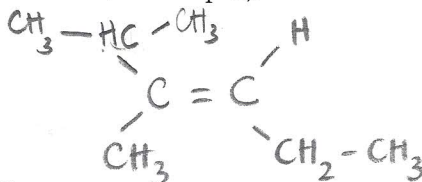


Read questions carefully to understand what is being asked. If you have doubt, do ask your instructor. Use the reverse side of answer paper as scratch. Use attached periodic table and important constants chart. On your scantron, please start from same number as the number of the multiple choice question. (Total pts. = 58 + (20 x 3 =) 60 = 118)

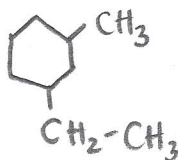
**SHORT ANSWER: Show all your calculations using appropriate set up and units.**

1) Draw skeletal or condensed structures of (2x5 = 10pts.):

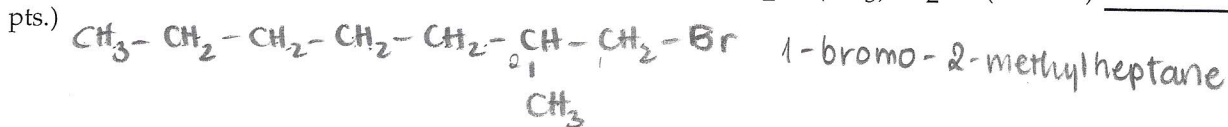
(a) E-2,3-dimethyl-3-hexene



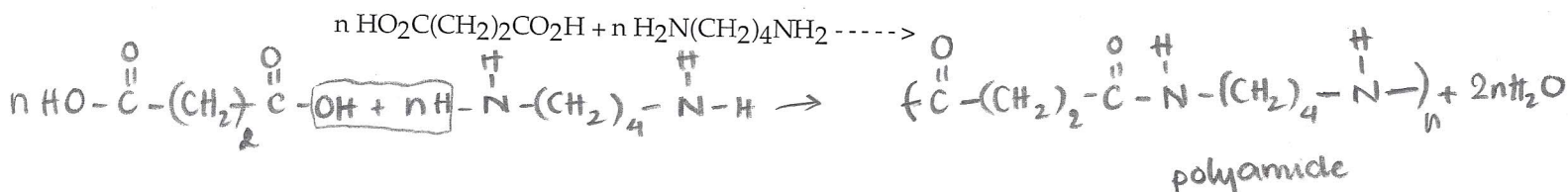
(b) 1-Ethyl-3-methylcyclohexane



2) What is the IUPAC name of the compound  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{Br}$ ? (4 pts.)

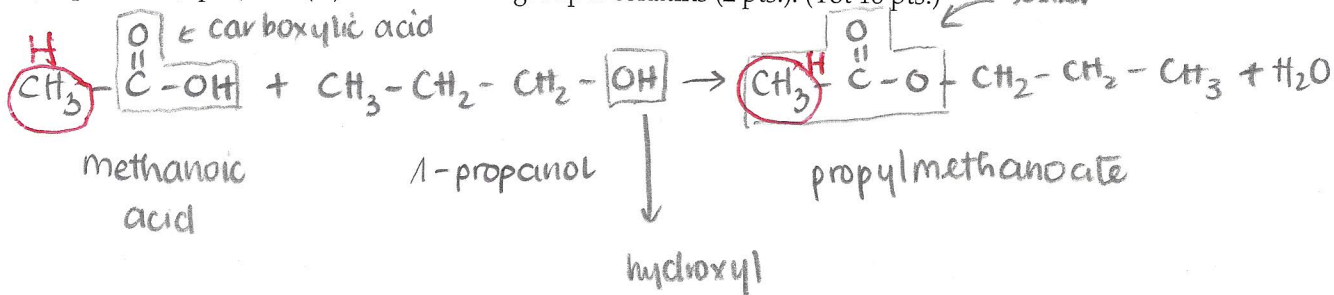


3) (A) Write the formula of the two (2) products of the following reaction (4 pts.):



(B) Name what kind of reaction is this (2 pts): polymerization  
condensation

4) Draw the condensed structures of the (A) reactants (2x3 = 6 pts.) and (B) product(s) (2x3=6 pts.) of the reaction between methanoic acid (Note the name and the number of C atoms in there) and 1-propanol. Also (C) name the major product (2 pts.) and (D) the functional group it contains (2 pts.). (Tot 16 pts.)



5) Fill up the following blank: London Dispersion Forces tend to increase in strength with increasing molecular weight (3 points). 5) \_\_\_\_\_

6) Fill up the following blank: The direct conversion of a solid to a gas is called sublimation (3 points). 6) \_\_\_\_\_

7) An 8.0 g ice cube is placed into 230 g water. Calculate the temperature change in the water upon complete melting of the ice. Given, the heat of fusion of ice is 6.02 kJ/mole and specific heat of water = 4.18 J/(g. °C) (Assume density of ice = density of water and  $q = m\Delta T$ . Be sure to include proper sign for the temperature change: positive for increase and negative for decrease) (8 pts.). 7) \_\_\_\_\_

$$8.0 \text{ g ice} \times \frac{1 \text{ mole}}{18 \text{ g}} = 0.44 \text{ mole ice}$$

$$q = n \cdot \Delta H_{\text{fus}} = 0.44 \text{ mole} \times \frac{6.02 \text{ kJ}}{\text{mole}} = 2.67 \text{ kJ}$$

$$q = m \cdot C \cdot \Delta T \Rightarrow \Delta T = \frac{q}{m \cdot C} = \frac{-q}{m \cdot C} = \frac{-2.675 \text{ kJ}}{230 \text{ g} \times 4.18 \frac{\text{J}}{\text{g} \cdot \text{C}} \times \frac{1 \text{ kJ}}{1000 \text{ J}}} = -2.78 \text{ }^\circ\text{C}$$

8) 2.0 g Salicylic Acid ( $\text{C}_7\text{H}_6\text{O}_3$ ; MW=138.2 g/mole) was heated with 5.0 mL acetic anhydride ( $\text{C}_4\text{H}_6\text{O}_3$ ; density=1.08 g/mL; MW= 102.1 g/mole) to get 2.15 g of Aspirin ( $\text{C}_9\text{H}_8\text{O}_4$ ; MW=180.0 g/mole). 8) \_\_\_\_\_

(a) Find out the limiting reagent (6 pts.) (s.a = salicylic acid, a.a = acetic anhydride, a.s = aspirin)

$$2.0 \text{ g}_{\text{s.a}} \times \frac{1 \text{ mole}_{\text{s.a}}}{138.2 \text{ g}_{\text{s.a}}} = 0.0145 \text{ mole}_{\text{s.a}}$$

$$5.0 \text{ mL}_{\text{a.a}} \times 1.08 \frac{\text{g}}{\text{mL}} \times \frac{1 \text{ mole}_{\text{a.a}}}{102.1 \text{ g}_{\text{a.a}}} = 0.0530 \text{ mole}_{\text{a.a}}$$

Since the ratio of salicylic acid and acetic anhydride is 1:1, salicylic acid is the limiting reagent.

(b) Calculate the theoretical yield of aspirin (4 pts.)

Theoretical yield of aspirin:

$$0.0145 \text{ mole}_{\text{s.a}} \times \frac{1 \text{ mole}_{\text{a.s}}}{1 \text{ mole}_{\text{s.a}}} \times \frac{180.0 \text{ g}}{1 \text{ mole}_{\text{a.s}}} = 2.61 \text{ g}_{\text{a.s}}$$

(b) Calculate the percentage yield of aspirin (2 pts.)

$$\% \text{ yield} = \left| \frac{2.15 \text{ g}_{\text{a.s}}}{2.61 \text{ g}_{\text{a.s}}} \right| \times 100\% = 82.38\%$$

**MULTIPLE CHOICE.** On scantron start from the same bubble number as the multiple choice question number. Select the one alternative that best completes the statement or answers the question (3 pts each).

- 9) The molecular geometry of each carbon atom in an alkane is \_\_\_\_\_. 9) B  
A) octahedral  
B) tetrahedral  
C) trigonal planar  
D) square planar  
E) trigonal pyramidal
- 10) Pentane has \_\_\_\_\_ structural isomers. 10) A  
A) 3                      B) 0                      C) 1                      D) 2                      E) 4  
*CH<sub>3</sub>-CH=CH<sub>2</sub>*
- 11) \_\_\_\_\_ could be the formula of an alkene. 11) B  
A) C<sub>3</sub>H<sub>8</sub>                      B) C<sub>3</sub>H<sub>6</sub> ✓                      C) C<sub>6</sub>H<sub>6</sub>                      D) CH<sub>8</sub>                      E) C<sub>17</sub>H<sub>36</sub>
- 12) The general formula of a carboxylic acid is \_\_\_\_\_. 12) A  
A) R-CO-OH  
B) R-CO-OR'  
C) R-O-R'  
D) R-H  
E) R-CO-R'
- 13) When NaCl dissolves in water, aqueous Na<sup>+</sup> and Cl<sup>-</sup> ions result. The force of attraction that exists between Na<sup>+</sup> and H<sub>2</sub>O is called a(n) \_\_\_\_\_ interaction. 13) E  
A) hydrogen bonding  
B) dipole- dipole  
C) London dispersion force  
D) ion- ion  
E) ion- dipole
- 14) The intermolecular force(s) responsible for the fact that CH<sub>4</sub> has the lowest boiling point in the set CH<sub>4</sub>, SiH<sub>4</sub>, GeH<sub>4</sub>, SnH<sub>4</sub> is/are \_\_\_\_\_. 14) E  
A) mainly hydrogen bonding but also dipole- dipole interactions  
B) hydrogen bonding  
C) mainly London- dispersion forces but also dipole- dipole interactions  
D) dipole- dipole interactions  
E) London dispersion forces
- 15) How high a liquid will rise up a narrow tube as a result of capillary action depends on \_\_\_\_\_. 15) D  
A) only the magnitude of adhesive forces between the liquid and the tube  
B) only the magnitude of cohesive forces in the liquid  
C) gravity alone  
D) the magnitudes of cohesive forces in the liquid and adhesive forces between the liquid and the tube, and gravity  
E) the viscosity of the liquid

16) Large intermolecular forces in a substance are manifested by \_\_\_\_\_.

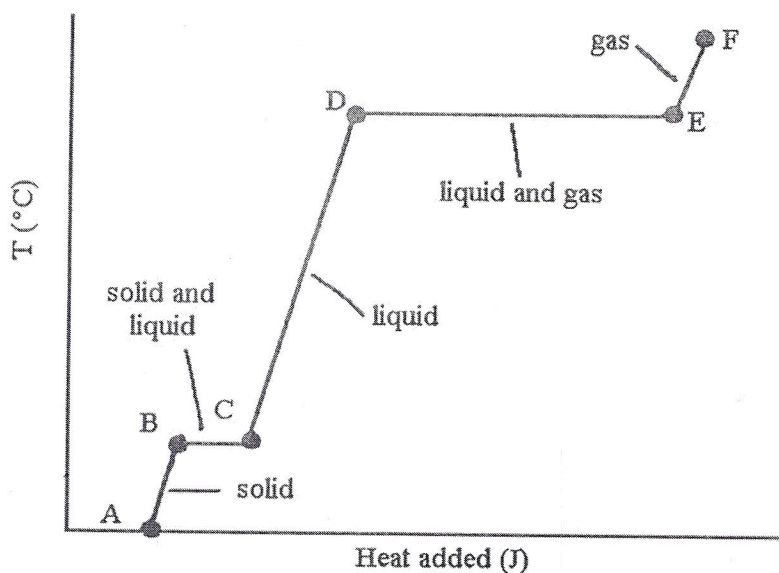
- A) high boiling point
- B) high critical temperatures and pressures
- C) low vapor pressure
- D) high heats of fusion and vaporization
- E) all of the above

16) E

17) Of the following, \_\_\_\_\_ is an exothermic process.

- A) boiling
- B) melting
- C) subliming
- D) freezing
- E) All of the above are exothermic.

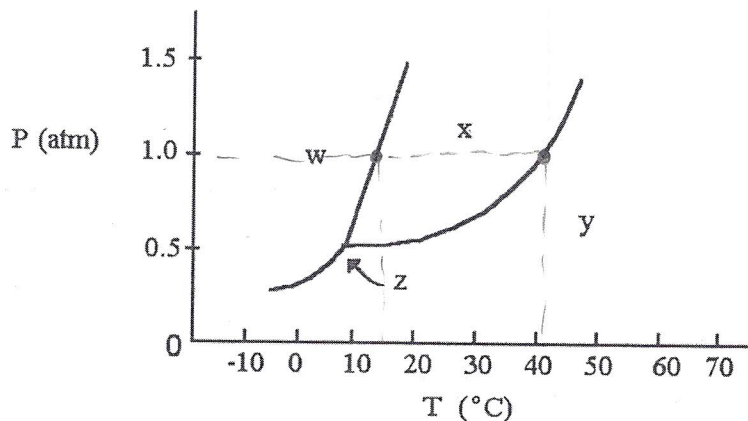
17) D



18) The heating curve shown was generated by measuring the heat flow and temperature for a solid as it was heated. The slope of the \_\_\_\_\_ segment corresponds to the heat capacity of the liquid of the substance.

- A) AB
- B) BC
- C) CD
- D) DE
- E) EF

18) C



19) The normal boiling point of the substance with the phase diagram shown above is \_\_\_\_\_ °C.

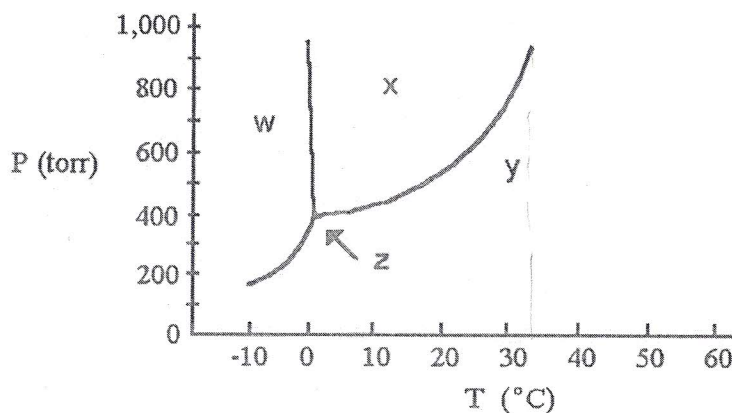
- A) 10
- B) 20
- C) 30
- D) 40
- E) 50

19) D



- 20) On a phase diagram, the critical temperature is \_\_\_\_\_.
- A) the temperature below which a gas cannot be liquefied
  - B) the temperature above which a gas cannot be liquefied
  - C) the temperature required to melt a solid
  - D) the temperature required to cause sublimation of a solid
  - E) the temperature at which all three states are in equilibrium

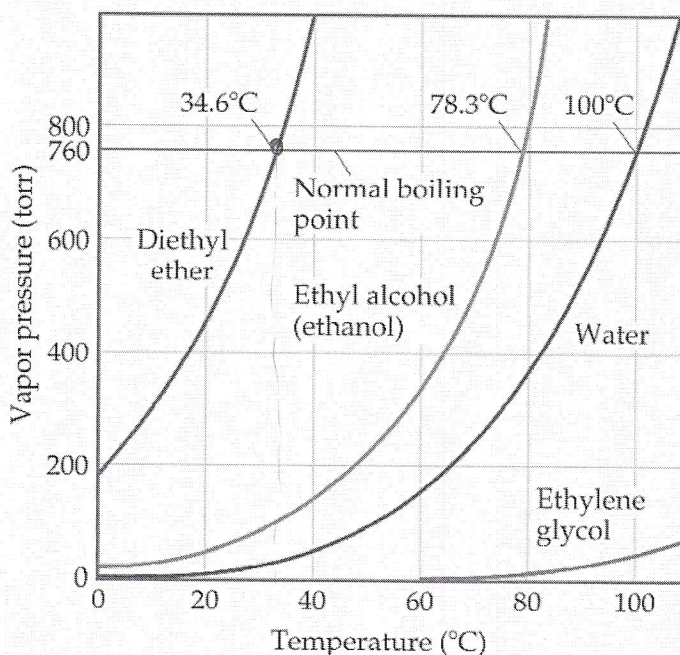
20) B



- 21) The phase diagram of a substance is shown above. The area labeled \_\_\_\_\_ indicates the gas phase for the substance.

21) C

- A) w
- B) x
- C) y
- D) z
- E) y and z



- 22) Based on the figure above, the boiling point of diethyl ether under an external pressure of 1.32 atm is \_\_\_\_\_ °C.

22) A

- A) 40
- B) 10
- C) 0
- D) 20
- E) 30

TRUE/FALSE. In your scantron, fill up bubble A for true and bubble B for false answers (3 pts./question).

- 23) A carbon with three or more attached groups will be chiral.

23) B

- 24) The overall polarity of organic molecules is high. 24) B
- 25) Cyclobutane is more reactive than butane. 25) ~~B~~ A
- 26) The principal source of the difference in the normal boiling points of ICl (97°C; molecular mass 162 amu) and Br<sub>2</sub> (59°C; molecular mass 160 amu) is both dipole-dipole interactions and London dispersion forces. 26) ~~A~~ B
- 27) The boiling points of normal hydrocarbons are higher than those of branched hydrocarbons of similar molecular weight because the London-dispersion forces between normal hydrocarbons are greater than those between branched hydrocarbons. 27) A
- 28) Under ordinary conditions, a substance will sublime rather than melt if its triple point occurs at a pressure above atmospheric pressure. 28) A

