Name: _____ date: _____ period: _____

ch. 6 & 7 light, atomic structure; periodic trends test 60 points AP chemistry

Academic Honesty: The answers on this test are my own and I am using only the allowed set of notes as described in the syllabus. I have not discussed the test questions with anyone before or during the test nor have I seen the test questions prior to the exam. If you violate any of the preceding items or do not sign, your semester grade is a F.

Signature: _____

In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) have the proper number of significant figures in your answer.

1. Incident light with a wavelength of 497 nm was shined onto a hypothetical material, where the emitted electrons had a kinetic energy of $1.3 * 10^{-19}$ Joules. What is ___ ? [25 points]

   a. frequency of the incident light

1 pt 2 2

$\lambda f = c \rightarrow f = \frac{c}{\lambda}$

$= \frac{3.0 \cdot 10^8 \text{ m}(\frac{1}{s})}{497 \text{ nm}} \quad 10^9 \frac{\text{nm}}{\text{m}}$

$= 6.0 \cdot 10^{14} \text{ Hz}$

   b. energy of the incident light

1 pt 2 2

$E = hf$

$= 6.63 \cdot 10^{-34} \text{ J}_s [6.04 \cdot 10^{14}(\frac{1}{s})]$

$= 4.0 \cdot 10^{-19} \text{ J}$

   c. minimum energy to emit electrons

1 pt 2 2

$E_{incid} = E_{min} + kE$

$4.0 \cdot 10^{-19} \text{ J} = E_{min} + 1.3 \cdot 10^{-19} \text{ J}$

$E_{min} = 2.7 \cdot 10^{-19} \text{ J}$

   d. minimum frequency to emit electrons

$E = hf$

$2.7 \cdot 10^{-19} \text{ J} = 6.63 \cdot 10^{-34} \text{ J}_s \, f$

$f = 4.1 \cdot 10^{14} \text{ Hz}$

   e. *range* of incident light that would cause the emission of electrons from the hypothetical surface

1 pt 2 2

$\lambda f = c \rightarrow \lambda = \frac{c}{f}$

$= \frac{3.0 \cdot 10^8 \text{ m}(\frac{1}{s})}{4.1 \cdot 10^{14}(\frac{1}{s})}$

$= 7.3 \cdot 10^{-7} \text{ m}$

range = $0 - 7.3 \cdot 10^{-7}$ m

2. Sketch the orbital diagram for ___; use noble gas short-cut notation. [10 points]

a. nitrogen

[He] ↑↓ (2s) ↑ ↑ ↑ (2p)

b. sulfur

[Ne] ↑↓ (3s) ↑↓ ↑ ↑ (3p)

3. What is the relative atomic size of magnesium and calcium ? basis / rationale ? [5 points]

Ca bigger than Mg
b/c Ca has more shells of e⁻

---

4. What is the relative 1st ionization energy of ___; basis / rationale ? [10 points]

a. aluminum versus silicon

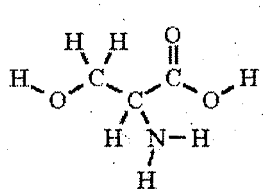
IE: Si > Al b/c
Si has ↑ Z ↑ e ... → ↑ Zeff → ↑ F → harder to remove e⁻ → more energy to remove e⁻

b. phosphorus versus sulfur

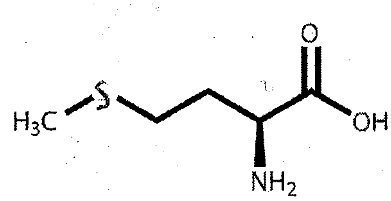
S < P b/c e⁻-e⁻ repulsion in S → ↓ F → easier to remove e⁻ → ↓ IE & ↓ energy

P: ↑ ↑ ↑ (p) S: ↑↓ ↑ ↑ (p)

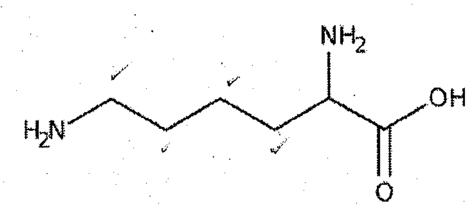
5. old topic: sketch the structural formula of a tripeptide, where its primary structure = methionine – serine – lysine, where the amino terminal is lysine; clearly identify the peptide bond(s). [10 points]



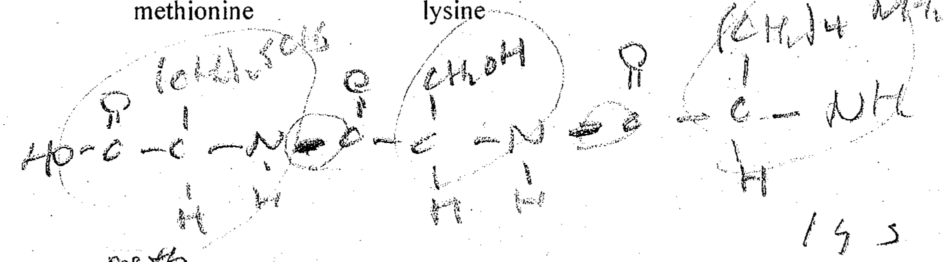
Serine



methionine



lysine



15

Name: ______________________________ date: _____________ period: _____

ch. 6 & 7 light, atomic structure; periodic trends retest 60 points AP chemistry

Academic Honesty: The answers on this test are my own and I am using only the allowed set of notes as described in the syllabus. I have not discussed the test questions with anyone before or during the test nor have I seen the test questions prior to the exam. If you violate any of the preceding items or do not sign, your semester grade is a F.

Signature: ________________

In problems involving any calculation, show your work in an organized manner, include (i) any relevant equation (or formula), (ii) conversion factor(s), (iii) put the proper units in your calculations and answer, and (iv) have the proper number of significant figures in your answer.

1. Incident light with a wavelength of 497 nm was shined onto a hypothetical material, where the emitted electrons had a kinetic energy of $1.3 * 10^{-19}$ Joules. If the frequency of the incident light is $7.0 * 10^{14}$ Hz, then what is the kinetic energy of the emitting electron ? [15 points]

i) $\lambda f = c$

$f = \frac{c}{\lambda} = \frac{3 \cdot 10^8 \text{ m/s}}{497 \text{ nm}} \cdot \frac{10^9 \text{ nm}}{\text{m}}$

$= 6.04 \cdot 10^{14}$ Hz

ii) $E = hf = 6.63 \cdot 10^{-34}$ J s $(6.04 \cdot 10^{14}$ Hz$)$

$= 4.0 \cdot 10^{-19}$ J

iii) $E_{incid} = E_{min} + KE$

$E_{min} = E_{incid} - KE$

$= 4.0 \cdot 10^{-19}$ J $- 1.3 \cdot 10^{-19}$ J

$= 2.7 \cdot 10^{-19}$ J

iv) $E = hf$

$= 6.63 \cdot 10^{-34}$ J s $(7 \cdot 10^{14}$ Hz$)$

$= 4.64 \cdot 10^{-19}$ J

v) $E_{incid} = E_{min} + KE$

$KE = E_{incid} - E_{min}$

$= 4.64 \cdot 10^{-19}$ J $- 2.7 \cdot 10^{-19}$ J

$= 1.94 \cdot 10^{-19}$ J

2. What is the maximum number of electrons in an 3p atomic orbital ? Basis / rationale ? [10 points]

6 e⁻ ble

p AO has 3 orientations

& ① orientation has max of 2 e⁻

3. Based on the Bohr model of hydrogen, what is the basis / rationale of the hydrogen emission spectrum ? That is, what is the basis / rationale of the limited number of signals in the visible range of light in hydrogen's emission spectrum ? [10 points]

quantized / limited # e⁻ energy levels

so ∃ limit possible e⁻ energy level transitions

which is basis of emission spectra

4. The first ionization energy (kJ / mol) of . . .

Li	Be	B	C	N	O	F	Ne
520	899	801	1086	1402	1314	1681	2081

5 pt@

What is the basis / rationale of the relative values of the first ionization energy of these atoms ? That is, basis / rationale of the general trend and any "exceptions". [15 points]

i) general trend : ↑ IE ~ Li → Ne b/c

1 pt@

↑ Z, ↑ S } → ↑ Zeff → ↑ Fatt → harder to remove e⁻ → have more energy to remove e⁻ → ↑ IE

ii) Be → B exception

s → p

5 : 3 pt / 2

⇅ s ⇅ s

IE : B < Be b/c p AO > s AO in e⁻ energy level, so . . .

iii) N → O exception

2+3 pt

↿ ↿ ↿ p ⇅ ↿ ↿ p e⁻ e⁻ repulsion O → ↓ Fatt ↓

↓ IE ← ↓ energy to remove e⁻ ← ↓ energy to remove e⁻

5. The relative ionization energy (kJ / mol) of magnesium is . . .

1st	2nd	3rd
738	1,450	7,730

What is the basis / rationale of the relative values of these ionization energies of magnesium ? That is, basis / rationale that 1st IE < 2nd IE << 3rd IE ? [10 points]

i) 1st IE < 2nd IE b/c remove e⁻ → ↓ e⁻ e⁻ repulsion or ↓ S, ↑ Z } → ↓ Zeff → ↓ Fatt → easier . . . ↓

1 pt@

↓ IE ← ↓ energy . . .

ii) 2nd IE << 3rd IE b/c 'next' e⁻ shell → ↓ Fattr . . .

"big" ↓ S b/c go to

3+2 pt