Question 12 (Answer: **A**)

- $K_c = [\mathrm{Hb(O_2)_4}]/([\mathrm{Hb}][\mathrm{O_2}]^4)$.
- The two equal concentrations cancel, leaving $K_c = 1/[\mathrm{O_2}]^4$.
- $1/(7.6 \times 10^{-6})^4 = 1/(3.34 \times 10^{-21}) = 3.0 \times 10^{20}$.

Question 12 (Answer: **B**)

- Adding 5.0 mol to 1.0 $\mathrm{dm^3}$ momentarily raises [Q] to 15 mol $\mathrm{dm^{-3}}$.
- Le Chatelier: the system shifts right to oppose the increase, using up some of the added Q.
- It cannot use all of it, so the new equilibrium value lies between 10 and 15.

Question 13 (Answer: **D**)

- A catalyst speeds up both directions equally, so it never moves the position of equilibrium – only the rate.
- K_p for the Haber process does have units, since the number of gas moles differs on the two sides.
- K_p depends only on temperature, so pressure cannot change it; and both processes use *solid* catalysts, making them heterogeneous.

Question 12 (Answer: **D**)

- 0.8 mol of $\mathrm{O_2}$ means 1.6 mol of NO formed and 1.6 mol of $\mathrm{NO_2}$ used up.
- So at equilibrium $\mathrm{NO_2}$ is $4 - 1.6 = 2.4$ mol in 1 $\mathrm{dm^3}$.
- $K_c = [\mathrm{NO}]^2[\mathrm{O_2}]/[\mathrm{NO_2}]^2 = (1.6)^2(0.8)/(2.4)^2$.

Question 13 (Answer: **D**)

- Statement 1 fails: for an exothermic reaction the forward activation energy is the *smaller* of the two.
- Statement 2 fails: equilibrium fixes the *rates*, not the raw collision frequencies, which depend on concentrations.
- Statement 3 holds: at equilibrium the forward and reverse rates are equal, and rate is the frequency of *effective* collisions.

1(a)	0.486 g
1(b)	M1 Dissolve the solid / KSCN(s) in (the beaker) (using a small volume of) (distilled) water M2 Transfer/add to a (250 cm^3 volumetric) flask **and** Rinse (with distilled water) M3 Top the 250 cm^3 volumetric flask up to mark (with distilled water) **and** Invert the (stoppered) flask Allow '250 volumetric flask' (i.e. units need not be seen)
1(c)(i)	to avoid oxidation (of contents of flask)
1(c)(ii)	to ensure that equilibrium has been reached
1(c)(iii)	Silver / Ag
1(d)(i)	(yes) **and** two titres (2 and 3) are within 0.10 cm^3 (of each other)
1(d)(ii)	**Working must be shown** $= \frac{2 \times 0.05}{21.90} \times 100 = 0.457\%$
1(d)(iii)	percentage error (in larger titre) is lower
1(e)(i)	0.0437 mol dm^{-3}
1(e)(ii)	0.00630 mol dm^{-3}
1(e)(iii)	M1 $K_c = 0.00630 / (0.04370)^2 = 3.30$
	M2 units = $dm^3\ mol^{-1}$
1(f)(i)	No **and** As temperature increases, K_c decreases
1(f)(ii)	(data points that obey a line of best fit are reliable because) there are no anomalous points.
1(f)(iii)	exothermic **and** As temperature increases: K_c decreases **or** equilibrium shifts to left