| Question | Answers | Extra information | Mark | AO /  Spec ref. |
| --- | --- | --- | --- | --- |
| **01** | Increasing solution temperature  more collisions every second **and** more collisions with enough energy to break bonds.  Adding a catalyst  more collisions every second with enough energy to break bonds.  Increasing gas pressure  more collisions every second. | If more than three lines are drawn, deduct **1** mark for each incorrect line. | 1  1  1 | AO1  C6.1.2  WS1.2 |
| **02.1** | At least **five** points plotted correctly;  all points correct;  smooth curve avoiding anomalous point. | ± half a small square | 1  1  1 | 2 × AO2  1 × AO3  C6.1.2  MS4a, 4c |
| **02.2** | Any **one** from:   * clock started too late * clock stopped too soon * sodium thiosulfate solution too concentrated * sodium thiosulfate solution warmer. | Accept any other sensible suggestions.  Must be an error that leads to an anomalous point that is too low. | 1 | AO3  C6.1.2  WS3.7 |
| **02.3** | Rate increases **or** time taken decreases as concentration increases;  particles closer together **or** more particles in a given volume;  particles collide more frequently/ more collisions in a given time. | Do not accept more collisions or more successful collisions. | 1  1  1 | AO2  C6.1.3  WS1.2 |
| **03** | **Level 3:** Detailed and coherent practical method described with most apparatus named **and** both evidences for reversibility. | | 5–6 | AO1  C6.2.2 |
| **Level 2:** Some description of practical method **or** named apparatus **and** one piece of evidence for reversibility. | | 3–4 |
| **Level 1:** Brief description of method **or** named apparatus **or** one piece of evidence for reversibility. | | 1–2 |
| **Level 0:** No relevant content. | | 0 |
|  | **Indicative content:**  Apparatus:   * Bunsen burner * test tube or crucible * pipette or dropper * any other valid apparatus.   Method:   * heat until colour change * allow to cool * add water (dropwise).   Evidence:   * white powder becomes blue again when water is added * and energy evolved/test tube gets hot   Other creditworthy ideas:   * word equation with reversible arrow:   endothermic  hydrated copper sulfate ⇌ anhydrous copper sulfate + water (blue) exothermic (white)   * endothermic in forwards direction * exothermic in backwards direction.   This indicative content is not exhaustive, other creditworthy responses should be awarded marks as appropriate. | | |  |
| **04.1** | Gas syringe **or** inverted measuring cylinder over water;  correctly named. | Must be water present in trough if measuring cylinder used. | 1  1 | AO2  C6.1.2  AT1 |
| **04.2** | when *t* = 0–20s |  | 1 | AO3  C6.1.1  MS4e |
| **04.3** | 2.25  cm3/s | Allow error carried forward from **04.2**;  allow **1** mark for evidence of 44 to 46 divided by 20. | 1  1 | AO2  C6.1.1  MS3c, 4a |
| **04.4** | steeper curve  same final volume (80 cm3) |  | 1  1 | AO2  C6.1.2  MS4e |
| **05.1** | reversible (reaction) |  | 1 | AO1  C6.2.1 |
| **05.2** | More sulfur trioxide;  fewer molecules **or** moles (of gas) on product side so equilibrium shifts right to lower the pressure. | Ignore references to rate. | 1  1 | AO2  C6.2.7 |
| **05.3** | Less sulfur trioxide;  forward reaction is exothermic so equilibrium shifts left to lower the temperature. | Ignore references to rate. | 1  1 | AO2  C6.2.6 |
| **05.4** | Lower activation energy/alternative reaction pathway;  resulting in higher proportion of molecules with enough energy to react. | Ignore surface area. | 1  1 | AO1  C6.1.3  C6.1.4 |