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COLLEGE: SCIENCE

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1i. 11H 🡪 10n + 01β

iia.The product of the decay is Boron 10

b. Nuclear equation: 106C🡪 105B + 01β

2. 2HI(g) <------> H2(g) + I2

For every n moles of HI, 0.223n moles of each product is formed and (1-0.223)n= 0.777n moles of HI remains. For it to be easier, we assume that n=1 and that the reaction is carried out in a 1L vessel, so we can substitute the concentration terms directly into the equilibrium expression.

 Kc = [H2] [I2] = (0.223)2 = 0.082

 [HI]2  (0.777)2

3a. t$\frac{1}{2}$ = $\frac{0.693}{k}$

 ln[$\frac{At}{Ao}]$ = kt -----(1)

conc = $\frac{mol}{dm3}$ = $\frac{mol}{46.1x10-3}$

Ao = $\frac{1000mol}{46.1}$

A5 = $\frac{1000mol}{37.1}$

From (1)

ln[$\frac{\frac{1000mol}{37.1}}{\frac{1000mol}{46.1}}$] = k(5)

ln[$\frac{1000mol}{37.1}$ x $\frac{46.1}{1000mol}$]

ln[1.243] = k(5)

0.2171 = k(5)

k = 0.0434

t$\frac{1}{2}$ = $\frac{0.693}{k}$

t$\frac{1}{2}$ = $\frac{0.693}{0.0434}$

t$\frac{1}{2}$ = 15.97 mins

b. t$\frac{1}{2}$ = $\frac{0.693}{k}$

5.00 = $\frac{0.693}{k}$

k = $\frac{0.693}{500}$

k = 1.39x10-3s-1

kt = ln$\frac{a}{(a-x)}$

1.39x10-3 x 800 = ln$\frac{a}{(a-x)}$

e1.39x10-3 x 800 = $\frac{a}{(a-x)}$

3 = $\frac{a}{(a-x)}$

3a-3x = a

3a-a = 3x

2a = 3x

x = $\frac{2}{3}a$

This means that 66.7% of a must have reacted after 800 seconds

4a. Acetic acid= HC2H3O2  0.20M

Sodium acetate= NaC2H3O2 0.15M

(Ka=1.8x10-5)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | HC2H3O2(aq)  |  + H20(l) <--> | H3O+(aq) +  | C2H3O2 |  |
|  Initial |  0.20 |  - |  0 |  0.15 |  |
|  |  -x |  - |  +x |  +x |  |
| Equilibrium |  0.20-x |  - |  x |  0.15+x |  |

Ka= [H3O+ ] [C2H3O2 ]

 [HC2H3O2 ]

1.8x10-5 = x(0.15+x)

 (0.20-x)

0.20(1.8x10-5 ) – (1.8x10-5) = x(0.15 + x)

0.20(1.8x10-5 ) - 1.8x10-5 x = 0.15x + x2

3.6x10-6 -0.150018x – x2

x = -0.150

x = 2.399x10-5

[H3O+] = 2.399x10-5

 pH = -log(2.399x10-5 )

pH = 4.6

 4b. Buffer capacity definition is given by:

β = $\frac{dn}{dpH}$ -----(1)

charge balance of the solution is given by:

[A+] + [OH-] = [B+] + [H+] ----(2)

[B+] is nothing else but concentration of the strong base present

Total concentration of the buffer, Cbuff is given by:

Cbuff = [HA] + [A-] ----(3)

From the dissociation constant definition we have:

[HA] = $\frac{\left[HA\right] [A-] }{Ka}$ --------(4)

So,

Cbuff = $\frac{\left[HA\right] [A-] }{Ka}$ + [A-] ------(5)

Or

[A-] = $\frac{Cbuff Ka}{Ka+[H+]}$ ------(6)

Eqn (2) and (6) and water ionization constant definition when combined give us formula for the amount of the strong base:

 n = $\frac{Kw}{[H+]}$ - [H+] + $\frac{Cbuff Ka}{Ka+[H+]}$ -----(7)

Now we are ready to calculate derivative:

β = $\frac{dn}{dpH}$ = $\frac{dn}{d[H+]}$ = $\frac{d\{H+]}{dpH}$ ------(8)

β = (-$\frac{Kw}{[H+]^{2}}$ - 1 - $\frac{Cbuff Ka}{Ka+[H+]} $) (-2.303[H+] )------(9)

ZFinally, buffer capacity is given by

β = 2.303 (-$\frac{Kw}{[H+]}$ + [H+] + $\frac{Cbuff Ka [H+]}{Ka+[H+]^{2}} $)--------(10)

This equation can be generalized for buffer capacity of solutions containing several buffers

β = 2.303 (-$\frac{Kw}{[H+]}$ + [H+] +$∑$ $\frac{Cbuff Ka [H+]}{Ka+[H+]^{2}}$ ------(11)

5a. Equation of reaction

 2Al + Fe2O3 🡪 Al2O3 + 2Fe

124g 0f Al + 601g of Fe2O3

 mass of Al2O3 formed

2 moles of Al reacted with 1 mole of Fe2O3 to produce 1 mole of Al2O3

Al : Fe2O3  Al : Al2O3

2 : 1 2 : 1

molar mass of Al = 26.98g/mol

no of moles of Al = $\frac{124}{26.98}$ = 4.596 moles

molar mass of Fe2O3  = (55.8 x 2) + (16 x 3)

 = 111.6 + 48

 =159.6g

no of moles = $\frac{601}{159.6}$ = 3.766 moles

1 mole of Fe2O3 = 2 moles of Al

3.766 moles of Fe2O3 = 7.532 moles of Al

The limiting reagent is Aluminium

4.596 moles of Al = 2.298 moles of Al2O3

Molar mass of Al2O3 = 101.96g

mass = no of moles x mm

 = 2.298 x 101.96g

 = 234.30g of Al2O3

5b. Percentage yield = $\frac{actual yield}{theoretical yield}$ x 100%

 actual yield = 46.0g

 C6H6 + Cl2 🡪 C6H5Cl + HCl

 1 mole of C6H6 = 1 mole of C6H5Cl

 no of moles of C6H6 = $\frac{40}{78}$ = 0.513 moles

 since 1 mole of C6H6 = 1 mole of C6H5Cl

 0.513 moles of C6H6 = 0.513 moles of C6H5Cl

 mass of C6H5Cl = RMM of C6H5Cl x no of moles

 = 112.5 x 0.513

 = 57.7125g

 Theoretical yield= 57.7125g

 percentage yield = $\frac{46}{57.7125}$ x 100%

 = 79.7%

5c. Equation of reaction

 C3H4 + 4O2 🡪 3CO2 + 2H20

 1 mole of C3H4 produces 3 moles of CO2 on reacting with excess oxygen

molar mass of C3H4 = 40g/mol

molar mass of CO2 = 44g/mol

So theoretically, 40g C3H4 produces 3 x 44 = 132g CO2

120g C3H4 produces$\frac{132}{40}$x 120g C02

=396g of CO2

### 5d. Classification of the elements in the periodic table can be done in four ways on the basis of their electronic configurations:

1. **S block elements:**

The valence electrons of elements in this group fall into the S shell. An example is Calcium- [Ar] 4s2

1. **P block elements:**

The valence electrons of elements in this group fall into the P shell. Group 3-7 are known as the p-block elements (outermost configuration varies from ns2np1 to ns2np5).

1. **D block elements:**

Elements between group 2 and 3 have their outer shell electronic configuration as (n-1)d1-10ns1-2 are referred to as transition elements. These elements are also known as the d-block elements.

1. **F block elements:**

Lanthanides and actinides series which falls at the bottom of the periodic table comes under the category of inner transition elements. In these elements the 4f and 5f orbitals are partially filled, rendering them special properties.

6 . Always protect your eyes with protective goggles when working in the laboratory.

7. Data should be recorded immediately into laboratory manual and not on a scrap paper to avoid loss of data.

8. Density = $\frac{mass}{volume}$

mass = 8.47g volume= 3.24cm3

 Density = $\frac{8.47g}{3.24cm3}$

 density = 2.6gcm-3

9. Equation of reaction

 BaCl2 + H2SO4 🡪 BaSO4 + 2HCl

 Volume = 5.00ml of H2SO4

5.00ml = 0.005dm3

 conc = 0.250 mol/dm3

no of moles of H2SO4 = 0.25 x 0.005

 = 1.25 x 10-3 moles

H2SO4 🡪 BaSO4

 1 mole of H2SO4 🡪 1 mole of BaSO4

1.25 x 10-3 moles of H2SO4 = 1.25 x 10-3 moles of BaSO4

molar mass of BaSO4 = 233g/mol

mass = molar mass x no of moles

 = 233 x 1.25 x 10-3

= 0.291g

10. Chemical formulae

 CoCL2.6H2O

mass of CoCl2.6H2O = 25.0g

mass of water = 11.3g

% of water in the hydrate

= $\frac{11.3}{25.0}$ x 100%

= 45.2%