Assessment Schedule – 2014

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

Evidence Statement

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

(b)

(c)</td>
<td>$CaCl_2$
$NaNO_3$
$Zn(NO_3)_2$

<table>
<tr><th>Atom</th><th>Atomic number</th><th>Electron arrangement of atom</th><th>Electron arrangement of ion</th><th>Charge on ion</th></tr>
<tr><td>Mg</td><td>12</td><td>2,8,2</td><td>2,8</td><td>+2</td></tr>
<tr><td>Al</td><td>13</td><td>2,8,3</td><td>2,8</td><td>+3</td></tr>
<tr><td>O</td><td>8</td><td>2,6</td><td>2,8</td><td>–2</td></tr>
</table>
Magnesium ion has a charge of +2 and oxide ion has a charge of –2. A compound overall has to have no charge. Therefore the +2 charge of magnesium ion cancels out the –2 charge of oxide ion, and so therefore the ratio of ions is one to one. The charge on the ions arises, as magnesium has to lose two electrons in order to have a full outer shell and have a charge of +2, and oxygen has to gain two electrons in order to have a full outer shell and have a charge of –2. In order to do this, magnesium gives its two electrons straight to oxygen and the ratio is one to one of the two ions.

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 oxide 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 outer shell. Because it has to give 3 electrons away and oxygen has to accept two electrons in order to have a full shell, the ratio of ions required is two to three.</td>
<td>• Correctly writes TWO formulae.
• Has THREE out of four rows correct for Mg and Al in the table.
• Shows (maybe diagram / table) that magnesium loses two electrons and that aluminium loses three electrons.
• States that overall an ionic compound has no charge as the charges must cancel out.
OR
States that the +2 charge on the magnesium ion cancels out the –2 charge on the oxide ion.
• States that magnesium donates its two electrons to the oxygen atom.
• States that the 2 aluminium atoms donate a total of 6 electrons to the 3 oxygen atoms.</td>
<td>• Explains that magnesium needs to lose two electrons to have a full outer shell and that oxygen needs to gain two electrons to gain a full outer shell.
• Explains that each aluminium atom needs to lose three electrons in order to have a full outer shell and that each oxygen atom needs to gain two electrons in order to have a full outer shell.
• Explains that because the magnesium ion has a charge of +2 and that the oxygen ion has a charge of –2, the ratio of the two ions is one to one in order to have a neutral compound overall.
• Explains that because aluminium ion has a charge of +3 and that the oxide ion has a charge of –2 the ratio of aluminium ions to oxide ions is 2:3 in order to have a neutral compound overall.
• States that the +6 charge of the two aluminium ions cancels out the –6 charge of the three oxide ions.</td>
<td>• Fully explains the ratio of ions in magnesium oxide, eg:
Magnesium ion has a charge of +2 and oxygen ion has a charge of –2. A compound overall has to have no charge. Therefore the +2 charge of magnesium ion cancels out the –2 charge of oxygen ion and so therefore the ratio of ions is one to one. The charge on the ions arises as magnesium has to lose two electrons in order to have a full outer shell and gets a charge of +2, and oxygen has to gain two electrons in order to have a full outer shell and gets a charge of –2.
• Fully explains the ratio of ions in aluminium oxide, eg:
Aluminium ion has a charge of +3, two aluminium ions with a combined charge of +6 are required to cancel out the charge on three oxide ions with a combined charge of –6. A compound overall has to have no charge. The charge on the ions arises as aluminium has to lose three electrons in order to have a full outer shell and gets a charge of +3, and oxygen has to gain two electrons in order to have a full outer shell and gets a charge of –2.</td>
</tr>
</table>

	Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q1	NØ = no response or no relevant evidence	N1 = 1 point from Achievement	N2 = 2 points from Achievement	A3 = 3 points from Achievement	A4 = 4 points from Achievement	M5 = 2 points from Merit	M6 = 3 points from Merit	E7 = 1 point from Excellence	E8 = 2 points from Excellence

Question	Evidence	Achievement	Merit	Excellence
TWO (a) (i)(ii)	When a metal carbonate reacts with an acid, carbon dioxide gas is released. This gas causes the balloon to inflate. It is faster when powder is used, because the surface area of the powder is greater. Because there is more surface area, there is more surface with which the HCl particles can collide. Because more collisions occur more frequently, the rate is faster, and CO_2 will be generated more quickly.	• A gas (CO_2) is released causing the balloon to inflate. • Powdered calcium carbonate has a greater surface area.	• Two of the three ideas below linked. - It is faster because the surface area of the calcium carbonate chips is greater. - Because there is more surface area, there is more surface for the HCl particles to collide. - Because of this, there are more collisions occurring more frequently and therefore the rate is faster.	It is faster because when smaller chips are used, the surface area of the chips is greater. Because there is more surface area, there is more surface for the (HCl) particles to collide. Therefore there are more collisions occurring per unit time.
(b)	One way of making the reaction occur faster is to increase the concentration of the acid used. When this happens there are more HCl particles in the same volume of acid, and therefore there is a greater chance of collisions occurring more frequently, and so the rate of reaction is faster. Because the rate is faster, CO_2 is produced more rapidly, and the balloon inflates faster. OR The other way is to increase the temperature of the acid. When this happens, the HCl particles move faster; because they are moving faster, there is a greater chance of collisions occurring more frequently, and so the rate of reaction is faster. Because the rate is faster, CO_2 is produced more rapidly, and the balloon inflates faster.	• States somewhere that the more collisions the faster the reaction. • The number of collisions increases when: - Concentration increases OR - SA increases OR - Temp (shaking occurs) increases OR - When more powdered calcium carbonate is used OR - Adding a catalyst increases the number of *effective* collisions.	• Explains that when the concentration is increased there are more particles present, and so therefore there is a greater chance of collisions occurring. OR Explains that as the temperature is increased (or when shaking occurs) the particles are moving faster and therefore there is a greater chance of collisions occurring. OR Explains that using a catalyst provides an alternative pathway (lowers the activation energy) and therefore increases the number of successful collisions. OR Explains that using more powdered calcium carbonate means there are more particles to react and hence there are more collisions.	Explains that when the concentration is increased, there are more particles present in the same volume and so therefore there is a greater chance of collisions occurring per unit time. OR Explains that the temperature (or when shaking occurs) is increased, the particles are moving faster, and therefore there is a greater chance of collisions per unit time. OR Explains that using a catalyst provides an alternative pathway (lowers the activation energy) and therefore increases the number of successful collisions per unit time. OR Explains that using more powdered calcium carbonate means there are more particles to react and hence there are more collisions per unit time.
	Hydrochloric acid + calcium carbonate → calcium chloride + carbon dioxide + water. $2HCl + CaCO_3 \rightarrow CaCl_2 + CO_2 + H_2O$	• Correct word equation.	• Correct equation, but not balanced.	• Correctly balanced equation.

	Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q2	NØ = no response or no relevant evidence	N1 = 1 point from Achievement	N2 = 2 points from Achievement	A3 = 3 points from Achievement	A4 = 4 points from Achievement	M5 = 2 points from Merit	M6 = 3 points from Merit	E7 = 2 points from Excellence	E8 = 3 points from Excellence

Question	Evidence	Achievement	Merit	Excellence
THREE (a) (b) (c)	Beaker 1 = water The green colour of the universal indicator indicates that this solution has a pH of 7 and therefore is neutral. The fact that both litmus papers stay the same colour also indicates that the liquid is neutral and has a pH of seven, and therefore Beaker 1 must be water. Beaker 2 = vinegar The orange colour of the universal indicator indicates that the solution is acidic and has a pH of 4–5. Because the blue litmus turns red, this also indicates that the solution is acidic, and therefore Beaker 2 must be vinegar (ethanoic acid) Beaker 3 = baking soda The blue colour of the universal indicator indicates that the liquid is basic and has a pH of 9–10. Because the red litmus turns blue, this also indicates that the liquid is basic, and therefore Beaker 3 must be basic, as baking soda (sodium hydrogen carbonate) is basic. Beaker with a pH of one is more acidic. In both solutions there are an excess of hydrogen ions compared to hydroxide ions, but in the solution with a lower pH the number of hydrogen ions is much more in excess compared to hydroxide ions; whereas when the pH is 6 the hydrogen ions are still in excess but not by as much.	• Identifies Beaker 1 as water and supports this with one correct statement. • Identifies Beaker 2 as vinegar and supports this with one correct statement. • Identifies Beaker 3 as a solution of baking soda and supports this with one correct statement. • Green UI = pH 7 OR Orange UI = pH 4, 5, or 6 OR Blue UI = pH 9 or 12 OR Red litmus turns blue in base . OR Blue litmus turns red in acid. • Both pieces of litmus stay the same colour in water / neutral. • Beaker 4 is more acidic as it has a lower pH or v. v. • The lower the pH, the more H^+ ions or vice versa (or less OH^-).	• Identifies liquid in two beakers, and explains this by linking all information regarding pH, colours of UI and use of litmus. • Explains that solutions in beakers 4 and 5 both have an excess of hydrogen ions. • Explains that when a solution has a pH of 1 it has more hydrogen ions compared to when a solution has a pH of 6.	• Identifies three beakers and explains this by linking all information regarding pH, colours of UI, and use of litmus. • Explains that solutions in beakers 4 and 5 both have an excess of hydrogen ions compared to hydroxide ions. • The solution with a pH of 1 has a greater excess of hydrogen ions compared to hydroxide ions, compared to a solution of pH 6, and hence the solution with pH of 1 is more acidic.

	Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q3	NØ = no response or no relevant evidence	N1= 1 point from Achievement (correct table)	N2 = 2 points from Achievement (correct table)	A3 = 3 points from Achievement	A4 = 4 points from Achievement	M5 = 2 points from Merit	M6 = 3 points from Merit	E7 = 2 point from Excellence	E8 = 3 points from Excellence

Question	Evidence	Achievement	yyyyyy	Excellence
FOUR (a) (b)(c)	**Equations** Sulfuric acid + sodium hydroxide → sodium sulfate + water $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$ **Explanations** The solution would be purple to start with, as the pH would be 13–14. The pH would be high, as there is a high number of OH^- ions present. At this stage OH^- ions are in excess when compared to H^+ ions. As H_2SO_4 is added, the solution would go blue. At this stage the pH would be 8–12 and OH^- ions are still in excess of H^+ ions, but not by as much as when the solution was purple. When the solution becomes green, the amount of H^+ ions added (from the H_2SO_4) cancel out the OH^- ions from the sodium hydroxide and form water in a neutralisation reaction. At this stage the pH would be 7. As more H_2SO_4 is added, the solution then turns yellow, then orange, and then red. When the solution is yellow or orange, the pH is 3–6 as there are now more H^+ ions present than OH^- ions. When it becomes red, the pH is 1–2, as there are now many more H^+ ions present than OH^- ions.	• Describes three correct colours in the beaker in correct order as H_2SO_4 is added. • Links two pH values to colour other than pH = 7. • States when colour is green and the pH is 7 the solution is neutral. • States that the acid / H_2SO_4 provides hydrogen ions. • States that the base / NaOH provides hydroxide ions. • Correct word equation. OR Correct symbol equation with Na_2SO_4 given as $NaSO_4$.	• Correct symbol equation but not balanced. • Explains that H^+ and OH^- form water/neutral • States that pH < 7 is acidic and pH > 7 is basic and links one acidic and basic pH value to colours as well as green is pH = 7. • Explains that before any H_2SO_4 is added to the beaker, that OH^- ions are in excess, and as more H_2SO_4 is added the concentration of H^+ increases until H^+ ions are in excess.	• Correctly balanced symbol equation. • Links the colour changes to the pH and ions. Must have hydroxide and hydrogen ions at all three points ie beginning, neutralisation, end. • Links the colour change to pH and ions present at an intermediary point of the reaction. (Must discuss hydrogen and hydroxide ions).

	Not Achieved			Achievement		Achievement with Merit		Achievement with Excellence	
Q4	NØ = no response or no relevant evidence	N1 = 1 point from Achievement	N2 = 2 points from Achievement	A3 = 3 points from Achievement	A4 = 4 points from Achievement	M5 = 2 points from Merit	M6 = 3 points from Merit	E7 = 2 points from Excellence	E8 = 3 points from Excellence

Cut Scores

	Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
Score range	0 – 8	9 – 16	17 – 24	25 – 32