Assessment Schedule – 2021

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

Evidence Statement

Q	Evidence	Achievement	Merit	Excellence
ONE (a)	Li atom: 2,1 Al atom: 2,8,3 O atom: 2,6	• Correctly gives the electron arrangement of TWO atoms.		
(b)(i)	Both ions have the electron arrangement 2,8.	• States the electronic arrangement of the ions.		
(ii)	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. O^{2-} because it has 8+ protons (+ charges) and 10 – electrons (– charges). It has 10 electrons, as its electron arrangement as an atom was 2,6 and when it forms an ion, it gains two electrons to form an arrangement of 2,8 to have a full outer shell, which is more stable.	• Defines an ion, e.g. An atom that has gained or lost an electron to become stable / has a full outer shell. • States that Al atom loses (three) electrons. OR O atom gains (two) electrons.	• Explains the charge on **one** ion in terms of electron arrangement AND atomic structure (protons and electrons). • Explains that Al needs to lose (three) electrons, and O needs to gain (two) electrons for each to have a full outer shell / be stable. • Explains the charge on the ions in terms of the balance of + protons and – electrons in the ion. (For M must show they know charges on protons and electrons.)	Al has 13+ protons and 13 – electrons has electron configuration of 2,8,3. It has three electrons in its valance (outer) shell so needs to lose them to have a full outer shell to become stable. It now has 3 less e– than p+ and the electron configuration of the ion is 2,8 and becomes Al^{3+}. AND O has 8 +protons and 8- electrons and has an electron configuration of 2,6. . It needs to gain 2 electrons to get a full outer shell and be stable. It now has 2 more electrons than protons and an electron configuration of 2,8 and so is O^{2-}. *For E, must show the charges on protons and electrons.*

(c)	The ratio is 2 aluminium atoms to 3 oxygen atoms. Aluminium loses 3 electrons to form Al^{3+}, ending up with a charge of +3. Oxygen will gain two electrons to become O^{2-} and have a charge of –2. As 2 Al react, they lose the 3 electrons in their outer shell to fill the outer shells of 3 oxygens. In order to have a neutral compound, two aluminium ions with a combined charge of +6 are needed to cancel out the charge on three oxide ions with a combined charge of –6.	• States that overall an ionic compound has no charge so charges must cancel out. OR +3 charge on aluminium ion cancels / balances the three –2 charges on oxide ion.	• Explains that since the aluminium needs to lose 3 electrons, two Al will react with three O as the O only need 2 electrons each. • Explains that because the aluminium ion has a charge of +3 and the oxide ion has a charge of –2, the ratio of aluminium ions to oxide ions is 2:3, so forming a neutral compound overall.	• The Al atom needs to lose three electrons but O needs only to gain two electrons. So, Al ion has a charge of +3 while O has –2, so there needs to be three Oxygens so that they can accept two electrons each from two Al. The charges then cancel each other out to make a compound with a neutral / no / zero charge. (In order to have a neutral compound, two aluminium ions with a combined charge of +6 are needed to cancel out the charge on three oxide ions with a combined charge of –6).

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	TWO Merit points.	THREE Merit points.	ONE Excellence point.	TWO Excellence points.

Q	Evidence	Achievement	Merit	Excellence
TWO (a)	Magnesium carbonate + hydrochloric acid → magnesium chloride + water + carbon dioxide $MgCO_3 + 2HCl \rightarrow MgCl_2 + H_2O + CO_2$	• Correct word equation. OR ALL product formulae correct.	• Correct formulae for symbol equation, but not balanced.	• Correctly balanced symbol equation.
(b)(i)	37 °C	• Correct temperature.		
(ii)	As the temperature of the hydrochloric acid increases, the particles move faster and have more (kinetic) energy. There are more collisions per second between the acid and the base particles due to higher speed, and more of these collisions have enough energy to cause a reaction. Therefore, increasing the temperature will cause more successful collisions per second, and the reaction will occur faster.	• Increasing temperature causes more (frequent) collisions OR particles have more energy / move faster OR vice versa. • Reaction occurs when particles collide successfully. OR More (successful) collisions per second cause a faster rate of reaction (vice-versa).	• Explains acid particles at the higher temperature will have more energy, so there will be more successful collisions. • Explains acid particles at the higher temperature move faster, so will have more frequent collisions / collisions per unit time.	• Fully explains that at high temperatures, acid particles will collide with more energy / force, producing more successful / effective collisions between acid and magnesium carbonate AND because the particles have more kinetic energy and move faster, there will be more frequent collisions / collisions per unit time, which will increase / speed up / cause a faster rate of reaction.
(c)	Reactions can take place only when the particles can collide. Chewed tablets will have a greater surface area so it is more likely that there will be collisions between the acid and the carbonate particles. The more collisions per second there are, the faster the rate of reaction, and so the faster the gas is produced, and the acid is used up.	• Identifies surface area. OR States that the chewed tablet has a greater surface area. • 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 the tablet, the more collisions there are with the HCl per second (or frequency). • Links faster rate of reaction to an observation, e.g. the gas is produced faster, or the acid is used up faster.	• Fully explains that a greater surface area of tablet means there is an increased surface area (of $MgCO_3$ / reactant particles exposed) for HCl to collide with, leading to a higher frequency of successful collisions, and therefore a faster rate of reaction, linked to an observation such as rate of gas production, rate of mass decrease, time for reaction to stop, works faster so quicker relief.

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	TWO Merit points.	THREE Merit points.	ONE Excellence point.	TWO Excellence points.

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

(ii)
(iii)</td>
<td>
<table>
<tr><th>Substance</th><th>pH</th><th>Observation with red litmus</th><th>Observation with universal indicator</th></tr>
<tr><td>Soap</td><td>8</td><td>Blue</td><td>Blue</td></tr>
<tr><td>Oven cleaner</td><td>12</td><td>Blue</td><td>Dark blue / purple</td></tr>
</table>
Universal indicator

The oven cleaner will turn the universal indicator deep blue / purple because it is a strong alkali / base, but the soap will turn the UI blue because it is a weak base. Because UI gives different results, it can be used to identify the substances.

Both substances are bases, so will both turn the red litmus blue. Because it gives the same result for both substances, it will not help identify the contents.
</td>
<td>• ONE row of table correct.
OR
ONE column of table correct.
• Gives a reason for ONE observation.
• Chooses UI as the correct indicator to use.</td>
<td>• Table correctly completed with ONE observation explained.
OR
TWO observations explained.</td>
<td>• Fully explains the choice of indicator linking to observations showing how the substances can be identified.</td>
</tr>
<tr>
<td>(b)</td>
<td>In discussion accept H^+ or H_3O^+.
As the lemon juice is added, the oven cleaner is being neutralised until water is formed. When no lemon juice is added, the solution is purple/ dark blue and has pH 12 because there is an excess of OH^- ions. While the lemon juice is being added, the solution becomes blue with a pH of 8–10. There is still an excess of OH^- ions, but not as big. When the numbers of H^+ and OH^- ions are equal, the solution is neutralised, green, and the pH is 7. As more lemon juice is added, the solution becomes yellow /orange, with a pH of 4–5. There is a small excess of H^+ ions over OH^- ions.</td>
<td>• Describes two correct colours in correct order as lemon juice is added.
• Links two pH values to correct colour.
• Identifies that OH^- ions are neutralised as H^+ ions are added.
• At pH7 / green / neutral, - acid and base cancel out.
OR
$H^+ = OH^-$ at pH 7.</td>
<td>• Explains that before any lemon juice is added, the OH^- ions are in excess, and as more lemon juice is added, the concentration of H^+ ions increases 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 all UI colours (red, yellow / orange, green, blue / purple) to EITHER correct pH values OR relative concentrations of ions present.</td>
<td>• Fully explains and links the colour changes to the changing pH, relative concentration of H^+ ions and OH^- ions present, and neutralisation reaction occurring (pH 7 when $H^+ = OH^-$ and neutral substances / water made).</td>
</tr>
</table>

(c)	To neutralise a base, enough H^+ ions need to be added to remove the excess OH^- ions. This means an acid is needed to neutralise a base to reach pH 7. Both oven cleaner and soap are bases so they do not contain enough H^+ ions to neutralise the OH^- ions they contain. OR The pH of the oven cleaner and the soap are both greater than pH 7, so adding them together will not reduce the pH to 7 (neutral).		• Explains that an acid is required to neutralise a base to reach pH 7. OR Explains that the pH of the oven cleaner and soap are greater than 7, so adding them together with result in a mixture of pH greater than 7, so not neutral.	

NØ	N1	N2	A3	A4	M5	M6	E7	E8
No response or no relevant evidence.	ONE Achievement point.	TWO Achievement points.	THREE Achievement points.	FOUR Achievement points.	TWO Merit points.	THREE Merit points.	ONE Excellence point.	TWO Excellence points.

Cut Scores

Not Achieved	Achievement	Achievement with Merit	Achievement with Excellence
0 – 6	7 – 13	14 – 19	20– 24