

Please read the questions very carefully to understand what is being asked. If you do not understand anything, please ask your instructor. Use the reverse side of your question paper as scratch. No outside paper is allowed. You can use the periodic table and constant data provided. Total points = $48 + (20 \times 3) = 60 = 108$

SHORT ANSWER. Please write the set-up equation and insert the raw data with units in the equation before doing your calculations. Write the word or phrase that best completes each statement or answers the question.

Given
 108.0 J
 $\Delta T = 4.7^\circ\text{C}$
 $c = 0.128 \text{ J/g}^\circ\text{C}$

- 1) Suppose it took 108.0 joules of energy to raise a bar of gold from 25.0°C to 29.7°C .
 Given that the specific heat capacity of gold is $0.128 \text{ J/g}^\circ\text{C}$, what is the mass (in grams) of the bar of gold? Show all your calculations with set up equation and units. (8 pts.)

$$q = c \times m \times \Delta T$$

$$m = \frac{q}{c \cdot \Delta T} = \frac{(108.0 \text{ J})}{(0.128 \text{ J/g}^\circ\text{C})(4.7^\circ\text{C})} = 180 \text{ g}$$

1) 180 g

- 2) How much heat (in joules) is necessary to raise the temperature of 21.0 g of water from 31.0°C to 95°C . Given specific heat of water = $4.18 \text{ joules/(g}^\circ\text{C)}$ (4 pts.)

Given
 21.0 g
 64°C
 $4.18 \text{ J/g}^\circ\text{C}$

$$q = c \times m \times \Delta T$$

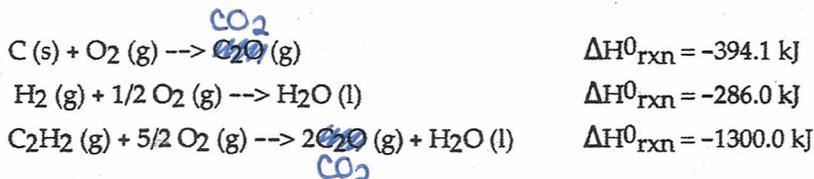
$$= (4.18 \text{ J/g}^\circ\text{C})(21.0 \text{ g})(64.0^\circ\text{C})$$

$$= 5620 \text{ J}$$

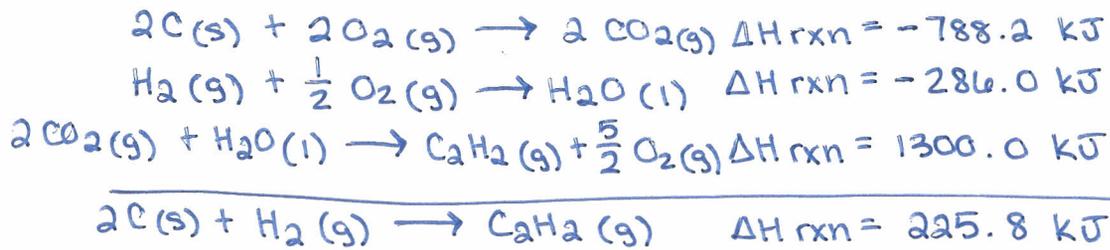
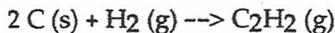
2) 5620 J

3) Given the following information:

3) 225.8 kJ

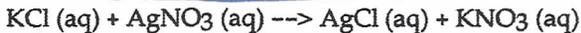


Calculate the $\Delta H^\circ_{\text{rxn}}$ for the reaction (10 pts.):



4) When 20.0 mL 0.15 M KCl reacts with 20.0 mL 0.15 M AgNO₃ in a coffee cup calorimeter, the temperature of the mixture increases from 25.2 °C to 26.8 °C and the combined solution weighs 40.8 g. If no heat is absorbed by the calorimeter, then calculate the $\Delta H_{\text{rxn}}/(\text{mole of AgNO}_3)$ for the reaction between AgNO₃ and KCl:

4) $-9.10 \times 10^4 \text{ J/mol}$



Given specific heat of water = 4.18 J/(g.K). (8 pts.)

$$\begin{aligned} \Delta H_{\text{rxn}} &= -q = -(c \times m \times \Delta T) \\ &= -[4.18 \text{ J/g}^\circ\text{C} \times (40.8 \text{ g}) \times (1.6 \text{ }^\circ\text{C})] \\ &= -273 \text{ J} \end{aligned}$$

$$\text{mol AgNO}_3 = 20.0 \text{ mL} \times \frac{\text{K}}{1000 \text{ mL}} \times \frac{0.15 \text{ mol}}{\text{K}} = 0.003 \text{ mol AgNO}_3$$

$$\begin{aligned} \Delta H_{\text{rxn}} / \text{mol AgNO}_3 &= \frac{-273 \text{ J}}{0.003 \text{ mol AgNO}_3} = -9.10 \times 10^4 \text{ J/mol AgNO}_3 \\ &= \frac{9.1 \times 10^4 \text{ J/mol AgNO}_3}{2 \text{ SF}} \end{aligned}$$

- 5) Calculate the energy of one mole of blue light with wavelength = 434 nanometer.
 Given, $E = h\nu$; $N = 6.022 \times 10^{23}/\text{mol}$; $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}/\text{photon}$, Vel of light $c = 2.89 \times 10^8 \text{ m/s}$. (8 pts.)

5) $2.66 \times 10^5 \text{ J/mol}$

$$E = h\nu = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s}/\text{photon})(2.89 \times 10^8 \text{ m/s})}{(434 \times 10^{-9} \text{ m})}$$

$$= \frac{4.41224424 \times 10^{-19} \text{ J}}{\text{photon}} \times \frac{6.022 \times 10^{23} \text{ photons}}{1 \text{ mol}}$$

$$= 2.66 \times 10^5 \text{ J/mol}$$

- 6) Bohr's equation for the energy of an electron E in the n-th shell is given by:

$$E_n = -Rhc/n^2 = -2.179 \times 10^{-18} \text{ J}/n^2$$

6) 481.8 nm
 $4.818 \times 10^2 \text{ nm}$

Use the equation to calculate the wavelength of the electromagnetic radiation that is emitted when an electron moves from $n = 4$ to $n = 2$. Rydberg constant, $R = 1.0974 \times 10^7 \text{ m}^{-1}$ (10 pts.)

$$E_{n=4} = -2.179 \times 10^{-18} \text{ J}/16 = -1.362 \times 10^{-19} \text{ J}$$

$$E_{n=2} = -2.179 \times 10^{-18} \text{ J}/4 = -5.448 \times 10^{-19} \text{ J}$$

$$\Delta E = E_{n=2} - E_{n=4} = -4.122 \times 10^{-19} \text{ J}$$

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

$$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34} \text{ J}\cdot\text{s})(2.997 \times 10^8 \text{ m/s})}{4.122 \times 10^{-19} \text{ J}}$$

$$= 4.818 \times 10^{-7} \text{ m} \times \frac{10^9 \text{ nm}}{\text{m}} = 4.818 \times 10^2 \text{ nm}$$

$$= 4.818 \times 10^2 \text{ nm}$$

$$= 481.8 \text{ nm}$$

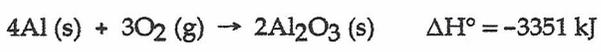
MULTIPLE CHOICE. On scantron, answer by filling the bubbles of the same number as the question number. Choose the one alternative that best completes the statement or answers the question. (3 points each)

- 7) Which one of the following conditions would always result in an increase in the internal energy of a system? 7) C
- A) The system loses heat and does work on the surroundings.
 - B) The system gains heat and does work on the surroundings.
 - C) The system gains heat and has work done on it by the surroundings.
 - D) The system loses heat and has work done on it by the surroundings.
 - E) None of the above is correct.

- 8) Which one of the following is an endothermic process? 8) Cancelled
- A) water freezing
 - B) ice melting
 - C) Hydrochloric acid and barium hydroxide are mixed at 25°C: the temperature increases.
 - D) boiling soup
 - E) Both A and C

- 9) Which one of the following statements is true? 9) C
- A) The enthalpy change of a reaction is the reciprocal of the ΔH of the reverse reaction.
 - B) Enthalpy is an intensive property.
 - C) Enthalpy is a state function.
 - D) The enthalpy change for a reaction is independent of the state of the reactants and products.
 - E) H is the value of q measured under conditions of constant volume.

- 10) The reaction 10) B



is _____, and therefore heat is _____ by the reaction.

- A) endothermic, absorbed
 - B) exothermic, released
 - C) exothermic, absorbed
 - D) endothermic, released
 - E) thermoneutral, neither released nor absorbed
- 11) For which one of the following reactions is the value of $\Delta H^\circ_{\text{rxn}}$ equal to ΔH°_f for the product? 11) A
- A) $2 \text{C (s, graphite)} + 2 \text{H}_2 \text{(g)} \rightarrow \text{C}_2\text{H}_4 \text{(g)}$
 - B) $\text{H}_2\text{O (l)} + 1/2 \text{O}_2 \text{(g)} \rightarrow \text{H}_2\text{O}_2 \text{(l)}$
 - C) $\text{N}_2 \text{(g)} + \text{O}_2 \text{(g)} \rightarrow 2 \text{NO (g)}$
 - D) $2 \text{H}_2 \text{(g)} + \text{O}_2 \text{(g)} \rightarrow 2 \text{H}_2\text{O (g)}$
 - E) $2 \text{H}_2 \text{(g)} + \text{O}_2 \text{(g)} \rightarrow 2 \text{H}_2\text{O (l)}$

- 12) Which one of the following is not a valid value for the magnetic quantum number of an electron in a 5d subshell? 12) D
- A) 0
 - B) 1
 - C) -1
 - D) 3
 - E) 2

0 s
1 p
2 d

- 13) An electron cannot have the quantum numbers $n =$ _____, $l =$ _____, $m_l =$ _____ 13) C
 A) $2, 1, -1$ B) $3, 2, 1$ C) $1, 1, 1$ D) $2, 0, 0$ E) $3, 1, -1$
 $2p$ $3p$ $1p$ $2s$ $3p$
- 14) Which one of the following is an incorrect subshell notation? 14) C
 A) $2p$ B) $3s$ C) $2d$ D) $4f$ E) $3d$
- 15) Which set of three quantum numbers (n, l, m_l) corresponds to a $3d$ orbital? 15) B
 A) $2, 1, 0$ B) $3, 2, 2$ C) $3, 3, 2$ D) $3, 2, 3$ E) $2, 3, 3$
 $3, 2$
- 16) The ground state electron configuration of Fe is _____. 16) C
 A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
 B) $1s^2 2s^2 3s^2 3p^6 3d^6$
 C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$
 D) $1s^2 2s^2 3s^2 3p^{10}$
 E) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4d^6$
- 17) The lowest orbital energy is reached when the number of electrons with the same spin is maximized. This statement describes _____. 17) E
 A) Planck's constant
 B) Pauli Exclusion Principle
 C) Heisenberg Uncertainty Principle
 D) deBroglie hypothesis
 E) Hund's rule
- 18) Of the following, which gives the correct order for atomic radius for Mg, Na, P, Si and Ar? 18) B
 A) $Ar > Si > P > Na > Mg$
 B) $Na > Mg > Si > P > Ar$ $Na \ Mg \ Si \ P \ Ar$
 C) $Mg > Na > P > Si > Ar$
 D) $Ar > P > Si > Mg > Na$
 E) $Si > P > Ar > Na > Mg$
- 19) The effective nuclear charge of an atom is primarily affected by _____. 19) D
 A) nuclear charge
 B) electron distribution
 C) outer electrons
 D) inner electrons
 E) orbital radial probability
- 20) Which one of the following atoms has the largest radius? 20) E
 A) Sr B) I C) Ca D) Co E) Ba
- 21) Of the following elements, _____ has the most negative electron affinity. 21) A
 A) Cl B) I C) Br D) Se E) S

Consider the following electron configurations to answer the questions that follow:

- (i) $1s^2 2s^2 2p^6 3s^1$ Na
- (ii) $1s^2 2s^2 2p^6 3s^2$ Mg
- (iii) $1s^2 2s^2 2p^6 3s^2 3p^1$ Al
- (iv) $1s^2 2s^2 2p^6 3s^2 3p^4$ S
- (v) $1s^2 2s^2 2p^6 3s^2 3p^5$ Cl

22) The electron configuration that belongs to the atom with the lowest second ionization energy is _____ 22) B
A) (i) B) (ii) C) (iii) D) (iv) E) (v)

TRUE/FALSE. On scantron, choose "A" for a true answer and "B" for wrong answer.

23) Work equals force times distance. 23) T
 $w = F \times d$

24) If a hydrogen atom electron jumps from the $n=6$ orbit to the $n=2$ orbit, energy is released. 24) T

25) The larger the principal quantum number of an orbital, the lower is the energy of the electrons in that orbital. 25) F

26) The effective nuclear charge acting on an electron is larger than the actual nuclear charge. 26) F