Exam 2

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 "**1**" 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.

Exam 2

$c = 3.00 \times 10^8$ m/sec	
$h = 6.626 \times 10^{-34}$ J·sec/photon	
$h = 3.99 \times 10^{-10}$ J·sec/mol photons	
No $= 6.022 \times 10^{23}$ "particles" / mol	
H_{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 **1** of the exam. Place **1** 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) + 2HCl (aq) → $MgCl_2$ (aq) + $2H_2O$ (aq)
(c) $Mg(OH)_2$ (s) + H^+ (aq) → Mg^{2+} (aq) + H_2O (aq)
(d•) $Mg(OH)_2$ (s) + 2 H^+ (aq) → Mg^{2+} (aq) + 2 H_2O (aq)
(e)   none of the above is a correctly balanced net ionic equation

2a. (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 1.0 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

	H°$_f$ kJ/mol
NH$_3$ (g)	-46.11
NO (g)	90.9
NO$_2$ (g)	33.18
N$_2$O (g)	82.05
HNO$_3$ (aq)	-207.36

(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:

$$2 \text{ NO (g)} + \text{O}_2 \text{ (g)} \quad 2 \text{ NO}_2 \text{ (g)}$$

3.   (8 points) How many moles of O$_2$ are required to react with 0.32 moles NO?

(a •) 0.16 mole (b) 0.32 mole   (c) 0.64 mole   (d) 2.0 mole   (e) 1 mole
Require 1 mol O$_2$ per 2 mol NO. (1/2)(0.32) = 0.16 moles

4a. (8 points) How many grams NO are consumed in producing 4.6 g NO$_2$?

(a) 4.6 g   (b) 0.10 g   (c •) 3.0 g   (d) 1.5 g   (e) 2.3 g
(4.6 g NO$_2$)(1/46.01g/mol) = 0.10 mole NO$_2$
(0.10 mol NO$_2$)(I mol NO / 1 mol NO$_2$) = 0.10 mole NO
 (0.10 mole NO)(30.01 g/mol) = 3.0 g NO

5.   (8 points) The oxidation number of nitrogen in NO$_2$ is

(a) 0   (b) +2   (c) −2   (d•) +4   (e) −4

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

(a) NO$_2$ (b •) NO   (c) O$_2$
(d) there is no reducing agent here

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

    (a) –57.7 kJ/mol   (b) +57.7 kJ/mol   (c •) –115.4 kJ/mol
    (d) +28.9 kJ/mol   (e) –28.9 kJ/mol
    2(33.18 kJ/mol) - 2(90.9 kJ/mol) = –115.4 kJ/mol

8. (4 points) This reaction is:

    (a •) exothermic   (b) endothermic

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

$$2 \text{ NO (g)} \quad \text{N}_2 \text{ (g)} + \text{O}_2 \text{ (g)}$$

    This reaction is:

    (a) endothermic   (b •) exothermic

10a. (8 points) In the compound H_2AsO_4, what is the oxidation number of As?

    (a) +4   (b) +5   (c) +8   (d•) +6   (e) +7

11a. (8 points) A 60 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

$$q_{water} = 4.184 \text{ J/g°K} \cdot 225 \text{ g} \cdot 4°\text{K}$$
$$q_{water} = 3765.6 \text{ J}$$
$$q_{metal} = -q_{water}$$
$$q_{metal} = -3765.6 \text{ J} = C_{metal} \text{ (J/g°K)} \cdot 60 \text{ g} \cdot (24° - 100°\text{K})$$
$$C_{metal} = 3765.6 \text{J}/60.76$$
$$\textbf{(d) } C_{metal} = .826 \text{ J/g°K}$$

12a. (8 points) How much heat is required to convert a small ice cube weighing 10g from $-10°C$ to liquid at $50°C$?

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

heat ice $-10°C$ $0°C$ · $T°K$ $q = C_{ice}$ J/g°K · m(g)

$q = 2.1 · 10 · 10$
$q = 210$ J

fuse ice H_2O $q =$ 333 J/g · 10g
$q = 3330$ J

liq @ p°C – liq @ 50°C $q = 4.184$ J/g°K · 10g · 50°
$q = 2092$ J

(b) q = 210 J + 3330 J + 2092 J = 5632 J

13a. (8 points) How much heat is provided by burning two lbs of propane (908 gms) in a furnace? The MW of propane C_3H_8 is 44.1, and the reaction which occurs in the combustion is:

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

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

908 g x $\dfrac{1 \text{ mol propane}}{44.1 \text{ gms}}$ = 20.6 moles of propane

(a) 20.6 mol propane x 2220 kJ/mol = 45,700 kJ

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

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

You know that:

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

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

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

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

   (d)   H° = −787 − 857.4 + 1559.7 = −84.7 kJ/mol

15a. (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

$$2C_3H_5(NO_3)_3(l) \quad 3N_2 \ (g) + \_O_2 \ (g) + 6CO_2 + 5H_2O \ (g)$$
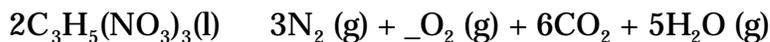
        $H°_f \ C_3H_5(NO_3)_3(l) = -364$ kJ/mol

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

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

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

16a. (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) 32,139 J   (b) 17,456 J   (c) 18,828 J   (d) 3213 J   (e•) 21,339 J

$$q_{heat\ given\ off} = q_{water} + q_{bomb}$$

$$q_{water} = C_{water}\ (J/g°K) \cdot m_{water}\ (g) \cdot \ T°K$$

$$q_{water} = 4.184\ J/g°K \cdot 1500\ g \cdot 3°K$$

$$q_{water} = 18,828\ J$$

$$q_{bomb} \quad = C_{bomb}\ (J/g°K \cdot \ T°K$$

$$= 837\ J/°K \cdot 3°K$$

$$= 2511\ J$$

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

17a. (8 points) The frequency of microwave radiation of all microwaves sold in the U.S. is 2.45 GHz, (1 Ghz = 10^9/sec). What is the wavelength of this radiation (in meters)?

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

$$V = c$$

$$= c/y$$

$$= 3.0 \times 10^8\ m\ s^{-1}/2.45 \times 10^9\ s^{-1}$$

(d)   = .122 m

18a. (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) 3.12 mol photons   (b) 2.36 x 10^9 mol photons   (c) 32.300 mol photons
(d•) 21,400 mol photons(e) 6860 mol photons

q required to heat coffee   = C(J/g °K) · m(g) ·   /T°K
                                   = 4.184 J/g°K · 100 g · 50°C
                                   = 20,920 J

E(J/mol photon) = hV
E(J/mol photon) = 3.99 x 10^{-10} J·sec/mol photon · 2.45 x 10^9 s^{-1}
E = .977 J/mol of photons

No. of photons   = 20,920 J/.977 J/mol of photons
(d)   21,400 mol of photons

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

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

(a) True   (b•) False

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

(a•) True   (b) False

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

(a•) True   (b) False

22a.   Orange light (= 625 nm) has a higher energy than radio waves (0.5 m)

(a•) True   (b) False

23a. 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

24a. In 1910, Rutherford tested Thomson's earlier model of the atom by passing a beam of -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.