Exam 2

Chem 111, Section 2 (10:10 am) Fall 1998

This test is closed book, closed notes, and closed neighbors. A periodic table and other useful information is available at the end of the test. When told to begin, read through the entire exam, and decide which questions you can answer quickly. After you have answered those questions, return to the more involved questions and answer them.

By signing below, I agree to abide by the University rules and regulations regarding honesty on exams. I understand that I am not to look at others' exams nor allow others to view mine. I hereby state that all answers on the answer sheet are my own.

I understand that Professor Martin considers academic honesty to be central to the goals of the University and that dishonest behavior will dealt with very seriously.

Printed Name: _____

Signature: _____

As soon as you have your OpScan (answer) sheet:

1) Place your name where indicated.

2) Place your student ID number where indicated, starting at column **A**.

3) Place a "**2**" in column "K" of the special codes section.

Fill in the bubbles corresponding to the above.

Failure to correctly enter any of the above 3 items will result in the deduction of 5 points from your exam.

Tear this page off and return with your completed answer sheet.

You should take the rest of your exam home with you because

As a homework assignment, you may earn up to 10% of the points you missed on this exam. Details are at the end of this exam.

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$c = 3.00 \times 10^{8}$ m/sec
$h = 6.626 \times 10^{-34}$ J·sec/photon
$h = 3.99 \times 10^{-10}$ J·sec/mol photons
No = 6.022×10^{23} "particles" / mol
ΔH_{Fusion} of ice = 333 J/g
1 nm = 10^{-9} m

Compound	Specific Heat Capacity (J/g K)
Cu (s)	0.385
C_2H_5OH(l) ethanol	2.46
H_2O(s)	2.1
H_2O(g)	2.0
H_2O(l)	4.184

Note that this exam is worth a total of 160 points

You have version **2** of the exam. Place **2** in column **K** of your answer sheet.

1a. (8 points) Which of the following is a **correct**, balanced net ionic equation?

(a) $Mg(OH)_2$ (s) + HCl (aq) → $MgCl_2$ (aq)+ H_2O (aq)
(b•) $Mg(OH)_2$ (s) + 2 H^+ (aq) → Mg^{2+} (aq) + 2 H_2O (aq)
(c) $Mg(OH)_2$ (s) + 2HCl (aq) → $MgCl_2$ (aq) + 2H_2O (aq)
(d) $Mg(OH)_2$ (s) + H^+ (aq) → Mg^{2+} (aq) + H_2O (aq)
(e) none of the above is a correctly balanced net ionic equation

2b. (8 points) You are preparing an enzyme sample for an experiment. You have an enzyme stock solution that is 0.1 mM and you would like to dilute this in to buffer to prepare 0.5 mL of a solution with a final enzyme concentration of 0.02 mM. What volume of enzyme stock solution should you add?

(a) 1.0 mL (b) 2.0 mL (c•) 0.10 mL (d) 0.20 mL (e) 0.05 mL

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(For questions 3-9) Last week the Nobel prize in Physiology and Medicine was awarded for pioneering work which recently discovered the role of nitric oxide (NO) in intracellular signaling. The rapid reaction of NO with oxygen ensures that the lifetime of such signals is short in aerobic cells:

	$\Delta H°_f$ kJ/mol
NH_3 (g)	-46.11
NO (g)	90.9
NO_2 (g)	33.18
N_2O (g)	82.05
HNO_3 (aq)	-207.36

$2\ NO\ (g) + O_2\ (g) \rightarrow 2\ NO_2\ (g)$

3b. (8 points) How many moles of O_2 are required to react with 0.64 moles NO?

(a) 0.16 moles (b •) 0.32 moles (c) 0.64 mole (d) 2 moles (e) 1 moles

Require 1 mol O_2 per 2 mol NO. (1/2)(0.64) = 0.32 moles

4b. (8 points) How many grams NO_2 are produced in the complete reaction of 3.0 g NO?

(a •) 4.6 g (b) 0.10 g (c) 3.0 g (d) 1.5 g (e) 2.3 g

(3.0 g NO)(1/30.01g/mol) = 0.10 mole NO
(3.0 g NO)(1 mol NO_2 / 1 mol NO) = 0.10 mole NO_2
(0.10 mole NO_2)(46.01 g mol) = 4.6 g NO_2

5. (8 points) The oxidation number of nitrogen in NO_2 is

(a) 0 (b •) +4 (c) –2 (d) +2 (e) –4

6. (8 points) In the above reaction, which species is the reducing agent?

(a) NO_2 (b) O_2 (c •) NO
(d) there is no reducing agent here

7. (8 points) What is $\Delta H°$ for this reaction?

(a) –57.7 kJ/mol (b) +57.7 kJ/mol (c) –28.9 kJ/mol
(d) +28.9 kJ/mol (e •) –115.4 kJ/mol

2(33.18 kJ/mol) - 2(90.9 kJ/mol) = –115.4 kJ/mol

8. (4 points) This reaction is:

(a) endothermic (b •) exothermic

9. (4 points) Nitric oxide is also a component of automobile exhaust. Catalytic converters in automobiles catalyze the reaction:

$$\mathbf{2\ NO\ (g) \rightarrow N_2\ (g) + O_2\ (g)}$$

This reaction is:

(a) endothermic (b •) exothermic

10b. (8 points) In the compound H_2SO_4, what is the oxidation number of S?

(a) +7 (b) +4 (c) +5 (d) +8 (e •) +6

11b. (8 points) An 80 g piece of metal is heated in boiling water to a temperature of 100°C and then dropped into an insulated beaker. There are 225 g of water in the beaker, and its temperature before the metal was dropped in was 20.0°C. The final temperature of the metal and water is 24.0°C. What is the specific heat of the metal? (Assume there is no heat transfer through the walls of the beaker.)

(a) 0.935 J/gK (b) 8.37 J/gK (c •) 0.619 J/gK
(d) 0.826 J/gK (e) 4.184 J/gK

12b. (8 points) How much heat is required to convert a small ice cube weighing 10g from –10°C to liquid at 30°C?

(a) 6230 J (b) 5632 J (c) 4322 J (d •) 4795 J (e) 2861 J

First steps the same
Last step:
$q = 4.184\ J/g°K \cdot 10\ g \cdot 30°C$

(d) q = 210 J + 3330 J + 1255 J = 4795 J

13b. (8 points) How much heat is provided by burning one lb of propane (454 gms) in a furnace? The MW of propane C_3H_8 is 44.1, and the reaction which occurs in the combustion is:

$C_3H_8(g) + 5O_2\ (g) \rightarrow 3CO_2\ (g) + 4H_2O(l)$ $\Delta H = -2220$ kJ/mol

(a) 45,700 kJ (b) 52,300 kJ (c •) 22,900 kJ (d) 33,700 kJ (e) 56,400 kJ

$454\ g \times \frac{1\ mol\ propane}{44.1\ gms} = 10.3$ moles of propane

(c) 10.3 mol propane x 2220 kJ/mol = 22,900 kJ

14b. (8 points) What is the enthalpy change for the formation of ethane, C_2H_6, from solid carbon and hydrogen gas?

$$2C(s) + 3H_2 \rightarrow C_2H_6\ (g) \qquad \Delta H° = ?$$

You know that:

(1) $C(s) + O_2\ (g) \rightarrow CO_2\ (g)$ $\Delta H° = -393.5$ kJ/mol

(2) $H_2\ (g) + 1/2\ O_2\ (g) \rightarrow H_2O(l)$ $\Delta H° = -285.8$ kJ/mol

(3) $C_2H_6\ (g) + 7/2\ O_2\ (g) \rightarrow 2CO_2\ (g) + 3H_2O\ (l)$ $\Delta H° = -1559.7$ kJ/mol

(a) –74.8 kJ/mol (b•) –84.7 kJ/mol (c) –47.8 kJ/mol
(d) –105.6 kJ/mol (e) –68.4 kJ/mol

(b) $\Delta H° = -787 - 857.4 + 1559.7 = -84.7$ kJ

15b. (8 points) Nitroglycerin $C_3H_5(NO_3)_3$ is a powerful explosive. How much heat is given off when 10.0 g = .044 mol of nitroglycerin is detonated? The reaction that takes place on detonation is

$$2C_3H_5(NO_3)_3(l) \rightarrow 3N_2\ (g) + \_O_2\ (g) + 6CO_2 + 5H_2O\ (g)$$

$\Delta H°_f\ C_3H_5(NO_3)_3(l) = -364$ kJ/mol

$\Delta H°_f\ CO_2\ (g) = -393.5$ kJ/mol

$\Delta H°_f\ H_2O\ (g) = -241.8$ kJ/mol

(a) +70.5 kJ/mol (b•) –62.6 kJ/mol (c) –231.5 kJ/mol
(d) –50.3 kJ/mol (e) –72.5 kJ/mol

16b. (8 points) Two grams of sugar ($C_{12}H_{22}O_{11}$) is burned in a combustion calorimeter. The temperature of the 1500 g of water in the calorimeter rises from 25.0°C to 28.0°C. If the heat capacity of the bomb is 837 J/K, how much heat was given off by the combustion of the sugar?

(a •) 21,339 J (b) 18,828 J (c) 17,456 J (d) 32,139 J (e) 3213 J

(a) $q_{\text{given off}}$ = 18,828 J + 2511 J = 21,339 J

17b. (8 points) The frequency of a popular FM radio station is 93.1 MHz on your FM dial -- (MHz = megahertz = $10^6 s^{-1}$). What is the wavelength of these radio waves (in meters)?

(a) .122 m (b •) 3.22 m (c) 12.2 m (d) .156 m (e) .32 m

$\lambda V = c$

$\lambda = c/V$

$\lambda = 3.0 \times 10^8 \text{ m} \cdot \text{s}^{-1} / 93.1 \times 10^6 \text{ s}^{-1}$

(b) λ = 3.22 m

18b. (8 points) The frequency of microwaves in your microwave is 2.45 GHz. How many moles of photons (of microwave radiation) will it take to heat a cup of coffee (100 g of coffee) from 25°C to 75°C (assume the heat capacity of coffee is 4.184 J/gm °C). (1 GHz = 1 10^9 s^{-1})

(a) 2.36x10^9 mol photons (b •) 21,400 mol photons (c) 3.12 mol photons
(d) 6860 mol photons (e) 32,300 mol photons

For each statement below (4 points each), indicate whether the statement is most likely true (A) or false (B).

19b. In order to melt 1g of ice, we need about 4.5 Joules of energy.

(a) True (b •) False

20b. One mole of liquid water has a lower potential energy than one mole of ice.

(a) True (b •) False

21b. It takes less heat to raise the temperature of steam by 20°F than of copper by 20°F.

(a) True (b•) False

22b. Radio waves (λ 0.5 m) have a lower energy than orange light (λ = 625 nm).

(a•) True (b) False

23b. In 1905 Einstein explained the photoelectric effect. His explanation relied upon Planck's earlier proposal that the energy of light was proportional to its frequency.

(a•) True (b) False

24b. In 1910, Rutherford tested Thomson's earlier model of the atom by passing a beam of α-particles through gold foil. His results confirmed Thomson's model that the atom is a uniform positively charged sphere with electrons embedded in the sphere.

(a) True (b•) False

Remember:

As a homework assignment, you may earn up to 10% of the points you missed on this exam (eg., if you scored a 110 on the exam, you can earn up to an extra 8 points), by doing the following:

1) Pick up an extra Op-Scan sheet when you turn in your exam.

2) Work through all of the problems at home (consultation with others is OK, but you should answer the questions yourself). Answer all of the questions. Turn in the Op-Scan sheet in class on Monday, October 26 (***no later!***).

Your revised exam will be scored and credit applied proportional to the total number of questions answered correctly. Complete the exam exactly as you did previously (except with all correct answers, of course!).

Answers and scores for the original exam will be available by October 26, after the deadline for turning exam re-takes in. Check our home page.