KEY

Chem 1A First Midterm Examination
February 7, 2005
Professor David Chandler

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Extra	

Name:_____ _____

Signature:_____

Section:_____

GSI:_____

Instructions

As indicated, either fill in blank space with appropriate symbol or number or circle the correct answer(s). Some multiple choice questions may have more than one correct answer, in which case all correct answers are required for full credit.

Use back of pages for your scratch work.

Physical constants you may need:

N_0 (Avogadro's #) = 6.022×10^{23} mol^{-1}

1 angstrom (Å) = 10^{-10} m = 100 pm

Speed of light = 3.0×10^8 m/s

H (Planck's constant) = 6.626×10^{-34} J·sec

Ionization Potential of H = 2.18×10^{-18} J

0 K = -273.15°C

10 pts 1. For an experiment in lab, a student reacts baking soda ($NaHCO_3$) with 6.00 M vinegar (CH_3COOH) to produce carbon dioxide (CO_2) plus sodium acetate ($NaCH_3COO$) and water (H_2O). If 0.9864 g of $NaHCO_3$ is reacted with 1.50 mL of vinegar, how many moles of CO_2 will be produced?

A) 1.17×10^{-2} B) 9.00×10^{-3} C) 0.396 D) 6.00 E) 9.00

3 pts 2. (a) An expected empirical formula for a compound of Mg and O is

A) Mg_2O B) MgO C) MgO_2 D) Mg_2O_3

3 pts (b) Similarly, a compound of Li and H

A) is LiH B) is LiH_2 C) doesn't exist D) is Li_2H

4 pts (c) Which of the following is NOT expected to be a stable compound

A) FeO B) Fe_2O_3 C) NaOH D) $Ca(OH)_3$

6 pts 3. A single K^+ ion contains ___**(B) 18**____ electrons, ___**(C) 19**__ protons and most probably __**(D) 20**__ neutrons. (Fill in all three blanks)

A) 17 B) 18 C) 19 D) 20

4 pts 4. The typical size of an atom is

A) 10^{-8} cm B) 10^{-8} km C) 10^{-8} m D) 1000 nm

4 pts 5. Which of the following equations represents the reaction which occurs least vigorously?

A. $Be(s) + 2HNO_3\,(aq) \rightarrow Be(NO_3)_2\,(aq) + H_2(g)$

B. $Ca(s) + 2HNO_3\,(aq) \rightarrow Ca(NO_3)_2\,(aq) + H_2(g)$

C. $Ba(s) + 2HNO_3\,(aq) \rightarrow Ba(NO_3)_2\,(aq) + H_2(g)$

10 pts 6. A 0.5 g sample of an unknown acid is neutralized with 20 ml of .25 M NaOH (aq). Assuming the acid has two acidic protons per molecule, the molecular mass of the acid is

A) 25 g/mol B) 50 g/mol C) 75 g/mol D) 100 g/mol E) 200 g/mol

4 pts 7. Small quantities of chlorine gas can be prepared by the following reaction

$$a\ MnO_2(s) + b\ HCl\ (aq) \rightarrow c\ MnCl_2(aq) + d\ Cl_2(g) + e\ H_2O\ (l)$$

where *a, b, c, d, e* are the stoichiometric coefficients. The ratio a/b for the balanced reaction is

A) 1/2 B) 1/3 C) 1/4 D) 2/3

8. The volume of 1 mole of solid Ne is: V = 13.2 cm^3

6 pts (a) Estimate the radius of a Ne atom, r_{Ne}

if the volume of a mole of atoms is 13.2 cm^3, then we can just solve for the volume of 1 atom

$$V_{atom} = \frac{13.2 cm^3}{6.02 \times 10^{23}} = 2.19 \times 10^{-23} cm$$

the cube root will be the diameter of one atom in cm

$$diameter_{atom} = \sqrt[3]{2.19 \times 10^{-23}} = 2.8 \times 10^{-8} cm$$

the diameter is 2 * radius, so the radius is 1.4×10^{-8} cm or 1.4 Å

1.4 Å

[Show work and put estimate in box]

4 pts (b) The distance between the centers of nearest neighbor oxygen atoms in ice is:

A. roughly the same as r_{Ne} B. roughly the same as $2r_{Ne}$

C. smaller than r_{Ne}

4 pts (c) The space filling radius of the F^- ion is:

A. roughly the same as r_{Ne} B. about 1Å larger than r_{Ne}

C. about 1Å smaller than r_{Ne}

4 pts (d) The F-F bond length of the F_2 molecule is:

A. roughly the same as $2r_{Ne}$ B. about 1Å larger than $2r_{Ne}$

C. about 1Å smaller than $2r_{Ne}$

4 pts (e) The closest distance between F atoms of different F_2 molecules in solid F_2 is:

A. roughly the same as $2r_{Ne}$ B. about 1Å larger than $2r_{Ne}$

C. about 1Å smaller than $2r_{Ne}$

4 pts 9. (a) According to the uncertainty principle, determining the location of a particle to some high accuracy:

A. is made possible by lowering the energy of the particle so as not to disturb it

B. forces the energy of the particle to be large

C. can never be accomplished

4 pts (b) The fact that light diffracts:

A. demonstrates that light is composed of photons with particle-like properties

B. demonstrates that light has wave-like properties

C. implies an uncertainty in the wavelength of a photon

4 pts (c) A typical x-ray wavelength is:

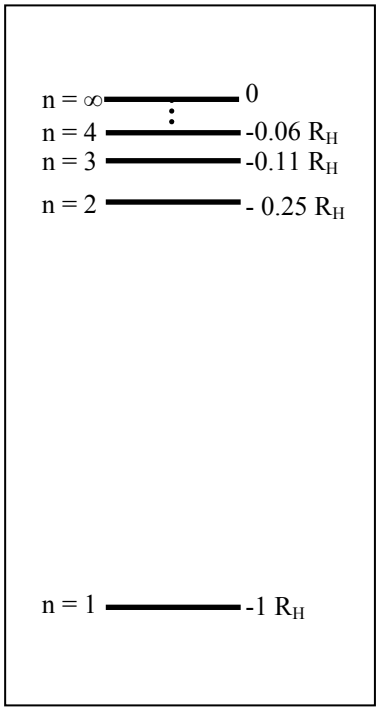
A) 1Å B) 1000Å C) 1cm D) 1m

8 pts (d) Imagine that an electron is confined to a sphere of radius 0.5 Å. In its lowest energy state, kinetic energy of the electron is on the order of:

A) 10^{-13} J B) 10^{-18}J C) 10^{-23}J D) 10^{-27}J

10. Given the diagram for the electronic energy levels of hydrogen atom, answer the two questions below.

Atomic Energy Levels for Hydrogen



5 pts (a) Suppose that you shine light of energy 0.75 R_H on an H atom in the ground state. What happens to the light and to the electron? (R_H is 2.179×10^{-18} J/atom)

A) The light is absorbed and the final energy of the electron is –0.20 R_H.

B) The light is absorbed and the final energy of the electron is –0.25 R_H.

C) The light is absorbed and the final energy of the electron is –0.80 R_H.

D) The light is not absorbed and the final energy of the electron is –1.00 R_H.

5 pts (b) What wavelength of light (nm) will be emitted by an excited hydrogen atom when an electron relaxes from the n=4 to the n=2 level?

A) 954 B) 656 C) 486 D) 434 E) 410

Extra Credit: 10 pts

10. An electron bound in an atom is photo ionized with an x-ray of wavelength $\lambda=2.2\text{Å}=2.2\times10^{-10}$m. The kinetic energy of the ionized electron is measured to be 1.1×10^{-16} J. With what energy is the electron bound before it is ionized? (Hint: Conservation of energy, the photon energy and the electron's final kinetic energy provide the information you need for your answer)

$KE_{(electron)} = h\nu - w$ or $KE_{(electron)} = E_{photon}$ – binding energy or equivalent

convert E_{photon} to joules $E = h\nu$, $c=\lambda\nu$, $E = hc/\lambda$

$$E_{photon} = \frac{(6.626\times10^{-34}\,\text{Js})\times(3.00\times10^{8}\,\text{m/s})}{2.2\times10^{-10}\,m} = 9.0\times10^{-16}\,J$$

binding energy = $KE_{(electron)}$ - E_{photon}

binding energy = $1.1\times10^{-16}J - 9.0\times10^{-16}J = 7.9\times10^{-16}J$

$7.9\times10^{-16}J$

[Show your work and put answer in box]