

CHM 2045 Exam 2 Review
Academic Resources

- 1) If 1000. g of boiling water (at 100 °C) was placed in an 1800. g cast iron skillet initially at 25°C, and the final equilibrium temperature of the water and the skillet was 88°C, estimate the specific heat capacity of the skillet. Assume this is a closed system and that the specific heat capacity of water is 4.184 J/°C•g.

- 2) Which statement is incorrect regarding internal energy (U, E) and the first law of thermodynamics?
 - A) The first law of thermodynamics states that energy must be conserved.
 - B) When the system gains heat and performs work, then $\Delta\{U, E\}$ for the system must be positive.
 - C) The first law of thermodynamics does not imply that heat can't be converted to work.
 - D) When the system loses heat and performs work, then $\Delta\{U, E\}$ for the system must be negative.
 - E) When its $\Delta\{U, E\}$ increases, then the system must gain heat or have work performed on it, or both.

- 3) Deterioration of buildings, bridges, and other structures through the rusting of iron costs millions of dollars a day. The enthalpy of formation of rust, Fe₂O₃(s), is -826.0 kJ/mol. How much heat is released (in kJ) when 0.500 kg of Fe reacts with 200. g of O₂, forming Fe₂O₃(s)?

- 4) When 50.0 ml of 0.200 M AgNO₃ and 50.0 ml of 0.100 M CaCl₂, both at 25.0°C, are reacted in a coffee-cup calorimeter, the temperature of the reacting mixture increases to 26.0°C. Calculate ΔH in kJ per mole of AgCl produced. Assume the density of the solution is 1.05 g/ml and the specific heat capacity of the solution 4.20 J/g°C.

- 5) The rate law for $2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$ was experimentally determined to be rate = $k[\text{NO}]^2[\text{O}_2]$. Based on this information, which of the following are plausible mechanisms for this reaction?

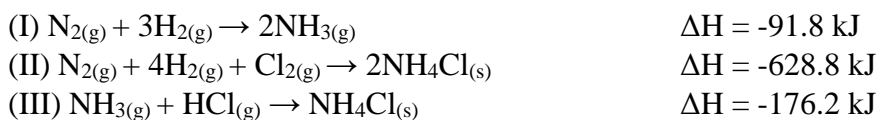
I:	$2 \text{NO}(\text{g}) \rightleftharpoons \text{N}_2(\text{g}) + \text{O}_2(\text{g})$ (slow equilibrium step) $\text{N}_2(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$ (fast second step)
II:	$2 \text{NO}(\text{g}) \rightleftharpoons \text{N}_2\text{O}_2(\text{g})$ (fast equilibrium step) $\text{N}_2\text{O}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$ (slow second step)
III:	$2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$ (one step)

- A) Only I
B) Only II
C) I and III
D) II and III
E) I, II, and III

- 6) The growth of Pseudomonas bacteria is a first-order process with rate constant $k = 0.035 \text{ min}^{-1}$ at 37°C . The time it takes to approximately double the population of these bacteria at 37°C is

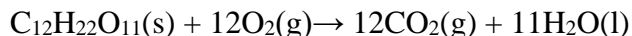
- 7) If 150. grams of iron ($0.450 \text{ J/g}^\circ\text{C}$) at 100°C is combined with 150. grams of water ($4.184 \text{ J/g}^\circ\text{C}$) at 20°C in an insulated container, what will be the final temperature of the water?

- 8) Find the heat of formation of gaseous HCl



- 9) A pure gold ring ($C = 0.128 \text{ J/g}^\circ\text{C}$) and pure silver ring ($C = 0.235 \text{ J/g}^\circ\text{C}$) have a total mass of 15.3g. The two rings are heated to 62.1°C and dropped into a 13.1mL of water ($\rho = 1.00 \text{ g/mL}$ and $C = 4.184 \text{ J/g}^\circ\text{C}$) at 20.9°C . When equilibrium is reached, the temperature of the water is 22.9°C . What was the mass of the gold ring?

10) Consider the reaction



in which 10.0 g of sucrose, $\text{C}_{12}\text{H}_{22}\text{O}_{11}$, was burned in a bomb calorimeter with a heat capacity of 7.50 kJ/°C. The temperature increase inside the calorimeter was found to be 22.0°C. What is the heat of this reaction per mole of sucrose?

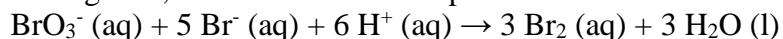
11) Find the rate law for the following reaction mechanism

- (I) $\text{HNO}_2 + \text{H}^+ \rightarrow \text{H}_2\text{O} + \text{NO}^+$ (fast)
- (II) $\text{NH}_4^+ \rightarrow \text{NH}_3 + \text{H}^+$ (fast)
- (III) $\text{NO}^+ + \text{NH}_3 \rightarrow \text{NH}_3\text{NO}^+$ (slow)
- (IV) $\text{NH}_3\text{NO}^+ \rightarrow \text{H}_2\text{O} + \text{H}^+ + \text{N}_2$ (fast)

- A) Rate = $k [\text{NO}^+] [\text{NH}_3]$
- B) Rate = $k [\text{NO}^+] [\text{NH}_4^+] [\text{H}^+]^{-1}$
- C) Rate = $k [\text{NO}^+] [\text{NH}_4^+] [\text{H}^+]$
- D) Rate = $k [\text{HNO}_2] [\text{NH}_4^+] [\text{H}_2\text{O}]^{-1}$
- E) Rate = $k [\text{NH}_3] [\text{H}^+] [\text{HNO}_2] [\text{H}_2\text{O}]^{-1}$

12) A red laser emits pulses of 679 nm and 0.528 J/pulse. How many photons are produced per pulse?

13) Given the following data, choose the correct expression for the rate law:



Exp	$[\text{BrO}_3^-]$ (M)	$[\text{Br}^-]$ (M)	$[\text{H}^+]$ (M)	Rate (M/s)
1	0.175	0.175	0.175	1.126×10^{-2}
2	0.350	0.175	0.175	2.251×10^{-2}
3	0.175	0.525	0.175	3.376×10^{-2}
4	0.350	0.175	0.263	5.084×10^{-2}

- (1) $k[\text{BrO}_3^-]^{1/2}[\text{Br}^-][\text{H}^+]$
- (2) $k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^{1/2}$
- (3) $k[\text{BrO}_3^-][\text{Br}^-]^{1/2}[\text{H}^+]^2$
- (4) $k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]^2$
- (5) $k[\text{BrO}_3^-][\text{Br}^-][\text{H}^+]$