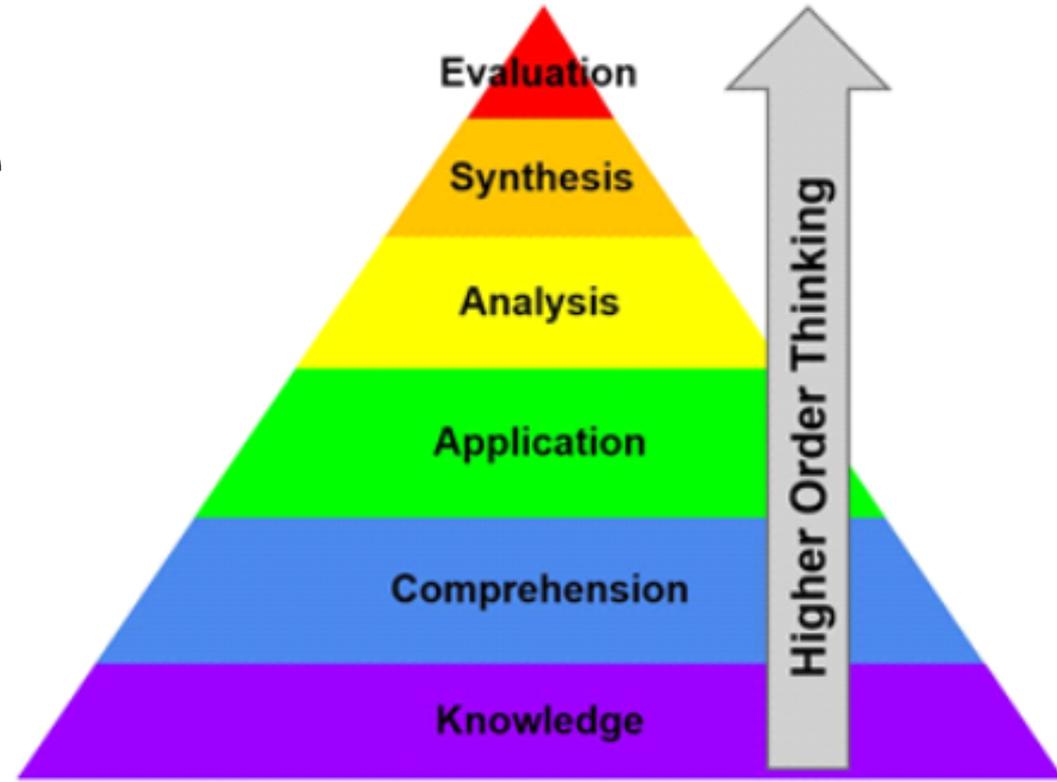


# Critical Thinking

“The careful, deliberate determination of whether one should accept, reject, or suspend judgment about a claim and the degree of confidence with which one accepts or rejects it.”

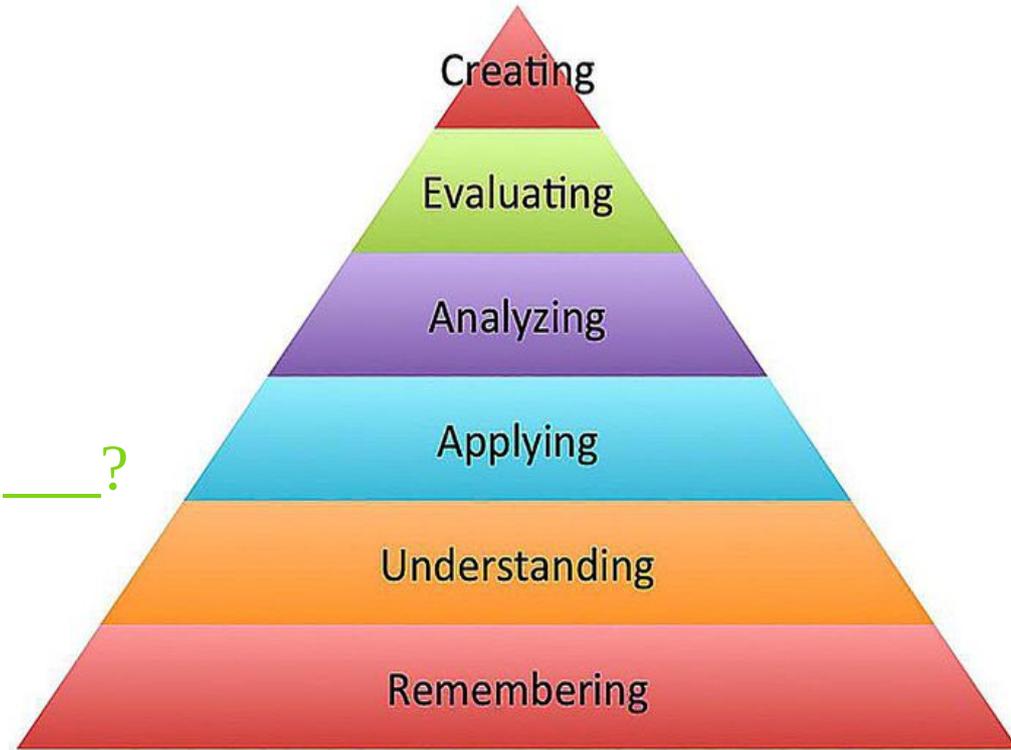
*(Critical Thinking. B. Moore and R. Parker, 2007)*

What are examples of different levels of higher order thinking?



Bloom's Taxonomy  
Cognitive Domain

# New Version of Bloom's Taxonomy



- **Analyzing:**

- How can you sort the parts \_\_\_\_?
- What can you infer \_\_\_\_?
- What ideas validate \_\_\_\_?

- **Evaluating:**

- What criteria would you use to assess \_\_\_\_?
- What data were used to evaluate \_\_\_\_?
- How could you verify \_\_\_\_?

- **Creating:**

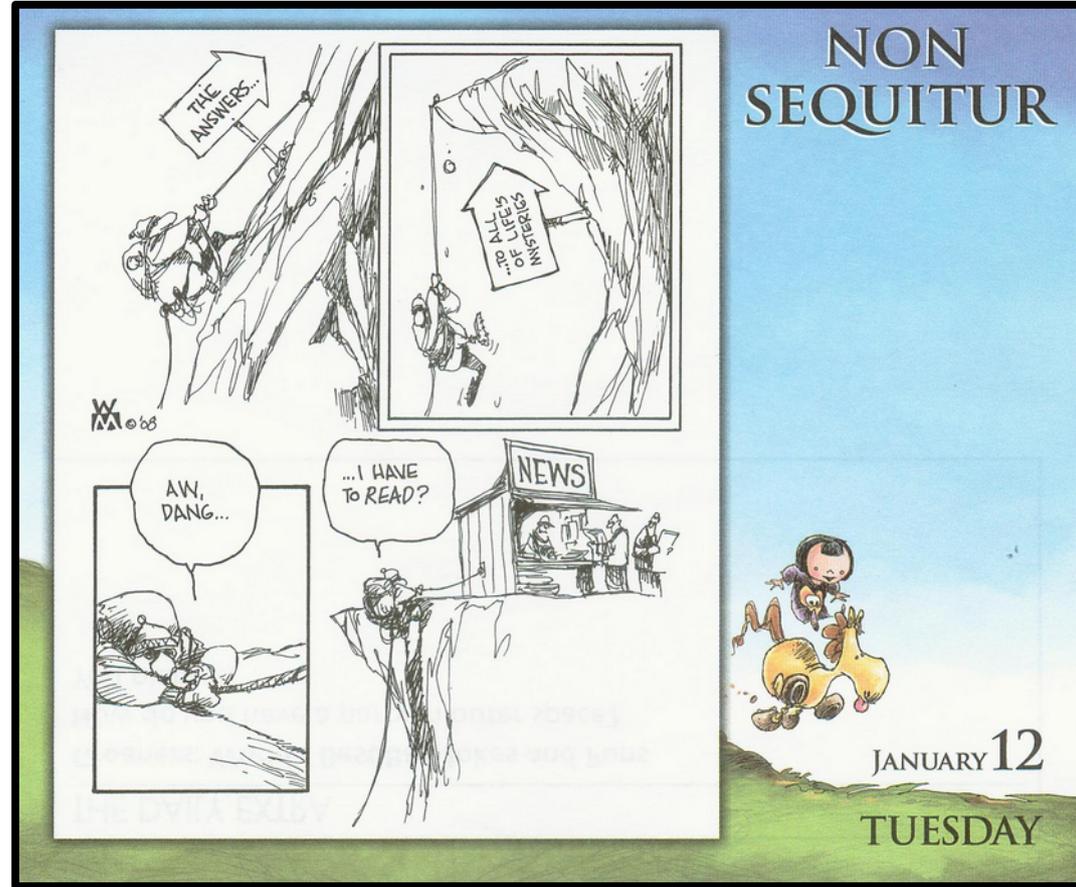
- What alternative would you suggest for \_\_\_\_?
- What changes would you make to revise \_\_\_\_?
- How would you generate a plan to \_\_\_\_?

What can you create  
working at a University?

# Examples of using Critical Thinking

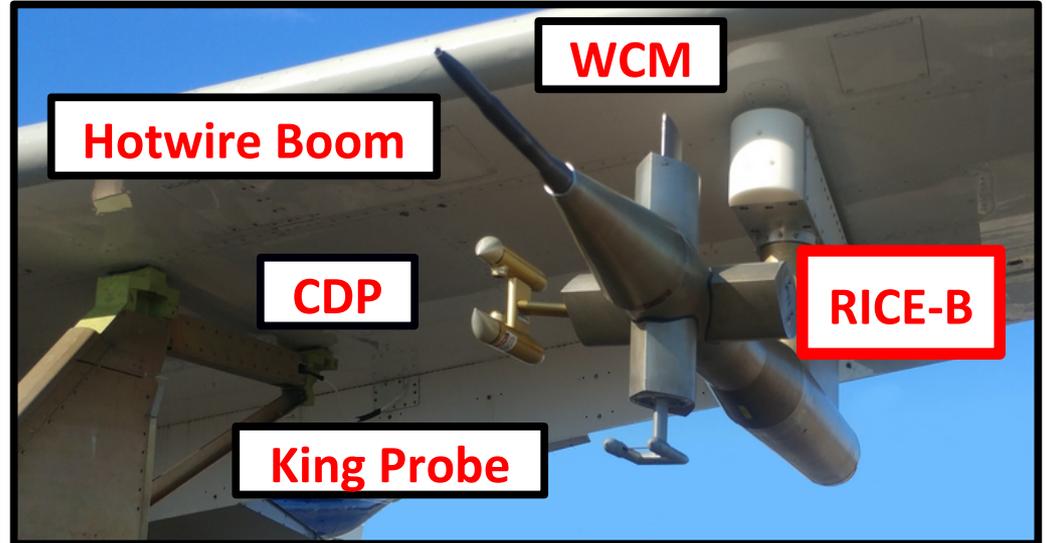
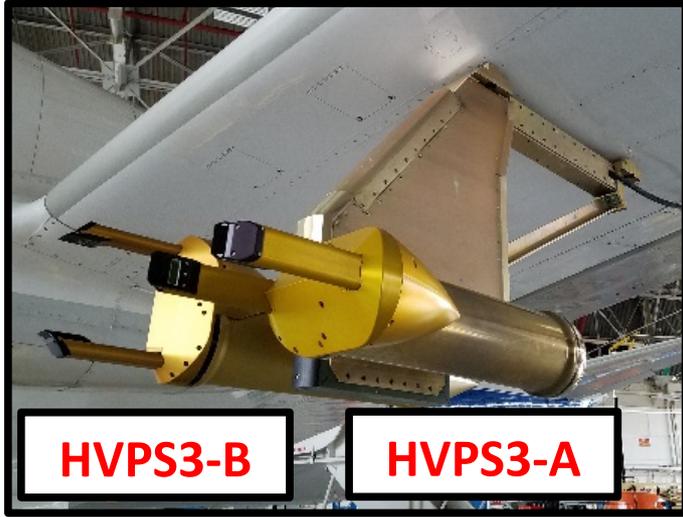
- To Approach Questions to Find an Answer
- To Solving Problems
- To Taking Action

Requires active thinking, the use of reason, and an open mind.



What is an example of how you used critical thinking?

# How Does Critical Thinking Apply to Research?



# Application of Critical Thinking

Critical thinking should be applied to:

- Expressing your own thoughts, beliefs, and opinions.
- Reading or listening to the thoughts, beliefs, opinions of others.



How can you apply critical thinking to class lectures?

# Elements of Reasoning (Thinking)

- Reasoning has a purpose.
- Reasoning is figure something out.
- Reasoning is based on assumptions.
- Reasoning is from a point of view.
- Reasoning is based on information.
- Reasoning is expressed through concepts and theories.
- **Reasoning contains interpretation of data and observations.**
- Reasoning has implications and consequences.

Periodic Table of the Elements

The image shows a periodic table of elements with various color-coded categories. A legend for Hydrogen (H) is provided, showing its atomic number (1), symbol (H), name (Hydrogen), atomic weight (1.008), and electron shell (1). The legend also includes a color key for the periodic table: State of matter (color of name), Subcategory in the metal-metalloid-essential trend (color of background), and other properties like Alkali metals, Lanthanides, Metalloids, Alkaline earth metals, Actinides, Reactive nonmetals, Transition metals, Post-transition metals, and Noble gases.

1 IA H Hydrogen 1.008	2 IIA He Helium 4.003											13 IIIA B Boron 10.81	14 IVA C Carbon 12.01	15 VA N Nitrogen 14.01	16 VIA O Oxygen 16.00	17 VIIA F Fluorine 18.99	18 VIIIA Ne Neon 20.18		
3 IIA Li Lithium 6.94	4 IIA Be Beryllium 9.01											13 IIIA Al Aluminum 26.98	14 IVA Si Silicon 28.09	15 VA P Phosphorus 30.97	16 VIA S Sulfur 32.06	17 VIIA Cl Chlorine 35.45	18 VIIIA Ar Argon 39.95		
19 IA Na Sodium 22.99	20 IIA Mg Magnesium 24.31	3 IIIB Sc Scandium 44.96	4 IVB Ti Titanium 47.88	5 VB V Vanadium 50.94	6 VIB Cr Chromium 51.99	7 VIIB Mn Manganese 54.94	8 VIIIB Fe Iron 55.85	9 VIIIB Co Cobalt 58.93	10 VIIIB Ni Nickel 58.69	11 VIIIB Cu Copper 63.55	12 IIB Zn Zinc 65.38	13 IIIA Ga Gallium 69.72	14 IVA Ge Germanium 72.64	15 VA As Arsenic 74.92	16 VIA Se Selenium 78.96	17 VIIA Br Bromine 79.90	18 VIIIA Kr Krypton 83.80		
37 IA K Potassium 39.10	38 IIA Ca Calcium 40.08	39 IIIB Y Yttrium 88.91	40 IVB Zr Zirconium 91.22	41 VB Nb Niobium 92.91	42 VIB Mo Molybdenum 95.94	43 VIIB Tc Technetium 98.91	44 VIIIB Ru Ruthenium 101.07	45 VIIIB Rh Rhodium 102.91	46 VIIIB Pd Palladium 106.42	47 VIIIB Ag Silver 107.87	48 IIB Cd Cadmium 112.41	49 IIIA In Indium 114.82	50 IVA Sn Tin 118.71	51 VA Sb Antimony 121.76	52 VIA Te Tellurium 127.60	53 VIIA I Iodine 126.91	54 VIIIA Xe Xenon 131.29		
55 IA Rb Rubidium 85.47	56 IIA Sr Strontium 87.62	57 IIIB Cs Cesium 132.91	58 IVB Ba Barium 137.33	59 VB La Lanthanum 138.91	60 VIB Hf Hafnium 178.49	61 VIIB Ta Tantalum 180.95	62 VIIIB W Tungsten 183.85	63 VIIIB Re Rhenium 186.21	64 VIIIB Os Osmium 190.23	65 VIIIB Ir Iridium 192.22	66 VIIIB Pt Platinum 195.08	67 VIIIB Au Gold 196.97	68 IIB Hg Mercury 200.59	69 IIIA Tl Thallium 204.38	70 IVA Pb Lead 207.2	71 VA Bi Bismuth 208.98	72 VIA Po Polonium 209	73 VIIA At Astatine 210	74 VIIIA Rn Radon 222
87 IA Fr Francium 223	88 IIA Ra Radium 226	89-102 Actinides	103 IIIB Rf Rutherfordium 261	104 IVB Db Dubnium 262	105 VB Sg Seaborgium 266	106 VIB Bh Bohrium 264	107 VIIB Hs Hassium 277	108 VIIIB Mt Meitnerium 268	109 VIIIB Ds Darmstadtium 271	110 VIIIB Rg Roentgenium 272	111 IIB Cn Copernicium 285	112 IIIA Nh Nihonium 284	113 IVA Fl Flerovium 287	114 VA Mc Moscovium 288	115 VIA Lv Livermorium 293	116 VIIA Ts Tennessine 289	117 VIIIA Og Oganesson 294		
57 Lanthanum 138.91	58 Cerium 140.12	59 Praseodymium 140.91	60 Neodymium 144.24	61 Promethium 145	62 Samarium 150.36	63 Europium 151.96	64 Gadolinium 157.25	65 Terbium 158.93	66 Dysprosium 162.50	67 Holmium 164.93	68 Erbium 167.26	69 Thulium 168.93	70 Ytterbium 173.05	71 Lutetium 174.97					
89 Actinium 227	90 Thorium 232.04	91 Protactinium 231.04	92 Uranium 238.03	93 Neptunium 237	94 Plutonium 244	95 Americium 243	96 Curium 247	97 Berkelium 247	98 Californium 251	99 Einsteinium 252	100 Fermium 257	101 Mendelevium 258	102 Nobelium 259	103 Lawrencium 260					

# Questions Using Elements of Reasoning

- Purpose
  - What am I trying to accomplish?
- Questions
  - What question am I raising or addressing?
  - Am I considering all the complexities?
- Information
  - What information or experience am I using?
  - What information do I need?
- Inferences/Conclusions
  - How did I reach this conclusion?
  - Is there another interpretation?



# Questions Using Elements of Reasoning

- Concepts
  - What is the main idea?
  - Can I explain it?
- Assumptions
  - What am I taking for granted?
  - What have I assumed?
- Implications/Consequences
  - What am I implying?
- Points of View
  - What point of view am I using?
  - Is there another point of view to consider?



# Intellectual Standards

- Clarity – Further elaboration, examples
- Accuracy – Verify, check out
- Precision – More specific, further details
- Relevance – Relate to question
- Depth – Complexities and difficulties
- Breadth – Another perspective, other point of view
- Logic – Makes sense, conclusions follow evidence
- Significance – Central idea, most important facts
- Fairness – Vested interest in the issue



# Applying Standards to Elements of Reason

- Intellectual Standards should be applied to Elements of Reason.
- This approach can be used to:
  - Analyze contents of an article.
  - Analyze and assess research.
  - Help you formulate your own conclusions.
  - Help you take a reasoned stand on an issue.
- This leads to developing Intellectual Traits.



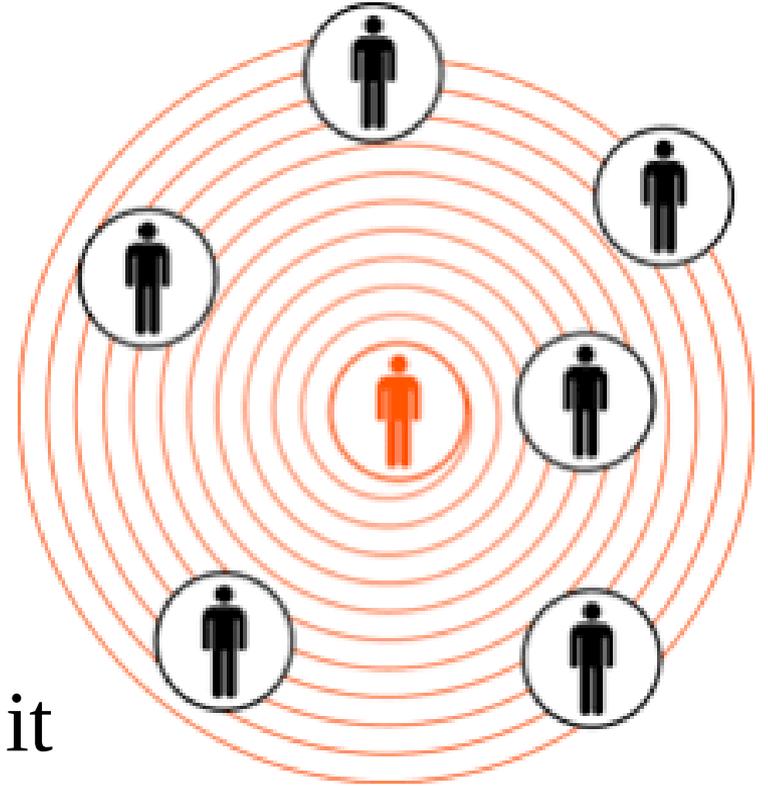
# Intellectual Traits

- Intellectual Humility - Realize limits of own knowledge
- Intellectual Courage - Ideas/beliefs/views that counter our own
- Intellectual Empathy - See the other side
- Intellectual Autonomy - Think for yourself
- Intellectual Integrity - Hold yourself to consistent, high standards
- Intellectual Perseverance - Work through confusion
- Confidence in Reason - Believe that high standards will win out
- Fair-mindedness - Treat all viewpoints alike

# Egocentric Thinking

It's true because:

- I believe it
- We believe it
- I want to believe it
- I have always believed it
- It is in my own interest to believe it



# Apply Critical Thinking to Weather Modification

- Elements of Reasoning
- Intellectual Standards
- Applying Standards to Elements of Reason
- Intellectual Traits
- Taking Action without Egocentric Thinking



Image from cloud seeding in North Dakota on July 2, 2012. Credit: David Delene