



# CHEMISTRY

## BOOKS - CENGAGE CHEMISTRY

### EMPIRICAL AND MOLECULAR FORMULA

#### Worked Examples

1. Calculate the percentage composition of magnesium sulphate . [Give : Atomic masses

Mg = 24, S = 32, O = 16].



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2. Find the percentage of water of hydration in blue vitriol ( $CuSO_4 \cdot 5H_2O$ ) . [Given : Atomic masses Cu = 63.6, S = 32 , H = 1 and O = 16].



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3. Find the percentage of carbon dioxide in calcium carbonate . [Give : Atomic masses Ca =

40 ,C=12 , and O = 16 ]

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4. Molecular formula of acetic acid is  $CH_3COOH$ . Calculate its percentage composition . [Given : Atomic masses C=12, H = 1 and O = 16].

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5. An organic compound with molecular mass 180 contains 40% carbon, 6.7% hydrogen and 53.3% oxygen. Find its empirical formula .



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6. An oxide of nitrogen contains 25.94% nitrogen . What is the empirical formula ?



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1. The molecular mass of a compound with empirical formula  $CH_2O$  is 60. What is its molecular formula?



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2. An inorganic salt on analysis gave the following percentage composition: Ca = 40, C = 12, O = 48. Find the empirical formula of the compound.



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3. A salt sample has the following percentage composition: Fe = 37, S = 21, O = 42. Calculate the empirical formula of the compound.



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4. An organic substance containing carbon, hydrogen and oxygen has the following percentage composition: C = 40.7, H = 5, and O = 54.3. 0.59 g of vapour of the compound

occupies  $112\text{cm}^3$  at STP. Find the molecular formula of the compound.



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5. Find the empirical formula of the compound containing Na = 29.1%, O = 30.38%, and S = 40.51%.



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6. An organic compound has been found to possess the empirical formula  $CH_2O$  and molecular mass 90. Give its molecular formula.



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7. A gaseous compound of carbon and nitrogen containing 53.8% by mass of nitrogen was found to have molecular mass 51.6. What is the molecular formula of the compound? (Atomic masses of N = 14, C = 12).





8. The empirical formula of a compound containing 50% of an element A (atomic mass = 10) and 50% of another element B (atomic mass = 20) is

A. AB

B.  $AB_2$

C.  $A_2B$

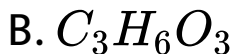
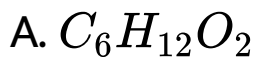
D.  $A_2B_3$

**Answer: C**



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9. Which of the following is the empirical formula of acetic acid ( $CH_3COOH$ )?

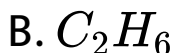


**Answer: C**



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**10.** An organic compound contains 75% by mass of carbon and the rest is hydrogen. Its empirical formula is

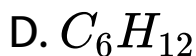


**Answer: A**



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**11.** Molecular mass of an organic compound containing carbon and hydrogen is 100. Its molecular formula is



**Answer: B**



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**12.** The percentage of water of crystallisation in washing soda  $Na_2CO_3 \cdot 10H_2O$  [Na = 23, C = 12, O = 16, H = 1] is

A. 0.6292

B. 0.5

C. 0.75

D. 0.9

**Answer: A**



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**13.** A formula with the lowest whole number ratio of elements in a compound is called

- A. covalent compound
- B. chemical formula
- C. molecular formula
- D. empirical formula

**Answer: D**



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**14.** A chemical formula that shows the actual number of atoms present in one molecule of a compound is called

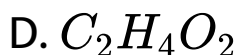
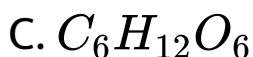
- A. molecular formula
- B. empirical formula
- C. ionic formula
- D. covalent formula

**Answer: A**



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**15.** The empirical formula of a substance is  $CH_2O$ . Its molar mass is 180. What is the molecular formula.



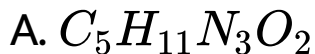


**Answer: C**



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**16.** A compound contains 59.0%C, 7.15%H, 26.2%O and 7.65%N and has a molar mass of 183 g/mole. What is its molecular formula.



**Answer: C**



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**17.** A compound contains 6 g of carbon and 1 g of hydrogen. The percent composition of the compound is.

A. 14% H, 86% C

B. 86% H, 14% C

C. 17% H, 83% C

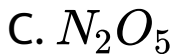
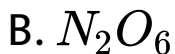
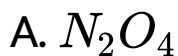
D. 83% H, 17% C

**Answer: A**



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**18.** Which of the following could be empirical formulas?



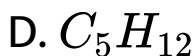
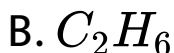
D. all

**Answer: C**



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**19.** If the empirical formula of a compound is  $\text{CH}$ , What is a possible molecular formula for the compound?



**Answer: C**



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**20.** If the empirical formula of a compound is  $P_2O_3$ , what could be a possible molar mass of the compound .

A. 55 g

B. 165 g

C. 275g

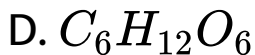
D. none

**Answer: D**



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21. A compound is 40% C, 53.3% oxygen and 6.66% hydrogen. What is its empirical formula.

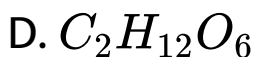
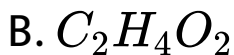
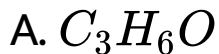


**Answer: C**



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22. If empirical formula is  $CH_2O$  and molar mass is 60 g/mol. What is the molecular formula.

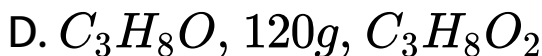
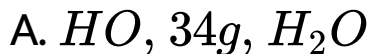


**Answer: B**



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**23.** Which of the following sets of empirical formula, molar mass and molecular formula is correct.



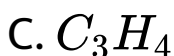
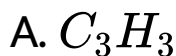


**Answer: C**



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24. The combustion of one mole of a compound yields 3.0 moles of  $CO_2$ , and 4.0 moles of  $H_2O$ . The empirical formula of this compound is.



D.  $C_3H_8$

**Answer: D**



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**25.** A sample of an oxide of an unknown metal  $M_1$  contains 46 g of M and 16 g of O. If the formula of the metal oxide is  $M_2O$ , what is the atomic weight of the metal M?

A. 23

B. 39

C. 46

D. 63.5

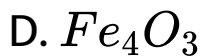
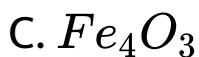
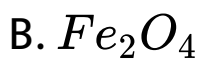
**Answer: A**



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**26.** The compound formed when 1.95 moles of oxygen combine with 1.46 moles of iron is

A.  $FeO$



**Answer: B**

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27.  $x$  is an element that consists of diatomic molecules ( $x_2$ ) Calculate the weight of an atom of  $x$  if  $1.23 \times 10^{23}$  molecules of  $x_2$  weight 32.7 g.

A.  $2.66 \times 10^{-22}$  g

B.  $1.36 \times 10^{-22}$  g

C.  $1.23 \times 10^{-23}$  g

D.  $7.52 \times 10^{-21}$  g

**Answer: B**



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**Consolidated Exercise**

1. Match the following:



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## Challenging Exercise

1. Find the empirical and molecular formula of an organic acid containing C = 40%, H = 6.67%, and having molecular mass = 60.



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2. Calculate the empirical formula of a compound whose molecular formula is  $C_8H_6O_4$  and empirical formula mass is 83. (C = 12, H = 1, O = 16)



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3. 15.3 g of element X (atomic mass = 27) combines with 13.6 g of oxygen to form an oxide.

(a) Express this in moles.

(b) What is the simplest formula for the oxide?



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4. An inorganic salt contains 15.89% calcium, 2.4% hydrogen, 24.6% phosphorus and 57.11% oxygen. Its molecular mass is 252.2. Deduce its molecular formula.



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5. Emerald contains 5.06% Be, 10.05% Al, 31.48% Si and 53.4% oxygen. Find its empirical formula.



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6. A metal sulphide (MS) which is responsible for the discolouration of paints contains 13.3% sulphur by mass. Identify the metal likely to be present in the sulphide?



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7. 0.8 g sample of gaseous hydrocarbon occupying 1.12 L at STP, when completely burnt in air produced 2.2 g of carbon dioxide and 1.8 g of water. Calculate.

(a) the mass of the compound

(b) the molecular formula of the compound,  
and

(c) the volume of oxygen at STP required for combustion.



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8. An organic compound contains C, H, and O. 0.30 g of this compound on combustion gives 0.44 g of carbon dioxide and 0.18 g of water. If the mass of one mole of the compound is 60, show that the molecular formula is  $C_2H_4O_2$



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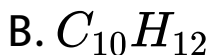
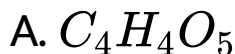
9. 0.5 g of an oxide of carbon was produced by oxidation of 0.135 g of carbon. If the molecular mass of the oxide is 44, find its molecular formula.

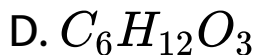


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## Olympiad And Ntse Level Exercises

1. A compound has an empirical formula  $C_2H_4O$ . An independent analysis gave a value of 132.16 for its molecular mass. What is the correct molecular formula .





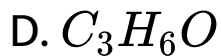
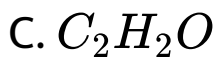
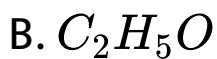
**Answer: D**



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2. An organic compound has an empirical formula  $CH_2O$ , its vapour density is 45. The molecular formula of the compounds is





**Answer: D**



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3. When 32.25 gm ethyl chloride dehydrohalogenated, if gives 50%. Alkene, what is the mass of product. (atomic mass of chlorine = 35.5)

A. 14 gm

B. 28 gm

C. 64.5 gm

D. 7 gm

**Answer: D**



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**4.** An organic compound made of C, H and N contains 20% nitrogen. Its molecular weight is.

A. 70

B. 140

C. 100

D. 65

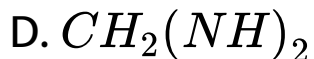
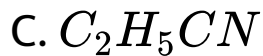
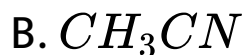
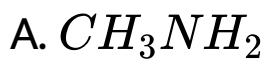
**Answer: A**



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5. An organic compound contains C = 38.8%, H = 16% and N = 45.2%. Empirical formula of the compound is





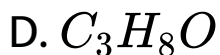
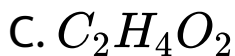
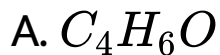
**Answer: A**



**View Text Solution**

6. 0.30 g of an organic compound containing C, H and Oxygen on combustion yields 0.44 g  $CO_2$ , and 0.18 g of  $H_2O$ . If one mole of

compound weighs 60, then molecular formula of the compound is

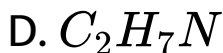
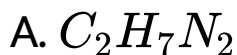


**Answer: C**



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7. An organic compound containing C, H and N gave following analysis : C = 40%, H = 13.33% and N = 46.67%. Its empirical formula would be .



**Answer: C**



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8. 0.24 g of an organic compound gave 0.22 g  $CO_2$ , on complete combustion. If it contains 1.66 % hydrogen, then the percentage of C and O will be .

A. 12.5 and 36.6

B. 25 and 75

C. 25 and 36.6

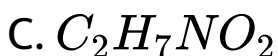
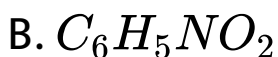
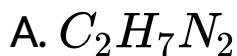
D. 25 and 80

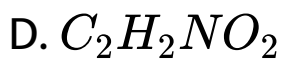
**Answer: B**



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9. 0.246 g of an organic compound containing 58.53% carbon and 4.06% hydrogen gave 22.4 mL of nitrogen at STP. What is the empirical formula of the compound?



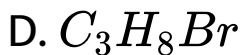
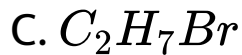
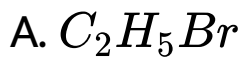


**Answer: B**



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**10.** 0.246 g of an organic compound gave 0.198 g of carbon dioxide and 0.1014 g of water on complete combustion. 0.37 g of the compound gave 0.638 g of silver bromide. What is the molecular formula of the compound if its vapour density is 54.4?



**Answer: B**



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