

## Multiple Choice Answers

Q5: A

## Multiple Choice Answers

Q6: C

## Multiple Choice Answers

Q6: B

Q24: C

## Multiple Choice Answers

Q7: D

|           |                                                                                                                                                                                                                                                         |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1(a)(i)   | 24 protons    28 neutrons    24 electrons                                                                                                                                                                                                               |
| 1(a)(ii)  | ( <sup>54</sup> Cr has two) more neutrons (than <sup>52</sup> Cr)                                                                                                                                                                                       |
| 1(a)(iii) | (relative) abundance (of each isotope)                                                                                                                                                                                                                  |
| 1(a)(iv)  | The fourth isotope has any value of RIM less than 51.996                                                                                                                                                                                                |
| 1(b)(i)   | 1s <sup>2</sup> 2s <sup>2</sup> 2p <sup>6</sup> 3s <sup>2</sup> 3p <sup>6</sup> (3d <sup>5</sup> 4s <sup>1</sup> )                                                                                                                                      |
| 1(b)(ii)  | 6                                                                                                                                                                                                                                                       |
| 1(c)(i)   | Cr / Cr <sub>2</sub> O <sub>7</sub> <sup>2-</sup> <b>AND</b> it gains electrons                                                                                                                                                                         |
| 1(c)(ii)  | (+) <sub>4</sub>                                                                                                                                                                                                                                        |
| 1(c)(iii) | <i>Due to an issue with question 1(c)(iii), the question has been removed from the question paper.</i>                                                                                                                                                  |
| 1(c)(iv)  | <b>M1</b> CO <sub>2</sub> has only instantaneous / temporary dipole–induced dipole forces<br><b>AND</b> methanal has permanent dipole–permanent dipole (and id-id) forces<br><br><b>M2</b> IMF's in methanal are stronger than IMF's in CO <sub>2</sub> |
| 1(d)(i)   | rate of forward and backward (reaction) are the same / equal<br><b>OR</b> concentrations of reactants and products are constant                                                                                                                         |
| 1(d)(ii)  | closed system                                                                                                                                                                                                                                           |
| 1(d)(iii) | <b>M1</b> (mixture becomes more) orange<br><br><b>M2</b> forward reaction is endothermic<br><br><b>M3</b> (mixture becomes more) orange<br><br><b>M4</b> equilibrium moves (forwards/right) to compensate for extra acid / H <sup>+</sup>               |
| 1(e)      | <b>M1</b> hydrolysis<br><br><b>M2</b> CrF <sub>4</sub> + 2H <sub>2</sub> O → CrO <sub>2</sub> + 4HF                                                                                                                                                     |

|                                                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
|--------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------|------|-----|---------------------------|-------------------|---------------------------------|----------------------|-------------------------------------------|-------------|-------------------------|-------------------------|--------------------------------------------------------|---------------------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| 1(a)(i)                                                | (halogens can) remove electron(s) (from a reactant)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(a)(ii)                                               | $2Al + 3Cl_2 \rightarrow 2AlCl_3$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(a)(iii)                                              | purple (gas) disappears                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(b)(i)                                                | <b>M1</b> Br—Br is weaker (than Cl—Cl) <b>AND</b> Br atoms are larger<br><b>M2</b> less (significant) overlap of orbitals (in Br-Br)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(b)(ii)                                               | HCl is more thermally stable                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(b)(iii)                                              | <b>M1</b> (enthalpy change / energy change) when one mole of a compound / substance is formed<br><b>M2</b> from its (constituent) elements in their standard state(s)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(b)(iv)                                               | <b>M1</b> $(6 \times -92) - (2 \times -46) =$<br><b>M2</b> $-460 \text{ (kJ mol}^{-1}\text{)}$                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(b)(v)                                                | <b>M1</b> (trigonal) pyramidal<br><b>M2</b> three bonding pairs <b>AND</b> one lone pair (of electrons)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(c)(i)                                                | <table><tr><td></td><td>NaCl</td><td>NaBr</td><td>NaI</td></tr><tr><td>with Ag<sup>+</sup>(aq)</td><td>white precipitate</td><td><b>M1</b> cream / off-white ppt</td><td><b>M2</b> yellow ppt</td></tr><tr><td>with conc. H<sub>2</sub>SO<sub>4</sub></td><td>acid – base</td><td>acid – base, then redox</td><td>acid – base, then redox</td></tr><tr><td>observations with conc. H<sub>2</sub>SO<sub>4</sub></td><td><b>M3</b> steamy fumes<br/><b>OR</b> fizzing</td><td><b>M4</b> brown liquid<br/><b>OR</b> fizzing</td><td><ul style="list-style-type: none"><li>• black solid</li><li>• yellow solid</li><li>• effervescence</li></ul></td></tr></table> |                                             | NaCl                                                                                                         | NaBr | NaI | with Ag <sup>+</sup> (aq) | white precipitate | <b>M1</b> cream / off-white ppt | <b>M2</b> yellow ppt | with conc. H <sub>2</sub> SO <sub>4</sub> | acid – base | acid – base, then redox | acid – base, then redox | observations with conc. H <sub>2</sub> SO <sub>4</sub> | <b>M3</b> steamy fumes<br><b>OR</b> fizzing | <b>M4</b> brown liquid<br><b>OR</b> fizzing | <ul style="list-style-type: none"><li>• black solid</li><li>• yellow solid</li><li>• effervescence</li></ul> |
|                                                        | NaCl                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | NaBr                                        | NaI                                                                                                          |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| with Ag <sup>+</sup> (aq)                              | white precipitate                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | <b>M1</b> cream / off-white ppt             | <b>M2</b> yellow ppt                                                                                         |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| with conc. H <sub>2</sub> SO <sub>4</sub>              | acid – base                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | acid – base, then redox                     | acid – base, then redox                                                                                      |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| observations with conc. H <sub>2</sub> SO <sub>4</sub> | <b>M3</b> steamy fumes<br><b>OR</b> fizzing                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | <b>M4</b> brown liquid<br><b>OR</b> fizzing | <ul style="list-style-type: none"><li>• black solid</li><li>• yellow solid</li><li>• effervescence</li></ul> |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(c)(ii)                                               | <b>M1</b> black solid = iodine / I <sub>2</sub> <b>AND</b> yellow solid = sulfur / S <sub>(8)</sub><br><b>M2</b> effervescence = hydrogen sulfide / H <sub>2</sub> S(g)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(d)(i)                                                | <b>M1</b> MgCl <sub>2</sub> (is ionic and) has mobile ions<br><b>M2</b> SiCl <sub>4</sub> is covalent <b>AND</b> no charge carriers<br><b>OR</b> (no ions and) no delocalised electrons<br><b>OR</b> no mobile / moving ions                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |
| 1(d)(ii)                                               | <b>M1</b> MgCl <sub>2</sub> pH = 7<br><b>M2</b> SiCl <sub>4</sub> pH 0 – 4                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                             |                                                                                                              |      |     |                           |                   |                                 |                      |                                           |             |                         |                         |                                                        |                                             |                                             |                                                                                                              |