Topic 17 / Review 2019 *[11 marks]*

1. 1.0 mol of $N_2(g)$, 1.0 mol of $H_2(g)$ and 1.0 mol of $NH_3(g)$ are placed in a 1.0 dm^3 sealed flask and left to reach equilibrium. At equilibrium the concentration of $N_2(g)$ is 0.8 mol dm^{-3}. *[1 mark]*

   $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

   What are the equilibrium concentration of $H_2(g)$ and $NH_3(g)$ in mol dm^{-3}?

	$[H_2(g)]$ / mol dm^{-3}	$[NH_3(g)]$ / mol dm^{-3}
A.	0.2	1.2
B.	0.4	1.4
C.	0.4	0.4
D.	0.8	1.2

2. At 700 ºC, the equilibrium constant, K_c, for the reaction is 1.075×10^8. *[1 mark]*

   $2H_2(g) + S_2(g) \rightleftharpoons 2H_2S(g)$

   Which relationship is always correct for the equilibrium at this temperature?

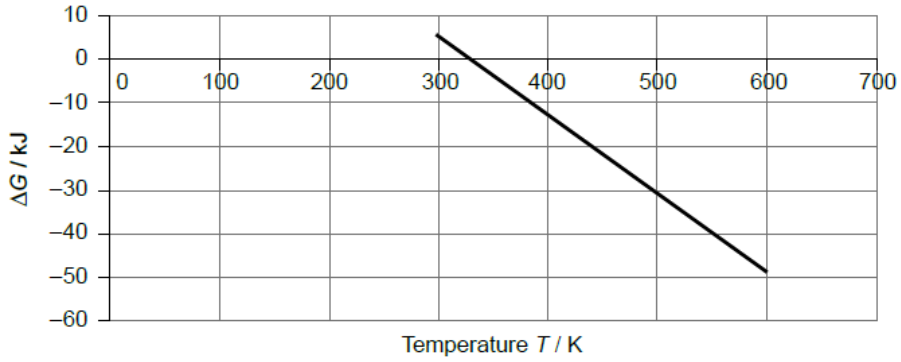
   A. $[H_2S]^2 < [H_2]^2 [S_2]$

   B. $[S_2] = 2[H_2S]$

   C. $[H_2S] < [S_2]$

   D. $[H_2S]^2 > [H_2]^2[S_2]$

3. The graph shows values of ΔG for a reaction at different temperatures. *[1 mark]*



   Which statement is correct?

   A. The standard entropy change of the reaction is negative.

   B. The standard enthalpy change of the reaction is positive.

   C. At higher temperatures, the reaction becomes less spontaneous.

   D. The standard enthalpy change of the reaction is negative.

4. Components X and Y are mixed together and allowed to reach equilibrium. The concentrations of X, Y, W and Z in the equilibrium mixture are 4, 1, 4 and 2 $\mathrm{mol\,dm^{-3}}$ respectively. *[1 mark]*

X + 2Y $\rightleftharpoons$ 2W + Z

What is the value of the equilibrium constant, K_c?

A. $\frac{1}{8}$

B. $\frac{1}{2}$

C. 2

D. 8

5. Which is correct for an isolated system in equilibrium? *[1 mark]*

	Gibbs free energy	Entropy
A.	maximum	maximum
B.	maximum	minimum
C.	minimum	maximum
D.	minimum	minimum

6. A mixture of 0.40 mol of CO (g) and 0.40 mol of H_2 (g) was placed in a 1.00 dm^3 vessel. The following equilibrium was established. *[1 mark]*

CO (g) + 2H_2 (g) $\rightleftharpoons$ CH_3OH (g)

At equilibrium, the mixture contained 0.25 mol of CO (g). How many moles of H_2 (g) and CH_3OH (g) were present at equilibrium?

	Equilibrium mol of H_2	Equilibrium mol of CH_3OH
A.	0.25	0.15
B.	0.50	0.25
C.	0.30	0.25
D.	0.10	0.15

7. The equation for the reaction between two gases, A and B, is: *[1 mark]*

$$2\mathrm{A(g)} + 3\mathrm{B(g)} \rightleftharpoons \mathrm{C(g)} + 3\mathrm{D(g)}$$

When the reaction is at equilibrium at 600 K the concentrations of A, B, C and D are 2, 1, 3 and 2 $\mathrm{mol\,dm^{-3}}$ respectively. What is the value of the equilibrium constant at 600 K?

A. $\frac{1}{6}$

B. $\frac{9}{7}$

C. 3

D. 6

8. A mixture of 2.0 mol of $\mathrm{H_2}$ and 2.0 mol of $\mathrm{I_2}$ is allowed to reach equilibrium in the gaseous state at a certain temperature in a $1.0\ \mathrm{dm^3}$ flask. At equilibrium, 3.0 mol of HI are present. What is the value of K_c for this reaction? *[1 mark]*

$$\mathrm{H_2(g) + I_2(g) \rightleftharpoons 2HI(g)}$$

A. $K_\mathrm{c} = \frac{(3.0)^2}{(0.5)^2}$

B. $K_\mathrm{c} = \frac{3.0}{(0.5)^2}$

C. $K_\mathrm{c} = \frac{(3.0)^2}{(2.0)^2}$

D. $K_\mathrm{c} = \frac{(0.5)^2}{(3.0)^2}$

9. What is the relationship between $\mathrm{p}K_\mathrm{a}$, $\mathrm{p}K_\mathrm{b}$ and $\mathrm{p}K_\mathrm{w}$ for a conjugate acid–base pair? *[1 mark]*

A. $\mathrm{p}K_\mathrm{a} = \mathrm{p}K_\mathrm{w} + \mathrm{p}K_\mathrm{b}$

B. $\mathrm{p}K_\mathrm{a} = \mathrm{p}K_\mathrm{w} - \mathrm{p}K_\mathrm{b}$

C. $\mathrm{p}K_\mathrm{a} \times \mathrm{p}K_\mathrm{b} = \mathrm{p}K_\mathrm{w}$

D. $\frac{\mathrm{p}K_\mathrm{a}}{\mathrm{p}K_\mathrm{b}} = \mathrm{p}K_\mathrm{w}$

10. When gaseous nitrosyl chloride, NOCl (g), decomposes, the following equilibrium is established: *[1 mark]*

$$\mathrm{2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)}$$

2.0 mol of NOCl(g) were placed in a $1.0\ \mathrm{dm^3}$ container and allowed to reach equilibrium. At equilibrium 1.0 mol of NOCl(g) was present. What is the value of K_c?

A. 0.50

B. 1.0

C. 1.5

D. 2.0

11. The indicator, HIn is used in a titration between an acid and base. Which statement about the dissociation of the indicator, HIn is correct? *[1 mark]*

$$\mathrm{HIn(aq) \rightleftharpoons H^+(aq) + In^-(aq)}$$

colour A colour B

A. In a strongly alkaline solution, colour B would be observed.

B. In a strongly acidic solution, colour B would be observed.

C. $[\mathrm{In^-}]$ is greater than [HIn] at the equivalence point.

D. In a weakly acidic solution colour B would be observed.