Chem 130.917
Exam Ch.7,8,9

SHOW YOUR WORK

Name_____

1. Infrared lamps used in restaurants to keep food warm emit a strong band of photons with a frequency of 1.87×10^{14} Hz. What is the **wavelength** of these photons, in nanometers? ($1nm = 10^{-9}m$)
(speed of light = 3.00×10^{8} m/s)

_____nm

2. Which **one** of the following statements is true?

a) As the energy increases, the frequency of the radiation decreases.
b) As the wavelength of the light increases, the frequency increases.
c) Red light has a higher frequency than blue light.
d) Light is only considered to have wave characteristics.
e) The product of wavelength and frequency of light is constant.

3. The MRI (magnetic resonance imaging) body scanners used in hospitals operate with 350 MHz radio frequency energy. How much **energy** does this correspond to **in kJ per mole of photons**.
($h=6.626 \times 10^{-34}$ J·s) ($N_a = 6.02 \times 10^{23}$)

_____kJ/mol

4. A beam of neutrons ($m = 1.67492 \times 10^{-27}$ kg) has a velocity of 2.80×10^{5} m/s. Calculate the **de Broglie wavelength** of the neutron wave.

_____m

5. A hydrogen electron drops directly from the n=7 level to the n=3 level. What is the **wavelength** of the photon emitted? ($R_h=2.18 \times 10^{-18}$ J)

_____**m**

6. Complete this sentence. Atoms **emit** visible and ultraviolet light:

a) as electrons jump from lower energy levels to higher energy levels.
b) as the atoms condense from a gas to a liquid.
c) as electrons jump from higher energy levels to lower energy levels.
d) as they are heated and the solid melts to form a liquid.
e) as the electrons move about the atom within an orbit.

7. Which one of the orbital occupancy designations shown below **doesn't** make sense?

a) $3s^3$ b) $3d^9$ c) $3p^1$ d) $4f^{13}$ e) $2p^6$

8. Give the **electron configuration** for each of the following atoms, and indicate the **number of valence electrons** for each.

a) $_{24}Cr$ _____ _____

b) $_{53}I$ _____ _____

9. The ground-state electron configuration of a Fe^{+2}ion is **$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6$.** Therefore Fe^{+2} is

a) diamagnetic.
b) paramagnetic with one unpaired electron.
c) paramagnetic with two unpaired electrons.
d) paramagnetic with three unpaired electrons.
e) paramagnetic with four unpaired electrons.

10. Which of the following sets of the four quantum numbers n, l, m_l and m_s describes **one of the outermost electrons** in a ground-state radium (at.no. 88) atom?

a) 6, 1, 1, 1/2 b) 7, 0, 1, -1/2 c) 7, 0, 0, -1/2 d) 7, 1, 0, 1/2 e) 7, 2, 1, -1/2

11. Draw and **label** the box diagram for the entire valence shell of $_{17}Cl$ and give the four quantum numbers for the last,ie, **the seventeenth**, electron.

12. Which of the following atoms has the **largest** atomic radius?

a) K b) Al c) S d) As e) Cs

13. Name three common ions that are isoelectronic with argon.

a) _____ b) _____ c) _____

14. When the headlights on your car get dim, is it because they are emitting fewer photons or because the photons they are emitting are of lower energy? Explain your reasoning.

15. Give an example of a **diamagnetic element** and a **paramagnetic element.** Use box diagrams to illustrate the difference.

16. Rank the following ions in order of **decreasing** radius.

Ar Na^{+1} Cl^{-1} O^{-2} Mg^{+2}

17. Which compound contains both **ionic** and **covalent** bonding?

a) PF_3 b) KF c) NaH d) $MgSO_3$ e) C_3H_8

18. The **smaller** the difference in electronegativity

1. **the more ionic the bond.**
2. **the more nonpolar the bond.**
3. **the more polar the bond.**

a) 1 only b) 2 only c) 3 only d) 1 and 3 only e) 2 and 3 only

19. Which element will display an unusually large jump in ionization energy values between I_3 and I_4, its third and fourth ionization energy?

a) Na b) Mg c) Al d) Si e) P

20. Draw the **Lewis Dot Formula** for each of the following **ionic** compounds.

a) Mg_3P_2 b) Li_3N

21. For each of the following hypothetical bonds, **use an arrrow** to indicate the direction in which the bonding electrons would shift.

Sb----N As----Cl N----Al I----F

22. From a consideration of the Lewis Structure of the thiocyanate ion, SCN^{-1}, in which the carbon has a double bond with both the sulfur and nitrogen atoms, the formal charges on the sulfur, carbon and nitrogen are, respectively,

a) 0,0,-1 b) -2,0,+1 c) -1,+1,-1 d) -2,+1,0 e) -1,0,0

23-25. (2pt. for each structure) **In the space below, draw the Lewis structures for the following. Draw resonance structures where appropriate**

ICl_2^{-1}

NH_2^{-1}

XeF_4

SF_4

NO_2^{-1}

Extra Credit (5 pt.)

Cesium is often used in "electric eyes" in self-opening doors in an application of the photoelectric effect. The amount of energy required to ionize a cesium atom is 3.89 electron volts. (1 eV = 1.60×10^{-19} J) What would be the **wavelength** in nanometers, of light with just sufficient light to ionize an atom of cesium?

($h = 6.626 \times 10^{-34}$ J·s) (Be sure to include your units)

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Name KEY

1. Infrared lamps used in restaurants to keep food warm emit a strong band of photons with a frequency of 1.87×10^{14} Hz. What is the **wavelength** of these photons, in nanometers? ($1nm = 10^{-9}m$)
(speed of light = 3.00×10^{8} m/s)

$\lambda = \frac{c}{\nu} = \frac{3.00 \times 10^{8}\ m/s}{1.87 \times 10^{14}\ s^{-1}} = 1.604 \times 10^{-6}\ m \equiv 1604\ nm$

1604 nm

2. Which **one** of the following statements is true?

a) As the energy increases, the frequency of the radiation decreases.
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$\nu \cdot \lambda = c$

3. The MRI (magnetic resonance imaging) body scanners used in hospitals operate with 350 MHz radio frequency energy. How much **energy** does this correspond to **in kJ per mole of photons**. $(350 \times 10^{6}\ s^{-1})$
($h=6.626 \times 10^{-34}$ J·s) ($N_a = 6.02 \times 10^{23}$)

$E = h\nu = (6.626 \times 10^{-34}\ J \cdot s)(350 \times 10^{6}\ s^{-1}) = 2.32 \times 10^{-25}\ J$

BAT per mole $= 2.32 \times 10^{-25} \times 6.02 \times 10^{23} = 0.142\ J$
$= 1.42 \times 10^{-4}\ kJ/mol$

1.42×10^{-4} kJ/mol

4. A beam of neutrons ($m = 1.67492 \times 10^{-27}$ kg) has a velocity of 2.80×10^{5} m/s. Calculate the **de Broglie wavelength** of the neutron wave.

$\lambda = \frac{h}{mv} = \frac{6.626 \times 10^{-34}\ J \cdot s}{1.67492 \times 10^{-27}\ kg \cdot 2.80 \times 10^{5}\ m/s} = 1.41 \times 10^{-12}\ m$

1.41×10^{-12} m

5. A hydrogen electron drops directly from the n=7 level to the n=3 level. What is the **wavelength** of the photon emitted? ($R_h = 2.18 \times 10^{-18}$ J)

$\frac{hc}{\lambda} = R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

so $\lambda = \frac{hc}{R_H\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)}$

$\lambda = \frac{(6.626 \times 10^{-34}\ J \cdot s)(3.00 \times 10^{8}\ m/s)}{2.18 \times 10^{-18}\ J\left(\frac{1}{32} - \frac{1}{72}\right)}$

$\lambda = 1.01 \times 10^{-6}\ m$

1.01×10^{-6} m

6. Complete this sentence. Atoms **emit** visible and ultraviolet light:

a) as electrons jump from lower energy levels to higher energy levels.
b) as the atoms condense from a gas to a liquid.
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d) as they are heated and the solid melts to form a liquid.
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7. Which one of the orbital occupancy designations shown below **doesn't** make sense?

a) $3s^3$ b) $3d^9$ c) $3p^1$ d) $4f^{13}$ e) $2p^6$

8. Give the **electron configuration** for each of the following atoms, and indicate the **number of valence electrons** for each.

a) $_{24}Cr$ (Ar) $4s^1\ 3d^5$ 1 (exception)

b) $_{53}I$ (Kr) $5s^2\ 4d^{10}\ 5p^5$ 7

9. The ground-state electron configuration of a Fe^{+2} ion is $\mathbf{1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^6}$. Therefore Fe^{+2} is

a) diamagnetic.
b) paramagnetic with one unpaired electron.
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$3d^6$ 

10. Which of the following sets of the four quantum numbers n, l, m_l and m_s describes **one of the outermost electrons** in a ground-state radium (at.no. 88) atom? $7s^2$

a) 6, 1, 1, 1/2 b) 7, 0, 1, -1/2 c) 7, 0, 0, -1/2 d) 7, 1, 0, 1/2 e) 7, 2, 1, -1/2

11. Draw and **label** the box diagram for the entire valence shell of $_{17}Cl$ and give the four quantum numbers for the last,ie, **the seventeenth**, electron.

$_{17}Cl - 1s^2 2s^2 2p^6 3s^2 3p^5$ 17TH e⁻

$3s^2$ $3p^5$

$n = 3$
$l = 1$ (p subshell)
$m_l = 0$ (middle box)
$m_s = -1/2$ (spin down)

12. Which of the following atoms has the **largest** atomic radius?

a) K b) Al c) S d) As e) Cs

closest to lower left

13. Name three common ions that are isoelectronic with argon.

a) S^{-2} b) Cl^{-1} c) K^{+}, Ca^{+2}

14. When the headlights on your car get dim, is it because they are emitting fewer photons or because the photons they are emitting are of lower energy? Explain your reasoning.

fewer photons. If energy of photons decreased the color would change.

15. Give an example of a **diamagnetic element** and a **paramagnetic element.** Use box diagrams to illustrate the difference.

(ALL PAIRED) Ne - $1s^2 2s^2 2p^6$ ⇅ ⇅ ⇅ ⇅ ⇅

(UNPAIRED e⁻) Fe (Ar) $4s^2 3d^6$ — 4 UNPAIRED ⇅ ↑ ↑ ↑ ↑

16. Rank the following ions in order of **decreasing** radius.

Ar Na^{+1} Cl^{-1} O^{-2} Mg^{+2}

$Cl^{-1} > Ar > O^{-2} > Na^{+} > Mg^{+2}$

18 e⁻ 18 e⁻

17. Which compound contains both **ionic** and **covalent** bonding?

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3 VAL e⁻

a) Na b) Mg c) Al d) Si e) P

20. Draw the **Lewis Dot Formula** for each of the following **ionic** compounds.

a) Mg_3P_2 Mg^{+2} Mg^{+2} Mg^{+2} $[:\ddot{P}\cdot]^{-3}$ $[:\ddot{P}\cdot]^{-3}$

b) Li_3N Li^{+} Li^{+} Li^{+} $[:\ddot{N}\cdot]^{-3}$

21. For each of the following hypothetical bonds, **use an arrrow** to indicate the direction in which the bonding electrons would shift.

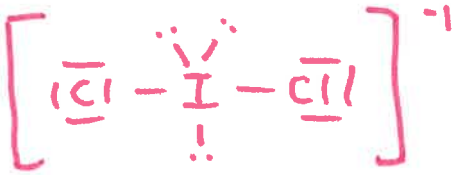
Sb--►N As--►Cl N◄--Al I--►F

22. From a consideration of the Lewis Structure of the thiocyanate ion, SCN^{-1}, in which the carbon has a double bond with both the sulfur and nitrogen atoms, the formal charges on the sulfur, carbon and nitrogen are, respectively,

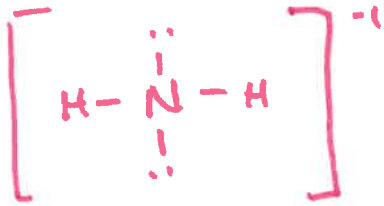
a) 0,0,-1 b) -2,0,+1 c) -1,+1,-1 d) -2,+1,0 e) -1,0,0

23-25. (2pt. for each structure) **In the space below, draw the Lewis structures for the following. Draw resonance structures where appropriate**

ICl_2^{-1}



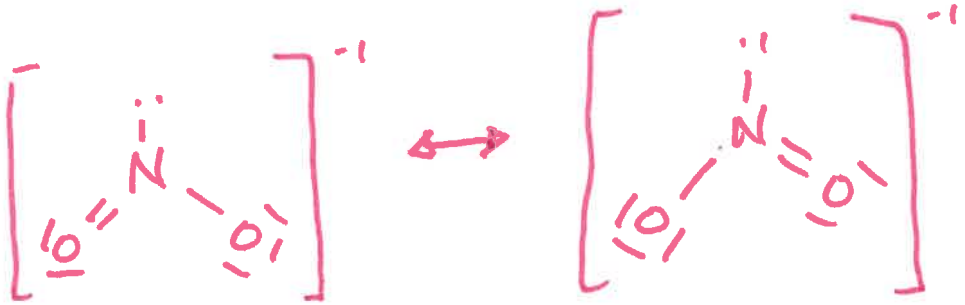
NH_2^{-1}



XeF_4

SF_4

NO_2^{-1}



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(h = 6.626 x 10^{-34} J·s) (Be sure to include your units)

$$3.89\,eV \cdot \frac{1.60\times10^{-19}\,J}{1\,eV} = 6.224\times10^{-19}\,J \text{ required.}$$

$$\lambda = \frac{hc}{E} = \frac{(6.626\times10^{-34}\,J\cdot s)(3.00\times10^{8}\,m/s)}{6.224\times10^{-19}\,J}$$

$$= 3.19\times10^{-7}\,m$$

$$= 319\,nm$$