ACID BASE PRACTICE QUESTIONS 5

Question 34 **[10 marks]**

Wines often contain a small amount of sulfur dioxide that is added as a preservative. The amount of sulfur dioxide added needs to be carefully calculated; too little and the wine goes bad; too much and the wine tastes of sulphur dioxide.

The sulfur dioxide content of a wine can be found using its reaction with aqueous iodine.

$SO_2(aq) + I_2(aq) + 2H_2O(l) \rightarrow SO4^{2-}(aq) + 2I^-(aq) + 4H^+(aq)$

(a) (i) State the oxidation number of sulfur in SO_2 and in SO_4^{2--} (2 marks)

SO_2 _____

SO_4^{2--} _____

(ii) State, with a reason, whether sulfur is oxidised or reduced in the conversion of SO_2 into SO_4^{2--} (3 marks)

_____

_____

_____

(b) The sulfur dioxide content of a wine can be found by titration. A chemist found that the sulfur dioxide in 50.0 mL of white wine reacted with exactly 16.4 mL of 0.0100 mol L^{-1} aqueous iodine.

(i) How many moles of iodine, I_2, did the chemist use in the titration? (1 mark)

_____

_____

_____

(ii) How many moles of sulfur dioxide were in the 50.0 mL of wine? (1 mark)

_____

(iii) What was the concentration of sulfur dioxide in the wine (2 marks)

in mol L^{-1} _____;

in gL^{-1}? _____;

(a) The generally accepted maximum concentration of sulfur dioxide in wine is 0.25 g L^{-1}.

A concentration of less than 0.01 g L^{-1} is insufficient to preserve the wine.
Comment on the effectiveness of the sulfur dioxide in the wine analysed in (b). (1 mark)

ANSWERS

Question 34 **[10 marks]**

Wines often contain a small amount of sulfur dioxide that is added as a preservative. The amount of sulfur dioxide added needs to be carefully calculated; too little and the wine goes bad; too much and the wine tastes of sulphur dioxide.

The sulfur dioxide content of a wine can be found using its reaction with aqueous iodine.

$$SO_2(aq) + I_2(aq) + 2H_2O(l) \rightarrow SO4^{2-}(aq) + 2I^-(aq) + 4H^+(aq)$$

(ii) State the oxidation number of sulfur in SO_2 and in SO_4^{2--} (2 marks)

SO_2 ____ +4

SO_4^{2-} ___ +6

(iii) State, with a reason, whether sulphur is oxidised or reduced in the conversion of SO_2 into SO_4^{2--} (3 marks)

oxidised (1) because electrons are lost(1) /oxidation number increases(1) (b) The sulfur dioxide content of a wine can be found by titration. A chemist found that the sulfur dioxide in 50.0 mL of white wine reacted with exactly 16.4 mL of 0.0100 mol L^{-1} aqueous iodine.

(i) How many moles of iodine, I_2, did the chemist use in the titration? (1 mark)

*moles I2 = 0.0100*16.4/1000 = 1.64 x 10-4 moles (1/2)*

(ii) How many moles of sulfur dioxide were in the 50.0 mL of wine? (1 mark)

moles SO_2 = 1.64 x 10^{-4} moles (1/2)

(iii) What was the concentration of sulfur dioxide in the wine (2 marks)

in mol L-1 *20 x 1.64 x 10-4 = 3.28 x 10-3 mol L-1*

in gL-1? *Mr of SO2 = 32.1+2x16 = 64.1 (1/2)*

64.1 x 3.28 x 10-3 = 0.210 g L-1 (1/2)

(c) The generally accepted maximum concentration of sulfur dioxide in wine is 0.25 g L^{-1}.
A concentration of less than 0.01 g L^{-1} is insufficient to preserve the wine.
Comment on the effectiveness of the sulfur dioxide in the wine analysed in **(b)**. (1 mark)

Comment will depend upon the answer from (b)(iii)
if ans (b)(iii) < 0.01 g L-1 then wine goes off / below minimum (1) OR

if 0.01 g L-1 < ans (b)(iii) < 0.25 g L-1 then wine is preserved
if ans (b)(iii) > 0.25 g L-1 then wine tastes of SO2 / above maximum (1)

Question 39 **(10 marks)**

A swimming pool holds 250 cubic metres of water. The owner tests the water and finds its hydroxide ion concentration, $[OH^-]$, is 5.55×10^{-5} mol L^{-1}. (1 cubic metre = 1000 L)

(a) What is the pH of the pool water? (4 marks)

(b) Thinking the pH is too low, the owner adds to the water 3.00 kg of caustic soda (NaOH). The water pump ensures that the caustic soda dissolves and becomes evenly mixed in the pool.

What is the new pH of the water? (6 marks)

ANSWER

Question 39 **(10 marks)**

A swimming pool holds 250 cubic metres of water. The owner tests the water and finds its hydroxide ion concentration, $[OH^-]$, is 5.55×10^{-5} mol L^{-1}. (1 cubic metre = 1000 L)

(a) What is the pH of the pool water? (4 marks)

$[H^+] = 10^{-14} / [OH^-] = 10^{-14} / 5.55 \times 10^{-5} = 1.802 \times 10^{-10}$ mol L^{-1} **2**

pH $= -\log [H^+] = -\log (1.802 \times 10^{-10}) = 9.74$ **2**

(b) Thinking the pH is too low, the owner adds to the water 3.00 kg of caustic soda (NaOH). The water pump ensures that the caustic soda dissolves and becomes evenly mixed in the pool.

What is the new pH of the water? (6 marks)

$n(OH^-)$ initially in the pool $= c\,V = (5.55 \times 10^{-5})(250\,000) = 13.875$ mol **1**

$n(OH^-)$ added $= n(NaOH) = m / M = 3000 / 39.99 = 75.004$ mol **1**

$n(OH^-)$ total in pool $= 75.004 + 13.875 = 88.879$ mol **1**

now $[OH^-] = n / V = 88.875 / 250\,000 = 3.556 \times 10^{-4}$ mol **1**

$[H^+] = 10^{-14} / [OH^-] = 10^{-14} / 3.556 \times 10^{-4} = 2.812 \times 10^{-11}$ mol L^{-1} **1**

pH $= -\log [H^+] = -\log (2.812 \times 10^{-11}) = 10.55$ **1**