

# Chemical Compounds Practice Problems

KEY

1) What is the molecular, empirical, structural, and condensed structural formula for each of the following molecules: \_\_\_\_\_

	<u>MOL.</u>	<u>EMP.</u>	<u>STRUC.</u>	<u>COND. STRUC.</u>
A) methane	CH <sub>4</sub>	CH <sub>4</sub>	CH <sub>4</sub>	CH <sub>4</sub>
B) ethane	C <sub>2</sub> H <sub>6</sub>	CH <sub>3</sub>	$\begin{array}{c} \text{H} \quad \text{H} \\   \quad   \\ \text{H}-\text{C}-\text{C}-\text{H} \\   \quad   \\ \text{H} \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>3</sub>
C) ethyne	C <sub>2</sub> H <sub>2</sub>	CH	H-C≡C-H	CH≡CH
D) propene	C <sub>3</sub> H <sub>6</sub>	CH <sub>2</sub>	$\begin{array}{c} \text{H} \quad \quad \text{H} \\ \diagdown \quad \diagup \\ \text{C}=\text{C} \\ \diagup \quad \diagdown \quad \diagup \quad \diagdown \\ \text{H} \quad \quad \text{H} \quad \quad \text{H} \end{array}$	CH <sub>2</sub> =CHCH <sub>3</sub>
E) methanol	CH <sub>4</sub> O	CH <sub>4</sub> O	$\begin{array}{c} \text{H} \\   \\ \text{H}-\text{C}-\text{O}-\text{H} \\   \\ \text{H} \end{array}$	CH <sub>3</sub> OH
F) ethanol	C <sub>2</sub> H <sub>6</sub> O	C <sub>2</sub> H <sub>6</sub> O	$\begin{array}{c} \text{H} \quad \quad \text{H} \\   \quad \quad   \\ \text{H}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad \quad   \\ \text{H} \quad \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> OH
G) butanal	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	C <sub>2</sub> H <sub>4</sub> O	$\begin{array}{c} \text{H} \quad \quad \text{H} \quad \quad \text{H} \quad \quad \text{O} \\   \quad \quad   \quad \quad   \quad \quad // \\ \text{H}-\text{C}-\text{C}-\text{C}-\text{C}-\text{O}-\text{H} \\   \quad \quad   \quad \quad   \\ \text{H} \quad \quad \text{H} \quad \quad \text{H} \end{array}$	CH <sub>3</sub> CH <sub>2</sub> CH <sub>2</sub> CHO

2) Which of the following must be an empirical formula? \_\_\_\_\_

- A) C<sub>10</sub>H<sub>14</sub>N<sub>2</sub> (nicotine)      B) C<sub>9</sub>H<sub>8</sub>O<sub>4</sub> (aspirin)   
 C) C<sub>6</sub>H<sub>8</sub>O<sub>6</sub> (vitamin c)      D) C<sub>8</sub>H<sub>10</sub>N<sub>4</sub>O<sub>2</sub> (caffeine)

3) What is the empirical formula for fumaric acid, C<sub>4</sub>H<sub>4</sub>O<sub>4</sub>? \_\_\_\_\_

CHO

4) A 2.000 g sample of water contains 11.19% H by mass and 88.81% O by mass. What % of H by mass will be found in a 6.375 g sample of water? \_\_\_\_\_

- A) 5.60%      B) 88.81%      C) 33.33%      D) 33.57%      E) 11.19%

## LAW OF DEFINITE PROPORTIONS

5) Determine percent H by mass in NH<sub>4</sub>Cl. \_\_\_\_\_

$$\begin{array}{l}
 4\text{H} \rightarrow 4(1.008) \\
 \text{NH}_4\text{Cl} \rightarrow 53.4912
 \end{array}
 \times 100 = 7.538\% \text{ H BY MASS}$$



13) White phosphorus (P<sub>4</sub>), spontaneously ignites in oxygen. If 6.500 g of white phosphorus reacts with oxygen to form 11.54 g of a phosphorus oxide, what is the empirical formula of this oxide? 13) \_\_\_\_\_

- A) P<sub>2</sub>O<sub>3</sub>      B) P<sub>2</sub>O<sub>6</sub>      C) PO<sub>3</sub>      D) P<sub>4</sub>O<sub>6</sub>

P:  $6.500\text{g} \times \frac{\text{mol P}}{30.9738\text{g}} = 0.2099\text{ mol P}$       PO<sub>1.5</sub> → P<sub>2</sub>O<sub>3</sub>

O:  $11.54\text{g} - 6.500\text{g} = 5.04\text{g} \times \frac{\text{mol O}}{16.00\text{g}} = 0.315\text{ mol O}$

14) The empirical formula of a substance is found to be CH<sub>2</sub>O. If its molecular weight is found to be approximately 93 g/mol, what is the exact molecular weight of this substance? 14) \_\_\_\_\_

CH<sub>2</sub>O EMP. FORM. MASS = 30.027 g/mol (ABOUT 1/3 OF 93)

ALSO, MOLECULAR FORMULA IS C<sub>3</sub>H<sub>6</sub>O<sub>3</sub>

$3(30.027\text{g/mol}) = 90.081\text{g/mol}$

15) Styrene has a percent composition by mass of 92.26% carbon and 7.74% hydrogen. If 1.41 × 10<sup>22</sup> styrene molecules weigh 2.44 grams, what is the molecular formula of styrene? 15) \_\_\_\_\_

- A) CH      B) C<sub>2</sub>H<sub>2</sub>      C) C<sub>6</sub>H<sub>6</sub>      D) C<sub>8</sub>H<sub>8</sub>      E) C<sub>4</sub>H<sub>4</sub> SO: C<sub>8</sub>H<sub>8</sub> (MOLEC. FORM.)

IN 100g:  $92.26\text{g} \times \frac{\text{mol C}}{12.011\text{g}} = 7.681\text{ mol C}$

$7.74\text{g} \times \frac{\text{mol H}}{1.008\text{g}} = 7.68\text{ mol H}$

SAME, SO: CH      13.019 g/mol

MOLAR MASS:

$\frac{2.44\text{g}}{1.41 \times 10^{22}\text{ MOLEC.}} \times \frac{6.022 \times 10^{23}\text{ MOLEC.}}{\text{mol}} = 104\text{g/mol}$

↑  $\frac{104}{13.019}$

16) A sample of pure copper weighing 3.178 gram is burned in the presence of oxygen until it is all converted to a black oxide. The resultant black powder weighs 3.978 g. What is the formula of the oxide? 16) \_\_\_\_\_

- A) CuO<sub>2</sub>      B) Cu<sub>2</sub>O      C) CuO<sub>3</sub>      D) CuO      E) Cu<sub>2</sub>O<sub>3</sub>

MASS CU =  $3.178\text{g} \times \frac{\text{mol Cu}}{63.546\text{g}} = 0.05001\text{ mol Cu}$

MASS O =  $3.978\text{g} - 3.178\text{g} = 0.800\text{g} \times \frac{\text{mol O}}{16.00\text{g}} = 0.0500\text{ mol O}$

SAME, SO: CuO

↑  
EMPIRICAL & MOLECULAR FORM.

17) How many atoms of potassium are in 1.00 × 10<sup>2</sup> g of potassium dichromate? 17) \_\_\_\_\_

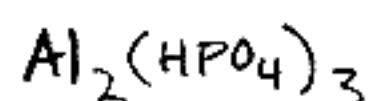
$1.00 \times 10^2\text{g} \times \frac{\text{mol K}_2\text{Cr}_2\text{O}_7}{294.184\text{g}} \times \frac{2\text{mol K}}{\text{mol K}_2\text{Cr}_2\text{O}_7} \times \frac{6.022 \times 10^{23}\text{ ATOMS}}{\text{mol K}} = 4.09 \times 10^{23}\text{ ATOMS}$

18) How many micrograms of chromium are found in 65.456 mg of chromium(III)perchlorate hexahydrate? (Cr(ClO<sub>4</sub>)<sub>3</sub> · 6H<sub>2</sub>O) 18) \_\_\_\_\_

$65.456\text{mg} \times \frac{10^{-3}\text{g}}{\text{mg}} \times \frac{\text{mol Cr}(\text{ClO}_4)_3 \cdot 6\text{H}_2\text{O}}{458.439\text{g}} \times \frac{1\text{mol Cr}}{1\text{mol Cr}(\text{ClO}_4)_3 \cdot 6\text{H}_2\text{O}} \times \frac{51.9961\text{g}}{\text{mol Cr}} \times \frac{\mu\text{g}}{10^{-6}\text{g}} = 7424.0\text{ }\mu\text{g}$

19) How many hydrogen atoms are there in 12.4 g of aluminum hydrogen phosphate?

19) \_\_\_\_\_



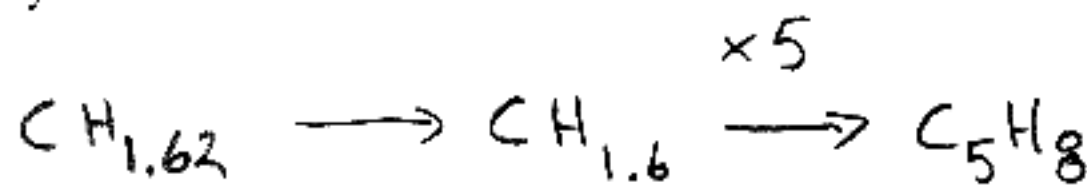
$$12.4 \text{ g} \times \frac{\text{mol Al}_2(\text{HPO}_4)_3}{341.901 \text{ g}} \times \frac{3 \text{ mol H}}{\text{mol Al}_2(\text{HPO}_4)_3} \times \frac{6.022 \times 10^{23} \text{ ATOMS}}{\text{mol H}} = 6.55 \times 10^{22} \text{ ATOMS}$$

20) Complete combustion of a 0.500 g sample of a pure hydrocarbon yielded 0.973 g CO<sub>2</sub> and

20) \_\_\_\_\_

0.319 g  $\rightarrow$  0.323 g H<sub>2</sub>O. What is the empirical formula of this hydrocarbon?

$$0.973 \text{ g} \times \frac{\text{mol CO}_2}{44.01 \text{ g}} \times \frac{\text{mol C}}{\text{mol CO}_2} = 0.0221 \text{ mol C}$$



$$0.323 \text{ g} \times \frac{\text{mol H}_2\text{O}}{18.016 \text{ g}} \times \frac{2 \text{ mol H}}{\text{mol H}_2\text{O}} = 0.0359 \text{ mol H}$$

↑ SORRY      ↑ SUPPOSED TO BE...

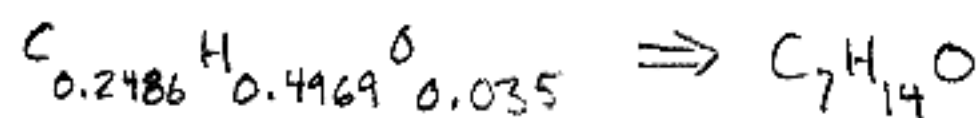
4.055 g  $\rightarrow$  21) A 4.05 g sample of a compound containing only C, H, and O was burned completely. The only combustion products were 10.942 g CO<sub>2</sub> and 4.476 g H<sub>2</sub>O. What is the empirical formula of the compound?

21) \_\_\_\_\_

$$\text{C: } 10.942 \text{ g} \times \frac{\text{mol CO}_2}{44.01 \text{ g}} \times \frac{\text{mol C}}{\text{mol CO}_2} = 0.2486 \text{ mol C} \quad (2.986 \text{ g})$$

$$\text{O: } 4.05 \text{ g} - 2.986 \text{ g} - 0.500 \text{ g} = 0.56 \text{ g} \times \frac{\text{mol O}}{16.00 \text{ g}} = 0.035 \text{ mol O}$$

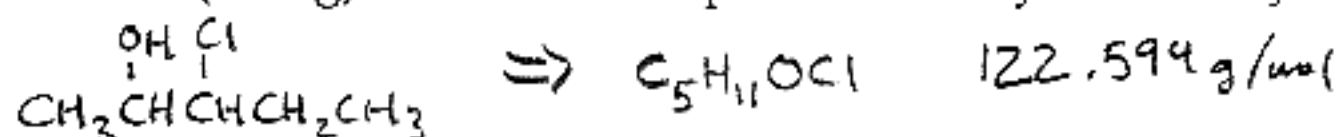
$$\text{H: } 4.476 \text{ g} \times \frac{\text{mol H}_2\text{O}}{18.016 \text{ g}} \times \frac{2 \text{ mol H}}{\text{mol H}_2\text{O}} = 0.4969 \text{ mol H} \quad (0.5009 \text{ g})$$



↑ SHOULD BE 0.0355 ☹️

22) What mass (in mg) of 3-chloro-2-pentanol will yield exactly 1 mmol of this compound?

22) \_\_\_\_\_

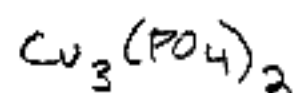


$$1 \text{ mmol} \times \frac{10^{-3} \text{ mol}}{\text{mmol}} \times \frac{122.594 \text{ g}}{\text{mol C}_5\text{H}_{11}\text{OCl}} \times \frac{\text{mg}}{10^{-3} \text{ g}} = 122.594 \text{ mg}$$

↑ EXACT

23) How many micrograms of cupric phosphate will provide 354.6 picomoles of copper?

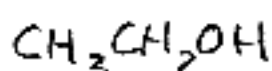
23) \_\_\_\_\_



$$354.6 \text{ pmol Cu} \times \frac{10^{-12} \text{ mol Cu}}{\text{pmol Cu}} \times \frac{1 \text{ mol Cu}_3(\text{PO}_4)_2}{3 \text{ mol Cu}} \times \frac{380.581 \text{ g}}{\text{mol Cu}_3(\text{PO}_4)_2} \times \frac{\mu\text{g}}{10^{-6} \text{ g}} = 4.498 \times 10^{-2} \mu\text{g}$$

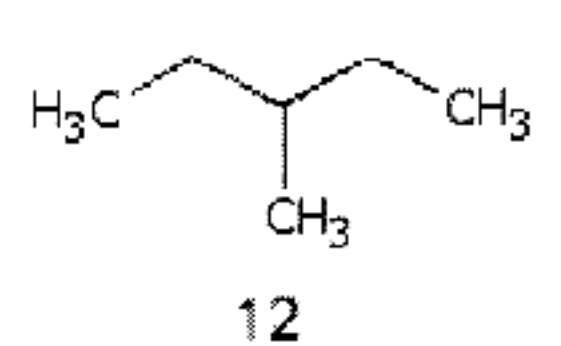
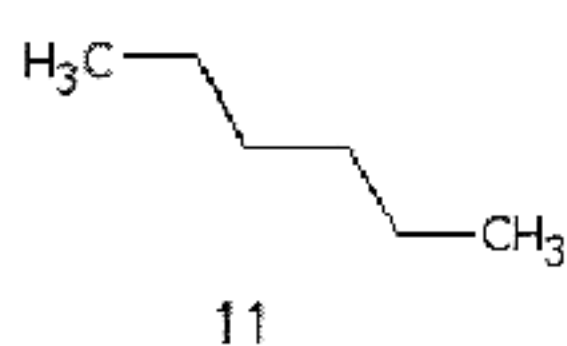
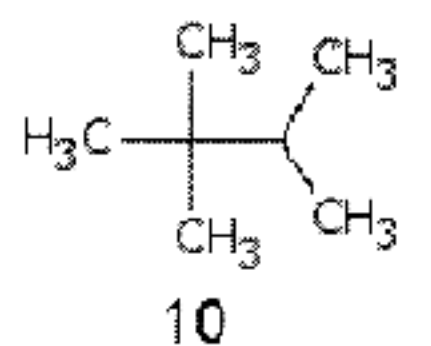
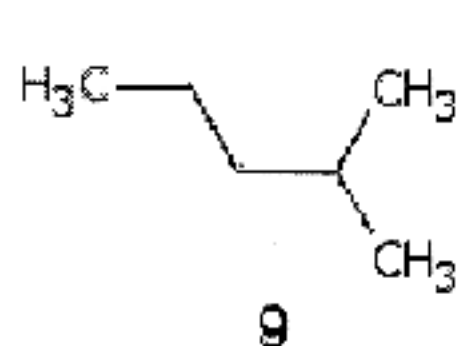
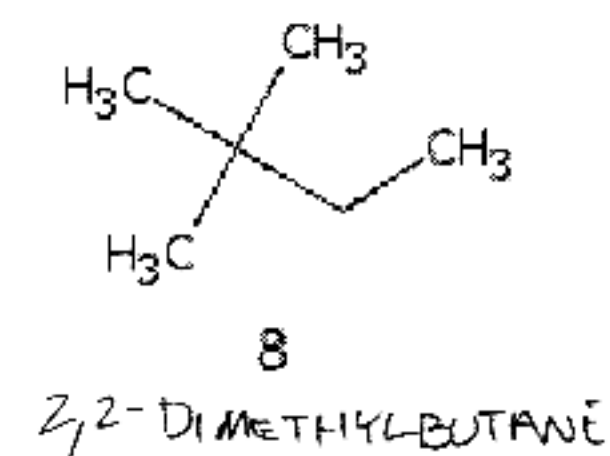
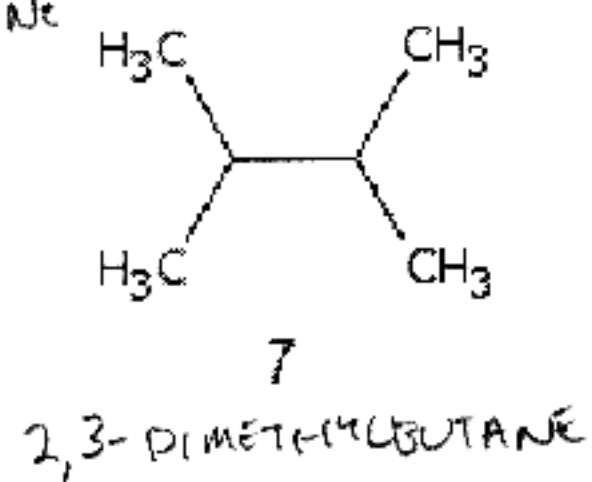
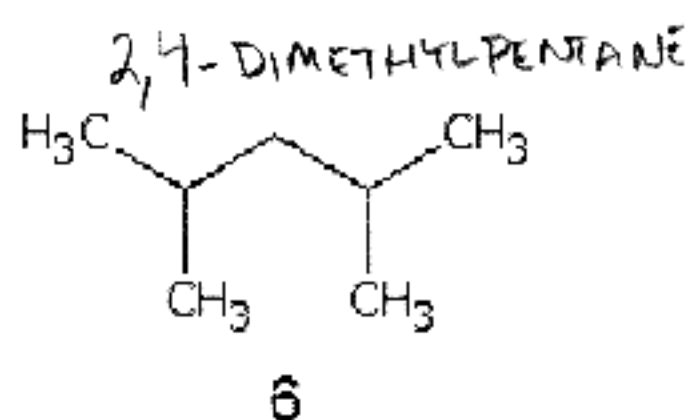
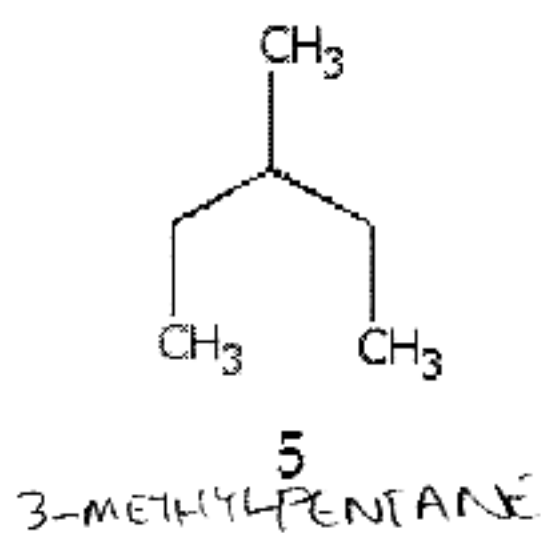
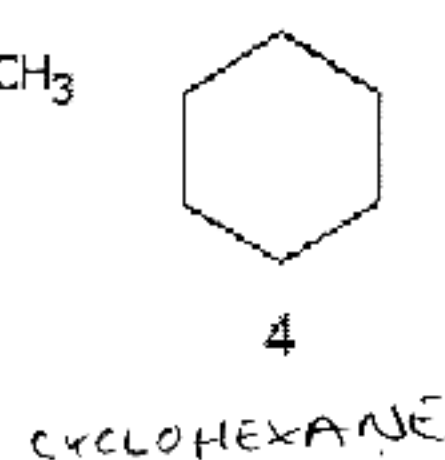
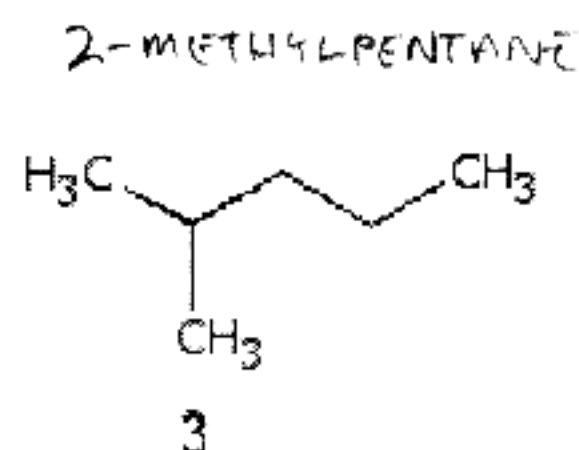
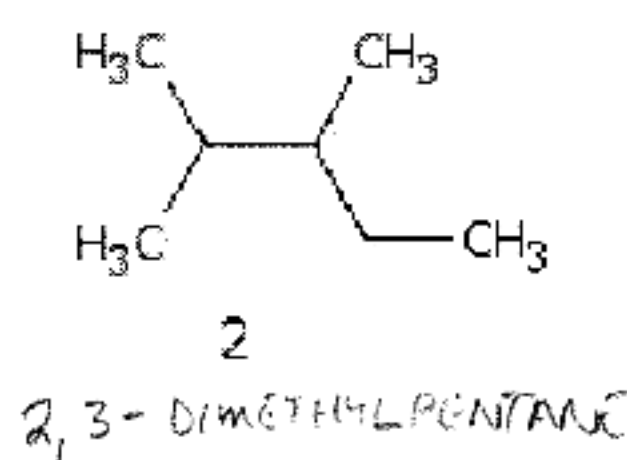
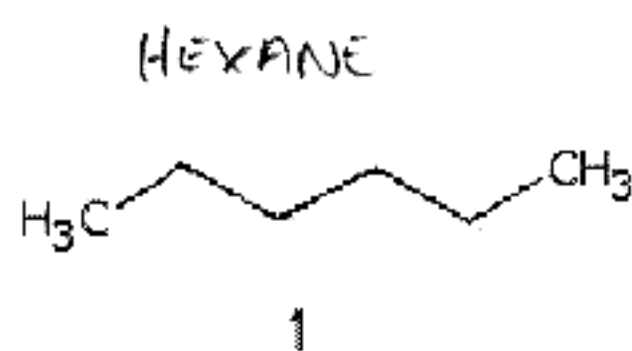
24) How many mL of ethanol are needed to provide  $1.00 \times 10^2$  millimoles of oxygen? The density of ethanol is 0.789 g/mL

24) \_\_\_\_\_



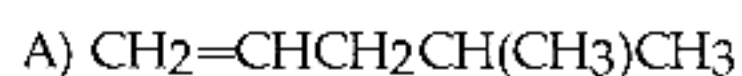
$$1.00 \times 10^2 \text{ mmol O} \times \frac{10^{-3} \text{ mol O}}{\text{mmol O}} \times \frac{1 \text{ mol CH}_3\text{CH}_2\text{OH}}{1 \text{ mol O}} \times \frac{46.069 \text{ g}}{\text{mol CH}_3\text{CH}_2\text{OH}} \times \frac{\text{mL}}{0.789 \text{ g}} = 5.84 \text{ mL}$$

25) Name each of the following hydrocarbons.

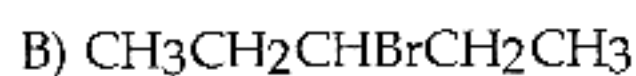


26) What is the correct name for the following organic structures.

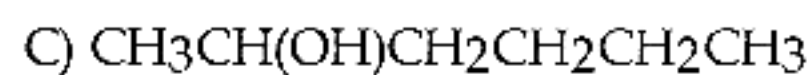
26) \_\_\_\_\_



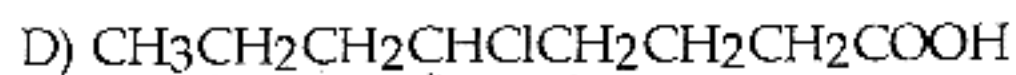
4-METHYL-1-PENTENE



3-BROMOPENTANE



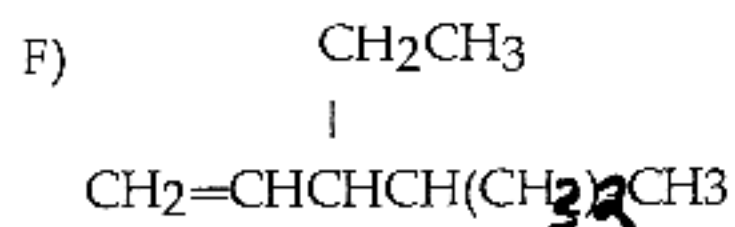
2-HEXANOL



5-CHLORO-OCTANOIC ACID



3,4,4-TRIMETHYL-1-PENTENE



3-ETHYL-4,4-DIMETHYL-1-PENTENE