

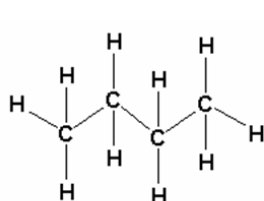
NAME Key

Raw Score _____

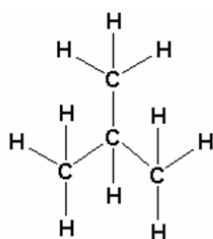
T-Score _____

- You will have **70 minutes** to complete the exam.
- There is **one best answer** to each question and all questions are worth the same number of points.
- **Sign your name on the answer sheet** above the General Purpose logo on the front.
- Write the form of the test you are taking next to your name.
- Print and fill in your name (**last name-space-first name**) on the back of your answer sheet.
- Be sure to mark the correct answers on your exam booklet so you can compare your answers to the answer key.
- An answer key will be posted immediately following the test at the course website as well as outside DO-236.

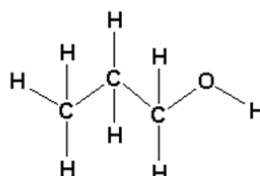
1. Which of the molecules shown below will have the lowest vapor pressure?



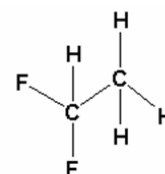
i



ii



iii



iv

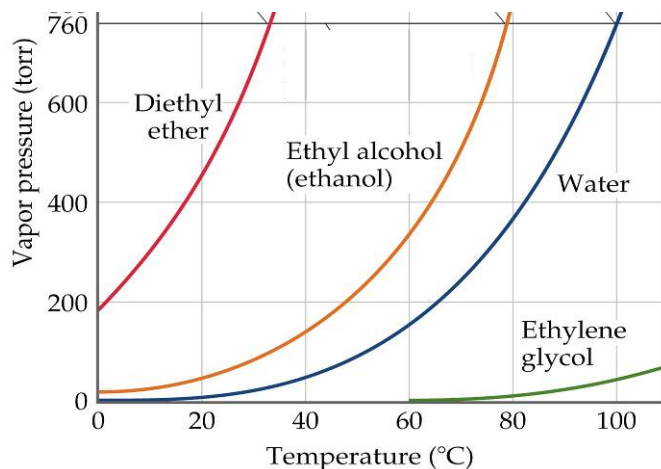
a. i

b. ii

c. iii

d. iv

2. Based on the graph given below, what is the approximate boiling point of ethanol at 0.45 atm pressure?



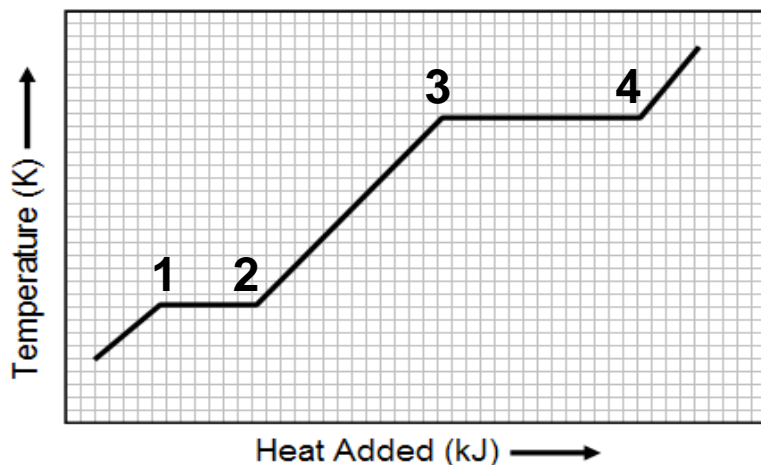
a. 80 °C

b. 20 °C

c. 40 °C

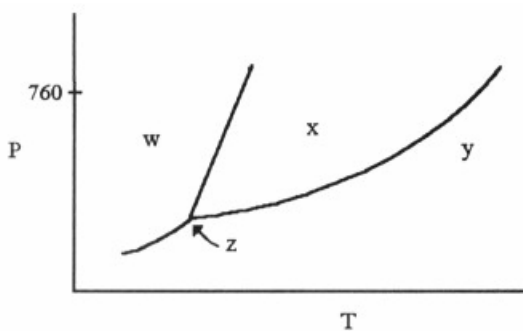
d. 60 °C

3. Shown below is the heating curve for a substance. Which of the following statements is not correct?



- a) The segment 1 – 2 corresponds to ΔH_{fusion}
 b) The segment 2 – 3 corresponds to the specific heat of the substance as a liquid.
 c) The segment 3 – 4 corresponds to $\Delta H_{\text{sublimation}}$
 d) All of the statements are correct.
4. What amount of heat is given off when 10 g of water, initially at 10 °C, are converted to ice at 0 °C? [The specific heat of water is 4.18 J/g·K and $\Delta H_{\text{fus}} = 6.01 \text{ kJ/mol}$]
- a. $6.3 \times 10^3 \text{ J}$ b. $1.2 \times 10^3 \text{ J}$ c. $3.8 \times 10^3 \text{ J}$ d. 421 J

The phase diagram shown below is used to answer questions 5 and 6.




5. The point marked by the arrow “z” in the phase diagram is the

- a. triple point b. critical point
c. melting point d. boiling point

6. The region “x” corresponds to the:

- a. Gas phase b. Critical point c. Liquid phase d. Solid phase

7.  Cesium metal crystallizes with a body-centered-cubic unit cell. The volume of the unit cell is $3.97 \times 10^{-22} \text{ cm}^3$. What is the atomic radius of cesium in pm?

- a. 265 pm b. 735 pm c. 1060 pm d. 2038 pm

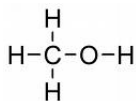
8. Which one of the following crystal structures is the least efficient for packing atoms?

- a. simple cubic
b. body-centered cubic
c. face-centered cubic
d. all of these are equally efficient

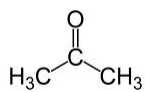
9. _____ solids consist of atoms or molecules held together by dipole-dipole forces, London dispersion forces, and/or hydrogen bonds.

- a. Ionic b. Covalent-network c. Metallic d. Molecular

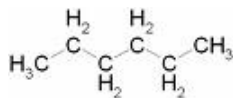
10. Which of the following liquids is immiscible with water?



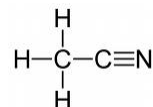
a. Methanol



b. acetone



c. hexane



d. acetonitrile

11. The Henry’s law constant for $\text{N}_2(g)$ at 25°C is $6.40 \times 10^{-4} \text{ M atm}^{-1}$. What mass (in g) of $\text{N}_2(g)$ will dissolve in 1000 mL of aqueous solution if the pressure of N_2 gas is 0.800 atm?

- a. $2.05 \times 10^{-3} \text{ g}$ b. $5.12 \times 10^{-4} \text{ g}$ c. $5.12 \times 10^{-3} \text{ g}$ d. $1.43 \times 10^{-2} \text{ g}$

12. Determine the molarity of a solution prepared by dissolving 5.5 g of HCl in 200 g of C₂H₆O if the density of the resulting solution is 0.79 g/mL.

- a. 21 M b. 0.93 M **c. 0.58 M** d. 1.72 M

13. What is the mole fraction of urea (MW = 60) in a solution prepared by dissolving 16 g of urea in 39 g of water (MW = 18) assuming the density of the resulting solution is 1.2 g/mL?

- a. 0.58 b. 0.37 c. 0.13 **d. 0.11**

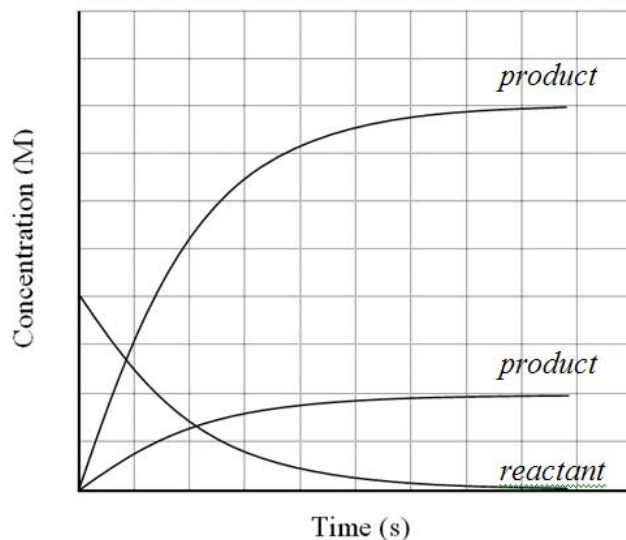
14. Which one of the following solutions will have the highest boiling point?

- a. 0.25 M C₆H₁₂O₆ b. 0.10 M Na₃PO₄
c. 0.75 M CH₃OH **d. 0.40 M CaCl₂**

15. An aqueous solution of NaCl boils at 102 °C. What is the freezing point of this solution? (K_b for water = 0.512 °C/m; K_f for water = 1.86 °C/m)

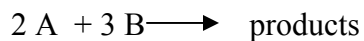
- a. -7.3 °C** b. -2.0 °C c. -3.6 °C d. -14 °C

16. Which of the reactions below is consistent with the following concentration profiles for reactant and products?



- a. $2 \text{NO}_3(g) \rightarrow 2 \text{NO}_2(g) + \text{O}_2(g)$
b. $2 \text{H}_2\text{O}_2(l) \rightarrow 2 \text{H}_2\text{O}(l) + \text{O}_2(g)$
c. $2 \text{N}_2\text{O}_5(g) \rightarrow 4 \text{NO}_2(g) + \text{O}_2(g)$
d. $2 \text{NaClO}_3(s) \rightarrow 2 \text{NaCl}(s) + 3 \text{O}_2(g)$

17. The following experimental data were collected for the reaction



Experiment #	Reactant A (M)	Reactant B (M)	Initial rate (M/s)
1	0.15	0.15	1.2×10^{-2}
2	0.32	0.53	2.6×10^{-2}
3	0.45	0.15	3.6×10^{-2}
4	0.15	0.30	1.2×10^{-2}

What is the rate law for the reaction?

- a. $\text{rate} = k [\text{A}]^2 [\text{B}]^3$ b. $\text{rate} = k [\text{A}] [\text{B}]^2$
c. $\text{rate} = k [\text{A}] [\text{B}]$ d. $\text{rate} = k [\text{A}]$

Use the following data for a first-order reaction to answer questions 18 to 20.

Time (s)	Reactant (M)
2	4.24
4	3.00
6	2.12
8	1.50
10	1.06
12	0.75

18. What is the average reaction rate between 6 and 10s?

- a. 1.06 Ms^{-1} b. 0.265 Ms^{-1} c. 3.77 Ms^{-1} d. 0.530 Ms^{-1}

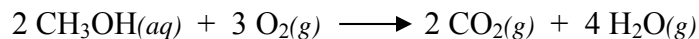
19. What is the half-time ($t_{1/2}$) for the reaction?

- a. 4.00 s b. 8.00 s c. 1.81 s d. 6.00 s

20. What is the rate constant (k) for the reaction?

- a. 2.77 s b. 5.77 s^{-1} c. 5.77 s d. 0.173 s^{-1}

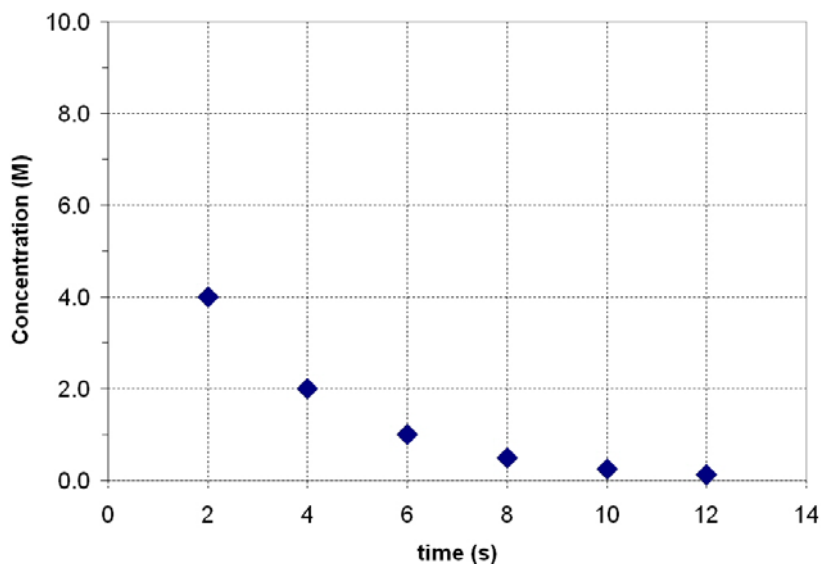
21. Methanol reacts with oxygen according to the following balanced equation.



Increasing which of the following would be most effective in increasing the rate of the reaction?

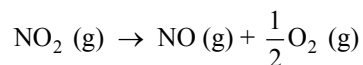
- a. the concentration of CH_3OH
- b. the partial pressure of O_2
- c. the concentration of CO_2
- d. insufficient information to answer the question

22. The following data were collected for a first-order reaction. What was the concentration of reactant at $t = 0$?



- a. 9.0 M
- b. 8.0 M
- c. 7.0 M
- d. 6.0 M

23. At elevated temperatures, nitrogen dioxide decomposes to nitrogen oxide and oxygen:



The reaction is second order in NO_2 with a rate constant of $0.543 \text{ M}^{-1}\text{s}^{-1}$ at 300°C . What would happen if the temperature were raised to 450°C ?

- A. The rate constant for the reaction will increase.
- B. The activation energy for the reaction will increase.
- C. Nothing, because monomolecular reactions are independent of temperature.
- D. The reaction will become endothermic.

Important Formulas and Constants

$$PV = nRT \quad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \quad PV = \frac{mRT}{M} \quad P_T = P_1 + P_2 + P_3 + \dots$$

$$X_a = \frac{n_a}{n_T} \quad P_a = X_a P_T \quad \frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}} \quad q = \Delta H_{\text{vap}} m \quad q = cm\Delta t$$

$$R = 0.0821 \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$$

$$\text{K} = ^\circ\text{C} + 273$$

$$1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr} = 101.3 \text{ kPa}$$

$$\text{For sc: } 2r = a \quad \text{For fcc: } 4r = a\sqrt{2} \quad \text{For bcc: } 4r = a\sqrt{3}$$

$$M = \frac{\text{moles}_{\text{solute}}}{L_{\text{solution}}} \quad m = \frac{\text{moles}_{\text{solute}}}{\text{kg}_{\text{solvent}}} \quad \text{ppm} = \frac{\text{mg}_{\text{solute}}}{\text{kg}_{\text{solution}}} \quad \text{ppb} = \frac{\mu\text{g}_{\text{solute}}}{\text{kg}_{\text{solution}}}$$

$$C_g = kP_g \quad P_A = \chi_A P_A^0 \quad \Delta T_b = iK_b m \quad \Delta T_f = -iK_f m$$

$$\text{Rate} = \frac{-\Delta[A]}{\Delta t} \quad \text{Rate} = k[A]^m[B]^n \quad \ln[A] = -kt + \ln[A]_0$$

$$t_{1/2} = \frac{0.693}{k} \quad k = Ae^{\frac{-E_a}{RT}}$$