Chem 1B Midterm 2
Version A

Credit will only be given for answers on this sheet. Units must be included in your answers and points will be taken off for incorrect or missing units. No partial credit will be awarded. Calculators are allowed. Cell phones may not be used as calculators.

Name:	Perm Number

Make sure your writing is dark and large enough to be picked up by a scanner. Failure to do this results in the loss of 5 points on the exam.

If you are sitting next to someone with the same version of the test, you both will lose 5 points on the exam.

If you are still writing after time is called, you will lose 5 points on the exam.

Fundamentals		
Question (Points)	**Answer**	
1 (6 pts)	V_{HNO_2} = 0.41 L	$V_{NO_2^-}$ = 0.59 L
2 (5 pts)	-470 kJ	
3 (6 pts)	$4 \times 10^{-29}\ M$	
4 (5 pts)	7.6 g	
5 (6 pts)	34.4 kJ	
6 (8 pts) 2 each	q = 560 J	w = -100 J
	ΔE = 460 J	ΔH = 760 J

Multiple Choice	
Question (Points)	**Answer**
7 (5 pts)	○ A ○ B ○ C ○ D ● E
8 (5 pts)	○ A ● B ○ C ○ D ○ E
9 (4 pts) 1 each	○ A ● B
	○ A ● B ○ C
	○ A ● B ○ C
	● A ○ B ○ C
10 (6 pts) 2 each	○ A ○ B ● C
	○ A ● B ○ C
	● A ○ B ○ C
11 (7 pts)	○ A ○ B ○ C ○ D ● E
12 (5 pts)	○ A ○ B ○ C ● D ○ E ○ F ○ G ● H

| Challenge Problems	
Question (Points)	**Answer**
13 (14 pts) 7 each	$26.6 \frac{kJ}{mol}$
	$6.00 \frac{kJ}{mol}$
14 (18 pts) 6 each	11.12
	9.42
	1.72

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Fundamental Questions

1) 6 pts What volumes of 0.50 M HNO_2 and 0.50 M $NaNO_2$ mut be mixed to prepare 1.00 L of a solution buffered at pH = 3.55?

2) 5 pts There are two steps in the usual industrial preparation of acrylic acid, the immediate precursor of several useful plastics. In the first step, calcium carbide and water react to form acetylene and calcium hydroxide:

$$CaC_2(s) + 2H_2O(g) \rightarrow C_2H_2(g) + Ca(OH)_2(s) \quad \triangle H = -414. \text{ kJ}$$
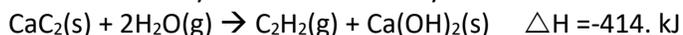
In the second step, acetylene, carbon dioxide and water react to form acrylic acid:

$$6C_2H_2(g) + 3CO_2(g) + 4H_2O(g) \rightarrow 5CH_2CHCO_2H(g) \quad \triangle H = 132 \text{ kJ}$$
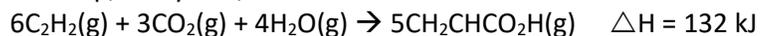
Calculate the net change in enthalpy for the formation of **one mole** of acrylic acid from calcium carbide, water and carbon dioxide from these reactions.
Round your answer to the nearest **kJ**.

3) 6 pts Calculate the solubility (in $\frac{mol}{L}$) of $Fe(OH)_3$ (K_{sp} 4×10^{-38}) for a solution buffered at pH=11.0.

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4)   5 pts   A chemistry graduate student is given 125. ml of 0.20 M dimethylamine ($(CH_3)_2NH$) solution. Dimethylamine is a weak base with $K_b = 5.4 \times 10^{-4}$. What mass of $(CH_3)_2NH_2Br$ should the student dissolve in the $(CH_3)_2NH$ solution to turn it into a buffer with pH =10.34?
You may assume that the volume of the solution doesn't change when the $(CH_3)_2NH_2Br$ is dissolved in it. Be sure your answer has a unit symbol, and round it to 2 significant digits.

5)   6 pts   The overall reaction in commercial heat pack can be represented as
$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s) \quad \Delta H = -1,652 \text{ kJ}$$
How much heat is released when 10.0 g of Fe and 2.00 g of O_2 are reacted?

6)   8 pts   Calculate (in J) q, w, ΔE, and ΔH for 1 mol of monatomic ideal gas undergoing the following changes:
$$1.0 \text{ atm, } 1.0 \text{ L} \rightarrow 1.0 \text{ atm, } 2.0 \text{ L} \rightarrow 2.0 \text{ atm, } 2.0 \text{ L}$$

7)   *5 pts*   Which of the following will not produce a buffer solution?

    A.   100 ml of 0.1 M Na_2CO_3 and 50 ml of 0.1 M HCl
    B.   100 ml of 0.1 M $NaHCO_3$ and 25 ml of 0.2 M HCl
    C.   100 ml of 0.1 M Na_2CO_3 and 75 ml of 0.2 M HCl
    D.   50 ml of 0.2 M Na_2CO_3 and 5 ml of 1.0 M HCl
    E.   100 ml of 0.1 M Na_2CO_3 and 50 ml of 0.1 M NaOH

8)   *5 pts*   Calculate $\Delta H°_{rxn}$ for the following reaction from the listed standard enthalpies of formation.

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

Substance	$\Delta H°_{rxn} \left(\frac{kJ}{mol} \right)$
$NH_3(g)$	-46
$NO(g)$	90.
$H_2O(g)$	-242

    A.   -862 kJ
    B.   -908 kJ
    C.   -1,276 kJ
    D.   Not enough information
    E.   None of the above

9)   *4 pts*   A mixture of gaseous reactants is put into a cylinder, where a chemical reaction turns them into gaseous products. The cylinder has a piston that moves in or out, as necessary, to keep a constant pressure on the mixture of 1 atm. The cylinder is also submerged in a large insulated water bath. (See sketch at right.)
From previous experiments, this chemical reaction is known to absorb 261 kJ of energy. The position of the piston is monitored, and it is determined from this data that the system does 310. kJ of work on the piston during the reaction.
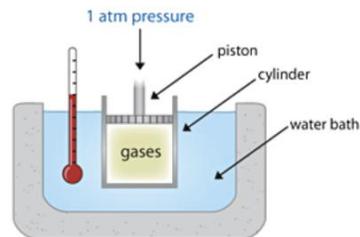
Is the reaction exothermic or endothermic
    A.   exothermic　　　　B.   endothermic
Does the temperature of the water bath go up or down?
    A.   up　　　　　　　　B.   down　　　　　　C.   neither
Does the piston move in or out?
    A.   in　　　　　　　　B.   out　　　　　　　C.   neither
Does heat flow into or out of the gas mixture
    A.   in　　　　　　　　B.   out　　　　　　　C.   neither

10) *6 pts* For the following reaction at constant pressure, predict if ΔH>ΔE, ΔH<ΔE, or ΔH=ΔE.

$2HF(g) \rightarrow H_2(g) + F_2(g)$

A.   ΔH>ΔE   B.   ΔH<ΔE   C.   ΔH=ΔE

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

A.   ΔH>ΔE   B.   ΔH<ΔE   C.   ΔH=ΔE

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

A.   ΔH>ΔE   B.   ΔH<ΔE   C.   ΔH=ΔE

11) *7 pts* What is the pH at the equivalence point for the titration of 1.0 M ethylamine, $C_2H_5NH_2$, by 1.0 M perchloric acid, $HClO_4$? (pK_b for $C_2H_5NH_2$ = 3.25)

A.   6.05
B.   2.24
C.   2.09
D.   5.38
E.   5.53

12) *5 pts* Select two solutions, which when equal amounts of them are mixed together, will make the best buffer at a pH of 9.26?

A.   3.0 M $NaC_2H_3O_2$
B.   0.2 M NH_4Cl
C.   0.2 M $NaC_2H_3O_2$
D.   3.0 M NH_3
E.   3.0 M $HC_2H_3O_2$
F.   0.2 M NH_3
G.   0.2 M $HC_2H_3O_2$
H.   3.0 M NH_4Cl

13a)   7 pts   In a coffee cup calorimeter, 1.60 g of NH_4NO_3 is mixed with 75.0 g of water at an initial temperature of 25.00°C. After dissolution of the salt, the final temperature of the calorimeter contents is 23.34°C. Assuming the solution has a heat capacity of 4.18 $\frac{J}{°C \cdot g}$ and assuming no heat loss to the calorimeter, calculate the enthalpy change for the solution of NH_4NO_3 in units of $\frac{kJ}{mol}$.

13b)   7 pts   In the same calorimeter 200. g of ice (T_i(ice) = 0°C) was added to 440.g water (T_i(water)=80.0°C). When the system reached thermal equilibrium the temperature of the system was 30.1°C. What is ΔH_{fus} in $\frac{kJ}{mol}$? $C_{H_2O(l)}$ 4.18 $\frac{J}{g \cdot °C}$

14a) *6 pts*   Consider the titration of 100. ml of 0.100 M NH_3 with 0.100 M HCl. Calculate the pH of the resulting solution after the following volumes of HCl have been added.
0.00 ml

14b) *6 pts*   40.0 ml

14c) *6 pts*   150.0 ml