Common Mistakes and Misconceptions in Physical Science: How Not to Be an Easy Target For Exam-Writers Who are Out to Stump You

Structure of Matter

1. *Confusing Solutions With Pure Substances*

Example:

Air can be clean but it can never be pure in a scientific sense. Why?

Answer: Air is a solution. Only compounds and elements can be pure.

2. *Inability to Differentiate Between Atoms & Molecules and between Empirical & Molecular Formulas*

Example: Why is it incorrect to speak of an atom of salt? Is there such a thing as a molecule of salt? Of water?

Answer: The basic unit of ionic compounds(metal+ non-metal) is an ion. These are interlocked in a repeating pattern in a crystal. Water exists as molecules because H_2O is covalent.

Models of the Atom

3. *Confusing Models With Experiments That Led to the Model*

Example: What experiments helped Thomson come up with his model of the atom?

Answer: The model is the plum-pudding one. What led to this model is the cathode ray experiment, which allowed him to get the mass to charge ratio of the electrons.

4. *Incorrectly Assuming that In Rutherford's Experiment a Rebounding Alpha Particle Has to Hit the Nucleus?(430)*

Example: How can an alpha particle miss the nucleus but fail to go through thin gold foil?

Answer: Because alpha particles are positively charged, they can be repelled if they come close enough to the positively charged nucleus.

5. *Not Distinguishing Between Mass Number and Number of Neutrons(416); Not Knowing the Difference between Mass Number and Atomic Mass(430)*

Example: Is it possible for a hydrogen atom to have no neutrons? What would its mass be? Why does the periodic table list a mass that is slightly greater than 1.0?

Answer: Most of the hydrogen in the universe has no neutrons and so has a mass number = neutrons + protons = 0+1 = 1. The periodic table lists 1.00797 u as the mass because this is the weighted average of the masses of hydrogen's three isotopes.

6. *Forgetting the Definitions of Isotopes and Ions*

Example: Give examples of two isotopes and two ions of iron. How do their properties differ from those of, say, ^{56}Fe?

Answer: ^{55}Fe and ^{59}Fe are two different isotopes of iron. They have different masses and different nuclear properties. For instance, unlike the stable isotope of iron (^{56}Fe), they break down very fast. ^{59}Fe, especially, has a short half-life of only 45 days.

Ions are charged atoms. Examples include Fe^{+2} and Fe^{+3}, which have lost two and three electrons, respectively, per atom.

Periodic Table

7. *Forgetting the Boundaries between Metals, Metalloids, Non metals and Noble Gases and How To Distinguish Between them in the Lab*

Example: How would you be able to identify the non-metal among the following? Ge, Sn, P, Ar

Answer: P is a non-metal. You could verify this by checking to see if it is a poor conductor; if it's non malleable; if it fails to react with acids, and if its oxide forms an acid when added to water.

8. *Not Knowing the Difference Between Ionization Energy and Electronegativity(430)*

Example: Why is electronegativity not measured for Ne? Why is ionization energy for Cs so low?

Answer: Electronegativity is a measure of an atom's tendency to pull electrons towards itself *while bonded to something else*. Since no compounds of neon have been prepared yet, its electronegativity has not been measured. Cs has a low ionization energy because its valence electron is many energy levels away from its nucleus and it takes little energy to remove it, only about 3.8939 eV, lower than any other element.

9. *Forgetting the Trend for Atomic Volume Across a Period (430)*

Example: Match the atomic radius in angstroms(1 Å =10^{-10} m) with the correct element.

B
Be
N

Atomic radius (Å)
0.90
0.92
1.12

Answer: Be = 1.12; Be = 0.92; N = 0.90. Nitrogen is the smallest. Its bigger nucleus can be thought of as pulling in more strongly on the same number of shells.

The Mole(430)

11. *Attempting Conversions with No Regard For Units*

Example: How many atoms of hydrogen are part of the molecules making up a 250 ml glass of pure water?

250 ml(1g/ml) (mole/18g)(6.02 X10^{23} molecules/mole of water)(2 atoms of H/mole of water) =
1.7 X 10^{25} atoms of H

12. *Ignoring the Ratio With Which Molecules React*

Example: If 3.0 g of sodium are heated in a beaker full of chlorine, how many grams of chlorine will suddenly and spectacularly become part of salt crystals?

$$2Na + Cl_2 \rightarrow 2\ NaCl$$

Answer: 3.0 g Na(mole Na/23 g)(1 Cl_2 /2 Na)(71g/mole) = 4.6 g of chlorine gas

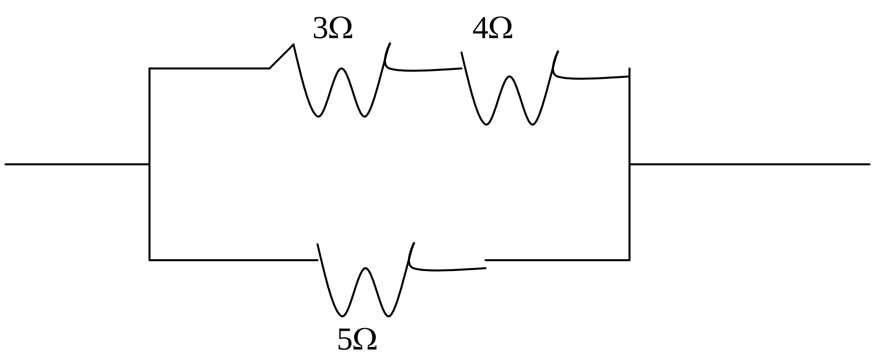
13. *Attempting to Plug Numbers Into $C_1V_1 = C_2V_2$ Without Picturing What's Physically Going On*

Example: There is 2.0 L of a 0.10 g/L NaOH solution which has to be diluted to create 1.0 L of a 0.010 g/L solution. How much water will be needed?

Answer: $C_1V_1 = C_2V_2$.
$0.10\ V_1 = 0.010(1)$
$V_1 = 0.100$ L so out of th e2.0 L we only take out 0.100L . To then make 1.0 L we have to add about 1.0 – 0.1 = 0.9 L of water.

Mixed Circuits(430)

14. *Failure to Use a Formula To Represent a Seemingly Unfamiliar Situation*



Example: A mixed circuit contains the above. The voltage is unknown, but Joe has to figure out which branch draws more current, and how many times more current it receives compared to the other. Help him out.

Answer: Since voltage is constant in parallel, $I_{top}R_{top} = I_{bottom}R_{bottom}$,

$$I_{top}(3+4) = I_{bottom}(5), \text{ so}$$

$$I_{bottom} = (7/5)\ I_{top}$$

This makes sense since the bottom branch has less resistance, so it attracts more (1.4 times as much) current.

Magnetism

15. *Confusing the Left Hand rule for Straight Current With the One for a Solenoid*

<u>Example</u>: A strong current is coming out of the plane of the paper, as indicated by the black dot. What angle does the magnetic field create with the plane of the paper? Where would the compass needle be pointing at the indicated(*) spot?