



Chem 1A Exam 2 Review Problems

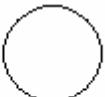
- At 0.967 atm, the height of mercury in a barometer is 0.735 m. If the mercury were replaced with water, what height of water (in meters) would be supported at this pressure? The densities of Hg and H₂O are 13.5 g/cm³ and 0.997 g/cm³, respectively.
- One statement of the first law of thermodynamics is that
 - the total energy change for a system is equal to the sum of the heat transferred to or from the system and the work done by or on the system.
 - the amount of work done on a system is dependent of pathway.
 - the total work done on a system must equal the heat absorbed by the system.
 - in any chemical process the heat flow must equal the change in enthalpy.
- Which of the following relationships is/are CORRECT for gases?
 - The moles of a gas is inversely proportional to its volume (at constant pressure).
 - The volume of a gas is inversely proportional to its temperature in kelvin (at constant pressure).
 - The pressure of a gas is directly proportional to its temperature in kelvin (at constant volume).
 - 1 only
 - 2 only
 - 3 only
 - 1 and 2
 - 2 and 3
- Which of the following statements is/are CORRECT?
 - A system is defined as an object or collection of objects being studied.
 - Surroundings are defined as everything outside of the system being studied.
 - In an exothermic reaction, heat is transferred from the system to the surroundings.
 - 1 only
 - 2 only
 - 3 only
 - 1 and 3
 - 1, 2, and 3
- Which of the following diagrams represent *d*-orbitals?



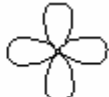
1



2



3



4

 - 1 only
 - 2 only
 - 3 only
 - 4 only
 - 1 and 4
- What type of orbital is designated $n = 4, \ell = 0, m_\ell = 0$?
 - 4s
 - 4p
 - 4d
 - 4f
 - none
- Which element has the following ground state electron configuration?

$$[\text{Ar}] \quad \boxed{\uparrow\downarrow} \boxed{\uparrow\downarrow} \boxed{\uparrow} \boxed{\uparrow} \boxed{\uparrow} \quad \boxed{\uparrow\downarrow}$$

$3d$ $4s$
- The change in energy for the following reaction is referred to as the ____ for oxygen.

$$\text{O}(\text{g}) + \text{e}^- \rightarrow \text{O}^-(\text{g})$$
 - first ionization energy
 - electronegativity energy
 - second ionization energy
 - electron affinity

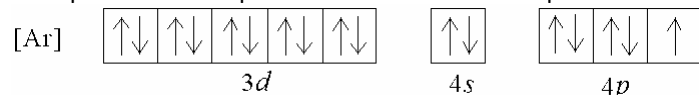
9. Which of the following chemical equations corresponds to the standard molar enthalpy of formation of SO_3 ?
- a. $2 \text{S}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{SO}_3(g)$ c. $1/8 \text{S}_8(s) + 3/2 \text{O}_2(g) \rightarrow \text{SO}_3(g)$
 b. $\text{SO}_2(g) + 1/2 \text{O}_2(g) \rightarrow \text{SO}_3(g)$ d. $\text{S}_8(s) + 12 \text{O}_2(g) \rightarrow 8 \text{SO}_3(g)$
10. Hund's rule states that the most stable arrangement of electrons (for a ground state electron configuration)
- a. has a filled valence shell of electrons.
 b. has three electrons per orbital, each with identical spins.
 c. has m_l values greater than or equal to +1.
 d. has the maximum number of unpaired electrons, all with the same spin.
11. Oxygen gas, O_2 , effuses through a barrier at a rate of 0.183 mL/minute. If an unknown gas effuses through the same barrier at a rate of 0.259 mL/minute, what is the molar mass of the gas?
12. Hydrazine, N_2H_4 , is a liquid used as a rocket fuel. It reacts with oxygen to yield nitrogen gas and water.
 $\text{N}_2\text{H}_4(l) + \text{O}_2(g) \rightarrow \text{N}_2(g) + 2 \text{H}_2\text{O}(l)$
 The reaction of 6.50 g N_2H_4 evolves 126.2 kJ of heat. Calculate the enthalpy change per mole of hydrazine combusted.
13. Propane, C_3H_8 , reacts with excess oxygen to produce carbon dioxide gas and water. What volume of CO_2 , measured at 27.2 °C and 0.918 atm is produced from the reaction of 10.1 g C_3H_8 with excess oxygen? ($R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$)
14. Which element has the electron configuration $1s^2 2s^2 2p^6 3s^2 3p^2$?
- a. Mg b. Ga c. Si d. Ge
15. What is the correct orbital box diagram for the ground state electron configuration of Cr?
16. Water can be decomposed by electrolysis into hydrogen gas and oxygen gas. What mass of water must decompose to fill a 5.00 L flask to a total pressure of 2.50 atm at 298 K with a mixture hydrogen and oxygen? ($R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$)
 $2 \text{H}_2\text{O}(l) \rightarrow 2 \text{H}_2(g) + \text{O}_2(g)$
17. Which of the following statements is CORRECT?
- a. If a reaction occurs at constant volume, $\Delta E > \Delta H$.
 b. If a reaction occurs at constant pressure, $q = \Delta H$.
 c. If a reaction occurs at constant volume, $w = \Delta E$.
 d. If a reaction occurs at constant pressure, $w = \Delta E$.
18. What is the root-mean-square velocity of ammonia molecules (NH_3) at 45 °C?
19. Which one of the following statements is INCORRECT?
- a. Increasing the thermal energy of a gas increases the motion of its atoms.
 b. Potential energy is the energy associated with motion.
 c. Energy is neither created nor destroyed in chemical reactions.
 d. Endothermic processes transfer heat from the surroundings into the system.
20. Determine the enthalpy change for the oxidation of iron,
 $4 \text{Fe}(s) + 3 \text{O}_2(g) \rightarrow 2 \text{Fe}_2\text{O}_3(s)$
 given the thermochemical equations below.
- | | |
|--|--|
| $\text{Fe}(s) + 3 \text{H}_2\text{O}(l) \rightarrow \text{Fe}(\text{OH})_3(s) + 3/2 \text{H}_2(g)$ | $\Delta_r H^\circ = +160.9 \text{ kJ}$ |
| $\text{H}_2(g) + 1/2 \text{O}_2(g) \rightarrow \text{H}_2\text{O}(l)$ | $\Delta_r H^\circ = -285.8 \text{ kJ}$ |
| $\text{Fe}_2\text{O}_3(s) + 3 \text{H}_2\text{O}(l) \rightarrow 2 \text{Fe}(\text{OH})_3(s)$ | $\Delta_r H^\circ = +288.6 \text{ kJ}$ |
21. Which 1+ ion has the ground state electron configuration $[\text{Kr}]4d^{10}$?
- a. Tc b. Cd c. Au d. Ag

22. The Schrödinger wave equation
- proves that energy is equal to mass times the speed of light squared.
 - is used to calculate the velocity of an electron.
 - calculates the exact position and momentum of an electron at any given time.
 - can be solved to determine the probability of finding an electron in a region of space.
23. If 25.0 g H₂O at 16.0 °C is combined with 70.0 g H₂O at 85.5 °C, what is the final temperature of the mixture? The specific heat capacity of water is 4.184 J/g·K.
24. Determine the enthalpy change for the oxidation of ethanol to acetic acid,
 $\text{CH}_3\text{CH}_2\text{OH}(\ell) + \text{O}_2(\text{g}) \rightarrow \text{CH}_3\text{COOH}(\ell) + \text{H}_2\text{O}(\ell)$
 given the thermochemical equations below.
- | | |
|---|--|
| $2 \text{CH}_3\text{CH}_2\text{OH}(\ell) + \text{O}_2(\text{g}) \rightarrow 2 \text{CH}_3\text{CHO}(\ell) + 2 \text{H}_2\text{O}(\ell)$ | $\Delta_r H^\circ = -400.8 \text{ kJ}$ |
| $2 \text{CH}_3\text{CHO}(\ell) + \text{O}_2(\text{g}) \rightarrow 2 \text{CH}_3\text{COOH}(\ell)$ | $\Delta_r H^\circ = -584.4 \text{ kJ}$ |
25. A balloon is filled with N₂ gas to a volume of 1.92 L at 37 °C. The balloon is placed in liquid nitrogen until its temperature reaches -142 °C. Assuming the pressure remains constant, what is the volume of the cooled balloon?
26. At what temperature does 1.00 atm of He gas have the same density as 1.00 atm of Ar gas at 273 K?
27. Which type of experiment demonstrates that light has the properties of a particle?
- nuclear fission
 - electron diffraction
 - light emission from atomic gases
 - photoelectric effect
28. As one moves horizontally from left to right across a period, the effective _____ charge increases, resulting in decreasing atomic radii.
29. Which of the following properties is associated with the value of the ℓ quantum number?
- the shape of an orbital
 - the number of electrons in an orbital
 - the energy of an orbital
 - the size of an orbital
30. Which of the following statements is INCORRECT?
- Electrons have both wave and particle properties.
 - It is not possible to know the exact location of an electron and its exact energy simultaneously.
 - The behavior of an atom's electrons can be described by circular orbits around a nucleus.
 - Quantum numbers define the energy states and the orbitals available to an electron.
31. _____ rule states that the most stable arrangement of electrons is that which contains the maximum number of unpaired electrons, all with the same spin direction.
32. If an FM radio station broadcasts at 92.1 MHz, what is the wavelength of this radiation?
33. When heated in a flame, sodium atoms emit light with a frequency of $5.09 \times 10^{14} \text{ s}^{-1}$. What is the wavelength of this radiation?
34. The procedure by which electrons are assigned to (or built up into) orbitals is known as the _____ principle.
- Bohr
 - aufbau
 - Pauli
 - Planck
35. At 212 mm Hg and 24 °C, a sample of gas occupies a volume of 125 mL. The gas is transferred to a 325-mL flask and the temperature is reduced to -5.0 °C. What is the pressure of the gas in the flask?
36. Which of the following sets of quantum numbers refers to a 4d orbital?
- $n = 4, \ell = 3, m_\ell = +2$
 - $n = 4, \ell = 2, m_\ell = -1$
 - $n = 4, \ell = 3, m_\ell = 0$
 - $n = 2, \ell = 1, m_\ell = -1$

37. Which type of experiment demonstrates that an electron has the properties of a wave?

- a. electron diffraction
- b. light emission from atomic gases
- c. photoelectric effect
- d. mass spectroscopy

38. What is a possible set of quantum numbers for the unpaired electron in the orbital box diagram below?



39. Which of the following statements is/are CORRECT for a carbon atom?

- 1. The effective nuclear charge felt by a 2s electron is greater than that felt by a 1s electron.
- 2. The effective nuclear charge felt by a 2p electron is less than that felt by a 2s electron.
- 3. The effective nuclear charges felt by 2s and 2p electrons are identical.

- a. 1 only
- b. 2 only
- c. 3 only
- d. 1 and 3
- e. 1, 2, and 3

40. The $n = \underline{\hspace{1cm}}$ shell is the lowest that may contain d -orbitals.

- a. 3
- b. 5
- c. 6
- d. 2

41. The pressure of N_2 in a 20.0 L flask is 0.603 atm at 62 °C. What mass of N_2 is in the flask? ($R = 0.08206$ L·atm/mol·K)

42. For which of the following elements is the second ionization energy greatest?

- a. Ti
- b. Mg
- c. Na
- d. Sc

43. What is the energy (in kJ) of 1.00 mole of photons of green light with a wavelength of 507 nm?

44. When 10.0 g KOH is dissolved in 100.0 g of water in a coffee-cup calorimeter, the temperature rises from 25.18 °C to 47.53 °C. What is the enthalpy change per gram of KOH dissolved in the water? Assume that the solution has a specific heat capacity of 4.18 J/g·K.

45. Non-ideal behavior for a gas is most likely to be observed under conditions of

- a. high temperature and low pressure.
- b. low temperature and high pressure.
- c. standard temperature and pressure.
- d. high temperature and high pressure.

46. Which of the following elements is a d -block element?

- a. Cs
- b. Cd
- c. C
- d. Cf

47. How many electrons can be described by the following quantum numbers: $n = 3, \ell = 1, m_\ell = 0, m_s = -1/2$?

48. The Bohr model predicts that the energy of an atom's electron is _____, meaning that the electron can only occupy orbitals of specific energies.

49. The standard molar enthalpy of formation of $NH_3(g)$ is -45.9 kJ/mol. What is the enthalpy change if 6.31 g $N_2(s)$ and 1.96 g $H_2(g)$ react to produce $NH_3(g)$?

50. According to experiments concerned with the photoelectric effect, which of the following will increase the kinetic energy of an electron ejected from a metal surface?

- 1. decreasing the wavelength of the light striking the surface
- 2. decreasing the frequency of the light striking the surface
- 3. increasing the number of photons of light striking the surface

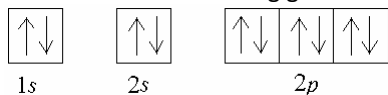
- a. 1 only
- b. 2 only
- c. 3 only
- d. 1 and 2
- e. 1 and 3

51. Calculate $\Delta_r H^\circ$ for the combustion of gaseous dimethyl ether, $\text{CH}_3\text{OCH}_3(\text{g}) + 3 \text{O}_2(\text{g}) \rightarrow 2 \text{CO}_2(\text{g}) + 3 \text{H}_2\text{O}(\ell)$ using standard molar enthalpies of formation.

molecule	$\Delta_f H^\circ$ (kJ/mol)
$\text{CH}_3\text{OCH}_3(\text{g})$	-184.1
$\text{CO}_2(\text{g})$	-393.5
$\text{H}_2\text{O}(\ell)$	-285.8

52. What is the binding energy of an electron in a photosensitive metal (in kJ/mol) if the longest wavelength of light that can eject electrons from the metal is 238 nm?
53. A mass of 0.645 g of an unknown gas is introduced into an evacuated 1.50 L flask. If the pressure in the flask is 0.764 atm at 96 °C, which of the following gases might be in the flask? ($R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$)
- a. NH_3 b. HCl c. N_2O d. C_2H_2
54. If a hydrogen atom in the excited $n = 4$ state relaxes to the ground state, what is the maximum number of possible emission lines?
- a. infinite b. 8 c. 1 d. 6
55. What is the ground state electron configuration for In^{+} ?
- a. $[\text{Kr}]4f^{14}5d^{10}5s^2$ b. $[\text{Kr}]4d^{10}5s^2$ c. $[\text{Kr}]4d^{10}5s^25p^2$ d. $[\text{Kr}]4d^{10}5p^2$
56. If 245 J is required to change the temperature of 14.4 g of chromium by 38.0 K, what is the specific heat capacity of chromium?

57. What 2- ion has the following ground state electron configuration?



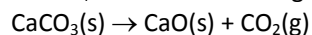
58. A 1.994 g sample of ethanol, $\text{CH}_3\text{CH}_2\text{OH}$, is combusted in a bomb calorimeter. The temperature of the calorimeter increases by 10.91 K. If the heat capacity of the bomb is 615.5 J/K and it contains 1.150 kg of water, what is the enthalpy change per mole of ethanol combusted? The specific heat capacity of water is 4.184 J/g·K and the molar mass of ethanol is 46.07 g/mol.
59. What 2+ ion has the following ground state electron configuration?



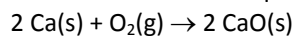
60. Which of the following transitions in a hydrogen atom would **emit** the highest energy photon?
- a. $n = 5$ to $n = 1$ b. $n = 3$ to $n = 2$ c. $n = 6$ to $n = 5$ d. $n = 2$ to $n = 8$
61. What is the maximum number of electrons that can occupy the $n = 3$ shell?
- a. 4 b. 18 c. 32 d. 50
62. Which one of the following sets of quantum numbers is NOT allowed?
- a. $n = 7, \ell = 0, m_\ell = 0, m_s = +1/2$ c. $n = 5, \ell = 3, m_\ell = -2, m_s = +1/2$
- b. $n = 2, \ell = 2, m_\ell = 0, m_s = -1/2$ d. $n = 3, \ell = 1, m_\ell = -1, m_s = +1/2$
63. Place the following atoms in order of increasing atomic radii: K, Mg, Ca, and Rb?
- a. $\text{Mg} < \text{Ca} < \text{K} < \text{Rb}$ b. $\text{Mg} < \text{K} < \text{Ca} < \text{Rb}$ c. $\text{K} < \text{Mg} < \text{Ca} < \text{Rb}$ d. $\text{K} < \text{Rb} < \text{Mg} < \text{Ca}$
64. Place the following gases in order of increasing average velocity at 300 K: CO, Ne, O_2 , and N_2O .
- a. $\text{CO} < \text{O}_2 < \text{N}_2\text{O} < \text{Ne}$ c. $\text{CO} = \text{Ne} = \text{O}_2 = \text{N}_2\text{O}$
- b. $\text{O}_2 < \text{N}_2\text{O} < \text{Ne} < \text{CO}$ d. $\text{Ne} < \text{CO} < \text{O}_2 < \text{N}_2\text{O}$

65. If the volume of a confined gas is reduced to 1/2 the original volume while its temperature remains constant, what change will be observed?
- The pressure of the gas will remain unchanged.
 - The pressure of the gas will increase to twice its original value.
 - The density of the gas will decrease to 1/2 its original value.
 - The average velocity of the molecules will double.

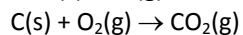
66. Calculate $\Delta_r H^\circ$ for the following reaction,



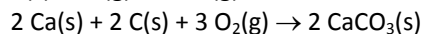
given the thermochemical equations below.



$$\Delta_r H^\circ = -1270.2 \text{ kJ}$$

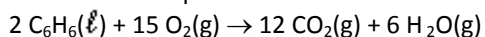


$$\Delta_r H^\circ = -393.5 \text{ kJ}$$



$$\Delta_r H^\circ = -2413.8 \text{ kJ}$$

67. The thermochemical equation for the combustion of benzene is shown below.



$$\Delta_r H^\circ = -3909.9 \text{ kJ/mol-rxn}$$

What is the enthalpy change for the combustion of 12.5 g C_6H_6 ?

68. For a neutron (mass = 1.675×10^{-27} kg) moving with a velocity of 3.10×10^4 m/s, what is the de Broglie wavelength (in pm)

Chem 1A Exam 2 Review Problems
Answer Section

- | | | | |
|-----|------------------|-----|----------------------------------|
| 1. | ANS: 9.95 m | 49. | ANS: -20.7 kJ |
| 2. | ANS: A | 50. | ANS: A |
| 3. | ANS: C | 51. | ANS: -1460.3 kJ |
| 4. | ANS: E | 52. | ANS: 503 kJ/mol |
| 5. | ANS: E | 53. | ANS: A |
| 6. | ANS: A | 54. | ANS: D |
| 7. | ANS: Co | 55. | ANS: B |
| 8. | ANS: D | 56. | ANS: 0.448 J/g·K |
| 9. | ANS: C | 57. | ANS: oxide ion |
| 10. | ANS: D | 58. | ANS: -1.368×10^3 kJ/mol |
| 11. | ANS: 16.0 g/mol | 59. | ANS: Sn^{2+} |
| 12. | ANS: -622 kJ/mol | 60. | ANS: A |
| 13. | ANS: 18.5 L | 61. | ANS: B |
| 14. | ANS: C | 62. | ANS: B |
| 15. | ANS: | 63. | ANS: A |
-
- [Ar]

↑	↑	↑	↑	↑	↑
$3d$					$4s$
- | | | | |
|-----|--------------------------------------|-----|----------------|
| 16. | ANS: 6.14 g | 64. | ANS: D |
| 17. | ANS: B | 65. | ANS: B |
| 18. | ANS: 682 m/s | 66. | ANS: +178.3 kJ |
| 19. | ANS: B | 67. | ANS: -313 kJ |
| 20. | ANS: -1648.4 kJ | 68. | ANS: 12.8 pm |
| 21. | ANS: D | | |
| 22. | ANS: D | | |
| 23. | ANS: 67.2 °C | | |
| 24. | ANS: -492.6 kJ | | |
| 25. | ANS: 0.811 L | | |
| 26. | ANS: 27.4 K | | |
| 27. | ANS: D | | |
| 28. | ANS: nuclear | | |
| 29. | ANS: A | | |
| 30. | ANS: C | | |
| 31. | ANS: Hund's | | |
| 32. | ANS: 3.26 m | | |
| 33. | ANS: 589 nm | | |
| 34. | ANS: B | | |
| 35. | ANS: 73.6 mm Hg | | |
| 36. | ANS: B | | |
| 37. | ANS: A | | |
| 38. | ANS: $n = 4, \ell = 1, m_\ell = -1,$ | | |
-
- $m_s = +1/2$

↑

- | | |
|-----|------------------------------|
| 39. | ANS: B |
| 40. | ANS: A |
| 41. | ANS: 12.3 g |
| 42. | ANS: C |
| 43. | ANS: 236 kJ |
| 44. | ANS: -1.03×10^3 J/g |
| 45. | ANS: B |
| 46. | ANS: B |
| 47. | ANS: 1 |
| 48. | ANS: quantized |