

Solutions

Original marking guidance: M1 method, A1 accuracy, B1 explanation.

2.1 $O = -1$; $H = -1$; $x + 4(-2) = -1$, so $Mn = +7$.

2.2 $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$. Effervescence/hydrogen gas or a cloudy hydroxide suspension.

2.3 Potassium has greater radius and more shielding, reducing attraction to its outer electron so it is lost more easily.

3.1 $Al \rightarrow Al^{3+} + 3e^-$; $Cu^{2+} + 2e^- \rightarrow Cu$. Multiply by 2 and 3: $2Al + 3Cu^{2+} \rightarrow 2Al^{3+} + 3Cu$. Cu^{2+} is reduced and is the oxidising agent.

3.2 $4LiNO_3 \rightarrow 2Li_2O + 4NO_2 + O_2$; $2NaNO_3 \rightarrow 2NaNO_2 + O_2$. Smaller Li^+ has greater charge density and polarises the nitrate more strongly. Oxygen relights a glowing splint. Brown NO_2 is toxic; an approved controlled demonstration is required.

3.3 Excited electrons fall to lower energy levels and emit photons of characteristic energy. Lithium crimson and sodium yellow; potassium lilac and barium apple-green. Magnesium ions have no characteristic flame colour; bright white burning metal is a different observation.