

A

Rational Approach

To

Learning O-Level Chemistry Principles

With

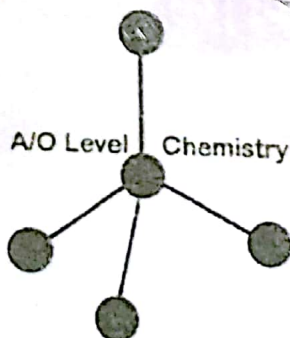
Rasheed Ahmed

03334277385

A/O Level Chemistry

RASHEED AHMED

A/O Level Chemistry



0333-4277385

Topic:

Class 10 - C

Category:

WorkSheets

Acids, Bases & Salts – MCQs

Substance X dissolves in water to form a colourless solution. This solution reacts with aqueous lead(II) nitrate in the presence of dilute nitric acid to give a yellow precipitate.

What is substance X?

- A calcium iodide
- B copper(II) chloride
- C iron(II) iodide
- D sodium chloride

A student mixed together aqueous solutions of Y and Z. A white precipitate formed.

Which could not be solutions Y and Z?

	solution Y	solution Z
A	hydrochloric acid	silver nitrate
B	hydrochloric acid	sodium nitrate
C	sodium chloride	lead(II) nitrate
D	sodium chloride	silver nitrate

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3. The tests below were carried out on a solution containing ions of the metal X.

test	observation
add sodium chloride solution	no change
add sodium sulfate solution	no change
add sodium hydroxide solution	a precipitate was formed, soluble in excess of the hydroxide

What is metal X?

- A calcium
- B iron
- C lead
- D zinc

4. Which is an anion that is present in the solution formed when an excess of dilute hydrochloric acid is added to calcium carbonate?

- A Ca^{2+} B Cl^- C CO_3^{2-} D H^+

5. Which pair of compounds could be used in the preparation of calcium sulfate?

- A calcium carbonate and sodium sulfate
B calcium chloride and ammonium sulfate
C calcium hydroxide and barium sulfate
D calcium nitrate and lead(II) sulfate

6. A metal reacts with dilute hydrochloric acid to produce a gas.

What is used to identify this gas?

- A a glowing splint
B a lighted splint
C damp blue litmus paper
D limewater

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7. Titration of an acid against a base is a method often used in the preparation of salts.

Which properties of the acid, the base and the salt are required if this method is to be used?

	acid	base	salt
A	insoluble	insoluble	insoluble
B	soluble	insoluble	insoluble
C	soluble	soluble	insoluble
D	soluble	soluble	soluble

8. Which reagent could be used to distinguish between dilute nitric acid and dilute hydrochloric acid?

- A aqueous barium chloride
B aqueous silver nitrate
C aqueous sodium hydroxide
D copper(II) carbonate

9. Which mixture would react with dilute sulfuric acid to form two **different** gases?

- A copper and magnesium carbonate
- B copper(II) carbonate and magnesium
- C copper(II) carbonate and magnesium oxide
- D copper(II) oxide and magnesium

10. Which salts are soluble in water?

- 1 ammonium carbonate, $(\text{NH}_4)_2\text{CO}_3$
- 2 calcium carbonate, CaCO_3
- 3 lead(II) carbonate, PbCO_3
- 4 sodium carbonate, Na_2CO_3

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- A 1 only B 1 and 2 C 1 and 4 D 2 and 3

11. Which compound in a 1 mol/dm^3 solution has the lowest pH value?

- A ethanoic acid
- B hydrogen chloride
- C sodium chloride
- D sodium hydroxide

12. In which reaction do the products formed **not** include a salt?

- A calcium(II) carbonate with hydrochloric acid
- B copper(II) oxide with hydrogen
- C copper(II) oxide with sulfuric acid
- D copper(II) sulfate with sodium hydroxide

13. Which type of compound will liberate ammonia when heated with ammonium sulfate?

- A an acid
- B an alkali
- C a reducing agent
- D a salt

14. A coin is analysed by dissolving it in nitric acid. To the resulting solution an excess of aqueous ammonia is added and the mixture is filtered.

A brown precipitate remains in the filter paper and a deep blue solution is obtained as the filtrate.

Which metals does the coin contain?

- A aluminium and copper
 - B copper and iron
 - C iron and lead
 - D lead and zinc
15. Which metal has a soluble carbonate, chloride and sulfate?

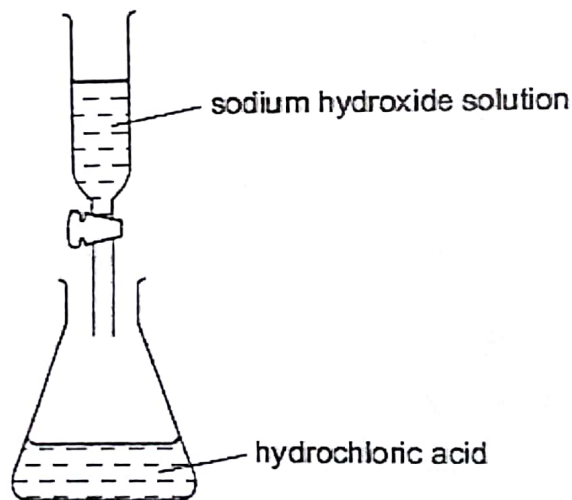
- A barium
- B calcium
- C copper
- D potassium

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16. Sodium hydroxide solution was added to dilute hydrochloric acid. The pH of the solution in the flask was measured at intervals until no further change of pH took place.



What would be the pH change in this reaction?

- A decrease to 1
- B decrease to 7
- C increase to 7
- D increase to 12

17. Solid Y is insoluble in water. It gives off a gas when heated and also when reacted with dilute sulfuric acid.

What is Y?

- A copper(II) carbonate
- B sodium carbonate
- C sodium nitrate
- D zinc oxide

18. Which gas reacts with sulfuric acid to form a fertiliser?

- A ammonia, NH_3
- B carbon dioxide, CO_2
- C hydrogen, H_2
- D nitrogen, N_2

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19. Carbon dioxide and carbon monoxide are both

- A absorbed by sodium hydroxide.
- B colourless.
- C inflammable in air.
- D lighter than air.

20. Solution X contains a simple salt.

The table shows the results of some tests on solution X.

test	observation
addition of aqueous sodium hydroxide	green precipitate forms
addition of acidified barium nitrate	white precipitate forms

What is the name of the salt in solution X?

- A iron(II) chloride
- B iron(III) chloride
- C iron(II) sulphate
- D iron(III) sulphate

21. Which element will burn in oxygen to form an acidic oxide?

- A calcium
- B carbon
- C iron
- D magnesium

22. Different solids were added to separate portions of warm dilute sulphuric acid.

For which solid is the observation correct?

	solid	observation
A	ammonium sulphate	alkaline gas produced
B	copper	gas evolved ignited with a pop
C	magnesium oxide	solid dissolved with no effervescence
D	zinc carbonate	gas evolved relights glowing splint

23. One mole of compound X gives three moles of ions in aqueous solution. X reacts with ammonium carbonate to give an acidic gas.

What is compound X?

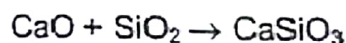
- A calcium hydroxide
- B ethanoic acid
- C sodium hydroxide
- D sulphuric acid

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24. What is the function of silica, SiO_2 , in the equation shown below?



- A a basic oxide
- B a reducing agent
- C an acidic oxide
- D an oxidising agent

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25. A student tested a solution by adding aqueous sodium hydroxide. A precipitate was not seen because the reagent was added too quickly.

What could not have been present in the solution?

- A Al^{3+} B Ca^{2+} C NH_4^+ D Zn^{2+}

26. Which equation describes the most suitable reaction for making lead sulphate?

- A $Pb + H_2SO_4 \rightarrow PbSO_4 + H_2$
 B $PbCO_3 + H_2SO_4 \rightarrow PbSO_4 + CO_2 + H_2O$
 C $Pb(NO_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2HNO_3$
 D $Pb(OH)_2 + H_2SO_4 \rightarrow PbSO_4 + 2H_2O$

27. Which equation represents the reaction between hydrochloric acid and sodium hydroxide?

- A $Cl^- + Na^+ \rightarrow NaCl$
 B $2H^+ + O^{2-} \rightarrow H_2O$
 C $\frac{1}{2}O_2 + H_2 \rightarrow H_2O$
 D $H^+ + OH^- \rightarrow H_2O$

28. The following statements about dilute sulphuric acid are all correct.

- 1 A white precipitate is formed when aqueous barium chloride is added.
- 2 The solution turns anhydrous copper(II) sulphate from white to blue.
- 3 Addition of Universal Indicator shows that the solution has a pH value of less than 7.0.
- 4 The solution reacts with copper(II) oxide, forming a blue solution.

Which two statements confirm the acidic nature of the solution?

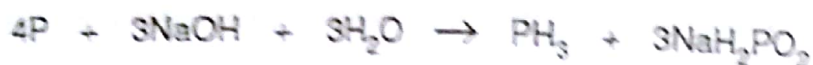
- A 1 and 2 B 1 and 3 C 2 and 4 D 3 and 4

29. Ammonia gas is produced when solid ammonium chloride is heated with

- A calcium hydroxide.
 B calcium sulphate.
 C hydrochloric acid.
 D magnesium nitrate.

Acid, Base & Salt - Theory

1. Phosphine, PH_3 , is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.



- (a) Draw a 'dot-and-cross' diagram for phosphine.

Show only the outer electrons.

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[1]

- (b) (i) Calculate the maximum mass of phosphine formed when 1.86 g of phosphorus reacts with excess aqueous sodium hydroxide.

[2]

- (ii) Calculate the volume of phosphine formed from 1.86 g of phosphorus at r.t.p.

[1]

- (c) Phosphine decomposes into its elements on warming. Write an equation for this reaction.

[2]

- (d) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I .

Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

- (i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide.

..... [1]

- (ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide?

..... [1]

- (e) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2 .

Calcium phosphide is an ionic compound.

- (i) Write the formula for the phosphide ion.

..... [1]

- (ii) Predict one physical property of calcium phosphide.

..... [1]

[Total: 10]

2. Ammonium nitrate, NH_4NO_3 , is a soluble salt.

The salt decomposes when heated gently to form steam and a colourless gas X.

- (i) Ammonium nitrate can be prepared by the reaction between aqueous ammonia and dilute nitric acid.

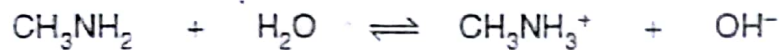
Name the experimental technique used to prepare aqueous ammonium nitrate and briefly describe how solid ammonium nitrate is obtained from the aqueous solution.

..... [2]

- (ii) Predict the formula of gas X.

..... [1]

3. Methylamine, CH_3NH_2 , is a base which has similar properties to ammonia. When methylamine dissolves in water, the following equilibrium is set up.



- (a) Explain why methylamine behaves as a base in this reaction.

.....[1]

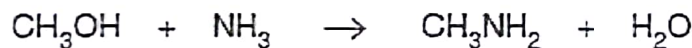
- (b) When aqueous methylamine is added to aqueous iron(III) chloride, a red-brown precipitate is observed. Suggest what you would observe when aqueous methylamine is added to aqueous iron(II) chloride.

.....[1]

- (c) Methylamine is a gas. Calculate the volume occupied by 6.2g of methylamine at room temperature and pressure.

[2]

- (d) Methylamine is made by reacting methanol with excess ammonia under pressure in the presence of a catalyst.



- (i) Define the term *catalyst*.

.....[1]

- (ii) Calculate the theoretical yield of methylamine that can be obtained from 240 kg of methanol.

[2]

[Total: 7]

4. The table shows the concentration of different ions found in a sample of aqueous industrial waste.

ion	concentration in mol/dm ³
Ca ²⁺	0.125
H ⁺	2.30
K ⁺	0.234
NO ₃ ⁻	3.68
Fe ²⁺	0.450

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Use the information in the table to answer the following questions.

(a) Write the formula of one salt that could be obtained from the sample.

..... [1]

(b) Is the sample of aqueous waste acidic, neutral or alkaline? Explain your answer.

..... [1]

(c) Calculate the mass of dissolved iron(II) ions, Fe²⁺, in 25 dm³ of the aqueous waste.

mass of iron(II) ions = g

(d) Excess aqueous sodium hydroxide is added, a small volume at a time, to a sample of the aqueous industrial waste. Describe and explain what you would observe.

.....

.....

.....

.....

.....

(e) Describe how you would confirm the presence of dissolved nitrate ions in the sample.

.....

.....

.....

.....

.....

.....

.....

..... [4]

[Total: 11]

5. Fertilisers supply the essential elements, nitrogen, phosphorus and potassium for plant growth.
A bag of fertiliser contains 500g of ammonium sulfate, $(NH_4)_2SO_4$, and 500g of potassium nitrate, KNO_3 .

(a) Calculate the percentage by mass of nitrogen in the bag of fertiliser.

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[4]

(b) Potassium sulfate is a soluble salt.

Outline the preparation of a pure, dry sample of potassium sulfate, starting from dilute sulfuric acid.

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.....

.....

..... [3]

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6. Phosphorus(V) oxide, P_2O_5 , absorbs water from the air to form meta-phosphoric acid HPO_3 .

(i) Write an equation for this reaction.

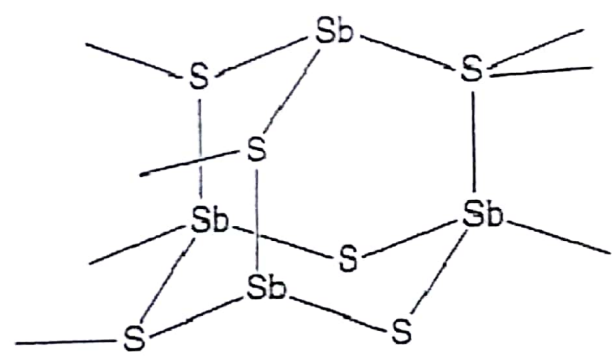
[1]

(ii) On addition of more water, phosphoric acid is formed. Phosphoric acid has typical acidic properties. What would you observe when aqueous phosphoric acid is added to

aqueous sodium carbonate,

blue litmus paper? [2]

Part of the chain structure of antimony sulphide is shown below.



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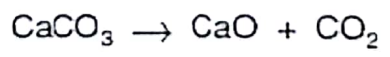
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Deduce the empirical formula of antimony sulphide.

..... [1]

7. Cement is made by heating clay with crushed calcium carbonate. During this process, the calcium carbonate is first converted to calcium oxide.



(a) (i) What name is given to this type of chemical reaction?

..... [1]

(ii) Suggest why calcium oxide is used to neutralise acidic soils.

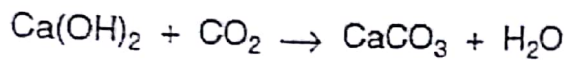
..... [1]

(b) Concrete is made from cement, sand and water. When set, concrete is slightly porous. When rain water soaks through concrete, some of the uncombined calcium oxide dissolves to form calcium hydroxide.

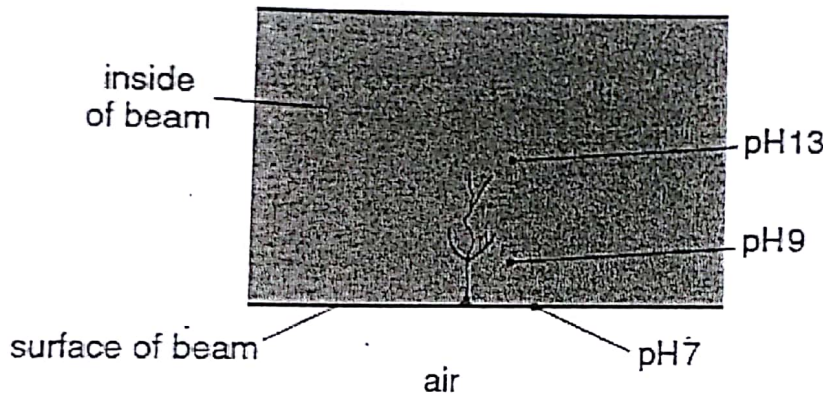
(i) Write an equation for this reaction.

[1]

(ii) The aqueous calcium hydroxide in wet concrete reacts with carbon dioxide in the air.



The diagram shows the pH at various points inside a cracked concrete beam.



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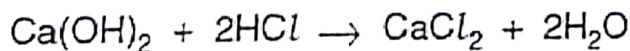
Describe and explain the change in pH from the surface to the centre of the beam.

.....

.....

.....[3]

(iii) 25.0 cm³ of an aqueous solution of calcium hydroxide is exactly neutralised by 18.0 cm³ of 0.040 mol/dm³ hydrochloric acid.



Calculate the concentration, in mol/dm³, of the aqueous calcium hydroxide.

[3]

8. (iii) Hydrochloric acid reacts with magnesium germanide, Mg_2Ge , to form germanomethane, GeH_4 , and magnesium chloride.
Write an equation for this reaction.

[1]

Germanium(IV) oxide, GeO_2 , is an amphoteric oxide.
What do you understand by the term *amphoteric*?

[1]

An aqueous solution of germanium(II) chloride reduces iron(III) ions to iron(II) ions.
Describe a test for iron(II) ions and give the result.

test

result

[2]

9. This table shows the soil pH ranges required by different crops for growth.

crop	pH range
peanut	5.0 – 6.5
millet	6.0 – 6.5
sunflower	6.0 – 7.5
paprika	7.0 – 8.5
mango	5.5 – 6.0

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- (a) A farmer plants peanut and millet crops. Only the peanut crop grows well.
Predict the pH of the soil.

..... [1]

- (b) Which other crop is most likely to grow well in the same soil?

..... [1]

(c) The farmer adds calcium hydroxide, Ca(OH)_2 , and ammonium sulphate, $(\text{NH}_4)_2\text{SO}_4$, to the soil.

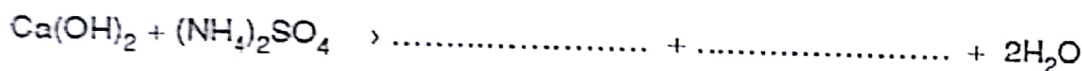
Explain the purpose of using each compound.

.....

 [3]

(d) A reaction occurs between calcium hydroxide and ammonium sulphate.

(i) Complete the equation for this reaction.



(ii) Explain why the farmer should not have added these two compounds to the soil at the same time.

..... [3]

[Total: 8 marks]

10. Brass is an alloy containing zinc and copper.

(a) Explain why the physical properties of brass are different from those of zinc and copper. [1]

(b) A sample of powdered brass is added to excess dilute nitric acid.

The mixture is heated gently until all the brass reacts.

The resulting solution, A, contains aqueous copper(II) ions and aqueous zinc ions.

(i) Suggest the colour of solution A. [1]

(ii) Describe and explain, with the aid of equations, what happens when aqueous sodium hydroxide is slowly added to solution A. [5]

(c) Another sample of powdered brass is added to excess dilute hydrochloric acid.

The mixture is heated and an aqueous solution of a compound B together with a solid C are formed.

(i) Name both B and C. [2]

(ii) Write an ionic equation for this reaction. [1]

Rasheed Ahmed (0333-4277385)

Molar Calculations (MCQs)

1. What is the concentration of iodine molecules, I_2 , in a solution containing 2.54 g of iodine in 250 cm^3 of solution?
- A 0.01 mol/dm^3
B 0.02 mol/dm^3
C 0.04 mol/dm^3
D 0.08 mol/dm^3

2. What is the mass of one mole of carbon-12?

A 0.012g B 0.024g C 1g D 12g

3. Two different hydrocarbons each contain the same percentage by mass of hydrogen.

It follows that they have the same

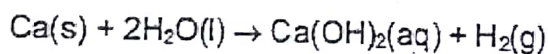
- A empirical formula.
B number of isomers.
C relative molecular mass.
D structural formula.

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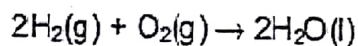
4. Calcium reacts with water as shown.



What is the total mass of the solution that remains when 40 g of calcium reacts with 100 g of water?

A 58g B 74g C 138g D 140g

5. Hydrogen reacts with oxygen as shown in the equation below.



How much gas will remain if 2 dm^3 of hydrogen are reacted with 1 dm^3 of oxygen at room temperature?

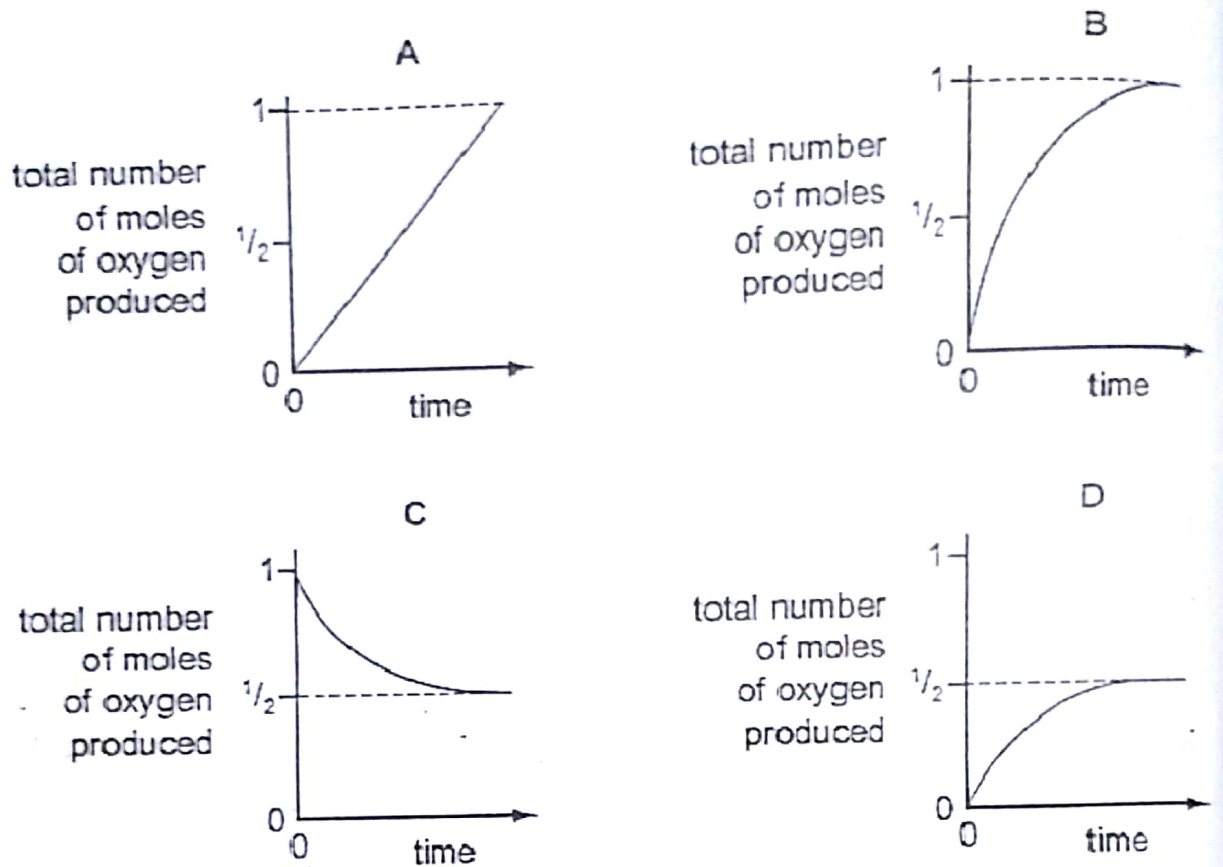
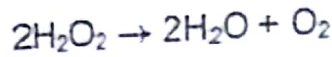
A 0 dm^3 B 1 dm^3 C 2 dm^3 D 3 dm^3

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Molar Calculations MCQs (O Level)

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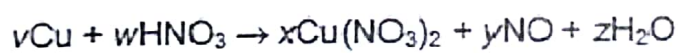
6. Which graph corresponds to the catalytic decomposition of 1 mole of hydrogen peroxide



7. What is the concentration of hydrogen ions in 0.05 mol/dm³ sulfuric acid?

- A 0.025g/dm³ B 0.05g/dm³ C 0.10g/dm³ D 2.0g/dm³

8. The equation for the reaction between copper and nitric acid is shown.



v, w, x, y and z are whole numbers.

Which values of v, w, x, y and z balance the equation?

	v	w	x	y	z
A	1	2	1	1	1
B	1	4	1	2	2
C	3	4	3	2	2
D	3	8	3	2	4

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9. Which gas contains the same number of molecules as 9 g of water?

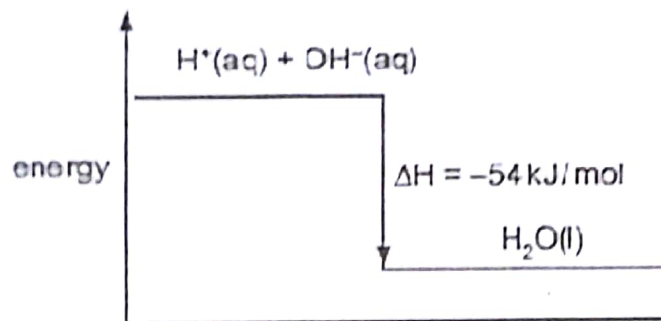
- A 2 g of hydrogen
- B 14 g of nitrogen
- C 32 g of oxygen
- D 44 g of carbon dioxide

10. The mass of one mole of a chloride formed by a metal Y is 74.5 g.

What is the formula of the chloride?

- A Y_3Cl
- B Y_2Cl
- C YCl
- D YCl_2

11. The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 hydrochloric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

- A 0.54 kJ
- B 2.70 kJ
- C 5.40 kJ
- D 10.8 kJ

12. When added to 20 cm^3 of 0.5 M sulphuric acid, which substance would give a neutral solution?

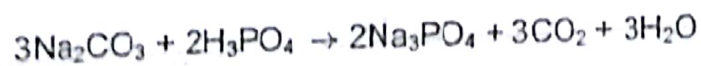
- A 20 cm^3 of 0.5 M sodium hydroxide
- B 10 cm^3 of 0.5 M sodium hydroxide
- C 40 cm^3 of 1.0 M sodium hydroxide
- D 20 cm^3 of 1.0 M sodium hydroxide

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13. Carbon dioxide can be obtained as shown in the equation.



How many moles of phosphoric acid, H_3PO_4 , are needed to produce 1.5 mol of carbon dioxide?

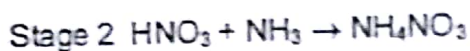
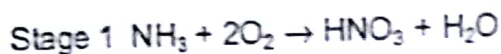
- A 0.5
- B 1.0
- C 1.5
- D 2.0

Molar Calculations MCQs (O Level)

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14. The fertiliser ammonium nitrate (NH_4NO_3 , $M_r = 80$) is manufactured from ammonia (NH_3 , $M_r = 17$) by a two-stage process.



What is the maximum mass of fertiliser that can be made if only 17 tonnes of ammonia is available?

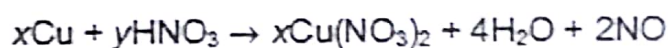
- A 34 tonnes B 40 tonnes C 80 tonnes D 97 tonnes

15. One mole of a sample of hydrated sodium sulphide contains 162 g of water of crystallisation.

What is the correct formula of this compound?

- A $\text{Na}_2\text{S} \cdot 3\text{H}_2\text{O}$ B $\text{Na}_2\text{S} \cdot 5\text{H}_2\text{O}$ C $\text{Na}_2\text{S} \cdot 7\text{H}_2\text{O}$ D $\text{Na}_2\text{S} \cdot 9\text{H}_2\text{O}$

16. The equation represents the action of dilute nitric acid on copper.



What are the values of x and y ?

- A $x = 1, y = 4$
 B $x = 1, y = 8$
 C $x = 3, y = 4$
 D $x = 3, y = 8$

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17. All ammonium salts on heating with sodium hydroxide produce ammonia gas.

From which ammonium salt can the greatest mass of ammonia be obtained?

- A 0.5 mol $(\text{NH}_4)_3\text{PO}_4$
 B 0.5 mol $(\text{NH}_4)_2\text{SO}_4$
 C 1.0 mol NH_4Cl
 D 1.0 mol NH_4NO_3

18. A 10cm^3 sample of a gaseous hydrocarbon is completely burnt in oxygen. The total volume of products is 70cm^3 .

Which equation represents the combustion of the hydrocarbon?

- A $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
 B $\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{g})$
 C $\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$
 D $2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$

19. The element X forms a gaseous molecule X_2 . One volume of X_2 combines with one volume of hydrogen to form two volumes of a gaseous hydride.

What is the formula for the hydride of X?

- A HX B HX_2 C H_2X D H_2X_2

20. Which substance has the highest percentage by mass of nitrogen?

- A NH_4NO_3 $M_r = 80$
 B $(\text{NH}_4)_2\text{SO}_4$ $M_r = 132$
 C $\text{CO}(\text{NH}_2)_2$ $M_r = 60$
 D $(\text{NH}_4)_3\text{PO}_4$ $M_r = 149$

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21. In an experiment 264g of strontium reacts with 213 g of chlorine.

What is the formula of strontium chloride?

- A SrCl B SrCl_2 C SrCl_3 D Sr_2Cl

22. 2 dm^3 of aqueous sodium hydroxide of concentration 5 mol/dm^3 were required for an experiment.

How many moles of sodium hydroxide were needed to make up this solution?

- A 2.5 B 5 C 7 D 10

23. An 8 g sample of oxygen atoms contains the same number of atoms as 16 g of element X.

What is the relative atomic mass, A_r , of X?

- A 4 B 8 C 16 D 32

24. What is the ratio of the volume of 2 g of hydrogen to the volume of 16 g of methane, both volumes at r.t.p.?

- A 1 to 1 B 1 to 2 C 1 to 8 D 2 to 1

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Molar Calculations MCQs (O Level)

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25. What is the mass of aluminium in 204 g of aluminium oxide, Al_2O_3 ?

A 26 g

B 27 g

C 54 g

D 108 g

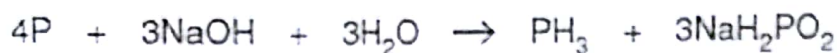
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Molar Calculations (Theory)

1. Phosphine, PH_3 , is a gas which has a smell of garlic. It is formed when white phosphorus is warmed with aqueous sodium hydroxide.



- (a) Draw a 'dot-and-cross' diagram for phosphine.

Show only the outer electrons.

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[1]

- (b) (i) Calculate the maximum mass of phosphine formed when 1.86 g of phosphorus reacts with excess aqueous sodium hydroxide.

[2]

- (ii) Calculate the volume of phosphine formed from 1.86 g of phosphorus at r.t.p.

[1]

- (c) Phosphine decomposes into its elements on warming. Write an equation for this reaction.

[2]

(d) Phosphine reacts with hydrogen iodide to form the salt phosphonium iodide, PH_4I .

Phosphonium salts react in a similar way to ammonium salts when warmed with aqueous sodium hydroxide.

(i) Write an equation for the reaction of phosphonium iodide with aqueous sodium hydroxide.

..... [1]

(ii) What should you notice when sodium hydroxide is warmed with phosphonium iodide?

..... [1]

(e) Phosphine is formed when water reacts with calcium phosphide, Ca_3P_2 .

Calcium phosphide is an ionic compound.

(i) Write the formula for the phosphide ion.

..... [1]

(ii) Predict one physical property of calcium phosphide.

..... [1]

[Total: 10]

2. Analysis of 21.25 g of gallic acid showed that it contained 10.50 g of carbon, 0.75 g of hydrogen and 10.00 g of oxygen.

Show that the empirical formula of gallic acid is $\text{C}_7\text{H}_6\text{O}_5$.

3. Analysis of a compound Z obtained from the planet Mars showed Z has the following composition.

element	percentage by mass
potassium	39.4
iron	28.3
oxygen	32.3

(a) Show that the empirical formula of Z is K_2FeO_4 .

.....

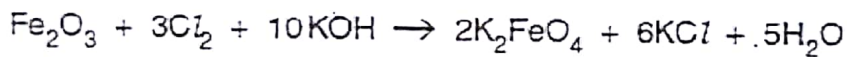
.....

.....

.....

..... [2]

(b) K_2FeO_4 can be prepared in the laboratory by the reaction between iron(III) oxide, Fe_2O_3 , chlorine, Cl_2 , and potassium hydroxide, KOH.



A 2.00 g sample of Fe_2O_3 is added to 20.0 cm³ of 4.00 mol dm⁻³ KOH.

(i) Calculate the amount, in moles, of Fe_2O_3 used:

.....

..... [2]

(ii) Calculate the amount, in moles, of KOH used.

.....

..... [1]

(iii) Which reagent, Fe_2O_3 or KOH, is in excess in this reaction?

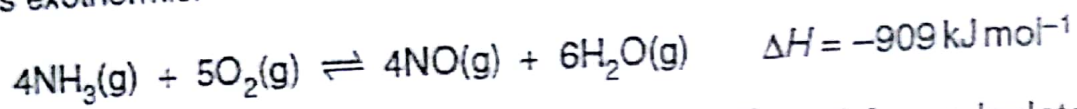
Explain your answer.

.....

..... [1]

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One of the reactions in the manufacture of nitric acid involves the oxidation of ammonia. This reaction is exothermic.



Using the information that one mole contains 6.02×10^{23} particles, calculate the number of electrons in one mole of NO molecules.

..... [1]

A factory uses 100 tonnes of ammonia each day to produce 160 tonnes of nitrogen monoxide, NO.
Calculate the percentage yield of nitrogen monoxide.

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percentage yield = % [3]

5. A student was given some hydrated iron(II) sulfate crystals, $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$. They were placed in a previously weighed crucible which was reweighed.

Mass of crucible + iron(II) sulfate crystals = 10.45 g
Mass of crucible = 6.60 g

(a) Calculate the mass of iron(II) sulfate crystals used in the experiment.

..... g [1]

(b) The crystals were gently heated until no more water vapour was given off.

(i) What word describes the iron(II) sulfate now that it has lost all of its water of crystallisation?

..... [1]

The crucible and contents were reweighed.

Mass of crucible + iron(II) sulfate after heating = 8.90 g

(ii) Calculate the mass of iron(II) sulfate which remained after heating.

..... g [1]

(iii) Calculate the mass of water lost from the crystals.

..... g [1]

(c) (i) Calculate the relative formula mass of iron(II) sulfate, FeSO_4 .

[A_r: Fe, 56; S, 32; O, 16]

.....

(ii) Calculate the relative formula mass of water.

[A_r: H, 1; O, 16]

..... [1]

(d) Using your answers to (b)(ii) and (iii), and (c)(i) and (ii), calculate

(i) how many moles of iron(II) sulfate remained after heating.

..... [1]

(ii) how many moles of water were lost during heating.

..... [1]

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(e) The value of x in the formula $\text{FeSO}_4 \cdot x\text{H}_2\text{O}$ can be found using the following formula.

$$x = \frac{\text{answer to (d)(ii)}}{\text{answer to (d)(i)}}$$

Calculate the value of x and hence write the formula of hydrated iron(II) sulfate.

$$x = \dots\dots\dots [1]$$

The formula of hydrated iron(II) sulfate is $\dots\dots\dots$ [1]

[Total: 9]

6. A small amount of xenon is present in the air. Several compounds of xenon have been made in recent years.

A compound of xenon contained 9.825 g of xenon, 1.200 g of oxygen and 5.700 g of fluorine.

Determine the empirical formula of this compound.

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7. Methylamine, CH_3NH_2 , is a base which has similar properties to ammonia. When methylamine dissolves in water, the following equilibrium is set up.



(a) Explain why methylamine behaves as a base in this reaction.

$\dots\dots\dots$ [1]

(b) When aqueous methylamine is added to aqueous iron(III) chloride, a red-brown precipitate is observed.

Suggest what you would observe when aqueous methylamine is added to aqueous iron(II) chloride.

[1]

- (c) Methylamine is a gas. Calculate the volume occupied by 6.2 g of methylamine at room temperature and pressure.

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[2]

- (d) Methylamine is made by reacting methanol with excess ammonia under pressure in the presence of a catalyst.



- (i) Define the term *catalyst*.

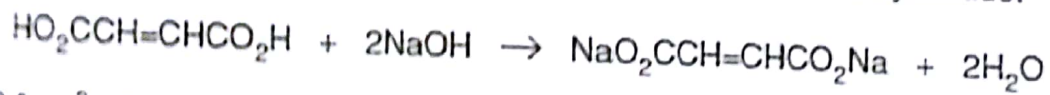
[1]

- (ii) Calculate the theoretical yield of methylamine that can be obtained from 240 kg of methanol.

[2]

[Total: 7]

8. A solution of fumaric acid was titrated against aqueous sodium hydroxide.



18.0 cm³ of 0.200 mol/dm³ sodium hydroxide were required to neutralise 60.0 cm³ of fumaric acid solution.

Calculate the concentration, in mol/dm³, of the fumaric acid solution.

9. A student produced zinc oxide by heating zinc nitrate.

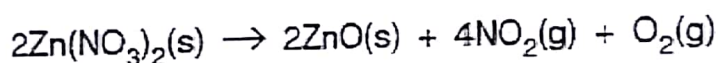
Some zinc nitrate was placed in a previously weighed crucible which was then reweighed.

$$\begin{aligned} \text{mass of crucible + zinc nitrate} &= 11.79 \text{ g} \\ \text{mass of crucible} &= 9.90 \text{ g} \end{aligned}$$

(a) Calculate the mass of zinc nitrate.

..... g [1]

The solid zinc nitrate was heated in a fume cupboard. The following reaction took place.



b) Using your answer to (a) calculate the number of moles of zinc nitrate used in the reaction.

[A_r: Zn, 65; N, 14; O, 16]

..... moles [1]

c) Using the equation for the reaction and your answer to (d) calculate the total volume of each gas produced from the reaction.

[1 mole of a gas occupies a volume of 24 dm³ at room temperature and pressure.]

volume of NO₂ cm³

volume of O₂ cm³

10. Octane burns in air.



A petrol-powered motor car travels at a constant speed of 80 km/h. For every kilometre travelled 108 g of carbon dioxide are formed.

When the motor car travels 100 km calculate

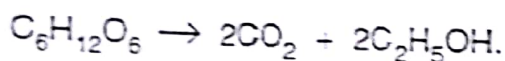
(i) the mass of carbon dioxide emitted by the car,

[1]

(ii) the mass of petrol burned by the car assuming that petrol is 100% octane.

11. Ethanol can also be manufactured from glucose, $C_6H_{12}O_6$.

[4]



A solution containing 18 kg of glucose makes only 0.92 kg of ethanol.
Calculate the percentage yield of ethanol.

[3]

12. A bag of fertiliser contains 500 g of ammonium sulfate, $(NH_4)_2SO_4$, and 500 g of potassium nitrate, KNO_3 .

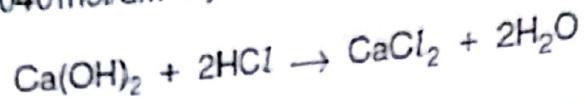
(a) Calculate the percentage by mass of nitrogen in the bag of fertiliser.

[4]

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13. 25.0 cm³ of an aqueous solution of calcium hydroxide is exactly neutralised by 18.0 cm³ of 0.040 mol/dm³ hydrochloric acid.



Calculate the concentration, in mol/dm³, of the aqueous calcium hydroxide.

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concentration =mol/dm³ [3]

14. Analysis of 10.0 g of carboxylic acid X shows that it contains 2.67 g carbon, 0.220 g hydrogen and 7.11 g oxygen.

- (i) Deduce the empirical formula of X.
- (ii) The relative molecular mass of X is 90. Deduce the molecular formula of X.

15. An impure sample of iron(II) sulphate was analysed by titration.

The sample was dissolved in 25.0 cm³ of dilute sulphuric acid and then titrated against 0.0400 mol/dm³ potassium dichromate(VI) solution.

19.0 cm³ of potassium dichromate(VI) solution was required to reach the end-point.

(i) Calculate the number of moles of potassium dichromate(VI) used in the titration.

..... moles [1]

(ii) One mole of potassium dichromate(VI) reacts with six moles of iron(II) ions. Calculate the mass, in grams, of iron(II) ions in the sample analysed.

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mass of iron(II) ions..... g [2]

16. Dilute ethanoic acid and dilute hydrochloric acid both react with magnesium ribbon to form hydrogen.

(a) Give the formula of one ion found in both of these dilute acids. [1]

(b) Magnesium ribbon reacts with hydrochloric acid as shown in the equation.



A 0.24 g sample of magnesium ribbon is added to 5.0 cm³ of 2.0 mol/dm³ hydrochloric acid.

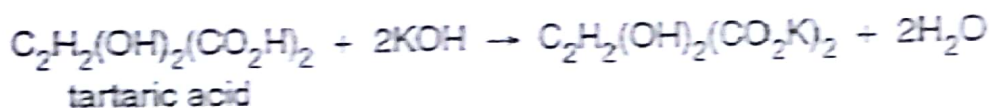
(i) Which reactant, magnesium or hydrochloric acid, is in excess? Use calculations to explain your answer. [2]

(ii) Calculate the maximum mass of magnesium chloride that can be formed in this reaction. [2]

17. A 1.2 g sample of powdered brass was analysed by reaction with excess dilute sulphuric acid. The zinc reacts as shown in the equation to form 0.072 dm³ of hydrogen measured at room temperature and pressure.



- (i) Suggest why brass was used in a powdered rather than lump form. [1]
- (ii) Calculate the mass of zinc in the sample of brass. [2]
- (iii) Calculate the percentage of zinc in the sample of brass. [1]
18. A solution of tartaric acid was titrated with 0.100 mol/dm³ potassium hydroxide.



It required 6.00 cm³ of the potassium hydroxide solution to neutralise 20.0 cm³ of tartaric acid. Calculate the concentration, in mol/dm³, of the tartaric acid solution.

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.....mol/dm³ [3]

Tartaric acid is purified by recrystallisation.

On analysis, 8.00g of impure tartaric acid was found to contain 7.40g of pure tartaric acid. Calculate the percentage purity of the impure tartaric acid.

.....% [1]

19. Carbon monoxide reacts with nickel to form a compound containing nickel, carbon and oxygen only. Analysis of 5.70 g of this compound showed that it contained 1.97 g nickel, 1.60 g carbon and 2.13 g oxygen.
Determine the empirical formula of this compound. [3]

20. Magnesium reacts with propanoic acid to form magnesium propanoate and hydrogen.



A student added 4.80 g of magnesium to 30.0 g of propanoic acid.

- (i) Which one of these reactants, magnesium or propanoic acid, is in excess?
Explain your answer. [2]
- (ii) Calculate both the number of moles of hydrogen and the volume of hydrogen formed at r.t.p. [2]

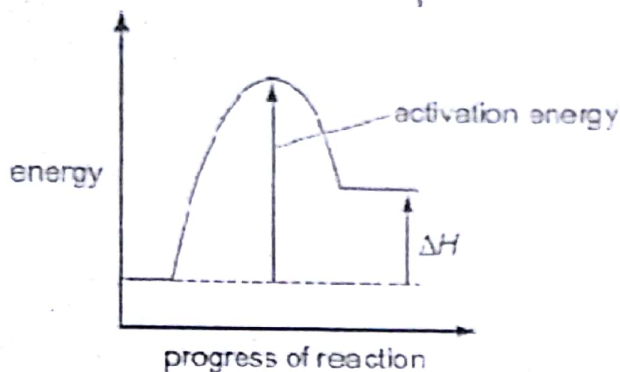
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Energy Changes (MCQs)

1. The energy profile for the forward direction of a reversible reaction is shown.



Which row correctly shows the sign of both the activation energy and the type of the enthalpy change for the reverse reaction?

	sign of activation energy	type of enthalpy change
A	negative	endothermic
B	negative	exothermic
C	positive	endothermic
D	positive	exothermic

2. The burning of hydrogen is an exothermic reaction.

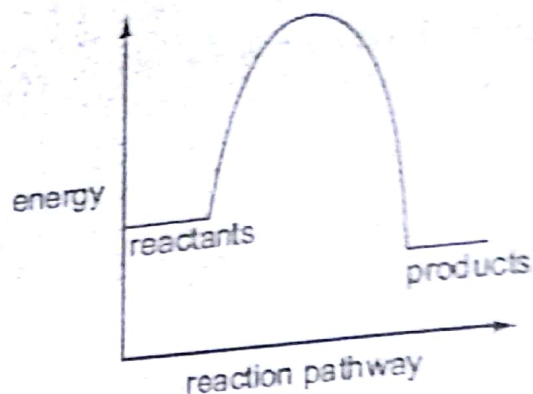
Which statement explains this?

- A More bonds are broken than are formed.
- B More bonds are formed than are broken.
- C Overall, the bonds broken are stronger than those formed.
- D Overall, the bonds formed are stronger than those broken.

3. In which process is energy released?

- A electrolysis of water to form hydrogen and oxygen
- B forming a hydrogen molecule from two hydrogen atoms
- C fractional distillation of crude oil
- D photosynthesis

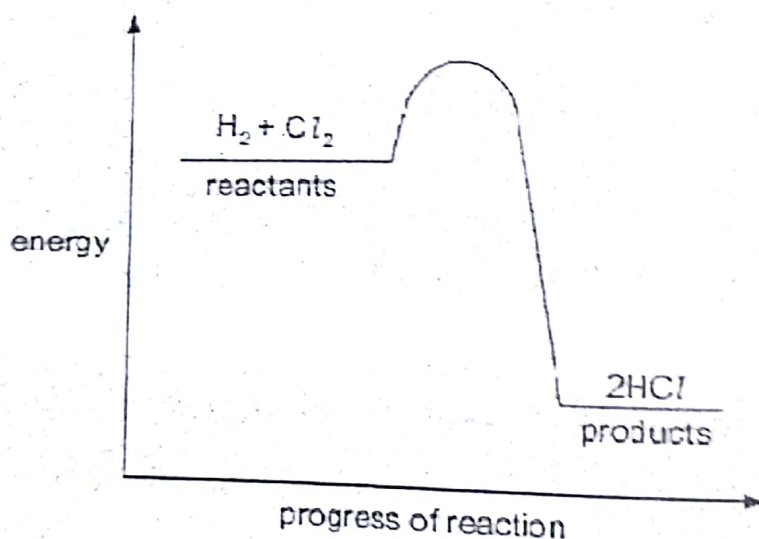
4. The diagram shows the reaction pathway for a given reaction without the use of a catalyst.



Which information correctly describes the effect of the catalyst on the activation energy and enthalpy change for the reaction?

	activation energy	enthalpy change
A	decrease	decrease
B	increase	no change
C	increase	increase
D	decrease	no change

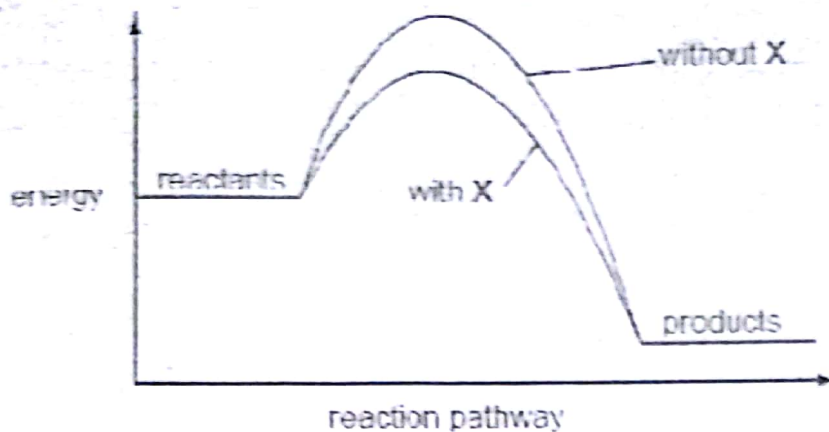
5. The energy profile diagram for the reaction between hydrogen and chlorine is shown.



What information about this reaction does the diagram show?

	type of reaction	sign of enthalpy change, ΔH
A	endothermic	negative
B	endothermic	positive
C	exothermic	negative
D	exothermic	positive

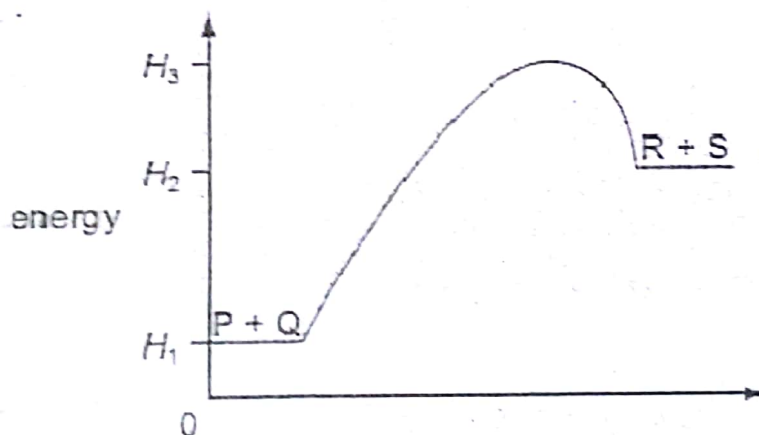
6. The energy profile diagrams show how adding a substance X to a reaction mixture changes the reaction pathway.



Which change occurs when X is added to the reaction mixture?

- A The rate of reaction decreases.
- B The rate of reaction increases.
- C The reaction becomes less exothermic.
- D The reaction becomes more exothermic.

7. The energy profile diagram below is for a reaction $P + Q \rightarrow R + S$.



Which statement is correct?

- A The activation energy of the reaction is $(H_3 - H_1)$.
- B The activation energy of the reaction is $(H_3 - H_2)$.
- C ΔH is $(H_1 - H_2)$.
- D ΔH is $(H_1 - H_3)$.

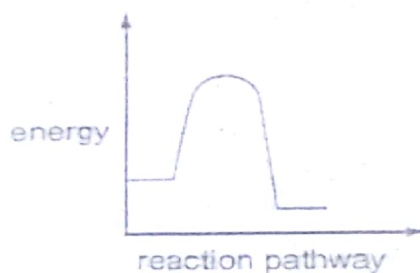
8. The table shows the energy released by the complete combustion of some compounds used as fuels.

compound	formula	M_r	ΔH in kJ/mol
methane	CH_4	16	-880
ethanol	C_2H_5OH	46	-1380
propane	C_3H_8	44	-2200
heptane	C_7H_{16}	100	-4800

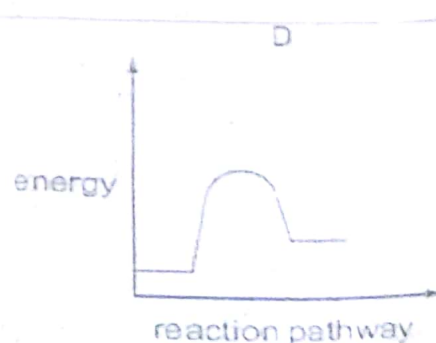
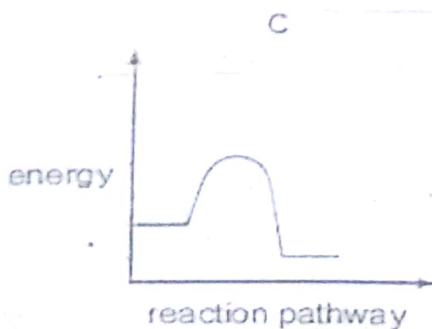
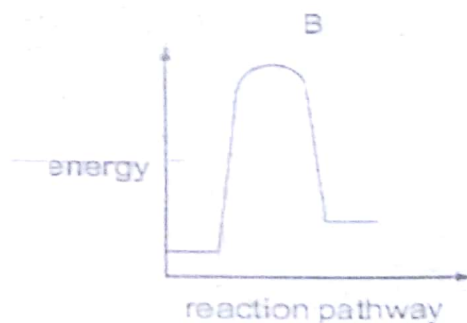
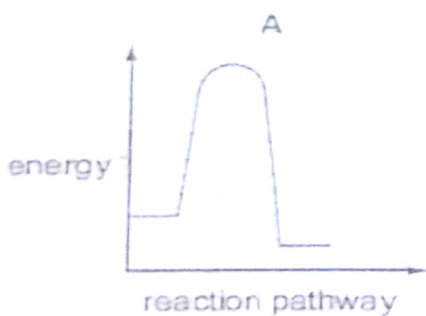
Which fuel produces the most energy when 1g of the compound is completely burned?

- A ethanol
- B heptane
- C methane
- D propane

9. The diagram shows the reaction pathway for a reaction without a catalyst.

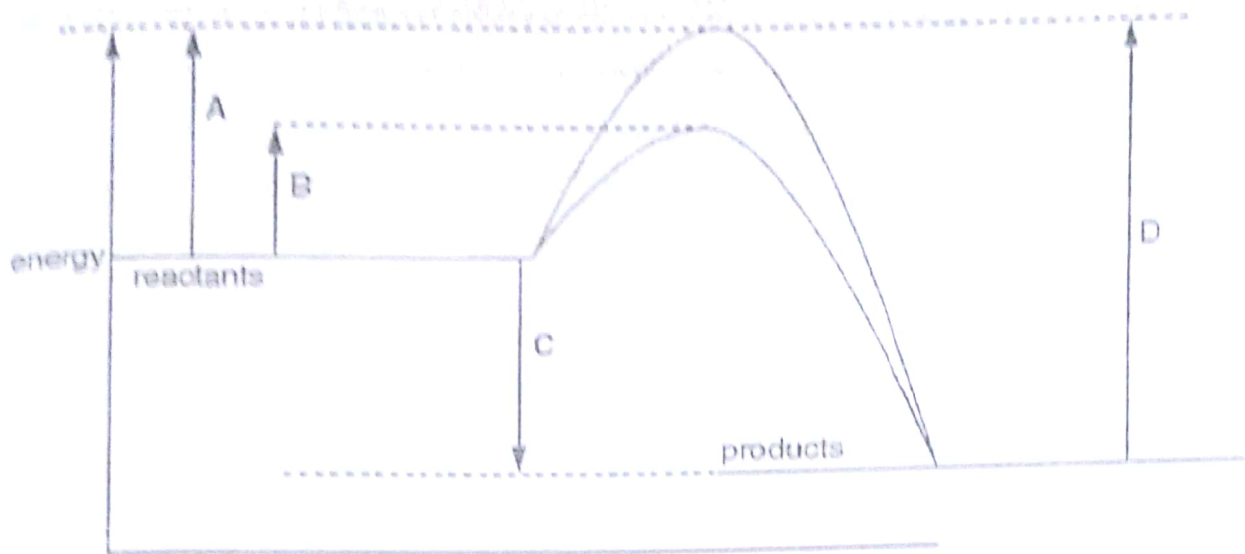


Which diagram shows the pathway resulting from the addition of a catalyst to the reaction?



10. The diagram shows an energy profile diagram for a chemical reaction.

Which energy change is the activation energy for the catalysed reaction?

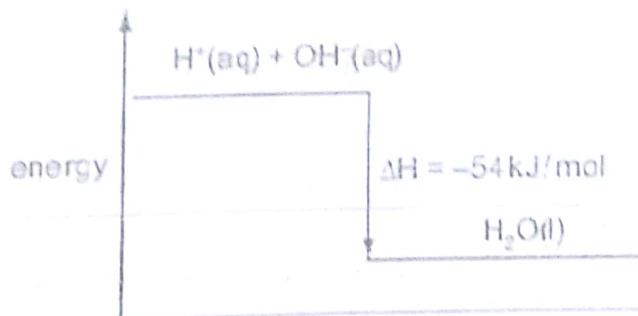


11. The formation of hydrogen iodide from hydrogen and iodine is an endothermic reaction



What may be deduced from this information?

- A The number of bonds broken is greater than the number of bonds formed.
 - B The formation of H - I bonds absorbs energy.
 - C The products possess less energy than the reactants.
 - D The total energy change in bond formation is less than that in bond breaking.
12. The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown.



Which quantity of heat is liberated when 100 cm^3 of 1 mol/dm^3 hydrochloric acid reacts with 100 cm^3 of 1 mol/dm^3 sodium hydroxide?

- A 0.54 kJ
- B 2.70 kJ
- C 5.40 kJ
- D 10.8 kJ

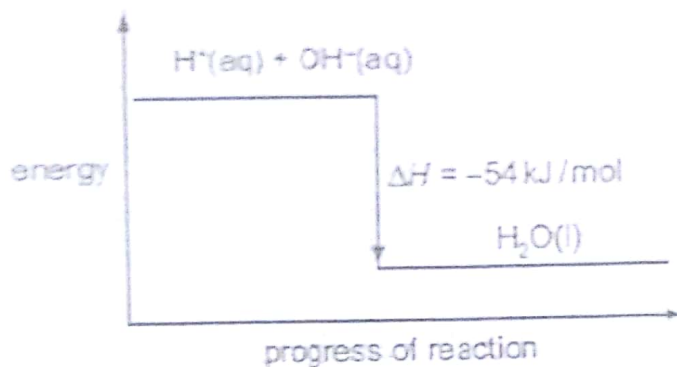
WSO-Energy Changes MCQs (O Level)

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13. Which of the following is an endothermic reaction?

- A the combustion of ethanol in air
- B the formation of a carbohydrate and oxygen from carbon dioxide and water
- C the oxidation of carbon to carbon dioxide
- D the reaction between hydrogen and oxygen

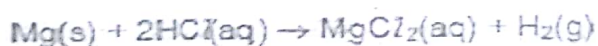
14. The energy diagram for the reaction between sodium hydroxide and hydrochloric acid is shown



What can be deduced from the diagram?

- A Heat is needed to start the reaction.
- B The products contain less energy than the reactants.
- C The reaction is rapid.
- D The OH^- ions have more energy than the H^+ ions.

15. The equation below shows an exothermic reaction.



Which statement about this exothermic reaction is not correct?

- A Magnesium chloride is soluble in water.
- B Magnesium is above hydrogen in the reactivity series.
- C One mole of magnesium produces one mole of hydrogen gas.
- D The total energy of the products is greater than that of the reactants.

16. The reaction $\text{C}_2\text{H}_4 + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 2\text{H}_2\text{O}$ is exothermic because

- A more bonds are broken than are formed.
- B more bonds are formed than are broken.
- C the energy needed to break the bonds is greater than that released on forming new bonds.
- D the energy needed to break the bonds is less than that released on forming new bonds.

17. Which of the following changes is endothermic?

- A $\text{H(g)} + \text{Cl(g)} \rightarrow \text{HCl(g)}$
- B $\text{H}_2\text{O(g)} \rightarrow 2\text{H(g)} + \text{O(g)}$
- C $\text{H}_2\text{O(l)} \rightarrow \text{H}_2\text{O(s)}$
- D $2\text{H}_2\text{(g)} + \text{O}_2\text{(g)} \rightarrow 2\text{H}_2\text{O(l)}$

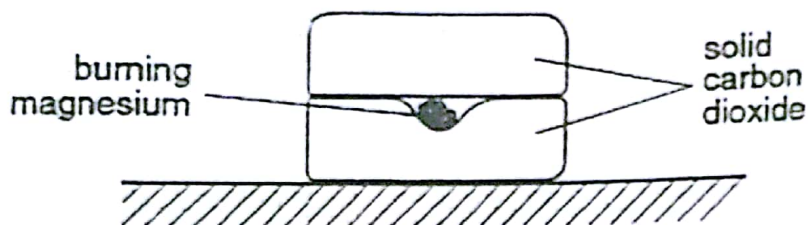
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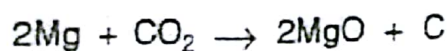
0333-4277385

Energy Changes (Theory)

1. Several small pieces of magnesium are placed on a block of solid carbon dioxide. The solid carbon dioxide is at a temperature of -60°C . The magnesium is ignited and another block of solid carbon dioxide is immediately placed on top.



A vigorous reaction is observed.



- (a) Suggest what could be seen as the reaction proceeds to completion.

 [2]
- (b) Why is another block of solid carbon dioxide placed above the burning magnesium?
 [1]
- (c) State one factor in the experiment which slows down the reaction.
 [1]
- (d) When 2 moles of magnesium react with one mole of carbon dioxide, 810 kJ of energy are released.
 Calculate the energy released when 2.0 g of magnesium reacts completely with carbon dioxide.
 [2]

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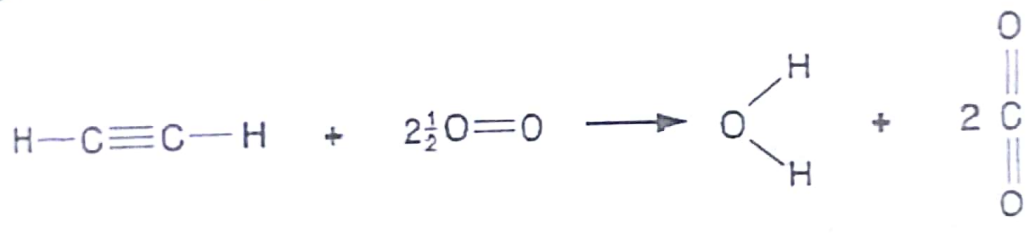
(e) In a second experiment 6.0g of magnesium and 4.4g of carbon dioxide are used. Which solid, magnesium or carbon dioxide is in excess? Show your working.

(f) Explain, in terms of the energy changes taking place in both bond-making and bond breaking, why the reaction is exothermic.

.....
.....
.....

[Total: 10]

2. Ethyne reacts with oxygen in an exothermic reaction.



(i) Explain why the combustion of ethyne is an exothermic reaction. Use ideas about the energy changes that take place during bond breaking and bond forming.

.....
.....
.....
.....

- (ii) The complete combustion of one mole of ethyne releases 1410 kJ of energy. Calculate the energy released when 1000 dm³ of ethyne, measured at room temperature and pressure, is completely combusted.

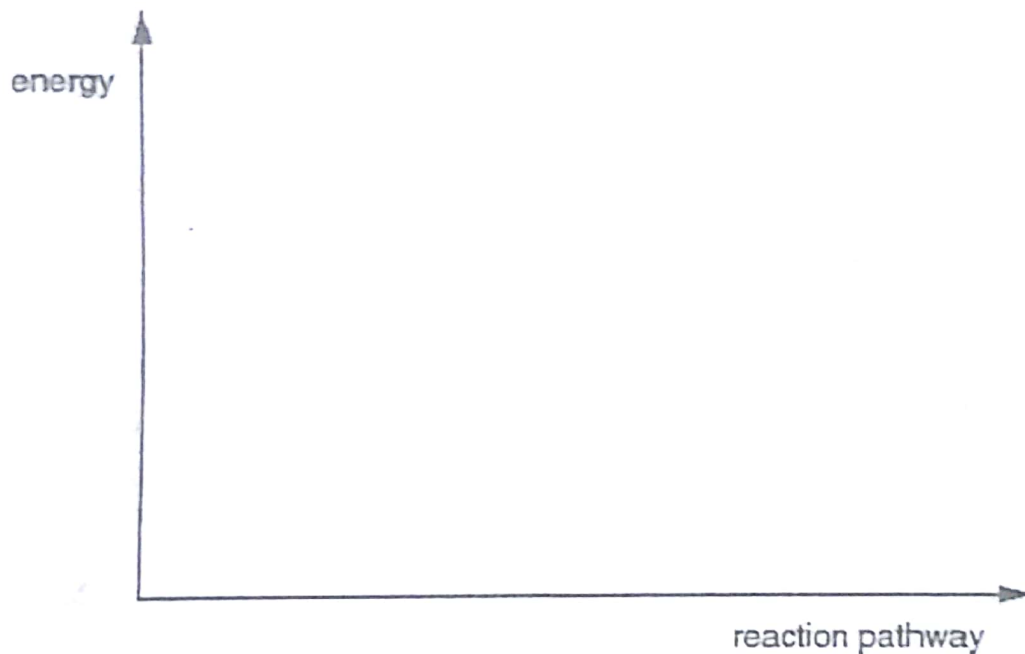
energy released = kJ [2]

3. Sulphur dioxide and nitrogen dioxide react together as shown in the equation.



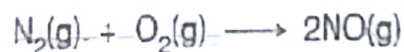
Draw an energy profile diagram for this reaction.

Indicate both the enthalpy change and the activation energy on your diagram.

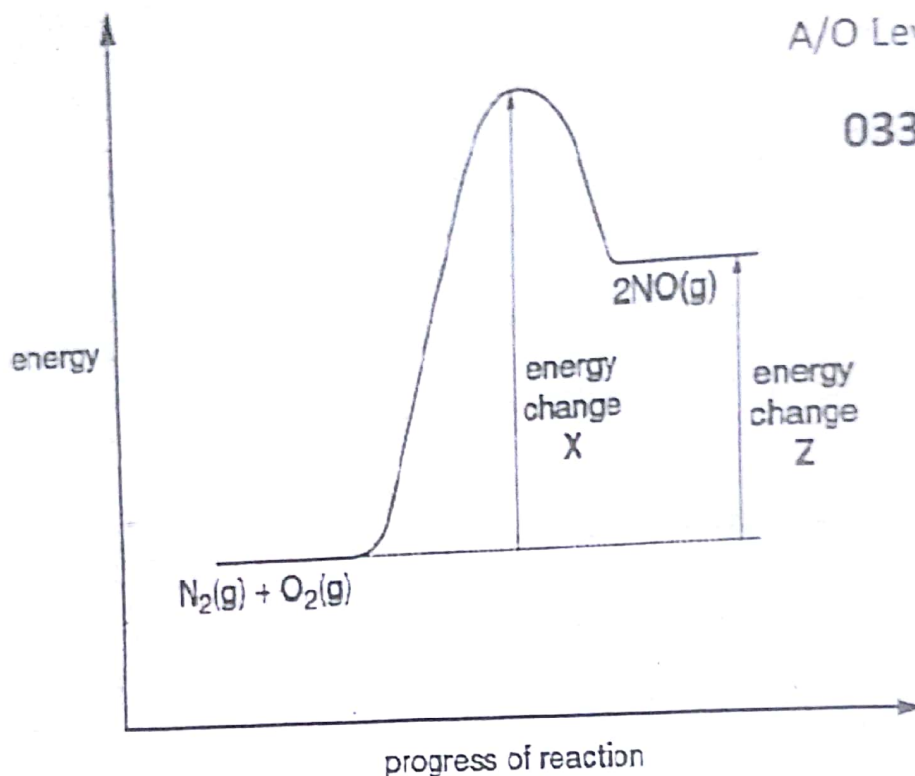


[3]

4. Oxides of nitrogen are atmospheric pollutants. Nitrogen monoxide, NO, is formed in an internal combustion engine when nitrogen and oxygen react together.



The diagram shows the energy profile for this reaction.



- (a) Identify the energy changes X and Z.
- (b) The reaction between nitrogen and oxygen is endothermic.
- Explain how you can tell from the diagram that the reaction is endothermic.
 - Explain, using ideas about bond breaking and bond making, why the overall reaction is endothermic.
- (c) The exhaust system of a motor car is fitted with a catalytic converter. When nitrogen monoxide passes through the converter it reacts with carbon monoxide.

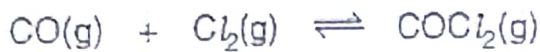


The catalyst increases the rate of this reaction.

- Explain how the catalyst in the converter increases the rate of this reaction.
- During the course of a journey 2.4 dm^3 of nitrogen monoxide was produced by the engine. Calculate the volume of nitrogen gas produced if all the nitrogen monoxide reacted in the converter.
- In reality, only 1.0 dm^3 of nitrogen was produced after the gases had passed over the catalytic converter. Calculate the percentage of nitrogen monoxide that had reacted.

Rate of Reactions (Theory)

1. Carbonyl chloride, COCl_2 , is a colourless, poisonous gas formed when carbon monoxide and chlorine combine in the presence of sunlight. The forward reaction is exothermic.



(a) Predict and explain how each of the following affects the position of equilibrium in this reaction:

(i) increasing the concentration of chlorine;

.....

 [2]

(ii) increasing the pressure;

.....

 [2]

(iii) increasing the temperature.

.....

 [2]

(b) Carbonyl chloride reacts with ammonia to form urea, $(\text{NH}_2)_2\text{CO}$, and ammonium chloride.

Write an equation for this reaction.

..... [2]

(c) Urea can be used as a fertiliser.

(i) How do fertilisers increase crop yields?

.....

.....

(ii) Urea is produced industrially by the reaction of ammonia with carbon dioxide.

The ammonia is manufactured using the Haber process by combining the elements nitrogen and hydrogen.

State the essential conditions in the Haber process which are necessary in order to produce a high yield of ammonia.

.....

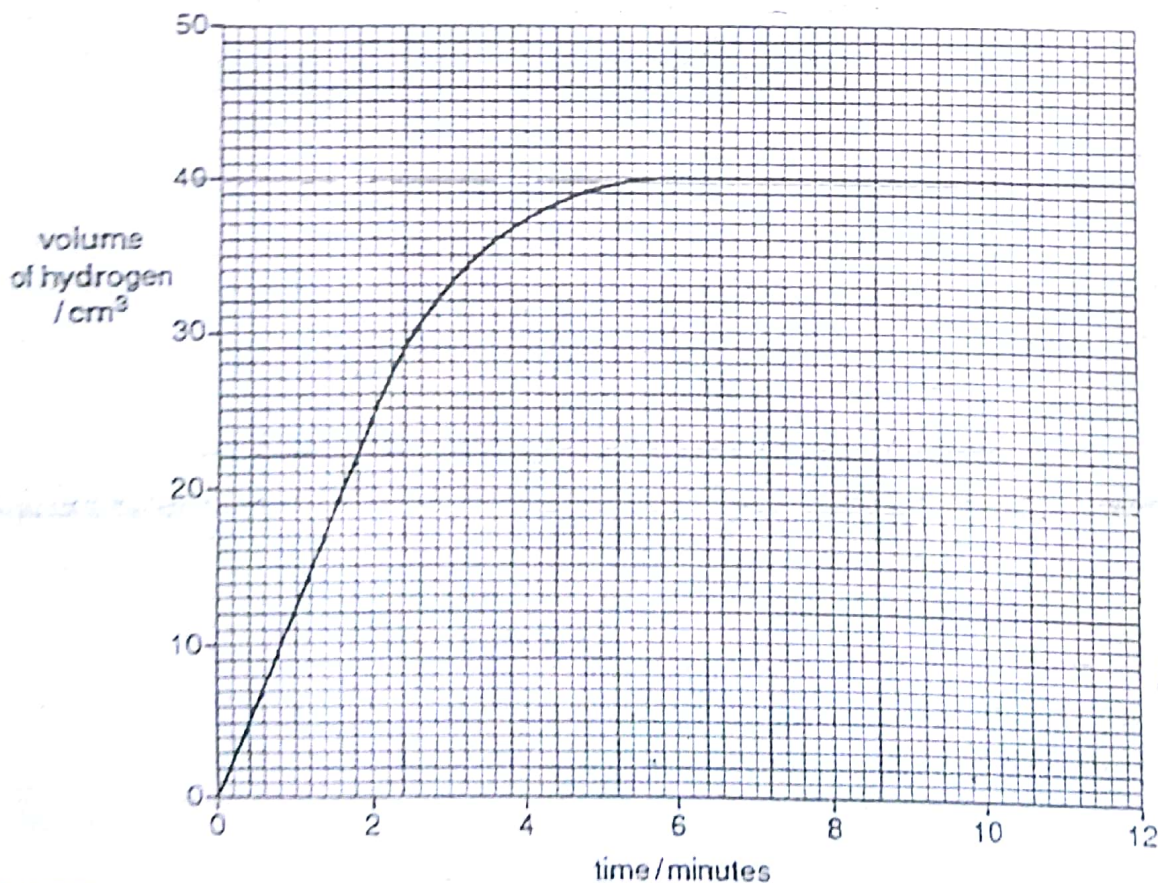
.....

.....

[Total: 10]

2. A student measured the volume of hydrogen produced over time when small pieces of zinc reacted with excess sulfuric acid.

The results are shown in the graph below.



(a) Use the information from the graph to calculate the average speed of reaction in the first two minutes.

[1]

(b) Explain why the reaction stopped after 6 minutes.

.....[1]

(c) Copper catalyses this reaction.

(i) On the axes above, sketch a line to show the expected results for the catalysed reaction. [1]

(ii) Explain how a catalyst changes the speed of reaction.

.....[1]

(d) Explain, using ideas about colliding particles, what happens to the speed of this reaction when larger particles of zinc are used.

.....
.....
.....[2]

(e) Explain, using ideas about colliding particles, what happens to the speed of this reaction when the temperature of the reaction mixture is increased.

.....
.....
.....[2]

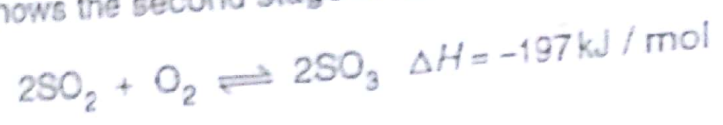
[Total: 8]

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3. (c) Sulfuric acid is manufactured by the Contact process.
Name the raw materials used in the first stage of the Contact process.

[1]

(d) The equation shows the second stage of the Contact process.



(d)

(i) State the meaning of the symbol ΔH .

[1]

(ii) Predict and explain the effect of increasing the temperature on the position of equilibrium in this reaction.

(e)

[2]

(iii) State the essential conditions for the reaction in the contact chamber.

4. Aqueous hydrogen peroxide, $\text{H}_2\text{O}_2(\text{aq})$, is used to sterilise contact lenses.
 $\text{H}_2\text{O}_2(\text{aq})$ slowly decomposes at room temperature to make water and oxygen.

- The decomposition can be made faster by
- using a more concentrated solution of $\text{H}_2\text{O}_2(\text{aq})$,
 - heating the $\text{H}_2\text{O}_2(\text{aq})$,
 - adding an enzyme called peroxidase.

(a) Construct the equation for the decomposition of $\text{H}_2\text{O}_2(\text{aq})$.

(b) Explain why concentrated $\text{H}_2\text{O}_2(\text{aq})$ decomposes faster than dilute $\text{H}_2\text{O}_2(\text{aq})$.

(c) Explain why hot $\text{H}_2\text{O}_2(\text{aq})$ decomposes faster than cold $\text{H}_2\text{O}_2(\text{aq})$.

.....

.....

..... [2]

(d) Explain, using ideas about activation energy, why an enzyme such as peroxidase makes the decomposition of $\text{H}_2\text{O}_2(\text{aq})$ faster.

.....

.....

..... [2]

(e) The table shows some information about an investigation on the decomposition of $\text{H}_2\text{O}_2(\text{aq})$ using two different catalysts. In each experiment, 0.100g of the catalyst and 25.0cm³ of $\text{H}_2\text{O}_2(\text{aq})$ were used. The concentration and temperature of the $\text{H}_2\text{O}_2(\text{aq})$ were kept constant.

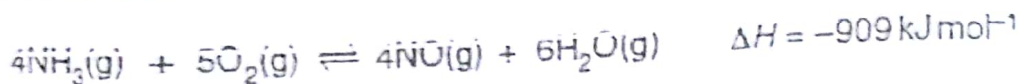
catalyst	time taken to collect 50 cm ³ of oxygen / s	total volume of oxygen made at the end of the reaction / cm ³
manganese(IV) oxide	25	95
peroxidase	10	

(i) What is the total volume of oxygen made at the end of the reaction in which peroxidase was used as a catalyst?

volume of oxygen = cm³ [1]

(ii) Describe, with the aid of a labelled diagram, how you could carry out an experiment to collect the measured volumes of gases recorded in the table.

5. One of the reactions in the manufacture of nitric acid involves the oxidation of ammonia. This reaction is exothermic.



(a) The reaction is carried out at a pressure of 10 atmospheres and a temperature of 900°C.

(i) Predict and explain the effect on the position of equilibrium if the reaction is carried out at 10 atmospheres pressure and 700°C rather than 900°C.

.....
.....
.....

(ii) Predict and explain the effect on the position of equilibrium if the reaction is carried out at 900°C and 20 atmospheres pressure rather than 10 atmospheres.

.....
.....
.....

(b) A factory uses 100 tonnes of ammonia each day to produce 160 tonnes of nitrogen monoxide, NO.

Calculate the percentage yield of nitrogen monoxide.

percentage yield = %

(c) Ammonium nitrate, NH_4NO_3 , is a soluble salt.
The salt decomposes when heated gently to form steam and a colourless gas X.

(i) Ammonium nitrate can be prepared by the reaction between aqueous ammonia and dilute nitric acid.

Name the experimental technique used to prepare aqueous ammonium nitrate and briefly describe how solid ammonium nitrate is obtained from the aqueous solution.

.....

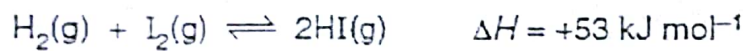
 [2]

(ii) Predict the formula of gas X.

..... [1]

[Total: 10]

Hydrogen and iodine react together to form hydrogen iodide in a reversible redox reaction. The forward reaction is endothermic.



Hydrogen and hydrogen iodide are colourless gases whereas iodine gas is purple.

(a) What is meant by the term *redox reaction*?

.....
 [1]

(b) A mixture of $\text{H}_2(\text{g})$, $\text{I}_2(\text{g})$ and $\text{HI}(\text{g})$ are in dynamic equilibrium at a pressure of 2 atmospheres and 200°C .

The temperature of the mixture is increased to 500°C but the pressure remains unchanged.

Explain why the mixture becomes less purple in colour.

.....

 [3]

(c) Calculate the maximum mass of hydrogen iodide that can be made from 45.3g hydrogen.

maximum mass of hydrogen iodide = g

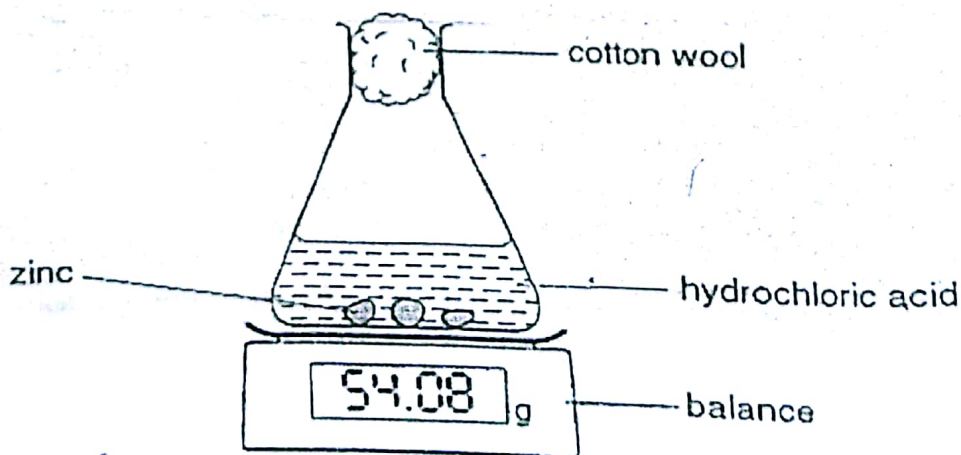
(d) Hydrogen iodide is dissolved in water to make solution X.

(i) X is acidified with dilute nitric acid and then aqueous lead(II) nitrate is added. A yellow precipitate is formed.
Write an ionic equation, including state symbols, for this reaction.

(ii) A small volume of acidified potassium manganate(VII) is added to X. The solution changes colour to orange-brown.
From this description what can you deduce about the chemical properties of X?

.....

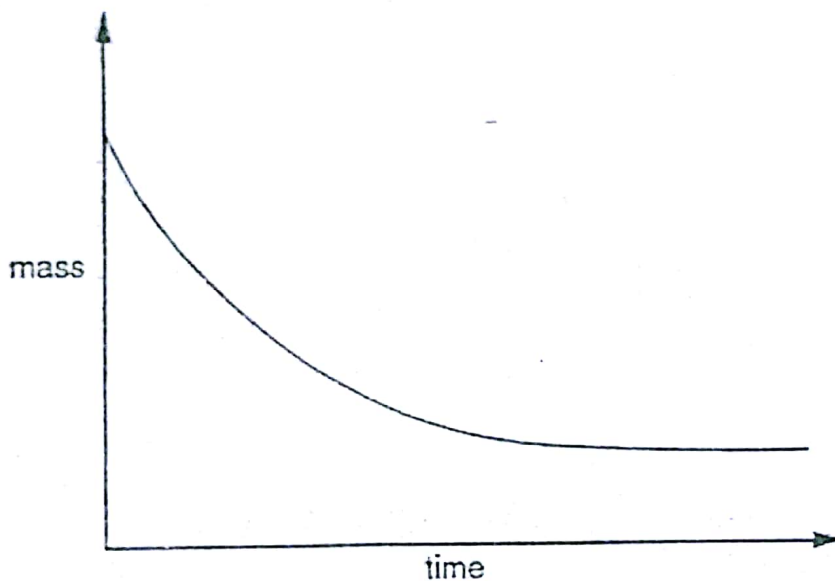
7. The diagram below shows apparatus that can be used to investigate the rate of reaction between zinc and hydrochloric acid. [Total 4 marks]



(a) Write the equation, including state symbols, for the reaction between zinc and hydrochloric acid.

[2]

(b) The graph shows the change in mass that occurs during the reaction between zinc and hydrochloric acid.



(i) Explain why the mass decreases during the course of the reaction.

.....
 [1]

(ii) Exactly the same experiment was repeated but with a catalyst added. Sketch on the graph the results that would be obtained in the presence of the catalyst. [2]

(c) Explain why zinc reacts more slowly with dilute hydrochloric acid than with concentrated hydrochloric acid.

.....

 [2]

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(d) Explain why hydrochloric acid reacts much faster with zinc powder than with lumps of zinc.

.....

.....

.....

(e) Zinc is added to excess hydrochloric acid. Aqueous sodium hydroxide is added drop by drop to this reaction mixture until it is in excess. Describe what you would observe.

.....

.....

.....

[Total:]

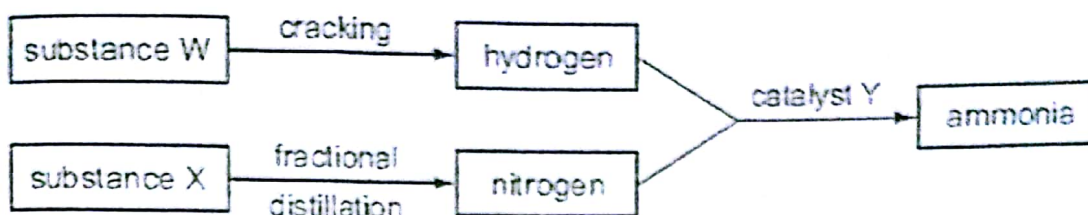
Rasheed Ahmed

A/O Level Chemistry

0333-42277385

Nitrogen & Sulphur (MCQs)

1. The diagram shows processes that take place in the manufacture of ammonia.



What are substances W and X and catalyst Y?

	W	X	Y
A	air	oil	iron
B	air	oil	vanadium(V) oxide
C	oil	air	iron
D	oil	air	vanadium(V) oxide

2. Sulfur is burnt in air.

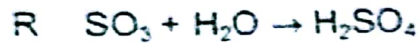
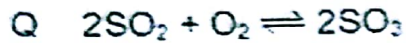
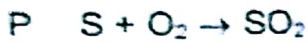
Which statement about this reaction is correct?

- A Sulfur is oxidised to sulfur trioxide.
- B The gas formed turns aqueous potassium dichromate(VI) from orange to green.
- C The reaction is reversible.
- D The reaction needs a catalyst.

3. Which compound will not produce ammonia when heated with ammonium sulfate?

- A calcium oxide
- B magnesium oxide
- C sodium hydroxide
- D sulfuric acid

4. These reactions are used in the manufacture of sulfuric acid.



Which reactions are speeded up by using a catalyst?

- A P only B Q only C R only D Q and R

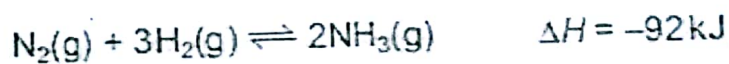
5. Which gas reacts with sulfuric acid to form a fertiliser?

- A ammonia, NH_3
 B carbon dioxide, CO_2
 C hydrogen, H_2
 D nitrogen, N_2

In the Contact process, the sulfur trioxide formed is

6. A passed into concentrated sulfuric acid.
 B passed into dilute sulfuric acid.
 C passed into oleum ($H_2S_2O_7$).
 D passed into water.

7. In the Haber process, nitrogen and hydrogen react to form ammonia.

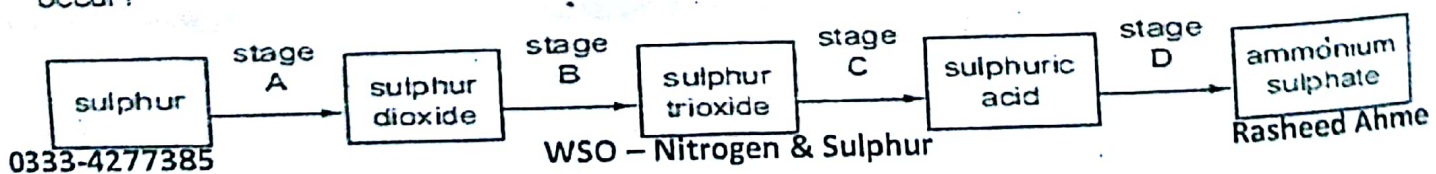


Which factor increases both the speed of reaction and the amount of ammonia produced?

- A addition of a catalyst
 B decreasing the temperature
 C increasing the pressure
 D increasing the temperature

8. Ammonium sulphate is an important fertiliser.

During which stage in the manufacture of ammonium sulphate does a neutralisation reaction occur?



9. Ammonia gas is produced when solid ammonium chloride is heated with

- A calcium hydroxide.
- B calcium sulphate.
- C hydrochloric acid.
- D magnesium nitrate.

10. Sulphur and selenium (Se) are in the same group of the Periodic Table.

From this, we would expect selenium to form compounds having the formulae

- A SeO , Na_2Se and NaSeO_4 .
- B SeO_2 , Na_2Se and NaSeO_4 .
- C SeO_2 , Na_2Se and Na_2SeO_4 .
- D SeO_3 , NaSe and NaSeO_4 .

11. All ammonium salts on heating with sodium hydroxide produce ammonia gas.

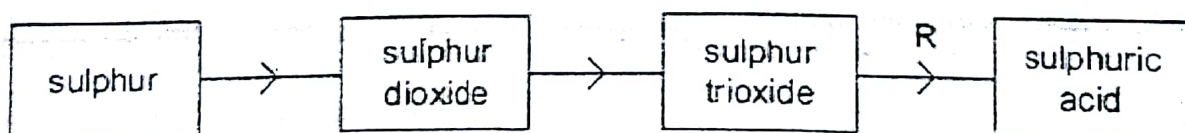
From which ammonium salt can the greatest mass of ammonia be obtained?

- A 0.5 mol $(\text{NH}_4)_3\text{PO}_4$
- B 0.5 mol $(\text{NH}_4)_2\text{SO}_4$
- C 1.0 mol NH_4Cl
- D 1.0 mol NH_4NO_3

12. Which is a use of sulphuric acid?

- A as a bleach
- B in the manufacture of ammonia
- C in the manufacture of fertilisers
- D in the manufacture of sulphur trioxide

13. The diagram represents the manufacture of sulphuric acid by the Contact process.



What is used in step R?

- A vanadium(V) oxide
- B water only
- C water followed by concentrated sulphuric acid
- D concentrated sulphuric acid followed by water

14. The element sulphur, S, is in Group VI of the Periodic Table.

Which formula is incorrect?

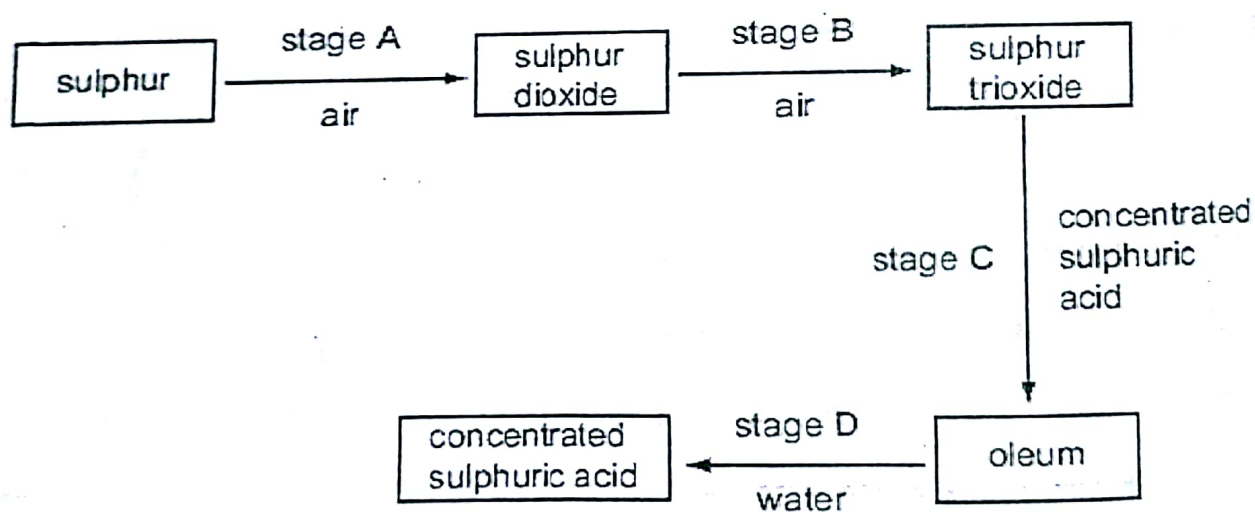
- A S^{2-}
- B S_2O_3
- C SO_4^{2-}
- D SO_3

15. Which method would not produce ammonia gas?

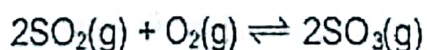
- A heating concentrated aqueous ammonia
- B heating ammonium chloride with calcium hydroxide
- C heating ammonium sulphate with sodium hydroxide
- D heating ammonium sulphate with dilute hydrochloric acid

16. The following scheme shows four stages in the conversion of sulphur to sulphuric acid.

In which stage is a catalyst used?



17. In the Contact process for making sulphuric acid, one step involves the oxidation of sulphur dioxide as shown below.

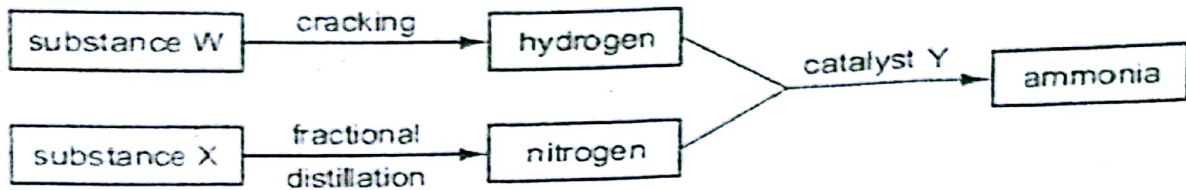


The forward reaction is exothermic.

Which change would increase the amount of sulphur trioxide produced at equilibrium?

- A increasing the temperature
- B decreasing the temperature
- C decreasing the pressure
- D adding a catalyst

18. The diagram shows processes that take place in the manufacture of ammonia.

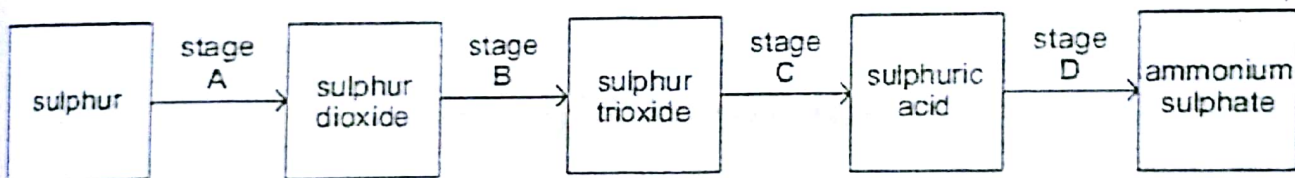


What are substances W and X and catalyst Y?

	W	X	Y
A	air	oil	iron
B	air	oil	vanadium(V) oxide
C	oil	air	iron
D	oil	air	vanadium(V) oxide

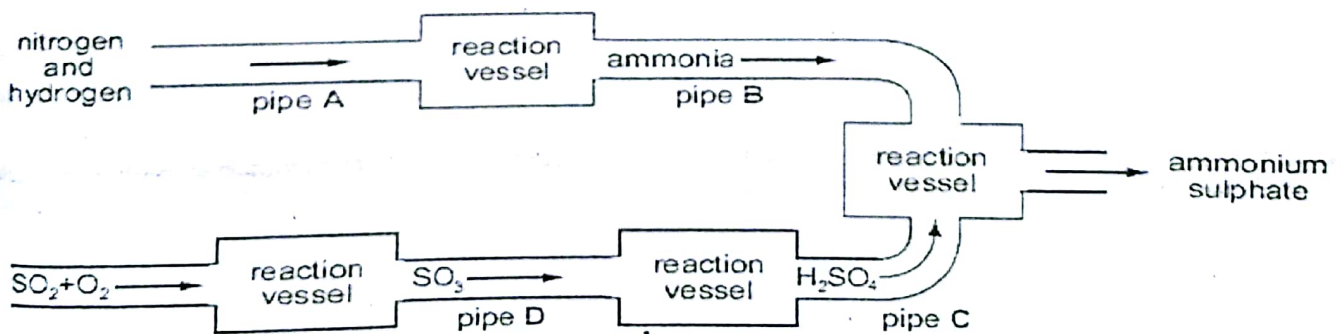
19. Ammonium sulphate is an important fertiliser.

During which stage in the manufacture of ammonium sulphate does a reaction with water occur?



20. The diagram shows some of the stages in the manufacture of ammonium sulphate.

From which connecting pipe would a major leak most increase the pH value of rain?



Nitrogen & Sulphur MCQs Marking Key

Question	Answer	Question	Answer
1	C	11	A
2	B	12	C
3	D	13	D
4	B	14	B
5	A	15	D
6	A	16	B
7	C	17	B
8	D	18	C
9	A	19	C
10	C	20	B

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O/A Level Chemistry

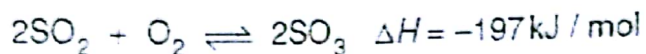
0333-4277385

Nitrogen & Sulphur (Theory)

1. (c) Sulfuric acid is manufactured by the Contact process.
Name the raw materials used in the first stage of the Contact process.

.....[1]

- (d) The equation shows the second stage of the Contact process.



- (i) State the meaning of the symbol ΔH .

.....[1]

- (ii) Predict and explain the effect of increasing the temperature on the position of equilibrium in this reaction.

.....

[2]

- (b) Acid rain is a solution of dilute sulfuric acid.
The acidity in lakes can be neutralised by adding powdered calcium carbonate.

- (i) Write an equation, including state symbols, for the reaction of calcium carbonate with sulfuric acid.

[2]

- (ii) State one industrial use of sulfuric acid.

.....[1]

- (iii) Sulfuric acid is a strong acid.
What do you understand by the term *strong acid*?

.....
[1]

Rasheed Ahmed

A/O Level Chemistry

2. Fertilisers supply the essential elements, nitrogen, phosphorus and potassium for plant growth.

A bag of fertiliser contains 500g of ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, and 500g of potassium nitrate, KNO_3 .

(a) Calculate the percentage by mass of nitrogen in the bag of fertiliser.

[4]

(b) Eutrophication occurs in river water polluted by fertilisers. Describe the principal processes involved in eutrophication.

.....

.....

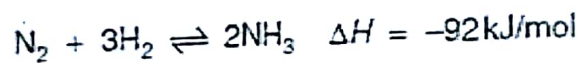
.....

.....

.....

[3]

3. Ammonia is made by the Haber process using an iron catalyst.



(a) On the same axes draw energy profile diagrams to show both the catalysed and the uncatalysed reaction. Label the diagram to show

- the catalysed and uncatalysed reactions,
- the reactants and products,
- the enthalpy change for the reaction.

[3]

(b) The raw materials for the Haber process can be obtained from the air and from hydrocarbons produced by the distillation of petroleum.

(i) Describe how pure nitrogen can be separated from other gases in the air.

[1]

(ii) Describe how hydrogen can be made from hydrocarbons.

[2]

(c) Explain how the position of equilibrium in the Haber process is altered by

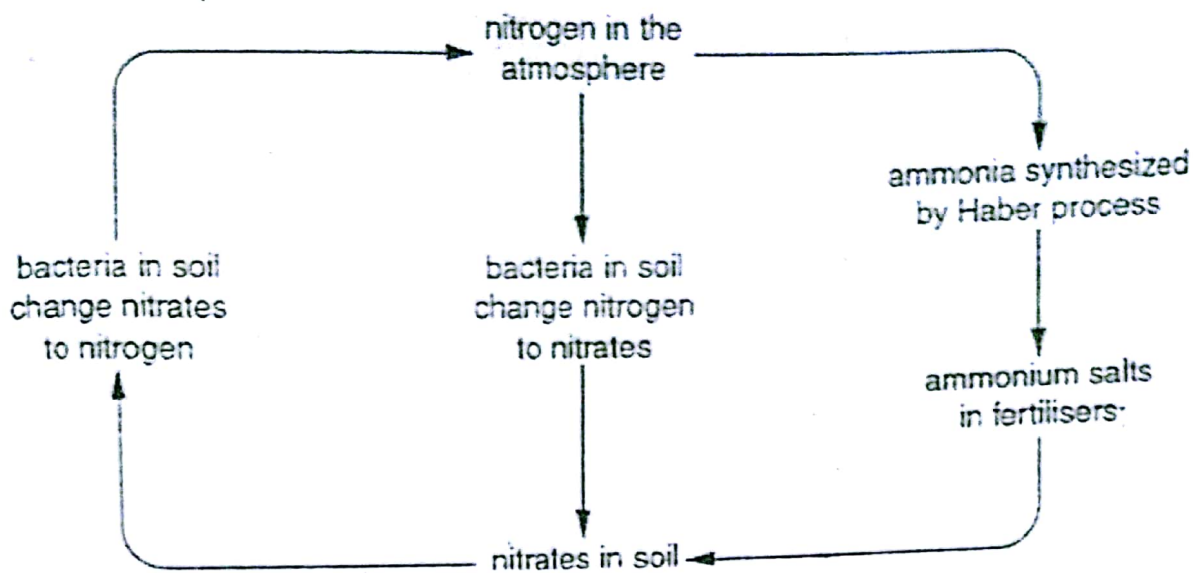
(i) an increase in pressure,

[2]

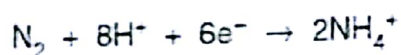
(ii) an increase in temperature.

[2]

Rasheed Ahmed
 A/C Level Chemistry
 0333-4277385
 4. A simplified diagram of the nitrogen cycle is shown below.



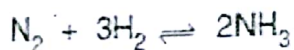
- (a) Although certain bacteria in the soil convert nitrogen gas into nitrates, other bacteria convert nitrogen into ammonium salts. The ionic equation for this second reaction is



Explain why this is a reduction reaction. [1]

- (b) In the presence of hydrogen ions, a different type of bacterium converts nitrate ions into nitrogen gas and water. Give the ionic equation for this reaction. [1]

- (c) Ammonia is synthesized by the Haber process.



- (i) State the sources of both the nitrogen and hydrogen needed for the Haber process. [2]

- (ii) State the essential conditions for the Haber process. [2]

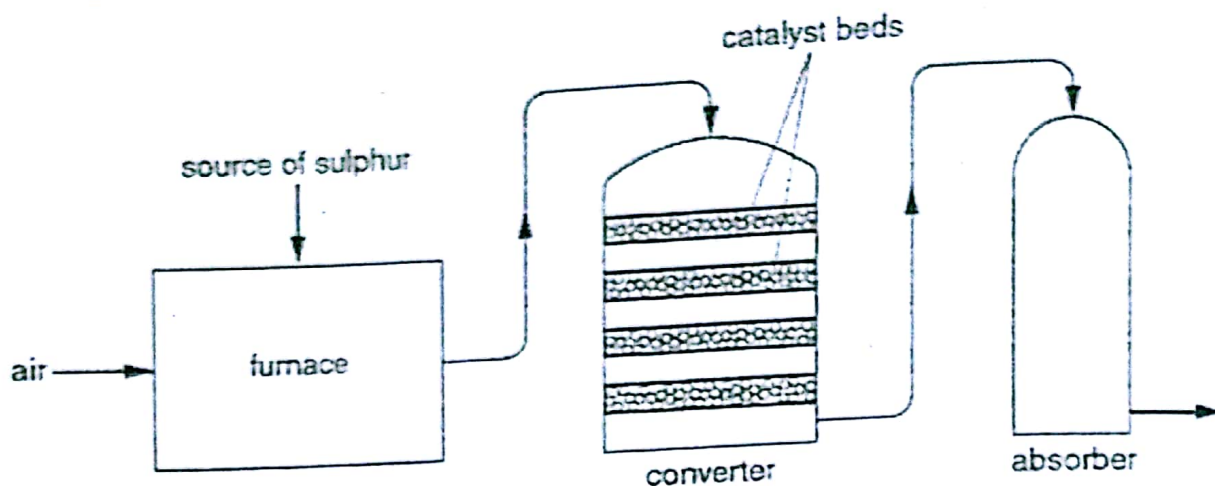
- (d) Fertilisers are added to the soil to improve crop yields. A farmer has the choice of two fertilisers, ammonium nitrate, NH_4NO_3 , or diammonium hydrogen phosphate, $(\text{NH}_4)_2\text{HPO}_4$.

Show by calculation which of these fertilisers contains the greater percentage of nitrogen by mass. [3]

You must show your working.

- (e) State one major problem caused when the nitrates from fertilisers leach from the soil into streams and rivers. [1]

5. The diagram shows the stages in the manufacture of sulphuric acid.

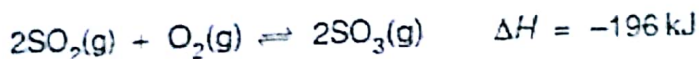


- (a) In the furnace, an ore containing zinc sulphide, ZnS , is heated in oxygen to make zinc oxide, ZnO , and sulphur dioxide.

Write an equation for this reaction.

[1]

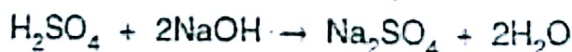
- (b) In the converter, sulphur dioxide and oxygen are passed over a series of catalyst beds at a temperature of about $420\text{ }^\circ\text{C}$.



- (i) An increase in pressure increases the yield of sulphur trioxide. Explain the reason for this effect.
- (ii) Even though an increase in pressure increases the yield of sulphur trioxide, the reaction in the converter is carried out at atmospheric pressure. Suggest a reason for this.
- (iii) In some sulphuric acid plants, the gases are cooled when they pass from one catalyst bed to the next. Use the equation to explain why the gases need to be cooled.
- (c) When sulphuric acid is reacted with excess iron powder, iron(II) sulphate and hydrogen are produced.

Suggest how crystals of iron(II) sulphate could be prepared from this reaction mixture.

- (d) 12.0 cm^3 of an aqueous solution of sulphuric acid exactly neutralised 20.0 cm^3 of a solution of sodium hydroxide of concentration 0.150 mol/dm^3 .



Calculate the concentration, in mol/dm^3 of the aqueous sulphuric acid.