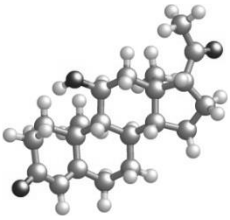

Chem!stry

Name: …………………… (   )

Class: ………………

Date: …… / …… / ……

Concentration of Solution / Titration Calculations – Answers

Answer One:

a) $HCl(aq) + NaOH(aq) \rightarrow NaCl(aq) + H_2O(l)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of HCl used = (0.200 × 30.0) ÷ 1000 = 0.00600 mol

from the balanced chemical equation, 1 mol of HCl reacts with 1 mol of NaOH

∴ 0.00600 mol of HCl reacts with $^1/_1$ × 0.00600 = 0.00600 mol of NaOH

there are 0.00600 mol of NaOH in 40.0 cm^3 of solution

∴ there are 0.00600 ÷ 40.0 = 0.000150 mol of NaOH in 1.00 cm^3 of solution

∴ there are 0.000150 × 1000 = 0.150 mol of NaOH in 1000.0 cm^3 of solution

i.e. the concentration of the NaOH is <u>0.150 mol/dm³</u> (3 s.f.)

Answer Two:

a) $HNO_3(aq) + KOH(aq) \rightarrow KNO_3(aq) + H_2O(l)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of HNO_3 used = (0.500 × 20.0) ÷ 1000 = 0.0100 mol

from the balanced chemical equation, 1 mol of HNO_3 reacts with 1 mol of KOH

∴ 0.0100 mol of HNO_3 reacts with $^1/_1$ × 0.0100 = 0.0100 mol of KOH

calculate the volume of a 0.400 mol/dm^3 solution of KOH that contains 0.0100 mol

moles = (concentration × volume) ÷ 1000

∴ volume = (moles ÷ concentration) × 1000

volume of KOH = (0.0100 ÷ 0.400) × 1000 = <u>25.0 cm³</u> (3 s.f.)

Answer Three:

a) $H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of H_2SO_4 used = (0.300 × 25.0) ÷ 1000 = 0.00750 mol

from the balanced chemical equation, 1 mol of H_2SO_4 reacts with 2 mol of KOH

∴ 0.00750 mol of H_2SO_4 reacts with $^2/_1$ × 0.00750 = 0.0150 mol of KOH

there are 0.0150 mol of KOH in 45.0 cm^3 of solution

∴ there are 0.0150 ÷ 45.0 = 0.000333 mol of KOH in 1.00 cm^3 of solution

∴ there are 0.000333 × 1000 = 0.333 mol of KOH in 1000 cm^3 of solution

i.e. the concentration of the KOH is <u>0.333 mol/dm³</u> (3 s.f.)

Answer Four:

a) $H_3PO_4(aq) + 3NaOH(aq) \rightarrow Na_3PO_4(aq) + 3H_2O(l)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of H_3PO_4 used = (0.0500 × 50.0) ÷ 1000 = 0.00250 mol

from the balanced chemical equation, 1 mol of H_3PO_4 reacts with 3 mol of NaOH

∴ 0.00250 mol of H_3PO_4 reacts with $^3/_1$ × 0.00250 = 0.00750 mol of NaOH

calculate the volume of a 0.300 mol/dm^3 solution of NaOH that contains 0.00750 mol

moles = (concentration × volume) ÷ 1000

∴ volume = (moles ÷ concentration) × 1000

volume of NaOH = (0.00750 ÷ 0.250) × 1000 = 30.0 cm^3 (3 s.f.)

Answer Five:

a) $K^+_{(aq)}$ from the $KMnO_4(aq)$ and $SO_4^{2-}(aq)$ from the $FeSO_4(aq)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of MnO_4^- used = (0.0200 × 34.0) ÷ 1000 = 0.000680 mol (3 s.f.)

c) from the balanced chemical equation, 1 mol of MnO_4^- reacts with 5 mol of Fe^{2+}

∴ 0.000680 mol of MnO_4^- reacts with $^5/_1$ × 0.000680 = 0.00340 mol of Fe^{2+} (3 s.f.)

d) there are 0.00340 mol of Fe^{2+} in 25.0 cm^3 of solution

∴ there are 0.00340 ÷ 25.0 = 0.000136 mol in 1.0 cm^3 of solution

∴ there are 0.000136 × 1000 = 0.136 mol in 1000 cm^3 of solution

i.e. the concentration of the Fe^{2+} is 0.136 mol/dm^3 (3 s.f.)

e) relative molecular mass of $FeSO_4$ = 56.0 + 32.0 + (4 × 16.0) = 152

mass in grams = moles × relative molecular mass

∴ mass of $FeSO_4$ = 0.136 × 152 = 20.7 g/dm^3 (3 s.f.)

∴ mass concentration of $FeSO_4$ = 20.7 g/dm^3 (3 s.f.)

Answer Six:

a) average of student's best titration results = (26.45 + 26.55) ÷ 2 = 26.50 cm^3

moles in solution = (concentration × volume) ÷ 1000

moles of I_2 used = (0.0100 × 26.50) ÷ 1000 = 0.000265 mol (3 s.f.)

b) from the balanced chemical equation, 1 mol of I_2 reacts with 1 mol of $C_6H_8O_6$

∴ 0.000265 mol of I_2 reacts with $^1/_1$ × 0.000265 = 0.000265 mol of $C_6H_8O_6$ (3 s.f.)

c) there are 0.000265 mol of $C_6H_8O_6$ in the 25.0 cm^3 of fruit juice that was pipetted

∴ there are (200 ÷ 25.0) × 0.000265 = 0.00212 mol of $C_6H_8O_6$ in 200 cm^3 of the fruit juice (3 s.f.)

d) relative molecular mass of $C_6H_8O_6$ = (6 × 12.0) + (8 × 1.0) + (6 × 16.0) = 176

mass in grams = moles × relative molecular mass

∴ mass of $C_6H_8O_6$ = 0.00212 × 176 = 0.373 g (3 s.f.)

Answer Seven:

a) $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$

b) moles in solution = (concentration × volume) ÷ 1000

moles of HCl spilt = 10.0 × 2.00 = <u>20.0 mol</u> (3 s.f.)

Note: the volume is given in dm^3, not cm^3, so no need to ÷ 1000

c) from the balanced chemical equation, 2 mol of HCl react with 1 mol of $CaCO_3$

∴ 20.0 mol of HCl react with $^1/_2$ × 20.0 = 10.0 mol of $CaCO_3$

relative molecular mass of $CaCO_3$ = 40.0 + 12.0 + (3 × 16.0) = 100

mass in grams = moles × relative molecular mass

mass of $CaCO_3$ required = 10.0 × 100 = <u>1000 g</u>

Answer Eight:

a) moles in solution = (concentration × volume) ÷ 1000

moles of HCl = (0.150 × 23.6) ÷ 1000 = <u>0.00354 mol</u> (3 s.f.)

b) from the balanced chemical equation 2 mol of HCl reacts with 1 mol of MCO_3

∴ 0.00354 mol of HCl reacts with $^1/_2$ × 0.00354 = <u>0.00177 mol</u> of MCO_3 (3 s.f.)

c) 0.00177 mol of M_2CO_3 weighs 0.245 g

relative molecular mass = mass in grams ÷ moles

∴ relative molecular mass of M_2CO_3 = 0.245 ÷ 0.00177 = <u>138.4</u> (138 to 3 s.f.)

d) 2 × relative atomic mass of M = 138 – relative molecular mass of CO_3^{2-}

2 × relative atomic mass of M = 138 – (12.0 + (3 × 16.0)) = 78.0

∴ relative atomic mass of M = 78.0 ÷ 2 = <u>39.0</u>

M is <u>potassium</u>

Answer Nine:

a) moles in solution = (concentration × volume) ÷ 1000

moles of HCl used = (0.500 × 38.40) ÷ 1000 = <u>0.0192 mol</u> (3 s.f.)

b) from the balanced chemical equation, 1 mol of HCl reacts with 1 mol of NaOH

∴ 0.0192 mol of HCl reacts with $^1/_1$ × 0.0192 mol = <u>0.0192 mol</u> NaOH (3 s.f.)

c) moles in solution = (concentration × volume) ÷ 1000

moles of NaOH originally used = (0.500 × 50.00) ÷ 1000 = <u>0.0250 mol</u> (3 s.f.)

d) moles of NaOH that reacted with $(NH_4)_2SO_4$ = 0.025 – 0.0192 = <u>0.00580 mol</u> (3 s.f.)

e) from the balanced chemical equation, 2 mol of NaOH react with 1 mol of $(NH_4)_2SO_4$

∴ 0.0058 mol NaOH react with $^1/_2$ × 0.0058 = <u>0.00290 mol</u> $(NH_4)_2SO_4$ (3 s.f.)

f) relative molecular mass of $(NH_4)_2SO_4$ = (2 × 14.0) + (8 × 1.0) + 32.0 + (4 × 16.0) = 132.0

mass in grams = moles × relative molecular mass

mass of $(NH_4)_2SO_4$ = 0.0029 × 132.0 = <u>0.383 g</u> (3 s.f.)

Answer Ten:

a) $CaCO_3(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l) + CO_2(g)$

b) $HNO_3(aq) + NaOH(aq) \rightarrow NaNO_3(aq) + H_2O(l)$

c) moles in solution = (concentration × volume) ÷ 1000

moles of HNO_3 added to the sample of rock = (0.500 × 50.0) ÷ 1000 = <u>0.0250 mol</u> (3 s.f.)

d) moles of NaOH that reacts with the excess HNO_3 = (0.20 × 37.50) ÷ 1000 = <u>0.00750 mol</u> (3 s.f.)

e) from the balanced chemical equation, 1 mol of NaOH reacts with 1 mol of HNO_3

∴ 0.00750 mol of NaOH reacts with $^1/_1$ × 0.00750 = <u>0.00750 mol</u> of HNO_3 (3 s.f.)

∴ there are 0.00750 mol of HNO_3 remaining in excess after the reaction with $CaCO_3$

f) moles of HNO_3 that reacted with the $CaCO_3$ in the sample of rock = 0.0250 – 0.00750 = <u>0.0175 mol</u> (3 s.f.)

g) from the balanced chemical equation, 2 mol of HNO_3 reacts with 1 mol of $CaCO_3$

∴ 0.0175 mol of HNO_3 reacts with $^1/_2$ × 0.0175 = <u>0.00875 mol</u> of $CaCO_3$ (3 s.f.)

h) relative molecular mass of $CaCO_3$ = 40.0 + 12.0 + (3 × 16.0) = 100

mass in grams = moles × relative molecular mass

mass of $CaCO_3$ in the rock sample = 0.00875 × 100 = <u>0.875 g</u> (3 s.f.)

i) percentage $CaCO_3$ in the rock sample = (mass of $CaCO_3$ ÷ mass of rock sample) × 100

percentage $CaCO_3$ in the rock sample = (0.875 ÷ 1.40) × 100 = <u>62.5 %</u> (3 s.f.)