

Chem 111**9:05a section****Final Exam v2**

This exam is composed of **50** questions. Go initially through the exam and answer the questions you can answer *quickly*. Then go back and try the ones that are more challenging to you and/or that require calculations..

$$PV = nRT \quad N_o = 6.022 \times 10^{23} \text{ mol}^{-1} \quad 1 \text{ mL} = 1 \text{ cm}^3 \quad h = 6.626 \times 10^{-34} \text{ J s}$$

$$E = hv = \frac{hc}{\lambda} \quad \overline{u^2} = \frac{3RT}{M} \quad \overline{K.E.} = \frac{1}{2} m \overline{u^2} \quad 1 \text{ atm} = 760 \text{ mm Hg} \quad c = 2.998 \times 10^8 \text{ m s}^{-1}$$

$$E_n^{H\text{-atom}} = -\frac{R_H hc}{n^2} \quad R_H hc = 1312 \text{ kJ mol}^{-1} \quad \Delta H_{\text{vap}}(H_2O) = 40.65 \text{ kJ mol}^{-1} \quad R = 0.0820 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

$$\Delta H_{\text{fus}}(H_2O) = 6.00 \text{ kJ mol}^{-1} \quad R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$$

$$\Delta E = q + w = \Delta H - P\Delta V \quad J = \text{kg m}^2 \text{ s}^{-2}$$

PERIODIC TABLE OF THE ELEMENTS

1A	2A	3B	4B	5B	6B	7B	8B	8B	8B	1B	2B	3A	4A	5A	6A	7A	8A
1 H 1.008																	2 He 4.003
3 Li 6.939	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Unq (261)	105 Unp (262)	106 Unh (263)	107 Uns (262)	108 Uno (265)	109 Une (266)									

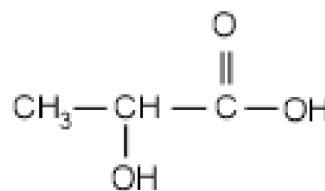
Solubility Rules for some ionic compounds in water**Soluble Ionic Compounds**

- All sodium (Na^+), potassium (K^+), and ammonium (NH_4^+) salts are SOLUBLE.
- All nitrate (NO_3^-), acetate (CH_3CO_2^-), chlorate (ClO_3^-), and perchlorate (ClO_4^-) salts are SOLUBLE.
- All chloride (Cl^-), bromide (Br^-), and iodide (I^-) salts are SOLUBLE -- EXCEPT those also containing: lead, silver, or mercury (I) (Pb^{2+} , Ag^+ , Hg_2^{2+}) which are NOT soluble.
- All sulfate (SO_4^{2-}) salts are SOLUBLE -- EXCEPT those also containing: calcium, silver, mercury (I), strontium, barium, or lead (Ca^{2+} , Ag^+ , Hg_2^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+}) which are NOT soluble.

Not Soluble Ionic Compounds

- Hydroxide (OH^-) and oxide (O^{2-}) compounds are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or barium (Na^+ , K^+ , Ba^{2+}) which are soluble.
- Sulfide (S^{2-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, ammonium, or barium (Na^+ , K^+ , NH_4^+ , Ba^{2+}) which are soluble.
- Carbonate (CO_3^{2-}) and phosphate (PO_4^{3-}) salts are NOT SOLUBLE -- EXCEPT those also containing: sodium, potassium, or ammonium (Na^+ , K^+ , NH_4^+), which are soluble.

1. Surgeons use biodegradable polymers for sutures. One commonly used polymer, poly(lactic acid), degrades to the small molecule lactic acid, shown at right. 0.5 moles of lactic acid corresponds to what mass of lactic acid?



- 1) 23.5 g 2) 90.1 g 3) 111 g 4) 38.0 g 5) 45.0 g
2. Direct reaction of iodine (I_2) and chlorine (Cl_2) produces an iodine chloride, I_xCl_y , a bright yellow solid. If you completely use up 0.339 g of iodine and produce 0.623 g of I_xCl_y , what is the empirical formula of the compound?

- 1) I_3Cl_2 2) I_3Cl 3) I_2Cl_3 4) ICl_3 5) I_3Cl_3

3. What is the formula of the ionic compound expected to form between the ions Fe^{4+} and SO_4^{2-} ?

- 1) $\text{Fe}_2(\text{SO}_4)_3$ 2) Fe_2SO_4 3) $\text{Fe}(\text{SO}_4)_2$ 4) FeSO_4 5) Fe_2SO_2

4. A sample of aspirin, $\text{C}_9\text{H}_8\text{O}_4$, contains 0.104 mol of the compound. What is the mass of this sample, in grams?
- 1) 20.1 g 2) 12.5 g 3) 37.3 g 4) 0.0730 g 5) 18.7 g
5. What is the wavelength of light with frequency 7.15×10^{14} Hz?
- 1) 209 nm 2) 420 nm 3) 501 nm 4) 162 nm 5) 250 nm
6. What is the wavelength of the photon emitted from or absorbed by a hydrogen atom when the electron goes from $n=2$ to $n=7$?
- 1) 0.023 nm 2) 397 nm 3) 434 nm 4) 923 nm 5) 22 nm
7. In the above question, does the energy of the H atom increase or decrease?
- 1) increase 2) decrease 3) doesn't change 4) can't tell

8. A local AM radio station broadcasts at an energy of 8.88×10^{-7} kJ/mol. Calculate the frequency at which it is broadcasting.
- 1) 1.39 MHz 2) 0.835 MHz 3) 1.39 KHz 4) 2.23 Mhz 5) Cant' tell
9. The magnetic quantum number m_l specifies:
- 1) subshell orbital shape 2) subshell orbital orientation
3) transition probability 4) subshell orbital karma
5) energy and distance from nucleus
10. The name of the element represented by the symbol N is:
- 1) carbon 2) nitrogen 3) oxygen 4) neon 5) aluminum
11. Which list below is in order of increasing ionization energy (low to high)?
- 1) Cl < S < P < Si 2) Ne < F < O < N
3) I < Br < Cl < F 4) K < Rb < Na < Li
5) none of the above
12. Which of the following correctly compares atomic sizes (small to large)?
- 1) Ne < Li < B < C < N 2) Ne < N < C < O < Be
3) Li < B < C < N < Ne 4) Si < P < S < Cl < Ar
5) none of the above
13. Which of the following correctly compares ionic/atomic sizes (small to large)?
- 1) Ca^{2+} < K^+ < Ar < Cl^- < S^{2-} 2) Ne < O < C < Mg^{2+} < Na^+
3) C < O < Ne < Na^+ < Mg^{2+} 4) Ne < Mg^{2+} < Na^+ < O < C
5) none of the above

14. The correct spectroscopic notation for phosphorous ion (P^{2-}) is:
- 1) $1s^2 2s^2 2p^6 3s^2 3p^2$ 2) $1s^2 2s^2 2p^6 3s^2 3p^3$
 3) $1s^2 2s^2 2p^6 3s^2 3p^4$ 4) $1s^2 2s^2 2p^6 3s^2 3p^5$
 5) $1s^2 2s^2 2p^6 3s^2 3p^6$
15. What is the **maximum number of electrons** that can be accommodated by the orbitals that can be identified by the set of quantum numbers $n=+2$ $l=1$?
- 1) 3 2) 6 3) 4 4) 10 5) 12
16. Draw the Lewis structure for NO_2^+
 Your resulting molecule has a total of:
- 1) Two single bonds 2) Two double bonds
 3) One single and one double bond 4) One double and one triple bond
 5) Two triple bonds

Bond Dissociation Energies (kJ mol^{-1}) (gas phase)

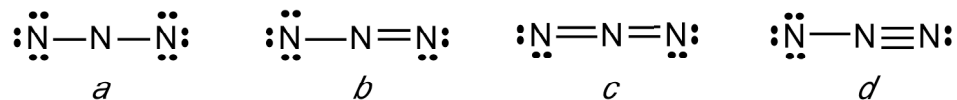
Bond	D	Bond	D	Bond	D
H-H	436	C-C	346	N-N	163
C-H	413	C=C	610	N=N	418
N-H	391	O-O	146	C-O	358
O-H	463	O=O	498	C=O	745

17. Consider the reaction: $HNNH(g) + H_2(g) \rightarrow 2 NH_3(g)$

What is the energy (ΔH° , in kJ mol^{-1}) for this reaction?

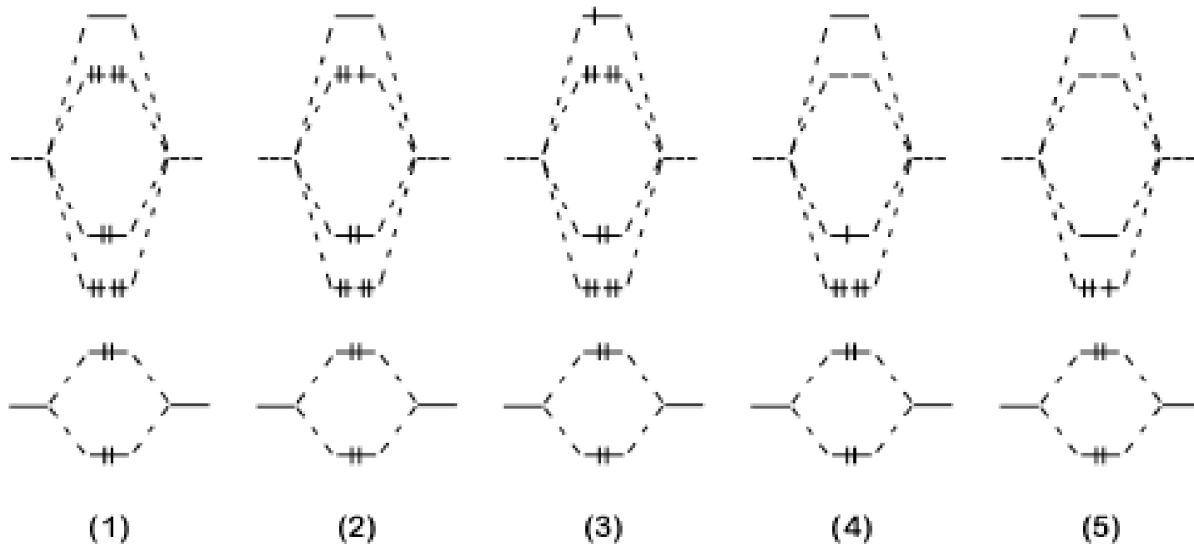
- 1) +183 2) -183 3) +274 4) +463 5) -274
 5) -1 for one O and 0 for the other O

(Questions 18-19) Consider the following resonance forms for the azide ion N_3^-



18. In resonance structure **a**, what is the formal charge on the central N?
- 1) +3 2) -2 3) -1 4) 0 5) +1
19. Which resonance structure is lowest in energy?
- 1) a 2) b 3) c 4) d 5) all same
20. Draw the Lewis structure for ClF_4^- . The molecular geometry is:
- 1) square planar 2) T-shaped 3) trigonal bipyramidal
 4) octahedral 5) none of the above
21. The molecule ClF_4^- is:
- 1) polar 2) nonpolar 3) can't tell
22. In ClF_4^- , what is the hybridization on Cl?
- 1) sp^3d^3 2) sp^3d^2 3) sp^3d 4) sp^3 5) sp^2

23. Which of the following molecular orbital representations correctly describes F_2^- ?



24. From molecular orbital theory, the bond order in F_2^- is:

- 1) single 2) double 3) 0.5 4) 1.5 5) 2.5

25. The molecule F_2^- is predicted to be:

- 1) paramagnetic 2) diamagnetic 3) can't tell

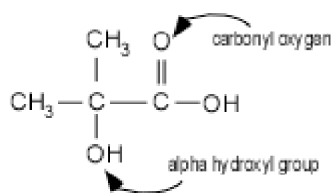
26. Consider the molecular orbital diagram shown at right:

This energy diagram best describes:

- 1) O_2 2) NO^- 3) NO^+ 4) N_2



27. Trendy anti-wrinkle creams advertise the presence of “alpha hydrox” as a key component. A structure of an alpha hydroxy acid is shown at right. In this molecule, what is the hybridization at the *alpha hydroxyl oxygen*? Hint: the oxygen atom is “happy.”

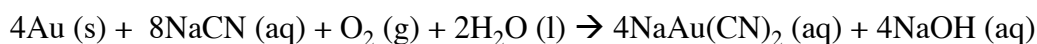


- 1) sp 2) sp^2 3) sp^3 4) sp^3d 5) sp^3d^2
28. Write the balanced, *net ionic equation* corresponding to the reaction of **magnesium bromide** and **barium hydroxide**. In your net ionic equation, the coefficient in front of OH^- (aq) is:
- 1) 1 2) 2 3) 3 4) 4
5) 0 (OH^- doesn't occur in the net ionic equation)
29. Write the balanced, *net ionic equation* corresponding to the reaction of **potassium carbonate** and **iron(II) iodide**. In your net ionic equation, the coefficient in front of CO_3^{2-} (aq) is:
- 1) 1 2) 2 3) 3 4) 4
5) 0 (CO_3^{2-} doesn't occur in the net ionic equation)

30. Mixing Na_2CO_3 with KCl in water leads to precipitation of:

- 1) a CO_3^{2-} salt 2) a Na^+ salt 3) a Cl^- salt
4) everything precipitates 5) no precipitation

31. Gold can be dissolved from gold-bearing rock by treating the rock with sodium cyanide in the presence of oxygen.



For this reaction, what is the reducing agent?

- 1) Au 2) NaCN 3) O_2 4) H_2O 5) H^+

32. What is the oxidation number of tin in SnO_3^{2-} ?

- 1) +2 2) +4 3) +6 4) -6 5) 0

33. Hydrogen peroxide, H_2O_2 , is a reasonably strong:

- 1) acid 2) base 3) reducing agent 4) oxidizing agent

34. In general, strong acids are:

- 1) good oxidants 2) good reductants 3) insoluble
4) weak electrolytes 5) strong electrolytes

35. In an endothermic process:

- 1) work is performed on the surroundings
2) heat is transferred to the surroundings
3) work is performed on the system
4) heat is transferred to the system

36. Ability to do work is best described as:
 1) ΔH 2) q 3) $\Delta E - q$ 4) ΔE 5) ΔG
37. A negative value of ΔE means that:
 1) heat is transferred to the surroundings
 2) heat is transferred to the system
 3) energy in the form of heat and/or work is transferred to the surroundings
 4) energy in the form of heat and/or work is transferred to the system
38. An automobile engine generates **2755** Joules of heat that must be carried away by the cooling system. The internal energy changes by **-3528** Joules in this process.
 How much work to push the pistons is available in this process ?
 1) 4918 J 2) 5833 J 3) 683 J 4) 6283 J 5) 773 J

39. An instant ice pack for first-aid treatment uses the dissolution of an ionic salt in water to provide cold therapy. Given the standard molar enthalpies of formation shown at right, determine ΔH for the reaction:



- 1) $-28.05 \text{ kJ mol}^{-1}$ 2) $+28.05 \text{ kJ mol}^{-1}$
 3) $-14.72 \text{ kJ mol}^{-1}$ 4) $+14.72 \text{ kJ mol}^{-1}$
 5) not enough information to determine

Subst	ΔH_f° (kJ/mol)
NH_4^+ (aq)	-132.51
NO_3^- (aq)	-205.0
Cl^- (aq)	-167.2
NH_4NO_3 (s)	-365.56
NH_4Cl (s)	-314.43

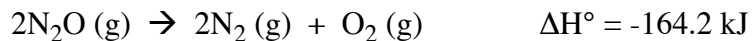
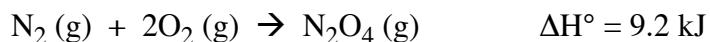
40. Given the information on page 1, what is the heat required to vaporize water at 298 K?

- 1) $-40.65 \text{ kJ mol}^{-1}$ 2) $40.65 \text{ kJ mol}^{-1}$ 3) $44.00 \text{ kJ mol}^{-1}$
4) $-44.00 \text{ kJ mol}^{-1}$ 5) not enough information to determine

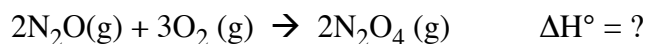
41. A 45.5 g sample of copper at 99.8 °C is dropped into a beaker containing 152 g of water at 18.5 °C. When thermal equilibrium is reached, what is the final temperature of the copper? The specific heat capacities of water and copper are 4.184 and 0.385 J $\text{g}^{-1} \text{K}^{-1}$, respectively.

- 1) 25.3 °C 2) 12.5 °C 3) 37.0 °C 4) 90.1 °C 5) 20.7 °C

42. Given the following information:



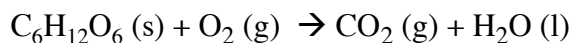
what is the standard enthalpy change for the reaction:



- 1) -155 kJ mol^{-1} 2) -146 kJ mol^{-1} 3) 155 kJ mol^{-1}
4) 146 kJ mol^{-1} 5) not enough information to determine

43. The average molecular speed in a sample of N_2 gas is 408 m/s at 303 K. The average molecular speed in a sample of CO gas at the same temperature is:
- 1) 408 m s^{-1} 2) 381 m s^{-1} 3) 478 m s^{-1} 4) 326 m s^{-1} 5) 318 m s^{-1}
44. A 1.28 mol sample of Ar gas is confined in a 31.5 liter container at 26.5°C . If 1.28 mol of F_2 gas is added while decreasing the temperature by half, the average kinetic energy per molecule will:
- 1) decrease 2) remain the same 3) increase
4) not enough information 5) I don't have a clue
45. A 1.96 mol sample of CO_2 gas is confined in a 49.1 liter container at 32.3°C . If the temperature of the gas sample is decreased to 25.0°C , holding the volume constant, the **pressure will decrease** because:
- 1) With lower average speeds, the molecules hit the walls of the container less often.
2) As the average speed decreases, each molecule hits the wall with less force.
3) With higher average speeds, on average the molecules hit the walls of the container with more force.
4) Both reasons (1) and (2) above
5) None of the above

46. In our bodies, sugar is broken down with oxygen to produce water and carbon dioxide. How many moles of glucose ($C_6H_{12}O_6$) are required to react completely with 33.6 L of oxygen gas (O_2) according to the following reaction at 0 °C and 1 atm pressure? Note that the reaction may need balancing.



- 1) 6.0 mol 2) 0.250 mol 3) 0.319 mol 4) 0.637 mol 5) 7.13 mol
47. What is the total volume of gaseous products formed when 160 L of bromine trifluoride (BrF_3) react completely to form Br_2 and F_2 ? (All gases are at the same temperature and pressure, before and after.)
- 1) 85 L 2) 190 L 3) 380 L 4) 320 L 5) 160 L
48. The temperature of the atmosphere on Mars can be as high as 28 °C at the equator at noon, and the atmospheric pressure is about 7.0 mm of Hg. If a spacecraft could collect 6.20 m³ of this atmosphere, compress it to a small volume, and send it back to earth, about how many moles would the sample contain?
- 1) 0.120 mmol 2) 0.395 mmol 3) 3.95 mol 4) 2.31 mol 5) 1.2 mol

49. What is the average kinetic energy of an O₂ molecule confined in 2.5 L at 1.0 atm and 25°C?

- 1) 5.71×10^3 J 2) 9.48×10^3 J 3) 5.71×10^{-21} J 4) 3.21×10^{-21} J 5) 6.17×10^{-21} J

50. The correct designator for this course is:

- 1) Chem 262 2) Chem 111 3) Econ 3.33 4) Sports 01 5) Bio 233