

CHEMISTRY 1100/1110 Fall 09

Exam 2

ANSWER KEY _____ **(PRINT)**
LAST NAME, FIRST NAME

SECTION

Academic Integrity is expected of everyone and anyone caught cheating will receive an F in the course.

A number 2 pencil must be used to fill out the Scantron form. If you must erase a mark on your Scantron form, please erase it completely. Write your name and section number on your Scantron form.

Equations and Constants

$$N_A = 6.022 \times 10^{23} \quad R = 8.314 \text{ J/mol K} = 0.08206 \text{ L atm/mol K}$$

$$m_e = 9.11 \times 10^{-31} \text{ kg} \quad c = 2.998 \times 10^8 \text{ m/sec} \quad h = 6.626 \times 10^{-34} \text{ J s}$$

$$R_{\text{Rydberg}} = 1.09678 \times 10^7 \text{ m}^{-1}$$

$$1 \text{ atm} = 760 \text{ mmHg} = 760 \text{ torr} = 1.01325 \text{ bar} = 1.01325 \times 10^5 \text{ Pa}$$

$$PV = nRT \quad P_A = X_A P_{\text{Total}} \quad u_{\text{rms}} = \sqrt{\frac{3RT}{MM}}$$

$$q = mc\Delta T$$

$$\Delta E = q + w \quad dw = -pdV \quad \Delta H = \Delta E + P\Delta V$$

$$\Delta H^\circ_{\text{rxn}} = \sum m \Delta H^\circ_{\text{f (products)}} - \sum n \Delta H^\circ_{\text{f (reactants)}}$$

$$E = h\nu \quad c = \nu\lambda$$

$$E_n = -(2.18 \times 10^{-18} \text{ J}) 1/n^2 \text{ (Hydrogen Atom)}$$

$$\text{KE(electron)} = h\nu - \Phi$$

$$\frac{1}{\lambda} = R_{\text{Rydberg}} \left(\frac{1}{n_1^2} - \frac{1}{n_2^2} \right) \text{ (where } n_2 > n_1)$$

$$\lambda = \frac{h}{mu} \quad \Delta x \cdot m\Delta u \geq \frac{h}{4\pi}$$

(4pts for each question, all or nothing, fill in your answers for questions 1-25 with a Number 2 pencil on the Scantron Answer Sheet) **ANSWERS ARE IN RED**

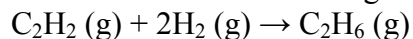
(1) A balloon is filled with helium. Its volume is 5.90L at 26°C. What will its volume be at -78°C, assuming no pressure change.

- (A) **3.85 L** (B) -17.7 L (C) 9.04 L (D) 6.93 L (E) 17.7 L

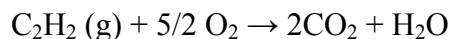
(2) At 1000°C and 0.0132 atm, the density of a certain element in the gas phase is 2.9×10^{-3} g/L. What is the element?

- (A) Ar
(B) Ne
(C) Br
(D) Cl
(E) **Na**

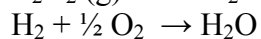
(3) Determine ΔH for the following reaction,



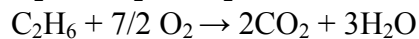
given the following heats of combustion



$$\Delta H = -1300 \text{ kJ}$$



$$\Delta H = -286 \text{ kJ}$$



$$\Delta H = -1560 \text{ kJ}$$

- (A) -154 kJ
(B) -256 kJ
(C) **-312 kJ**
(D) -648 kJ
(E) -3146 kJ

(4) The energy required to break one mole of hydrogen-hydrogen bonds in H_2 is 436 kJ/mol. What is the minimum wavelength of light necessary to break a single hydrogen-hydrogen bond?

- (A) 2.97 pm
(B) 1.34 nm
(C) 126 nm
(D) **274 nm**
(E) 3.44 nm

(5) Consider a sample of gas in a tank. Under which of the following conditions would you expect the most ideal behavior?

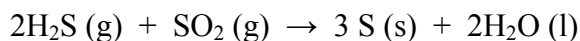
- (A) High temperature and high pressure
- (B) High temperature and low pressure**
- (C) Moderate temperature and moderate pressure
- (D) Low temperature and low pressure
- (E) Low temperature and high pressure

(6) If the same amount of heat is added to 50.0g samples of each of the metals below, which metal will experience the largest temperature change?

<u>Metal</u>	<u>Specific Heat (J/g·K)</u>
Ag	0.902
Cu	0.385
Fe	0.451
Au	0.128
K	0.753

- (A) Al
- (B) Cu
- (C) Fe
- (D) Au**
- (E) K

(7) The noxious gas H₂S can be used to remove the acid rain component SO₂ from factory emissions. What volume of H₂S in liters at STP will be needed to remove 2.00 kg of SO₂? (Molar Mass SO₂: 64.0 g/mol)



- (A) 1400 liters**
- (B) 7 liters
- (C) 700 liters
- (D) 350 liters
- (E) 50 liters

(8) Which gas, present in the same closed system, has the greatest average kinetic energy at a given temperature?

- (A) hydrogen
- (B) neon
- (C) carbon dioxide
- (D) helium
- (E) None; the average kinetic energy is the same for each gas.**

(9) Calculate the wavelength of the line in the Lyman series that results from the transition $n=5$ to $n=1$.

- (A) 54.2 nm
- (B) 95.0 nm**
- (C) 114 nm
- (D) 126 nm
- (E) 209 nm

(10) A 10.0 g sample of a metal is heated to 100.0 °C and then added to 20.0 g of water at 23.0 °C in an insulated calorimeter. At thermal equilibrium the temperature of the system was measured as 25.0 °C. What is the specific heat of the metal? (Specific Heat of Water: 4.2 J/g·°C)

- (A) 0.11 J/g·K
- (B) 0.22 J/g·K**
- (C) 6.6 J/g·K
- (D) 17 J/g·K
- (E) 34 J/g·K

(11) One statement of the first law of thermodynamics is that

- (A) the amount of work done on a system is independent of pathway.
- (B) the total energy flow in or out of a system is equal to the sum of the heat absorbed and the work done on the system.**
- (C) the heat flow in or out of a system is independent of pathway.
- (D) the total work done on a system must equal the heat absorbed by the system.
- (E) in any chemical process the sum of the heat flow and the work must equal zero.

(12) The volume of a given mass of gas varies inversely with pressure, provided that the temperature remains constant because

- (A) attractive forces between gas molecules are negligible.
- (B) attractive forces between gas molecules are appreciable.
- (C) the average kinetic energy of the molecules of a gas is proportional to the absolute temperature.
- (D) increasing the molecular concentration, at constant temperature, means increasing the number of collisions between molecules and container.**
- (E) collisions between gas molecules are perfectly elastic.

(13) The Kelvin temperature of one liter of gas is doubled and its pressure is tripled, volume will then be

- (A) $\frac{1}{6}$ L
- (B) $\frac{2}{3}$ L**
- (C) $\frac{3}{2}$ L
- (D) 3 L
- (E) 6 L

(14) For which of the following reactions will ΔH be exactly equal to ΔE ?

- (A) $\text{P}_4(\text{s}) + 6\text{Cl}_2(\text{g}) \rightarrow 4\text{PCl}_3(\text{g})$
(B) $\text{NO}(\text{g}) + \text{NO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2\text{O}_5(\text{g})$
(C) $\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$
(D) $\text{C}(\text{diamond}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g})$
(E) $\text{Cu}_2\text{O}(\text{s}) + \frac{1}{2}\text{O}_2(\text{g}) \rightarrow 2\text{CuO}(\text{s})$

(15) A mixture of 11.0 g of CO_2 and 8.00 g of O_2 and an undetermined amount of H_2 occupies 22.4 L at 760 mmHg and 0.00°C . How many grams of H_2 are present?

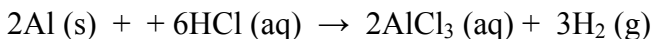
- (A) 0.100 g (B) 0.500 g **(C) 1.00 g** (D) 2.00 g (E) 4.00 g

(16) Which statement regarding the photoelectric effect is true?

1. When electron emission occurs, the rate of emission is proportional to the intensity of the radiation used.
2. Electrons are only emitted if the incident electromagnetic radiation has a wavelength greater than some threshold value.
3. Electrons are only emitted if the incident electromagnetic radiation has an intensity greater than some threshold value.

- (A) 1 only** (B) 2 only (C) 1 and 3 only (D) 2 and 3 only (E) 1, 2 and 3

(17) If a 0.0067 mol sample of aluminum metal is dropped into 400 mL of 6 M HCl, hydrogen gas is evolved. The hydrogen evolved is collected over water at 25°C and the total pressure is adjusted to atmospheric pressure (1.02 atm.) What will be the total volume of gas collected in L? (water vapor pressure at $25^\circ\text{C} = 23.8 \text{ mmHg}$)

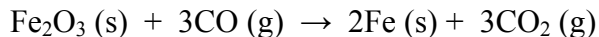


- (A) $6.7 \times 10^{-3} \text{ L}$
(B) 0.010 L
(C) 0.22 L
(D) 0.25 L
(E) 0.99 L

(18) What is the kinetic energy of an electron emitted from the surface of sodium metal ($\phi = 4.41 \times 10^{-19} \text{ J}$) by absorption of a photon of with a wavelength of 300nm?

- (A) $2.21 \times 10^{-19} \text{ J}$**
(B) $6.62 \times 10^{-19} \text{ J}$
(C) $4.41 \times 10^{-19} \text{ J}$
(D) $4.34 \times 10^{-19} \text{ J}$
(E) 0 J

(19) Calculate the standard enthalpy of reaction for the following process:



$\Delta H_f^\circ(\text{Fe}_2\text{O}_3, \text{s}) = -825.5 \text{ kJ/mol}$, $\Delta H_f^\circ(\text{CO}, \text{g}) = -110.5 \text{ kJ/mol}$,
 $\Delta H_f^\circ(\text{CO}_2, \text{g}) = -393.5 \text{ kJ/mol}$

- (A) +542.5 kJ
- (B) -2337.5 kJ
- (C) +23.5 kJ
- (D) -542.5 kJ
- (E) -23.5 kJ**

(20) Emission spectra (line spectra) may be attributed to an electron

- (A) spiraling into a nucleus.
- (B) changing its atomic energy level.**
- (C) orbiting the nucleus.
- (D) escaping from the atom.
- (E) being converted into a photon.

(21) Five identical balloons are inflated to the same extent with the indicated gases. Which balloon will be the first to collapse?

- (A) N₂ (B) SO₂ **(C) Ne** (D) O₂ (E) Kr

(22) What is the energy required to completely remove an electron from the $n = 5$ energy level of a Hydrogen atom?

- (A) $2.09 \times 10^{-18} \text{ J}$
- (B) $2.18 \times 10^{-18} \text{ J}$
- (C) $4.36 \times 10^{-19} \text{ J}$
- (D) $1.09 \times 10^{-17} \text{ J}$
- (E) $8.72 \times 10^{-20} \text{ J}$**

(23) What is the work done by or on a system if the total change in internal energy of the system is -652 J and the system emits 254 J of heat?

- (A) 906 J of work done on the system
- (B) 906 J of work done by the system
- (C) 398 J of work done by the system**
- (D) 398 J of work done on the system
- (E) 652 J of work done by the system

(24) If the de Broglie wavelength of an electron is 1.07 nm, what is its velocity?
($m_e = 9.11 \times 10^{-31}$ kg)

- (A) 8.10 m/s
- (B) 712 m/s
- (C) 8.11×10^4 m/s
- (D) 6.80×10^5 m/s**
- (E) 3.09×10^9 m/s

(25) The Heisenberg Uncertainty Principle tells us that

- (A) there is a fundamental limit to the accuracy of measurements.**
- (B) the exact position of an electron in an atom can be determined.
- (C) the position and momentum of a particle can be known simultaneously.
- (D) for a large object, the uncertainty in position and speed are not negligible.