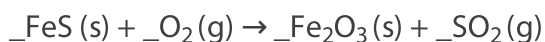


How much [39 marks]

1. [Maximum mark: 1]

What is the sum of the coefficients for the balanced equation of the combustion of iron(II) sulphide using the smallest whole numbers?



A. 6

B. 7

C. 14

D. 17

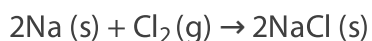
[1]

2. [Maximum mark: 1]

What is the yield of sodium chloride, in grams, when 2.30 g of sodium reacts with 11.4 dm³ of chlorine gas at STP?

$$M_r \text{NaCl} = 58.4$$

$$\text{Molar volume of gas} = 22.7 \text{ dm}^3 \text{ mol}^{-1}$$



A. 2.92

B. 5.84

C. 29.2

D. 58.4

[1]

3. [Maximum mark: 11]

Aluminium is useful as a metal, in alloys, and in ceramic compounds.

- (a.i) Using graphite electrodes, aluminium is extracted by the electrolysis of a molten mixture containing alumina, Al_2O_3 .

Explain why adding cryolite to the molten electrolyte improves the process.

[2]

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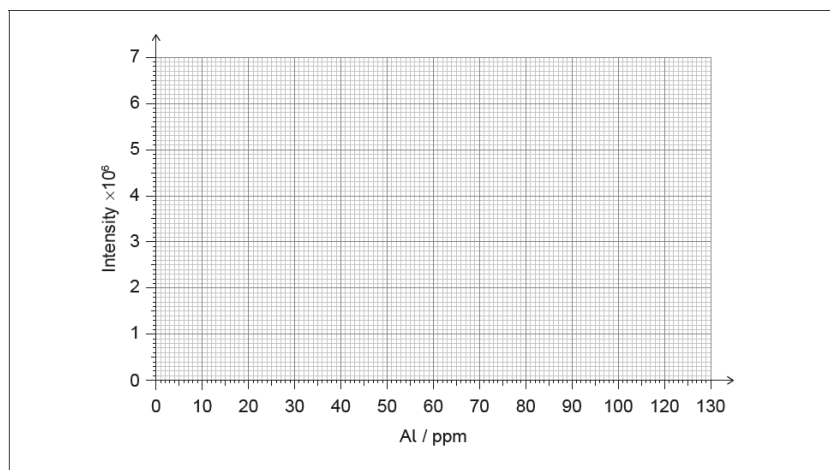
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- (a.ii) Aluminium oxide is a hard ceramic. Outline the bonding and electrical conductivity of this ceramic. Use sections 9 and 17 of the data booklet.

Bonding:	
	
	
	
Electrical conductivity:	

[3]

- (b) Inductively Coupled Plasma Optical Emission Spectroscopy (ICP-OES) is used for quantifying trace amounts of aluminium in samples. On the axes, draw a graph of intensity against the concentration of aluminium, given that a concentration of 40 ppm of Al has an intensity of 2×10^6 . Assume the only species yielding a signal is Al.



[1]

- (c.i) Alloys of aluminium containing nickel are used to make engine parts. Explain, by referring to the structure of these alloys, why they are less malleable than pure aluminium.

[2]

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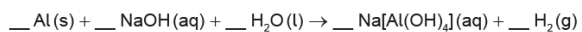
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- (c.ii) Raney nickel catalysts are produced by treating a Ni–Al alloy with sodium hydroxide to remove some of the aluminium, which creates a porous material.

Deduce the coefficients to complete the balanced equation for this process.



[1]

- (c.iii) Ni is used as a catalyst for hydrogenation reactions. Suggest why Raney nickel is particularly effective for this reaction.

[1]

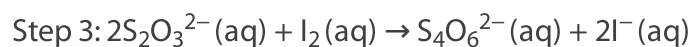
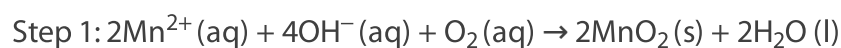
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- (c.iv) Suggest how the catalytic activity of Ni could have been discovered before the way it works was understood.

[1]

4. [Maximum mark: 3]

The Winkler Method is used to find the concentration of oxygen in water.

200 cm³ of water was taken from a river and analysed using this method. The reactions taking place are summarized.



- (a) Identify, with a reason, the species which is reduced in step 1.

[1]

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- (b) 4.8×10^{-3} moles of I^{-} were formed in step 3. Determine the number of moles of O_2 in the water sample.

[1]

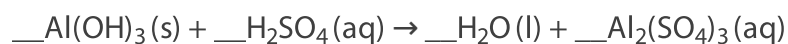
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- (c) Calculate the concentration of oxygen, in g dm^{-3} , in the water sample. If you did not obtain an answer in (b), use 2.0×10^{-3} mol although this is not the correct answer.

[1]

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5. [Maximum mark: 1]

What is the sum of the coefficients when the equation is balanced with the smallest whole numbers?

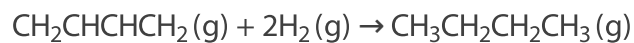


- A. 8
B. 9
C. 11
D. 12

[1]

6. [Maximum mark: 1]

Which species are present after 15 dm^3 of buta-1,3-diene has reacted with 18 dm^3 of hydrogen to produce butane?

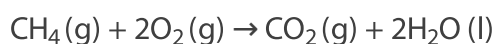


- A. 9 dm³ of butane and 6 dm³ of hydrogen
- B. 9 dm³ of butane and 6 dm³ of buta-1,3-diene
- C. 15 dm³ of butane and 3 dm³ of hydrogen
- D. 18 dm³ of butane and 3 dm³ of buta-1,3-diene

[1]

7. [Maximum mark: 1]

64 g of methane and 96 g of oxygen are reacted according to the equation.



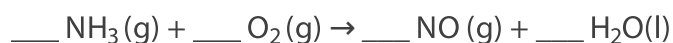
What would be found in the reaction vessel at completion of the reaction?

- A. CO₂(g) and H₂O(l) only
- B. O₂(g), CO₂(g) and H₂O(l) only
- C. CH₄(g), CO₂(g) and H₂O(l) only
- D. CH₄(g), O₂(g), CO₂(g) and H₂O(l)

[1]

8. [Maximum mark: 1]

Ammonia reacts with oxygen to produce nitrogen (II) oxide and water.



What is the NH₃:O₂ ratio in the balanced equation?

- A. 2:5

B. 4:5

C. 1:1

[1]

D. 2:1

9. [Maximum mark: 9]

Methanoic acid can be converted into methyl methanoate, HCOOCH_3 .

(a) State the name of the reagent and catalyst required.

Reagent:.....
.....

Catalyst:.....
.....

[2]

(a) 1.72 g of methyl methanoate is produced from 2.83 g of methanoic acid and excess of the other reagent. Determine the percentage yield.

[2]

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(c) The conversion of methanoic acid to methyl methanoate can be followed by changes in spectra.

(c.i) State **one** similarity and **one** difference you would expect in the infrared (IR) spectra of methanoic acid and methyl methanoate in the region of $1500\text{--}3500\text{ cm}^{-1}$. Use section 26 of the data booklet.

Similarity:.....
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Difference:.....
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[2]

- (b) State the class of compounds to which methyl methanoate belongs.

[1]

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- (c) Draw the full structural formula of the carboxylic acid isomer of methyl methanoate.

[1]

- (f) State the name of a compound that produces the isomer in (e) when refluxed with acidified potassium dichromate (VI).

[1]

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10. [Maximum mark: 1]

How many moles of carbon dioxide are produced by the complete combustion of 7.0 g of ethene, C_2H_4 (g)?

$$M_r = 28$$

A. 0.25

B. 0.5

C. 0.75

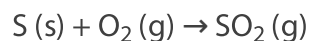
D. 1.0

[1]

11. [Maximum mark: 7]

Lignite, a type of coal, contains about 0.40 % sulfur by mass.

- (a) Calculate the amount, in mol, of sulfur dioxide produced when 500.0 g of lignite undergoes combustion.



[2]

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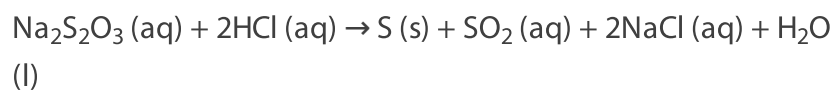
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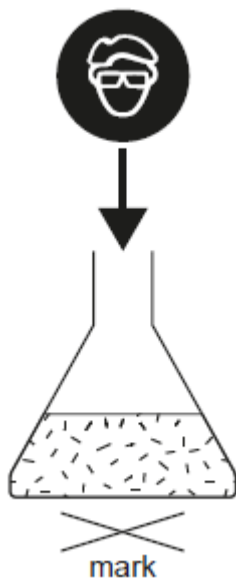
- (b) Write an equation that shows how sulfur dioxide can produce acid rain.

[1]

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(c) Sodium thiosulfate reacts with hydrochloric acid as shown:



The precipitate of sulfur makes the mixture cloudy, so a mark underneath the reaction mixture becomes invisible with time.



Suggest **two** variables, other than concentration, that should be controlled when comparing relative rates at different temperatures.

[2]

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(d) Discuss **two** different ways to reduce the environmental impact of energy production from coal. [2]

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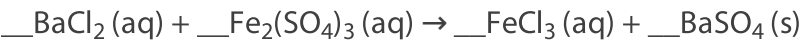
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12. [Maximum mark: 1]
What is the sum of the coefficients when the equation is balanced with the smallest whole numbers?

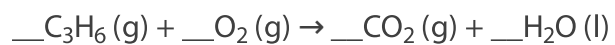


- A. 4
- B. 6
- C. 8
- D. 9

[1]

13. [Maximum mark: 1]

What is the sum of the integer coefficients when propene undergoes complete combustion?



A. 11

B. 17

C. 21

D. 23

[1]