Assessment Schedule – 2016

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

Evidence Statement

<table>
<tr><th>Q</th><th>Evidence</th><th>Achievement</th><th>Achievement with Merit</th><th>Achievement with Excellence</th></tr>
<tr><td>ONE
(a)</td><td>
<table>
<tr><td></td><td>Atomic number</td><td>Electron arrangement of atom</td><td>Electron arrangement of ion</td></tr>
<tr><td>F</td><td>9</td><td>2, 7</td><td>2, 8</td></tr>
<tr><td>S</td><td>16</td><td>2, 8, 6</td><td>2, 8, 8</td></tr>
<tr><td>Ca</td><td>20</td><td>2, 8, 8, 2</td><td>2, 8, 8</td></tr>
</table>
</td><td>• Correctly gives the electron arrangement of two atoms.
OR
Correctly gives the electron arrangement of two ions.</td><td></td><td></td></tr>
<tr><td>(b)(i)
(ii)
(iii)</td><td>AgF
K_2SO_4
$Ca(NO_3)_2$</td><td>• Correctly writes two formulae.</td><td></td><td></td></tr>
</table>

(c)(i)	Na is a group one element, so the Na atom has one valence electron and an electron configuration of 2, 8, 1. The Na atom loses its one valence electron to gain a full outer shell – it now has 1 more proton (11) than electrons; the Na^+ ion is formed. O is a group sixteen element, so the O atom has six valence electrons and an electron configuration of 2, 6. The O atom gains two electrons to gain a full outer shell – it now has 2 less protons (8) than electrons; the O^{2-} ion is formed.	• States that sodium loses one electron and oxygen gains two electrons when forming ions. OR One atom / ion correct for the group, number of protons, and electron arrangement.	• Compares the two ions: Explains that sodium is a group one element and therefore has one valence electron, and that oxygen will have six valence electrons since it is in group sixteen. OR Explains that sodium must lose one electron to have a full outer shell, and that oxygen must gain two electrons to gain a full outer shell. OR Explains that the sodium ion has one more proton than electron, hence + charge, and that the oxygen ion has two fewer protons than electrons hence –2 charge • One ion correct for group, number of protons and electrons and ion formation.	• Fully explains that sodium is a group one element because it has one valence electron in its outer shell. It loses its one valence electron to gain a full outer shell. Oxygen is a group sixteen element because it has six valence electrons in its outer shell, and will therefore gain two electrons to gain a full outer shell. Relates the charges to the difference between the protons and electrons in the ions.
(ii)	The Na atom loses one electron to form the Na+ ion; however, the O atom requires two electrons to fill its outer shell. Therefore, two Na atoms react for every one O atom. The two Na+ ions have a total charge of +2 to balance the –2 charge of the O^{2-} ion, i.e. an ionic compound has no overall charge. The bonding / attraction between the Na^+ ions and the O^{2-} ions is an ionic bond, formed when the electrons lost by the Na are gained by the O.	• States that overall an ionic compound has no charge since the charges must cancel out. OR O is 2–, and Na is 1+, so ratio is 1:2.	• Explains ratio: Because the sodium ion has a charge of +1 and the oxide ion has a charge of –2, the ratio of sodium ions to oxide ions is 2:1 in order to have a neutral compound overall. OR Explains that since the oxygen atom must gain two electrons, it will react with two sodium atoms since each sodium atom will donate one electron so the ratio of sodium ions to oxide ions is 2:1 to have the number of electrons gained = number lost.	• Fully explains that since the oxygen atom must gain two electrons, it will react with two sodium atoms, since each sodium atom will donate one electron. This means two sodium ions with a combined charge of +2 will be required to balance the –2 charge on the oxide ion to give the ionic compound a neutral charge overall. The Na^+ ions and O^{2-} ions are attracted to each other by an ionic bond.
(d)	sodium hydroxide + sulfuric acid → sodium sulfate + water $2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$	• Correct word equation.	• Correct formulae for symbol equation, but not balanced.	• Correctly balanced symbol equation.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE PARTIAL idea from Achievement.	ONE idea from Achievement.	TWO ideas from Achievement.	THREE ideas from Achievement.	TWO points from Merit.	THREE points from Merit.	TWO points from Excellence.	THREE points from Excellence.

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
TWO (a)	The mass of the flask and its contents decreases over time because one of the products is carbon dioxide gas. Since the reaction takes place in an open conical flask, the mass of the CO_2 gas is lost to the surroundings.	• States the mass is decreasing since (carbon dioxide) gas is being released.		
(b)(i) (ii)	Surface area. The mass of the flask and its contents will decrease faster with the powder (experiment 2) compared to the chunks (experiment 1), and the gas production will be faster. This is because the powder has a larger surface area than the large chips, so more particles of calcium carbonate are exposed for the acid to react with / collide with, and therefore experiment 2 has a higher frequency of successful collisions, and subsequently a faster rate of reaction. Both reactions will get to the same mass, as both have the same amount of reactants and therefore release the same amount of CO_2, but at different rates.	• Identifies surface area. OR States that the powdered calcium carbonate has a greater surface area in (ii). • States that more collisions cause a faster (rate of) reaction. • One correct observation or conclusion (higher surface area = faster reaction rate (rate of gas production, rate of mass decrease, time for reaction to stop, etc.).	• Explains that the greater the surface area of calcium carbonate, the more collisions there are with the HCl per sec (or frequency). • Links an observation, e.g. mass of the powder decreases faster, to more exposed particles / collision frequency. OR Both experiments get to the same mass, as both have the same number of reactant particles, so the same number of successful collisions / amount of CO_2 released.	• Fully explains that a greater surface area of calcium carbonate means there is an increased surface area for HCl to collide with, leading to a higher frequency of successful collisions and therefore a faster rate of reaction, linked to an observation. • Fully explains why both reactions get to the same final mass, but do so with different rates, i.e. there are more successful collisions / sec in the powder, but the same number of successful collisions in total.
(c)	An acid with a pH of 1 has a higher $[H^+]$ than an acid with a pH of 5. Since experiment 2 has more H^+ ions per unit volume / a higher concentration of H^+ ions, it will have a higher frequency of successful collisions (more successful collisions per second) and subsequently a higher / faster rate of reaction.	• Identifies the lower the pH, the more H+ ions in solution / the more acidic the solution is. • States the number of collisions /reaction rate increases as the concentration of H^+ ions increases / pH decreases.	• Explains that an acid of pH 1 has a higher concentration of H^+ ions than an acid of pH 5, therefore more H^+ particles per mL / vol in experiment 2. Explains that an increase in the H^+ concentration means there is a greater frequency of collisions and therefore the rate is higher / faster in experiment 2 than in experiment 3.	• Fully explains that the acid of pH 1 has a higher concentration of H^+ ions than an acid of pH 5 and therefore has more H^+ per unit volume, leading to a higher frequency of successful collisions and therefore a higher / faster rate of reaction.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE PARTIAL idea from Achievement.	ONE idea from Achievement.	TWO ideas from Achievement.	THREE ideas from Achievement.	TWO points from Merit.	THREE points from Merit.	TWO points from Excellence.	THREE points from Excellence.

Q	Evidence	Achievement	Achievement with Merit	Achievement with Excellence
THREE (a)	KOH has a higher [OH^-] than K_2CO_3 and therefore has a higher pH / is more basic than K_2CO_3. UI is purple at a pH of 12–14, whereas UI is blue for a base with a lower pH of 8–11.	• Recognises that solutions are basic and KOH is more basic than K_2CO_3.	• Links KOH being more basic to higher pH or higher [OH^-] or strength. (Or v.v.)	
(b)	hydrochloric acid + potassium carbonate→ potassium chloride + water + carbon dioxide $2HCl + K_2CO_3 \rightarrow 2KCl + H_2O + CO_2$	• Correct word equation for Beaker 1.	• Correct formulae for symbol equation, but not balanced.	• Correctly balanced symbol equation.
(c)	Beaker 2 is initially purple since [OH^-] is much greater than [H+]; the pH is 12–14. As HCl is added, the H^+ start to neutralise some of the OH^-. As the pH decreases to 8–11, the solution turns blue and [OH^-] > [H^+]. Once enough HCl has been added such that [OH^-] = [H^+], the UI turns green since all the OH^- have been neutralised by H^+ ions to form water, and the pH equals 7. As more HCl is added, the pH decreases to pH 3–6 since [H^+] > [OH^-], so the UI turns yellow / orange. As more HCl is added, the pH decreases to 1–2 since [H^+] becomes much greater than [OH^-], so UI turns red. Information could come from (a).	• Describes three correct colours in correct order in Beaker 2 as HCl is added. • Links two pH values to correct colour in Beaker 2. • Identifies that OH^- ions are neutralised as H^+ ions are added OR reaction is neutralisation.	• Explains that before any HCl is added to Beaker 2 the OH^- ions are in excess, and as more HCl is added, the concentration of OH^- ions decreases until H^+ ions are in excess. • Explains that once a sufficient number of H^+ ions have been added to neutralise all the OH^- ions to form water, the pH equals 7. • Links three UI colours (purple, blue, green, yellow / orange, red) to correct pH values and relative concentrations of ions present.	• Fully explains and links the colour changes in Beaker 2 to the changing pH, relative concentration of H^+ ions and OH^- ions present, and type of reaction (neutralisation) occurring.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response; or no relevant evidence.	ONE PARTIAL idea from Achievement.	ONE idea from Achievement.	TWO ideas from Achievement.	THREE ideas from Achievement.	TWO points from Merit.	THREE points from Merit.	BOTH points from Excellence with minor omission in explanation.	BOTH points from Excellence.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0–7	8–13	14–19	20–24