

Name:	Target Grade:	Actual Grade:
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## CHEMICAL CHANGES MCQ and STRUCTURED QUESTIONS

### READ THESE INSTRUCTIONS FIRST

#### INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.
2. Spend one minute on each mark.
3. Time yourself for every single question.
4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.
5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.
6. Highlight question types that you tend to keep making mistakes and review them nearing exams.
7. Always review the common questions and question type that you tend to make mistakes nearing exams.
8. During exams, classify the question type and recall what you have learnt, how you need to analyse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ Wishing you all the best for this test!

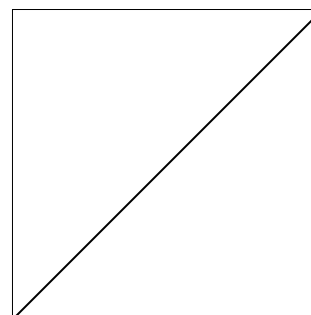
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**MARKS**

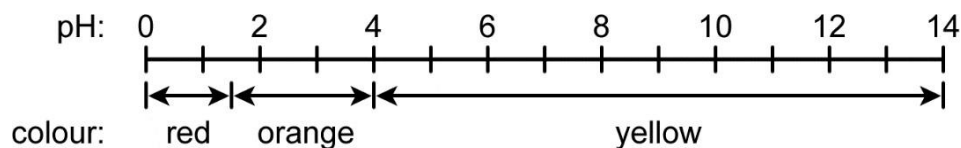


**CHEMICAL CHANGES MCQ**

1 Which one of the following **always** occurs when a chemical reaction takes place?

- A** A gas is produced.
- B** A precipitate is formed.
- C** A colour change takes place.
- D** A new substance is formed.

2 The colour of indicator **Y** in solutions with different pH values is shown in the diagram below.



Which two solutions can indicator **Y** be used to distinguish between?

- A** Dilute hydrochloric acid and dilute nitric acid.
- B** Dilute sodium hydroxide and aqueous sodium chloride (table salt).
- C** Distilled water and dilute hydrochloric acid.
- D** Distilled water and dilute sodium hydroxide.

3 Four aqueous solutions have the pH values shown in the table.

Solution	<b>P</b>	<b>Q</b>	<b>R</b>	<b>S</b>
p	2	6	8	10

If pairs of the solutions are mixed, which pair **must** produce an acidic mixture?

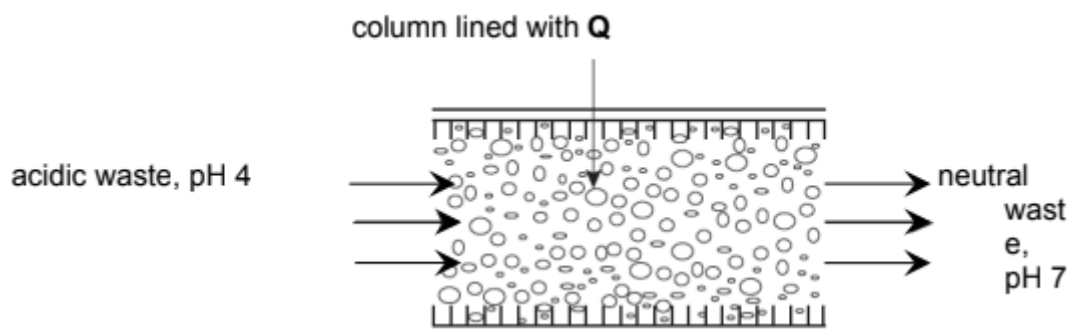
- A** **P** and **Q**
- B** **P** and **R**
- C** **P** and **S**
- D** **Q** and **R**

4 Which statement **best** explains why farmers should not add slaked lime (calcium hydroxide) and fertiliser (ammonium nitrate) to the soil at the same time?

- A** It is not economically viable to add two substances to the soil at the same time.
- B** The slaked lime will react with the fertiliser to make the soil too acidic for plant growth.
- C** The slaked lime will react with the fertiliser to make the soil too alkaline for plant growth.
- D** The slaked lime will react with the fertiliser to produce ammonia which will result in a loss of nitrogen from the soil.

- 5 Calcium, calcium oxide and calcium carbonate all react with nitric acid at room temperature and pressure. Which of the following statement(s) is true for all three reactions?
- 1 a salt is produced
  - 2 water is produced
  - 3 a gas is produced
- A 1 only
  - B 2 only
  - C 1 and 2 only
  - D 2 and 3 only
- 6 Which of the following pairs of substances will react with dilute sulfuric acid to produce a **visible** change?
- A ammonium chloride and sodium chloride
  - B copper and sodium carbonate
  - C magnesium and sodium carbonate
  - D sodium hydroxide and sodium chloride
- 7 Which chemical equation for the reaction between calcium carbonate and phosphoric acid is correct?
- A  $\text{Ca}(\text{CO}_3)_2 + \text{H}_3\text{PO}_4 \rightarrow \text{CaPO}_4 + 2\text{H}_2\text{O} + 2\text{CO}_2$
  - B  $\text{Ca}_2\text{CO}_3 + 2\text{H}_3\text{PO}_4 \rightarrow 2\text{CaPO}_4 + 3\text{H}_2\text{O} + \text{CO}_2$
  - C  $2\text{CaCO}_3 + 3\text{H}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 2\text{H}_2\text{O} + 2\text{CO}_2$
  - D  $3\text{CaCO}_3 + 2\text{H}_3\text{PO}_4 \rightarrow \text{Ca}_3(\text{PO}_4)_2 + 3\text{H}_2\text{O} + 3\text{CO}_2$
- 8 Which reaction will result in the formation of an **insoluble** salt?
- A  $\text{Ba}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{H}_2\text{O}$
  - B  $\text{Cu}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{CuSO}_4 + 2\text{H}_2\text{O}$
  - C  $\text{Fe}(\text{OH})_2 + \text{H}_2\text{SO}_4 \rightarrow \text{FeSO}_4 + 2\text{H}_2\text{O}$
  - D  $2\text{NaOH} + \text{H}_2\text{SO}_4 \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O}$
-

- 9 Which of the following equation is **not** balanced?
- A  $C_3H_6 + 5O_2 \rightarrow CO_2 + 3H_2O$   
 B  $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$   
 C  $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$   
 D  $2KNO_3 \rightarrow 2KNO_2 + O_2$
- 10 Which process is **not** a chemical change?
- A Heating sugar until it becomes brown.  
 B Digesting starch to glucose in our bodies.  
 C Electroplating a hair accessory with a layer of silver.  
 D Heating copper(II) sulfate solution until saturated to form crystals.
- 11 Acidic waste gases produced in a factory are treated with substance **Q** as shown.



- 12 An aqueous solution contains either potassium hydroxide or potassium carbonate.
- Which substance, when added, will **not** be able to differentiate the two types of solutions?
- A ammonium chloride  
 B ethanoic acid  
 C magnesium  
 D sulfuric acid

13 Hydrogen chloride is added separately to hexane (an organic solvent) and water.

Which of the following could be observed when blue litmus is dipped in both?

	hydrogen chloride in hexane	hydrogen chloride in water
<b>A</b>	remains blue	remains blue
<b>B</b>	remains blue	turns red
<b>C</b>	turns red	remains blue
<b>D</b>	turns red	turns red

14 Some substances are heated in air and the observations made are recorded in the table.

Which substance is most likely to have undergone a physical change?

	before heating	during heating	after heating
<b>A</b>	green	black	black solid
<b>B</b>	solid grey	solid light given off	white solid
<b>C</b>	silvery grey liquid	white liquid	white solid
<b>D</b>	silvery grey solid	silvery grey liquid	silvery grey solid

15 The table gives information about three indicators and their colours at different pH.

indicator	colour change as pH increases	pH at which indicator changes colour
methyl orange	red → yellow	5
bromothymol blue	yellow → blue	7
phenolphthalein	colourless → pink	9

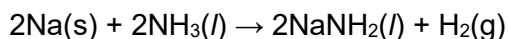
What would be the colour observed at pH 5.6 if equal volumes of the three indicators are mixed together?

- A** green
- B** orange
- C** purple
- D** yellow

- 16 Popping candy is made using citric acid and sodium bicarbonate. When placed in the mouth, these two chemicals react together to make gas bubbles that fizzes and pops in the mouth.

Which of the following is true?

- A The gas bubbles that form is hydrogen gas.
  - B Saliva in the mouth makes the citric acid acidic.
  - C Warmer temperature in the mouth allows the reaction to proceed.
  - D Saliva releases carbon dioxide trapped inside sodium bicarbonate.
- 17 Which one of the following, when added in **excess** to acidic soil, will increase the pH of the soil to exactly 7.0?
- A calcium carbonate
  - B calcium chloride
  - C sodium hydroxide
  - D sodium sulfate
- 18 Sodium reacts with liquid ammonia at a temperature of  $-33\text{ }^{\circ}\text{C}$  according to the following balanced chemical equation.



How is the liquid ammonia behaving in this reaction?

- A As an acid.
  - B As an alkali.
  - C As an indicator.
  - D As a salt.
- 
-

19 The table below shows information about four different pH indicators.

indicator	pH at which colour change takes place	colour at low pH	colour at high pH
methyl orange	3.2 to 4.4	red	yellow
bromocresol blue	3.8 to 5.4	yellow	blue
methyl red	4.8 to 6.0	red	yellow
bromothymol blue	6.0 to 7.6	yellow	red

Which indicator, or set of indicators, is most precise in showing that a solution has a pH of approximately 4.5 to 4.7?

- A** methyl red only
- B** bromocresol blue only
- C** methyl red and methyl orange
- D** methyl red and bromothymol blue

20 Study the following reactions:

- 1 hydrochloric acid + copper
- 2 nitric acid + zinc
- 3 hydrochloric acid + calcium hydroxide
- 4 nitric acid + calcium carbonate

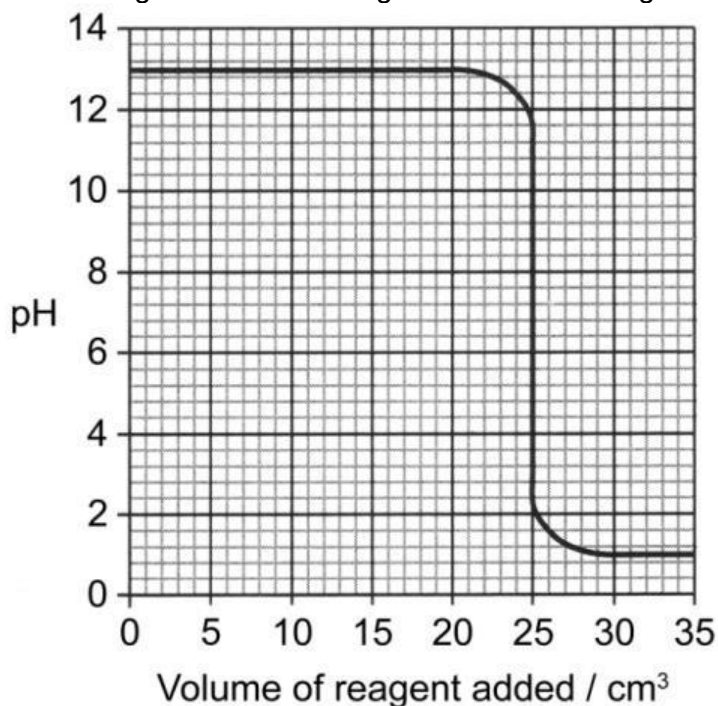
Which reactions will produce a *gas* as one of the products?

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



**CHEMICAL CHANGES STRUCTURED QUESTIONS**

- 1 A student performed an experiment by reacting dilute nitric acid and an aqueous solution of sodium hydroxide together in a conical flask. The graph in Fig. 5.1 shows how the pH of the solution in the conical flask changed as the two reagents were mixed together.



**Fig. 5.1**

- (a) State which reagent, dilute nitric acid or aqueous sodium hydroxide, was present in the conical flask at the start of the experiment. Explain your answer.

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

[2]

- (b) State the pH of the solution in the conical flask after 30.0 cm<sup>3</sup> of reagent had been added.

.....

[1]

- (c) The solution in the conical flask contained some universal indicator. State the colours of the solution in the conical flask after the following volumes of reagent had been added

(i) 30.0 cm<sup>3</sup>: .....

(ii) 10.0 cm<sup>3</sup>: .....

[2]

(d) State the volume of dilute nitric acid required to neutralise the aqueous solution of sodium hydroxide.

..... [1]

(e) Write a balanced chemical equation, including state symbols, for the reaction between the dilute nitric acid and the aqueous solution of sodium hydroxide.

..... [2]

2 Heartburn occurs when hydrochloric acid from the stomach moves up into the oesophagus, causing pain and irritation. This discomfort may be eased by taking an antacid. The antacid reacts with the excess hydrochloric acid and neutralises it. There are different types of antacids available on the market. Antacids that contain calcium carbonate as the active ingredient are sold as chewable tablets. Antacids that contain a suspension of solid magnesium hydroxide in water are sold under the name *Milk of Magnesia*.



(a) State and explain which antacid a person should take if they **do not wish** to feel 'gassy' and 'bloating': the one containing calcium carbonate or the one containing magnesium hydroxide.

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

- (b) Write a balanced chemical equation, including state symbols, for **either** the reaction between calcium carbonate and hydrochloric acid **or** for the reaction between magnesium hydroxide and hydrochloric acid.

..... [2]

- (c) Fig. 6.1 shows the pH of some substances.

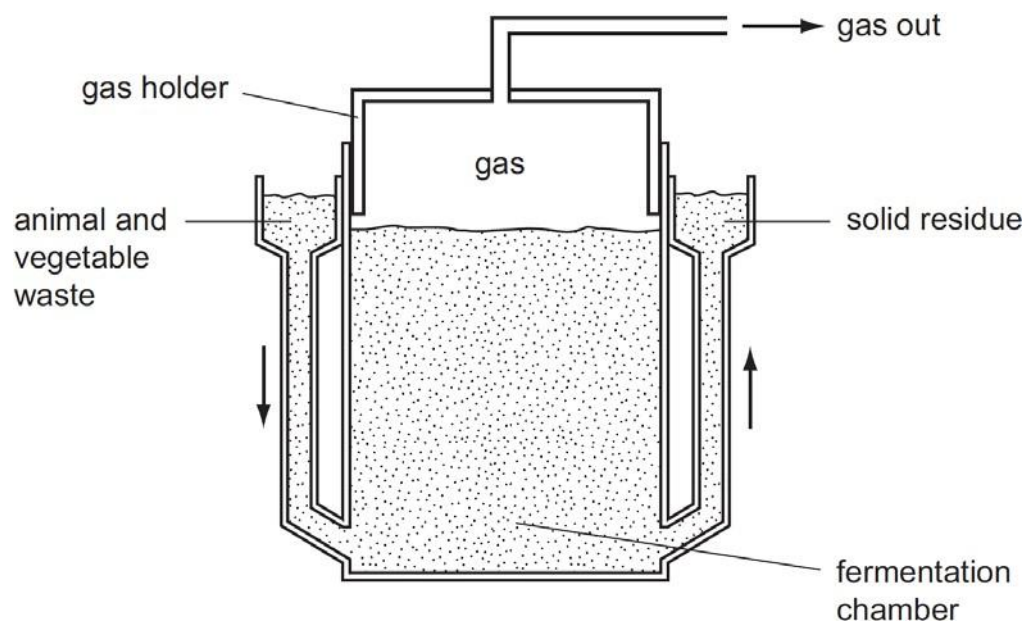
Substan	p
ce vinegar	H
baking soda	3
solution of table salt	8
fizzy drink	7

**Fig. 6.1**

State and explain what a person who does not have any antacid tablets could take to relieve their heartburn.

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

- 3 Fig 3.1 shows a biogas digester. Animal and vegetable wastes are fermented by bacteria. The gas produced is a mixture of mainly carbon dioxide and methane.



**Fig 3.1**

- Is fermentation a physical or chemical change? Explain your answer.

[1]

- Hydrogen is also produced during the fermentation but will react with carbon dioxide to give methane and water.
  - Write a chemical equation for this reaction.

[1]

- Describe how you can test to check if carbon dioxide is still present in the gas exiting the biogas digester.

[2]

- The solid residue from the biogas digester can be used as an organic fertiliser. Chemical fertilisers use certain chemicals to provide plants with nitrogen and phosphorus.

The table shows some common chemicals added to fertilisers. Complete the table.

chemical name	chemical formula
potassium chloride	
	$\text{Ca}_3(\text{PO}_4)_2$
ammonium sulfate	

[3]

**Total [ 7 ]**

- 4** In Singapore, it is safe to drink our tap water directly, as it has been chemically treated, filtered, and disinfected.

To kill bacteria and remove viruses, the water is disinfected with chlorine. Chlorine reacts with water to give hypochlorous acid and hydrochloric acid:



To balance the pH of water after disinfection, lime (solid calcium hydroxide) is added. The average pH of Singapore's tap water is 8.1, and generally ranges from pH 7.8 to 8.4.

- Hypochlorous acid is an acid. Define the term '*acid*'.

[1]

- (i) Write the chemical equation, with state symbols, for the reaction of calcium hydroxide with hydrochloric acid.

\_\_\_\_\_ [2]

- (ii) Suggest the formula of the salt formed when hypochlorous acid reacts with calcium hydroxide.

\_\_\_\_\_ [1]

- Table 4.1 shows some pH indicators and their colours at various pH.

**Table 4.1**

indicator	colour in type of solution		pH range that it changes colour in
	strongly acidic	strongly alkaline	
chlorophenol blue			4.8 – 6.4
bromothymol blue			6.0 – 7.6
cresol red	yellow	red	7.2 – 8.8
phenolphthalein	yellow	blue	8.3 – 10.0
	yellow	red	
	colourless	pink	

- State the colour of chlorophenol blue when added to our tap water.

[1]

- Which pair of indicators should be used to show that the pH range of our tap water is around pH 7.8 to 8.4? Explain your answer.

[2]

- Given that some water pipes could be made of metal, explain whether it is preferable for our water to be slightly alkaline or acidic.

[2]

**Total [ 9 ]**

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5 In baking, leavening agents are used to cause production of gas bubbles that lighten and soften the dough mixture.

- a. In the past, solid ammonium carbonate,  $(\text{NH}_4)_2\text{CO}_3$ , was used as a leavening agent in traditional recipes, as shown in the ingredients listed in Fig 11.1 below.

**Ingredients**  
 Fortified **wheat** flour (**wheat** flour, iron, thiamin, nicotinic acid, calcium carbonate), Sugar, Palm oil, Desiccated coconut (8%), **Wheat** starch, Glucose syrup, Raising agents (ammonium carbonates, sodium carbonates), **Milk** powder, Salt, Flavourings.

**Fig 11.1**

It can react with both acidic and alkaline ingredients in the dough mixture to produce a gas.

- (i) Write the balanced chemical equation for the reaction between ammonium carbonate and nitric acid.

[1]

- (ii) Solid ammonium carbonate cannot be kept for too long at high temperatures because it decomposes to form water vapour, carbon dioxide and ammonia gas.

Write the balanced chemical equation for the reaction, with state symbols.

[2]

- b. Another leavening agent that is more commonly used now is sodium hydrogen carbonate,  $\text{NaHCO}_3$ . When dissolved in water, sodium hydrogen carbonate ionises, but it does not turn blue litmus red.

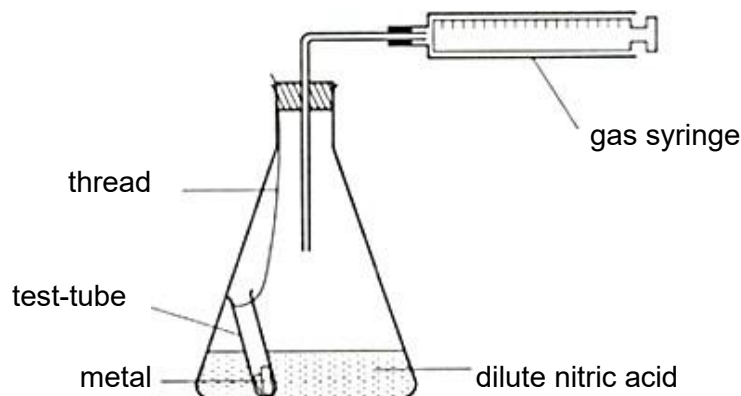
Explain what can be deduced about the ions that sodium hydrogen carbonate forms when dissolved in water.

[2]

**Total [5]**



- 6 An experiment was done to investigate how different metals reacted with dilute nitric acid. The set-up for the experiment is shown in Fig 12.1 below.



**Fig 12.1**

A gas syringe was used to collect the gas produced from the reaction. The time taken for effervescence to stop was measured and recorded in Table 12.2 below.

metal	Fe	P	S	Zn
time / s	37	b	n	28

**Table 12.2**

- c. Arrange the metals in increasing order of reactivity.

[1]

- d. Write the balanced chemical equation for the reaction between the most reactive metal in (a), and dilute nitric acid.

[1]

- e. Suggest, with reasons, what would have been observed if copper metal had been added to dilute nitric acid.

[2]

- f. Explain why this method of measuring volume of gas is **not** suitable for all gases.

7 Soil pH is a measure of acidity or alkalinity of the soil in which plants grow.

In some areas, some soils are too alkaline due to the minerals that are found in them. As such, they need to be acidified and this is usually done by adding sulfur into the soil.

- g. State the type of chemical reaction that occurs between an acid and the alkaline soil.

[1]

- h. Sulfur, S, reacts with oxygen in the air and water in the soil to produce sulfuric acid, which helps to increase the soil acidity.

Write the balanced chemical equation for this reaction.

[1]

- i. *Hydrangea macrophylla* is a species of flowering hydrangea. Its flowers' colours are determined by the pH of the soil that they are grown in, as shown in Table 13.1 below.

pH							
4.5	5.0	5.5	6.0	6.5	7.0	7.5	
blue					pink		red

**Table 13.1**

It was observed that the flowers growing in a plot of soil were blue.

In order to change the flowers' colour to pink, either sodium hydroxide solution or calcium carbonate powder could be used. Suggest which is a better option and give a reason for your choice.

[2]

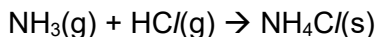
**Total [4]**

- 8 There is more than one theory to define what acids and bases are.

The Arrhenius definition of an acid is a substance that dissolves in water to produce  $H^+$  ions, while an alkali is a substance that dissolves in water to produce  $OH^-$  ions.

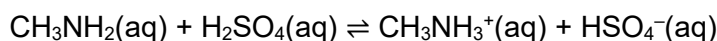
The Bronsted-Lowry definition of an acid is a substance that is capable of donating a proton,  $H^+$  while a base is a substance that is capable of accepting a proton.

Example 1:



Hydrogen chloride acts as the proton donor (acid) while ammonia acts as the proton acceptor (base).

Example 2:



Sulfuric acid acts as the proton donor (acid) while methylamine,  $CH_3NH_2$ , acts as the proton acceptor (base).

- (a) Acid-base reactions by the Arrhenius definition are also acid-base reactions by the Bronsted-Lowry definition.

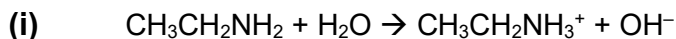
Write the balanced chemical equation of the reaction between limewater and hydrochloric acid (state symbols are not required).

\_\_\_\_\_ [1]

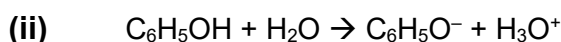
- (b) Why is the reaction in Example 1 not an acid-base reaction by the Arrhenius definition?

\_\_\_\_\_ [1]

- (c) For each of the equation shown, identify the acid based on the Bronsted-Lowry definition.



Acid: \_\_\_\_\_ [1]



Acid: \_\_\_\_\_ [1]

- 9 pKa is a measure of the strength of an acid. The lower the pKa, the stronger the acid. Below is a table showing the pKa of a few acids.

acid	p
CH <sub>3</sub> COOH	K
H <sub>2</sub> SO <sub>4</sub>	a
H	5
Cl	-3
HBr	-6

- a. (i) Define the term “strength of an acid”.

---

[1]

- (ii) Group 17 elements form hydrogen halides (HX) that dissolve in water to give strong acids. Based on the pKa table, describe the changes in strength of the acid HX formed down group 17.

---

[1]

- b. To a 50 cm<sup>3</sup> solution of 1 mol/dm<sup>3</sup> hydroiodic acid, 50 cm<sup>3</sup> of water was added. State how this would affect the following factors in the table below (doubled, halved or no change).

Factor	Expected change
Strength	
Concentration	
Basicity	

[3]

**Total [5]**

- 10** When propane ( $C_3H_8$ ), a substance used in cooking gas, is burnt in the presence of oxygen, it produces water, as well as carbon dioxide or carbon monoxide. This is known as a combustion reaction. The table below shows the melting and boiling points of carbon dioxide and carbon monoxide.

name	formula	melting point/ $^{\circ}C$	boiling point/ $^{\circ}C$
carbon monoxide	CO	-205	-192
carbon dioxide	CO <sub>2</sub>	-57	-79

- c. Balance the following equations by writing coefficients wherever necessary.

(i)



(ii)



- d. Based on your answer in (a), suggest what kind of reaction condition would carbon monoxide be produced instead of carbon dioxide during the combustion of propane gas.

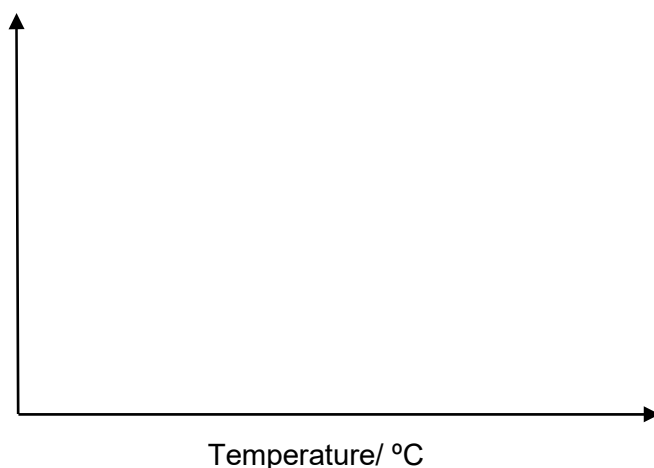
[Hint: look at the ratio of propane : oxygen gas]

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- e. Draw the boiling curve for carbon dioxide with the axes below.



[1]

- f. Define the type of bond present in carbon dioxide.

[2]

---



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[1]

- g. The bonding of carbon monoxide contains a **dative** bond, where the sharing of electrons is **unequal**. Below is the dot-and-cross diagram (showing only valence electrons) of carbon monoxide.



- i. Draw the structural formula of carbon monoxide.

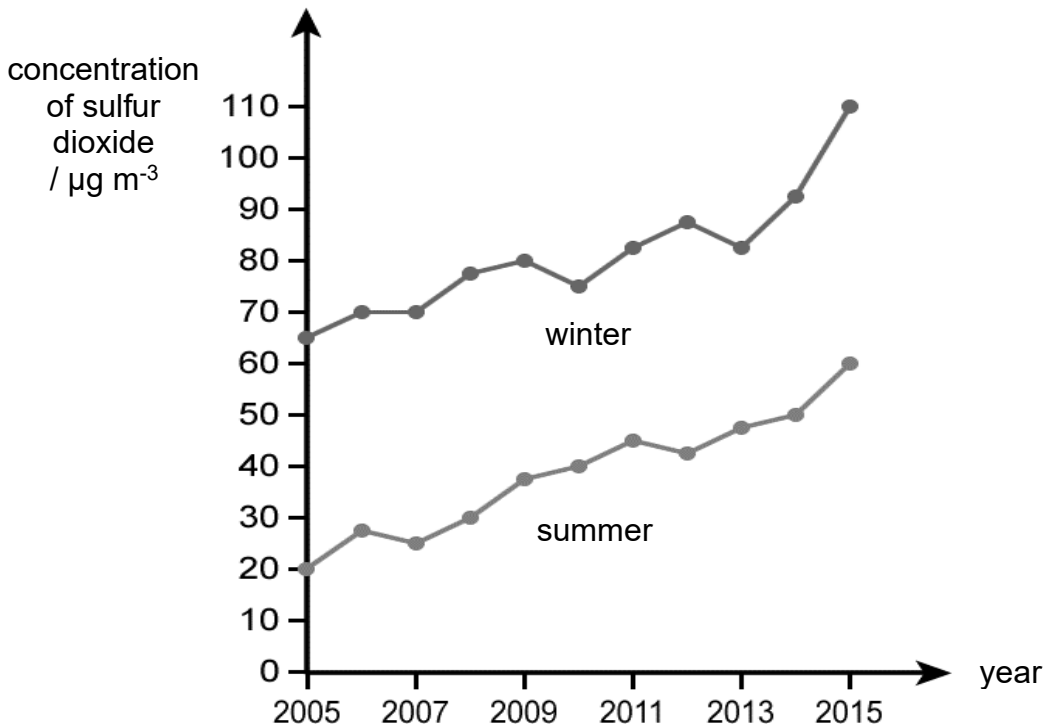
[1]

- ii. How many electrons **in total** are **not** involved in bonding in one molecule of carbon monoxide?

[1]

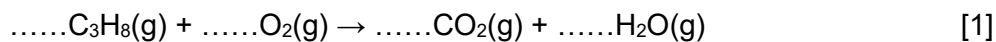
**Total [8]**

- 11** Sulfur dioxide is an acidic gas that is released into the Earth’s atmosphere when fossil fuels are burned in power stations to produce energy. The concentration of sulfur dioxide is checked regularly in all major cities around the world. Fig. 3.1 shows how the average winter and summer concentrations of sulfur dioxide changes at one monitoring station in a city in Northern China between 2005 and 2015.



**Fig. 3.1**

- (d)** One example of a fossil fuel is propane, formula C<sub>3</sub>H<sub>8</sub>. Propane burns in air to form carbon dioxide and water. Balance the following equation by writing whole number coefficients in the spaces provided.



- (e)** With reference to data from the graph, state how the concentration of sulfur dioxide gas has changed from 2005 to 2015 during the summer.

..... [1]

- (f) Based on the information given, comment and explain on the significant difference between the winter and summer levels of sulfur dioxide from 2005 to 2015.

..... [2]

- (g) What environmental problems will be caused when large volumes of sulfur dioxide gas are released into the Earth's atmosphere?

..... [2]

[Total: 6m]



- 12 Citric acid, chemical formula  $C_6H_8O_7$ , is found naturally in citrus fruits such as lemons and limes, giving them their typical sour taste. The full structural formula of a citric acid molecule is given in Fig. 4.1.

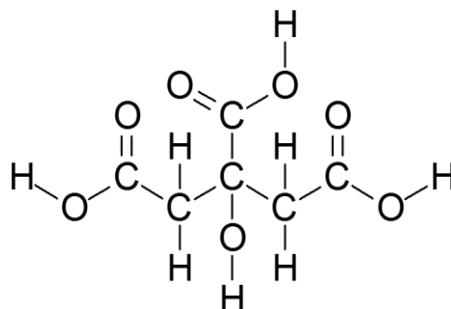


Fig. 4.1

This complex molecule may be simplified to the structure given in Fig. 4.2.

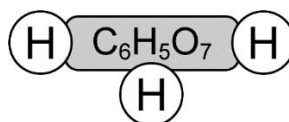


Fig. 4.2

- a. Citric acid dissolves in water to produce hydrogen ions as the only positive ion. Fig. 4.3 shows a solution made by dissolving citric acid in water. Note: The water molecules have been omitted for clarity.

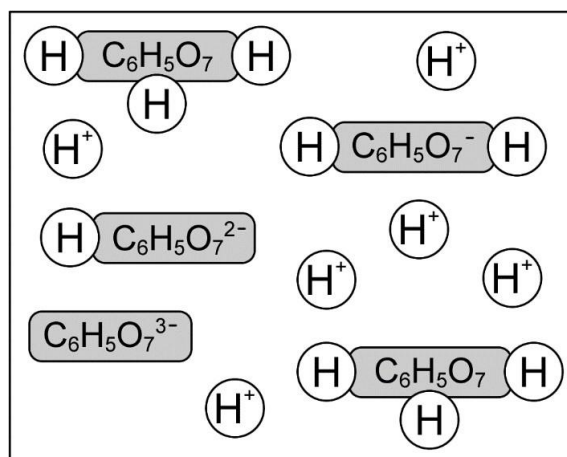
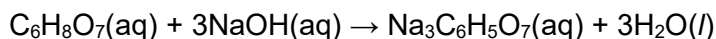


Fig. 4.3

Using information given in the diagram, state the basicity and strength of citric acid.

..... [2]

- b. Citric acid reacts with sodium hydroxide to form sodium citrate and water according to the following balanced chemical equation.



- (i) From the information provided, deduce the balanced chemical equation for the reaction between citric acid and potassium carbonate to produce a salt, water and carbon dioxide. State symbols are **not** required.

\_\_\_\_\_ [2]

- (ii) Draw a dot-and-cross diagram to clearly show the bonding in carbon dioxide. You are only required to draw the valence electrons. [1]

- c. Citric acid will react with magnesium, a metal from Group 2 of the Periodic Table, to form magnesium citrate and hydrogen gas.

- (i) Give the formula for magnesium citrate.

\_\_\_\_\_ [1]

- (ii) Name **two** metals that will **not** react with citric acid.

\_\_\_\_\_ [1]

- (iii) Describe the laboratory test for hydrogen gas.

\_\_\_\_\_ [1]

- d. Apart from carbon dioxide and hydrogen, another gas that can be easily prepared in the laboratory is ammonia. One way of preparing a sample of ammonia is by reacting aqueous ammonium sulfate with solid calcium oxide to form a solid salt, water and ammonia as the products.

- (i) Write the balanced chemical equation for this reaction, including state symbols.

\_\_\_\_\_ [2]

- (ii) Draw a dot-and-cross diagram to clearly show the bonding in calcium oxide. You are only required to draw the valence electrons. [1]

[Total: 11m]

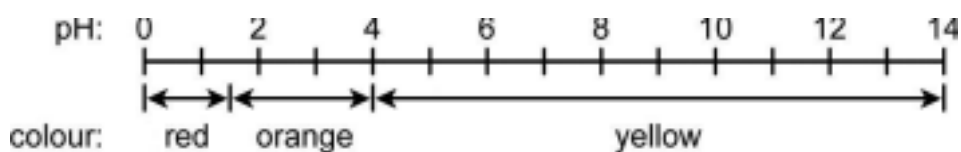
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**ANSWER FOR CHEMICAL CHANGES MCQ**

1. Which one of the following **always** occurs when a chemical reaction takes place?

- A A gas is produced.
- B A precipitate is formed.
- C A colour change takes place.
- D A new substance is formed.**

2 The colour of indicator Y in solutions with different pH values is shown in the diagram below.



Which two solutions can indicator Y be used to distinguish between?

- A Dilute hydrochloric acid and dilute nitric acid.
- B Dilute sodium hydroxide and aqueous sodium chloride (table salt).
- C Distilled water and dilute hydrochloric acid.**
- D Distilled water and dilute sodium hydroxide.

3 Four aqueous solutions have the pH values shown in the table.

Solution	P	Q	R	S
pH	2	6	8	10

If pairs of the solutions are mixed, which pair **must** produce an acidic mixture?

- A P and Q**
- B P and R
- C P and S
- D Q and R

- 4 Which statement **best** explains why farmers should not add slaked lime (calcium hydroxide) and fertiliser (ammonium nitrate) to the soil at the same time?

A It is not economically viable to add two substances to the soil at the same time.

B The slaked lime will react with the fertiliser to make the soil too acidic for plant growth.

C The slaked lime will react with the fertiliser to make the soil too alkaline for plant growth.

**D The slaked lime will react with the fertiliser to produce ammonia which will result in a loss of nitrogen from the soil.**

- 5 Calcium, calcium oxide and calcium carbonate all react with nitric acid at room temperature and pressure. Which of the following statement(s) is true for all three reactions?

1 a salt is produced

2 water is produced

3 a gas is produced

**A 1 only**

B 2 only

C 1 and 2 only

D 2 and 3 only

- 6 Which of the following pairs of substances will react with dilute sulfuric acid to produce a **visible** change?

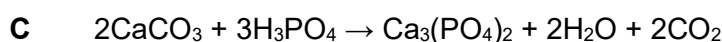
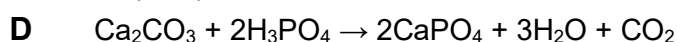
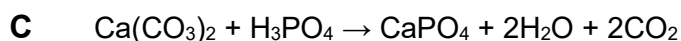
A ammonium chloride and sodium chloride

B copper and sodium carbonate

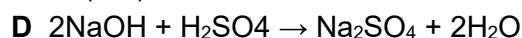
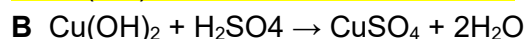
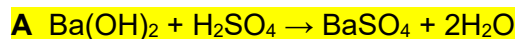
**C magnesium and sodium carbonate**

D sodium hydroxide and sodium chloride

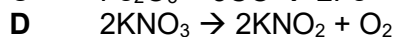
- 7 Which chemical equation for the reaction between calcium carbonate and phosphoric acid is correct?



8 Which reaction will result in the formation of an **insoluble** salt?



9 Which of the following equation is **not** balanced?



10 Which process is **not** a chemical change?

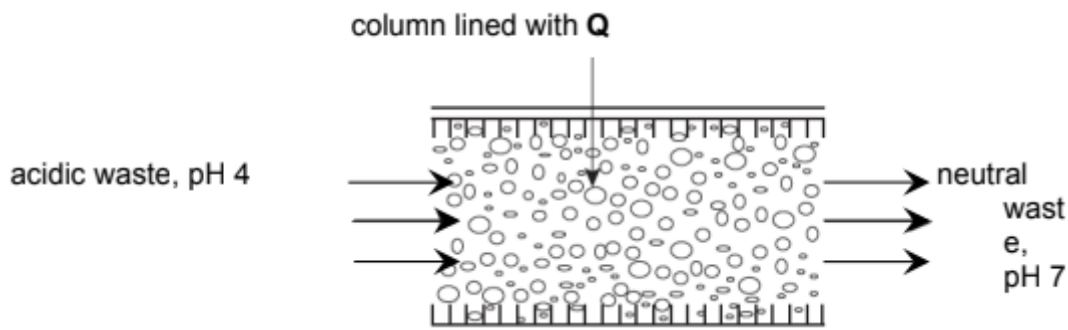
**A** Heating sugar until it becomes brown.

**B** Digesting starch to glucose in our bodies.

**C** Electroplating a hair accessory with a layer of silver.

**D** Heating copper(II) sulfate solution until saturated to form crystals.

11 Acidic waste gases produced in a factory are treated with substance **Q** as shown. column lined with **Q**



What can Q be?

table salt

**slaked lime**

vinegar

water

12 An aqueous solution contains either potassium hydroxide or potassium carbonate.

Which substance, when added, will **not** be able to differentiate the two types of solutions?

**A** ammonium chloride

**B** ethanoic acid

**C** magnesium

**D** sulfuric acid

13 Hydrogen chloride is added separately to hexane (an organic solvent) and water.

Which of the following could be observed when blue litmus is dipped in both?

	hydrogen chloride in hexane	hydrogen chloride in water
A	remains blue	remains blue
B	remains blue	turns red
C	turns red	remains blue
D	turns red	turns red

14 Some substances are heated in air and the observations made are recorded in the table.

Which substance is most likely to have undergone a physical change?

	before heating	during heating	after heating
A	green solid	black solid	black solid
B	grey solid	light given off	white solid
C	silvery grey liquid	white liquid	white solid
D	silvery grey solid	silvery grey liquid	silvery grey solid

15 The table gives information about three indicators and their colours at different pH.

indicator	colour change as pH increases	pH at which indicator changes colour
methyl orange	red → yellow	5
bromothymol blue	yellow → blue	7
phenolphthalein	colourless → pink	9

What would be the colour observed at pH 5.6 if equal volumes of the three indicators are mixed together?

- A green
- B orange
- C purple
- D yellow

16 Popping candy is made using citric acid and sodium bicarbonate. When placed in the mouth, these two chemicals react together to make gas bubbles that fizzes and pops in the mouth.

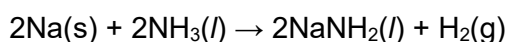
Which of the following is true?

- A The gas bubbles that form is hydrogen gas.
- B Saliva in the mouth makes the citric acid acidic.
- C Warmer temperature in the mouth allows the reaction to proceed.
- D Saliva releases carbon dioxide trapped inside sodium bicarbonate.

17 Which one of the following, when a **excess** to acidic soil, will increase soil to exactly 7.0?

- A calcium carbonate**
- B calcium chloride
- C sodium hydroxide
- D sodium sulfate

18 Sodium reacts with liquid ammonia at a temperature of  $-33\text{ }^{\circ}\text{C}$  according to the following balanced chemical equation.



How is the liquid ammonia behaving in this reaction?

- A As an acid.**
- B As an alkali.
- C As an indicator.
- D As a salt.

19 The table below shows information about four different pH indicators.

indicator	pH at which colour change takes place	colour at low pH	colour at high pH
methyl orange	3.2 to 4.4	red	yellow
bromocresol blue	3.8 to 5.4	yellow	blue
methyl red	4.8 to 6.0	red	yellow
bromothymol blue	6.0 to 7.6	yellow	red

Which indicator, or set of indicators, is most precise in showing that a solution has a pH of approximately 4.5 to 4.7?

- A methyl red only
- B bromocresol blue only
- C methyl red and methyl orange**
- D methyl red and bromothymol blue

20 Study the following reactions:

- 1 hydrochloric acid + copper
- 2 nitric acid + zinc

3 hydrochloric acid + calcium hydroxide

4 nitric acid + calcium carbonate

Which reactions will produce a *gas* as one of the products?

A 1 and 2 only

B 1 and 3 only

C 2 and 3 only

D 2 and 4 only

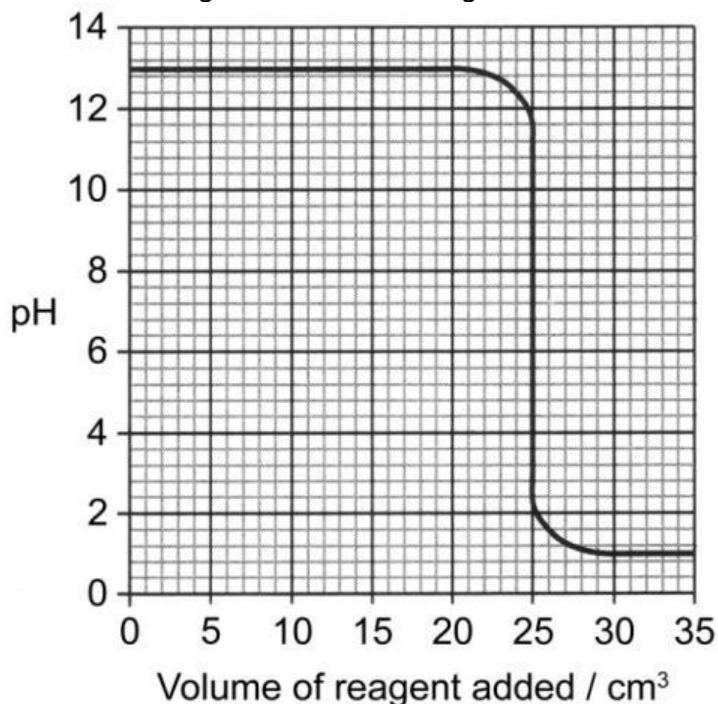
**ANSWER FOR CHEMICAL CHANGES STRUCTURED QUESTIONS**

1 A student performed an experiment by reacting dilute nitric acid and an aqueous solution of

---



sodium hydroxide together in a conical flask. The graph in Fig. 5.1 shows how the pH of the solution in the conical flask changed as the two reagents were mixed together.



**Fig. 5.1**

- a. State which reagent, dilute nitric acid or aqueous sodium hydroxide, was present in the conical flask at the start of the experiment. Explain your answer.

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

- b. State the pH of the solution in the conical flask after 30.0 cm<sup>3</sup> of reagent had been added.

.....[1]

- c. The solution in the conical flask contained some universal indicator. State the colours of the solution in the conical flask after the following volumes of reagent had been added

(i) 30.0 cm<sup>3</sup>: .....

(ii) 10.0 cm<sup>3</sup>: .....

[2]

d. State the volume of dilute nitric acid required to neutralise the aqueous solution of sodium hydroxide.

.....[1]

e. Write a balanced chemical equation, including state symbols, for the reaction between the dilute nitric acid and the aqueous solution of sodium hydroxide.

..... [2]

Answer:

(a) Sodium hydroxide was present in the flask at the start of the reaction. 1 mark The pH of the reagent in the flask at the start of the reaction is 13.0, showing that it is alkaline. 1 mark

(b) pH = 1.0. 1 mark

(c) (i) 30.0 cm<sup>3</sup>: Red. 1 mark

(ii) 10.0 cm<sup>3</sup>: Blue or purple. 1 mark

(d) 25 cm<sup>3</sup> or 25.0 cm<sup>3</sup>. 1 mark

(e)  $\text{HNO}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaNO}_3(\text{aq}) + \text{H}_2\text{O}(\text{l})$  1

mark for correct formulae and correctly balanced 1 mark for correct state symbols

[Total = 8 marks]

2 Heartburn occurs when hydrochloric acid from the stomach moves up into the oesophagus, causing pain and irritation. This discomfort may be eased by taking an antacid. The antacid reacts with the excess hydrochloric acid and neutralises it. There are different types of antacids available on the market. Antacids that contain calcium carbonate as the active ingredient are sold as chewable tablets. Antacids that contain a suspension of solid magnesium hydroxide in water are sold under the name *Milk of Magnesia*.



(a) State and explain which antacid a person should take if they **do not wish** to feel 'gassy' and 'bloating': the one containing calcium carbonate or the one containing magnesium hydroxide.

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

[2]

- (b) Write a balanced chemical equation, including state symbols, for **either** the reaction between calcium carbonate and hydrochloric acid **or** for the reaction between magnesium hydroxide and hydrochloric acid.

.....[2]

- (c) Fig. 6.1 shows the pH of some substances.

Substan	p
ce vinegar	H
baking soda	3
solution of table salt	8
fizzv drink	7

**Fig. 6.1**

State and explain what a person who does not have any antacid tablets could take to relieve their heartburn.

.....  
 .....

..... [2]

Answer:

- (a) The antacid that contains magnesium hydroxide. 1 mark  
 Magnesium hydroxide reacts with hydrochloric acid to form a salt and water only, while calcium carbonate will also produce carbon dioxide gas. 1 mark



OR



1 mark for correct formulae and correctly balanced

1 mark for correct state symbols

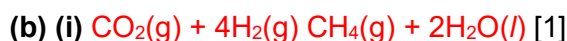
- (c) Baking soda. 1 mark

It is the only chemical from the list that has a pH value greater than seven (and hence it will neutralise the acid).

1 mark

[Total = 5 marks]

- 3 (a) It is a chemical change as new substances (CO<sub>2</sub> and CH<sub>4</sub>) are produced. [1]



- (ii) Bubble the gas into limewater [1].  
If white precipitate formed, CO<sub>2</sub> is produced [1].

[2]

chemical name	chemical formula
potassium chloride	KCl
calcium phosphate	Ca <sub>3</sub> (PO <sub>4</sub> ) <sub>2</sub>
ammonium sulfate	(NH <sub>4</sub> ) <sub>2</sub> SO <sub>4</sub>

(c) [3]

**Total [7]**

- 4 (a) It is a substance that dissolves in water to produce H<sup>+</sup> ions. [1]

- (b) (i)  $2\text{HCl}(\text{aq}) + \text{Ca}(\text{OH})_2(\text{s}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$  [2]

- (ii)  $\text{Ca}(\text{OC})_2$  [1]

- (c) (i) Red. [1]

- (ii)  
Bromothymol blue and phenolphthalein. [1]

When bromothymol blue is blue, and phenolphthalein is colourless, it indicates that the pH range is between 7.6 and 8.3, close to the pH range of 7.8 – 8.4. [1]

[2]

- (d) Preferable to be alkaline, as if the water is acidic, it might react with metal water pipes to give salt and hydrogen gas. [1]

Accept any reasonable problem that might pose [1]:  
- the metal pipes will be corroded and might eventually collapse/ burst hydrogen gas is a flammable gas and the accumulation of it in the pipes might lead to an explosion/ fire

[2]

5 (a) (i)  $(\text{NH}_4)_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NH}_4\text{NO}_3 + \text{CO}_2 + \text{H}_2\text{O}$  [1]

(ii)  $(\text{NH}_4)_2\text{CO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g}) + 2\text{NH}_3(\text{g})$

1m for balanced equation 1m for state symbols

(b) Sodium bicarbonate does not ionize to form  $\text{H}^+$  ions as the solution was not acidic and hence did not turn blue litmus red.

R: it produced  $\text{OH}^-$  ions and was alkaline (it could have been neutral as well)

[2]

Total [ 5 ]

6 (a) Pb, Sn, Fe, Zn (the shortest time indicates the most reactive metal) [1]

(b)  $\text{Zn} + 2\text{HNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + \text{H}_2$  [1]

(c) There would have been no effervescence / there would be no visible observations. [1]

R: no changes / no reaction / no observation

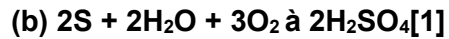
This is because copper is unreactive when added to dilute acids. [1]

[2]

(d) Some gases are soluble in water (and hence will not enter the gas syringe). [1]

Total [ 5 ]

7 (a) neutralisation [1]



(c) Calcium carbonate is a better choice. Both can react with the acid but sodium hydroxide is an alkali and can cause the pH to increase beyond 7.0.

[2]

OR

Sodium hydroxide, but it has to be measured and added in an exact amount so that not too much is added such that it brings the pH up to beyond 7.0 and makes the flowers red instead.

R: calcium carbonate is a better acid (it is not);

calcium carbonate is a solid hence it will not react (it will!); calcium carbonate will not dissolve and hence will last longer;  
sodium hydroxide will be absorbed by the plant more easily (it is not meant to be absorbed by the plant but to react with the soil);  
sodium hydroxide is an alkali and will be able to neutralise the acid (actually once the calcium carbonate reacts with the acid, there will be less H<sup>+</sup>ions and pH will increase);  
sodium hydroxide will not produce a greenhouse gas (but it will not solve the problem of the soil being pH 7.0 either).

Total [ 4 ]

8 (a) (i)  $(\text{NH}_4)_2\text{CO}_3 + 2\text{HNO}_3 \rightarrow 2\text{NH}_4\text{NO}_3 + \text{CO}_2 + \text{H}_2\text{O}$  [1]

(ii)  $(\text{NH}_4)_2\text{CO}_3(\text{s}) \rightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}_2(\text{g}) + 2\text{NH}_3(\text{g})$

1 m for balanced equation 1m for state symbol

(b) Sodium bicarbonate **does not ionize to form H<sup>+</sup>ions** as the solution **was not acidic** and hence did not turn blue litmus red.

R: it produced OH<sup>-</sup>ions and was alkaline (it could have been neutral as well)  
[2]

**Total [5]**

9 (a) Pb, Sn, Fe, Zn (the shortest time indicates the most reactive metal) [1]

(b)  $\text{Zn} + 2\text{HNO}_3 \rightarrow \text{Zn}(\text{NO}_3)_2 + \text{H}_2$  [1]

(c) There would have been **no effervescence** / there would be **no visible observations**. [1]

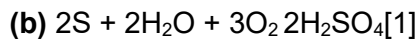
R: no changes / no reaction / no observation

This is because copper is **unreactive when added to dilute acids**. [1]

(d) Some gases are **soluble in water** (and hence will not enter the gas syringe).

**Total [ 5 ]**

10 (a) neutralisation [1]



(c) Calcium carbonate is a better choice. Both can react with the acid but **sodium hydroxide is an alkali** and can cause the pH to **increase beyond 7.0**. [2]

OR

Sodium hydroxide, but it has to be **measured and added in an exact amount** so that **not too much is added** such that it brings the pH up to beyond 7.0 and makes the flowers red instead.

R: calcium carbonate is a better acid (it is not);

calcium carbonate is a solid hence it will not react (it will!); calcium carbonate

will not dissolve and hence will last longer;

sodium hydroxide will be absorbed by the plant more easily (it is **not** meant to be absorbed by the plant but to react with the soil);

sodium hydroxide is an alkali and will be able to neutralise the acid (actually once the calcium carbonate reacts with the acid, there will be less  $H^+$  ions and pH will increase);

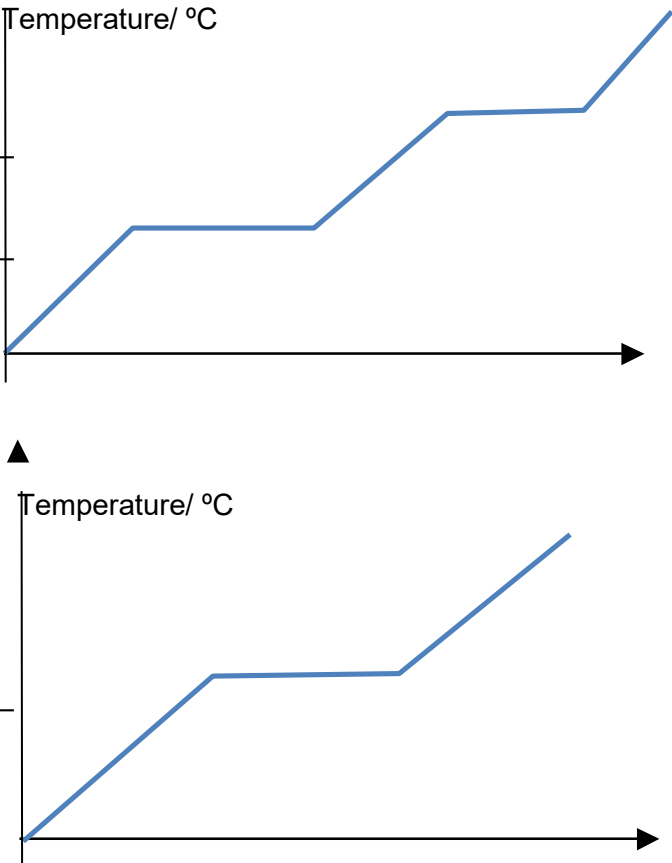
sodium hydroxide will not produce a greenhouse gas (but it will not solve the problem of the soil being pH 7.0 either).


**Total [ 4 ]**

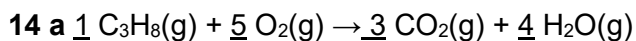


11	(a)	$\text{Ca(OH)}_2 + 2\text{HCl} \rightarrow \text{CaCl}_2 + 2\text{H}_2\text{O}$		[1]
	(b)	<p>HCl is not dissolved in water, hence it is not an acid by the Arrhenius definition.</p> <p>Accept:</p> <ul style="list-style-type: none"> <li>- HCl is in gaseous state and does not produce <math>\text{H}^+</math> ions</li> <li>- HCl is not in aqueous state</li> <li>- Water is not produced in the reaction even though acid-base reactions produce salt and water</li> </ul> <p>Reject:</p> <ul style="list-style-type: none"> <li>- <math>\text{H}^+</math> and <math>\text{OH}^-</math> ions not produced in the reaction</li> <li>- <math>\text{NH}_3</math> is not an alkali/base</li> <li>- <math>\text{NH}_3</math> does not dissolve in water to give hydroxide ions</li> <li>- acid-base reactions produce salt and water</li> </ul>		[1]
	(c)	(i)	$\text{H}_2\text{O}$	[1]
		(ii)	$\text{C}_6\text{H}_5\text{OH}$	
				<b>Total [4]</b>
12	(a)	(i)	It is the extent / degree of dissociation/ ionization to give $\text{H}^+$ ions (in water)	[1]
		(ii)	Down the group, the strength of the acid HX becomes stronger.	[1]
	(b)			[3]
				<b>Total [5]</b>

Factor	Expected change
Strength	no change
Concentration	halved
Basicity	no change

13	(a)	(i)	.....C <sub>3</sub> H <sub>8</sub> + .....5.....O <sub>2</sub> → .....3.....CO <sub>2</sub> + .....4.....H <sub>2</sub> O	[1]	
		(ii)	.....2.....C <sub>3</sub> H <sub>8</sub> + .....7.....O <sub>2</sub> → .....6.....CO + .....8.....H <sub>2</sub> O	[1]	
	(b)	<p>Carbon monoxide is produced when <b>oxygen supply is limited</b> [1]</p> <p>Accept:</p> <ul style="list-style-type: none"> <li>- more propane than oxygen is present</li> <li>- the ratio of oxygen : propane is less than 5:1</li> </ul> <p>Reject:</p> <ul style="list-style-type: none"> <li>- More propane is used</li> <li>- when the ratio of propane : oxygen is 2:7 instead of 1:5</li> <li>- When we use more propane and oxygen</li> </ul>			[1]
	(c)	 <p>1 m for -57 being aligned to a straight line 1 m for the correct shape of the graph</p>			[2]
	(d)	It is the electrostatic attraction between the positive nuclei and the shared localized electrons (of carbon and oxygen).			[1]
	(e)	(i)	Carbon Monoxide:		

				[1]
		(ii)	8	[1]
				<b>Total [8]</b>



Award mark if “1” is missing from in front of C<sub>3</sub>H<sub>8</sub>.

[1]

b The concentration of sulfur dioxide increased from 20 µg m<sup>-3</sup> in 2005 to 60 µg m<sup>-3</sup> in 2015.

[1]

c More energy is required / used in the winter compared to the summer (to heat buildings).

More fossil fuel must be burned to produce the additional energy, which leads to higher levels of sulfur dioxide being produced / released during the winter.

[2]

d Sulfur dioxide is an acidic gas.

OR Sulfur dioxide dissolves in rain water to produce acid rain

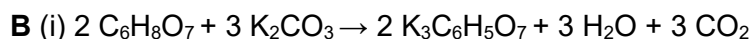
For the second mark, students should provide one environmental problem caused by acid rain, for example, corroding buildings, lowering the pH of soil and killing plants, lowering the pH of lakes and rivers and killing marine life, dissolving corals in the oceans. [2]

**[Total: 6]**

15 a Citric acid is a tribasic acid.

Citric acid is a weak acid.

[2]

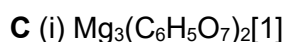


correct formulae

correctly balanced

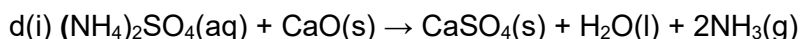
[2]

(ii)



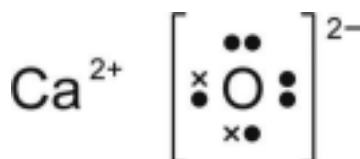
(ii) Any two from copper, gold, platinum, silver [1]

(iii) Extinguishes a burning splint with a (squeaky) “pop” sound. [1]



correct formulae correctly balanced and correct state symbols (allow one error) [2]

d(ii)



[1]

**[Total: 11]**