Answers to examination-style questions

Answers	Marks	Examiner's tips
1 a) $K_c = \frac{[H_2]^3[C_2H_2]}{[CH_4]^2}$	**1**	If round brackets are used, this will be penalised but examiners will continue to mark the rest of the question without further penalty.
b) $K_c = \frac{\left(\frac{0.28}{0.25}\right)^3\left(\frac{0.12}{0.25}\right)}{\left(\frac{0.44}{0.25}\right)^2}$ $= \frac{(1.12)^3(0.48)}{(1.76)^2}$ $= 0.218\ \text{mol}^2\ \text{dm}^{-6}$	**4**	One mark is given for dividing throughout by the volume. If moles are used instead of concentration, candidates can only score a maximum of 2 marks in this part of the question. Allow values of between 0.217 – 0.22 $\text{mol}^2\ \text{dm}^{-6}$ Allow 1.36×10^{-2} if vol not used. One mark is given for the correct units.
c) to right / to products / forwards; increase;	**2 max.**	
d) to left / to reagent / backwards: no effect;	**2 max.**	Only temperature affects the value of K_c
2 a) i) moles of $C_2F_4 = 0.40$ moles of HC1 = 0.80	**2**	Look at the equation to get the ratio. Since 0.2 moles are left this means 0.8 have been used up to make products. The ratio of reactant to C_2F_4 is 2 : 1 so this means 0.4 moles of C_2F_4 are made. Since the ratio of reactant to HCl is 1 : 1 the moles of HCl is 0.8.
ii) $K_c = \frac{[C_2F_4][HCl]^2}{[CHClF_2]^2}$	**1**	
iii) $K_c = \frac{\left(\frac{0.40}{18.5}\right)\left(\frac{0.8}{18.5}\right)^2}{\left(\frac{0.20}{18.5}\right)^2}$ $= 0.35\ \text{mol dm}^{-3}$	**3**	An incorrect K_c means you can only score a mark for units.

Answers	Marks	Examiner's tips
b) i) increase	**1**	Reaction is endothermic.
ii) decrease	**1**	There are more moles on the right side of the equilibrium.
3 a) i) moles of O_2 at equilibrium: $\frac{7.04}{32} = 0.22$ moles of NO at equilibrium: 0.44	**2**	moles = mass /M_r Twice as many moles of NO as O_2 in the equilibrium equation.
ii) Original number of moles of NO_2 $\frac{21.3}{46} = 0.463$ Number of moles of NO_2 at equilibrium: 0.463 – 0.44 = 0.023	**2**	1 mark can be given for the correct process of obtaining the answer. Full marks are given for correct answer.
b) $K_c = \frac{[NO]^2[O_2]}{[NO_2]}$ $K_c = \frac{\left(\frac{0.44}{11.5}\right)^2 \times \left(\frac{0.22}{11.5}\right)}{\left(\frac{0.023}{11.5}\right)^2} = 7.0 \text{ mol dm}^{-3}$	**4**	Remember to divide all concentrations by the total volume. One mark is given for the correct equation. One mark given for the correct units.
c) $pV = nRT$ $T = \frac{pV}{nR} = \frac{(3.30 \times 10^5) \times (11.5 \times 10^{-3})}{0.683 \times 8.31}$ $T = 669$ K	**3**	One mark is given for the correct rearranged equation. One mark is given just for using $V = 11.5 \times 10^{-3}$
d) the yield is increased, K_c stays the same	**2**	K_c only affected by T and this stays the same.
4 a) i) C + 3D → 2A + B **ii)** mol dm^{-3} **iii)** forward reaction is exothermic	**3**	You could also say more products formed in **iii)**.
b) i) N_2O_4 $M_r = 92.0$ Mol = $\frac{36.8}{92.0} = 0.400$	**2**	
ii) mol N_2O_4 reacted = 0.400 – 0.180 = 0.220 mol NO_2 formed = 0.440	**2**	

Answers	Marks	Examiner's tips
iii) $K_c = \frac{(NO_2)^2}{(N_2O_4)}$ $= \frac{\left(\frac{0.44}{16}\right)^2}{\left(\frac{0.18}{16}\right)}$ $= 0.067$	**3**	Put the products over the reactants to get K_c. One mark for each step in the calculation, full marks are given for the correct answer.
iv) The equilibrium will move to the right, K_c will remain the same	**2**	K_c only affected by *T* and this stays the same.
5 a) i) Increase; higher *pressure* gives lower yield; the equilibrium shifts to reduce *p* or equilibrium favours side with fewer moles of gas	**3**	If this trend is wrong then there are no more marks for you in part **i)**.
ii) Endothermic; Increased temperature increases yield; Equilibrium shifts to reduce temperature or equilibrium favours endothermic direction	**3**	If this trend is wrong then there are no more marks for you in part **ii)**.
b) i) Moles of iodine = 0.023; Moles of HI = 0.172	**2**	
ii) $K_c = \frac{[H_2][I_2]}{[HI]^2}$	**1**	Square brackets must be used for K_c since this represents concentration.
iii) Volume cancels in K_c expression	**1**	Since there are the same numbers of moles on each side of the equation.
iv) $K_c = \frac{(0.023)^2}{(0.172)^2}$ $= 0.0179$	**2**	
v) $K_c = 55.9$	**1**	You can get a mark here consequential on you answer to part **iv)**. It is the reciprocal of you part **iv)** answer.