2009 SPRING Semester Midterm Examination
For General Chemistry I

Date: March 25 (Wed), Time Limit: 7:00 ~ 9:00 p.m.

Write down your information neatly in the space provided below; print your Student ID in the upper right corner of every page.

Professor Name	Class	Student I.D.	Name

Problem	points	Problem	points	TOTAL pts
1	/20	**5**	/20	
2	/15	**6**	/20	
3	/15	**7**	/20	
4	/10			**/120**

** This paper consists of 13 sheets with 7 problems. Please check all page numbers before taking the exam. Write down your work and answers in the (Answer) space below each question.

Please take a good use of the reference materials (Page 12 and 13), which include (a) Fundamental constants, (b) Conversion factors, and (c) Periodic table with atomic weights.

No questions are allowed during the exam.

You are not allowed to leave during the exam. You have to hold your nature call.

Please write down the unit of your answer when applicable. You will get 30% deduction for a missing unit.

NOTICE: SCHEDULES on RETURN and CLAIM of the MARKED EXAM PAPER.

(채점답안지 분배 및 이의신청 일정)

1. Period, and Procedure

   1) Return and Claim Period: ***March 30 (Mon), Quiz Session; 7: 00 ~ 7:30***

   2) Procedure: During the quiz hour, you can take your mid-term paper scored. If you have any claims on it, you can submit a claim paper with your opinion. After writing your opinions on any paper you can get easily, attach it with a stapler to your mid-term paper scored (Please, write your name, professor, and class.). Submit them to your TA. The papers with the claims will be re-examined by TA.

***The claim is permitted only on the period. Keep that in mind*!**

(A solution file with answers for the examination will be uploaded on 3/29 at the web.)

2. Final Confirmation

   1) Period: April 6 (Mon)-7 (Tue)

   2) Procedure: During this period, you can check final score of the examination *on the website* again.

** For further information, please visit a *General Chemistry website* at www.gencheminkaist.pe.kr.

[1] (20 pts) An unidentified compound (MW = 46.07) reacts with O_2 to produce CO_2, H_2O, and N_2. Analysis shows that the unknown material consists of 26.1% carbon, 13.1% hydrogen, and 60.8% nitrogen by mass.

(a) (5 pts) What is its molecular formula? 5 pts for a correct answer and 0 pt for a wrong answer. 2.5 pts if the approach is correct and clear except some error in the calculation.

(Answer)

(a)

$$26.1g\,C \times \frac{1mol\,C}{12.011g\,C} = 2.17\,mol\,C$$

$$13.1g\,H \times \frac{1mol\,H}{1.008g\,H} = 13.0\,mol\,H$$

$$60.8g\,N \times \frac{1mol\,N}{14.0067g\,N} = 4.34\,mol\,N$$

$C_{2.17}H_{13.0}N_{2.00}$ $(CH_{5.99}N_{2.00})$

Close to CH_6N_2

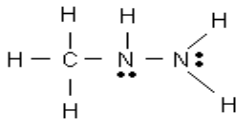
12.011 + (6 X 1.008) + (2 X 14.0067) = 46.07

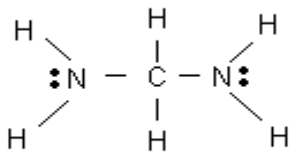
(b) (5 pts) Briefly describe a possible bonding pattern by drawing possible two Lewis structures. 2.5 points each for a correct Lewis structure and 0 pt for wrong answers.

(Answer)

(b) 20 valence electrons (four from carbon, one from six hydrogen, and five each from two nitrogen).

Arrange them, we have two possibilities.





(c) (5 pts) Write a balanced equation for the reaction. 5 pts for a correct answer and 0 pt for a wrong answer.

(Answer)

(c)

$$\_CH_3NHNH_2 + \_O_2 \rightarrow \_CO_2 + \_H_2O + \_N_2$$

$$2CH_3NHNH_2 + 5O_2 \rightarrow 2CO_2 + 6H_2O + 2N_2$$

(d) (5 pts) When a 9.21g sample reacts with 32.0g O_2, how many grams of CO_2 should we expect? 5 pts for a correct answer and 0 pt for a wrong answer. 2.5 pts if the approach is correct and clear with some error in the calculation.

(Answer)

(d)

CH_3NHNH_2 is limiting reactant

$$9.21g\ CH_3NHNH_2 \times \frac{1mol\ CH_3NHNH_2}{46.07g\ CH_3NHNH_2} = 0.2mol$$

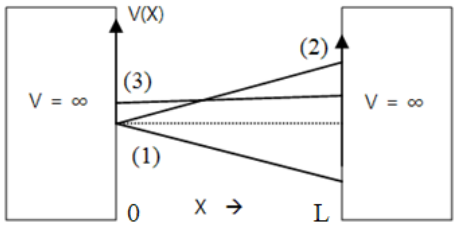
$$0.2mol\ CH_3NHNH_2 \times \frac{1mol\ CO_2}{1mol\ CH_3NHNH_2} \times \frac{44.01g\ CO_2}{1mol\ CO_2} = 8.80g\ CO_2$$

[2] (15 pts) Consider an electron in a one-dimensional box subject to an electric field *E*. When the potential energies are given as below, sketch the wavefunctions for the first two energy levels of this system, and predict the average value of the position of the particle. You don't have to calculate wavefunctions. 5 pts for each case. For each case, 2 pts for each correct wavefunction and 1 pt for the correct prediction for the average value of the position of the particle.

(1) $V(x) = \begin{cases} \infty & x \le 0;\ x \ge L \\ -eEx & 0 < x > L \end{cases}$

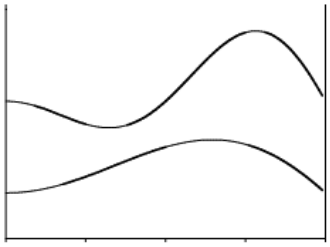
(2) $V(x) = \begin{cases} \infty & x \le 0;\ x \ge L \\ eEx & 0 < x > L \end{cases}$

(3) $V(x) = \begin{cases} \infty & x \le 0;\ x \ge L \\ -eE & 0 < x > L \end{cases}$



(Answer)

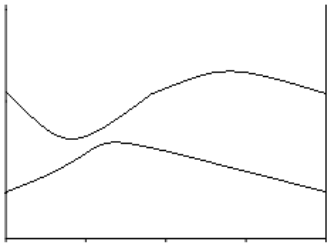
(1)



The average value for x > L/2

(The shape of graph is shifted to right)

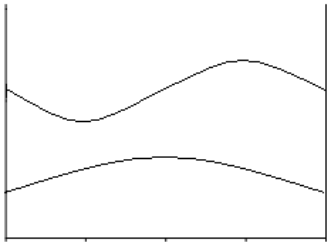
(2)



The average value for x < L/2

(The shape of graph is shifted to left)

(3)



The average value for x = L/2

(In this case, same as V(x) = 0)

[3] (15 pts) The ionization energy of a 1s electron of an hydrogen atom is 13.64 eV.

(a) (5 pts) What is the ionization energy of a 2p electron of an hydrogen atom? 5 pts for a correct answer and 0 pt for a wrong answer. No other pts.

(Answer)

(a) 13.64/4 = 3.41 (eV)

(b) (5 pts) What is the ionization energy of a 1s electron of a He^+ ion? 5 pts for a correct answer and 0 pt for a wrong answer. No other pts.

(Answer)

(b) 13.64*4=54.56 (eV)

(c) (5 pts) The electron with charge –e and the positron with charge +e form a bound state analogous to the hydrogen atom. What is the ionization energy? 5 pts for a correct answer and 0 pt for a wrong answer. No other pts.

(Answer)

(c) The reduced mass = half of the electron mass (because the positron has the same mass as the electron), so 13.64/2 = 6.82 (eV)

[4] (10 pts) Ionization energies for the 1s electrons of the second-row atoms are:

Li	Be	B	C	N	O	F	
4820	10,600	18,300	27,000	38,600	51,100	66,600	(kJ/mol)

Now suppose that a certain substance is bombarded by X-rays having a wavelength of 0.989 nm. If photoelectrons with kinetic energy of 94,000 kJ/mol are ejected from the material, which of the element listed above must be present in the sample? 10 pts for a correct answer with a clear approach and 0 pt for a wrong answer. 5 pts if the approach is correct and clear with some error in the calculation.

(Answer)

(Answer)

$$E = h\nu = \frac{hc}{\lambda}$$

E = ionization energy(I) + kinetic energy of ejected

$(\frac{1}{2}mv^2)$ photoelectron

$$= I + \frac{1}{2}mv^2$$

$$I = E - \frac{1}{2}mv^2$$

$$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34} J \cdot S)(3.00 \times 10^{8} m/s)}{0.989 \times 10^{-9} m} \times \frac{1 kJ}{1000 J} \times \frac{6.02 \times 10^{23}}{1 mol}$$

$$= 1.21 \times 10^{5}\ kJ/mol$$

$$I = E - \frac{1}{2}mv^2$$

$$= (1.21 - 0.94) \times 10^{5}\ kJ/mol$$

$$= 2.7 \times 10^{4}\ kJ/mol$$

appropriate for a carbon atom

[5] (20 pts)

(a) (5pts) Rank the following atoms in the order of increasing electronegativity (for example A < B < C < D < E). 5 pts for a correct answer and 0 pt for a wrong answer. No other pts.

N, Cl, Na, Ca, H.

(Answer)

(a) Na < Ca < H < N < Cl

(b) (5 pts) Rank the following atoms in the order of increasing atomic radius. 5 pts for a correct answer and 0 pt for a wrong answer. No other pts.

Ne, Cl, Ar

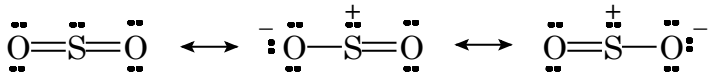
(Answer)

(b) Ne < Ar < Cl

(c) (5 pts) Draw three resonance structures of sulfur dioxide (SO_2). Indicate the formal charges. Indicate which structure is most plausible. 1.5 pts for each correct Lewis structure. 0.5 pt for correctly indicating the most plausible structure.

(Answer)

(c) Three resonance structures with formal charges are:

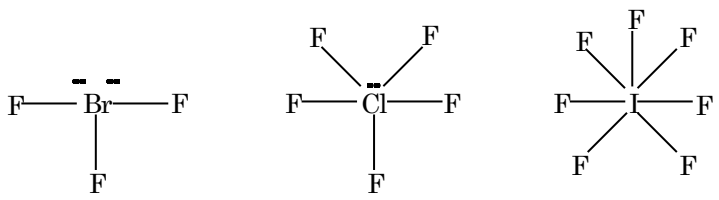


The resonance structure with formal charges of zero (the one on the left) is the most plausible.

(d) (5 pts) Write Lewis structures for BrF_3, ClF_5, and IF_7. Draw only one Lewis structure for each, the most stable one. Identify those in which the octet rule is not obeyed. 1.5 pts for each correct Lewis structure. 0.5 pt for correctly indicating those in which the octet rule is not obeyed.

(Answer)

(d) The three pairs of nonbonding electrons adjacent to each fluorine have been omitted for simplicity.



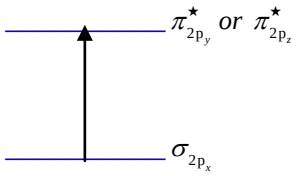
The octet rule is not obeyed in any of the compounds.

[6] (20 pts) Consider an N_2 molecule in its first excited electronic state, that is, when an electron in the highest occupied molecular orbital is promoted to the lowest unoccupied molecular orbital.

(a) (5 pts) Identify the molecular orbitals involved and sketch a diagram for the transition. 2 pts for each correct molecular orbital. 1 pt for a reasonable drawing of the diagram.

(Answer)

(a) From Table 3.4 of the text:



First excited state: N_2^*

Ground state: N_2

(b) (5 pts) What are the bond orders of N_2* and N_2 where the asterisk denotes the excited molecule? Which one has a longer bond length? 2 pts for each correct bond order and 1 pt for the correctly indicating the one with a longer bond length.

(Answer)

(b) The bond order for N_2 is 3. The bond order for N_2^* is ½(5 – 1) □
N_2^* should have a longer bond length than N_2.

(c) (5 pts) Is N_2* diamagnetic or paramagnetic? Note that electrons do not change their spins during transitions. 5 pts for a correct answer, 0 pt for no answer, and **-5 pts for a wrong answer**. No other points.

(Answer)

(c) N_2^* is diamagnetic or paramagnetic. Both of them are correct.

(d) (5 pts) When N_2* loses its excess energy and converts to the ground state, it emits a photon of wavelength 470 nm, which makes up part of the auroras lights. Calculate the energy difference between these levels. 5 pts for a correct answer and 0 pt for a wrong answer. 2.5 pts if the approach is correct and clear with some error in the calculation.

(Answer)

(d) $$E = \frac{hc}{\lambda} = \frac{(6.63 \times 10^{-34}\ \text{J s})(3.00 \times 10^{8}\ \text{m s}^{-1})}{470 \times 10^{-9}\ \text{m}} = 4.23 \times 10^{-19}\ \text{J}$$

[7] (20 pts) Classify each of the following statements as 'True' or 'False'. You will get 1 pt for a correct answer, 0 pt for no answer, and **-0.5 pt for a wrong answer**.

(a) A homogenous mixture is also called solution.

(Answer) (a) T

(b) Water is a compound.

(Answer) (b) T

(c) Radiant energy is the energy associated with the random motion of atoms and molecules.

(Answer) (c) F

(d) Millikan determined the electron charge-to-mass ratio.

(Answer) (d) F

(e) Chadwick provided experimental evidence for the existence of neutron.

(Answer) (e) T

(f) An allotrope is one of two or more distinct forms of a compound.

(Answer) (f) F

(g) Molality is the number of molecules of solute dissolved in 1000 g of solvent.

(Answer) (g) F

(h) Young's two-slit experiment demonstrate the wave-like property of light.

(Answer) (h) T

(i) Franck-Hertz experiment confirmed the Einstein's interpretation of the photoelectric effect.

(Answer) (i) F

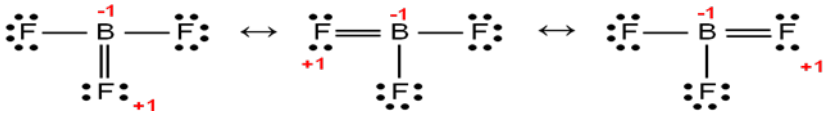
(j) Schrodinger postulated that the probability of finding the particle in a particular small region of space was proportional to the square of the wavefunction.

(Answer) (j) F

(k) The quantization of the energy levels of a system is a direct result of the localization of the particle in a finite region of space by the potential energy.

(Answer) (k) T

(l) Boron trifluoride (BF_3) readily reacts with ammonia. This property is best explained by the following three resonance structures.



(Answer) (l) F

(m) Valence bond theory is based on the concept that electrons in a molecule occupy the atomic orbitals of the individual atoms. Therefore, the ground-state wavefunction of H_2 can be best written as the product of the two 1*s* orbitals on the separate hydrogen atoms A and B as shown below, where the labels 1 and 2 denote electron 1 and electron 2, respectively.

$$\psi_{VB} = \phi_{A,1s}(1)\phi_{B,1s}(2)$$

(Answer) (m) F

(n) O_2^-, O_2 and O_2^+ species are all paramagnetic with the increasing bond order of $O_2^- < O_2 < O_2^+$.

(Answer) (n) T

(o) The occurrence of a closely spaced doublet Na D-line is due to the screening effect and the existence of electron spins.

(Answer) (o) T

(p) The quantum state of an electron in hydrogen or hydrogen-like ions is completely specified by the four quantum numbers n, ℓ, m_ℓ and m_s. The quantum numbers n, ℓ, and m_ℓ determine the energy, orientation and shape of orbitals, respectively and m_s denotes electron's intrinsic spin.

(Answer) (p) F

(q) The first ionization energies of elements in a period increase with increasing atomic number. But, for the third period, an irregularity occurs between P and S due the reason of the better shielding ability of the core and ns^2 electrons.

(Answer) (q) F

(r) Atomic radii of elements N, O, F, Na, Mg, and Al decrease in the order of Na > Mg > Al > N > O > F. But, the radii of their isoelectronic ions decrease in the order of $N^{3-} > O^{2-} > F^{-} > Na^{+} > Mg^{2+} > Al^{3+}$.

(Answer) (r) T

(s) The effective nuclear charge is the charge felt by a nucleus screened by core electrons.

(Answer) (s) F

(t) Shown below are X-ray (left figure) and electron (right figure) diffraction pattern of Al foil. These experiments are supportive of not only de Broglie's hypothesis but also the hypothesis made by Einstein to explain the photoelectric effect.

(Answer) (t) T

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3	/10	**7**	/10	
4	/15			**/100**

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(채점답안지 분배 및 이의신청 일정)

1. Period, Location and Procedure

   1) Return and Claim Period: ***May 23 (Saturday), 9: 00 ~ 12:00***

   2) Location: Lobby (1st floor), Goong-Ni Laboratory Building

   3) Procedure: During the period, you can take your paper scored. If you have any claims on it, you can submit a claim paper with your opinion. After writing your opinions on any paper you can get easily, attach it with a stapler to your paper scored (Please, write your name, professor, and class.). **Put them into a paper box in front of elevator**. The papers with the claims will be re-examined by TA.

   ***The correction is permitted only on the period. Keep that in mind*!**

   (A solution file with answers for the examination will be uploaded on 5/22 at the web.)

2. Final Confirmation

   1) Period: May 26 (Tue)-27 (Wed)

   2) Procedure: During this period, you can check final score of the examination *on the website* again.

[1] (20 pts) Mixing $SbCl_3$ and $GaCl_3$ in a 1:1 molar ratio, gave a solid ionic compound of molecular formula $GaSbCl_6$. Possible structures are $(SbCl_2^+)(GaCl_4^-)$ and $(GaCl_2^+)(SbCl_4^-)$.

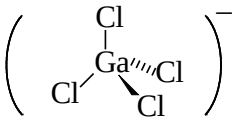
(a) (6 pts) Using VSEPR theory, predict the geometries of the anions ($GaCl_4^-$ and $SbCl_4^-$) in the above possible structures. 3 pts for each correct answer.

(Answer)

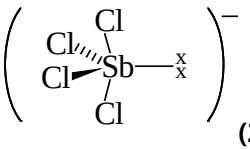
(Answer)

(a)

In $GaCl_4^-$, the central atom (Ga, group 3) has a steric number (SN) of 4 and is tetrahedral:



Sb (group 5) in $SbCl_4^-$ has SN = 5, with a trigonal bipyramidal arrangement of electrons. Its actual shape is "seesaw", with distorted ClSbCl bond angles:

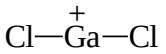


(2 x 3 points)

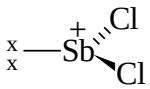
(b) (4 pts) It was discovered from vibrational spectroscopy that the cation in the compound has a bent geometry. Based on this fact, determine which of the above formulations is correct. Show working. No pts if the reasoning (working) is not shown or wrong.

(Answer)

(b) The cation $GaCl_2^+$ is linear, whereas $SbCl_2^+$ is bent:



(SN =2)



(SN =3)

Hence $(SbCl_2^+)(GaCl_4^-)$ is the correct formulation.

(c) (4 pts) Describe each of the following molecules as polar or nonpolar. 4 pts for six correct answers, 2 pts for five or four correct answers, and 0 pts for three or a smaller number of correct answers.

(i) SO_3

(Answer) (i) SO_3 **nonpolar**

(ii) SO_2

(Answer) (ii) SO_2 **polar**

(iii) NO_2

(Answer) (iii) NO_2 **polar**

(iv) CO_2

(Answer) (iv) CO_2 **nonpolar**

(v) BCl_3

(Answer) (v) BCl_3 **nonpolar**

(vi) $BClF_2$

(Answer) (vi) $BClF_2$ **polar**

(d) (6 pts) State which attractive forces are likely to predominate in associations among the particles of the following substances. 2 pts for each correct answer.

(i) SO_2 (liquid)

(Answer) (i) SO_2 (liquid) **dipole-dipole**

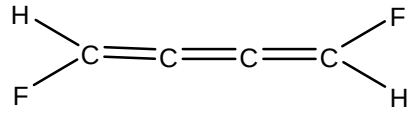
(ii) C_6H_{14} (hexane) (liquid)

(Answer) (ii) C_6H_{14} (hexane) **London dispersion** (liquid)

(iii) CaF_2 (solid)

(Answer) (iii) CaF_2 (solid) **ionic** or **electrostatic**

[2] (15 pts)

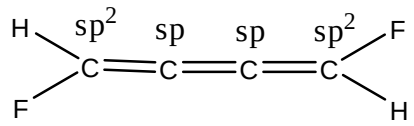


1,4-difluorobuta-1,2,3-triene

(a) (4 pts) Use Pauling's atomic hybridization theory to label the hybridization mode for each of the carbon atoms in the molecule 1,4-difluorobuta-1,2,3-triene:

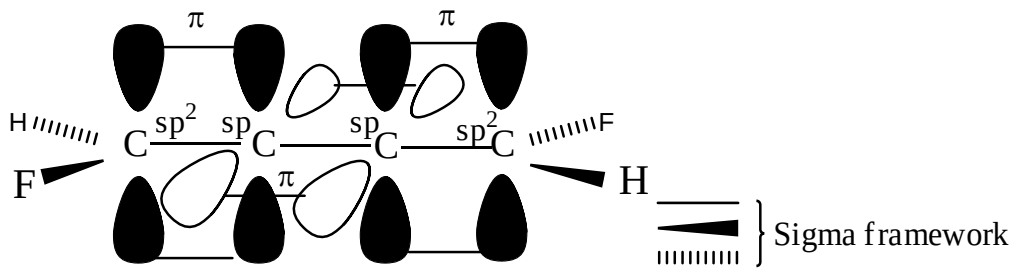
(Answer)

1 pt for each



(b) (7 pts) Sketch the sigma framework (4 pts) and π–bonds (3 pts) for this structure.

(Answer)



0.5 pt for each sigma framework (0.5 pt×7 = 3.5 pts + 0.5 pt). 0.5 pt for each π bonds. (0.5 pt × 6)

(c) (4 pts) Explain whether this molecule has a dipole moment.

(Answer)

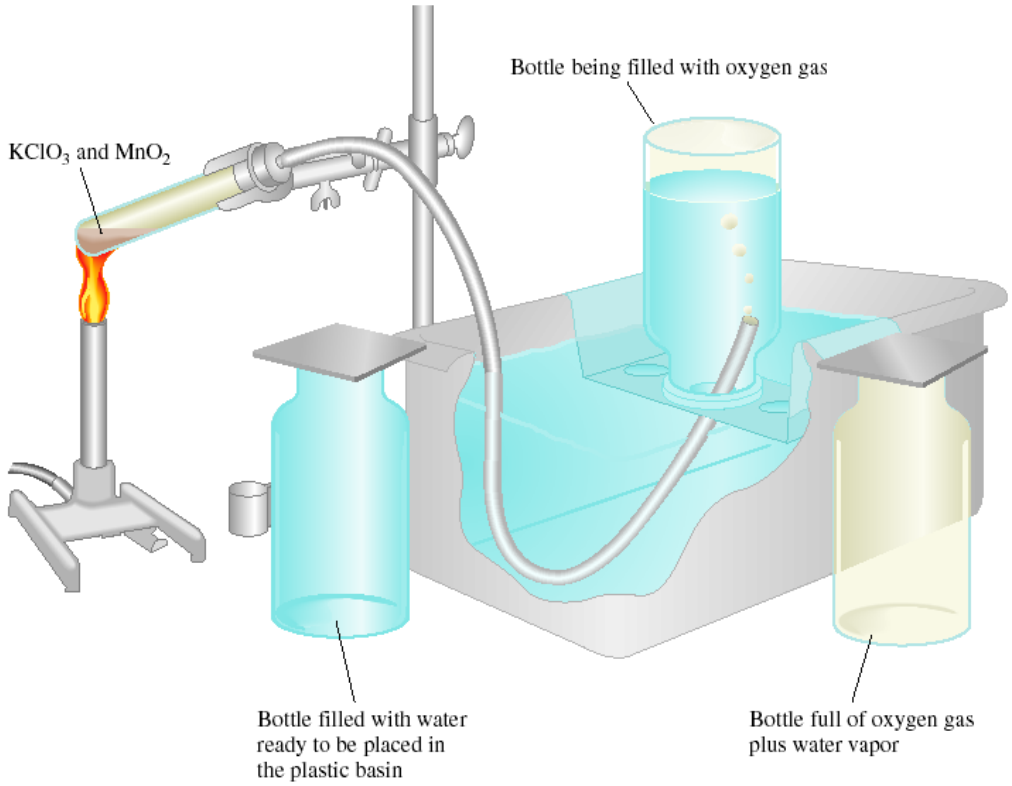
(c) Since the H and F atoms are in the same plane and the molecule has a center of symmetry, bond dipole moments cancel. (2 pts) Hence this molecule as a zero dipole moment. (2 pts)

[3] (10 pts)

(a) (4 pts) Oxygen gas generated by the decomposition of potassium chlorate according to the reaction

$$2KClO_3\,(s) \longrightarrow 2KCl\,(s) + 3O_2\,(g)$$

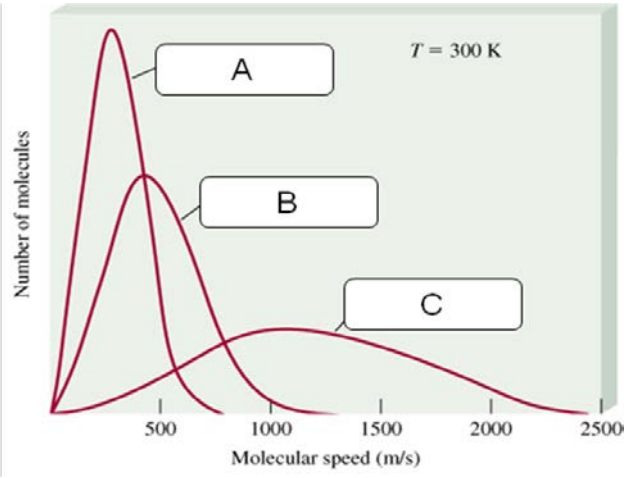
is collected over water at 32°C and an ambient pressure of 762 torr as shown in the following figure. The equilibrium vapor pressure of water at 32°C is 32 torr. What is the partial pressure of oxygen?



(Answer)

(a) 762 torr – 32 torr = 730 torr

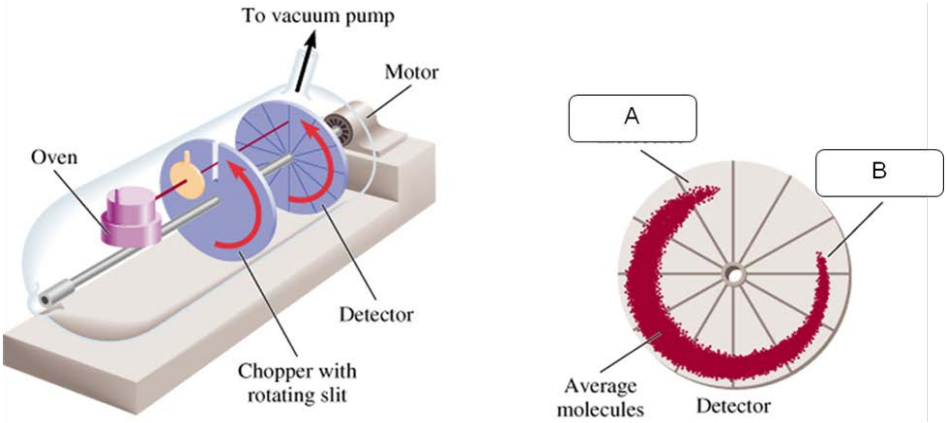
(b) (3 pts) The following figure shows the distribution of molecular speeds for three different gases (He, N_2, and Cl_2) at 300 K. Which curve among A, B and C corresponds to He? 3 pts for the correct answer, 0 pts for no answer, and **-2 pt for wrong answers**.



(Answer)

(b) C

(c) (3 pts) The following figure shows an apparatus for studying molecular speed distribution at a certain temperature and the measured spread of the deposit on the detector. Among A and B, which part corresponds to fast molecules? 3 pts for the correct answer, 0 pts for no answer, and **-2 pt for wrong answers**.



(Answer)

(c) B

[4] (15 pts) Consider a body-centered cubic unit cell.

(a) (2 pts) What is the coordination number? 2 pts for a correct answer and 0 pts for wrong answers.

(Answer) 8

(b) (2 pts) How many complete sphere atoms are contained in one unit cell? 2 pts for a correct answer and 0 pts for wrong answers.

(Answer)

2

(c) (5 pts) The mathematical relationship between the edge length (a) and the radius (r) of an atom is $a = \frac{4r}{\sqrt{3}}$. Show the steps leading to this relationship. 5 pts for a correct derivation and 0 pts for wrong or insufficient derivations. Some partial points can be given if the error is minor.

(Answer)

$b^2 = a^2 + a^2$

$c^2 = a^2 + b^2 = 3a^2$

$c = \sqrt{3}a = 4r$

$a = \frac{4r}{\sqrt{3}}$

(d) (6 pts) What fraction of the total space in a body-centered cubic unit cell is unoccupied? Assume that the central atom touches each of the eight corner atoms of the cube and the atoms are spherical. (1~2 pts for the approach is correct and clear with some error in the calculation.)

(Answer)

First determine the volume of the atoms.
no. of atoms in unit cube
$= (\frac{1}{8} atom/corner \times 8 corners)$ + 1 atom (in center) = 2 atoms

The volume of a sphere is $\frac{4}{3}\pi r^3$

volume of 2atoms $= 2 \times \frac{4}{3}\pi(1)^3 = 8.38$

the volume of the cube is equal to the length of the side cubed.
The relationship between the edge length a and radius r of atoms in the body-centered cubic cell is $a = \frac{4r}{\sqrt{3}}$

Volume of cube = $(\frac{4}{\sqrt{3}})^3$ = 12.32

Volume of space = Volume of cube - Volume of spheres
= 12.32 - 8.38 = 3.94

percentage of cube taken by up space = $\frac{3.94}{12.32} \times 100 = 32\%$

[5] (15 pts) Consider a system composed of one mole of liquid water at 25°C placed in a cylinder with a movable piston. In other words, the system includes liquid water plus the cylinder. This system is then heated under a constant external pressure of 1 bar until all the water evaporates and the final volume of the gas is 33.0 liter.

The change in state is

H_2O(l, 25°C, 1 bar) + Cylinder(25°C) → H_2O (g, T, 1 bar, 33L) + Cylinder(T)

Assume that gaseous water is an ideal gas. C_p of liquid water and gaseous water is 75.3 J K^{-1} mol^{-1} and 40.2 J K^{-1} mol^{-1}, respectively. C_p of cylinder is 1000 JK^{-1}. The heat of vaporization of water at 1 bar and 373 K is 40.6 kJ mol^{-1}.

a) (5 pts) Calculate the final temperature of the system.

(Answer)

$$T = \frac{PV}{R} = \frac{(1)(33)}{0.082} = 402K$$

b) (10 pts) Compute ΔH for the system. (10 pts for correct working and answers. 3 pts for the approach is correct and clear with some error in the calculation.)

(Answer)

(b)

H_2O(l, 298K, 1bar)+C(298K)→H_2O(l, 373K, 1bar)+C(373K) $-\triangle H_1$

H_2O(l, 373K, 1bar)+C(373K)→H_2O(g, 373K, 1bar)+C(373K) $-\triangle H_2$

H_2O(g, 373K, 1bar)+C(373K)→H_2O(g, 402K, 1bar)+C(402K) $-\triangle H_3$

$\triangle H = \triangle H_1 + \triangle H_2 + \triangle H_3$

= 75.3 (373-298) + 1000 (373-298) + 40600

+ 40.2 (402-373) + 1000 (402-373)

= 5647.5 + 75000 + 40600 + 1165.8 + 29000

= 151413.3J = **151.4kJ**

[6] (15 pts) From the following data, calculate the heat of solution for KI. (Hint: $\Delta H_{soln} = U_{latt.} + \Delta H_{hydr}$, where ΔH_{soln} is the heat of solution, U_{latt} is the lattice energy, and ΔH_{hydr} is heat of hydration)

	NaCl	NaI	KCl	KI
Lattice energy (kJ mol^{-1})	788	686	699	632
Heat of solution (kJ mol^{-1})	4.0	-5.1	17.2	?

(15 pts for correct answers. 4 pts for the approach is correct and clear with some error in the calculation.)

(Answer)

(Answer)

Begin by using $\Delta H_{soln} = U_{latt} + \Delta H_{hydr}$, where U_{latt} is the lattice energy (see section 7.6).

(1) $Na(g) + Cl^-(g) \rightarrow Na(aq) + Cl^-(aq)$ $\Delta H_{hydr} = (4.0 - 788)\ kJ\ mol^{-1} = -784.0\ kJ\ mol^{-1}$

(2) $Na(g) + I^-(g) \rightarrow Na(aq) + I^-(aq)$ $\Delta H_{hydr} = (-5.1 - 686)\ kJ\ mol^{-1} = -691.1\ kJ\ mol^{-1}$

(3) $K(g) + Cl^-(g) \rightarrow K(aq) + Cl^-(aq)$ $\Delta H_{hydr} = (17.2 - 699)\ kJ\ mol^{-1} = -681.8\ kJ\ mol^{-1}$

Adding together equation (2) and (3) and then subtracting equation (1) gives the equation for the hydration of KI.

(2) $Na(g) + I^-(g) \rightarrow Na(aq) + I^-(aq)$ $\Delta H = -691.1\ kJ\ mol^{-1}$

(3) $K(g) + Cl^-(g) \rightarrow K(aq) + Cl^-(aq)$ $\Delta H = -681.8\ kJ\ mol^{-1}$

(1) $Na(aq) + Cl^-(aq) \rightarrow Na(g) + Cl^-(g)$ $\Delta H = 784.0\ kJ\ mol^{-1}$

$K(g) + I^-(g) \rightarrow K(aq) + I^-(aq)$ $\Delta H = -588.9\ kJ\ mol^{-1}$

We combine this last result with the given value of the lattice energy to arrive at the heat of solution of KI.

$\Delta H_{soln} = U_{latt} + \Delta H_{hydr} = (632\ kJ\ mol^{-1} - 588.9\ kJ\ mol^{-1}) = 43\ kJ\ mol^{-1}$

[7] (10 pts) Classify each of the following statements as 'True' or 'False'. You will get 0.5 pt for a correct answer, ***0 pt for no answer***, and **-0.3 pt for a wrong answer**.

(a) Geometric isomers come in pairs that differ from each other in their interactions with plane-polarized light.
(Answer) F

(b) The VSEPR model predicts that the molecular structure of XeF_6 is octahedral.
(Answer) F

(c) The four hydrogen atoms of $CH_2=C=CH_2$ are present in the same plane.
(Answer) F

(d) The zeroth law of thermodynamics can be stated that for a given two systems in contact temperature is the quantity that controls the direction of energy flow between the two systems.
(Answer) F

(e) Earth has only a trace amount of helium in its atmosphere because the natural abundance of helium in Earth is very low.
(Answer) F

(f) For a given gas molecule, the most probable molecular speed and the distribution of molecular speed increases and becomes narrow, respectively, as the temperature increases.
(Answer) F

(g) There are 14 Bravais types of unit cells.
(Answer) F

(h) The ABAB arrangement in closest packing gives rise to a cubic cell that shows the relationship of $a = (8)^{1/2} r$ between the atomic radius r and the edge length a.
(Answer) F

(i) The calculated molar C_P of CO_2 molecule at room temperature largely deviates from that of the measured value due to its linear nature.
(Answer) F

(j) According to the equipartition theorem of energy, a nonlinear ideal gas molecule containing N atoms has 3N degree of freedom and thus can contribute (3/2)NR to C_V.

(Answer) F

(k) The root-mean-square speed is larger than the most probable speed.

(Answer) T

(l) The MOs for O_3 have a nonbonding orbital.

(Answer) T

(m) Acetic acid (CH_3COOH) exists largely as dimeric molecules in solvents such as carbon tetrachloride.

(Answer) T

(n) When adhesion is greater than cohesion, a depression of the liquid in the capillary tube results.

(Answer) F

(o) The constant-pressure heat capacity is always larger than the constant-volume heat capacity.

(Answer) T

(p) For the heating curve (x-axis: energy added as heat, y-axis: temperature), the slope for liquid water is larger than the slope for liquid argon.

(Answer) F

(q) Enthalpy change is always stored as bond energies.

(Answer) F

(r) Solids containing donor impurities are called n-type semiconductors.

(Answer) T

(s) The measured heat capacity of Cl_2 is larger than that of I_2 at 298 K and 1 bar.

(Answer) F

(t) Triclinic lattice has the lowest symmetry.

(Answer) T