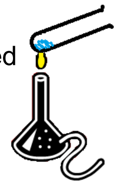
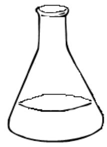
STARTER FOR 10...

2.1. The equilibrium constant, K_c

1. Match each of the reactions to the correct description; (2 marks)

Wood burning 

Heating hydrated $CuSO_4.5H_2O$ 

Making an ester;
$CH_3COOH(aq) + CH_3OH(aq) \rightleftharpoons CH_3COOCH_3(aq) + H_2O(aq)$ 

A reversible reaction at equilibrium	A reversible reaction	An irreversible reaction

Explain your choice;

....

....

....(2 marks)

2. We can define a constant, K_c for a reaction at equilibrium. Provided the temperature is constant, the value of K_c is constant.

For each of the equilibria below, write an expression for the rate constant, K_c and derive the units of the constant.

(a) Electrophilic addition of HCN to propanone; $CH_3COCH_3(aq) + HCN(aq) \rightleftharpoons CH_3C(OH)(CN)CH_3(aq)$

K_c = ______________________ Units = ... (2 marks)

(b) Esterification; $CH_3CH_2COOH(aq) + CH_3OH(aq) \rightleftharpoons CH_3CH_2COOCH_3(aq) + H_2O(aq)$

K_c = ______________________ Units = ... (2 marks)

(c) The Haber Process; $N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$

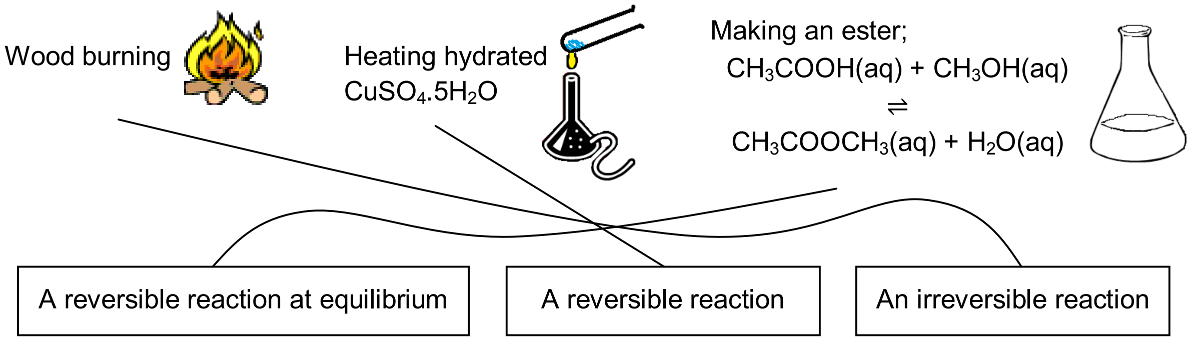
K_c = ______________________ Units = ... (2 marks)

STARTER FOR 10...

2. Equilibria answers

2.1. The equilibrium constant, K_c

1.



(2 marks for all three correct, 1 mark for 1 correct)

The products from burning wood cannot be turned back into wood so it is irreversible. The copper sulphate once dehydrated can be turned back into the hydrated form by the addition of water. Hence it is a reversible reaction *(1 mark for above two points).* The esterification reaction is in a <u>closed system</u> so neither products nor reactants can escape so it is a reaction at equilibrium *(1 mark).*

2. (a) $K_c = \frac{[CH_3C(OH)(CN)CH_3(aq)]}{[CH_3COCH_3(aq)][HCN(aq)]}$ Units = $\frac{\cancel{mol\ dm^{-3}}}{\cancel{mol\ dm^{-3}} \times mol\ dm^{-3}}$ = $\underline{mol^{-1}\ dm^3}$ *(2 marks)*

(b) $K_c = \frac{[CH_3CH_2COOCH_3(aq)]\ [H_2O(aq)]}{[CH_3CH_2COOH(aq)]\ [CH_3OH(aq)]}$ Units = $\frac{\cancel{mol\ dm^{-3}} \times \cancel{mol\ dm^{-3}}}{\cancel{mol\ dm^{-3}} \times \cancel{mol\ dm^{-3}}}$ = <u>no units</u> *(2 marks)*

(c) $K_c = \frac{[NH_3(g)]^2}{[N_2(g)]\ [H_2(g)]^3}$ Units = $\frac{(mol\ dm^{-3})^2}{mol\ dm^{-3} \times (mol\ dm^{-3})^3}$ = $\underline{mol^{-2}\ dm^6}$ *(2 marks)*

2.2. Calculations with K_c

1. (a) $K_c = \frac{[SO_3]^2}{[SO_2]^2\ [O_2]}$ *(1 mark)* $= \frac{(1.4\ mol\ dm^{-3})^2}{(1\ mol\ dm^{-3})^2\ (0.2\ mol\ dm^{-3})}$ = $\underline{9.8\ mol^{-1}\ dm^3}$ *(1 mark for value, 1 mark for units)*

(b) The temperature has been decreased. Therefore the equilibrium will shift in favour of the exothermic reaction (to the right) in order to oppose the temperature decrease. Therefore <u>the value of K_c will increase</u>. *(1 mark)*