

## C4.3 Mastery Quiz: Quantitative Chemistry

### Mark Scheme

#### Section A

Qu	Answer	Marks	Supporting information for fix-it tasks
1	C	1	<p>Answering A suggests that the student has added together the relative atomic masses and has not considered that there are three bromines in the formula.</p> <p>Answering B suggests that the student has added together the relative atomic masses and multiplied the answer by 3, thinking that the subscript '3' in the formula refers to both the iron and bromine atoms.</p> <p><i>To fix it, model for students how to work out this answer correctly. Then give students similar questions to calculate relative formula masses.</i></p>
2	B	1	<p>Answering A or C indicates that students cannot recall the ions present in alkaline solutions.</p> <p><i>To fix-it, look at the formulae of some common acids and alkalis and ask students to identify what they have in common.</i></p>
3	C	1	<p>Answering A, C or D means students are mixing up different reactions and cannot recall what a neutralisation reaction is.</p> <p><i>To fix it, provide an example of each of these types of reaction (in equation form), with a definition of each, and ask students to match these up.</i></p>
4	C	1	<p>Answering A or B suggests that students cannot relate the colour of universal indicator with the pH of a solution.</p> <p><i>To fix-it, show students a coloured pH scale which demonstrates the colour of universal indicator in various pHs. Give students some unknown solutions to test using universal indicator and identify their pHs.</i></p>
5	A	1	<p>Answering B suggests the misconception that <math>\text{CO}_3</math> is an atom. <i>To fix it, ask students to write out which elements are present in <math>\text{MgCO}_3</math>.</i></p> <p>Answering C suggests the misconception that the subscript number refers to all elements in the compound. <i>To fix it, reteach what the subscript numbers and the coefficients mean and then give students more practice questions to determine the numbers of atoms.</i></p>
6	C	1	<p>Answering A suggests the misconception that because an aqueous solution is liquid, then the state symbol is (l).</p>



			<p>Answering B suggest the misconception that because solution starts with 's' the state symbol is (s).</p> <p>To fix it, reteach the state symbols and then ask students to write out the state symbols in books. Then give them a symbol equation from Q2 and ask them to add in the state symbols.</p>
7	B	1	<p>Answering A suggests the misconception that gases do not have mass.</p> <p>Answering C suggests a misconception that reactants have more mass than the products that they form.</p> <p>To fix it reteach: The law of conservation of mass indicates that mass cannot be created or destroyed. The <b>total mass reactants = total mass products</b>, even if a gas is produced. Then give students examples of masses to calculate how much of x is produced to practice applying this.</p>
8	B	1	<p>Answering A or C suggests a gap in knowledge about how salt compounds are derived from neutralisation reactions. To fix it, reteach this by modelling how to deduce which metal reacts with what non-metal in a neutralisation reaction to form the salt.</p>
9	C	1	<p>Answering A shows a gap in knowledge about when to convert units. To fix it, model how A would be correct if the units were cm and not dm<sup>3</sup>. Then give students similar practice questions to do.</p> <p>Answering B shows a gap in knowledge about how to calculate concentration since this option is concentration/mass. To fix it, reteach how to calculate concentration, focussing on how the units tell you what concentration is, i.e. 200 g in/per 1 dm<sup>3</sup> of volume. Then ask students to write out this question and label the mass, volume and then show how to calculate concentration i.e. 200/1.</p>
10	C	1	<p>Answering A suggests that pupils are confusing the mass number of fluorine with the number of atoms in one mole.</p> <p>Answering B suggests students are misremembering Avogadro's number.</p> <p>To fix-it, use examples of other substances to show the mass of one mole for each. Then point out that one mole of any substance contains exactly Avogadro's number of atoms/particles/molecules.</p>
11	B	1	<p>Answering A or C suggests that students are unsure how to convert between cm<sup>3</sup> and dm<sup>3</sup>.</p> <p>To fix-it, model for students how to do this conversion, and then give students some similar conversions to try independently.</p>
12	A	1	<p>Answering B suggests that students are unsure how to work out the limiting reactant.</p> <p>Answering C suggests that students are unable to identify a reactant in an equation.</p>



			<p><i>To fix-it, model for students how to work out the number of moles of each reactant, and to compare this to the molar ratio from the equation.</i></p>
13	A	1	<p>Answering B suggests that students mistakenly think that strong acids only partially ionise in aqueous solution.</p> <p>Answering C suggests that students have not recognised the name of ethanoic acid (vinegar) as a weak acid.</p> <p><i>To fix-it, ask students to sort the names of common acids into strong and weak acids. They should then label one list with 'partially ionises in aqueous solution' and another with 'fully ionises in aqueous solution'.</i></p>
14	B	1	<p>Answering A suggests that students can describe concentration in terms of the proportion of water molecules mixed with the acid, but they cannot relate this to the concentration of H<sup>+</sup> ions.</p> <p>Answering C suggests that students are mixing up the descriptions of a weak acid with that of a concentrated acid.</p> <p><i>To fix-it, use particle diagrams to explain the difference between weak and concentrated acids. Ask students to explain this back to you by referring to the proportion of water molecules mixed with the acid, and the resulting concentration of H<sup>+</sup> ions.</i></p>
15	A	1	<p>Answering B suggests that students have mistakenly divided the number of moles by the relative formula mass, either because they guessed or made a mistake when rearranging the formula that links mass, number of moles and relative formula mass.</p> <p>Answering C suggests that students have mistakenly divided the relative formula mass by the number of moles, either because they guessed or made a mistake when rearranging the formula that links mass, number of moles and relative formula mass.</p> <p><i>To fix-it, give students more practise in using the formula that links mass, number of moles and relative formula mass. Ensure students are given enough practise in rearranging this formula to find each unknown.</i></p>
16	B	1	<p>Answering A suggests that students divided concentration by volume in order to find number of moles, instead of multiplying.</p> <p>Answering C suggests that students have calculated the number of moles, and have not done the additional steps to convert this to a mass.</p> <p><i>To fix it, model the steps of this calculation for students, pointing out how two different equations are used to get to the final answer. Give students some similar questions to answer.</i></p>
17	C	1	<p>Answering A or B suggests that students are unable to use the equation to determine the molar ratio, and to use this to calculate</p>



			<p>the number of moles of one substance when given the number of moles of another.</p> <p><i>To fix-it, model how to work this out on the board. Substitute the number of moles of ethanedioic acid in the question with another number and repeat to find the number of moles of sodium hydroxide solution that would react with it. Repeat with more numbers. Give students similar questions with different equations to see if they can still apply their learning.</i></p>
18	A	1	<p>Answering B or C shows that students are unable to determine the reinforcement and the matrix (binder) in a composite material.</p> <p><i>To fix-it, give students further examples of composite materials and ask them to determine the reinforcement and the matrix (or binder)</i></p>
19	C	1	<p>Answering A or B suggests that students are unable to explain the use of a white tile in a titration.</p> <p><i>To fix-it, demonstrate a simple colour change both using a white tile and on a dark wooden desk to demonstrate the purpose.</i></p>
20	B	1	<p>Answering A suggests that students have used all of the figures to calculate the average titre, and not just those within <math>0.2\text{ cm}^3</math> of each other.</p> <p>Answering C suggests that students have used 4 of the 5 figures to calculate the average titre, even though only three are within <math>0.2\text{ cm}^3</math> of each other.</p> <p><i>To fix-it, give students lists of numbers to circle the ones within within <math>0.2\text{ cm}^3</math> of each other.</i></p>
21	B	1	<p>Answering A or C suggests that students are unable to calculate the volume of a gas using the mass and relative formula mass, and formula volume of a gas at rtp =number of moles x 24</p> <p><i>To fix-it, model for students how this calculation is made with the formula provided. Give students practice using this formula and a selection of different masses or number of moles of gases.</i></p>

## Section B

Qu	Model answer	Marks	Supporting information Suggestions for fix-it tasks
1 (a)	The mass of the products is equal to the mass of the reactants.	1	To fix-it, use a simple chemical



	Allow atoms are not created or destroyed in a chemical reaction.		reaction (such as burning magnesium ribbon) to show that the mass of reactants always equals the mass of products.
1 (b)	<ul style="list-style-type: none"><li>The total mass of the reactants (Beaker A and contents before mixing + beaker B and contents before mixing) is not equal to the measured mass of beaker A and B and contents after mixing</li><li>because a gas (<math>\text{CO}_2</math>) is produced (which dissipates into the atmosphere and so its mass is not measured on the balance)</li></ul>	1 1	To fix-it, demonstrate a reaction where a gas is produced. Carry out the reaction with the reaction vessel sitting on a balance, so that students can see the mass decrease as a gas is produced.
1 (c)	0.01g	1	
1 (d)	$(23 \times 2) + (12) + (16 \times 3) \\ = 106$	1 1	To fix-it, give students a list of common chemical formulae to calculate their relative formula mass.
1 (e)	$(23 \times 2) / 106 = 0.434 \times 100 \\ = 43.4\%$	1 1	
1 (f)	$\text{CO}_3^{2-}$	1	
1 (g)	$\text{H}^+$ ions	1	
1 (h)	Red	1	To fix-it, demonstrate the colour changes of universal indicator in solutions of various pH's. Allow students to use the coloured pH scale to attempt similar questions.



2 (a)	Mr sodium chloride = $23 + 35.5 = 58.5 \text{ g}$  Number of moles sodium chloride: $11.5/58.5 = 0.19658 \text{ mol}$  Number of moles sodium carbonate: $0.19658/2$ $= 0.098 \text{ mol}$  Mr sodium carbonate = $(2 \times 23) + 12 + (3 \times 16) = 106$  Mass sodium carbonate = $0.098 \times 106$ $= \mathbf{10.42 \text{ g}}$  <i>If students round earlier, they will get 10.39 g. Students should keep answers on calculator for as long as possible.</i>	1 1 1 1	To fix-it, model the steps taken to solve this calculation for students, giving each step a name. Give students an opportunity to practise similar calculations with other equations.
2 (b)	$1.0 \times 10^{-3} \text{ mol/dm}^3$ is more concentrated than $1.0 \times 10^{-5} \text{ mol/dm}^3$ by a factor of 100 ( $10 \times 10$ )  Therefore the pH of the second solution will be greater by 2.  So, the second solution has a pH of 4.	1 1 Allow an answer of pH 4 with no working for 2 marks	To fix-it, ask students to identify the bigger number from two numbers written in standard form. Then from here, explain how to tell by how many factors of 10 is one bigger than the other.