**G10 IB Bridging Year Chemistry** Score: \_\_\_\_\_\_\_/36

**Topic 5 Stoichiometric relationships**

Reacting masses, percentage yield and limiting reagents

1. Paracetamol (acetaminophen) can be synthesised from 4-aminophenol.

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In one experiment 7.559g of paracetamol were obtained from 10.913 g of 4-aminophenol. What was the percentage yield?

1. 69.3%
2. 50.0%
3. 51.7%
4. 72.2%
5. When calcium carbonate is heated it decomposes according to the equation:

CaCO3 (s) → CaO (s) + CO2 (g)

When 60 g of calcium carbonate is heated, 16.8 g of calcium oxide are formed. What is

the percentage yield?

1. 16.8%
2. 25%
3. 50%
4. 60%
5. What is the maximum amount of methanol, in mol, that could be formed when 4 mol of carbon dioxide and 6 mol of hydrogen gas are placed in a container and react according to the equation below?

CO2 (g) + 3H2 (g) → CH3OH (l) + H2O (l)

A. 1

B. 2

C. 3

D. 4

1. 32 g of a metal, M, reacts with 8 g of oxygen to form an oxide. The formula of the oxide is MO. What is the atomic mass of M in g mol-1?

A. 16

B. 32

C. 64

D. 128

1. The reaction below represents the reduction of iron ore to produce iron.

2Fe2O3 + 3C 🡪 4Fe + 3CO2

A mixture of 30.0 kg of Fe2O3 and 5.0 kg of C was heated until no further reaction occurred.

Calculate the maximum mass of iron that can be obtained from these masses of reactants.

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(Total 5 marks)

**6.** An oxide of copper was reduced in a stream of hydrogen as shown below.



After heating, the stream of hydrogen gas was maintained until the apparatus had cooled.

The following results were obtained.

Mass of empty dish = 13.80 g   
Mass of dish and contents before heating = 21.75 g   
Mass of dish and contents after heating and leaving to cool = 20.15 g

(a) Explain why the stream of hydrogen gas was maintained until the apparatus cooled.

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(1)

(b) Calculate the empirical formula of the oxide of copper using the data above, assuming complete reduction of the oxide.

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(3)

(c) Write an equation for the reaction that occurred.

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(1)

(d) State **two** changes that would be observed inside the tube as it was heated.

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(2)

(Total 7 marks)

**7.** When lead (II) nitrate reacts with sodium iodide, sodium nitrate and lead (II) iodide are formed.

1. Balance the following equation: **(1)**

Pb(NO3)2 (aq) + NaI (aq) 🡪 PbI2 (s) + NaNO3 (aq)

1. 25.0 g of lead (II) nitrate and 15.0 g of sodium iodide are used in the reaction. Determine the mass of sodium nitrate formed.

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1. Calculate the mass of excess reactants remaining.

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1. 6.0 g of sodium nitrate are actually obtained in the reaction. Calculate the percent yield of this reaction.

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(Total 11 marks)

**8.** 0.502 g of an alkali metal sulfate is dissolved in water and excess barium chloride solution, BaCl2 (aq) is added to precipitate all the sulfate ions as barium sulfate, BaSO4 (s). The precipitate is filtered and dried and weighs 0.672 g.

(a) Calculate the amount (in mol) of barium sulfate formed.

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(2)

(b) Determine the amount (in mol) of the alkali metal sulfate present.

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(1)

(c) Determine the molar mass of the alkali metal sulfate and state its units.

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(2)

(d) Deduce the identity of the alkali metal, showing your workings.

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(2)

(e) Write an equation for the precipitation reaction, including state symbols.

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(2)

(Total 9 marks)

Marking Scheme

**1. B 2. C 3. B 4. C**

**5.** n(Fe2O3) = 30×103÷159.7/n(Fe2O3) = 188 mol;

n(C) = 5.0×103÷12.01/n(C) = 416 mol;

Fe2O3 is the limiting reagent or implicit in calculation;

n(Fe) = 2×n(Fe2O3) = 2×188 = 376 mol;

m(Fe) = 376×55.85 = 21 kg;

Accept 2 sig. fig. or 3 sig. fig., otherwise use - 1(SF).

Correct final answers score **[5]**.

Allow ECF.

[5]

**6.** (a) to prevent (re)oxidation of the copper/*OWTTE*; 1

(b) number of moles of oxygen =  = 0.10;  
number of moles of copper =  = 0.10;  
empirical formula = Cu (0.10) : O (0.10) = CuO; 3

Allow ECF.

Award **[1]** for CuO with no working.

Alternate solution

 = 79.8%  = 20.2%

 = 1.25  = 1.29

(c) H2 + CuO → Cu + H2O; 1

Allow ECF.

(d) (black copper oxide) solid turns red/brown;   
condensation/water vapour (on sides of test tube); 2

Accept change colour.   
Do **not** accept reduction of sample size.

[7]

**7.** (a) n(Cu2O) = 10.0×103÷143.1 = 69.9 mol;

n(Cu2S) = 5.00×103÷159.16 = 31.4 mol;

Penalise failure to convert kg to g once only.

Cu2S is the limiting reagent; 3

ECF from above answers.

(b) n(Cu) = 6×n(Cu2S) = 6×31.4 = 188 mol;

m(Cu) = 188×63.55 = 11900 - 12000 g/11.9 - 12.0 kg; 2

If Cu2O given in (a), allow 3×n(Cu2O) and 3×n(Cu2O)×63.55.

Allow ECF from (a).

[5]

**8.** (a) *M*(BaSO4) (= 137.34 + 32.06 + 4(16.00)) = 233.40 (g mol-1);

Accept 233.4 but not 233

n(BaSO4)  = 0.00288 / 2.88×10-3(mol); 2

ECF from M value

(b) n (alkali metal sulfate) = 0.00288 / 2.88×10-3(mol); 1

ECF

(c)  174.31 / 174.3 / 174;

ECF

units: g mol-1; 2

(d) (2(*A*r) + 32 + 4(16) = 174, thus) *A*r = 39 / *A*r =  =39;

Accept answer between 38.9 and 39.2

ECF

potassium/K;

ECF from Ar value 2

(e) K2SO4(aq) + BaCl2(aq) 🡪 BaSO4(s) + 2KCl(aq) 2

Award **[1]** for balanced equation and **[1]** for state symbols

ECF if another alkali metal arrived at in (d)

Accept net ionic equation

If no answer arrived at in (d), but correct equation given involving any alkali metal, then award **[1 max]** [9]