CH301 Fall 2013 **Name:_____KEY_____**

Sparks **UT EID:_____**

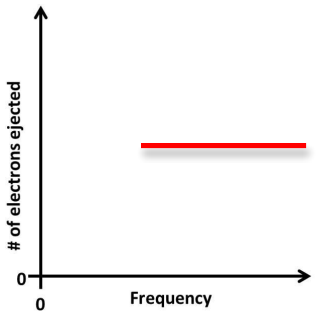
Unit 2 Exam **VERSION #: _____**

25 POINTS

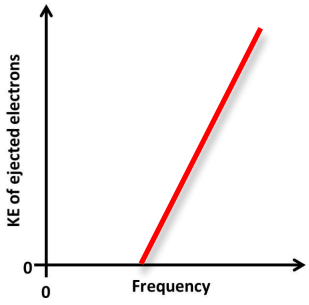
Questions on front and back. Show work for partial credit. Your work and answers must fit in the boxes below each question. ***Responses outside the boxes will not be graded.***

1. (6 points) The threshold frequency for cesium is 4.715 x 10^{14} Hz. On the axes below, draw the graphs for (a) # of electrons vs. frequency and (b) kinetic energy of the ejected electrons vs. frequency

(a)

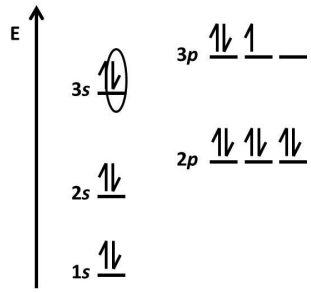


(b)



Each graph is worth 3 points for a total of 6 pts on this question:
+1 pt for NOT starting at the origin but at some frequency to the right of the origin
+2 points for the correct linear relationship (no slope in part a, positive slope in part b)

2. (7 points) A 301 student completed the following orbital diagram for a neutral atom.



(a) What are the possible quantum numbers associated with the circled electron?

3, 0, 0, ± ½
+ 1 pt for each quantum number for a total of 4 pts
Either + ½ , - ½ or ± ½ will be accepted for the last quantum number

(b) What is the identity of the neutral atom?

Phosphorous OR the atomic symbol P
+1 pt for correct answer or symbol

© Unfortunately, the orbital diagram was not completed properly. Which rule did the student forget?

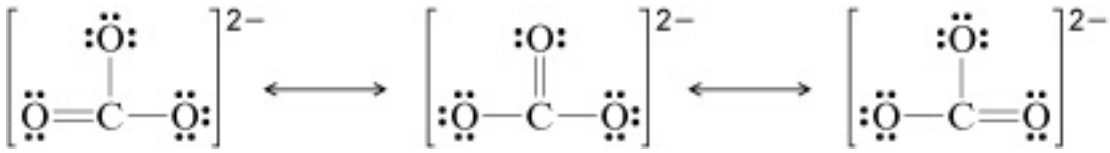
Hund's Rule or a correct description of Hund's Rule meaning that the electrons do not pair in degenerate orbitals until each degenerate orbital has been filled with at least one electron
+1 pt for correct answer or a correct description of Hund's Rule

→ → Questions on front and back → →

(d) Is the atom paramagnetic or diamagnetic?

Paramagnetic
+1 pt for correct answer

3. (6 points) Draw the resonance structures of the carbonate ion and identify the formal charge on each atom in each structure.



The Formal Charge on each carbon is 0
The Formal Charge on each double-bonded oxygen is 0
The Formal Charge on each single-bonded oxygen is -1

+1 pt given for each correct resonance structure (must have correct bonding and lone pairs)
+1 pt for each correct formal charge assignment.
Total of 6 points

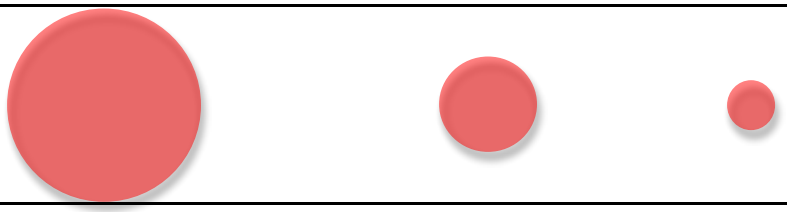
If an incorrect resonance structure is drawn but the assigned formal charges are correct for the structure drawn, partial credit will be given.

4. (6 points) (a) Calculate Z_{eff} for silicon, phosphorus, and germanium.

Z_{eff} Si = 14 – 10 = +4
Z_{eff} P = 14 – 10 = +5
Z_{eff} Ge = 32 - 28 = +4

+ 1 pt for showing an understanding that Z_{Eff} is related to the protons and the core electrons
+1 pt for getting at least one correct answer
+1pt for getting all three correct answers
(3 pts total)

(b) Using your answer from part a, please pictorially represent the trend in atomic radii for the three atoms.



→ → Questions on front and back → →

Ge > Si > P
+1 pt for a pictorial representation that correctly displays the order of size

(c) Describe how Z_{eff} affects atomic radius.

As Z_{eff} **increases**, the atomic radius **decreases** BECAUSE a higher Z_{eff} indicates there are a greater number of protons in the nucleus than core electrons shielding the valence electrons compared to an atom with a smaller Z_{eff}. Therefore the valence electrons "feel" a stronger positive attractive force toward the nucleus and so the radius of the atom is smaller than for an atom with a smaller Z_{eff}.

+1 pt for the Z_{eff} increases, Atomic Radius decreases relationship
+1 pt for a correct explanation of the observation
(Total of 2 pts)

→ → Questions on front and back → →