

Chemistry 14A Fall 2007: Quiz 1 Professor: Lavelle

Name: Cristina Souza

Student ID Number: 503589224

TA: _____

Discussion Section: _____

Write in Pen.

Check your significant figures and units.

Good Luck.

Total points: 40

Total time: 40 minutes

2pt for sf

2pt for units

Planck's constant, $h = 6.62608 \times 10^{-34} \text{ J}\cdot\text{s}$

Avogadro's constant, $N_A = 6.02214 \times 10^{23} \text{ mol}^{-1}$

Rydberg constant, $R = 3.28984 \times 10^{15} \text{ Hz}$

Boltzmann's constant, $k = 1.38 \times 10^{-23} \text{ J}\cdot\text{K}^{-1}$

Faraday's constant, $F = 96,485 \text{ C}\cdot\text{mol}^{-1}$

Gas constant, $R = 8.314 \text{ J}\cdot\text{K}^{-1}\cdot\text{mol}^{-1} = 8.206 \times 10^{-2} \text{ L}\cdot\text{atm}\cdot\text{K}^{-1}\cdot\text{mol}^{-1} =$

$8.314 \times 10^{-2} \text{ L}\cdot\text{bar}\cdot\text{K}^{-1}\cdot\text{mol}^{-1} = 62.364 \text{ L}\cdot\text{Torr}\cdot\text{K}^{-1}\cdot\text{mol}^{-1}$

Mass of electron, $m_e = 9.1095 \times 10^{-31} \text{ kg}$

Speed of light, $c = 2.99792 \times 10^8 \text{ m}\cdot\text{s}^{-1}$

$C_2 =$ Second radiation constant $= 0.0144 \text{ K}\cdot\text{m}$

$0^\circ\text{C} = 273.15 \text{ K}$

$1\text{L} = 1 \text{ dm}^3$

$1 \text{ atm} = 101.325 \text{ kPa}$

$\pi = 3.14$

Water Density $= 1 \text{ g}\cdot\text{ml}^{-1}$

$\ln(X) = 2.303 \log_{10}(X)$

$1 \text{ kcal} = 4.18 \text{ kJ}$

$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$

$$c = \lambda \nu$$

$$E = h \nu$$

$$E = pc$$

$$p = mv$$

$$E_n = -\frac{hR}{n^2}$$

$$\lambda = \frac{h}{p}$$

$$E = \frac{1}{2} m v^2$$

$$T \lambda_{\text{MAX}} = \frac{1}{5} C_2$$

$$\Delta p \times \Delta x \geq \frac{h}{4\pi}$$

$$E_n = \frac{h^2 n^2}{8 m L^2}$$

$$E_{\text{TOTAL}} \psi(x) = E_K \psi(x) + V(x) \psi(x) = -\frac{h^2}{8\pi^2 m} \frac{d^2 \psi(x)}{dx^2} + V(x) \psi(x)$$

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 $R = 8,31447 \text{ J mol}^{-1} \text{ K}^{-1}$
 Avogadro skaitis
 $N = 6,022137 \cdot 10^{23} \text{ mol}^{-1}$
 Faradėjaus skaitis
 $F = 96485,31 \text{ C/mol}$

1. Suppose 12.4 g of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, are dissolved in water to produce 800. mL of solution. What is the molarity of ethanol molecules in the solution? (3 pts)

Answer

0.336 M

$$M = \frac{m_{\text{solute}}}{L_{\text{solution}}} = \frac{.2695652 \text{ mol}}{.8 \text{ L}} = .336 \text{ M}$$

2. You need to prepare 666. mL of 0.150 M $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (aq) using a 0.900 M $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (aq) stock solution. What is the volume of stock solution needed? (3 pts)

Answer

→ .111 L

3. What is the wavelength of a radio station transmitting at 99.1 MHz? (3 pts)

- A. 330 nm
- B. 303 nm
- C. 0.00303 m
- D. 3.03 m
- E. 0.330 m

$$c = \lambda \nu \rightarrow 3 \times 10^8 = \lambda (99100000)$$

$$\lambda = 3.03 \text{ m}$$

4. A lawyer who received a speeding ticket argues that because of the Heisenberg uncertainty principle the radar reading is uncertain. The judge, who happens to have a science degree, rules against the lawyer. Which of the following statements is true? (3 pts)

- A. The judge is incorrect because the uncertainty in position is large.
- B. The judge is correct because the car is so massive that the uncertainty in speed is very small.
- C. The judge is correct because the uncertainty in momentum is very large.
- D. The judge is incorrect because radar has only wave characteristics.
- E. The judge is incorrect because $(m\Delta v)(\Delta x) \geq \frac{1}{2}h$.

5. According to the Heisenberg uncertainty principle, if the uncertainty in the speed of an electron is 4.1×10^3 m/s, the uncertainty in its position (in m) is at least: (3 pts)

- A. 65 m
- B. 19 m
- C. 6.6×10^{-8} m
- D. 1.4×10^{-8} m

$$\Delta p \Delta x \geq \frac{h}{4\pi} \rightarrow \frac{6.626 \times 10^{-34}}{4\pi} \Delta x = 5.79 \times 10^{-5}$$

$$\rightarrow \Delta x = 1.4 \times 10^{-8}$$

$$\Delta p = m \Delta v$$

$$\Delta p = (9.1095 \times 10^{-31})(4.1 \times 10^3) = 3.734895 \times 10^{-27}$$

6. The work function for gold is 4.54 eV. What is the wavelength of the lowest frequency radiation needed to eject electrons from gold metal? (3 pts)

- A. 1.16×10^{13} nm.
- B. 273 nm.
- C. 4.87×10^5 nm.
- D. 4.16×10^{-26} m.

$$\phi = 4.54 \text{ eV} \times \frac{1.602 \times 10^{-19} \text{ J}}{1 \text{ eV}} = 7.273 \times 10^{-19} \text{ J}$$

$$E = h\nu$$

$$c = \lambda \nu \rightarrow \lambda = 4.125 \times 10^{-26} \text{ m}$$

7. Calculate the velocity of an oxygen molecule, given that it has a de Broglie wavelength of 0.0140 nm. (3 pts)

- A. $890. \text{ m} \square \text{ s}^{-1}$
- B. $3.00 \times 10^8 \text{ m} \square \text{ s}^{-1}$
- C. $1780 \text{ m} \square \text{ s}^{-1}$
- D. $445 \text{ m} \square \text{ s}^{-1}$
- E. $8.90 \text{ m} \square \text{ s}^{-1}$

$$p = mv, \lambda = \frac{h}{p}$$

8. Which set of quantum numbers could correspond to a 3d-orbital? (3 pts)

- A. $n = 3, l = 3, m_l = +2$
- B. $n = 3, l = 2, m_l = +3$
- C. $n = 3, l = 2, m_l = -2$

- S $l = 0$
- P $l = 1$
- d $l = 2$
- f $l = 3$

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- D. $n = 2, l = 1, m_l = +1$
 E. $n = 2, l = 1, m_l = 0$

~~X~~ The total number of orbitals in a shell with principal quantum number 5 is (3 pts)

- A. 32.
 B. 50.
 C. 25.
 D. 40.
 E. 5.

$ml = 5$

s	1 orbital
p	3
d	5
f	7

~~X~~ Which of the following statements is true? (3 pts)

- A. A 2s orbital has one nodal plane.
 B. An electron in a p-orbital has zero probability of being found at the nucleus.
 C. A p-orbital has a spherical boundary surface.
 D. An s-orbital becomes more dense as the distance from the nucleus increases.
 E. An electron in an s-orbital has a zero probability of being found at the nucleus.

11. Below is the mass percentage of each element in a compound:

54.53% C, 9.15% H, and 36.32% O.

Determine the empirical formula of the compound. Show all your work. (5pts)

$$54.53 \text{ g C} \times \frac{1 \text{ mol C}}{12 \text{ g C}} = 4.544 \text{ mol C}$$

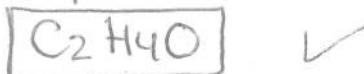
$$9.15 \text{ g H} \times \frac{1 \text{ mol H}}{1 \text{ g H}} = 9.15 \text{ mol H}$$

$$36.32 \text{ g O} \times \frac{1 \text{ mol O}}{16 \text{ g O}} = 2.27 \text{ mol O}$$

$$\frac{4.544 \text{ mol C}}{2.27 \text{ mol O}} \approx 2$$

$$\frac{9.15 \text{ mol H}}{2.27 \text{ mol O}} \approx 4$$

emp formula:



12. Light of wavelength 589 nm is absorbed by a sodium atom in the gas phase. What is the total energy needed to excite 1.50 moles of sodium atoms in the gas phase? Show all your work. (5pts)

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

$\boxed{5.32 \times 10^{17} \text{ J}}$

+21/40

+6