AP Chem - Unit 5 WKst: FR Atomic Structure & Periodicity

1).

A) The 6 isotopes of selenium have the same number of protons (34) But a different number of neutrons causing different masses. 1pt

B) Se complete electron configuration

$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$ 1pt

No credit for [Ar]$4s^2 3d^{10} 4p^4$

unpaired electrons ↑↓ ↑ ↑
4p

There are 2 unpaired electrons 1pt

c) Hunds Rule, each orbital (P has 3) gets 1 electron 1pt
Before another gets a second

c) i) Br [Ar] $4s^2 3d^{10} 4p^5$ ↑↓ ↑↓ ↑
Se [Ar] $4s^2 3d^{10} 4p^4$ ↑↓ ↑ ↑

The ionized electron in Both Se & Br are in same energy Level (n=4), But Br has one more proton than Se ∴ radius smaller for Br & it has a greater nuclear charge than Se. Zeff higher for Br than Se 1pt

ii) Te [Kr] $5s^2 4d^{10} 5p^4$

The electron for Te is Removed from $5p^4$ vs $4p^4$ for Se. Te $5p^4$ has more shielding, due to another energy level ∴ TE's electron will Require less energy to Remove than Se 1pt

2/6

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2) $\lambda = 495\ nm$ to Break Cl-Cl Bond

A) i) $\nu = ?\ 1/s$ $\quad c = \lambda\nu$

$c = 3.00 \times 10^{17}\ nm/s$ $\quad \nu = \frac{c}{\lambda} = \frac{3.00 \times 10^{17}\ nm/s}{495\ nm}$

$\boxed{\nu = 6.06 \times 10^{14}\ 1/s}$ 1pt

ii) $E = ?\ J$ $\quad E = h\nu$

$h = 6.626 \times 10^{-34}\ J \cdot s$ $\quad = (6.626 \times 10^{-34}\ J \cdot s)(6.06 \times 10^{14}\ 1/s)$

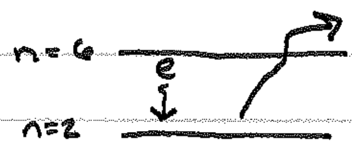
$\boxed{E = 4.02 \times 10^{-19}\ J}$ this is per photon 1pt

iii) ? minimum energy, in KJ/mol to Break Cl-Cl Bond

$$\left(\frac{4.02 \times 10^{-19}\ J}{1\ \text{Photon}}\right)\left(\frac{1\ KJ}{1000\ J}\right)\left(\frac{6.022 \times 10^{23}\ \text{photons}}{1\ \text{mole}}\right) = \boxed{242\ KJ/mole}$$

$$*\left(\frac{6.022 \times 10^{23}\ \text{Anything}}{1\ \text{mole}}\right)$$ Reminder!!

B) electronic transition in H Atom $n=6$ to $n=2$

1 i) 

Energy is emitted 1pt

The $n=6$ state is at a higher energy (more excited) than the $n=2$ state (less excited). Going from a high energy state to a low energy state means that energy must be emitted 1pt

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2) B) cont.

ii) λ = ? nm

$$E = -2.178 \times 10^{-18} J \left(\frac{Z^2}{n^2}\right)$$

Z = nuclear charge for H w/ 1 proton

$E_2 = -2.178 \times 10^{-18} J \left(\frac{1^2}{2^2}\right)$ $E_6 = -2.178 \times 10^{-18} J \left(\frac{1^2}{6^2}\right)$ Z = 1

$= -5.45 \times 10^{-19} J$ $= -6.05 \times 10^{-20} J$ n = energy level

$\Delta E = E_6 - E_2 = -6.05 \times 10^{-20} J - (-5.45 \times 10^{-19} J)$

$\Delta E = 4.84 \times 10^{-19} J$ energy moving from n=6 to n=2 1 pt

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E} = \frac{(6.626 \times 10^{-34} J \cdot s)(3.00 \times 10^{17} nm/s)}{4.84 \times 10^{-19} J}$$

λ = 411 nm 1 pt

iii) The positive charge holding the e is greater for He^+ (Has 2 proton's) than H which has 1 proton. The stronger attraction (Btwn $^{+2}$proton & electrons) means that it requires more energy for the e to move to higher energy levels. ∴ Transitions from high to lower energy will be more energy for He^+ than H.

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3)
Radius

A) Ca   .197 nm   why? $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$
Ca^{+2} .099 nm $1s^2 2s^2 2p^6 3s^2 3p^6$ ~~$4s^2$~~ ^{0}

1pt

Ca^{+2} has 2 fewer electrons. The Ca^{+2} ion has lost its 4S subshell making the Ion smaller

1pt explanition

B) i) Ca [Ar] $4s^2$
K [Ar] $4s^1$

Calcium has 1 more proton than K so Ca has Attraction to its electrons than K does. ∴ Ca has a higher 1st ionization Energy

ii) Ca^+ $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$ 2nd Ion 1140 KJ/mol

K^+ $1s^2 2s^2 2p^6 3s^2 3p^6$ ~~$4s$~~ ^{0} 3050 KJ/mol   ? why

The outermost electron in Ca are in the 4S, which is a higher energy orbital, which is a greatest distance from the nucleus, ∴ the Attractive forces dissipate allowing a lower 2nd Ionization energy compared to K^+ which outer shell is $3p^6$ & closer to nucleus

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3 cont/

c) Mg [Ne] $3s^2$ — 1st ionization E: 738 KJ/mol — why different?

Al [Ne] $3s^2 3p^1$ — 578 KJ/mol

↑ more distance ∴ Attractive forces dissipated

Mg $3s^2$ electrons "penetretes to the neucleus" more than does Al $3p^1$ orbitals. This causes the 3s electrons to be Attracted to the Nucleus more than the $3p^1$ ∴ it takes more Energy to Remove the $3s^2$ electrons

4)

A) Why K lower 1st Ionization than Li

Li: $1s^2 2s^1$

K $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$

K $4s^1$ electron has a larger Radius, meaning Attractive forces dissipate with distance. Also K has a much higher Shielding ∴ lowering the energy Required to Remove the $4s^1$ from K compared to Li $2s^1$ which has its electron much closer to Nucleus.

B) N^{-3} vs O^{-2} 1p+

N^{-3} + O^{-2} ions are isoelectric. O^{-2} has one more proton than N^{-3} does. This Additional proton in O^{-2} will cause more positive nucleus Attraction on the electrons in O^{-2} than the N^{-3} ion has. 1p+

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4) conti

c) Ca Zn ? why

O vs O

[Ar]$4s^2$ [Ar]$4s^2 3d^{10}$

Zn atom has more protons (10) than an atom Ca, causing more Z_{eff} for Zn 1pt

Electrons in d orbitals of Zn have a lower principal quantum number ∴ they are not in orbitals that are farther from nucleus 1pt

D) B lower 1st ionization energy than Be why?

B $1s^2 2s^2 2p^1$ vs Be $1s^2 2s^2$ 1pt

A drop in IE occurs from Be to B because the $2p^1$ electrons do not penetrate the nuclear region as greatly as $2s^2$ electrons do & are therefore not as tightly held 1pt