Neutralisation Reaction Chemistry Questions with Solutions

Q-1: Write the net ionic equation for the neutralisation reaction between calcium hydroxide and hydrobromic acid solution?

Answer: Write the molecular equation first.

$Ca(OH)_2 (aq) + 2HBr(aq) \rightarrow CaBr_2(aq) + 2H_2O(l)$

Dissociate the ionic compounds in the aqueous phase into ions
$Ca^{2+}(aq) + 2OH^-(aq) + 2H^+(aq) + 2Br^-(aq) \rightarrow Ca^{2+}(aq) + 2Br^-(aq) + 2H_2O(l)$

Remove the spectator ions from the above equation to get the net ionic equation.
$2OH^-(aq) + 2H^+(aq) \rightarrow 2H_2O(l)$
Or
$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

Q-2: In comparison to acetic acid, formic acid is a stronger acid. Formate ion or acetate ion: which is the stronger base?

Answer: Acetate ion is a stronger base.

Explanation: A conjugate base is formed when an acid releases protons. A strong acid has a weak conjugate base and a weak acid always has a strong conjugate base.

Q-3: Make a list of the several uses for neutralisation reactions.
Answer: The various applications of neutralisation reactions are**:**

1. Titration methods: Chemical titration is used to determine unknown acid or base concentrations by determining their neutralisation point. A pH indicator or pH metre is used to locate the point where neutralisation occurs. The molarity of the unknown particle can be determined using simple stoichiometric calculations and knowledge of the volume and molarity of the known quantity.

2. Toothpaste: Toothpaste is used not only to keep our mouths clean, but it also acts as a neutralizer for the effects of the foods we eat. The majority of the food we eat is acidic, and the acidic action of the food reacts with the enamel or calcium phosphate layer of our teeth, causing a cavity to form. It is toothpaste's basic quality that prevents cavities by neutralising the reaction.

3. Digestive systems: Food must be neutralised as it travels from our stomach to our intestines. However, an alkaline environment is essential for nutrients to be absorbed via the intestinal walls. To achieve this favourable state, antacid bicarbonate is created.

4. Controlling soil pH: Plants cannot grow in very acidic or excessively basic soil, neutralisation is frequently used to adjust the pH of the soil. Adding bases such as $CaCO_3$, CaO, or burnt wood ash to the soil is a safe way to regulate its acidity.

5.Wastewater treatment: The majority of trash that comes in the form of industrial effluents contains toxins that are damaging to our ecosystem. As a result, we must first neutralise their toxicity before discarding them. Different chemicals are utilised depending on the application. Sodium bicarbonate, magnesium hydroxide, and calcium carbonate are among examples.

Q-4: Is it possible to have a neutralisation reaction when one of the reactant phases is solid?

Answer: Yes, it is possible to conduct a neutralisation reaction with one reactant in solid phase.

The following is an example:

$Cr(OH)_2\,(s) + 2HCl(aq) \rightarrow CrCl_2(aq) + 2H_2O(l)$

Q-5: Which of the following statements about spectator ions is incorrect?

a) They are a part of the net ionic equation.
b) Their elimination leads to a net ionic equation.
c) No reaction takes place if there are only spectator ions
d) They are present only at the reactant side.

Answer: a) and d)

Explanation: Chemical reactions are not affected by spectator ions. It can be found in both the reactant and the product. We cancel the spectator ions from both sides of the equation when creating a net ionic equation.If all of the ions are spectators, no reaction occurs.

Q-6: When phosphoric acid combines with calcium hydroxide, the pH of the salt formed is

a) Greater than 7
b) Less than 7
c) Slightly less than 7
d) Exact;y 7

Answer: a) Greater than 7

Explanation: The following reaction takes place when phosphoric acid (H_3PO_4) combines with calcium hydroxide($Ca(OH)_2$):

$2H_3PO_4(aq) + 3Ca(OH)_2(aq) \rightarrow 6H_2O(l) + Ca_3(PO_4)_2(s)$

Because phosphoric acid is a weak acid and calcium hydroxide is a little stronger base, a basic salt with a pH higher than 7 is produced.

Q-7: What happens if you write a neutralisation reaction with a hydronium ion instead of a proton? Explain your answer with a suitable example.

Answer:
Let us consider a neutralisation reaction between KOH and HCl

$KOH(aq) + HCl(aq) \rightarrow KCl(aq) + H_2O(l)$

Dissociate the aqueous solution of ionic compounds into ions

$K^+(aq) + OH^-(aq) + H^+(aq) + Cl^-(aq) \rightarrow K^+(aq) + Cl^-(aq) + H_2O(l)$ ……….1)

The net ionic equation (when proton is used) is:
$OH^-(aq) + H^+(aq) \rightarrow H_2O(l)$

Replace H^+ ion with H_3O^+ ion in equation 1

$K^+(aq) + OH^-(aq) + H_3O^+(aq) + Cl^-(aq) \rightarrow K^+(aq) + Cl^-(aq) + 2H_2O(l)$

The net ionic equation (when H_3O^+ ion is used) is:
$OH^-(aq) + H_3O^+(aq) \rightarrow 2H_2O(l)$

As a result, the only difference is the presence of an additional water molecule as a product.

Q-8: A 250 mL aqueous solution of 6.3 g oxalic acid dihydrate is prepared. The volume of 0.1N NaOH necessary to neutralise 20mL of this solution is

a) 80 mL
b) 40 mL
c) 8 mL
d) 4 mL

Answer: a) 80 mL

<u>Explanation:</u>

Step-1 Calculate the number of moles of oxalic acid dihydrate

Moles = Weight of oxalic acid dihydrate/Molar mass of oxalic acid dihydrate
=(6.3g)/(126g/mol)
= 0.05 mol

Step-2 Calculate the molarity of oxalic acid dihydrate.

Molarity = Number of moles of oxalic acid dihydrate/Volume (in L)
= 0.05 mol/0.25 L
= 0.2 M

Step-3 Calculate the normality of oxalic acid dihydrate

Normality = Molarity × n-factor
= 0.2 × 2
= 0.4 N

Use the equation,

N_1V_1 (oxalic acid) = N_2V_2 (NaOH)
0.4 N× 20 mL = 0.1N × V_2

V_2 = 80 mL

Note: n-factor of an acid is equal to the number of replaceable H-atoms present in it.

Q-9: If the products of neutralisation are HOH and $SrSO_4$, what are the acid and base?

a) H_2SO_4 + SrOH
b) H_2SO_4 + $Sr(OH)_2$
c) HSO_4 + $Sr(OH)_2$
d) Acid + base

Answer: b) H_2SO_4 + $Sr(OH)_2$

<u>Explanation:</u> The neutralisation reaction takes place as:

H_2SO_4 (aq) + $Sr(OH)_2$(aq) $\rightarrow$ $SrSO_4$(aq) + $2H_2O$(l)

Q-10: Which of the following statements is an example of a neutralisation reaction?

a) Addition of litmus solution to sulphuric acid
b) Addition of litmus solution to baking soda
c) Applying of quick lime to basic soil
d) Applying magnesium hydroxide on ant bite

Answer: d) Applying magnesium hydroxide on ant bite

Explanation: When an ant bites, formic acid is released, causing irritation. Thus, a basic substance such as magnesium hydroxide can be used to neutralise its effects.

Since, it involves a reaction between an acid and base, therefore a perfect example of neutralisation reaction.

Q-11: In a calorimeter, equal amounts of 50 mL, 3M HCl and 3M NaOH react at a temperature of 20.0°C. The temperature of the resulting solution is 40.0°C.Calculate

a) $q_{reaction}$
b) Enthalpy change for the reaction

Assume that the densities and specific heat capacity of the solutions(C) are approximately 1.0 g/ml and 4.18 J/g°C, respectively,

Answer:

a) Mass of solution, m = Density of solution × Volume of total solution
= 1.0 g/ml × (50mL +50 mL)
= 100 g

$q_{solution}$ = mCΔt
= 100g × 4.18 J/g°C × (40-20)°C
= 8360 J

The energy released by the reaction is $q_{reaction}$,
$q_{reaction}$ + $q_{solution}$ = 0

$q_{reaction}$ = - $q_{solution}$ = - 8,360 J

b) The limiting reactant is either the HCl or the NaOH since there are equimolar amounts present, therefore we can consider moles of any substance.

Moles of the limiting reactant,HCl = (M×V(L))

$= (0.050L \times 3M)$
$= 0.15$ mol

$\Delta H_{rxn} = q_{reaction}$ / moles of limiting reactant
$=(-8,360$ J)/ (0.15 mol)
$= -55733.3$ J/mol

Q-12: Neutralisation reaction is a

a) Physical and reversible change
b) Physical and irreversible change
c) Chemical and reversible change
d) Chemical and irreversible change

Answer: d) Chemical and irreversible change

Explanation: A neutralisation reaction is always a chemical and irreversible change since new products are generated as a result of chemical reaction and products cannot be changed back to reactants.

Q-13: a) How many moles of $Ca(OH)_2$ will it take to completely neutralise 4 moles of H_3PO_4?
b) How many litres of 1.4 M H_3PO_4 will it take to neutralise 500mL of 0.80 M $Ca(OH)_2$?

Answer: The neutralisation reaction takes place as:

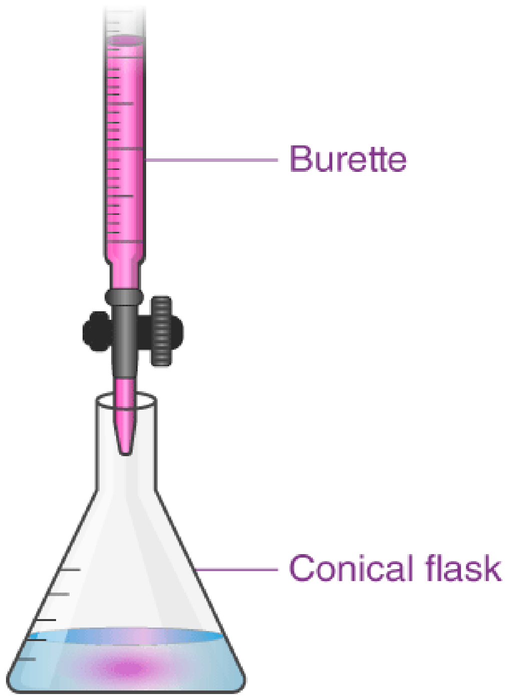
$2H_3PO_4(aq) + 3Ca(OH)_2(aq) \rightarrow 6H_2O(l) + Ca_3(PO_4)_2(s)$

a) According to the reaction,
3 moles of $Ca(OH)_2$ neutralises 2 moles of H_3PO_4
4 moles of $Ca(OH)_2$ neutralise 8/3 moles of H_3PO_4

b) Moles of $Ca(OH)_2$ = Molarity of $Ca(OH)_2$ × Volume of $Ca(OH)_2$(in L)
$= 0.80 \text{ M} \times 0.5 \text{ L}$
$= 0.4$ moles
3 moles of $Ca(OH)_2$ neutralises 2 moles of H_3PO_4
0.4 moles of $Ca(OH)_2$ neutralises $(2 \times 0.4)/3$ moles of H_3PO_4
$= 0.27$ moles of H_3PO_4

Volume of H_3PO_4 required to neutralise 500mL of 0.80 M $Ca(OH)_2$ = Moles of H_3PO_4 used for neutralisation/ Molarity of H_3PO_4
Volume of H_3PO_4 = 0.27 moles/1.4 M
$= 0.2$ L

Q-14: Which of these acid-base neutralisation processes might be titrated to a sharp end point using the apparatus shown below?



a) Sulphuric acid + aluminium oxide
b) Sulphuric acid + Magnesium hydroxide
c) Sulphuric acid + sodium hydroxide
d) Sulphuric acid + magnesium oxide

Answer: c) Sulphuric acid + sodium hydroxide

Explanation: Since, both sulphuric acid and sodium hydroxide split up completely and instantly in the reaction hence giving a sharp end point.

Q-15: Which indicator is preferred in a strong acid and weak base titration?
a) Phenolphthalein
b) Methyl orange
c) Malachite green
d) None of the above

Answer: b) Methyl orange

Explanation: Methyl orange will change sharply at the equivalence point. Hence a good choice of indicator in this case.

Practise Questions on Neutralisation Reaction

Q-1: Write the oxalic acid and calcium hydroxide neutralisation reaction. How are you going to handle a net ionic equation? Is the reaction slow or fast?

Answer: $H_2C_2O_4(s) + Ca(OH)_2(s) \rightarrow 2H_2O(l) + CaC_2O_4\ (s)$

Because there are no substances to divide into ions because nothing is dissolved, the net ionic equation is the equation of the three solids and one liquid.

The reaction between oxalic acid and calcium hydroxide is very slow.

Q-2: Consider the reaction between a strong acid and strong base
$OH^- + H^+ \rightarrow H_2O(l)$

The reaction is

a) Endothermic and $q_{reaction}$ is positive
b) Exothermic and $q_{reaction}$ is positive
c) Endothermic and $q_{reaction}$ is negative
d) Exothermic and $q_{reaction}$ is negative

Answer: d) Exothermic and $q_{reaction}$ is negative

Explanation: The reaction between an acid and base is a neutralisation reaction. A neutralisation reaction is accompanied by the release of heat energy making it exothermic with $q_{reaction}$ negative.

Q-3: Calculate the pH of the resultant solution after mixing 200 mL of a 0.15 M hydrobromic acid solution(HBr) with 100 mL of a 0.2M KOH solution.

Answer:

Step-1: Calculate moles of HBr

Moles of HBr = Molarity of HBr × Volume(in L)
= 0.15 M × 0.2 L
= 0.03 moles

Step-2: Calculate moles of KOH

Moles of KOH = Molarity of KOH × Volume(in L)
= 0.2 M × 0.1 L
= 0.02 moles

The following neutralisation reaction takes place:

	HBr	+ KOH $\rightarrow$	HOH	+ KBr
Initial moles	0.03	0.02	-	-
After reaction moles	0.01	-	-	0.02

In order to calculate the pH, we should know $[H^+]$

SInce after reaction, moles of HBr= 0.01 mol
This implies, moles of H^+ = 0.01 mol

Total volume = (200+100)mL
= 300 mL
= 0.3 L
$[H^+]$ = Moles of H^+/ Volume of solution(in L)
= (0.01 mol)/ (0.3 L)
= 0.033 M

pH = $-\log[H^+]$
= -log[0.033 M]
= 1.5

Q-4: Is it possible to classify a neutralisation reaction as a salt metathesis reaction?

Answer: A neutralisation reaction is considered as a salt metathesis reaction. A double displacement reaction is another name for a salt metathesis reaction. Atoms or groups of atoms from two distinct compounds swap positions in a double displacement process.

Consider a neutralisation reaction,

$NaOH + HCl \rightarrow NaCl + H_2O$

We can clearly see atoms are replacing each other and forming new products, hence can be considered as a salt metathesis reaction.

Q-5: In a neutralisation reaction between HCl(aq) and $Fe(OH)_3$(s), what is/are spectator ions?

a) Cl^-
b) Fe^{3+}
c) H^+
d) OH^-

Answer: a) Cl^-

Explanation: The chemical reaction between HCl(aq) and $Fe(OH)_3$(s) proceeds according to the equation:

$$3HCl(aq) + Fe(OH)_3(s) \rightarrow 3H_2O(l) + FeCl_3(aq)$$

It can also be written as:

$3H^+(aq) + 3Cl^-(aq) + Fe(OH)_3(s) \rightarrow 3H_2O(l) + Fe^{3+}(aq) + 3Cl^-(aq)$

Iron (II) hydroxide is insoluble, we cannot separate it into ions for the complete ionic equation.

The net ionic equation is

$3H^+(aq) + Fe(OH)_3(s) \rightarrow 3H_2O(l) + Fe^{3+}(aq)$

Hence, the spectator ion is Cl^-.