AP Chemistry
2000 Student Samples

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A1

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Answer EITHER Question 7 below OR Question 8 printed on page 24. Only one of these two questions will be graded. If you start both questions, be sure to cross out the question you do not want graded. The Section II score weighting for the question you choose is 15 percent.

7. Answer the following questions about the element selenium, Se (atomic number 34).

(a) Samples of natural selenium contain six stable isotopes. In terms of atomic structure, explain what these isotopes have in common, and how they differ.

(b) Write the complete electron configuration (e.g., $1s^2\ 2s^2$. . . etc.) for a selenium atom in the ground state. Indicate the number of unpaired electrons in the ground-state atom, and explain your reasoning.

(c) In terms of atomic structure, explain why the first ionization energy of selenium is

(i) less than that of bromine (atomic number 35), and

(ii) greater than that of tellurium (atomic number 52).

(d) Selenium reacts with fluorine to form SeF_4. Draw the complete Lewis electron-dot structure for SeF_4 and sketch the molecular structure. Indicate whether the molecule is polar or nonpolar, and justify your answer.

a) All Isotopes of an element have the same number of protons and electrons. However, different isotopes have different numbers of neutrons.

b) Se: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$
2 unpaired electrons: 4 e^- in 4p subshell that can hold 6 e^-. According to Hund's rule, put 1 e^- in each orbital before spin pairing. Therefore, this orbital looks like $\uparrow\ \uparrow\ \uparrow$ 4p and contains 2 unpaired e^-.

c) i. Bromine has more protons than selenium which results in a higher nuclear charge. Therefore, it pulls its electrons in more tightly than selenium does. Since its additional e^- is added to the same subshell, it receives no comparable shielding from the other e^- within the subshell. Therefore, the electrons of bromine feel a greater nuclear tug so more energy is needed to rip an e^- out of Br.

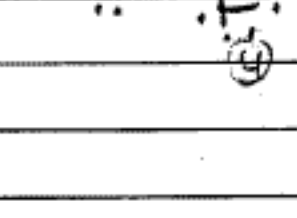
A2

ADDITIONAL PAGE FOR ANSWERING QUESTION 7.

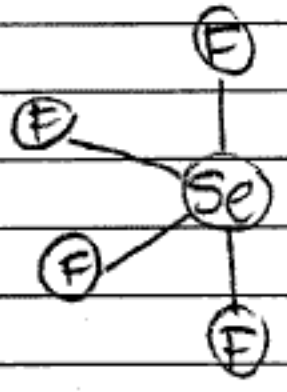
ii. The outermost electrons of tellurium are added to a whole new shell which is farther away from the nucleus. Furthermore, the electrons in this shell are well shielded from the nucleus by e^- in inner shells. As a result, the outermost e^- of Te feel less of a nuclear tug than those of Se so less energy is needed to rip an e^- out of Te and

d) the first ionization energy of tellurium is less than that of selenium.

d) SeF_4 $6+4(7)=28+6=34$ valence e^-



4 bonding pairs, 1 nonbonding pair of e^- around central Se- yields irregular tetrahedral structure. Overall dipole moment yields polar molecule since Although Flourines 1 and 2 cancel each others polar Se-F bonds out, the absence of a 3rd F in the equitorial position yields a directional dipole moment.



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B1

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a) Isotopes of any element contain the same atomic number, which is the number of protons. but have different atomic masses because of the number of neutrons.

b) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$, There would be only two unpaired electrons because 4 electrons in the p sublevel would cause one orbital to be filled up and two half filled. (↑↓ ↑ ↑)

c) i) The first ionization energy or the energy required to take away an electron would be less than that of Br because an atom is more stable when it has either filled or half-filled sublevels. Taking an electron away from Se would cause it to have a half-full p sublevel.

ii) The more energy levels you add the easier it is to take away an electron. Since Te is on 5p rather than 4p the electron would be further away from the positive nucleus of the atom.

B2

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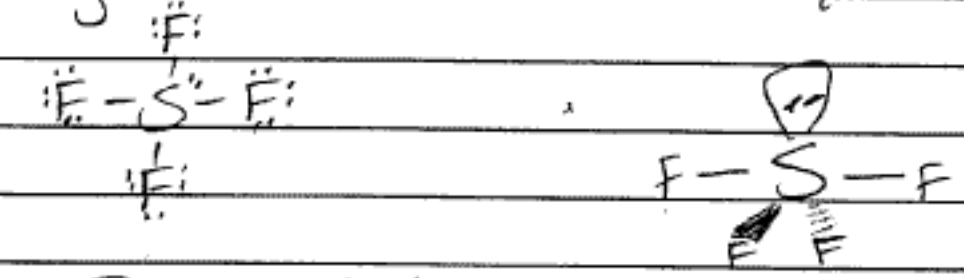
making it easier to take away.

d)



SeF4 would be polar because it contains one pair of unshared electrons.

C

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(a) Se They will have different ionization energies & radii. But they will all have same atomic # and same atomic mass.

(b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^4$
OR
$[Ar]\ 4s^2\ 3d^{10}\ 4p^4$

↑↓	↑

it has 2 unpaired because in the boxes e⁻ one fills up and starts over. Two are unfilled b/c it only goes to 4; not 6.

C2

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(c) (i) Ionization energy increases left to right. Since bromine is to the right of Se it has a greater ionization energy.

(ii) Ionization energy decreases going down. Since Tellurium is below Se, Se has a higher ionization energy.

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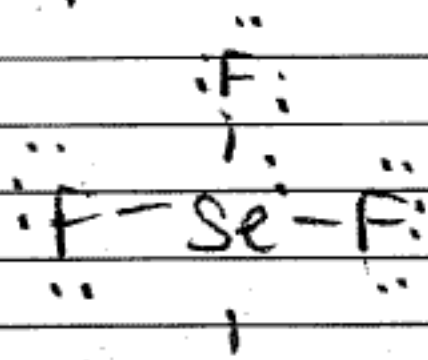
4
34

(d) SeF_4



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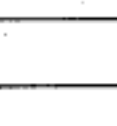

It is polar because it is not nonsymmetrical.