Question - 01

This question is about an equilibrium.

$$2\ P(aq) + Q(aq) \rightleftharpoons R(aq) + 3\ S(aq)$$
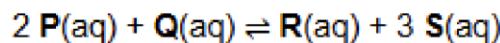
A 25.0 cm^3 sample of a solution of P is added to a 20.0 cm^3 sample of a solution of Q. The mixture is allowed to reach equilibrium.

The amounts in the equilibrium mixture are

P = 0.0145 mol   Q = 0.0275 mol   R = 0.0115 mol   S = 0.0345 mol

(a)   Calculate the amount, in moles, of P before the reaction with Q.

Use your answer to calculate the concentration, in mol dm^{-3}, of P in the initial 25.0 cm^3 sample.

Amount of P _____ mol

Concentration _____ mol dm^{-3}

(2)

(b)   Give the expression for the equilibrium constant, K_c

Calculate the value of K_c and deduce its units.

K_c

Value of K_c _____ Units _____

(4)

(c) Explain why the amount of **S** increases when water is added to the equilibrium mixture.

_____

_____

_____

_____

(2)

(a) **M1** mol P = 0.0145 + (2 × 0.0115) = 0.0375

M2 $[P] = \frac{M1}{0.025} = 1.50$ mol dm^{-3}

ECF from incorrect M1

2

(b)

M1 $K_c = \frac{[R][S]^3}{[P]^2[Q]}$

M1 Must be square brackets in expression

M2 $K_c = \frac{\left(\frac{0.0115}{0.045}\right)\left(\frac{0.0345}{0.045}\right)^3}{\left(\frac{0.0145}{0.045}\right)^2\left(\frac{0.0275}{0.045}\right)}$ or $= \frac{(0.256)(0.767)^3}{(0.322)^2(0.611)}$

M2 Inserts values and divides by volume in dm^3

M3 = 1.81 to 1.82

M3 Evaluates expression
If no use of volume lose M2 but can score M3 for 0.0817

M4 units mol dm^{-3}

M4 Allow consequential to their expression

4

(c) **M1** equilibrium shifts to side with most moles

M2 to oppose decrease in concentration of all reactants and products / dilution of everything

Allow
M2 oppose the decrease in concentration of S

OR

M1 K_c is expressed as a function of concentrations and concentration equals amount over volume.

$K_c = RS^3/P^2Q \times 1/V$ *(where R,S etc are amounts)*
So, if V increases R and S must increase relative to P and Q to keep K_c constant

M2 If Volume increases the amount of **R** and **S** must increase in order to keep K_c constant.

2

End of Question