Assessment Schedule – 2015

Science: Demonstrate understanding of aspects of acids and bases (90944)

Evidence Statement

Question	Evidence	Achievement	Merit	Excellence
ONE (a)	As the reactant particles collide, they form product particles. As the reaction proceeds, there are fewer and fewer reactant particles left to collide, and so the rate of reaction becomes slower. At the start (section A) of the reaction, more product particles are being formed. This is because at the start of the reaction there are many particles present; therefore there will be many collisions, and the more collisions (per unit time), the faster the rate of reaction, and the more gas produced. In section B, there are now fewer (less) reactants, and so there are fewer collisions per second (unit time); therefore a slower rate of reaction and so less product is formed. In section C, the reaction has stopped, as one of the reactants (marble chips or nitric acid) has run out, so there are no particles left to react.	• Correct word equation OR correct symbol equation with one mistake in ionic formula. • Shows the line **drawn** as less steep. • Both the **drawn** and the given lines are horizontal. • States that the reaction is fastest in Section A, then it gets slower in Section B, and stops in Section C. • Section C: Horizontal line indicates reactant used up. OR Section C: Horizontal line indicates no more gas is being produced. OR Section C: Horizontal line indicates reaction is finished.	• Correct symbol equation, but not balanced. • Explains that the reaction slows down to a stop over time as the reactant particles are being used up. • Explains that a horizontal line indicates reaction is finished / one of the reactants has been used up / no more gas is produced. • Explains from graph that the rate of reaction of the two reactions are different but the same volume of gas is produced in the end / when the reaction is complete.	• Correctly balanced symbol equation. • Links each reaction being finished when the line becomes horizontal, as one (or more) of the reactants have been used up and therefore no more gas is produced. • Explains from graph that the rate of reaction at 20° and 50° are different, but the same volume of gas is produced as in both reactions there was the same amount of reactants.
(b)	A line is drawn with a less steep gradient but levelling out at the same volume of gas produced. The reaction is slower at the lower temperature, because the particles have less kinetic energy, and therefore are moving slower. When they are moving slower, there will be less frequent collisions, and less of these collisions will be effective, as the particles will collide with less energy. The line drawn represents this slower reaction, as it is less steep at the start. Both lines become horizontal at the same point on the Y-axis, as this is when both reactions have finished, i.e. one of the reactants has been completely used up and therefore no more gas is produced. Both finished with same amount of gas produced, as both reactions had the same amount of reactants to start with. nitric acid + calcium carbonate → calcium nitrate + carbon	• At lower temperatures, reactants move slower OR there are fewer collisions (or vice versa). • States that there is the same amount of gas produced in both reactions.	• When there is a lower temperature, the reactants move slower, and therefore there are less frequent collisions. (Or fewer collisions per unit time)	• The reaction is slower at a lower temperature because the ions / particles have less (kinetic) energy / move slower. When they are moving slower, there will be fewer frequent collisions and fewer effective/ successful collisions.

(c)	dioxide + water $2HNO_3 + CaCO_3 \rightarrow Ca(NO_3)_2 + H_2O + CO_2$								
Q1	NØ = no response or no relevant evidence	N1 = 1 point	N2 = 2 points	A3 = 3 points	A4 = 4 points	M5 = 2 points	M6 = 3 points	E7 = 2 points	E8 = 3 points

Question	Evidence	Achievement	Merit	Excellence
TWO (a)	Al^{3+} because it has 13 protons (+ charges) and only 10 electrons (– charges). It has only 10 electrons, as its electron arrangement as an atom was 2,8,3, and when it forms an ion, it loses three electrons to form an arrangement of 2,8 to have a full outer shell, which is more stable. S^{2-} because it has 16 protons (+ charges) and 18 electrons (– charges). It has 18 electrons, as its electron arrangement as an atom was 2,8,6, and when it forms an ion, it gains two electrons to form an arrangement of 2,8,8 to have a full outer shell, which is more stable. Cl^- because it has 17 protons (+ charges) and 18 electrons (– charges). It has 18 electrons, as its electron arrangement as an atom was 2,8,7, and when it forms an ion it gains one electron to form an arrangement of 2,8,8 to have a full outer shell, which is more stable.	• States the charge on one ion in terms of electron arrangement. E.g. the charge on Al is 3+ because it has lost 3 electrons. • States that an ionic bond forms due to opposite charges attracting each other. • States that an ionic bond will not form between chloride ions and sulphide ions, as they are both negative. • States that overall an ionic compound has no charge, as the charges must cancel out. • States that the +3 charge on the aluminium ion cancels out the three –1 charges on the chloride ion. • States that aluminium donates its three electrons to the three chlorides. • States that the +6 charge of the two aluminium ions cancels out the –6 charge of the three sulfide ions. OR states that the 2 aluminium atoms donate a total of 6 electrons to the 3 sulfur atoms. • States correct ratio of ions and/or correct formulae.	• Explains that an ionic bond will not form between chloride ions and sulphide ions, as they are both negative because they have both gained negative electrons in order to gain a full valence shell. • Explains that aluminium needs to lose three electrons to have a full outer shell and that chlorine needs to gain one electron to gain a full outer shell, and so therefore the aluminium atom donates its three electrons to each of the three chlorine atoms. • Explains that because the aluminium ion has a charge of +3 and that the chlorine ions each has a charge of –1, the ratio of the two ions is 1:3 to one in order to have a neutral compound overall. • Explains that each aluminium atom needs to donate three electrons in order to have a full outer shell and that each sulfur atom needs to gain two electrons in order to have a full outer shell, and so therefore a total of two aluminium atoms donate 6 electrons to three sulfur atoms. • Explains that because the aluminium ion has a charge of +3 and the sulfide ion has a charge of –2, the ratio of aluminium ions to sulfide ions is 2:3 in order to have a neutral compound overall.	• Fully explains the charge on three ions in terms of electron arrangement AND atomic structure so the ions have a full outer shell to become stable. • Fully explains the ratio of ions in aluminium chloride, i.e. In order to have a neutral compound, the aluminium ion with a charge of +3 has given away 3 electrons and 3 chlorine ions each with a charge of –1 will accept 1 electron each. Therefore the +3 charge of aluminium ion cancels out the three –1 charges of chlorine ion, and so therefore the ratio of ions is 1;3. The charge on the ions arises, as aluminium has to lose three electrons in order to have a full, stable outer shell and have a charge of +3, and each chlorine has to gain one electron in order to have a full stable outer shell and have a charge of –1. • Fully explains the ratio of ions in aluminium sulfide, i.e. In order to have a neutral compound overall, two aluminium ions with a combined charge of +6 are required to cancel out the charge on three sulfide ions with a combined charge of –6. The charge on the aluminium ion arises as it gives away three electrons in order to have a full, stable outer shell. Because it has to give 3
(b)	An ionic bond is the attraction between a positive ion and a negative ion. It is formed because opposite charges will attract one another. An ionic bond would not form between chloride ions and sulphide ions, as they both have negative charges because they have both gained negative electrons in order to form a full valence shell, and the ions with the same charge will repel each other.			
(c)	**Elements 1 and 3: $AlCl_3$** Aluminium has a charge of +3. In order to have a neutral compound overall, one aluminium ion is required to cancel out the charge on three chloride ions with a combined charge of –3. The charge on the aluminium ion arises as it gives away three electrons in order to have a full outer shell. Because it has to give 3 electrons away and each chlorine has to accept one electron, in order to have a full shell, the ratio of ions required is one to three. **Element 1 and 2: Al_2S_3**			

	The aluminium ion has a charge of +3. In order to have a neutral compound overall, two aluminium ions with a combined charge of +6 are required to cancel out the charge on three 2^- sulfide ions with a combined charge of –6. The charge on the aluminium ion arises as aluminium gives away three electrons in order to have a full outer shell. Because it has to give 3 electrons away and sulfur has to accept two electrons in order to have a full shell, the ratio of ions required is two to three.							electrons away and each sulfur has to accept two electrons in order to have a full, stable outer shell, the ratio of ions required is 2;3.	
Q2	NØ = no response or no relevant evidence	N1 = 1 point	N2 = 2 point	A3 = 3 points	A4 = 4 points	M5 = 2 points	M6 = 3 points	E7 = 2 points	E8 = 3 points

<table>
<tr><th>Question</th><th>Evidence</th><th>Achievement</th><th>Merit</th><th>Excellence</th></tr>
<tr>
<td>THREE
(a)

(b)

(c)

(d)</td>
<td>
<table>
<tr><th></th><th>Colour with UI</th><th>pH</th></tr>
<tr><td>HCl</td><td>Red</td><td>1– 3</td></tr>
<tr><td>NaOH</td><td>Purple</td><td>12–14</td></tr>
<tr><td>H_2O</td><td>green</td><td>7</td></tr>
</table>
When HCl reacts it donates an H^+ and when NaOH reacts it provides OH^-, and these two ions combine to form (neutral) H_2O.

As the NaOH is added, the HCl is being neutralised until water is formed, then after that the solution becomes more basic.
When no NaOH has been added, the solution is red and has a pH of 1–2 and there is an excess of H^+ ions. The concentration of hydroxide ions is very low. At pH 4, the solution is orange–yellow and there is still an excess of H^+ ions but not as big an excess as when the pH was lower. At pH 7 the solution is green, which is neutral. At this point, the number of H^+ and OH^- ions is equal and they cancel each other out to form neutral water.
At pH 10 the solution is blue, and there is now an excess of OH^- ions. At pH 13 the solution is purple, and there is now a greater excess of OH^- ions than when the solution was blue.

Hydrochloric acid + magnesium hydroxide → magnesium chloride + water
$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2H_2O$
</td>
<td>• Correct word equation OR correct symbol equation with one mistake in ionic formula.
• pH column correct.
• States when the pH is 7 the solution is neutral
OR that H^+ and the OH^- combine to form water / neutralise.
• States that the acid / HCl provides hydrogen ions.
• States that the base / NaOH provides hydroxide ions.
• Gives colours at pH 4 and pH 10.</td>
<td>• Correct symbol equation but not balanced.
• Explains that H^+ from the acid and the OH- from the base combine to form water / neutralise each other.
• Explains that before any NaOH is added to the beaker that H^+ are in excess, and as more NaOH is added the concentration of OH^- increases until OH^- ions are in excess.</td>
<td>• Correctly balanced symbol equation.
• Links the colour change to the pH by relating it to the ions that are present at all 5 pH points
• Links the relative amount of hydrogen ions to the amount of sodium hydroxide added at pH 1-4, equal amount of ions at pH 7 and excess hydroxide ions at pH 10-13.</td>
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<tr>
<td>Q3</td>
<td>NØ = no response or no relevant evidence</td><td>N1 = 1 point</td><td>N2 = 2 point</td>
<td>A3 =3 points</td><td>A4 = 4 points</td>
<td>M5 = 2 point</td><td>M6 = 3 points</td>
<td>E7 = 2 points</td><td>E8 = 3 points</td>
</tr>
</table>

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 7	8 – 12	13 – 19	20 – 24