

Solutions

2.1 The equilibrium ($\rightleftharpoons$) arrow.

2.2 The rates of the forward and reverse reactions.

2.3 The right-hand side – 2 molecules of SO_3 against 3 of reactants.

3.1 A closed system prevents reactants or products escaping; both forward and reverse reactions continue to occur; their rates become exactly equal; so the concentrations of all substances remain constant – equilibrium is dynamic, not static.

3.2 (a) The system counteracts the added hydrogen by using it up – the position shifts right, more HI forms until equilibrium is restored. (b) The forward reaction is endothermic, so cooling shifts the position in the exothermic direction – to the left, less HI; because the system releases energy to counteract the fall in temperature.

3.3 A low temperature favours the exothermic forward direction and the yield; but rate falls steeply with temperature, so production would be too slow; a moderate temperature compromises yield against rate, keeping the process economic.