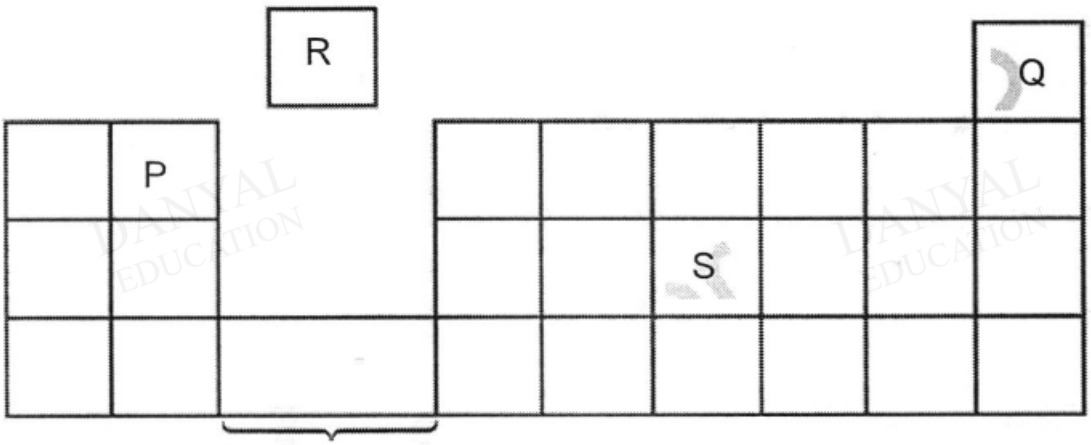
(e) An element that can be obtained by heating its oxide with coke. [1]

_____

Answers

Periodic Table Test 2.0

Q1



Q2

(a)

trend	only true down a group	only true across a period	true for both	not true for both
The mass number increases.			✓	
The atomic radius increases.	✓			
The melting point increases.				✓
There is a change in the character of the oxides from basic to amphoteric to acidic.		✓		

(b)	(i) Reactivity increases down Group I and decreases down Group VII [1] For Group I: easier to remove valence electrons as they are further away from the nucleus/there are more electron shells [1] For Group VII: more difficult to accept/attract one electron as incoming electron is further away from the nucleus/there are more electron shells [1] (ii) Group I: H atom has one valence electron / able to form singly positively charged ion (H^+) [1] Group VII: H atom able to gain one electron to form a singly negatively charged ion (H^-) / forms diatomic molecules (H_2) [1]
(c)	(i) The two ions are of the same charge and repel, hence they are not able to collide with each other (frequently) [1] (ii) It is not (chemically) used up in the reaction / It is regenerated during the reaction [1] (iii) It exhibits variable oxidation states. [1]

Q3

(a) B

(b) J

(c) K

(d) D

(e) HJ_3

Q4

(a) The difference in electronegativity between each element and oxygen decreases from 2.6 for Na to 0.5 for Cl across the period. [2]

Trend [1], quote data [1]

(b) Oxygen atom has one lesser electron shell (2 electron shells) than each element in Period 3 [1] [2]

Hence there is a stronger electrostatic attraction between the positively charged nucleus and the valence electrons [1]

(c) The student's conclusion is true for oxides. [3]
The difference in electronegativities between Si, P and Cl and O is less than 2.0 and bond character is covalent. [1]

His conclusion does not apply for chlorides.
The difference in electronegativities between Mg and Cl is less than 2.0 at 1.8 and the bond is ionic. [1]

Data cited for both statements [1]

(d) Bond nature in beryllium chloride is covalent and that in beryllium oxide is ionic .[1] [2]

Since the electronegativity of beryllium is approximately same as aluminium. [1]

(e) 0.0 [1] [2]
Argon is unreactive as it has a stable complete electronic configuration and
Hence unlikely to attract electrons to itself.[1]

Q5

a		E	1
b		C OR D	1
c		B	1
d		G	1
e		C	1