| Question | Marking guidance | Mark | AO | Comments |
|---|---|---|---|---|
| 07.1 | **Y** | 1 | AO3 1a | |
| 07.2 | **X** | 1 | AO3 1a | |
| 07.3 | Jump in trend of ionisation energies after removal of fifth electron<br>Fits with an element with 5 outer electrons ($4s^2 3d^3$) like V | <br>1 | <br>AO2b | |
| 07.4 | Explanation: Two different colours of solution are observed<br><br>Because each colour is due to vanadium in a different oxidation state | 1<br><br>1 | AO2g<br><br>AO2g | |

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|---|---|---|---|---|
| 07.5 | | | | Extended response<br>Maximum of 5 marks for answers which do not show a sustained line of reasoning which is coherent, relevant, substantiated and logically structured. |
| | **Stage 1:** mole calculations in either order<br>Moles of vanadium = 50.0 × 0.800/1000 = 4.00 x $10^{-2}$ | 1 | AO2d | |
| | Moles of $SO_2$ = pV/RT = (98 000 × 506 × $10^{-6}$ )/(8.31 × 293)<br>= 2.04 × $10^{-2}$ | 1 | AO2d | |
| | **Stage 2:** moles of electrons added to $NH_4VO_3$<br>When $SO_2$ (sulfur(IV) oxide) acts as a reducing agent, it is oxidised to sulfate(VI) ions so this is a two electron change | 1 | AO2d | |
| | Moles of electrons released when $SO_2$ is oxidised = 2.04 × $10^{-2}$ × 2<br>= 4.08 × $10^{-2}$ | 1 | AO2d | |
| | **Stage 3 :** conclusion<br>But in $NH_4VO_3$ vanadium is in oxidation state 5 | 1 | AO2b | |
| | 4.00 × $10^{-2}$ mol vanadium has gained 4.08 × $10^{-2}$ mol of electrons therefore 1 mol vanadium has gained 4.08 × $10^{-2}$/ 4.00 × 10–2 = 1 mol of electrons to the nearest integer, so new oxidation state is 5–1=4. | 1 | AO2d | |