



Cycle 5 Chemistry I Honors Topic

Trends in the Periodic Table

Vocab: “Ionization Energy”, “Electron Shielding”, “Electron Affinity”, “Atomic/Ionic Radius”

Classwork: p. 141 #12-16

Thinking questions:

- a) There are rare compounds of gold called ‘aurides’, where gold forms the Au^{-1} ion. Which element would be most likely to form an ‘auride’ with gold, and why?
- b) Would the Au^{-1} ion have a larger or smaller radius than a neutral atom of Au, and why? What about Au^{+5} ion?
- c) There is one known compound of Au^{+5} . Which element forms the anion? Why?





Periodic Trends

- The arrangement of the periodic table reveals trends in the properties of the elements.
- A **trend** is a predictable change in a particular direction.
- Understanding a trend among the elements enables you to make predictions about the chemical behavior of the elements.
- These trends in properties of the elements in a group or period can be explained in terms of electron configurations.





Ionization Energy

- The **ionization energy** is the energy required to remove an electron from an atom or ion.



neutral atom

ion electron



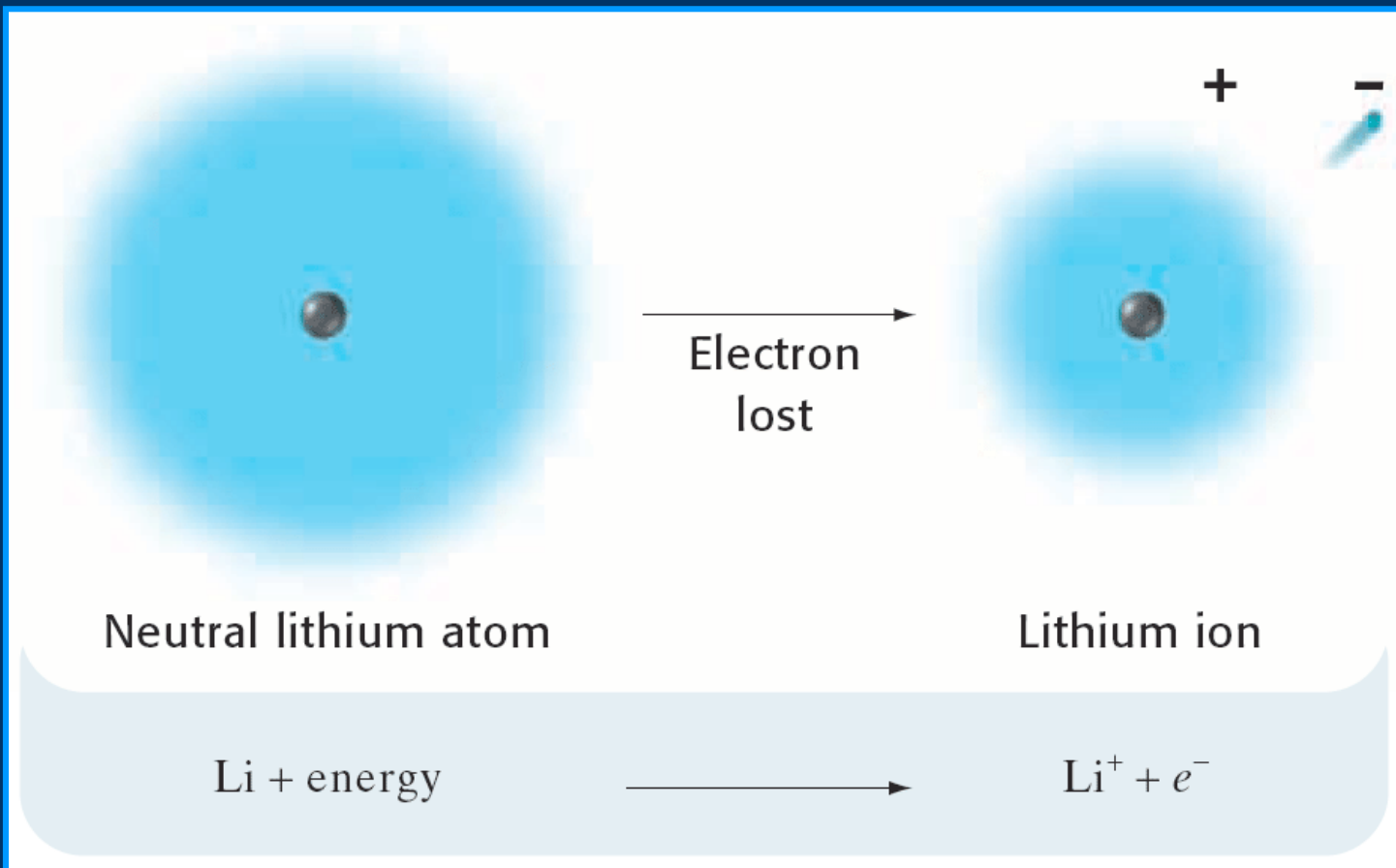
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Ionization Energy



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Ionization Energy Decreases Down a Group

- Each element in a group has more shells than the one above it has.
 - The valence electrons get farther from the nucleus, as we move down a group.
 - This weakens the attraction to the positive nucleus (inverse square law).
- Inner shells provide “**Electron Shielding**” between the nucleus and the valence electrons.
 - Pretend you are the $6s^1$ electron of a Cesium atom and you look down towards the nucleus.
 - You see a nucleus of 55 protons, with 54 electrons wrapped around it. You pretty much only feel a single positive charge, not all 55!
 - This makes you only weakly attracted to the nucleus.





Ionization Energy Increases Across a Period

- Ionization energy tends to increase as you move from left to right across a period.
- From one element to the next in a period, the number of protons and the number of electrons increase by one each.
 - The additional proton increases the nuclear charge.
 - The '**electron shielding**' from inner shells remains mostly the same.
- Imagine you are a 2s electron in lithium. You look 'down' and see 3 protons surrounded by 2 electrons, almost like a single +
- Imagine you are a 2p electron in fluorine. You look 'down' and see 9 protons surrounded by 2 electron, like a +7. This is a strong attraction!





Ionization

1 H																	2 He																												
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne																												
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar																												
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr																												
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe																												
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn																												
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Uun	111 Uuu	112 Uub	114 Uuq	116 Uuh	118 Uuo																															
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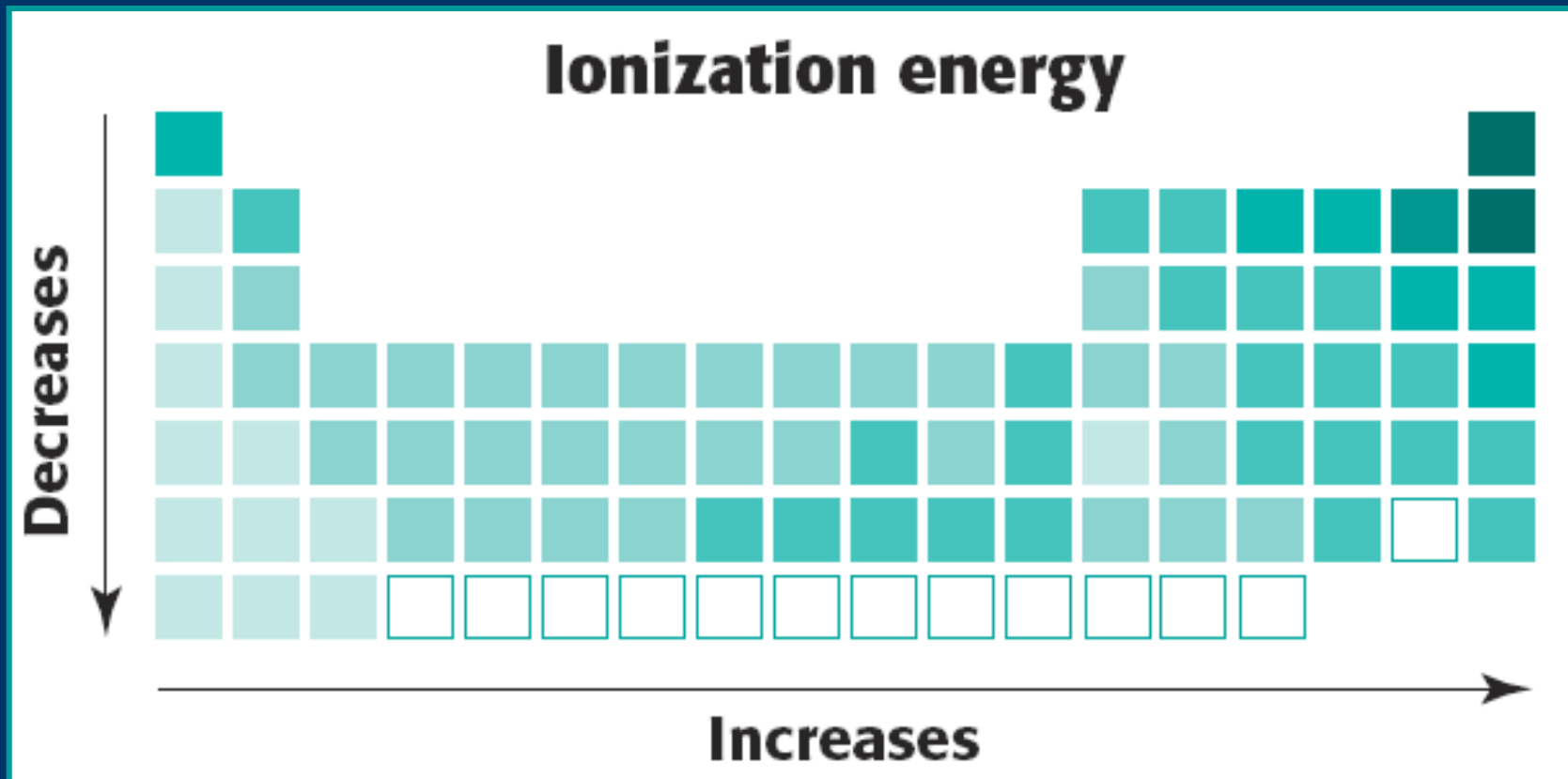
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Ionization Energy Trends



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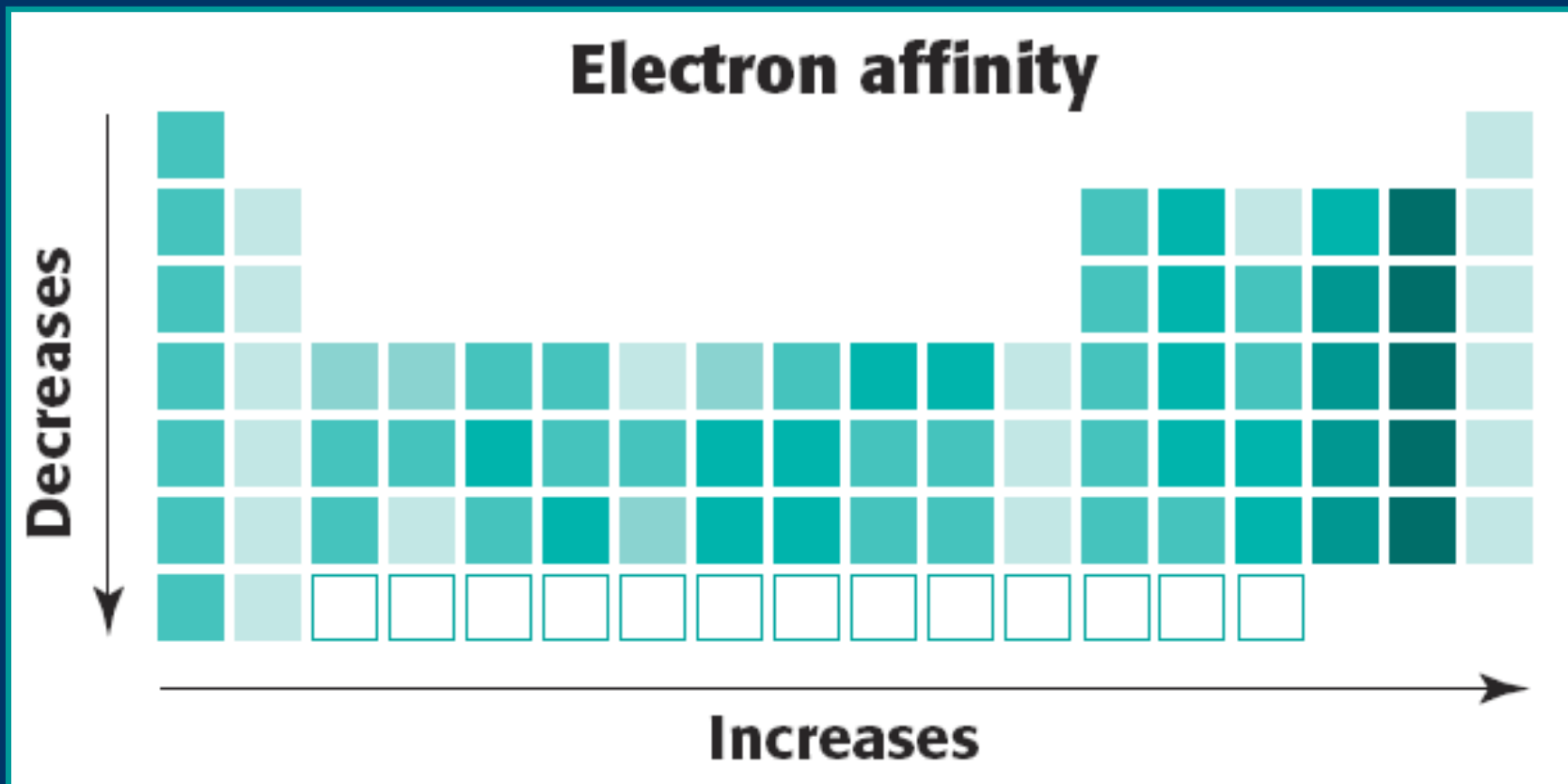
Periodic Trends in Electron Affinity

- The energy change that occurs when a neutral atom gains an electron is called the atom's **electron affinity**.
- The electron affinity tends to decrease as you move down a group because of the increasing effect of **electron shielding** and the larger distance from the nucleus in outer shells.
- Electron affinity tends to increase as you move across a period because of the increasing nuclear charge.
 - 1 more proton in the nucleus each time you move right, this is more attraction to a new valence electron.





Periodic Trends in Electron Affinity



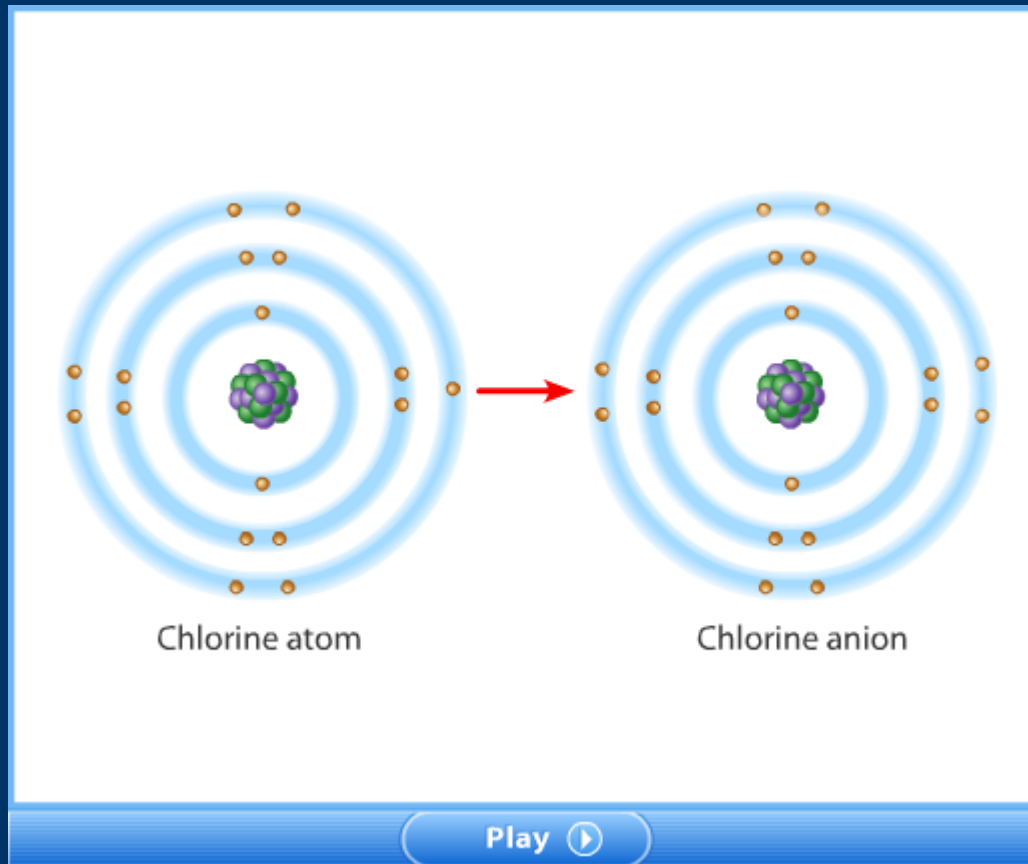
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Electron Affinity



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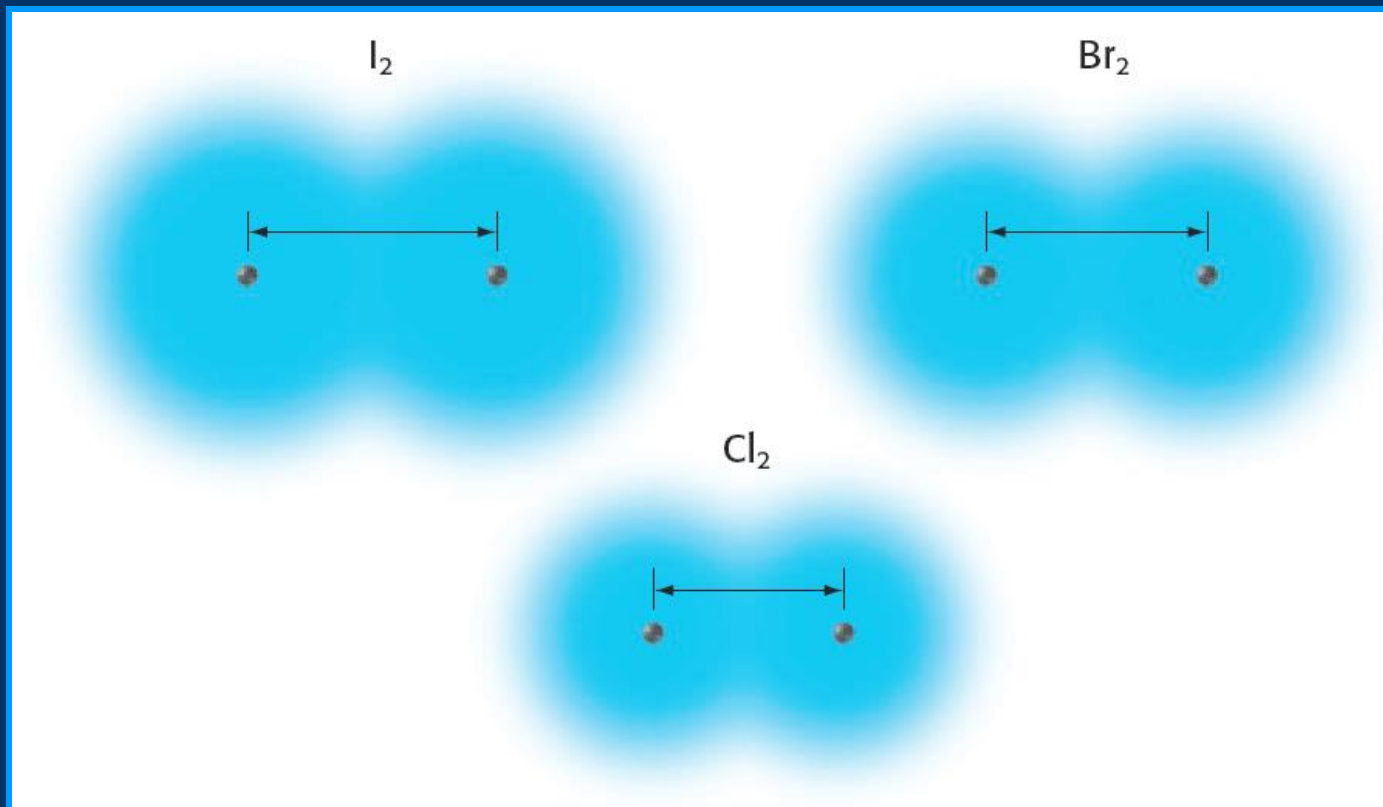
Atomic Radius

- The exact size of an atom, or '**atomic radius**', is hard to determine. The volume the electrons occupy is thought of as an electron cloud, with no clear-cut edge.
- In addition, the physical and chemical state of an atom can change the size of an electron cloud.
- One method for calculating the size of an atom involves calculating the **bond radius**, which is half the distance from center to center of two like atoms that are bonded together.
 - The bond radius can change slightly depending on what atoms are involved.





Atomic Radius, *continued*



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Atomic Radius Increases as You Move Down a Group

- As you proceed from one element down to the next in a group, another shell (energy level) is filled.
- The addition of another level of electrons increases the size, or atomic radius, of an atom.
- More shells, bigger atom – like an onion.
 - Cs is bigger than Li.
 - I is bigger than F.





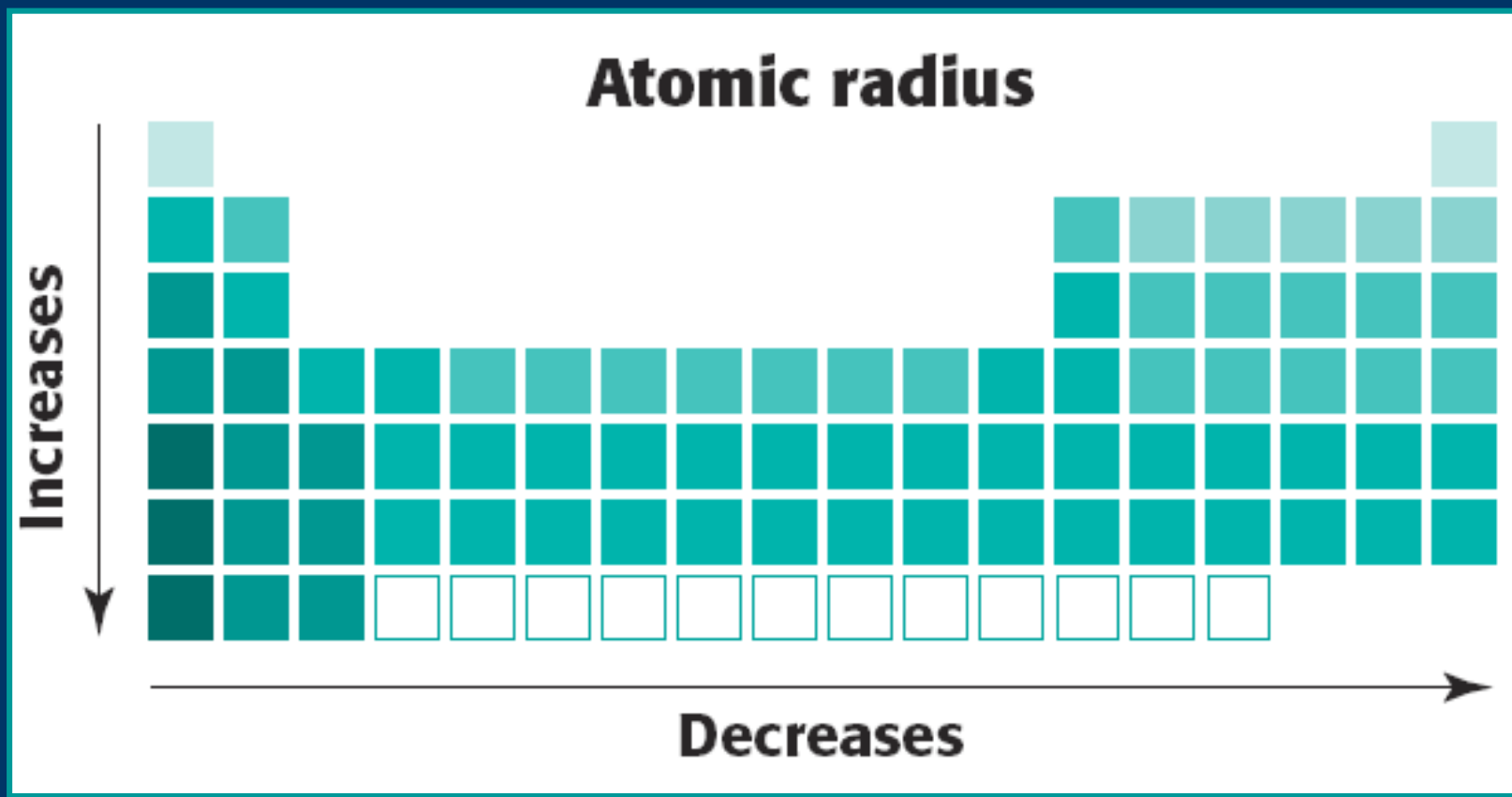
Atomic Radius Decreases as You Move Across a Period

- As you move from left to right across a period, each atom has one more proton and one more electron than the atom before it has.
- All additional electrons go into the same valence shell
- As there are more protons towards the right of the period, the valence electrons are attracted more strongly and move closer to the nucleus.
- F is smaller than Li!
- I is smaller than Rb!





Atomic Radius



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Radius of Ions

- Ions, both cations & anions, follow the same periodic trends of radius as neutral atoms do.
- Cations (positive) have a smaller radius than the neutral element.
 - Less electrons in the valence shell repelling each other, so they can cluster closer to the nucleus.
- Anions (negative) have a larger radius than the neutral element.
 - More electrons in the valence shell repel each other, forcing them out farther from the nucleus.





Thinking questions:

a) There are rare compounds of gold called ‘aurides’, where gold forms the Au^- ion. Which element would be most likely to form an ‘auride’ with gold, and why?

Hint – element needs (high/low) (ionization energy/electron affinity)?

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