

REFERENCE SHEET FOR CHEM 1 MIDTERM EXAMINATION  
(Not all data on this sheet will be necessary for any given exam)

THIS EXAM HAS 8 PAGES (INCLUDING THE COVER)  
MAKE SURE YOU HAVE THEM ALL

**PERIODIC CHART OF THE ELEMENTS**

IA	IIA	IIIB	IVB	VB	VIB	VIIIB	VIII	IB	IIB	IIIA	IVA	VA	VIA	VIIA	INERT GASES				
1 H 1.00797														1 H 1.00797	2 He 4.0026				
3 Li 6.939	4 Be 9.0122													5 B 10.811	6 C 12.0112	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.183
11 Na 22.9898	12 Mg 24.312													13 Al 26.9815	14 Si 28.086	15 P 30.9738	16 S 32.064	17 Cl 35.453	18 Ar 39.948
19 K 39.102	20 Ca 40.08	21 Sc 44.956	22 Ti 47.90	23 V 50.942	24 Cr 51.996	25 Mn 54.9380	26 Fe 55.847	27 Co 58.9332	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.9216	34 Se 78.96	35 Br 79.909	36 Kr 83.80		
37 Rb 85.47	38 Sr 87.62	39 Y 88.905	40 Zr 91.22	41 Nb 92.906	42 Mo 95.94	43 Tc (99)	44 Ru 101.07	45 Rh 102.905	46 Pd 106.4	47 Ag 107.870	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.904	54 Xe 131.30		
55 Cs 132.905	56 Ba 137.34	*57 La 138.91	72 Hf 178.49	73 Ta 180.948	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.967	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.980	84 Po (210)	85 At (210)	86 Rn (222)		
87 Fr (223)	88 Ra (226)	+89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (266)	108 Hs (265)	109 Mt (266)	110 ? (271)	111 ? (272)	112 ? (277)								

Numbers in parenthesis are mass numbers of most stable or most common isotope.

Atomic weights corrected to conform to the 1963 values of the Commission on Atomic Weights.

The group designations used here are the former Chemical Abstract Service numbers.

\* Lanthanide Series

58 Ce 140.12	59 Pr 140.907	60 Nd 144.24	61 Pm (147)	62 Sm 150.35	63 Eu 151.96	64 Gd 157.25	65 Tb 158.924	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.97
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† Actinide Series

90 Th 232.038	91 Pa (231)	92 U 238.03	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (249)	99 Es (254)	100 Fm (253)	101 Md (256)	102 No (256)	103 Lr (257)
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PHYSICAL CONSTANTS

$c=2.998 \times 10^8$  m/s (speed of light)

$e=1.602 \times 10^{-19}$  C (charge of one electron)

$m_e=9.1094 \times 10^{-28}$  g (mass of one electron)

Gas Constant:  $R=8.3145$  J/(mol K) =  $0.08206$  L atm/(mol K)

1 atomic mass unit =  $1.66 \times 10^{-24}$  kg

Planck's Constant:  $h=6.62606876 \times 10^{-34}$  J s

Rydberg constant:  $R_H=1.10 \times 10^7$  m<sup>-1</sup> =  $2.18 \times 10^{-18}$  J

1 cal = 4.184 J

Specific heat of water:  $4.184$  J/g°C

$0.00^\circ\text{C} = 273.15$  K

1 atm = 760 mmHg

**YOU MAY TEAR THIS SHEET OFF  
AND USE IT FOR REFERENCE**

**PUT YOUR NAME ON THE THIRD  
PAGE, AND ALL FOLLOWING PAGES**

NAME \_\_\_\_\_

DATE:

INSTRUCTOR (circle): Islam Kazimierska Zhao Voloshchuk

SHOW ALL WORK USE CORRECT UNITS AND SIGNIFICANT DIGITS  
YOU MAY SHOW YOUR WORK ON THE BACK OF THE SHEET, BUT INDICATE  
YOUR ANSWER ON THE FRONT

PERIODIC TABLE AND REFERENCE DATA MAY BE TORN OFF OF EXAM

14 QUESTIONS, 100 POINTS TOTAL (+2 EXTRA CREDIT AT END OF EXAM)

1. (10 points) Indicate whether each of the following statements is true or false:

T F

- An endothermic reaction absorbs heat from the environment.
- A calorie is the amount of heat required to raise the temperature of 1 g of water by 1°C.
- All molecules in a gas move at the same speed, and that speed increases with temperature.
- Standard Temperature and Pressure (STP) correspond to a temperature of 25° C and a pressure of 1 atmosphere.
- The pressure exerted by a gas is the force of gas particles colliding with a surface averaged over an area of the surface.
- Gamma rays are lower in frequency than visible light.
- One cannot know the exact position and exact momentum of an electron simultaneously.
- Under low pressure conditions, a high voltage applied to an atomic gas will cause it to emit light at certain discrete frequencies.
- In a hydrogen atom, the energy of the electron depends only on the principal quantum number  $n$ .
- The probability density is the probability of finding a quantum mechanical body in a given region of space.

2. (6 points) Vessel A contains O<sub>2</sub> gas at 25°C and 1.0 atm. Vessel B contains CO<sub>2</sub> gas at 10.0°C and 0.75 atm. Both vessels have the same volume. Answer each of the following.

A. (2 points) Which vessel contains more molecules?

B. (2 points) Which vessel contains more mass?

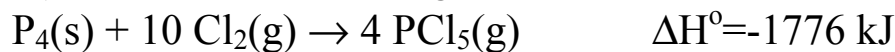
C. (2 points) In which vessel is the root-mean-square speed of the molecules higher?

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3. (12 points) Answer all of the following. No more than 3 sentences should be required.
- A. (3 points) You are conducting an experiment on the photoelectric effect, and observe that, at a certain frequency and intensity of light, no current flows. According to classical physics, what should you do to make current flow between the electrodes?
- B. (3 points) According to de Broglie's theory of matter waves, you have a wavelength. Why haven't you noticed it before?
- C. (3 points) State the First Law of Thermodynamics in words.
- D. (3 points) According to classical mechanics, what should happen to an electron orbiting an atomic nucleus, and what does this imply about an atom?

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4. (6 points) Consider the following reaction:

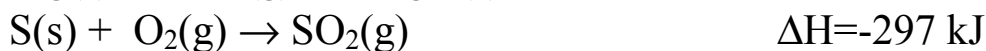
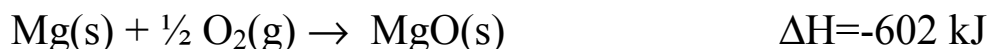
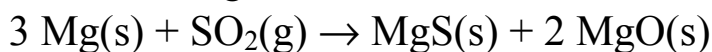


A. (3 points) State how much heat is involved in the creation of 3 moles of  $\text{PCl}_5(\text{g})$ , and state whether the heat is released or absorbed.

B. (3 points) Give the standard enthalpy of formation for  $\text{PCl}_5(\text{g})$ .

5. (4 points) An electrically powered pump is used to pull water out of a well. In the course of an afternoon, the pump does 8.3 kJ of work lifting water out of a well. It also heats up, and releases 300 J of heat to the environment before returning to its original temperature. If there was no net change in the energy of the pump, how much electrical energy was required?

6. (6 points) Use the following information to calculate  $\Delta H$  for the reaction:



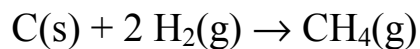
NAME \_\_\_\_\_

7. (6 points) A 100.0 g sample of an unknown metal at  $90.0^{\circ}\text{C}$  is thrown into a calorimeter containing 50.0 g of water at  $25.0^{\circ}\text{C}$ . After the system comes to equilibrium, the temperature is  $31.6^{\circ}\text{C}$ . If no heat is lost to the environment or the calorimeter, calculate the heat capacity of the metal. The heat capacity of water is  $4.184 \text{ J/g K}$ .
8. (6 points) A gas occupies a volume of 0.600 L at  $36^{\circ}\text{C}$  and 1.00 atm pressure. What will its volume be at  $0^{\circ}\text{C}$  and 150.0 mmHg?
9. (6 points) Calculate the mass density of a sample of argon gas at  $-15.0^{\circ}\text{C}$  and 10.0 atm in a 1.00 L flask.

NAME \_\_\_\_\_

10. (5 points) A sample of argon gas escapes through a small hole in a flask at a rate of 5.0 micromoles per second. Calculate the rate of escape for helium from the same flask.

11. (6 points) Hydrogen gas reacts with graphite to form methane according to the equation:



What volume of hydrogen gas at 3.0 atm and 300.0 K is required to react with 36.0 g of carbon?

NAME \_\_\_\_\_

12. (15 points) Answer the following questions.

A. (6 points) Write the full electronic configuration of each atom. Do not condense filled shells.

Na:

Fe:

Kr:

B. (3 points) How many unpaired electrons are there in a sulfur atom?

C. (3 points) In a single atom, what is the maximum number of electrons that can have the quantum numbers  $n=4$ ,  $m_l=2$ ?

D. (3 points) Circle the answer that correctly arranges the species in order of increasing ionization potential:

Cl, Ar,  $K^+$

$K^+$ , Ar, Cl

$K^+$ , Cl, Ar

Cl,  $K^+$ , Ar

13. (6 points) An electron in the hydrogen atom falls from the  $n=5$  state to the  $n=3$  state.

A. (3 points) Calculate the energy released.

B. (3 points) Calculate the frequency of the light emitted in transition.

NAME: \_\_\_\_\_

14. (6 points) Microwave light has a wavelength of  $1.0 \times 10^{-2}$  m. Calculate the number of photons required to heat 10.0 g of water from  $25.0^\circ\text{C}$  to  $30.0^\circ\text{C}$ . The heat capacity of water is  $4.184 \text{ J/g K}$

EXTRA CREDIT:

(1 point): One food calorie is equal to \_\_\_\_\_ metric calories (*i.e.* calories as used in our textbook).

(1 point): Einstein received the Nobel Prize in Physics for his work on what phenomenon?