Chem 1141
Fall 2014
Exam 3D

Name:_____

Please write your full name, and which exam version (3D) you have on the scantron sheet.

Please ☑ check the box next to your correct section number.

Section #:
- ❒ 1. (Tuesday Lab, 4 – 6:50 pm)
- ❒ 2. (Thursday Lab, 4 – 6:50 pm)
- ❒ 3. (Monday Lab, 11 – 1:50 pm)
- ❒ 4. (Wednesday Lab, 11 –1:50pm)
- ❒ 5. (Wednesday Lab, 2 – 4:50 pm)

Multiple Choice:	_____ **/30**
Q11:	_____ **/10**
Q12:	_____ **/10**
Q13:	_____ **/10**
Q14:	_____ **/10**
Q15:	_____ **/10**
Q16:	_____ **/10**
Q17:	_____ **/10**
BONUS:	_____ **/3**
TOTAL:	_____ **/100**

Multiple Choice. [3 points each.] Record your answers to the multiple choice questions on the scantron sheet.

Q1. The amount of heat required to raise the temperature of **one gram** of a substance by 1°C is the sample's:
a) heat capacity b) internal energy c) enthalpy d) specific heat
e) calorimetry

Q2. In the van der Waals equation, what does the term ***a*** account for?
a) The polarity of the gas particles b) The kinetic energy of the gas particles
c) The attractions between the gas particles d) The size of the gas particles
e) The diffusion of the gas particles

Q3. The overall reaction in a commercial heat pack can be represented as:
$4Fe(s) + 3O_2(g) \longrightarrow 2Fe_2O_3(s)$ $\Delta H^\circ_{rxn} = -1652$ kJ/mol
How much heat is released when 6.000 mol of $O_2(g)$ is reacted?

a) 1652 kJ b) 826.0 kJ c) 3304 kJ d) 9910 kJ e) 275.3 kJ

Q4. Given the following thermochemical equation:
$A(aq) + 2B(aq) \longrightarrow C(g) + D(s)$; $\Delta H^\circ_{rxn} = +12.0$ kJ/mol

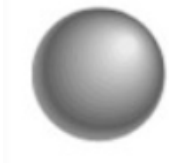
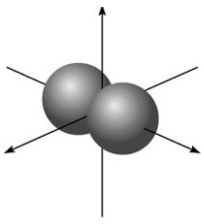
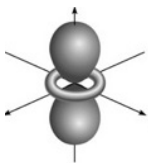
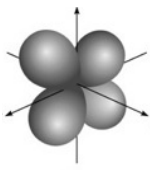
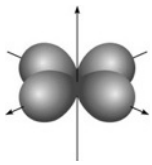
Then calculate ΔH°_{rxn} for:
$2C(g) + 2D(s) \longrightarrow 2A(aq) + 4B(aq)$
a) +24.0 kJ/mol b) −24.0 kJ/mol c) +6.0 kJ/mol d) −6.0 kJ/mol
e) Not enough information to determine

Q5. Which substance(s) below **does not** have a heat of formation (ΔH_f°) equal to zero at 25°C and 1 atm?
a) $N_2(l)$ b) Xe(g) c) Na(s) d) $O_2(g)$ e) a and b

Q6. The set of quantum numbers that correctly describes an electron in a 3p orbital is:
a) $n = 3$; $l = 0$; $m_l = 0$; $m_s = 0$
b) $n = 3$; $l = 2$; $m_l = -2, -1, 0, +1$, or $+2$; $m_s = +½$ or $-½$
c) $n = 3$; $l = 1$; $m_l = -1, 0$, or $+1$; $m_s = +½$ or $-½$
d) $n = 4$; $l = 0$; $m_l = -1, 0$, or $+1$; $m_s = +½$ or $-½$
e) none of the above

Q7. "No two electrons in an atom can have the same four quantum numbers" is a statement called:
a) Pauli exclusion principle b) Bohr's equation c) Hund's rule
d) de Broglie's relation e) Dalton's atomic theory

Q8. Which of the following corresponds to the shape of a p-orbital?

a)  b)  c)  d)  e) 

Q9. Which color of visible light has the highest energy per photon?
a) Red b) Orange c) Yellow d) Green e) Blue

Q10. The ground-state electron configuration of $_{24}Cr$ is:

a) $[Ar]4s^2 3d^4$ b) $[Ar]4s^2 4p^6$ c) $[Ar]4s^0 3d^6$ d) $[V]3d^1$ e) $[Ar]4s^1 3d^5$

Short Response.

Show all work to receive credit. You must use the factor-label (conversion-factor) method for all conversions. Be sure to show all units and write your answers using the correct number of significant figures or decimal places.

Q11. [10 pts.] a) Write the full electron configuration for $_{22}Ti$.

b) Draw out the full orbital diagram for $_{22}Ti$.

c) Is $_{22}Ti$ diamagnetic or paramagnetic? Explain your answer.

Q12. [10 pts.] Calculate the pressure of 23.4 g of nitrogen gas at a temperature of –68 °C and a volume of 0.310 L using the ideal gas equation, and the van der Waals equation. Note: see the table on the back of the exam for the van der Waals parameters.

Q13. [10 pts.] Consider the following reaction:

$2Ca(s) + O_2(g) \longrightarrow 2CaO(s)$ $\Delta H^\circ_{rxn} = -1271.0$ kJ/mol

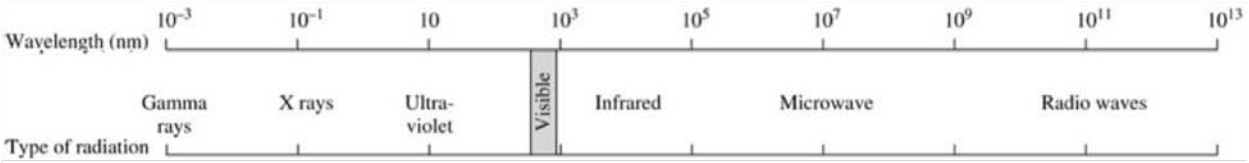
a) Is this reaction **exothermic** or **endothermic**?

b) Calculate the amount of heat transferred when 2.4 g of Ca(s) reacts at constant pressure.

c) How many grams of CaO are produced during an enthalpy change (q_p) of –96 kJ?

d) How much heat is absorbed when 7.50 g of CaO(s) is **<u>decomposed</u>** into Ca(s) and $O_2(g)$ at constant pressure?

Q14. [10 pts.] According to Bohr's theory of the atom, calculate the wavelength of light **absorbed/emitted** (**state which**) by the hydrogen atom in an electron transition from $n = 3$ to $n = 1$. What region of the EM spectrum does this wavelength correspond to?



Q15. [10 pts.] The specific heat of the organic solvent toluene, C_7H_8, is 1.13 J/g·°C. How much heat is needed to raise the temperature of 0.155 kg of toluene from 22.8°C (room temperature) to its boiling point, 111.0°C?

Q16. [10 pts.] Calculate $\Delta H°_{rxn}$ for:

$$C(\text{graphite}) + 2H_2(g) + \tfrac{1}{2}\, O_2(g) \longrightarrow CH_3OH(l)$$

using the following information

$$C(\text{graphite}) + O_2(g) \longrightarrow CO_2(g) \qquad \Delta H° = -393.5 \text{ kJ/mol}$$

$$H_2(g) + \tfrac{1}{2}\, O_2(g) \longrightarrow H_2O(l) \qquad \Delta H° = -285.8 \text{ kJ/mol}$$

$$CH_3OH(l) + {}^3/_2\, O_2(g) \longrightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H° = -726.4 \text{ kJ/mol}$$

Q17. [10 pts.] Fill in the blanks:

Electrons in atoms are described using four quantum numbers. The principal quantum number, n, determines the _____ of the orbital. The angular momentum quantum number, l, which takes values from _____ to _____, determines the _____ of the orbital. The third quantum number, m_l, which is called the _____ quantum number, determines the _____ of the orbital. The final quantum number, m_s which can only take one of two values, is called the _____ quantum number.

The symbol for the wavefunction, or orbital, is given by the Greek letter psi, which is written: _____.

The wavefunction comes from solving the _____ equation—one of the fundamental equations in quantum mechanics.

BONUS: A 60.0 g sample of an alloy was heated to 96.0 °C and then dropped into a beaker containing 87.0 g of water at a temperature of 24.10 °C. The temperature of the water rose to a final value of 27.63 °C. The specific heat of water is 4.184 J/g·°C. What is the specific heat of the alloy?

Useful Information:

$pV=nRT$ $\left(p+\frac{an^2}{V^2}\right)(V-nb)=nRT$ 1 atm = 760 mmHg = 101325 Pa

$R = 0.08206 \frac{\text{atm}\cdot\text{L}}{\text{mol}\cdot\text{K}}$ $v_{rms}=\sqrt{\frac{3RT}{M}}$

$q = ms\Delta t$ $q = C\Delta t$ $c = \nu\lambda$ $E = h\nu$ c = 3.00 x 10^8 m/s

h = 6.626 x 10^{-34} J·s

$E_n = -R_H\left(\frac{1}{n^2}\right)$ R_H = 2.18 x 10^{-18} J $\lambda = \frac{h}{mu}$

van der Waals Constants of Some Common Gases

Gas	a $\left(\frac{\text{atm}\cdot\text{L}^2}{\text{mol}^2}\right)$	b $\left(\frac{\text{L}}{\text{mol}}\right)$
He	0.034	0.0237
Ne	0.211	0.0171
Ar	1.34	0.0322
Kr	2.32	0.0398
Xe	4.19	0.0266
H_2	0.244	0.0266
N_2	1.39	0.0391
O_2	1.36	0.0318
Cl_2	6.49	0.0562
CO_2	3.59	0.0427
CH_4	2.25	0.0428
CCl_4	20.4	0.138
NH_3	4.17	0.0371
H_2O	5.46	0.0305

Periodic Table

1 IA												13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1 **H** 1.01	2 IIA																2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9 VIIIB	10	11 IB	12 IIB	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.1	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.69	29 **Cu** 63.55	30 **Zn** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.6	53 **I** 126.9	54 **Xe** 131.29
55 **Cs** 132.9	56 **Ba** 137.3	57 **La*** 138.9	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.9	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.1	79 **Au** 197.0	80 **Hg** 200.6	81 **Tl** 204.4	82 **Pb** 207.2	83 **Bi** 209	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac^** (227)	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (264)	108 **Hs** (265)	109 **Mt** (268)	110 **Ds** (271)	111 **Rg** (272)							

*	58 **Ce** 140.1	59 **Pr** 140.9	60 **Nd** 144.2	61 **Pm** (145)	62 **Sm** 150.4	63 **Eu** 152.0	64 **Gd** 157.3	65 **Tb** 158.9	66 **Dy** 162.5	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0	71 **Lu** 175.0
^	90 **Th** 232.0	91 **Pa** (231)	92 **U** 238.0	93 **Np** (237)	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (257)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)