

Solutions

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

2.1 A closed system with equal forward and reverse rates. Constant concentrations result from equal rates; there is no requirement for equal amounts of different substances.

2.2 No shift: two gas moles on each side. Rates may change, but the pressure comparison does not favour one side.

2.3 Higher temperature favours the endothermic reverse reaction and lowers C yield. Catalyst changes approach speed, not equilibrium composition.

3.1 Higher pressure favours two rather than three gas moles; low temperature favours the exothermic direction. Low temperature gives a slow rate. High pressure requires costly equipment/energy and greater safety provision; an explicit rate–yield–cost compromise is needed.

3.2 Removal lowers product concentration, so net forward reaction replaces some product. The closed-system definition does not directly describe the whole flowing process; local equilibrium/steady operation must be distinguished.