08 The Periodic Table and Periodicity

Set A **Answer key**

A From the lesson

28 MARKS

1 **C** P^{3-} [1]

The anions have one more shell than the cations.

Of the anions, P^{3-} has the fewest protons pulling on its 18 electrons, so it is the largest (0.212 nm).

2 **C** Si [1]

Silicon has a giant covalent structure: very many strong covalent bonds must break.

Mg and Al are metallic, and S is simple molecular.

3 **B** Al_2O_3 [1]

Aluminium oxide is amphoteric.

MgO is basic, and SiO_2 and P_4O_{10} are acidic.

4 **B** The ionic radius increases. [1]

Each ion down the group has one more shell, so it is larger.

Reducing power and reactivity increase down the group, and electronegativity decreases.

5 **B** Chlorine displaces astatine. [1]

Reactivity decreases down the group, so chlorine is more reactive and displaces astatine.

Melting points increase down the group, so astatine is a solid.

6 **C** magnesium oxide [1]

Magnesium is above carbon in the reactivity series.

It is extracted by electrolysis. The other three metals are below carbon.

7 **(a)** Mg^{2+} has lost its outer (third) shell.

The same 12 protons pull on 10 electrons instead of 12. [2]

(b) The electron removed from S is paired in a 3p orbital.

Repulsion between the paired electrons makes it easier to remove. [2]

8 **(a)**

Each Al atom gives 3 delocalised electrons and each Na atom only 1, so there are more mobile charge carriers. **[1]**

(b)

S_8 molecules have more electrons than Cl_2, so the instantaneous dipole–induced dipole forces are stronger. **[1]**

9 **(a)**

Na_2O is ionic: $Na_2O + H_2O \rightarrow 2NaOH$.

SO_3 is covalent: $SO_3 + H_2O \rightarrow H_2SO_4$. **[2]**

(b)

Silicon (its chloride is $SiCl_4$). **[1]**

10

$2Rb + 2H_2O \rightarrow 2RbOH + H_2$

Rubidium hydroxide and hydrogen. **[2]**

11

Calcium carbonate.

Ca^{2+} is smaller, so it has a higher charge density and polarises the carbonate ion more, weakening its C–O bonds. **[2]**

12 **(a)**

The colourless solution turns brown.

Bromine is more reactive and displaces iodine: $Br_2 + 2KI \rightarrow 2KBr + I_2$. **[2]**

(b)

The H–I bond (299 kJ mol^{-1}) is weaker than H–Cl (431 kJ mol^{-1}). **[1]**

13 **(a)**

Red-brown copper forms and the blue colour fades.

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$ **[2]**

(b)

Heat it with carbon: $2SnO + C \rightarrow 2Sn + CO_2$. **[1]**

14 **(a)**

Zinc is more reactive than iron, so it corrodes instead of the iron.

Tin is less reactive than iron, so it only works as a barrier. **[2]**

(b)

Attach blocks of zinc or magnesium (sacrificial protection). **[1]**

B Practice

17 MARKS

15 **C** non-metallic character [1]

The elements change from metals to non-metals across the period.

All have three shells, and melting point rises to silicon and then falls.

16 **D** The tendency to gain electrons increases. [1]

The nuclear charge rises with the same shielding, so the atoms attract electrons more strongly.

Conductivity falls after aluminium, and the number of valence electrons increases.

17 **D** fewer valence electrons [1]

With only two valence electrons, magnesium loses electrons easily to form a positive ion, which is metallic behaviour.

Both have three shells. Having fewer electrons or protons overall is not the reason.

18 **B** row B [1]

$2M + 2H_2O \rightarrow 2MOH + H_2$: a hydroxide and hydrogen.

The valence electron is lost more easily down the group, so reactivity increases.

19 **B** I and III [1]

Group 1 metals are soft and their melting points decrease down the group.

They lose electrons, so they are reducing agents, and their reactivity increases down the group.

20 **D** Its melting point is higher. [1]

Melting points decrease down Group 1, so rubidium melts at a lower temperature than sodium.

A, B and C follow from the group trends.

21 **B** stored under oil [1]

Group 1 metals react with oxygen and water in air, so they are kept under oil.

Losing one electron is easier, so they are more reactive than Group 2. All have one outer electron, and the melting point falls because the attraction gets weaker.

22 **D** row D [1]

Each halogen down the group has one more shell, so its atoms are larger.

Its molecules have more electrons, so the forces between them are stronger and the boiling points rise.

23 **A** ability as an oxidising agent [1]

The incoming electron is further from the nucleus and more shielded, so the halogen gains it less easily.

Boiling point, colour intensity and density all increase down the group.

24 **D** increasing distance, harder to attract [1]

Down the group the outer shell is further from the nucleus, so an incoming electron is attracted less strongly.

A halogen reacts by gaining an electron, so it becomes less reactive.

25 **C** P is the stronger oxidising agent. [1]

P is bromine and Q is iodine. Bromine is above iodine, so it is the stronger oxidising agent.

Iodine atoms have more shells, both are diatomic, and iodine cannot displace bromine.

26 **B** row B [1]

Only a halogen above bromine can displace it, so X_2 is chlorine.

Bromine forms, so the colourless solution turns orange.

27 **C** chlorine and lithium iodide [1]

Chlorine is above iodine, so it displaces brown iodine from lithium iodide.

In A, B and D the halogen is below the halide, so nothing happens.

28 **C** row C [1]

Melting points rise down the group, so astatine is a solid.

It is the least reactive of these halogens, so it displaces none of them.

29 **C** row C [1]

Group 1 gets more reactive down the group, so potassium is the more reactive metal.

Group 17 gets less reactive down the group, so fluorine is the more reactive halogen.

30 **B** Helium is less dense than air. [1]

Helium is used in balloons because it is less dense than air.

The noble gases are unreactive, all gases at room temperature, and exist as single atoms.

31

C full outer shells [1]

Their outer shells are full, which is why they are unreactive.

They exist as single atoms, they are colourless, and the number of electrons does not always rise by eight (argon 18, krypton 36).