

Practice problems for Midterm 1: Chs. 6 (Gases),
7(Thermochemistry) and 14 (Kinetics)

Note: there will be 30 questions of similar format on the
midterm

- 1) Which statement regarding a sample of an ideal gas is false?
 - A) If the pressure is doubled at constant temperature, the volume decreases by a factor of two.
 - B) If the temperature is doubled at constant pressure, the volume decreases by a factor of two.
 - C) If the temperature is doubled at constant volume, the pressure increases by a factor of two.
 - D) If the volume is doubled at constant temperature, the pressure decreases by a factor of two.
 - E) If the number of moles of gas is doubled at constant temperature and pressure, the volume increases by a factor of two.

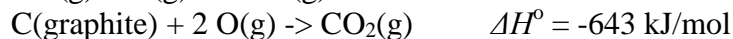
- 2) Halothane is a modern anesthetic that is nonflammable and relatively safe for patients. What is the molar mass of halothane (in grams per mole) if 798 milligrams occupies 92.4 milliliters at 16.5 °C and 790 Torr?
 - A) 197
 - B) 304
 - C) 1.24×10^3
 - D) 27.4
 - E) 209

- 3) A 1.54 L vessel contains He at a temperature of 22 °C and a pressure of 270 mmHg. A 688 mL vessel contains Ne at a temperature of 36.2 °C and a pressure of .165 atm. Both of these gases are placed in a 2.00 L vessel at 302 K. What is the final pressure (in atm) in the 2.00 L vessel?
 - A) 0.187
 - B) 0.714
 - C) 0.0725
 - D) 0.460
 - E) 0.335

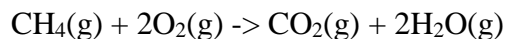
- 4) A 54.6 mL sample of nitrogen gas was collected over water at 23.7 °C and a barometric pressure of 752 mmHg. What mass of nitrogen was collected? [Vapor pressure of water at 23.7 °C is 22 mmHg]
- A) 60.3 mg
B) 58.7 mg
C) 56.8 mg
D) 61.4 mg
E) 63.3 mg
- 5) In a sample of air at STP, the ratio of the root-mean-square velocity of O₂ to that of N₂ (i.e. $u_{\text{rms}}(\text{O}_2)/u_{\text{rms}}(\text{N}_2)$) is equal to:
- A) 1.27
B) 1.00
C) 0.94
D) 0.82
E) 1.12
- 6) The complete combustion of octane (C₈H₁₈(l)) is given by the equation:
 $2 \text{C}_8\text{H}_{18}(\text{l}) + 25 \text{O}_2(\text{g}) \rightarrow 16 \text{CO}_2(\text{g}) + 18 \text{H}_2\text{O}(\text{g})$
How many liters of CO₂(g) are produced at 72.4 °C and 659 mmHg for every 3.785 L of octane burned? (density of C₈H₁₈(l) = 0.703 g/mL)
- A) 6.10 L
B) 8.48×10^2 L
C) 6.09×10^3 L
D) 2.78×10^3 L
E) 9.45 L
- 7) The measured Pressure of a non-ideal van der Waals gas compared to an ideal gas is:
- A) lower, because the gases expand
B) lower, because of intermolecular attractive forces
C) higher, because the molecules repel each other
D) lower, because the molecules occupy space
E) higher, because of intermolecular attractive forces
- 8) Which of the following is not a part of the kinetic-molecular theory of gases?
- A) A gas is composed of a large number of extremely small particles
B) Individual molecules may gain or lose energy as a result of collisions, but the total energy remains constant at fixed temperature
C) Gas particles are involved in constant, random straight line motion.
D) Gas particles collide only with the walls of the container
E) Gas particles are separated by great distance; a gas is mostly empty space.

- 9) A gaseous mixture consists of 50.0% O₂, 25.0% N₂, and 25.0% Cl₂, by mass. At standard temperature and pressure, the partial pressure of:
- A) O₂(g) is equal to 380 torr
 - B) Cl₂(g) is less than 0.25 atm
 - C) O₂(g) is equal to 1.6 atm
 - D) N₂(g) is equal to 0.20 atm
 - E) Cl₂(g) is greater than 0.25 atm
- 10) Assuming ideal gas behavior, which of the following gases would have the lowest density at standard temperature and pressure?
- A) N₂
 - B) Kr
 - C) SF₆
 - D) Ne
 - E) CO₂
- 11) The heat of fusion for water is 6.25 kJ/mol and for ethyl alcohol is 5.67 kJ/mol. The amount of heat that would melt 30.0 grams of water would melt how many grams of ethyl alcohol (C₂H₅OH) ?
- A) 33.1 g
 - B) 11.7 g
 - C) 31.0 g
 - D) 8.2 g
 - E) 84.5 g
- 12) The standard enthalpy of formation for CoCl₂ · 6H₂O(s) is -325.0 kJ/mole at 25°C. The chemical equation to which this value applies is:
- A) Co(s) + Cl₂(g) + 6 O₂(g) + 6 H₂(g) → CoCl₂ · 6H₂O(s)
 - B) Co(s) + Cl₂(g) + 6 H₂O(g) → CoCl₂ · 6H₂O(s)
 - C) CoCl₂(s) + 6H₂O(g) → CoCl₂ · 6H₂O(s)
 - D) Co(s) + Cl₂(g) + 3 O₂(g) + 6 H₂(g) → CoCl₂ · 6H₂O(s)
 - E) CoCl₂(s) + 3 O₂(g) + 6 H₂(g) → CoCl₂ · 6H₂O(s)
- 13) 260.0 g of hot coffee at 92.1 °C are placed in a 0.212 kg mug at 21.0 °C. The specific heat of the coffee is 4.10 J/g °C, while that of the mug is 0.82 J/g °C. Assuming no heat is lost to the surroundings, what is the final temperature of the system: mug + coffee?
- A) 84.7 °C
 - B) 56.6 °C
 - C) 74.0 °C
 - D) 105.6 °C
 - E) 82.1 °C

14) Given the following thermochemical equations:



Calculate the heat of combustion of methane:



- A) -498.0 kJ
- B) -643.0 kJ
- C) -1991.9 kJ
- D) -804 kJ
- E) -845.1 kJ

15) Calculate ΔH°_f of pentane, $\text{C}_5\text{H}_{12}(\text{l})$, given the enthalpy of combustion of pentane to $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$, -3273 kJ/mol , and the standard enthalpies of formation of $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\text{l})$, -393.5 kJ/mol and -241.8 kJ/mol , respectively.

- A) -6691.3 kJ/mol
- B) -145.3 kJ/mol
- C) -11141.1 kJ/mol
- D) -249.2 kJ/mol
- E) $+478.3 \text{ kJ/mol}$

16) For the reaction: $\text{H}_2(\text{g}) + 1/2 \text{ O}_2(\text{g}) \rightarrow \text{H}_2\text{O(g)} \quad \Delta H^\circ = -250.8 \text{ kJ/mol}$
What quantity of heat is evolved when a 0.060 kg mixture containing equal parts of H_2 and O_2 (by mass) is burned?

- A) 470.3 kJ
- B) 544 kJ
- C) 235.3 kJ
- D) 3997.3 kJ
- E) 4587.7 kJ

17) What is the final temperature if 5 grams of octane (C_8H_{18}) is combusted in a bomb calorimeter with heat capacity of $25.0 \text{ kJ}/^\circ\text{C}$ and an initial temperature of $22.0 \text{ }^\circ\text{C}$? The heat of combustion of octane is -44.43 kJ/g .

- A) $30.87 \text{ }^\circ\text{C}$
- B) $51.04 \text{ }^\circ\text{C}$
- C) $34.01 \text{ }^\circ\text{C}$
- D) $29.88 \text{ }^\circ\text{C}$
- E) $13.14 \text{ }^\circ\text{C}$

18) Which statement is correct?

- A) The standard heat of formation of an element is always negative
- B) Since $\Delta H = \Delta U + \Delta(PV)$, ΔH cannot equal ΔU
- C) q and w are state functions
- D) The first law of thermodynamics says $q = -w$ for a closed system
- E) $q + w$ is a state function

19) Steam engines have been extremely important devices. To get a sense of why, answer the following question: How much work is done when 18.0g of liquid water is vaporized at $100 \text{ }^\circ\text{C}$ against a constant external pressure of 101.3 kPa ?

- A) No work is done
- B) 1.3 kJ
- C) 2.3 kJ
- D) 3.1 kJ
- E) 3100 kJ

20) An Exothermic reaction will (choose the best answer):

- A) Decrease the temperature of an isolated system
- B) Result in a positive heat flow in a closed system
- C) Decrease the internal energy of a closed system
- D) Increase the internal energy of an isolated system
- E) Increase the internal energy of a closed system.

21) Which of the following does NOT determine the rate of a reaction?

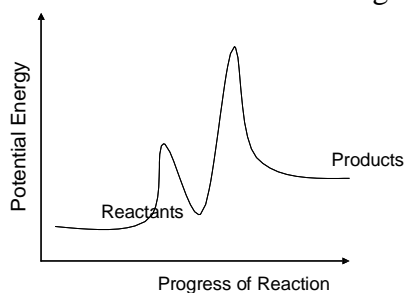
- a) Frequency of collisions
- b) Activation energy
- c) Value of ΔH°
- d) Temperature of the reactants
- e) Molecular orientation

22) Choose the INCORRECT statement.

- a) An activated complex appears at a minimum on the potential energy diagram
- b) The steady-state approximation assumes that the concentration of any reaction intermediates are constant.
- c) The rate-determining step of a reaction is the slow-step
- d) Reaction intermediates are both produced and consumed during the course of a reaction
- e) An activated complex is an unstable chemical species

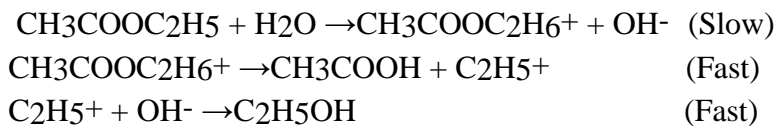
23) A potential energy diagram for a two-step reaction is shown below.

Which of the following best describes the reaction:



- a) Exothermic with step 2 occurring faster than step 1
- b) Exothermic with step 1 occurring faster than step 2
- c) Endothermic with step 1 occurring faster than step 2
- d) Endothermic with step 2 occurring faster than step 1
- e) None of the above

24) What is the rate law for the following mechanism?



- a) Rate = $k[\text{CH}_3\text{COOC}_2\text{H}_5][\text{H}_2\text{O}]$
- b) Rate = $k[\text{C}_2\text{H}_5\text{OH}]$
- c) Rate = $k[\text{CH}_3\text{COOC}_2\text{H}_5][\text{H}_2\text{O}]^2$
- d) Rate = $k[\text{CH}_3\text{COOH}]$
- e) Rate = $k[\text{CH}_3\text{COOC}_2\text{H}_5]$

25) For the reaction: $\text{N}_2\text{O}_5(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g}) + \frac{1}{2}\text{O}_2(\text{g})$ the rate law is:

$$\frac{\Delta[\text{O}_2]}{\Delta t} = k[\text{N}_2\text{O}_5]$$

At 350 K, the half-life is 67.3 seconds and the activation energy is 103.3 kJ (per mol O_2). What is the half-life at 400 K?

- a) 1.32×10^4 s
- b) 0.795 s
- c) 4.28×10^{-3} s
- d) 1.09×10^{-15} s
- e) 21.5 s

26) Given the following initial rate data, write the rate law expression.

Experiment	[A] ₀ , M	[B] ₀ , M	Initial rate, M/s
1	5.1×10^{-4}	0.35×10^{-4}	2.7×10^{-8}
2	5.1×10^{-4}	0.70×10^{-4}	5.4×10^{-8}
3	5.1×10^{-4}	0.18×10^{-4}	1.35×10^{-8}
4	1.0×10^{-3}	0.35×10^{-4}	10.8×10^{-8}
5	1.5×10^{-3}	0.35×10^{-4}	24.3×10^{-8}

- a) $k[\text{A}]^2[\text{B}]$
- b) $k[\text{A}][\text{B}]$
- c) $k[\text{A}]^2$
- d) $k[\text{B}]^2$
- e) $k[\text{A}]^2[\text{B}]^2$

27) In the first order, reaction $\text{A} \rightarrow \text{products}$, $[\text{A}] = 0.500$ M initially and 0.350 M after 12.0 min, at what time will $[\text{A}] = 0.150$ M?

- a) 63.9 min
- b) 15.0 min
- c) 40.5 min
- d) 51.0 min
- e) 22.1 min

28) The reaction $\text{A} + \text{B} \rightarrow \text{C} + \text{D}$ is second order in A and zero order in B. The value of k is $0.068 \text{ M}^{-1} \text{ min}^{-1}$. What is the rate of this reaction when $[\text{A}] = 0.275$ M and $[\text{B}] = 0.590$ M?

- a) $5.1 \times 10^{-3} \text{ M min}^{-1}$
- b) $3.4 \times 10^{-3} \text{ M min}^{-1}$
- c) $8.6 \times 10^{-3} \text{ M min}^{-1}$
- d) $2.7 \times 10^{-4} \text{ M min}^{-1}$
- e) 1.8 M min^{-1}

29) In a second order reaction which of the following are true:

- I) the sum of the exponents in the rate law is equal to two.
- II) at least one of the exponents in the rate law is a two.
- III) the half-life is not constant
- IV) the half-life is constant.
- V) K can be expressed as $M^{-2}s^{-1}$ or $M^{-2}min^{-1}$

- a) I and III
- b) II and IV
- c) II and III
- d) I and IV
- e) I, III and V