

(MC score _____ FR score _____ Total raw _____ total % _____)

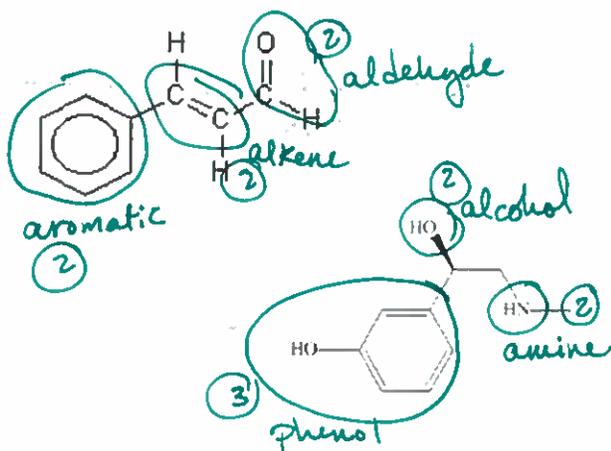
1. a. [10 pts] Write a balanced equation, with appropriate phase labels, for the reaction between aqueous solutions of CN^- and HCl . *← since HCl is strong, → is required (not ⇌)*

*(reminder--did you include phase labels?)*

b. [10 pts] Write a balanced equation, with appropriate phase labels, for the combustion of hexene.

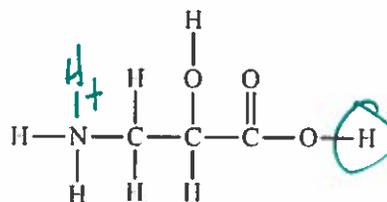
*(reminder--did you include phase labels?)*

2. [6 pts] Circle and clearly label all functional groups in the structures below.



4. The structure below is an amphiprotic molecule.

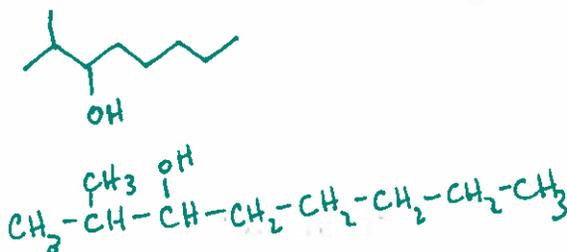
a. [5 pts] Identify and circle all acidic hydrogen atoms in the structure (that is, any hydrogen atoms that can be donated to a base.)



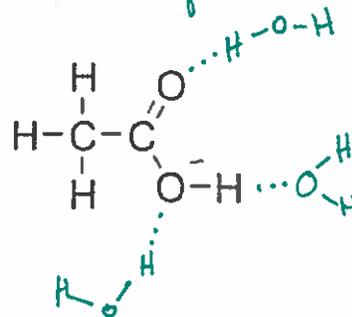
b. [2 pts] When the molecule functions as a base, where does H^+ bond? Show by adding H^+ to the structure in the appropriate place.

3. [7 pts] Draw the structure of 2-methyl-3-octanol.

8c alcohol on carbon #3



5. [5 pts] Sketch a hydrogen bonding interaction between the molecule below and a molecule of water. *Only 1 interaction required*



Multiple Choice [3 points each]. Choose the **best** answer and record it on your Scantron card. (Questions marked ** come directly from the assigned homework in the text or from worksheets in class.)

1 A sample contains 0.033 mol of aluminum ions. What is this value in **mmol** (millimoles)? (Chapter 1 review)

$$0.033 \text{ mol} \times \frac{1000 \text{ mmol}}{\text{mol}} = 33 \text{ mmol}$$

- A 0.000033 mmol B 0.033 mmol C 0.33 mmol
D 33 mmol E 33,000 mmol

2 A sample contains 0.42 mol of aluminum ions. How many grams of aluminum is this? (Chapter 2 review)

- A 0.016 g B 0.088 g **C 11 g** D 27 g E 64 g

$$0.42 \text{ mol} \times \frac{26.98 \text{ g}}{\text{mol}} = 11 \text{ g}$$

3 Imagine that you are writing a chemical reaction equation that includes **elemental nitrogen** (under standard laboratory conditions). Which of these is the best representation of the formula of **elemental nitrogen**?

- A N B N⁻ C N³⁻ **D N₂** E N₂³⁻

-gen elements are diatomic

4 What is the most appropriate **phase label** for elemental nitrogen?

- A (s) B (l) **C (g)** D (aq)

most of the diatomics are gases at room temp

5** Which of the following represents the **self-ionization of water**?

- A $2\text{H}_2\text{O}(\text{l}) \rightleftharpoons \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq})$** B $\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}(\text{g}) + \text{O}(\text{g})$
 C $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$ D $2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$
 E $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g})$

6 Which reaction in #5 represents a **combustion reaction**? **E**

→ rxn with O₂

7 Which reaction in #5 involves only breaking bonds, without forming any new bonds? **B**

8 Which of these is the best representation of the formula of **calcium phosphate**?

- A CaP B Ca₂P₃ C Ca₃P₂ **D Ca₃(PO₄)₂** E Ca₂(PO₄)₃

Ca²⁺ PO₄³⁻

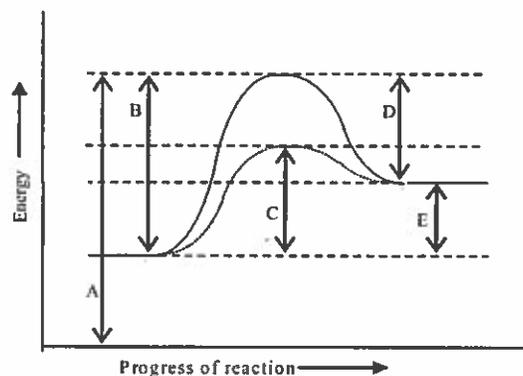
9 If some calcium phosphate is placed in water, which of these is the most appropriate phase label for the calcium phosphate in the resulting mixture? **calcium phosphate is insoluble**

- A (s)** B (l) C (g) D (aq)

10 In the diagram at right, which arrow corresponds to the activation energy for the **uncatalyzed** reaction? (Use the letters marking the arrows.) *From reactants to the top of the higher curve - B*

11 Which arrow indicates the value of ΔH for the reaction?

difference between reactants & products - E



12 Which of the following is an **endothermic** process?

- A forming a covalent bond *exo*
- C combusting methane *exo*
- E more than one of these

- B condensing water vapor *exo (evaporating is endo)*
- D melting sodium chloride

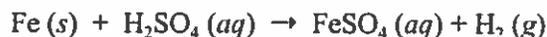
13 Balance the following reaction:



When this reaction is balanced with lowest-whole-number coefficients, what is the coefficient of Al?

- A 0 B 1 C 2 D 3 **E 4**

14 Iron reacts with sulfuric acid (H_2SO_4) according to the following equation:



Which change will **decrease the activation energy** of the reaction?

- A Increasing the concentration of H_2SO_4
- B Increasing the temperature
- C Grinding the iron metal into powder
- D Adding a catalyst**

15 A chemist puts 2.00 g of N_2O_4 into a container. Some of the N_2O_4 breaks down into NO_2 , forming an equilibrium mixture.



If the chemist then puts 2.00 g of NO_2 into an identical container, which of the following statements will be true?

- A All of the NO_2 will turn into N_2O_4 .
- B Some of the NO_2 will turn into N_2O_4 .**
- C None of the NO_2 will turn into N_2O_4 .

16 If you breathe rapidly and shallowly, expelling CO_2 from your lungs more rapidly than usual, what effect will this have on your blood?

- A Your blood will become more acidic.
- B Your blood will become more basic.**
- C Your blood will become amphiprotic.
- D Your blood will become hypertonic.

- E Your blood will become isotonic.

17 What is the pH of a solution with $[H^+] = 0.044 \text{ M}$?

A 2.2×10^{-13}

B 0.044

C 1.36

D 2.49

E 11.51

$$pH = -\log[H^+] = -\log(0.044)$$

18 What is the $[OH^-]$ in a solution with $[H^+] = 0.044 \text{ M}$?

A 2.2×10^{-13}

B 0.044

C 1.35

D 2.49

E 11.51

$$[OH^-] = \frac{K_w}{[H^+]} = \frac{1.0 \times 10^{-14}}{0.044}$$

19 Which species is the conjugate acid of HPO_4^{2-} ? *add H^+*

A H^+ B H_3PO_4 C $H_2PO_4^-$ D PO_4^{3-} E OH^-

20 Which of these species is diprotic? *2 H at beginning of formula*

A H^+ B H_3PO_4 C $H_2PO_4^-$ D PO_4^{3-} E OH^-

21 Which of the species is amphiprotic? *can act as both acid and base*

A H^+ B H_3PO_4 C $H_2PO_4^-$ D PO_4^{3-} E OH^-

base: anion
acid: starts w/ H

22 In a tertiary alcohol, how many H atoms are attached to the carbon atom with the alcohol group?

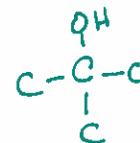
A 0

B 1

C 2

D 3

E it's variable



23 What product is formed in the hydration of 2-butene? (Hint: write out the reaction, using structures!)

A 1-butene

B butane

C 2-butanol

D a mixture of 2-butanol and 3-butanol



24 Give the correct, systematic name for this molecule: $CH_3CH_2CH_2CH_2CH_2OH$

A pentane hydroxide

B 1-pentanol

C 5-pentanol

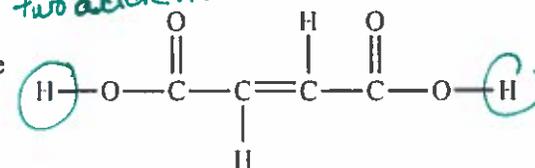
D 5-pentanal

E pentanoic acid

25 The structure shown at right is fumaric acid, a molecule found in many fruits. Which molecular formula most accurately represents the acidic nature of this molecule?

A $C_4H_4O_4$ B $HC_4H_3O_4$ C $H_2C_4H_2O_4$ D $H_3C_4HO_4$ E $H_4C_4O_4$

two acidic H:



two acidic H

Turn your Scantron card over and start with #26. The remaining questions earn 1 point each.

Decide whether each combination below, when dissolved in aqueous solution, will form a buffer solution or not.

	B Buffer	C No buffer conjugates? weak?	buffer?
26 $\text{H}_2\text{S} + \text{HS}^-$		✓	yes - B
27 $\text{S}^{2-} + \text{HS}^-$		✓	yes - B
28 $\text{Cl}^- + \text{HCl}$		X	NO - C
29 $\text{HF} + \text{NaF}$ $\text{Na}^+ + \text{F}^-$		✓	yes - B

For the next few problems, assign each solution as acidic, basic or neutral as appropriate.

A acidic

B basic

C neutral

A 30 A solution with $[\text{H}^+] = 3.2 \times 10^{-3} \text{ M} > 1.0 \times 10^{-7}$ so acidic

A 31** A solution with $\text{pH} = 1 < 7$ so acidic

B 32** A solution of sodium hydroxide strong base ($\text{NaOH} \rightarrow \text{Na}^+ + \text{OH}^-$)

B 33 A solution of methylamine, CH_3NH_2 weak base (amine)

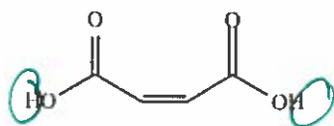
A 34 A solution of $\text{H}_2\text{C}_2\text{O}_4$ acid (starts w/ H)

N 35 A solution with $[\text{OH}^-] = 1.0 \times 10^{-7} \text{ M} =$ the conc in water

N 36 A solution of $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ alcohol - neutral

B 37 A solution with $[\text{H}^+] = 2 \times 10^{-8} \text{ M} < 1 \times 10^{-7}$ basic

A 38



acidic H atoms

 $\text{H}-\text{O}-\overset{\text{O}}{\parallel}{\text{C}}$, carboxylic acid groups

B 39

