Northern Arizona University
CHM 151, General Chemistry I
Section 4, Fall 2005

Quiz #6
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Name ________________________________

1. How much heat (in J) is needed to warm 0.250 kg of water (about 1 cup) from 22°C (about room temperature) to near its boiling point, 98°C? **Circle the correct answer.** $s_{H_2O} = 4.184$ J/g·°C [3 pts]

a) −79.5 J **b) 7.95 × 10⁴ J** c) 79.5 J d) 2.30 × 10⁴ J e) −7.95 × 10⁴ J

$q = ms\Delta T$
$q = (250 \text{ g})(4.184 \text{ J/g·°C})(98 - 22)\text{°C}$
$\mathbf{q = 7.95 \times 10^4 \text{ J}}$

2. A 12.0 g sample of an unknown metal is heated to 91.0°C and is placed in a perfectly insulated container along with 154 g of water at an initial temperature of 21.45°C. After a short time the temperature of both the metal and water become equal at 24.65°C. The specific heat of water is 4.184 J/g·°C in this temperature range. What is the **specific heat**, ***s***, of the metal? [4 pts]

$-q_{\text{metal}} = +q_{\text{water}}$

$-m_m s_m \Delta t_m = +m_w s_w \Delta t_w$

$-(12.0 \text{ g})(s_m)(24.65 - 91.0)\text{°C} = +(154 \text{ g})(4.184 \text{ J/g·°C})(24.65 - 21.45)\text{°C}$

s_{metal} = **2.59 J/g·°C**

3. **True or False**

a) Blue light has a higher frequency than red light. [1 pt]

TRUE

b) X-rays have a shorter wavelength compared to radio waves. [1 pt]

TRUE

4. What is the **frequency** of an electromagnetic wave, the wavelength of which is 8.8×10^{-8} m?
Circle the correct answer. [3 pts]

a) 2.3×10^{-18} Hz b) 2.3×10^{-16} Hz c) 26 Hz **d) 3.4×10^{15} Hz** e) 2.9×10^{16} Hz

$c = \lambda\nu$

$$\nu = \frac{c}{\lambda}$$

$$\nu = \frac{3.00 \times 10^8 \text{ m/s}}{8.8 \times 10^{-8} \text{ m}}$$

ν = **3.4×10^{15} Hz**

5. How much **energy** (in joules) is contained in one mole of photons of frequency 3.3×10^{13} Hz? **Circle the correct answer.** [3 pts]

a) 2.2×10^{-20} J/mol   b) 3.6×10^{-15} J/mol   c) 61 J/mol
d) $\mathbf{1.3 \times 10^{4}}$ J/mol   e) 1.8×10^{10} J/mol

$E = h\nu$

$E = (6.626 \times 10^{-34}\ \text{J·s})(3.3 \times 10^{13}\ \text{/s}) = 2.2 \times 10^{-20}$ J/photon

$$\frac{2.2 \times 10^{-20}\ \text{J}}{1\ \text{photon}} \times \frac{6.022 \times 10^{23}\ \text{photons}}{1\ \text{mol}} = \mathbf{1.3 \times 10^{4}\ J/mol}$$

6. **True or False.** When an electron in an (unbound) hydrogen atom [H(*g*)] is excited from the ground state to the $n = 3$ state:

a) The electron is closer to the nucleus on average in the $n = 3$ state than in the ground state. [1 pt]

FALSE

b) The first excited state corresponds to $n = 3$. [1 pt]

FALSE, the first excited state corresponds to $n = 2$.

c) The wavelength of light emitted when the electron drops from $n = 3$ to $n = 2$ is longer than the wavelength of light emitted if the electron falls from $n = 3$ to $n = 1$. [1 pt]

TRUE

d) The wavelength of the light emitted when the electron returns to the ground state from $n = 3$ is the same as the wavelength of light absorbed to go from $n = 1$ to $n = 3$. [1 pt]

TRUE

7. The energy (in joules) of an electron energy level in the Bohr atom is given by the expression:

$E_n = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{n^2}\right)$ where n is the principal quantum number for the energy level.

a) Calculate the **energy** (in J) of both the 3rd energy level and the 7th energy level in a hydrogen atom? [3 pts]

$$E_3 = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{3^2}\right) = \mathbf{-2.42 \times 10^{-19}\ J}$$

$$E_7 = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{7^2}\right) = \mathbf{-4.45 \times 10^{-20}\ J}$$

b) Calculate ΔE between the 3rd and 7th energy levels in the hydrogen atom. [2 pts]

$\Delta E = E_f - E_i$
$\Delta E = -4.45 \times 10^{-20}\ \text{J} - (-2.42 \times 10^{-19}\ \text{J}) = \mathbf{1.98 \times 10^{-19}\ J}$

c) What is the **wavelength** of the photon necessary to promote an electron from $n = 3$ to $n = 7$ in a hydrogen atom? [2 pts]

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

$$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34}\ \text{J}\cdot\text{s})(3.00 \times 10^{8}\ \text{m/s})}{1.98 \times 10^{-19}\ \text{J}} = \mathbf{1.00 \times 10^{-6}\ m}$$

Potentially Useful Information

$q = ms\Delta T$	$\Delta T = T_f - T_i$	$s_{H_2O} = 4.184$ J/g·°C	$c = \lambda\nu$
$E = h\nu$	$E = \frac{hc}{\lambda}$	$c = 3.00 \times 10^{8}$ m/s	$h = 6.626 \times 10^{-34}$ J·s
$E_n = -R_H\left(\frac{1}{n^2}\right)$	$R_H = 2.18 \times 10^{-18}$ J	$\Delta E = E_f - E_i$	