**Spot the errors in the answers, there are 3 sets in each answer.**

**Please DO NOT attempt these questions until you are VERY confident**

**with Chemical Reactions, or you may get yourself confused!**

**Question 1** Carbon reacting with oxygen.

**Observations:** *A black powder/solid when heated and placed in a jar of pure oxygen, burns with a yellow flame and produces a colourless, odourless gas called carbon dioxide.*

1. (i) Write a word equation for this reaction

carbon + oxygen 🡪 carbon dioxide

(ii) Write a balanced chemical equation for this reaction, **including physical states.**

C (s) + 2O (g) 🡪 CO2(g)

1. Describe all observations and link them to the chemical species responsible

When a black powder solid carbon is heated and reacts with oxygen gas. A yellow flame is seen and a colourless, odourless gas, carbon dioxide is produced.

1. (i) Name the type of chemical reaction \_\_Combination reaction\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(ii) Justify your choice of reaction type by linking the observed changes to the “definition” of the

 type of reaction.

This is a **combination** reaction because two reactants (solid carbon + gaseous oxygen molecules) combine together to form a single gaseous product (carbon dioxide) when heated.

1. Discuss why this reaction occurs with reference to electron arrangements of the reactant(s) and product(s).

This reaction occurs between two non-metal elements.

Both the carbon and oxygen atoms will gain electrons to achieve a full stable outer shells of electrons. The electron configuration of carbon atoms is 2, 4 and that of oxygen atoms is 2,6. Carbon needs to lose 4 electron and oxygen needs to gain 2 electrons.

The non-metal, carbon atoms lose 4 electrons and oxygen atoms gain 2 electrons so that both elements end up with full stable valence shells of electrons. There is a transfer of electrons.

An ionic bond is formed with 1:2 ratio of carbon to oxygen ions. An ionic compound is formed, CO2 which has no overall charge.

**Question 2** Heating sodium bicarbonate (aka sodium hydrogen carbonate) powder.

**Observations:** *When a white powder is heated in a Bunsen flame the powder appears to “boil” and a colourless liquid condenses at the top of the test-tube. A white solid remains at the bottom of the test-tube.*

1. (i) Write a word equation for this reaction

sodium bicarbonate 🡪 sodium oxide + carbon dioxide + water

(ii) Write a balanced chemical equation for this reaction, **including physical states.**

2NaHCO3(s) 🡪 Na2O(s) + CO2(g) + H2O(l)

1. Describe all observations and link them to the chemical species responsible

When white solid/powder sodium bicarbonate is heated, it gives off colourless carbon dioxide gas **and** water vapour which condenses at the top of the test-tube to form a colourless liquid and a white solid remains.

1. (i) Name the type of chemical reaction \_\_\_Decomposition\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(ii) Justify your choice of reaction type by linking the observed changes to the “definition” of the

 type of reaction.

This is a **decomposition** reaction because a single (solid sodium bicarbonate) reactant forms three separate products (solid sodium carbonate + carbon dioxide gas and liquid water) when heated.

1. Explain how you would identify the non-solid products produced in this reaction.

The carbon dioxide gas produced, if bubbled into limewater will turn colourless limewater a cloudy/milky colour.

**Question 3** Adding calcium chloride solution to iron (III) sulfate solution.

**Observations:** *When a colourless solution is added to a pale orange solution, a white solid forms in a pale orange solution.*

1. (i) Write a word equation for this reaction

calcium chloride + iron(III)sulfate 🡪 iron(III)chloride + calcium sulfate

(ii) Write a balanced chemical equation for this reaction, including **physical states**.

CaCl2 (aq) + FeSO4(aq) 🡪 FeCl2(aq) + CaSO4(s)

1. Describe all observations and link them to the chemical species responsible

When a colourless solution of calcium chloride and pale orange solution of iron(III)sulfate are added together, a white solid/precipitate of iron(III) chloride is produced, which sinks to the bottom of a pale orange solution of calcium sulfate.

1. (i) Name the type of chemical reaction \_\_\_Precipitation\_\_\_\_\_\_\_\_\_\_\_

(ii) Justify your choice of reaction type by linking the observed changes to the “definition” of the

 type of reaction.

This is an **precipitation** reaction because two solutions (calcium chloride and iron(III) sulfate) combine together to produce a solid/precipitate (calcium sulfate) and a solution (iron(III) chloride).

1. Use the solubility table on the datasheet to explain why this reaction happens.

According to the solubility rules, “Chlorides are all **soluble** except silver chloride, lead chloride”, so calcium chloride is a soluble solution.

and according to the solubility rules, “Sulfates are all **soluble** except barium sulfate, lead sulfate, calcium sulfate”, so iron(III)sulfate is a soluble solution.

After they are mixed two new products are possible: calcium sulfate and iron(III)chloride.

Iron(III)chloride remains in solution because the attractive forces between the water molecules and the Fe3+ and Cl- ions are stronger than the attractions between the oppositely charged ions (Fe3+ and Cl- ions).

Calcium sulfate is insoluble because the attractive forces between the water molecules and the Ca2+ and SO42- ions are weaker than the attractions between the oppositely charged ions (Ca2+ and SO42- ions).

1. (i) Identify any “spectator ions” and explain briefly why they do not need to be included in the nett ionic equation.

The spectator ions are Fe3+ and Cl- ions because they do not form the precipitate.

(ii) Write a balanced ionic equation

Ca2+(aq) + SO42-(aq) 🡪 CaSO4 (s)

**Question 4** Reaction of lead metal with copper nitrate solution

**Observations:** *When a dark grey coloured metal is placed into a pale blue solution, the colour of the solution slowly changes to colourless and a reddisb brown solid forms a coating on the dark grey metal which becomes thinner.*

1. (i) Write a word equation for this reaction

lead + copper nitrate 🡪 copper + lead nitrate

(ii) Write a balanced chemical equation for this reaction, **including physical states.**

Pb(s) + Cu(NO3)2(aq) 🡪 Cu(s) + Pb(NO3)2(aq)

1. Describe all observations and link them to the chemical species responsible

When a dark grey coloured metal/solid lead is placed into a pale blue coloured solution of copper nitrate, a reddish brown solid of copper forms on the surface and the solution turns colourless because of the Pb2+/Pb(NO3)2.

1. (i) Name the type of chemical reaction \_\_\_\_Precipitation\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

(ii) Justify your choice of reaction type by linking the observed changes to the “definition” of the type of reaction.

This is a **displacement** reactionbecause a more reactive metal (lead) takes the place of a less reactive metal (copper ions) in a compound.

1. Use the activity series on the data sheet to explain why this reaction occurs by comparing the relative reactivity of the chemical species.

Lead is a more reactive metal than copper and so lead will have preference for ending up in its stable ionic/compound form.

1. (i) Identify any spectator ions in this reaction.

NO3- ions are spectator ions because they are not involved in the reaction/neither lose or gain electrons

(ii) Write a balanced ionic equation that does not include spectator ions.

Pb2+ (s) + Cu(aq) 🡪 Cu2+ (s) + Pb(aq)