Equilibrium Test Mark Scheme

1 Consider the equilibrium: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

What is the effect of decreasing the pressure on the position of equilibrium and the value of the equilibrium constant, K_c?

A The position of equilibrium shifts to the right and K_c increases

B The position of equilibrium shifts to the left and K_c decreases

C The position of equilibrium is unchanged and K_c does not change

D The position of equilibrium shifts to the left and K_c stays the same

2 Consider the equilibrium

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$

What is the effect of increasing the temperature on the position of equilibrium and the value of the equilibrium constant, K_c?

A The position of equilibrium shifts to the right and K_c increases

B The position of equilibrium shifts to the left and K_c decreases

C The position of equilibrium is unchanged and K_c does not change

D The position of equilibrium shifts to the left and K_c stays the same

3 Explain what is meant by the term *dynamic equilibrium*. [2]

Macroscopic properties remain constant;

Rate of forward reaction = rate of reverse reaction;

4 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \quad \Delta H = -92 \text{ kJ mol}^{-1}$

State and explain the effect of introducing an iron catalyst on the position of equilibrium and the value of the equilibrium constant, K_c? [3]

No effect of on position of equilibrium;

or value of K_c;

Speeds up forward and reverse reactions equally;

5 Consider the reversible reaction $A(g) + 2B(g) \rightleftharpoons 2C(g) + D(g)$

2.0 mol A and 2.0 mol of B are put in a reaction vessel of volume 5 dm^3 and allowed to come to equilibrium. At equilibrium there were 1.6 mol of A present. Calculate the value of the equilibrium constant. [3]

	$A(g)$	$+ 2B(g)$	$\rightleftharpoons 2C(g)$	$+ D(g)$	
Equlibrium number of moles	1.6	1.2	0.8	0.4	;
Equlibrium concs	0.32	0.24	0.16	0.08	;

$K_c = \frac{0.16^2 \times 0.08}{0.32 \times 0.24^2} = 0.11$; *correct final answer scores [3]*

6 Consider the following reversible reaction at 300K

$$2A(g) + B(g) \rightleftharpoons X(g) + Z(g) \qquad K_c=25$$

Species	Number of moles
A	0.10
B	0.30
X	0.20
Z	0.20

A and B are introduced into a reaction vessel of volume 10 dm^3. At a certain point in time the number of moles of each species present is given in the table.

State and explain whether the system is at equilibrium or not. [2]

$Q = \frac{0.020 \times 0.020}{0.010^2 \times 0.030} = 133$;

$Q \neq K_c$ therefore the system is not at equilibrium ;

7 Consider the reversible reaction: $A(g) + B(g) \rightleftharpoons C(g) + D(g)$ K_c=1.20 at 300 K

(a) 1.00 mol A, 1.00 mol of B, 2.00 mol C and 2.00 mol D were introduced into a reaction vessel of volume 1.00 dm^3 and allowed to come to equilibrium. Calculate the number of moles of A present at equilibrium. [3]

	A(g) +	B(g) ⇌	C(g) +	D(g)	
Initial / mol	1.00	1.00	2.00	2.00	
Equilibrium/mol	1+x	1+x	2-x	2-x	;

($Q>K_c$ therefore reaction will proceed to left towards equilibrium – although this does not affect the calculation)

$1.20 = \frac{(2-x)(2-x)}{(1+x)(1+x)}$;

x= 0.43 number of moles of A at equilibrium = 1.43 mol;

(b) Calculate the value of ΔG for this reaction at 300 K. [2]

$\Delta G = -RT\ln K$

$= -8.31 \times 300 \times \ln 1.20$;

$\Delta G = -455 \text{ J mol}^{-1}$;