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| **1.** | (a) | lead (IV) oxide | **M1: PbO2** |
|  | (b) | lithium carbonate | **M2: Li2CO3** |
|  | (c) | barium nitrate | **M3: Ba(NO3)2** |
|  | (d) | ammonium sulphate | **M4: (NH4)2SO4** |
|  | (e) | calcium nitride | **M5: Ca3N2**  [5] |
| **2.** | M1: 17.0/40.1 : 11.9/14 : 67.7/16 : 3.4/1  M2: divide by smallest: 1:2:10:8  M3: ef = **CaN2O10H8**  M4: max 4 water, so CaN2O6.4H2O  M5: = **Ca(NO3)2.4H2O**  [5] | | |
| **3.** | (a) | M1: mass of HNO3 in 1 cm3 = 65/100 x 1.4 = 0.91 g HNO3  M2: moles of HNO3 in 1 cm3 = 0.91/63 = 0.01444  M3: molarity = n/V = 0.0144/0.001 = **14 moldm-3**  (answer should be 2sf, allow 2sf or 3sf – if 3sf must be 14.4) | |
|  | (b) | M4: fully dissociated so [H+] = 1.4 moldm-3  M5: pH = log10[H+] = **-1.2** (should be 1 dp, allow 1 dp or 2dp – if 2dp must be 1.16)  [5] | |
| **4.** | (a) | M1: moles of Mg(NO3)2 = 10.0 / 148.3 = 0.0674  M2: moles of NO2 = 0.0674 x 2 = 0.135  M3: volume of NO2 = nRT/P  M4: = 0.135 x 8.31 x 573 / 100000 = 6.42 x 10-3 m3 (= **6.42 dm3**) (3sf) | |
|  | (b) | M5: volume of O2 = 6.42/4 = **1.61 dm3** (or by deducing moles of O2 and using V = nRT/P) | |
|  | (c) | M6: total volume = **8.03 dm3** (or by summing moles of NO2 and O2 and using V = nRT/P)  All answers should be 3sf – if rounding errors but correct to 2sf then -1 only  [5] | |
| **5.** | (a) | M1: moles of CaCO3 = 0.8/ 100.1 = 7.99 x 10-3  M2: moles of HCl = .05 x .2 = 0.010  M3: moles of HCl needed = 0.016 moles, so there is not enough HCl  OR moles of CaCO3 needed = 0.050, so there is enough CaCO3  M4: so **CaCO3 is in excess** | |
|  | (b) | M5: moles of CO2 = 0.01 / 2 = 0.05  M6: volume of CO2 = 0.05 x 24.4 = **1.2 dm3** (should be 2sf allow 3sf if 1.22 dm3)  [5] | |

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| **6.** | (a) | Deduce the percentage atom economy of this reaction for the production of ethanol.  M1: total mr of useful product = 2 x 46 = 92 and total mr of all products = 180  M2: so % atom economy = 92/180 x 100 = **51.1 %** (3sf) | |
|  | (b) | M3: moles of glucose = 250,000 /180 = 1389  M4: expected moles of ethanol = 2778  M5: actual moles of ethanol = 2326  M6: so % yield = 2326/2778 = **83.7%** (3 sf)  [5] | |
| **7.** | M1: moles of HCl = 0.0173 x 0.1 = 0.00173  M2: moles of Na2CO3 (used in titration) = 8.65 x 10-4 | | |
|  | Either  M3: moles of Na2CO3 (in volumetric flask) = 8.65 x 10-4 x 10  M4: = 8.65 x 10-3  M5: molar mass of Na2CO3.xH2O = 2.43/0.00865 = 280.9 | | or  M3: molarity of Na2CO3 = 8.65 x 10-4 / 0.025 = 0.0346 moldm-3  M4: mass concentration of Na2CO3.xH2O = 2.43/0.25 = 9.72 gdm-3  M5: molar mass of Na2CO3.xH2O = 9.72/0.0346 = 280.9 |
|  | M6: xH2O = 280.9 – 106 = 174.9  M7: 174.9/18 = 9.7 so **x = 10** (must be integer)  [5] | | |
| **8.** | M1: moles of H+ = 0.025 x 0.15 = 3.75 x 10-3  M2: moles of OH- = 0.01 x 0.2 = 0.002  M3: excess H+ after reaction = 0.00375 – 0.002 = 0.00175  M4: total volume of solution = 25 + 10 = 35 cm3 = 0.035 dm3  M5: [H+] = 0.00175 / 0.035 = 0.035 moldm-3  M6: pH = -log10[H+] = **1.30** (2dp)  [5] | | |
| **9.** | (a) | M12: BaCO3 + 2HNO3 🡪 Ba(NO3)2 + CO2 + H2O | |
|  | (b) | M34: 2NH3 + H2SO4 🡪 (NH4)2SO4 | |
|  | (c) | M56: H3PO4 + 2NaOH 🡪 Na2HPO4 + 2H2O | |
|  | (d) | M78: 3HCl + Al(OH)3 🡪 AlCl3 + 3H2O | |
|  | (e) | M910: 2NaHCO3 🡪 Na2CO3 + CO2 + H2O  [5] | |