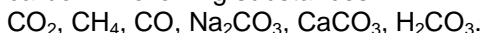


## CARBON

1. Choose the correct statements about carbon and if it is wrong correct it:

- A. It is in 5A group;
- B. There are 4 electrons in the second energy level;
- C. The charge of nuclei is + 16;
- D. It might be oxidizing and reducing agent;
- E. It has more oxidizing characteristic;
- F. It has +2 and sometimes +4 oxidation states;
- G. It is nonmetal;
- H. It has some allotropic forms;
- I. It is not found in free form in nature;
- K. Its most common inorganic compound is carbonates.

2. Find the bond type and calculate the oxidation state of carbon in following substances:



3. Amorphous carbon burns at  $300 - 500^\circ\text{C}$ , the graphite at  $580 - 600^\circ\text{C}$  and diamond at  $770 - 800^\circ\text{C}$ .

Explain these differences in allotropic form of carbon with respect to activity.

4. What is the adsorption? Explain what conditions affect the adsorbent capacity of carbon. How is it applied?

5. Explain, how we can determine existence of carbon compounds in potatoes, milk and pastries.

6. Find the relative density of  $\text{CO}$ ,  $\text{CO}_2$ , and  $\text{CH}_4$  with respect to

- A.  $\text{H}_2$    B.  $\text{O}_2$    C. air

7. Explain, why we need to ventilate the room when we use gas burners.

8. Explain the effect of carbon monoxide in human body. What precautions are necessary when we work with it?

9. Write the reaction of:

- A. carbon,
  - B. carbon monoxide
- with following substances:

oxygen, iron(III) oxide, copper(II) oxide, lead (IV) oxide. Write the balanced equation, and show the oxidant and reductant in each reaction.

10. Perform the following transformations:

- A.  $\text{C} \rightarrow \text{CO}_2 \leftrightarrow \text{CO}$ ;
- B.  $\text{C} \leftrightarrow \text{CH}_4 \rightarrow \text{CO}_2$ ;   C.  $\text{C} \rightarrow \text{CO} \rightarrow \text{CO}_2 \leftarrow \text{CH}_4$
- D.  $\text{C} \rightarrow \text{CaC}_2 \rightarrow \text{C}_2\text{H}_2 \rightarrow \text{CO}_2$
- E.  $\text{C} \rightarrow \text{Al}_4\text{C}_3 \rightarrow \text{CH}_4 \rightarrow \text{CO}_2$

11. Find the volume of carbon dioxide which is formed from burning of:

- A. 60 g of soot
- B. 60 g of coal that contains 10% impurities.

12. Find the

- A. mass of carbon
  - B. volume of carbon oxide.
- necessary to reduce iron from 320 kg iron mineral, that contain 80 % iron (III) oxide.

13. The coal contains:

82.2 % - C, 4.6 % - H, 1.0 % - S, 1.2 % - N, 1.0 % -  $\text{H}_2\text{O}$ , 6.0% - soot.

Calculate the oxygen and air volume (21% oxygen) necessary to burn 1 kg coal.

14. Find the mass of carbide that is formed from the reaction of 10 g coal (96 % carbon) with:

- A. 10 g calcium;
- B. 10.8 g aluminum;

15. Methane gas leak happened in a  $25\text{-m}^3$  room. Find the volume of gas necessary for the explosion. How explosion can be prevented?

16. Find the volume of:

- A. oxygen gas,
  - B. air
- necessary to burn  $1\text{ m}^3$  of natural gas, that contains 92% methane by volume. Find volume of obtained carbon dioxide.

17. 16.8 L carbon dioxide was obtained by the combustion of 17.5 L natural gas at STP. Find the percent of methane by volume in natural gas.

18. Find the mass of calcium hydroxide necessary to change it into carbonate salt with carbon dioxide, obtained from the burning of:

- A. 9.6 g of coal;
- B. 54 g of coal which contains 10 % impurities;
- C. 78.4 g methane;
- D. 35 L of natural gas at STP, which contains 96% methane by volume.

19. Find the mass of precipitate that is formed from the reaction of calcium hydroxide solution with carbon dioxide that is obtained by the combustion of:

- A. 8.4 g of coal that contains 95 % carbon;
- B. 5.96 L of natural gas that contains 94% methane.

20. Find the mass percentage of carbon in 20 g coal sample, when burned it produces carbon dioxide which is used for the absorption with 840 g of 20% potassium hydroxide solution by mass.

## CARBON COMPOUNDS

21. Compare the carbon dioxide with carbon monoxide with respect to:

- A. oxidation state of carbon;
- B. bond type;
- C. physiological action;
- D. physical character;
- E. chemical properties;
- F. preparation method;
- G. application area.

22. Write the formation reaction for carbon dioxide from:

- A. carbon, methane, acetylene with combustion reaction;
- B. calcium carbonate, sodium carbonate, magnesium carbonate with double displacement reaction;
- C. calcium carbonate, magnesium carbonate with decomposition reaction.

23. Write the molecular and ionic reactions which show acidic character of carbon dioxide.

24. Select the substances: KOH, HCl, H<sub>2</sub>O, O<sub>2</sub>, Ca(OH)<sub>2</sub>, BaO, NaNO<sub>3</sub>, CaCO<sub>3</sub>, Cu(OH)<sub>2</sub>, C, SiO<sub>2</sub>, that react with carbon dioxide. Write the reaction equation for each case.

25. Complete the following reactions:

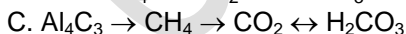
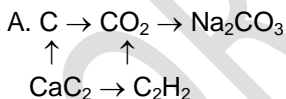
- A.  $\text{CO}_2 + \text{Ba}(\text{OH})_2 \rightarrow$
- B.  $\text{CO}_2 + \text{O}_2 \rightarrow$
- C.  $\text{CO}_2 + \text{K}_2\text{SO}_4 \rightarrow$
- D.  $\text{CO}_2 + \text{HNO}_3 \rightarrow$
- E.  $\text{CO}_2 + \text{CaO} \rightarrow$
- F.  $\text{CO}_2 + \text{Fe}(\text{OH})_2 \rightarrow$
- G.  $\text{CO}_2 + \text{C} \rightarrow$
- H.  $\text{CO}_2 + \text{H}_2\text{O} \rightarrow$
- I.  $\text{CO}_2 + \text{Li}_2\text{O} \rightarrow$
- K.  $\text{CO}_2 + \text{NaOH} \rightarrow$

26. There are three gas mixtures in vessels:

- A. O<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>;
- B. H<sub>2</sub>, CO<sub>2</sub>, H<sub>2</sub>S;
- C. CO<sub>2</sub>, HCl, Cl<sub>2</sub>.

Explain how we can identify each gas in the each mixture.

27. Perform the following transformations.



28. Sodium hydroxide can be stored in powder form if it is kept in air, but calcium hydroxide forms an insoluble solid substance. Can you explain the reason of these phenomena? Write possible reactions for the related matter.

29. Write the reactions that happen with carbon oxide with respect to combination or preparation in:

- A. laboratory
- B. industry
- C. everyday life.

30. A person can produce 1131 g carbon dioxide per 24 hours. Calculate the volume of carbon dioxide produced at STP.

31. Annual use of natural coal (average mass percentage of carbon is 80% coal) makes up about  $3.6 \times 10^9$  tons. Calculate the volume of carbon dioxide at STP discarded annually in the Earth's atmosphere due to coal burning.

32. A car consume 4350 kg oxygen and produce 3520 kg carbon dioxide, 530 kg carbon monoxide, 0.3 kg hydrocarbon and 27 kg nitrogen oxides. Find the volume of air that is necessary to obtain carbon dioxide and carbon monoxide.

33. The principal method of obtaining carbon dioxide is limestone calcinations. Calculate the volume of carbon dioxide which can be obtained from 0.5 ton of limestone with 95% calcium carbonate.

34. It was analyzed that 5 g of limestone was dissolved in hydrochloric acid and 716.8 mL carbon dioxide at STP obtained. Find the mass percentage of calcium carbonate in limestone.

35. Find the volume percentage of carbon dioxide in an air sample, if 2 g precipitate was obtained by the reaction of 1000 L air with Ca(OH)<sub>2</sub>.

36. Volume of an average human lung is 3500 cm<sup>3</sup>. Determine the volume and mass of oxygen and carbon dioxide gases that is contained in the air which is taken by human respiration for an hour if a man respire 16 times per minute.

37. It was found that 0.8 mg at 15°C and 1.8 mg at 25°C of carbon dioxide was removed during respiration of potato at night on a 1 m<sup>2</sup> of leaf area per hour. Calculate the volume of carbon dioxide is excreted in 24 hours at 15°C and 25°C.

38. Cereals from an area of one hectare with a harvest of 25 quintals (1 quintal = 100 kg) absorb 15 tons of carbon dioxide annually. As one hectare of cereal in a year;

- A. how many tons of carbon will be absorbed?
- B. How many liters of air will be cleaned from carbon dioxide?

## CARBONIC ACID AND CARBONATES

39 Choose the statements that characterize the carbonic acid and its salts:

- A. it is obtained by dissolution of carbon oxide in water;
- B. it is a strong acid;
- C. it is diprotic oxy acid.
- D. it does not dissociate in water;
- E. it forms carbonates and carbohydrates;
- F. alkali metal carbonates decompose by heating;
- G. carbohydrates are formed in excess of carbon dioxide;
- H. calcium carbonate and magnesium carbonate give temporary hardness to water;
- I. reaction with lime water is used to identify the carbon dioxide and the carbonates.

40. List down the carbonic acid salts that have the most important uses. Write their formulas and indicate their application areas.

41. Write down the reactions to obtain by different methods of:

- A. sodium carbonate;
- B. sodium hydrogen carbonate;
- C. calcium carbonate;
- D. calcium hydrogen carbonate.

42. Write the reaction equations that describe the chemical properties of following substances by using bond structure:

- A. sodium carbonate;
- B. sodium hydrogen carbonate.

43. Explain why insoluble alkaline earth metal carbonates (Ca, Sr, and Ba) were dissolved in saturated carbon dioxide solution.

44. Choose from these substances: KOH, HNO<sub>3</sub>, H<sub>2</sub>O, Ca(OH)<sub>2</sub>, NaNO<sub>3</sub>, CaCl<sub>2</sub>, CO<sub>2</sub> that react with:

- A. K<sub>2</sub>CO<sub>3</sub>(aq);
- B. KHCO<sub>3</sub>(aq);
- C. CaCO<sub>3</sub>;
- D. Ca(HCO<sub>3</sub>)<sub>2</sub> (aq).

Write down the reactions ionic and molecular form.

45. Complete the following reactions if possible:

- I
- A. CO<sub>2</sub> + KOH →
- B. K<sub>2</sub>CO<sub>3</sub> + NaCl →
- C. CaCO<sub>3</sub> + HCl →
- D. NaHCO<sub>3</sub> + HNO<sub>3</sub> →
- E. NaHCO<sub>3</sub> + KCl →
- F. Ca(HCO<sub>3</sub>)<sub>2</sub> + (temp.) →
- G. Na<sub>2</sub>CO<sub>3</sub> + (temp.) →
- H. (NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub> + Ca(NO<sub>3</sub>)<sub>2</sub> →

II

- A. CO<sub>2</sub> + H<sub>2</sub>O →
- B. CO<sub>2</sub> + FeO →
- C. CaCO<sub>3</sub> + CO<sub>2</sub> + H<sub>2</sub>O →
- D. CaCO<sub>3</sub> + (temp.) →

- E. CaCO<sub>3</sub> + Na<sub>2</sub>SO<sub>4</sub> →
- F. KHCO<sub>3</sub> + H<sub>2</sub>SO<sub>4</sub> →
- G. K<sub>2</sub>CO<sub>3</sub> + CO<sub>2</sub> →
- H. KHCO<sub>3</sub> + (temp.) →

III

- A. CO<sub>2</sub> + Li<sub>2</sub>O →
- B. CO<sub>2</sub> + SiO<sub>2</sub> →
- C. Na<sub>2</sub>CO<sub>3</sub> + CO<sub>2</sub> + H<sub>2</sub>O →
- D. Mg(HCO<sub>3</sub>)<sub>2</sub> + (temp.) →
- E. Na<sub>2</sub>CO<sub>3</sub> + H<sub>2</sub>SO<sub>4</sub> →
- F. Na<sub>2</sub>CO<sub>3</sub> + KNO<sub>3</sub> →
- G. Na<sub>2</sub>CO<sub>3</sub> + BaCl<sub>2</sub> →
- H. Ca(HCO<sub>3</sub>)<sub>2</sub> + Na<sub>2</sub>CO<sub>3</sub> →

IV

- A. CO<sub>2</sub> + Ca(OH)<sub>2</sub> →
- B. Na<sub>2</sub>CO<sub>3</sub> + HNO<sub>3</sub> →
- C. BaCO<sub>3</sub> + (temp.) →
- D. K<sub>2</sub>CO<sub>3</sub> + (temp.) →
- E. Li<sub>2</sub>CO<sub>3</sub> + Mg(NO<sub>3</sub>)<sub>2</sub> →
- F. Na<sub>2</sub>CO<sub>3</sub> + Ba(OH)<sub>2</sub> →
- G. Ca(HCO<sub>3</sub>)<sub>2</sub> + HCl →
- H. Mg(HCO<sub>3</sub>)<sub>2</sub> + CO<sub>2</sub> →

46. Match formulas and technical names of carbonic acid salts:

Chalk	MgCO <sub>3</sub>
washing soda	NaHCO <sub>3</sub>
dolomite	Na <sub>2</sub> CO <sub>3</sub> · 10H <sub>2</sub> O
marble	CaCO <sub>3</sub>
magnesite	Na <sub>2</sub> CO <sub>3</sub>
baking powder	K <sub>2</sub> CO <sub>3</sub>
potash	MgCO <sub>3</sub> · CaCO <sub>3</sub>
soda ash	

47. Write down two molecular equations for each ionic equation:

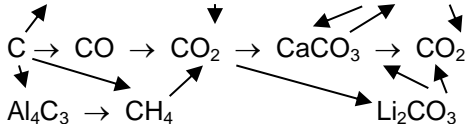
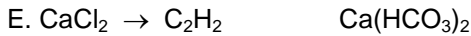
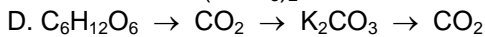
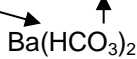
- A. CO<sub>2</sub> + 2OH<sup>-</sup> → CO<sub>3</sub><sup>2-</sup> + H<sub>2</sub>O
- B. 2H<sup>+</sup> + CO<sub>3</sub><sup>2-</sup> → H<sub>2</sub>O + CO<sub>2</sub>↑
- C. CaCO<sub>3</sub> + 2H<sup>+</sup> → Ca<sup>2+</sup> + CO<sub>2</sub>↑ + H<sub>2</sub>O
- D. Mg<sup>2+</sup> + CO<sub>3</sub><sup>2-</sup> → MgCO<sub>3</sub>

48. Balance the following redox reactions by oxidation number method:

- A. P<sub>2</sub>O<sub>5</sub> + C + (temp.) → P + CO
- B. Fe<sub>2</sub>O<sub>3</sub> + C + (temp.) → ? + ?
- C. CH<sub>4</sub> + O<sub>2</sub> → ? + ?
- D. Mg + CO<sub>2</sub> + (temp.) → MgO + C
- E. C + HNO<sub>3</sub> (conc.) + (temp.) → CO<sub>2</sub>↑ + NO↑ + H<sub>2</sub>O
- F. Fe<sub>2</sub>O<sub>3</sub> + CO + (temp.) → ? + ?
- G. C + H<sub>2</sub>SO<sub>4</sub> (conc.) + (temp.) → CO<sub>2</sub>↑ + SO<sub>2</sub>↑ + H<sub>2</sub>O

49. Perform the following transformations.

- A.  $\text{CaCl}_2 \rightarrow \text{CaCO}_3 \rightarrow \text{Ca}(\text{HCO}_3)_2 \rightarrow \text{CaCO}_3$   
 B.  $\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 \rightarrow \text{CaCO}_3 \rightarrow \text{CaCl}_2$   
 C.  $\text{Ba}(\text{NO}_3)_2 \rightarrow \text{BaCO}_3 \rightarrow \text{BaCO}_3 \rightarrow \text{CO}_2 \rightarrow \text{NaHCO}_3$



50. Describe the experiment that demonstrates the used air contains mainly carbon dioxide than in atmospheric one. Write the reaction equations.

51. Propose an identification method for each of the solutions of substance:

- A.  $\text{Na}_2\text{CO}_3$ ,  $\text{Na}_2\text{SO}_4$ ,  $\text{NaCl}$ ;  
 B.  $\text{Na}_2\text{S}$ ,  $\text{Na}_2\text{CO}_3$ ,  $\text{H}_2\text{SO}_4$ ;  
 C.  $\text{NH}_4\text{Cl}$ ,  $\text{HCl}$ ,  $\text{K}_2\text{CO}_3$ ;  
 D.  $\text{Ca}(\text{HCO}_3)_2$ ,  $\text{MgCl}_2$ ,  $\text{Ba}(\text{NO}_3)_2$ ;  
 E.  $\text{NaHCO}_3$ ,  $\text{AgNO}_3$ ,  $\text{K}_2\text{SO}_4$ .

Write down the reactions in ionic and molecular form. Describe the observations.

52. Find the mass of crystalline soda  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$  that is necessary for preparing 100 kg of 0.8 % sodium carbonate solution by mass.

53. Find the volume of carbon dioxide that is obtained by the reaction of sulfuric acid with:

- A. sodium hydrogen carbonate;  
 B. soda;  
 C. crystallized soda  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ , if the mass of salts 1 kg.

In which one sulfuric acid is the least amount? Which salt is more advantageous to fill the fire extinguishers?

54. Find the volume of carbon dioxide that is released from 12 kg of 8% sodium hydrogen carbonate by mass.

55. Calculate the carbon dioxide obtained from 8.4 g of sodium hydrogen carbonate by

- A. heating;  
 B. treating with hydrochloric acid.

56. Find the mass of 10% hydrochloric acid solution by mass that is necessary for the reaction with:

- A. 10.6 g sodium carbonate;  
 B. 15 g chalk with 10% impurities by mass;  
 C. 42 g of 5% sodium hydrogen carbonate solution by mass;  
 D. 14.3 g crystallized soda,  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$ .

57. The excess of sodium carbonate reacts with 50 g calcium chloride solution. The mass of precipitate after filtration and drying was equal to 2.5 g. Find the mass percentage of calcium chloride in initial solution.

58. Find the mass of precipitates obtained by the reaction of:

- A. 37 g calcium hydroxide solution with 2.24 L carbon dioxide at STP;  
 B. 32.5 g of 10% calcium nitrate solution by mass with 39.6 g of 10% sodium carbonate solution by mass.

59. Usually, in the preparation of pastry 5 g of alimentary soda is dissolved in 30 g of 6% vinegar solution by mass. Find the volume of carbon dioxide obtained.

60. Find the yield of carbon dioxide by mass, if 60 g of carbon dioxide were obtained by the reaction of 150 g calcium carbonate with excess hydrochloric acid.

61. A 27.4 g mixture of sodium carbonate and sodium hydrogen carbonate was heated until the gas release stops. 23 g of dry residue is obtained. Find the mass of each salt in the mixture.

62. 1-L, at STP, of carbon monoxide and carbon dioxide mixture is being passed through water and 2 g blurry solution is obtained. Calculate the volume of each gas in the mixture.

63. To analyze the hardness of water, 200 ml water sample is neutralized with 200 g of 0.365% hydrochloric acid solution. Calculate the temporary hardness of water by using  $\text{HCO}_3^-$  ion content in:

- A. mol in 1-L water;  
 B. mg in 1-L water.