**ANSWERS** **Solubility with change in pH**

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| **2018** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | In a saturated solution:  Fe(OH)3  Fe3+ + 3OH–  As the pH is lowered, [H3O+] increases. The H3O+ will remove and neutralise OH– /  H3O+ + OH– → 2H2O  A decrease in [OH–] will result in the forward reaction being favoured, to restore equilibrium/ minimise the change.  This causes more solid Fe(OH)3 to dissolve, i.e. the solubility of Fe(OH)3 increases / so that [Fe3+][OH–] will again equal *K*s. | Recognises Fe(OH)3 is more  soluble when the pH is lowered. | Explains that the solubility of Fe(OH)3 increases due to removal of OH– from the equilibrium. | Fully explains, using equilibrium  principles, how the solubility of  Fe(OH)3 increases when the pH is  lowered. Must include neutralisation equation. |

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| **2017** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | When copper(II) hydroxide is dissolved in an acidic solution, the H3O+ ions neutralize the OH– ions /  H3O+ + OH– → 2H2O  A decrease in [OH-] will result in the forward reaction being favoured, to restore equilibrium / minimise the change.  This causes more solid Cu(OH)2 to dissolve, i.e. the solubility of Cu(OH)2 increases /so that [Cu2+][OH–] will again equal *K*s. | Recognises OH– ions are reacting with acid. | Partial explanation for an increase in solubility. | Complete explanation for the increased solubility of Cu(OH)2 in an acidic solution. |

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| **2016** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | Ag2CO3(*s*)  2Ag+(*aq*) + CO32–(*aq*)  Ag+(*aq*)+ 2NH3(*aq*)→ [Ag(NH3)2](*aq*)  The equilibrium responds by favouring the forward reaction and thus more dissolves. | * One correct equation. * Recognises that a complex ion is formed. | Explanation linked to the effect on equilibrium. | Correct explanation, giving both correct equations. |

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| **2015** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | The H3O+ from the acidic solution reacts with the CO32–. This reduces [CO32–], causing the equilibrium to shift towards the products / RHS to replace some of the lost CO32–. Therefore more solid CaCO3 will dissolve.  2H3O+ + CO32– → 3H2O + CO2  (or other correct alternative). | Recognises H3O+ will remove / neutralise the CO32– from the equilibrium. | Recognises H3O+ will remove / reacts with CO32– with a relevant balanced equation AND uses equilibrium principles to link to an increased solubility of CaCO3. |  |

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| **2014** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | Zn(OH)2(*s*) ⇌ Zn2+(*aq*) + 2OH–(*aq*)  When pH is less than 4 / low, [OH–] is decreased due to the reaction with H3O+ to form water,  H3O+ + OH– → H2O  so equilibrium shifts to the right to produce more [OH–], therefore more Zn(OH)2 will dissolve.  When pH is greater than 10 / high, then more OH– is available and the complex ion (zincate ion) will form.  Zn(OH)2(*s*)+ 2OH– → [Zn(OH)4]2–  OR Zn2+ + 4OH– → [Zn(OH)4]2–  This decrease in [Zn2+] causes the position of equilibrium to shift further to the right, therefore more Zn(OH)2 dissolves. | * Writes the equilibrium equation. * Recognises solubility increases at pH of less than 4 (acidic conditions) **due to removal of OH–.**   OR  Recognises the solubility increases at a pH greater than 10 **due to formation of a complex ion.** | * Partial explanation for BOTH changes in pH, not fully related to the effect on the equilibrium.   OR  One change in pH fully explained. | * Complete explanation for BOTH changes in pH. |
| **2012** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | When the pH is decreased, [H3O+] will increase. The H3O+ will react with the OH– and therefore remove them from the equilibrium. This will cause the reaction to replace some of the removed OH–. As a result more Fe(OH)3 will dissolve, so decreasing the pH will increase the solubility of Fe(OH)3. | States [OH–] decreases / [H3O+] increases causing Fe(OH)3 to be more soluble. | Either:  States the change in [OH–], its impact on the equilibrium position and therefore more Fe(OH)3 dissolves.  OR  Discussion of effect of decreasing pH on Fe(OH)3 dissolving in terms of [H3O+]/ [OH–] changing. | Complete discussion of effect of decreasing pH on Fe(OH)3 solubility, including role of H3O+ (reacting with OH–). |

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| **2011** | **Evidence** | **Achieve** | **Merit** | **Excellence** |
|  | Raising the pH will increase the concentration of OH– ions.  This will initially cause additional precipitate to form.  Once the pH has been increased sufficiently (enough OH- has been added) the formation of a complex ion with Zn2+ will occur, lowering OH– ion concentration in solution.  Thus the precipitate will redissolve as a complex ion and less precipitate will be at the bottom of the test tube. | Recognises that [OH–] has increased.  Recognises equilibrium will shift to the left. | ONE of:  • Recognises that a complex ion will form and links this to either less solid remaining or  equilibrium shifting to the right.  • Identifies equilibrium shifting to the left due to additional OH–.  • Explains equilibrium shifting to the left in terms of the I.P. now exceeding Ks. | Complex ion forms, precipitate  re-dissolves, as equilibrium  shifts in the forwards direction /  to RHS. This shift to the right will occur so more Zn2+ and OH– will dissolve into solution so that the solution becomes saturated again. |

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