Name of the Student:_____
Max. Marks : 16 Marks **Time : 16 Minutes**

Q1.

This question is about pH.

Pure water dissociates slightly.

$$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq) \qquad \Delta H = +57 \text{ kJ mol}^{-1}$$

The equilibrium constant, $K_c = \dfrac{[H^+][OH^-]}{[H_2O]}$

The ionic product of water, $K_w = [H^+][OH^-]$

(a) Explain why $[H_2O]$ is not shown in the K_w expression.

_____

_____

(1)

Table 1 shows how K_w varies with temperature.

Table 1

Temperature / °C	**K_w / mol^2 dm^{-6}**
10	2.93×10^{-15}
20	6.81×10^{-15}
25	1.00×10^{-14}
30	1.47×10^{-14}
50	5.48×10^{-14}

(b) Explain why the value of K_w increases as the temperature increases.

_____

_____

_____

_____

(2)

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(c) Give the expression for pH.

Calculate the pH of pure water at 50 °C
Give your answer to 2 decimal places.

Explain why water is neutral at 50 °C

Expression _____

Calculation

pH _____

Explanation _____

_____

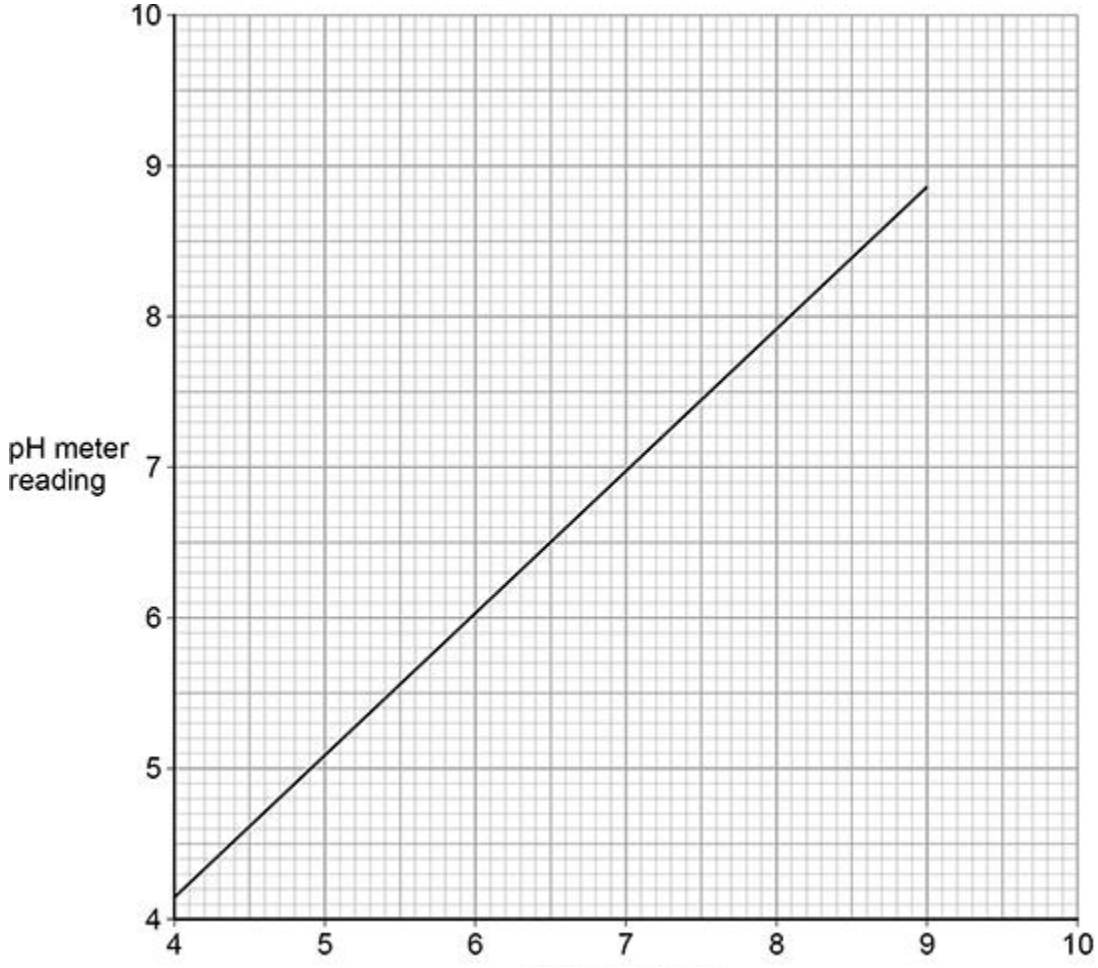
(4)

A pH meter is calibrated using a calibration graph.
To create the calibration, the pH meter is used to measure the pH of separate solutions, each with a known, accurate pH.

Figure 1 shows the calibration graph.

Figure 1

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(d) Use **Figure 1** to give the true pH value when the pH meter reading is 5.6

_____

(1)

(e) Suggest why the pH probe is washed with distilled water between each of the calibration measurements.

_____

_____

(1)

(f) The calibrated pH meter is used to monitor the pH during a titration of hydrochloric acid with sodium hydroxide.

Explain why the volume of sodium hydroxide solution added between each pH measurement is smaller as the end point of the titration is approached.

_____

_____

(1)

Figure 2 shows the pH curve for a titration of hydrochloric acid with sodium hydroxide solution.

Figure 2

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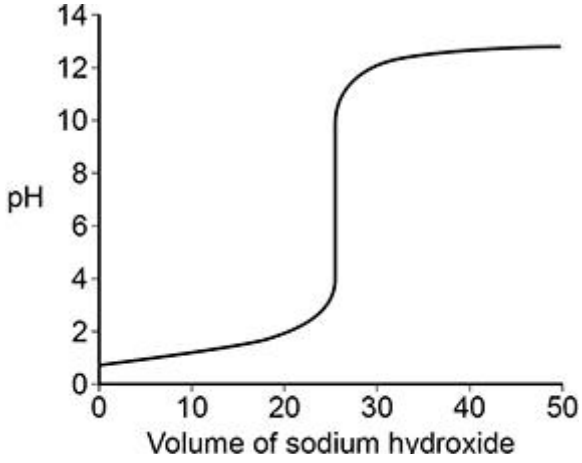


Table 2 shows data about some indicators.

Table 2

Indicator	pH range	Colour at low pH	Colour at high pH
Bromocresol green	3.8 – 5.4	yellow	blue
Phenol red	6.8 – 8.4	yellow	red
Thymolphthalein	9.3 – 10.5	colourless	blue

The student plans to do the titration again using one of the indicators in **Table 2** to determine the end point.

(g) State why all three of the indicators in **Table 2** are suitable for this titration.

_____

_____

(1)

(h) 36.25 cm^3 of 0.200 mol dm^{-3} sodium hydroxide solution are added to 25.00 cm^3 of 0.150 mol dm^{-3} hydrochloric acid.

Calculate the pH of the final solution at 25 ºC

$K_w = 1.00 \times 10^{-14}$ mol^2 dm^{-6} at 25 ºC

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pH _____

(5)

(Total 16 marks)

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