**Sample Paper-02**
**Chemistry (Theory)**
**Class – XI**

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**Time allowed: 3 hours** **Maximum Marks: 70**

**General Instructions:**

a) All the questions are compulsory.
b) There are **26** questions in total.
c) Questions **1** to **5** are very short answer type questions and carry **one** mark each.
d) Questions **6** to **10** carry **two** marks each.
e) Questions **11** to **22** carry **three** marks each.
f) Questions **23**is value based question carrying **four** marks.
g) Questions **24**to **26** carry **five** marks each.
h) There is no overall choice. However, an internal choice has been provided in one question of two marks, one question of three marks and all three questions in five marks each. You have to attempt only one of the choices in such questions.
i) Use of calculators is **not** permitted. However, you may use log tables if necessary.

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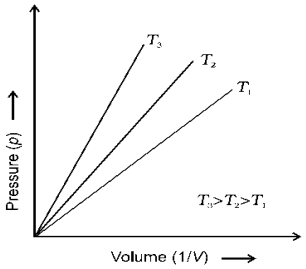
1. What will be the volume of ammonia formed if 2L of nitrogen is mixed with 2L of hydrogen at constant temperature and pressure?
2. Give two examples of state functions.
3. Why the molar enthalpy of vapourisation of acetone is less than that of water?
4. How many electrons are present in 16g of methane?
5. How many grams of $Na_2CO_3$ should be dissolved to make 100cc of 0.15M $Na_2CO_3$?
6. Which of these electrons experience lowest effective nuclear charge?
   (a) The Br atom containing 35 electrons in which 6 electrons are in 2p orbital or
   (b) 6 electrons in 3p orbital and 5 electrons in 4p orbital.
7. Write structural formulas of the following compounds :
   (a) 3, 4, 4, 5–Tetramethylheptane
   (b) 2,5-Dimethyhexane

   **Or**

   Write the structural formula of:
   (a) O-Ethylanisole
   (b) 2,3 - Dibromo -1 - phenylpentane
8. (a) How change in velocity of a moving particle change the wavelength of the particle?
   (b) Give the difference in the angular momentum of an electron present in 3p and 4p orbitals?
9. What is hydride gap? Why is heavy water used in nuclear reactors?
10. Though carbon dioxide is inert and harmless gas, it is thought to be a serious pollutant. Why?

11. (a)Give the importance of measuring BOD of a water body.
    (b) What is desirable concentration of fluoride ion pH of drinking water?
    (c) Give the harmful effect of nitrogen dioxide.
12. (a)Define:
    (i) Intensive properties
    (ii) Adiabatic process
    (b) Derive $\Delta G=-T\Delta S_{total}$ from the relationship G=H – TS.
13. We know that 75% of solar energy reaching the earth, is absorbed by earth's surface increases its temperature. The rest of heat radiates back to the atmosphere. Some of the heat is trapped by gases such as CO, $CH_4$, $O_3$, CFC's and water vapours present in the atmosphere. This causes global warming.
    (a) Suggest some measures to decrease CO gas in the atmosphere.
    (b) Give a method to save ozone layer.
    (c) Will the use of solar energy solve our problems? Comment.
14. Comment on the graph below.




15. If the density of 3M solution of NaCl is 1.25g/mL, calculate the molality of the solution.
16. Calculate the standard enthalpy of formation of one mole of $CH_3OH$ (l), if the combustion of one mole of methanol takes place at 298 K and 1 atm and after combustion $CO_2$ (g) and $H_2O$ (l) are produced and 726 kJ of heat is liberated. Assume that the standard enthalpies of formation of $CO_2$ (g) and $H_2O$ (l) are - 393 kJ/mol and -286 kJ mol respectively.
17. What are the uses of sodium carbonate?
18. Describe in detail the expanded octet with suitable examples.
19. How would you prepare alkanes from alkenes?
20. (a) Calculate the concentration of hydroxyl ion in 0.1 M solution of ammonium hydroxide having $K_b = 1.8\times10^{-5}$, if $K_{sp}$ value of two sparingly soluble salts Ni $(OH)_2$ and AgCN are $2\times10^{-15}$ and $6.0\times10^{-17}$ respectively.
    (b) Which salt is more soluble?

    **Or**

    (a) When certain buffer is made by mixing sodium formate and formic acid in water, explain how it neutralizes an addition of a small amount of an acid or a base.
    (b) When a basic buffer is made by mixing ammonium hydroxide and ammonium nitrate in water, explain how it resists change in its pH on addition of a small amount of an acid or a base.
21. Give the names and formulae of the compounds in the statements given below:

(i) A compound of Ca used in setting fractured bones.

(ii) A compound of Mg, S, O and H used as purgative in medicines.

(iii) A compound of Ca and C used for the production of acetylene.

(iv) A compound of Ca, C and N used as fertilizer.

22. 0.45 g of an organic compound gave 0.792 g of $CO_2$ and 0.324 g of water on combustion. 0.24 g of same substance was Kjeldahlised and the $NH_3$ formed was absorbed in 50.0 $cm^3$ of $\frac{M}{8} H_2SO_4$. The excess acid required 77.0 $cm^3$ of $\frac{M}{8} NaOH$ for complete neutralization. Calculate the empirical formula of the compound.

23. Prasad did not paint his iron gate and so it got corroded. Iron gets rusted in presence of oxygen and moisture and large amount of iron gets wasted due to corrosion. Corrosion is a process in which metals react with compounds present in atmosphere to form surface compounds.

(a) Justify: "Corrosion is an electrochemical phenomenon".

(b) How rusting of iron be prevented?

(c) What happens to the metal which undergoes corrosion?

24. (a) The species $H_2O$, $HCO_3$, $HSO_4^-$ and $NH_3$ can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

(b) Consider the following endothermic reaction: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

(i) Write expression for Kp for the above reaction.

(ii) How will the equilibrium be affected by?

1. Increasing the pressure 2. Using a catalyst

**Or**

(a) Predict the acidic, basic or neutral nature of the following salt: NaCN, KBr, $NaNO_2$, $NH_4NO_3$.

(b) How many grams of KBr are added to 1 L of 0.05 M solution of silver nitrate just to start the precipitation of AgBr? Ksp of AgBr = $5.0 \times 10^{-13}$

25. With the help of structures, give the IUPAC names of different chain isomers of alkanes corresponding to the molecular formula $C_6H_{14}$.

**Or**

The preparation of acetaldehyde by passing mixture of ethene and oxygen under pressure into aqueous solution of $PdCl_2$ and $CuCl_2$ as a catalyst is called Wacker's process. Acetalydehyde is a useful chemical which is used for silvering of mirror. It can be prepared

by various methods. It is used in the commercial preparation of acetic acid, ethyl acetate etc. Paraldehyde, a trimer of aldehyde is used as hypnotic.

(a) Give the best method to prepare acetaldehyde. Give two reasons.

(b) Give the chemical equation for Wacker's process of preparation of acetaldehyde.

(c) Give the disadvantage of preparing it from ethyne.

26. Give the net ionic equation for the reaction of potassium dichromate (VI) with sodium sulphite in an acid solution to give chromium (III) ion and the sulphate ion.

**Or**

Explain the reason for the following reactions to proceed differently.

$Pb_3O_4 + 8\ HCl \rightarrow 3\ PbCl_2 + Cl_2 + 4\ H_2O$ and

$Pb_3O_4 + 4\ HNO_3 \rightarrow 2\ Pb(NO_3)_2 + PbO_2 + 2\ H_2O$

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**Time allowed: 3 hours** **Answers** **Maximum Marks: 70**

1. 1L of nitrogen will react with 3L of hydrogen,

   2L of nitrogen will react with 6L of hydrogen, but we have 2L of hydrogen, therefore hydrogen is limiting reactant.

   So, 3L of hydrogen gives 2L of ammonia,

   2L of hydrogen gives $\frac{2}{3}$ x 2 = $\frac{4}{3}$ = 1.33L of ammonia.

2. ΔH, the enthalpy change and ΔU, the internal energy change are state functions as they depend on initial and final state and note on the path.

3. It is because acetone has weak van der Waals' forces of attraction whereas water molecules have strong hydrogen bonding, therefore, $\Delta_{vap}H^0$ of water is more.

4. 1 molecule of methane = 6 + 4 = 10 electrons

   16 of methane contains 10 x 6.022 x $10^{23}$ electrons = 6.022 x $10^{24}$ electrons.

5. 1000 $cm^3$ of 0.15 M $Na_2CO_3$ contains 0.15 moles of $Na_2CO_3$

   So, 100 $cm^3$ of 0.15 M $Na_2CO_3$ will contain = $\frac{0.15 \text{ x } 100}{1000}$

   = 0.015 moles of $Na_2CO_3$

   $$\text{Number of moles} = \frac{\text{Mass}}{\text{Molar mass}}$$

   $$\therefore 0.015 = \frac{\text{Mass}}{106\text{g}}$$

   Molar mass of $Na_2CO_3$ = 106 g

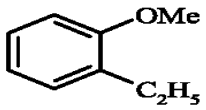
   = 0.015 x 106 = 1.59 g

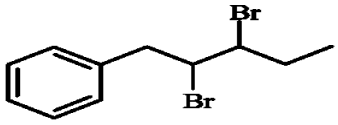
6. As we go away from the nucleus, the effective nuclear charge pull goes on increasing. Hence electrons present in 4p orbital experience the lowest effective nuclear charge.

7. (a) $CH_3-CH_2-CH(CH_3)-C(CH_3)_2-CH(CH_3)-CH-CH_3$

   (b) $CH_3-CH(CH_3)-CH_2-CH_2-CH(CH_3)-CH_3$

**Or**




8. (a) Wavelength decreases with increase in velocity of moving particle.

   (b) Angular momentum of 3p and 4p orbitals will be same because l = 1 for p-orbital.

9. The metals of groups 7, 8 and 9 do not form hydrides. This region of periodic table from group 7 to 9 is referred to as hydride gap. Heavy water is used in the nuclear reactors to slow down the speed of neutrons (as moderator).

10. Carbon dioxide absorbs IR radiations from atmosphere which lead to global warming. So, if carbon dioxide level increases beyond 0.03%, the natural greenhouse balance may get disturbed. So it is considered as serious pollutant.

11. (a) BOD is a measure of level of pollution caused by organic biodegradable material. Low value of BOD means water is less polluted.

    (b) 1 ppm is desirable concentration of fluoride ions in drinking water. The pH of drinking water should be between 5.5 – 9.5.

    (c) Nitrogen dioxide is extremely toxic to living tissues and harmful to plants, paints, textiles and metals. It causes acid rain. It produces photochemical smog.

12. (a) (i) The properties which depend only on the nature of the substance and not on the amount of the substance are called intensive properties. Example: Density.

    (ii) A process in which no heat flows between the system and the surroundings is called an adiabatic process i.e. q= 0.

    (b) Change in Gibbs energy, $\Delta G = G_2 - G_1$,

    Enthalpy change, $\Delta H = H_2 - H_1$,

    Entropy change, $\Delta S = S_2 - S_1$,

    $\Delta G = \Delta H - T\Delta S$

    $\Delta S_{total} = \Delta S_{system} + \Delta S_{surrounding}$

    $$\Delta S_{total} = \Delta S_{system} - \frac{\Delta H_{sys}}{T}$$

    $$\Delta S_{total} = \Delta S - \frac{\Delta H}{T}$$

Multiply by T,

$T\Delta S_{total} = T\Delta S - \Delta H$

$T\Delta S_{total} = \Delta H - T\Delta S = \Delta G$

Therefore, $\Delta G = - T\Delta S_{total}$

13. (a) Using CNG as a fuel, using public transports, electric cars and bicycles and avoiding burning of dry leaves, plastic bags etc.

(b) Banning CFCs used in refrigerators, AC etc., and using less amount of diesel and petrol.

(c) Yes. Solar energy reduces pollution. By making green building, a lot of natural light and natural cooling and heating takes place which save lot of energy and environment.

14. It represents the graph between p and 1/V. It is a straight line passing through origin. However at high pressures, gases deviate from Boyle's law and under such conditions a straight line is not obtained in the graph.

15. Molarity = 3M

Density = 1.25g/mL

Mass of NaCl in 1L solution

= Molarity x molar mass = 3 x 58.5 = 175.5g

Density = Mass/Volume

Mass of 1LNaCl solution = 1.25 x 1000 = 1250g

Mass of water in solution = 1250-175.5 = 1074.5g = 1.0745 kg

Molality = No. of moles of solute/Mass of water

$= \frac{3}{1.0745} = 2.79$ m

16. (a) Combustion of methanol:

$CH_3OH\ (l) + 3/2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (l)$; $\Delta H = -726$ kJ/mol ----- (1)

(b) Enthalpy of formation of carbon dioxide:

$C_{(graphite)} + O_2\ (g) \rightarrow CO_2\ (g)$ ; $\Delta H = -393$ kJ/mol ---------- (2)

(c) Enthalpy of formation of water:

$H_2\ (g) + ½\ O_2\ (g) \rightarrow H_2O\ (l)$; $\Delta H = -286$ kJ/mol ---------- (3)

(d) Required reaction:

$C_{(graphite)} + 2H_2\ (g) + 1/2\ O_2 \rightarrow CH_3OH\ (l)$ ; $\Delta H = ?$ ---------- (4)

$\Delta H = (– 572 – 393) – 726 = – 239$ kJ/mol

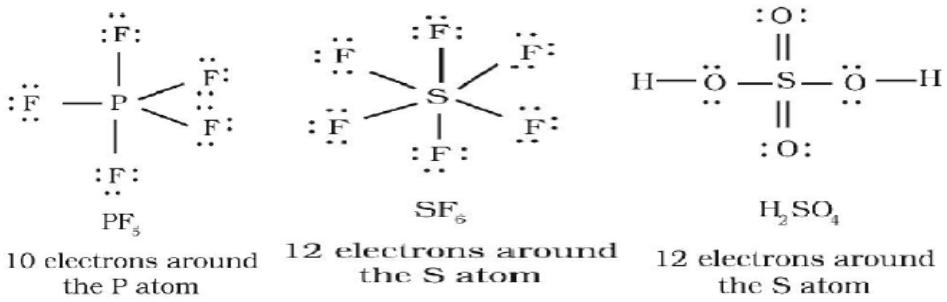
17. (a) It is used in water softening, laundering and cleaning.

(b) It is used in the manufacture of glass, soap, borax and caustic soda.

(c) It is used in paper, paints and textile industries.

(d) It is an important laboratory reagent both in qualitative and quantitative analysis.

18. Elements in and beyond the third period of the periodic table have, apart from 3*s* and 3*p* orbitals, 3*d* orbitals also available for bonding. In a number of compounds of these elements there are more than eight valence electrons around the central atom. This is termed as the expanded octet. Obviously the octet rule does not apply in such cases. Some of the examples of such compounds are: $PF_5$, $SF_6$, $H_2SO_4$ and a number of coordination compounds.




19. Dihydrogen gas adds to alkenes and alkynes in the presence of finely divided catalysts like platinum, palladium or nickel to form alkanes. This process is called hydrogenation. These metals adsorb dihydrogen gas on their surfaces and activate the hydrogen – hydrogen bond. Platinum and palladium catalyses the reaction at room temperature but relatively higher temperature and pressure are required with nickel catalysts.

$$CH_2 = CH_2 + H_2 \xrightarrow{Pt / Pd / Ni} CH_3 - CH_3$$

$$CH_3 - CH = CH_2 + H_2 \xrightarrow{Pt / Pd / Ni} CH_3 - CH_2 - CH_3$$

20. (a) $NH_4OH(aq) \Leftrightarrow NH_4^+(aq) + OH^-(aq)$

$$K_b = \frac{[NH_4^+][OH^-]}{[NH_4OH]}$$

$$\left[NH_4^+\right] = \left[OH^-\right]$$

$$\left[NH_4OH\right] = 0.1M$$

$$K_b = \frac{\left[OH^-\right]^2}{\left[NH_4OH\right]}$$

$$[OH^-]^2 = 1.8 \text{ x } 10^{-5} \text{ x } 0.1$$

$$= 0.18 \text{ x } 10^{-5}$$

$$\therefore \left[OH^-\right] = 1.34 \text{ x } 10^{-3} \text{ mol/L}$$

(b) $AgCN \Leftrightarrow Ag^{+} + CN^{-}$

Let x mol/L be the solubility of AgCN

Thus $[Ag^{+}] = x$

$[CN^{-}] = x$

$K_{SP} = [Ag^{+}][CN^{-}]$ = $X^2$

$x = \sqrt{K_{SP}}$

$= \sqrt{6.0 \text{ x } 10^{-17}}$

= $7.75 \text{ x } 10^{-9}$

$Ni(OH)_2 \Leftrightarrow Ni^{2+} + 2OH^{-}$

Let y mol/L be the solubility of $Ni(OH)_2$

Thus $[Ni^{2+}] = y \;\&\; [OH^{-}] = 2y$

$K_{SP} = [Ni^{2+}][OH^{-}]^2$

= y x $(2y)^2$ = $4\,y^3$

$y = \left(\frac{K_{SP}}{4}\right)^{1/3}$

$y = \left(\frac{2x10^{-1}}{4}\right)^{1/3}$

$y = \sqrt[3]{0.5x10^{5}}$

Since solubility of $Ni(OH)_2$ is more than AgCN, $Ni(OH)_2$ is more soluble than AgCN.

**Or**

(a) Here, $HCOO^-$ is common ion. So when small amount of hydrogen ions are added, it combines with $HCOO^-$ which are in excess to form HCOOH and $H^+$ remains the same. So pH remains constant. When a small amount of hydroxide ions are added, hydroxide ions take up hydrogen ions and so dissociation of HCOOH will increase so as to maintain concentration of hydroxide ions. So pH is not affected.

(b) Here, ammonium ions are common ions. So when a small amount of hydrogen ions are added, hydrogen ion will take up hydroxide ion and dissociation of ammonium hydroxide will increase so as to maintain hydroxide constant. So, pH remains constant. When a small amount of hydroxide ions are added, ammonium ions which are in excess will combine

with hydroxide ions to form ammonium hydroxide back so as to maintain hydroxide constant. So, pH remains constant.

21. (a) Plaster of Paris: $CaSO_4.1/2H_2O$

(b) Epsom salt: $MgSO_7.H_2O$

(c) Calcium carbide: $CaC_2$

(d) Calcium cyanamide: $CaCN_2$

22. $\% \ C = \frac{12}{44} \text{x} \frac{0.792}{0.43} \text{x} 100 = 48\%$

$\%H = \frac{2}{18} \text{x} \frac{0.324}{0.45} \text{x} 100 = 8\%$

$M_1V_1 \quad = \quad 2M_2V_2$

$(NaOH) \qquad (H_2SO_4)$

$\frac{1}{10} \text{x} 77 = 2\text{x} \frac{1}{8} \text{x} V_2$

$V_2 = 30.8cm^3$

Volume of $\frac{M}{8} H_2SO_4$ consumed by $NH_3$ = 2(50 – 30.8) = 2 x 19.2 $cm^3$

19.2 $cm^3$ of $\frac{M}{8} H_2SO_4$ = 2 x 19.2 $cm^3$ of $\frac{M}{8} NH_3$

$\%N = \frac{1.4\text{x}2\text{x}V_1\text{x}M_1}{W} = \frac{1.4\text{x}2\text{x}19.2\text{x}1}{0.24\text{x}8} = 28\%$

23. (a) electrons in presence of oxygen to form water.

(b) It can be prevented by painting, oiling, greasing and galvanization.

(c) The metal gets oxidised.

24. (a)

| Species | Conjugate Acid | Conjugate Base |
|---|---|---|
| $H_2O$ | $H_3O^+$ | $OH^-$ |
| $HCO_3^-$ | $H_2CO_3$ | $CO_3^-$ |
| $HSO_4^-$ | $H_2SO_4$ | $SO_4^{2-}$ |
| $NH_3$ | $NH_4^+$ | $NH_2^-$ |

(b) For the reaction: $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

(i) $K_p = \frac{(p_{CO})(p_{H_2})^3}{(p_{CH_4})(p_{H_2O})}$

(ii) (a) On increasing pressure, the reaction equilibrium will shift in the backward direction.

(b) There is no effect of catalyst in equilibrium composition; however the equilibrium will be attained faster.

**Or**

(a) NaCN, $NaNO_2$– Solution are basic as they are salts of strong base and weak acid. (HCN and $HNO_2$ are weak acids and NaOH is strong base). $NH_4NO_3$- Its solution is acidic as it is salt of strong acid ($HNO_3$) and weak base ($NH_4OH$).

(b) KBr - This solution is neutral as it salt of strong acid HBr and strong base KOH.

25. $CH_3$ - $CH_2$ - $CH_2$ - $CH_2$ - $CH_2$ - $CH_3$ - n-hexane

$CH_3$ - CH ($CH_3$)- $CH_2$ - $CH_2$ - $CH_3$ - 2-Methylpentane

$CH_3$ - $CH_2$ - CH ($CH_3$)- $CH_2$ - $CH_3$ - 3-Methylpentane

$CH_3$ - C ($CH_3$)$_2$ - $CH_2$ - $CH_3$ - 2,2-Dimethylpentane

$CH_3$ - CH($CH_3$) - CH($CH_3$) - $CH_3$ - 2,3-Dimethylbutane

**Or**

(a) Wacker's method.

(i) Eco-friendly and safest method.

(ii) It gives 90% yield.

(b) In Wacker's method,

$$R - CH = CH_2 \xrightarrow{PdCl_2 \ / \ air \ / \ Cu_2Cl_2} R - CO - CH_3$$

$$CH_2 = CH_2 \xrightarrow{PdCl_2 \ / \ air \ / \ Cu_2Cl_2} CH_3 - CHO$$

(c) $HgSO_4$ is unsafe for the environment.

26. Step 1: The skeletal ionic equation is:

$$Cr_2O_7^{2-}(aq) + SO_3^{2-}(aq) \rightarrow Cr^{3+}(aq) + SO_4^{2-}(aq)$$

Step 2: Assign oxidation numbers for Cr and S $\overset{+6}{Cr}_2\overset{-2}{O}_7(aq) + \overset{+4}{S}\overset{-2}{O}_3(aq) \rightarrow \overset{+3}{Cr}(aq) + \overset{+6}{S}\overset{-2}{O}_4(aq)$

Step 3: Calculate the increase and decrease of oxidation number, and make them equal: $\overset{+6}{Cr}_2\overset{-2}{O}_7(aq) + 3\overset{+4}{S}\overset{-2}{O}_3(aq) \rightarrow 2\overset{+3}{Cr}(aq) + 3\overset{+6}{S}\overset{-2}{O}_4(aq)$

Step 4: As the reaction occurs in the acidic medium, and further the ionic charges are not equal on both the sides, add 8H+ on the left to make ionic charges equal

$$Cr_2O_7^{2-}(aq) + 3SO_3^{2-}(aq) + 8H^+ \rightarrow 2Cr^{3+}(aq) + 3SO_4^{2-}(aq)$$

Step 5: Finally, count the hydrogen atoms, and add appropriate number of water molecules on the right to achieve balanced redox change.

$Cr_2O_7^{2-}(aq)+3SO_3^{2-}(aq)+8H^+(aq) \rightarrow 2Cr^{3+}(aq)+3SO_4^{2-}(aq)+4H_2O$

**Or**

$Pb_3O_4$ is actually a stoichiometric mixture of 2 mol of PbO and 1 mol of $PbO_2$. In $PbO_2$, lead is present in +4 oxidation state, whereas the stable oxidation state of lead in PbO is +2. $PbO_2$ thus can act as an oxidant (oxidising agent) and, therefore, can oxidise$Cl^-$ ion of HCl into chlorine. Since PbO is a basic oxide, the reaction

$Pb_3O_4 + 8HCl \rightarrow 3PbCl_2 + Cl_2 + 4H_2O$ can be splitted into two reactions namely:

$2PbO + 4HCl \rightarrow 2\ PbCl_2 + 2H_2O$ (acid-base reaction)

+4 –1 +2 0

$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$ (redox reaction)

Since $HNO_3$ itself is an oxidising agent therefore, it is unlikely that the reaction may occur between $PbO_2$and $HNO_3$. However, the acid-base reaction occurs between PbO and $HNO_3$ as:

$2PbO + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + 2H_2O$

It is the passive nature of $PbO_2$ against $HNO_3$ that makes the reaction different from the one that follows with HCl.