

Section A (50 M)

A1a)

| trend | Only true down a group | Only true across a period | True for both |
|--|------------------------|---------------------------|---------------|
| The number of electron shell increases | ✓ | | |
| The number of valence electrons increases | | ✓ | |
| Proton number increases | | | ✓ |
| There is a change in character from metallic to non-metallic | | ✓ | |

All correct 2m
2-3 correct 1m
0-1 correct 0m

- b) i) Melting point decreases down Group I
Melting point increases down Group VII Both required for 1m
- ii) Reactivity increases down Group I
Reactivity decreases down Group VII Both required for 1m

- c) Catalysts are not consumed after the reaction so they can always be reused after buying them without incurring any additional cost. 1
- Catalysts speeds up the rate of reaction of industrial processes, which means that less cost is incurred since processes run for a shorter period of time, hence saving cost. 1

- A2a) Extraction involves reduction as the oxidation state of iron decreases from +3 in Fe₂O₃ to 0 in Fe. 1
- Rusting involves oxidation as the oxidation state of iron increases from 0 in Fe to +3 in Fe₂O₃ 1

- b) i) An alloy is a mixture of a metal and one or more other elements. 1
- ii) The oil, paint and plastic coating forms a protective layer around the iron and prevents exposure to oxygen and water, slowing down rusting. 1
- iii) Zinc is more reactive than iron and hence acts as a sacrificial metal and reacts with surrounding oxygen and water in place of iron. 1

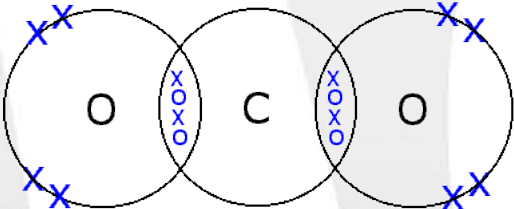
- A3a) There a small difference between the predicted earth's temperature of -18°C and actual temperature of 15°C due to the presence of 0.04% of carbon dioxide which is a greenhouse gas that traps heat and causes the temperature to increase. 1

In Venus, the temperature difference between the predicted temperature of -41°C and actual temperature of 462°C is much greater due to the presence of 97% carbon dioxide in Venus's atmosphere. 1

In Mercury, the predicted temperature of 163°C is very close to the actual temperature of 167°C as there no carbon dioxide in the atmosphere to trap heat. 1m if no mention of values from the table.

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Suggested Answers for 2016 O Level Pure Chemistry Paper 2

- b) i) Volcanic eruptions 1
 ii) The pH of the water will be lower than 7 1
 iii) The surface temperature of 462°C is much higher than the boiling point of water which is 100°C, hence water boils into gaseous steam even before reaching the surface of venus. 1
 No marks if surface temperature is not stated
- c) i) Plants undergo photosynthesis and in the process take in carbon dioxide and give out oxygen. 1
 This will cause the percentage of carbon dioxide to decrease and the percentage of oxygen in the atmosphere to increase. 1
 ii) Rapid deforestation is decreasing the amount of carbon dioxide being converted into oxygen. 1
 OR
 Increase in burning of fossil fuels is producing more carbon dioxide into the atmosphere than the plants can remove. 1
 iii)  1
 1m for number of shared electrons
 1m for number of un-bonded electrons
 1m for correct ratio of carbon to oxygen and covalent diagram

A4a)

| Name of salt | Formula of salt | Name of acid used to make salt | Name of other compound used to make salt |
|---------------------|---|--------------------------------|--|
| Potassium sulfate | K ₂ SO ₄ | Sulfuric acid | Potassium hydroxide |
| Potassium phosphate | K ₃ PO ₄ | Phosphoric acid | Potassium hydroxide |
| Ammonium nitrate | NH ₄ NO ₃ | Nitric acid | Aqueous ammonia |
| Calcium phosphate | Ca ₃ (PO ₄) ₂ | Phosphoric acid | Calcium hydroxide |

1m for each row correct

- b) Ammonium nitrate and potassium phosphate 1m for both correct
- c) i) Calcium phosphate 1
 It contains phosphorus and does not contain nitrogen and potassium. 1

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ii)

| | K | P | O | |
|-----------------|---------------------------------------|-------------------------------------|-------------------------------------|---|
| Mol ratio | 3 | 1 | 4 | |
| Mr | 39 | 31 | 16 | |
| Mass | 3x39=117 | 31 | 4 x 16 = 64 | 1 |
| Mass percentage | 117 | 31 | 64 | |
| | $\frac{117}{117 + 31 + 64}$ = 55 % | $\frac{31}{117 + 31 + 64}$ = 15% | $\frac{64}{117 + 31 + 64}$ = 30% | 1 |

N : P : K = 0 : 55 : 15

- A5a)** Silver chloride, barium sulfate and lead sulfate 2
 Precipitation reactions are used to produce insoluble salts and these 1
 three salts are insoluble

b)

| compounds | Use | | | | | |
|-------------------|--------------------|--------------------------------|------------------------------|----------------------|-------------------|---|
| | To make detergents | To make polymers for packaging | For flue gas desulfurisation | As a solvent in inks | For road surfaces | |
| Bitumen | | | | | ✓ | 3 |
| Sulfuric acid | ✓ | | | | | |
| Ethene | | ✓ | | | | |
| Ethyl ethanoate | | | | ✓ | | |
| Calcium carbonate | | | ✓ | | | |

- A6a)** Chemical formula for each subsequent member from HCHO to CH₃CHO and C₂H₅CHO differs by a CH₂ unit. Any 2
 They each have the same functional group of -CHO.
 Their physical properties differ gradually from one member to the next

- b) C₃H₇CHO 1
 76°C OR 77°C 1

- c) i) Isomers are organic compounds with the same chemical formula but different structural formula. 1
 Ethanol and methoxymethane are isomers as they have the same chemical formula of C₂H₅O but different structural formulas 1
 Ethanal is not an isomer of ethanol and methoxymethane because it has a different chemical formula of C₂H₄O 1

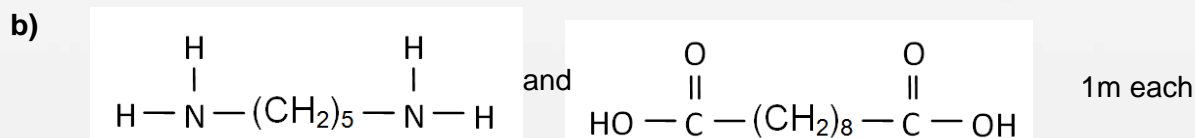
- ii) $2 \text{C}_2\text{H}_4\text{O} + 3 \text{O}_2 \rightarrow 4 \text{CO}_2 + 4 \text{H}_2\text{O}$ 1m for correct compounds
 1m for balancing
 0m if ethanal is written as C₂H₄O

- iii) $2 \text{CH}_3\text{CHO} + \text{O}_2 \rightarrow 2 \text{CH}_3\text{COOH}$

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Section B (30M)

- B7a)** Nylon X : Nylon 4,6 2
 Nylon Y : Nylon 11 1



- c)** Mr of one repeat unit = $12(12) + 2(14) + 2(16) + 22(1) = 226$ 1
 Minimum no. of repeat units = $10000/226 = 44.25 \approx 45$ 1

- d)** The shorter the chain length of the diamine, the higher the melting point 1
 Nylon 4,6 has a shorter diamine chain length compared to nylon 6,6 and has a higher melting point 1
 The longer the chain of the dicarboxylic acid, the lower the melting point 1
 Nylon 6,12 has a longer dicarboxylic acid chain length compared to nylon 6,10 and nylon 6,6 and the melting point decreased from nylon 6,6 to nylon 6,12. 1

- e)** No of mol of 1kg of nylon 6 repeat unit. = $\frac{1000}{6(12)+14+16+11(1)} = 8.85 \text{ mol}$ 1
 No of mol of $\text{CO}_2 = 8.85 \times 6 = 53.1 \text{ mol}$
 Mass of $\text{CO}_2 = 53.1 \times (12 + 2(16)) = 2336.4 \text{ g} \approx 2340 \text{ g (3sf)}$ 1

- B8a)** $\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3$ 1
 According to the equation, 1 mol of nitrogen gas reacts with 3 mols of hydrogen gas to form ammonia, since molar volume of gases are constant at a fixed temperature and pressure, the mol ratio corresponds to the volume ratio. 1

- b)**
- i) A lower pressure results in lesser reacting particles per unit volume, 1
 Decreasing the rate of effective collisions and hence resulting in a decrease in the rate of reaction. 1
 - ii) According to the graph, as the pressure decreases, a lower percentage yield of ammonia is obtained. 1
 This would result in an increase in the amount of hydrogen and nitrogen and a decrease in the amount of ammonia that leaves the main reactor. 1
 - iii) A lower pressure has no effect on the final amount of ammonia produced, 1
 because un-reacted nitrogen and hydrogen are recycled back into the reactor until almost all of the hydrogen and nitrogen are reacted. 1

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Suggested Answers for 2016 O Level Pure Chemistry Paper 2

Either
B9a)

| solution | Name of products of electrolysis | | Ionic equation for reaction at each electrode |
|--|----------------------------------|--------------------|--|
| | Negative electrode | Positive electrode | |
| Concentrated aqueous copper(II) chloride | Negative electrode | Copper metal | $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$ |
| | Positive electrode | Chlorine gas | $2\text{Cl}^{-}(\text{aq}) \rightarrow \text{Cl}_2(\text{g}) + 2\text{e}^{-}$ |
| Dilute aqueous copper(II) sulfate | Negative electrode | Copper metal | $\text{Cu}^{2+}(\text{aq}) + 2\text{e}^{-} \rightarrow \text{Cu}(\text{s})$ |
| | Positive electrode | Oxygen and water | $4\text{OH}^{-}(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g}) + 4\text{e}^{-}$ |

1m for each row

b) A and D Both needed for 1m

c) A: both solutions turn from blue to colourless and a pinkish brown deposit is seen. 2

B: a white precipitate is formed in copper(II) chloride but no observable change is seen in copper(II) sulfate 1

C: no observable change is seen in copper(II) chloride but a white precipitate is seen in copper(II) sulfate 1

D: a light blue precipitate is formed in both solutions that does not dissolve in excess sodium hydroxide. 1

Or
B9a) i) Blue solution turns green and a pinkish brown deposit is seen. 1

ii) Copper from mining waste can be extracted and sold for money instead of being wasted when thrown away. 1

The scrap iron is used to extract copper instead of being thrown away at landfills and causing land pollution. 1

b) $\text{Cl}_2(\text{g}) + 2\text{Br}^{-}(\text{aq}) \rightarrow 2\text{Cl}^{-}(\text{aq}) + \text{Br}_2(\text{aq})$ 1m for balance eq
1m for state symbols

c) Similarities:
both reactions involve using a more reactive element to displace the less reactive element in the compound. 1

Both reactions will result in changes in color to the reaction mixture 1

Difference:
when copper is extracted, it is reduced from Cu^{2+} to Cu while bromine is oxidised from Br^{-} to Br_2 1

A solid is formed in the displacement reaction involving copper but no solid is formed in that of bromine. 1