Workbook Answers
Level 1 Science
Acids and Bases

Section One
Part One

1. Atomic Structure

1. Positive (+1). Each proton has one positive charge.

2. In the nucleus at the centre of the atom.

3. Negative (-1). Each electron has one negative charge.

4. Around the nucleus in shells.

5. Zero, or no charge. Neutral means 'no charge'.

6. In a neutral atom, there are the same number of protons and electrons. For example, the lithium atom has three protons and three electrons.

7. Protons each have one positive charge (+1). Electrons each have one negative charge (-1). Since a neutral atom has the same number of protons as electrons, it has the same number of positive and negative charges. This means that the charges cancel out, and the atom has zero charge overall (is neutral). For example, the lithium atom has 3 protons (+3) and 3 electrons (-3). The charges cancel: +3 - 3 = 0.

8. a. The symbol "C" tells us that this element is carbon. On the periodic table, the letter in the box represents the name of the element.

   b. The number of protons in a neutral carbon atom.

   c. The mass of a neutral carbon atom. The mass of the atom is the number of protons plus the number of neutrons (mass = protons + neutrons).

   d. For any element on the periodic table, the smaller number is always the number of protons, and the bigger number is the mass number. If there is only one number, it represents the number of protons.

   e. This element has 6 protons.

f. This element has 6 electrons.

g. Note: in some versions of the workbook, the question for f. is repeated for g. The correct question for g. should be the following:

Question: How can you tell how many electrons this element has?

Answer: The elements on the periodic table represent neutral atoms. A neutral atom has the same number of electrons as it has protons. Since the carbon element has 6 protons, it must also have 6 electrons.

9. Note: for the following questions, some versions of the workbook have i. – vii. which has been updated to a. – g. for consistency. If your workbook still has this numbering, use the yellow numbers to match the answer to your workbook.

a. (Previously i.) The symbol "O" tells us that this element is oxygen. On the periodic table, the letter in the box represents the name of the element.

b. (Previously ii.) The number of protons in a neutral oxygen atom.

c. (Previously iii.) The mass of a neutral oxygen atom. The mass of the atom is the number of protons plus the number of neutrons (mass = protons + neutrons).

d. (Previously iv.) For any element on the periodic table, the smaller number is always the number of protons, and the bigger number is the mass number. If there is only one number, it represents the number of protons.

e. (Previously v.) This element has 8 protons.

f. (Previously vi.) This element has 8 electrons.

g. (Previously vii.) The elements on the periodic table represent neutral atoms. A neutral atom has the same number of electrons as it has protons. Since the oxygen element has 8 protons, it must also have 8 electrons.

10. a. Hydrogen, H.

b. One proton.

c. One electron. It has the same number of protons and electrons.

d. Neon, Ne.

e. 10 protons.

f. 10 electrons. It has the same number of protons and electrons.

g. Phosphorous, P.

h. 15 protons.

i. 15 electrons. It has the same number of protons and electrons.

11. Electrons are arranged in shells around the nucleus. A 'shell' is a region of space where the electron can be found. The electron moves around within this space. Shells form concentric spheres around the nucleus, like the layers of an onion. The innermost 'shell' is found closest to the nucleus. The outermost shell of electrons is on the outside of the atom, furthest from the nucleus. The innermost shells are filled first.

12. Two electrons.

13. Up to eight electrons.

14. Up to eight electrons.

15. Eighteen electrons: two in the first shell, plus eight in the second shell, plus eight in the third shell. 2 + 8 + 8 = 18 electrons in total.

16. Argon, Ar.

17. The electron configuration of an atom is the arrangement of its electrons - how many are in each shell. For example, in argon, the electron configuration is 2, 8, 8 ⟶ two electrons in the first shell, eight electrons in the second shell, and eight electrons in the third shell. The first number is always the number of electrons in the first shell, the second number is the number of electrons in the second shell, and so on.

18. The valence electrons are the electrons in the outermost shell of the atom. For argon, this would be the eight electrons in the third shell, since there are no electrons in the fourth shell. The valence electrons are important for chemical reactions. They determine how the atom will react with other atoms in chemical reactions.

19.

Atom	Electron Configuration
Na	2, 8, 1
P	2, 8, 5
F	2, 7

Atom	Electron Configuration
Ar	2, 8, 8
Al	2, 8, 3
B	2, 3

20.

a./b. Hydrogen: 1 proton, 1 electron
Lithium: 3 protons, 3 electrons
Sodium: 11 protons, 11 electrons
Potassium: 19 protons, 19 electrons.

c. Hydrogen: 1
Lithium: 2, 1
Sodium: 2, 8, 1
Potassium, 2, 8, 8, 1

d. All of these elements have one valence electron.

e. They all have the same number of valence electrons (1 valence electron).

f. Yes, all of these elements are in the first column, and they all have one valence electron.

21.a. Carbon: 6 protons, 6 electrons
Silicon: 14 protons,14 electrons.

c. Carbon: 2, 4
Silicon: 2, 8, 4

d. Both of these elements have four valence electrons.

e. They both have the same number of valence electrons (4 valence electrons).

f. Yes, all of these elements are in the fourteenth column, and they all have four valence electrons. This is the column number (14) minus 10. 14 − 10 = 4. The same pattern holds for all of the elements on the right-hand side of the table. For example, the elements in the 15th column have 15 – 10 = 5, so five valence electrons.

22. An ion has a charge; a neutral atom has no charge. In the ion, the number of protons is not the same as the number of electrons, so the positive and negative charges do not balance, and the ion has an overall charge. In a neutral atom, the number of protons is the same as the number of electrons, so the positive and negative charges cancel and the neutral atom has an overall charge of zero.

23. Atoms like to have full or empty outer (valence) electron shells. This is when they are most stable. If an atom does not already have a full valence electron shell, it will lose or gain electrons until it does. For example, the sodium atom has 11 electrons, with an electron configuration of 2, 8, 1 (2 electrons in the first shell, 8 in the second, and 1 in the third, valence, shell). The outermost shell is not full. However, the second shell is full of electrons. Sodium will lose the one electron in its third shell. This leaves it with a full valence shell as the second shell. Losing an electron causes a sodium ion to form, as this more stable for the atom.

24. An electron shell is most stable when the valence shell is at the maximum number of electrons it can hold.

25. This depends on whether the atom is closer to having a full valence shell or an empty valence shell. If the atom has 3 or less electrons in the valence shell, it will lose electrons until it has none in this shell. If it has 5 or more electrons in the valence shell, it will gain electrons until it has eight. Atoms that have exactly four electrons in their outer shell tend to form covalent bonds instead and rarely make ions.

26. A neutral oxygen atom will gain two electrons when it forms an ion.

27. The electron configuration of neutral oxygen is 2,6. To have a full outer shell, oxygen will gain two

electrons.

28. A neutral potassium atom will lose a single electron when it forms an ion.

29. The electron configuration of neutral potassium is 2,8,8,1. To have a full outer shell, potassium will lose one electron.

30. O_2^- - the oxygen ion has a 2- charge, because it gained two electrons. The oxygen ion still has the same number of protons as the neutral atom (8 protons), but now it has gained two electrons so it has 10 electrons. This means it has 8 positives charges but 10 negative charges, so the charges don't cancel - there are two more negative charges than positive charges, so the ion has a -2 charge overall.

31. K^+ - the potassium ion has a +1 charge, because it lost one electron. The potassium ion still has the same number of protons as the neutral atom (19 protons), but now it has one less electron (18 electrons). This means it has 19 positive charges but only 18 negative charges, so it has one more positive charge. This means it has an overall +1 charge.

32. How do you work this out? Let's use sodium (Na) as an example. The neutral sodium atom has 11 electrons - we can see this from the periodic table (because sodium has 11 protons on the periodic table, and a neutral atom has the same number of protons and electrons). First, we think about the electron configuration of a neutral sodium atom. It can fit 2 electrons in the first shell, up to 8 in the second, and up to 8 in the third. So the electron configuration is 2, 8, 1. This means there is one electron in the valence electron shell. To become more stable, the sodium atom will either lose or gain electrons to make a full outer shell. Since it has less than 4 electrons in its valence shell, it is easiest for sodium to lose its one third shell electron, leaving a full second shell. This creates a sodium ion, Na^+. The electron configuration is now 2, 8 since the 1 from the third shell has been lost.

Ion	Electron Configuration
Na^+	2, 8
Cl^-	2, 8, 8
Ca^{2+}	2, 8, 8

Ion	Electron Configuration
Al^{3+}	2, 8
S^{2-}	2, 8, 8
Li^+	2

33.

Cl^-	Chloride
OH^-	Hydroxide
H^+	Hydrogen
K^+	Potassium
O^{2-}	Oxide
NO_3^-	Nitrate

SO_4^{2-}	Sulfate
CO_3^{2-}	Carbonate
HCO_3^-	Hydrogen carbonate
S^{2-}	Sulfide
Ca^{2+}	Calcium
Mg^{2+}	Magnesium

34. Note: for the following questions, some versions of the workbook have c. twice. If your workbook contains this error, use the yellow numbers to match the answer to your workbook.

a. −2

b. −1

c. −2

d. (Previously c.) +1

e. (Previously d.) −1

f. (Previously e.) +2

35. An ionic compound forms when two ions with opposite charges come together and form an ionic bond. Opposite charges attract, so negatively charged ions are attracted to positively charged ions. This forms an ionic compound. For example, positively charged Na^+ ions will join with negatively charged Cl^- ions to form NaCl, an ionic compound. Ionic compounds are also sometimes referred to as 'salts'.

36. Ionic compounds form because opposite charges attract, so positively charged ions are attracted to negatively charged ions. When these ions get together to form an ionic compound, their charges cancel out, to form a stable, neutral, ionic compound or salt.

37. a. The 4 tells us that there are 4 oxygen atoms attached to one sulfur atom. A small subscript number means that number of whatever element it comes after. In this case, the subscript 4 comes after O, so it means 4 oxygen atoms.

b. This "2" means that the molecule overall has a 2- charge. A superscript number tells us what the charge on the ion is.

38. a. The "2" tells us that there are 2 OH^- molecules attached to one magnesium ion. A small subscript number means that number of whatever element it comes after. In this case, the subscript 4 comes after O, so it means 4 oxygen atoms. In this case, the number comes after a molecule which is in brackets, so it means two of the molecule in the brackets.

b. The "3" means that there are three $Mg(OH)_2$ molecules. When the number comes at the front of the formula, it means that there are that number of the whole molecule which comes after it. In this case, the three is in front of the molecule $Mg(OH)_2$, so there are three $Mg(OH)_2$ molecules.

39.

NaCl	Sodium Chloride
MgO	Magnesium Oxide
$Al(OH)_3$	Aluminium Hydroxide
$CuCO_3$	Copper Carbonate

Li_2S	Lithium Sulfide
$PbSO_4$	Lead Sulfate
FeF_3	Iron Fluoride
$Ba(NO_3)_2$	Barium Nitrate

40. Na^+ has a +1 charge. Cl^- has a -1 charge. This means that when one Na^+ and one Cl^- come together to form an ionic bond, their charges cancel, forming a neutral ionic compound (NaCl) with no overall charge (+1 - 1 = 0). However, SO_4^{2-} has a 2- charge. This means that two Na^+ ions are needed to balance the charge and form a neutral ionic compound ((2x+1) - 2 = 0)).

41. How to work this out: First, consider the charge on each ion. For example, the charge on a silver ion is +1 and the charge on a sulfide ion is -2. To cancel the charges, we need two silver ions (to give +2 total). To show that we need two of the silver ions, we write a subscript 2 after the silver ion

symbol: Ag_2. We then write the symbol for sulfide (S), to give: Ag_2S. When we write the chemical formula for ionic compounds, we write the positive ion first, so in this case we write Ag first.

Silver sulfide	Ag_2S
Aluminium oxide	Al_2O_3
Potassium chloride	KCl
Copper hydroxide	$CU(OH)_2$

Sodium carbonate	Na_2CO_3
Ammonium nitrate	NH_4NO_3
Zinc sulfate	$ZnSO_4$
Calcium nitrate	$Ca(NO_3)_2$

2. Acids & Bases

1. An acid is a chemical which releases H^+ ions into the solution when dissolved. For example, when we dissolve HCl in water, it breaks apart into H^+ and $Cl\_$ ions, therefore adding H^+ ions to the solution.

2. HNO_3 Nitric acid.
   H_2SO_4 Sulfuric acid.
   HCl Hydrochloric acid.

3. A base is a chemical which releases hydroxide (OH^-) ions into the solution when dissolved. For example, when we dissolve NaOH in water, it breaks apart into Na^+ and OH^- ions, therefore adding OH^- ions to the solution.

4. MgO Magnesium oxide (or any metal oxide).
   NaOH Sodium hydroxide (or any metal hydroxide).
   NH_3 Ammonia.

5. A neutralisation reaction

6. One example is HCl + NaOH. This produces a salt (NaCl, sodium chloride) and water (H_2O). Other examples could be any combination of the other acids (nitric, sulfuric) or bases (e.g. ammonia, metal oxides).

7. Salt + water

8. One example is HCl reacting with $Mg(OH)_2$. This produces a salt ($MgCl_2$) and water (H_2O). Other examples could be any combination of the other acids (nitric, sulfuric) or metal hydroxides.

9. Salt + water + carbon dioxide (CO_2)

10. One example is HCl reacting with $MgCO_3$. This produces a salt ($MgCl_2$), water (H_2O) and carbon dioxide (CO_2). Other examples could be any combination of the other acids (nitric, sulfuric) and metal carbonates or metal hydrogen carbonates.

11. The concentration of H^+ ions in solution OR the relative amount of H^+ and OH^- in solution.

12. A solution with a low pH (less than 7) is an acidic solution. This solution has a lot of H^+ ions - many more H^+ ions than OH^- ions.

13. A solution with a high pH (greater than 7) is a basic solution. This solution has a lot of OH^- ions in it, and not very many H^+ ions. It has many more OH^- ions than H^+ ions.

14. A solution with a pH of 7 is a neutral solution. This solution has the same number of H^+ ions as OH^- ions.

15. The pH 3 solution has the highest concentration of H^+ ions. The lower the pH, the more H^+ ions in the solution.

16. The pH 4 solution has the highest concentration of OH^- ions. The higher the pH, the more OH^- ions.

17. The pH 12 solution has the highest concentration of OH^- ions. The higher the pH, the more OH^- ions.

18. The pH 8 solution has the highest concentration of H^+ ions. The lower the pH, the more H^+ ions in the solution.

19.

pH	Colour, pH Range
Strongly Acidic	Red: pH 1-2
Strongly basic	Purple: pH 13-14
Mildly acidic	Orange/yellow: pH 3-5
Mildly basic	Blue: pH 8-10
Neutral	Green: pH 7

20. Blue

21. No change

22. No change

23. Red

24. No change

25. No change

3. Rates of Reaction

1. The concentration of a solution refers to how many molecules are dissolved in the volume of liquid. For example, a concentration of 2000 atoms per millilitre would mean that there are 2000 atoms dissolve in each millilitre of liquid. If you had 2 millilitres of this solution, you would have 4000 atoms in total.

2. Collision theory says that a chemical reaction occurs when particles collide with each other. In order for a reaction to occur the particles must collide in the **correct orientation** and with **enough energy.**

3. Activation energy is the energy barrier that must be overcome for a reaction to occur. For the reaction to occur, the particles must collide with at least this much, or more, energy. For example, if the activation energy is 2kJ, the particles must have at least 2kJ of energy when they collide or the reaction won't occur (and they'll just bounce off each other, instead of reacting).

4. Something that speeds up the rate of reaction (by providing an alternative reaction pathway) without being used up in the reaction.

5. One: You could **heat** the reaction mixture. Heating the mixture adds extra energy to the mixture. This causes the particles to move faster (have more kinetic energy) which means that they collide more often, so more reactions take place. The particles also have more energy, so more of the collisions will meet the activation energy and more reactions will take place.

   Two: Increase the **surface area**. If you break apart or powder a solid before mixing it with the other reactant, this will increase the rate of reaction. This is because more of the solid particles will be exposed to the other reactant, so more reactions can occur in the same amount of time.

   Three: Increase the **concentrations of the reactants.** Increasing the concentration means that more of the reactant particles are available in the same volume of liquid. This means that the particles are more likely to collide with each other, so more reactions take place.

   Four: Use a **catalyst**. The catalyst speeds up the reaction by lowering the activation energy so that when the particles collide, more of them cause reactions.

4. Neutralisation Reactions

1. Reactants: NaCl and $Mg(OH)_2$
   Products: NaOH + $MgCl_2$

2. A balanced chemical equation has the same number of each type of element on each side of the arrow. For example, in the above reaction, there are 2Na on the reactant side and 2Na on the product side.

3. a. $NaOH + H_2SO_4 \longrightarrow H_2O + Na_2SO_4$
   $2NaOH + H_2SO_4 \longrightarrow 2H_2O + Na_2SO_4$

   How to work this out: To balance the chemical equation, you need to make sure there are the same number of each type of element on each side of the arrow. On the products side there are two Na atoms, but on the reactant side, there is only one Na. We need two Na on the reactant side too, so we add a 2 to the NaOH.
   $2NaOH + H_2SO_4 \longrightarrow H_2O + Na_2SO_4$

   Then re-check to see if there are the same number on each side now.

Reactants: Na = 2; O = 2 + 4 = 6; H = 2 + 2 = 4. S = 1
Products: Na = 2; H = 2; O = 5; 2 = 1

We see that there are not enough H or O on the products side. We need two more H and one more O. This means we need one more H_2O molecule, so we add a 2 in front of the H_2O, to give $2H_2O$. Now the equation is balanced.

b. $Al(OH)_3 + HCl \longrightarrow H_2O + AlCl_3$
$Al(OH)_3 + 3HCl \longrightarrow 3H_2O + AlCl_3$

c. $MgO + HNO_3 \longrightarrow Mg(NO_3)_2 + H_2O$
$MgO + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2O$

d. $K_2CO_3 + HCl \longrightarrow H_2O + CO_2 + KCl$
$K_2CO_3 + 2HCl \longrightarrow H_2O + CO_2 + 2KCl$

e. $Zn(HCO_3)_2 + H_2SO_4 \longrightarrow ZnSO_4 + CO_2 + H_2O$
$Zn(HCO_3)_2 + H_2SO_4 \longrightarrow ZnSO_4 + CO_2 + 2H_2O$

4. You would see bubbles of gas being produced

Section Two

Part One

Just a general note for the answers from here on out. You will notice that the answers to similar questions look pretty much the same as each other. This is on purpose. In science exams being straight to the point and being repetitive is a good thing (especially in the eyes of NZQA). This is not an english exam where you have to try and get an emotional response from the reader, **straightforward answers, not boring**. Keep your sentences short and don't worry if you end up repeating yourself a few times when answering a question, as long as what you say is right you'll get the marks!

1. Atomic Structure

1. Oxygen atoms have an atomic number of 8. This means that they have 8 protons. In a neutral atom, the number of protons is the same as the number of electrons, so oxygen atoms also have 8 electrons. The electron configuration is the way that the electrons are arranged around an atom. Electrons are found in shells around the nucleus of an atom. The first shell can hold two electrons, and the second shell can hold up eight. Oxygen atoms have an electron configuration of 2,6, with two electrons in the first shell and six in the second shell. This means they have six valence electrons. An atom will form an ion in order to obtain a full valence shell, because this is more stable. In order to gain a full outer shell the oxygen atoms will gain 2 electrons to get to a 2,8 electron configuration. It gains 2 electrons because it is easier for it to gain just 2 electrons than it is to lose 6 electrons. The oxygen ion now has 10 electrons. However, it still has 8 protons. Since there are two more electrons than protons there are unbalanced charges. Each proton is worth +1, and each electron is worth -1, so altogether, the ion will have a charge of -2.

2. Sodium and lithium are in the same group of the periodic table. Atoms in the same group will have the same number of electrons in their outer shell. Lithium has an atomic number of 3, which means it has three protons and three electrons, while sodium has an atomic number of 11, with 11 protons and 11 electrons. The electron configuration describes how the electrons are arranged around the nucleus of the atom in shells. The first shell can fit 2 electrons, the second shell can fit 8, and the third shell can fit 8. For lithium, the electron configuration is 2,1 (two in the first shell, one in the second shell) and sodium has an electron configuration of 2,8,1 (two in first, 8 in second, 1 in third). Therefore they both have one electron in their outer shell (one valence electron). Atoms will form ions to obtain a full valence shell, because this is more stable. To obtain a full outer shell, both lithium and sodium will lose one electron, because losing one electron is easier than gaining 7 electrons to get a full outer shell. However, both ions still have the same number of protons they started with, so now that they have lost an electron, they have unbalanced charges. They have one more proton (positive charge) than electrons, so both ions have a +1 charge.

3. In order for a bond to form between ions they must have an opposite charge. There must be at least one negative ion and one positive ion. Opposite charges attract, which draws the ions together and forms the ionic bond.

4. Calcium has an electron arrangement of 2,8,8,2. It will lose two electrons to achieve a full outer shell (2,8,8 configuration) and have a +2 charge because there will be two more protons than electrons. Chlorine has an electron configuration of 2,8,7 and will gain one electron to get a full outer shell (2,8,8) configuration. Chloride ions have a charge of -1 because they now have one more electron than protons.

   When an ionic compound is formed the total positive charge must be equal to the total negative charge. Because calcium ions have a charge of +2 and chloride ions have a charge of -1 there will need to be two chloride ions for every calcium ion in order for them to cancel out their charges. This leads us to the formula $CaCl_2$

2. Acids and Bases

1. When adding universal indicator to all three solutions the nitric acid will go red/yellow/orange indicating that it is an acid. The NaOH solution will turn blue/purple because it is a base and the KCl will be green because it is a neutral salt.

2. Start by adding red litmus paper to all of the solutions. The one that turns blue is the NaOH because it is a base. The other two solutions will remain unchanged. Then add blue litmus to the remaining two solutions, the one that turns red is the nitric acid as it is an acid. The one that did not change with either blue or red litmus paper is KCl which is a neutral salt.

3. The solution would begin purple as the KOH is concentrated and highly basic. As you added HCl it would go blue and then green once it reached a neutral pH. Upon further addition of HCl the solution would yellow orange and finally red.

4. pH is a measure of the concentration of H^+ ions in solution. When the HCl is concentrated, there will be more H^+ ions in the solution and so the solution will have a lower pH. The dilute solution will have a lower concentration of H^+ ions so it will have a higher pH.

5. At pH 7 the amount of OH^- ions in solution is the same as the amount of H^+ ions in the solution. Since they have the same concentration the solution is neither acidic nor basic, so it is neutral

3. Reaction Rates

1. In order for a reaction to occur, the particles must collide with enough energy and in the correct orientation.

   As the temperature is increased the kinetic energy of the particles increases which means they are moving faster. Because the particles are moving faster, the number of particle collisions occurring per second will increase. Since more particle collisions per second are occurring the rate of reaction will increase. Also, because the particles have more energy it is more likely that they will have enough energy for the reaction to occur (the activation energy), this means that any collision is more likely to be successful at higher temperatures.

   Therefore, not only are more collisions happening per second, but there are more successful collisions happening per second.

2. In order for a reaction to occur, the particles must collide with enough energy and in the correct orientation.

   As the surface area of a solid reactant increases there are more particles exposed to the solution. This means that there are more particles available to collide with. This means that more collisions will occur per second which will increase the rate of reaction.

3. In order for a reaction to occur, the particles must collide with enough energy and in the correct orientation.

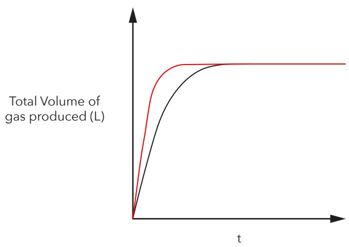
   When the concentration of a reactant increases, there are more particles in a given volume of solution. Because there are more particles a collision is more likely to occur. Because more collisions are occurring per second the rate of reaction will increase.

4. In order for a reaction to occur, the particles must collide with enough energy and in the correct orientation.

   A catalyst works by lowering the activation energy of a reaction. This means that any collision that occurs between particles is more likely to have the energy required to react. This means that more successful collisions will be happening every second which means the rate of reaction will increase.

5. At the beginning of the reaction, there is a lot of reactants in the beaker. This means the concentration is high, which means a lot of collisions are going to be happening every second which means the rate of reaction will be fast. This is shown by the steepness of the curve. As the reaction proceeds, more and more of the reactants is used up which means there is less and less reactant left to react. Because the concentration has gone down there are less collisions occurring every second and so the reaction slows down. This is shown by the curve becoming less steep over time. Finally all of the silver carbonate is used up so no more of the reaction can occur so no more gas is produced, this is shown by the flat portion of the graph.

a.



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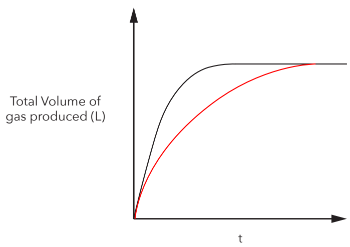

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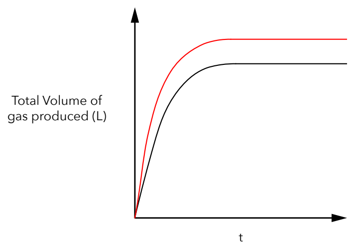


4. Neutralisation Reactions

1. a. Zinc carbonate + Nitric acid ⟶ Zinc Nitrate + Water + Carbon dioxide
   $ZnCO_3 + 2HNO_3 \longrightarrow Zn(NO_3)_2 + H_2O + CO_2$

   b. Silver hydroxide + Sulfuric acid ⟶ Silver sulfate + Water
   $2AgOH + H_2SO_4 \longrightarrow Ag_2SO_4 + 2H_2O$

c. Calcium oxide + Hydrochloric acid ⟶ Calcium chloride + Water
$CaO + 2HCl \longrightarrow CaCl_2 + H_2O$

d. Aluminium oxide + Sulfuric acid ⟶ Aluminium sulfate + Water
$Al_2O_3 + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2O$

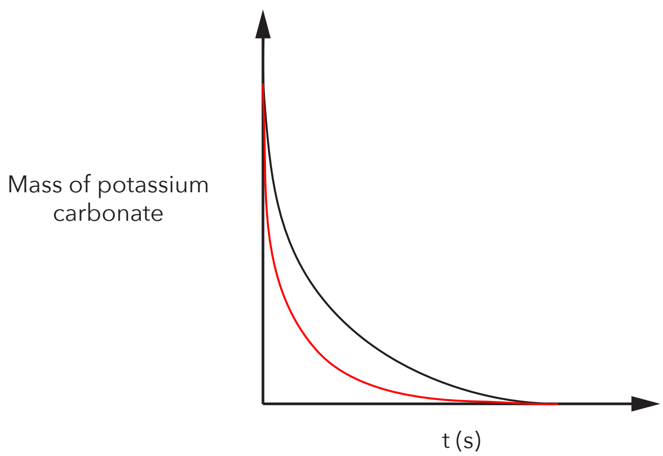
e. Copper hydrogen carbonate + Nitric acid ⟶ CO_2 + H_2O + Carbon + Water + Copper nitrate
$Cu(HCO_3)_2 + 2HNO_3 \longrightarrow Cu(NO_3)_2 + 2CO_2 + 2H_2O$

2. The solution would go green indicating a neutral solution

3. When an acid reacts with a base a neutral salt and water is produced. The H^+ ions produced by the acid react with the OH^- ions produced by the base to make water. Once all the H^+ and OH^- ions have reacted with each other there is only water left which is neutral.

Long Answer Questions

1.



In order for a reaction to occur the particles must collide with the correct orientation and energy. When the potassium carbonate is in powdered form the surface area is much larger. This means there are more particles in contact with the solution and so more collisions are going to be happening every second. This means the reaction rate will increase with the powdered potassium carbonate.

The line shows this by the mass of potassium carbonate decreasing more quickly at the start of the reaction as it is being used up faster. It starts from the same point since the mass of potassium carbonate to begin with is the same. The curve still goes to 0 since all the potassium carbonate will react but it will reach zero sooner.

2. First take samples of all three liquids and use blue litmus paper in all of them. The one that changes to red is the hydrochloric acid because it is an acid. The other two solutions are neutral and so will not change blue litmus.

Once the HCl has been identified, take two samples of it. Add each of the solutions to their own sample of the HCl. One solution will remain unchanged and the other will start to bubble. The one that bubbles when added to HCl is the sodium carbonate. This is because the following reaction will occur:

$$2HCl + Na_2CO_3 \longrightarrow 2NaCl + CO_2 + H_2O$$

The gas is caused by the CO_2 that is produced. The solution that did not cause the bubbling is the lithium chloride.

3. Sodium and fluorine are in two different periods on the periodic table. Sodium and aluminium are in the same period.

Sodium has an electron configuration of 2,8,1. When it forms ions it will lose one electron to obtain a full outer shell and an electron configuration of 2,8. Once it has lost one electron it will form an ion with a +1 charge because it will have one more proton than electron.
Fluorine has an electron configuration of 2,7. When it forms ions it will gain one electron to obtain a full outer shell and an electron configuration of 2,8. Once it has gained one electron it will form an ion with a -1 charge because it will have one more electron than proton.

Since sodium ions have a +1 charge and fluorine ions have a -1 charge they can form an ionic compound because opposite charges attract each other.

Aluminium has an electron configuration of 2,8,3. When it forms ions it will lose three electrons to obtain a full outer shell and an electron configuration of 2,8. Once it has lost three electrons it will form an ion with a +3 charge because it will have three more protons than electrons.

Since aluminium ions and sodium ions both have a positive charge they can not form an ionic compound since like charges repel each other.

Section Three

Practice Exam

Question One

a. i. The solution at pH 1 has the higher concentration of sulfuric acid. pH is a measure H^+ ion concentration in a solution, the lower the pH the higher the concentration of H^+. Acids release H^+ ions in solution so the greater the concentration of acid the greater the concentration of H^+ ions and the lower the pH will be. Therefore the pH one solution will have a higher H^+ concentration and a higher sulfuric acid concentration and the pH 3 solution will have a lower H^+ concentration and a lower sulfuric acid concentration.

ii. Neutralisation reaction.

iii. Zinc Carbonate + Sulfuric acid ⟶ Zinc Sulfate + Carbon dioxide + Water

$ZnCO_3 + H_2SO_4 \longrightarrow ZnSO_4 + CO_2 + H_2O$

iv. In order for a reaction to occur the particles must collide in the correct orientation and with enough energy.

The solution with pH 1 will dissolve the zinc carbonate the fastest. The solution with pH one has the higher H_2SO_4 concentration. The higher the concentration of the reactants, the faster the reaction will proceed. This is because with higher concentration there will be more particles in the solution, this will mean that there are more collisions are happening every second which means the rate of reaction will increase. This means that the pH 1 solution will have a faster rate of reaction so the zinc carbonate will dissolve faster.

Question Two

a. Sodium gives an electron to the chlorine. The sodium becomes Na^+ and the chlorine becomes Cl^-

b. When atoms form ions they do so to obtain a full outer shell of electrons. Sodium atoms have an electron arrangement of 2,8,1. Sodium atoms lose their outermost electron to form sodium ions with an electron arrangement of 2,8. Since it has lost an electron and now has one more proton than electron the sodium ion has a charge of +1.
Chlorine atoms have an electron arrangement of 2,8,7. Chlorine atoms gain an electron to form chloride ions with an electron configuration of 2,8,8. Since they gained an electron and now have one more electron than protons chloride ions have a charge of -1.

When both ions have a full outer shell they are stable and are no longer reactive on their own.

c. When sodium forms ions it goes from an electron arrangement of 2,8,1 to a 2,8 arrangement as the ion. It loses 1 electron to get to a full outer shell. Because it has lost one electron but still has the same number of protons the ion will have a +1 charge.

When chlorine forms ions it goes from an electron arrangement of 2,8,7 to a 2,8, 8 arrangement as the ion. It gains 1 electron to get to a full outer shell. Because it has gained 1 electron but still has the same number of protons the ion will have a -1 charge.

When sulfur forms ions it goes from an electron arrangement of 2,8,6 to a 2,8, 8 arrangement as the ion. It gains 2 electrons to get to a full outer shell. Because it has gained 2 electrons but still has the same number of protons the ion will have a -2 charge.

When ions form ionic compounds the total number of negative charges must equal the total number of positive charges. Only one sodium ion (+1 charge) is needed to cancel out the -1 charge on the chloride ion so the compound formed is NaCl, with one Na for every Cl.

On the other hand, 2 sodium ions are required to cancel out the -2 charge on a sulfide ion so the formula of the ionic compound is Na_2S which has 2 sodium ions for every sulfide ion.

Question Three

a.

Solution	Colour of red litmus when used with solution	Colour in universal indicator in solution
Sulfuric acid	Stays red	Red/orange
Magnesium chloride	Stays red	Green
Calcium hydrogen carbonate	Turns blue	Blue/purple

b. Sulfuric acid and calcium hydrogen carbonate, bubbles of gas would be observed.

c. Sulfuric acid + calcium hydrogen carbonate ⟶ calcium sulfate + water + carbon dioxide
$H_2SO_4 + Ca(HCO_3)_2 \longrightarrow CaSO_4 + 2H_2O + 2CO_2$

d. i. Decrease it

ii. In order for a reaction to occur particles must collide with the correct amount of energy and in the correct orientation.

When the temperature decreases the particles have less kinetic energy and are moving more slowly. This means that the particles will be colliding less often.

However, because the particles have less energy, they will also be less likely to have the energy required to react even if they do collide. This means that not only are there less collisions per second, there are less successful collisions per second. Both of these factors combine and will result in a slower rate of reaction.

