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 Δ{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 Δ{U, E} for the system must be negative.
   E) When its Δ{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, $Fe_2O_3(s)$, is −826.0 kJ/mol. How much heat is released (in kJ) when 0.500 kg of Fe reacts with 200. g of O_2, forming $Fe_2O_3(s)$?

4) When 50.0 ml of 0.200 M $AgNO_3$ and 50.0 ml of 0.100 M $CaCl_2$, 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 NO(g) + O_2(g) → 2 NO_2(g) was experimentally determined to be rate = k$[NO]^2[O_2]$. Based on this information, which of the following are plausible mechanisms for this reaction?

I:	2 NO(g) ⇄ N_2(g) + O_2(g) (slow equilibrium step) N_2(g) + 2 O_2(g) → 2 NO_2(g) (fast second step)
II:	2 NO(g) ⇄ N_2O_2(g) (fast equilibrium step) N_2O_2(g) + O_2(g) → 2 NO_2(g) (slow second step)
III:	2 NO(g) + O_2(g) → 2 NO_2(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 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 J/g°C) at 100°C is combined with 150. grams of water (4.184 J/g°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

(I) $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$ $\Delta H = -91.8$ kJ
(II) $N_{2(g)} + 4H_{2(g)} + Cl_{2(g)} \rightarrow 2NH_4Cl_{(s)}$ $\Delta H = -628.8$ kJ
(III) $NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)}$ $\Delta H = -176.2$ kJ

9) A pure gold ring (C = 0.128 J/g°C) and pure silver ring (C = 0.235 J/g°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 (ρ = 1.00 g/mL and C = 4.184 J/g°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

$$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$$

in which 10.0 g of sucrose, $C_{12}H_{22}O_{11}$, 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) $HNO_2 + H^+ \rightarrow H_2O + NO^+$ (fast)
(II) $NH_4^+ \rightarrow NH_3 + H^+$ (fast)
(III) $NO^+ + NH_3 \rightarrow NH_3NO^+$ (slow)
(IV) $NH_3NO^+ \rightarrow H_2O + H^+ + N_2$ (fast)

A) Rate = k $[NO^+]$ $[NH_3]$
B) Rate = k $[NO^+]$ $[NH_4^+]$ $[H^+]^{-1}$
C) Rate = k $[NO^+]$ $[NH_4^+]$ $[H^+]$
D) Rate = k $[HNO_2]$ $[NH_4^+]$ $[H_2O]^{-1}$
E) Rate = k $[NH_3]$ $[H^+]$ $[HNO_2]$ $[H_2O]^{-1}$

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:

$$BrO_3^- (aq) + 5\,Br^- (aq) + 6\,H^+ (aq) \rightarrow 3\,Br_2 (aq) + 3\,H_2O (l)$$

Exp	$[BrO_3^-]$ (M)	$[Br^-]$ (M)	$[H^+]$ (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) $k[BrO_3^-]^{1/2}[Br^-][H^+]$
(2) $k[BrO_3^-][Br^-][H^+]^{1/2}$
(3) $k[BrO_3^-][Br^-]^{1/2}[H^+]^2$
(4) $k[BrO_3^-][Br^-][H^+]^2$
(5) $k[BrO_3^-][Br^-][H^+]$