Explaining periodic trends Q/A – what will/what won't get the points…

General strategy:

1) Locate both elements on the periodic table and state the principal energy level *(n)* and sublevel *(orbital set)* containing the valence electron for each element.

2) Do they have the same or different *(n)* values?
   - If the same, discuss point with Z_{eff}
   - If different, discuss point with *n* vs. *n* distance

Trend:	**Atomic radii decrease as atomic number increases in any given period *(left to right trend)***
Example question:	Which is larger in the ground state: S or Al? Explain why.
Will get points	Effective nuclear charge (Z_{eff}) increases the attraction of the nucleus and therefore pulls the electron cloud closer to the nucleus resulting in a smaller atomic radius
Won't get points	Stating the trend

Trend:	**Atomic radii increase as atomic number increases down a column or group *(top to bottom trend)***
Example question:	Which is larger in the ground state: S or Te? Explain why.
Will get points	• Increased number of energy levels (*n*) increases the distance over which the nucleus must pull and therefore reduces the attraction for the electrons • Full energy levels provide some shielding between the nucleus and the valence electrons
Won't get points	Stating the trend

Trend:	**Ionization energy increases as atomic number increases in any given period *(left to right trend)***
Example question:	Which has a larger ionization energy, Ge or Se? Explain why.
Will get points	• Effective nuclear charge (Z_{eff}) increases the attraction of the nucleus and therefore holds the electrons more tightly • Exception: a drop in IE occurs between groups 2A and 3A because the *p* electrons do not penetrate the nuclear region as greatly as the *s* electrons do and therefore are not held as tightly • Exception: a drop in IE occurs between group 5A and 6A because the increased repulsion created by the first pairing of electrons outweighs the increase in Z_{eff} and thus less energy is required to remove the electron
Won't get points	• Stating the trend • Stating that *p* electrons are further away from the nucleus • Stating that atoms are more stable with a half filled orbital (not an explanation!)

Trend:	**Ionization energy decreases as atomic number increases down a column *(top to bottom trend)***
Example question:	Which has a larger ionization energy, Mg or Sr? Explain why.
Will get points	• The increased number of energy levels (*n*) increases the distance over which the nucleus must pull and therefore reduces the attraction for electrons • Full energy levels provide some shielding between the nucleus and valence electrons
Won't get points	Stating the trend

Trend:	**Positive ions are smaller than their respective neutral atoms**
Example question:	Which is larger in the ground state: Sr or Sr^{2+}? K^{+} or Ca^{2+}? Explain why.
Will get points	• Positive metal ions result from the loss of valence electrons. In many cases this means the farthest electrons are now in a smaller principal energy level (*n*) than the neutral atom, thus there is an increase in the Z_{eff} felt by the remaining valence electrons. • As electrons are lost, the ratio of p+/e- increases and thus the electrons are held closer and with more strength.
Won't get points	• Stating the trend • Saying the ion is smaller because it lost electrons • Failing to mention the difference in energy levels now occupied • Ignoring the change to the p+/e- ratio

Trend:	**Negative ions are larger than their respective neutral atoms**
Example question:	Which is larger in the ground state: S or S^{2-}? Explain why.
Will get points	• Negative nonmetal ions result from the addition of valence electrons. As electrons are added the p+/e- ratio decreases and the electrons are not as closely held • Increased e-/e- repulsion also plays a role in expanding the electron cloud
Won't get points	• Stating the trend • Saying the ion is bigger because it has gained electrons • Ignoring the change to the p+/e- ratio • Ignoring the effect of increased e-/e- repulsion

Trend:	**Metals are more reactive as you move down a column**
Example question:	Which more reactive: Sr or Ca? Explain why.
Will get points	Metals react by losing electrons, and a loosely held electron will result in a more reactive metal. This is directly related to ionization energy. With an increased number of occupied energy levels (*n*) comes increased distance from the nuclear attraction and thus a more loosely held electron available for reacting.
Won't get points	• Stating the trend • Saying "they want to follow the octet rule" • Saying that metals are more reactive at the bottom left corner of the table

Trend:	**Nonmetals are more reactive as you move up a column**
Example question:	Which more reactive: S or Se? Explain why.
Will get points	Because nonmetals tend to gain electrons, a strong nuclear attraction will result in a more reactive non-metal. This means the atom with the highest Z_{eff} ***and*** the least number of occupied energy levels should be the most reactive nonmetal (F) because its nucleus exerts the strongest pull.
Won't get points	• Stating the trend • Saying "they want to follow the octet rule" • Saying that nonmetals are more reactive at the top right corner of the table