

CHEMISTRY 102C/D
Hour Exam I
February 21, 2024
T. Hummel

NAME _____

SIGNATURE _____

SECTION _____

FORM "A"

This exam is made up of an answer sheet, two cover sheets and 7 numbered pages. Below are instructions for coding the answer sheet. The last pages of this exam contains some useful equations and constants, plus the periodic table, and some scratch paper.

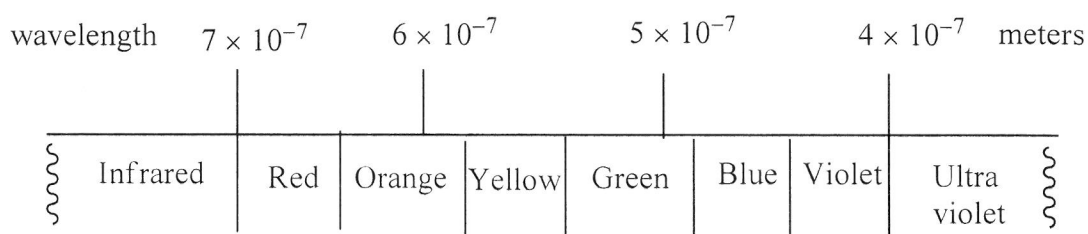
On the answer sheet:

1. **Use #2 pencil. Erase cleanly.**
2. Print your **NAME** in the appropriate designated spaces, then blacken in the letter boxes below each printed letter, last name first, then your first name initial.
3. Fill in your university **ID** number under **STUDENT NUMBER**.
4. Under **SECTION** write the five digit number that corresponds to your section designation, and then blacken in the corresponding number of boxes. **For 102C students**, the numbers are: CQ1 = 00011, CQ2 = 00012, CQ3 = 00013, CQ4 = 00014, CQ5 = 00015, CQ6 = 00016, CQ7 = 00017, CQ9 = 00019, CQA = 00021, CQB = 00022, CQF = 00026, CQG = 00027, CQH = 00028, CQI = 00029. **For 102D students**, the numbers are: DQ1 = 00031, DQ2 = 00032, DQ3 = 00033, DQ4 = 00034, DQ5 = 00035, DQ6 = 00036, DQ7 = 00037, DQ8 = 00038, DQA = 00041, DQB = 00042.
5. Under **NETWORK ID** print your University Network ID beginning on the left-hand side with box #1, and then blacken in the corresponding letters, numbers and/or dashes under each character. Do not fill in a character for any unused boxes.
6. Under **TEST FORM** blacken the letter corresponding to the form designated on the upper left hand corner of the exam booklet.
7. Your TA's name should be printed for **INSTRUCTOR** and write your section number for **SECTION** in the lines provided.
8. **Sign** your name (do not print) on the line provided. Print your name underneath it.
9. **Mark** only one answer per question and do not use the answer sheet for scratch paper or make any stray marks on it. Erase cleanly if you wish to change an answer. The exam itself can be used for scratch paper.

Work carefully and efficiently. If your answer differs from one given in the last proper significant figure, mark that answer as correct and not the response "none of these". All questions are worth the same.

1. The density of osmium (the densest metal) is 22.57 g/cm^3 . If a 1.00 kg rectangular block of osmium has two dimensions of $4.00 \text{ cm} \times 4.00 \text{ cm}$, calculate the third dimension of the rectangular block. The volume of a rectangle is $\text{length} \times \text{width} \times \text{height}$.
- a) 44.3 cm b) 16.0 cm c) 2.77 cm
d) 1.41 cm e) 3.97 cm

Use the figure below to answer the next two questions.



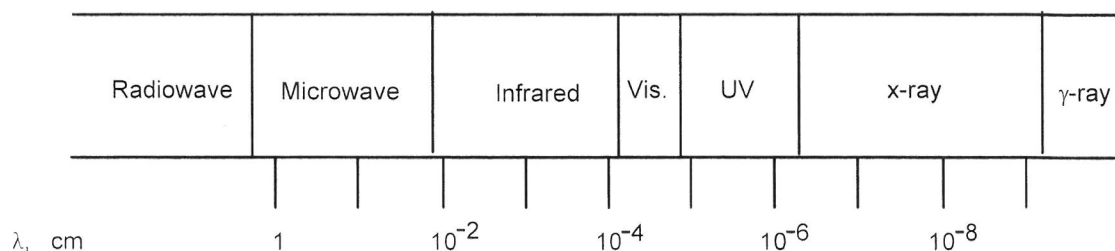
2. What color is electromagnetic radiation having a frequency of $5.0 \times 10^{14} \text{ sec}^{-1}$?
- a) red b) orange c) yellow d) green e) violet
3. In the emission spectrum for hydrogen, what color is the $n = 5$ to $n = 2$ electronic transition?
- a) red b) orange c) yellow d) green e) violet
-
4. Consider the compound butane, which has a formula of C_4H_{10} . If a sample of butane contains 2.59×10^{23} atoms of hydrogen, what mass of butane is present?
- a) 25.0 g b) 6.25 g c) 5.00 g
d) 1.25 g e) 2.50 g
5. An unknown element E forms a covalent compound with fluorine having the formula EF_4 . The shape of the EF_4 molecule is see-saw. Which of the following elements could be E?
- a) O b) N c) Se d) P e) I

6. Place the following atoms/ions in order of **decreasing** size (largest to smallest).
F, Te^- , I, Ne^+
- a) $\text{Te}^- > \text{I} > \text{F} > \text{Ne}^+$ b) $\text{F} > \text{Te}^- > \text{I} > \text{Ne}^+$ c) $\text{I} > \text{Te}^- > \text{F} > \text{Ne}^+$
d) $\text{Te}^- > \text{F} > \text{Ne}^+ > \text{I}$ e) $\text{Ne}^+ > \text{F} > \text{Te}^- > \text{I}$
7. Which of the following ground state electron configurations is associated with the atom having the **largest** ionization energy?
- a) $[\text{Ne}]3s^23p^2$ b) $[\text{Ne}]3s^23p^3$ c) $[\text{He}]2s^22p^4$
d) $[\text{He}]2s^22p^3$ e) $[\text{Ar}]4s^23d^{10}4p^3$
8. The ground state electron configuration for an atom or ion has 2 electrons in the $n = 1$ orbital, 8 electrons in $n = 2$ orbitals, 18 electrons in $n = 3$ orbitals, and 12 electrons in $n = 4$ orbitals. Which of the following could be this atom or ion?
- a) Zr b) Mo^{2+} c) Sr^{2-} d) Cd e) Pd^{2-}
9. Draw the Lewis structure for ICl_5 . How many of the following four statements (I-IV) is/are **true** regarding ICl_5 ?
- I. The central atom in ICl_5 has one lone pair of electrons.
II. Some of the Cl-I-Cl bond angles are approximately 90° .
III. ICl_5 is polar.
IV. The shape of ICl_5 is square pyramid.
- a) 0 (None are true.) b) 1 c) 2 d) 3 e) 4 (All are true.)
10. A compound or ion has delocalized π electrons resulting in equivalent bonds to oxygen. All of the bonds in this compound or ion are stronger than single bonds yet are significantly weaker than double bonds. Which of the following could be this compound or ion?
- a) CO_2 b) NO_2^+ c) SO_3^{2-}
d) NO_3^- e) XeO_3

11. Which of the following statements is **false**?
- a) When a metal reacts with a nonmetal, an ionic compound is generally produced.
 - b) Nonmetals generally form anions when reacted with a metal to form a compound.
 - c) Alkaline earth metals generally form stable +2 charged ions when in ionic compounds.
 - d) Transition metals generally gain electrons to form stable ions when in ionic compounds.
 - e) When two nonmetals react with each other, a covalent compound is generally produced.
12. The most stable ion of a certain isotope contains 15 protons and has a mass number of 33. Which of the following statements (a-d) about this ion is **true**? Note: the most stable ion is the ion that forms when this isotope is in an ionic compound.
- a) The net charge of the ion is -3.
 - b) The ion contains 10 electrons.
 - c) The ion contains 33 neutrons.
 - d) The ion is sulfur.
 - e) All of the above statements (a-d) are false.
13. When the following calculation is performed, how many significant figures are in the correct answer?

$$(1.00866 - 1.00776) \times (6.022 \times 10^{23})$$

- a) 1 b) 2 c) 3 d) 4 e) 6
14. Which of the following statements (a-d) about the electromagnetic spectrum is **true**? Note that wavelengths are given in units of cm.



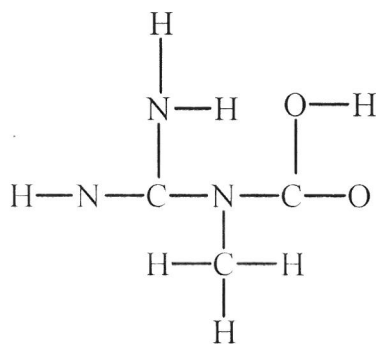
- a) Ultraviolet (UV) radiation has a longer wavelength than visible (Vis.) radiation.
- b) The frequency of microwave radiation is higher than the frequency of visible (Vis.) radiation.
- c) Gamma (γ) ray radiation travels faster than radiowaves because it has a shorter wavelength.
- d) A photon of x-ray radiation is more energetic than a photon of microwave radiation.
- e) None of the above statements (a-d) are true.

Consider the following five compounds for the next two questions.



15. How many of these five compounds are polar?
- a) 1 b) 2 c) 3 d) 4 e) 5 (All are polar.)
16. Which of the following statements about these five compounds is **false**?
- a) In XeF_4 , the central Xe atom is sp^3 hybridized.
b) In SF_4 , the central S atom is dsp^3 hybridized.
c) In PCl_5 , the central P atom is dsp^3 hybridized.
d) In COS , the central C atom is sp hybridized.
e) In SO_2 , the central S atom is sp^2 hybridized.
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17. Which of the following statements (a-d) is **true** regarding element 117 (symbolized as X)?
- a) Element 117 would form a stable compound with potassium having the formula K_2X .
b) Element 117 has 2 unpaired electrons in the ground state.
c) Element 117 has one valence electron in the ground state.
d) Element 117 has 14 electrons in various f orbitals in the ground state.
e) None of the above statements (a-d) are true.
18. Which of the following statements is **false**?
- a) The periodic table predicts that the 8s atomic orbital will be lower in energy than the 6d atomic orbitals.
b) The quantum mechanical model assumes that the electron has wave properties.
c) The Heisenberg uncertainty principle implies that we cannot know the exact location of an electron in an atom.
d) DeBroglie hypothesized that all matter exhibits both particulate and wave properties.
e) The quantum mechanical model tells us that there are seven degenerate (same energy) 4f atomic orbitals.
19. Draw the Lewis structures for the following four compounds: BH_3 , PS_2 , BrF_3 , and OCl_2 . How many of these four compounds can **satisfy** the octet rule (duet rule for H) for all elements in the compound?
- a) 0 (none) b) 1 c) 2 d) 3
e) 4 [All satisfy the octet rule (duet rule for H)].

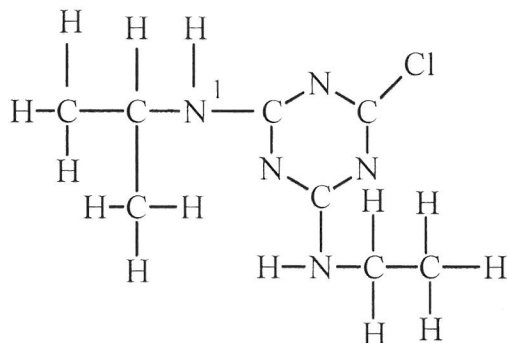
- Creatine is an organic compound important to the building of muscle tissue in the body. The skeletal structure of creatine is below. Complete the Lewis structure and answer the next two questions.



22. How many of the carbon and nitrogen atoms exhibit approximately 109° ?
- a) 0 b) 1 c) 2 d) 3 e) 4
23. How many double bonds are in the completed Lewis structure?
- a) 0 b) 1 c) 2 d) 3 e) 4

24. Draw the Lewis structures for the following four diatomic ions: C_2^{2-} , N_2^{2-} , O_2^{2-} , and F_2^{2+} . How many of these four diatomic ions must have a double or triple bond in order to satisfy the octet rule?
- a) 0 (none) b) 1 c) 2 d) 3
- e) 4 (All of these ions must have a double or triple bond in order to satisfy the octet rule.)
25. Which of the following statements is **true** concerning atoms of bromine?
- a) Br should have a larger radius (larger size) than Rb^{2+} .
b) Br should have a smaller ionization energy than Br^{2-} .
c) Br should have a smaller electronegativity value than Ba (element #56).
d) Br should have a smaller radius (smaller size) than Br^{2+} .
e) Br should have a larger ionization energy than Ne.
26. Which of the following bonds to selenium should be the most pure (nonpolar) covalent bond?
- a) Se – Ga b) Se – Cl c) Se – I d) Se – In
27. A pure substance that can be broken down into other substances by chemical change is classified as a(n):
- a) mixture b) element c) phase d) solution e) compound
28. Sarin is a nerve gas whose chemical formula has 2 atoms of oxygen for each molecule of sarin. If 50.0 g of sarin contains 11.4 g of oxygen, calculate the molar mass of sarin.
- a) 280. g/mol b) 35.0 g/mol c) 70. g/mol
- d) 210. g/mol e) 140. g/mol
29. How many of the following four compounds is/are named **correctly**?
- MgCO_3 , magnesium carbonate
 P_2O_5 , phosphorus oxide
 $\text{Co}(\text{ClO}_2)_3$, cobalt(VI) perchlorate
 HNO_3 , nitric acid
- a) 0 (none) b) 1 c) 2 d) 3 e) 4 (All are correctly named.)

30. A widely used herbicide is atrazine, $C_8N_5ClH_{14}$, whose skeletal structure is shown below. Complete a Lewis structure for this organic compound.



- Which of the following statements concerning the Lewis structure for atrazine is **false**?
- a) Atrazine has zero atoms which are sp hybridized.
 - b) Eight of the carbon and nitrogen atoms in atrazine have at least one unhybridized p atomic orbital.
 - c) There are 28 sigma (σ) bonds and 3 pi (π) bonds in the Lewis structure.
 - d) The nitrogen atom labeled 1 is sp^3 hybridized.
 - e) All the carbon-hydrogen bonds in atrazine are formed from overlap of sp^3 hybrid orbitals from carbon with $1s$ orbitals from hydrogen.
31. Which of the following statements about hybrid orbitals is **true**?
- a) Valence atomic orbitals always combine with inner core atomic orbitals to produce hybrid orbitals.
 - b) The orientation in space of the hybrid orbitals is identical to the orientation in space of the atomic orbitals from which they are formed.
 - c) An sp^2 hybrid orbital from one atom can overlap to form a bond with an sp^3 hybrid orbital from another atom.
 - d) Overlap of hybrid orbitals form π bonds.
 - e) Atoms which are sp^2 hybridized form 2 π bonds.
32. My answers for this Chemistry 102 exam should be graded with the answer sheet associated with:
- a) Form A b) Form B c) Form C d) Form D e) Form E

USEFUL CONSTANTS/EQUATIONS

$$R_H = 2.178 \times 10^{-18} \text{ J}$$

$$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{sec}$$

$$c = \lambda \nu$$

$$E_n = -R_H Z^2 (1/n^2), Z = \text{atomic number}$$

$$E = h\nu = hc/\lambda$$

$$\lambda = h/mv \quad (\text{de Broglie equation})$$

$$N = 6.022 \times 10^{23}$$

$$1 \text{ pm} = 1 \times 10^{-12} \text{ m}; \quad 1 \text{ nm} = 1 \times 10^{-9} \text{ m}$$

$$c = 2.998 \times 10^8 \text{ m/sec}$$

Density = mass/volume

$$1 \text{ kHz} = 1000 \text{ Hz} = 1000 \text{ s}^{-1}$$

$$\text{Mass \% of A} = \frac{\text{mass of A}}{\text{total mass}} \times 100$$

$$1 \text{ J} = 1 \text{ kg m}^2/\text{sec}^2$$

$$\Delta E = -R_H Z^2 \left(\frac{1}{n_2^2} - \frac{1}{n_1^2} \right)$$

$$1 \text{ mL} = 1 \text{ cm}^3$$

PERIODIC TABLE OF THE ELEMENTS

1 1A												13 3A	14 4A	15 5A	16 6A	17 7A	18 8A			
1 H 1.008	2 2A											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	2 He 4.003			
3 Li 6.941	4 Be 9.012	<div><div>26 Fe 55.85</div><div>←Atomic number</div><div>←Atomic mass</div></div>										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 58.70	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.59	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 98	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 180.9	74 W 183.9	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	89 Ac ⁺ 227	104 Rf 261	105 Db 262	106 Sg 266	107 Bh 262	108 Hs 265	109 Mt 266	110 Ds 271	111	112									
†Lanthanides			58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm 145	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0				
†Actinides			90 Th 232.0	91 Pa 231	92 U 238	93 Np 244	94 Pu 242	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 251	99 Es 252	100 Fm 257	101 Md 258	102 No 259	103 Lr 260				