Northern Arizona University
CHM 151, General Chemistry I
Section 6, Fall 2008

Quiz #6
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Name (PRINT) **KEY** **(35 points total)**

1. How much **heat** needs to be added to a 4.33 g piece of aluminum to raise its temperature from 22.0°C to 27.0°C? [s_{Al} = 0.900 J/g·°C] [3 pts]

a) 24.1 J b) 0.0416 J **c) 19.5 J *** d) 21.7 J e) none of these

$q = ms\Delta T$
$\boldsymbol{q} = (4.33\text{ g})(0.900\text{ J/g·°C})(27.0°\text{C} - 22.0°\text{C}) = \mathbf{19.5\ J}$

2. If the same amount of heat is added to 5.00 g samples of the metals listed below, which metal will experience the **largest temperature change**? [3 pts]

Metal	Specific Heat Capacity (J/g·°C)
Al	0.897
Au	0.129
Cu	0.385
Fe	0.449
K	0.753

a) K b) Fe c) Cu **d) Au *** e) Al

3. A piece of stainless steel (s_{steel} = 0.50 J/g·°C) is transferred from an oven (183°C) to 125 g of water at 21.5°C, into which it is immersed. The water and steel together reach a temperature of 49.8°C. What is the **mass** of the steel? [s_{H_2O} = 4.184 J/g·°C] [4 pts]

$-q_{ss} = +q_{water}$
$-m_{ss}s_{ss}\Delta T_{ss} = +q_w s_w \Delta T_w$
$-(m_{ss})(0.50\text{ J/g·°C})(49.8°\text{C} - 183°\text{C}) = +(125\text{ g})(4.184\text{ J/g·°C})(49.8°\text{C} - 21.5°\text{C})$
$66.6m_{ss} = 1.48 \times 10^4$
$\boldsymbol{m_{ss}} = \mathbf{222\ g}$

4. A particular form of electromagnetic radiation has a frequency of 4.25×10^{14} 1/s.

a) What is its **wavelength** (λ) in **nanometers**? [3 pts]

$c = \lambda\nu$
$3.00 \times 10^8\text{ m/s} = \lambda(4.25 \times 10^{14}\text{ 1/s})$
$$\lambda = 7.06 \times 10^{-7}\text{ m} \times \frac{1\text{ nm}}{1 \times 10^{-9}\text{ m}} = \mathbf{7.06 \times 10^2\ nm} = \mathbf{706\ nm}$$

b) What is the **energy** (in joules) of *one photon* of this radiation? [2 pts]

$E = h\nu$
$\boldsymbol{E} = (6.626 \times 10^{-34}\text{ J·s})(4.25 \times 10^{14}\text{ 1/s}) = \mathbf{2.82 \times 10^{-19}\ J}$

c) What is the **energy** of a *mole* of photons with the above frequency? [2 pts]

$$\frac{2.82 \times 10^{-19}\text{ J}}{1\text{ photon}} \times \frac{6.022 \times 10^{23}\text{ photons}}{1\text{ mol}} = \mathbf{1.70 \times 10^5\ J / mol}$$

5. TRUE or FALSE

a) Blue light has a shorter wavelength than red light. [2 pts]

TRUE

b) The energy of electromagnetic radiation is *inversely* proportional to the frequency of the radiation. [2 pts]

FALSE, the energy and frequency are directly proportional.

6. An electron in an excited state of the hydrogen atom, drops from the $n = 7$ energy state to the $n = 4$ energy state. Which of the following statements is **true**? [3 pts]

a) This change is called absorption.
b) The *wavelength* of light emitted when an electron moves from the $n = 7$ to the $n = 4$ energy state is ***shorter*** than the wavelength emitted when an electron moves from the $n = 7$ to the $n = 1$ energy state.
c) The $n = 7$ to $n = 4$ electronic transition in a hydrogen atom will have the same energy change as the $n = 7$ to $n = 4$ transition in a helium atom.
d) The *magnitude* of the energy change in going from $n = 7$ to $n = 4$ is the *same* as going from $n = 4$ to $n = 7$.
e) None of the above is true.

7. If the frequency of electromagnetic radiation **decreases**, which of the following statements is **correct**? [3 pts]

a) The number of cycles passing a given point per unit time increases.
b) The velocity of the radiation decreases.
c) The wavelength of the radiation decreases.
d) The energy of the radiation increases.
e) None of the above is correct. *

8. 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 1st energy level and the 5th energy level in a hydrogen atom? [3 pts]

$$E_1 = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{1^2}\right) = \mathbf{-2.18 \times 10^{-18}\ J}$$

$$E_5 = -2.18 \times 10^{-18}\ \text{J}\left(\frac{1}{5^2}\right) = \mathbf{-8.72 \times 10^{-20}\ J}$$

b) Calculate ΔE between the 1st and 5th energy levels in the hydrogen atom. [2 pts]

$\Delta E = E_f - E_i$
$\Delta E = -8.72 \times 10^{-20}\ \text{J} - (-2.18 \times 10^{-18}\ \text{J}) = \mathbf{2.09 \times 10^{-18}\ J}$

c) What is the **wavelength** of the photon necessary to promote an electron from $n = 1$ to $n = 5$ in a hydrogen atom? [3 pts]

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

$$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34}\ \text{J}\cdot\text{s})(3.00 \times 10^{8}\ \text{m/s})}{2.09 \times 10^{-18}\ \text{J}} = \mathbf{9.51 \times 10^{-8}\ m}$$

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	$\Delta E = E_f - E_i$	