

AP Chemistry Summer Assignment



Ms. Natalie

Welcome to the AP chemistry course! As an AP Chemistry student, you are about to embark on an exciting adventure into the world of Chemistry. It will be a challenging year. The summer assignments are designed to ensure everyone will be on the same wavelength for the first day of school in September. A portion of this material is a review of your first year of Chemistry. For some of you that was a while ago, and you may need to refresh basic concepts. For others, you have just completed the general chemistry course or honors course. However, you may need to strengthen your skills. Be advised, AP Chemistry will investigate previously learned concepts at a higher level. A significant portion of this work will introduce you to new concepts which require a solid foundation in Chemical principles.

Your summer assignment will cover two out of the six big ideas of the AP chemistry course.

Some of the topics were previously addressed in general and honors chemistry.

We need to use our class time effectively so one of the goals of this summer packet is that you will have reviewed much of the material from your first chemistry class. All students are required to memorize the below material included in this packet:

- 1) Polyatomic ions (including name, symbol, and charge)
- 2) Variable charges for transition metals
- 3) Naming Acids
- 4) Naming Ionic Compounds
- 5) Naming Covalent Compounds

You will be required as well to watch 26 short videos (average of 7 min per video) each covering a concept from big idea 1 and big idea 2. The videos are created by Paul Andersen owner of Bozemanscience website. Then you will solve 7 corresponding worksheets. Stoichiometry is also one of the main topics you are encouraged to review extensively this summer.

<http://www.bozemanscience.com/ap-chemistry/>

The time needed for completion of this summer assignment is estimated to be between 12 to 15 hours in total. This assignment is to be submitted on the first day of school.

Big Idea 1: Atoms & Elements

- 1 - Molecules & Elements
- 2 - Chemical Analysis
- 3 - The Mole
- 4 - Coulomb's Law
- 5 - Electron Configuration
- 6 - Periodicity
- 7 - Quantum Mechanical Model
- 8 - Atomic Models

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- 9 - Mass Spectrometry
- 10 - Light & Matter
- 11 - Symbolic Representations
- 12 - Conservation of Atoms

Big Idea 2: Structure & Properties of Matter

- 13 - Solids & Liquids
- 14 - Gases
- 15 - Solutions
- 16 - London Dispersion Forces
- 17 - Dipole Forces
- 18 - Intermolecular Forces
- 19 - Covalent Bonding
- 20 - Ionic Bonding
- 21 - Metallic Bonding
- 22 - Lewis Diagrams & VSEPR Models
- 23 - Ionic Solids
- 24 - Metallic Solids
- 25 - Covalent Network Solids
- 26 - Molecular Solids

AP Required Memorization – Charges of Ions

POSITIVE IONS: - periodic table connections

+1	+2	+3	+4	+5
Group 1	Group 2	Group 13	Group 14	Group 15
Alkali	Alkaline Earth	Boron	Carbon	Nitrogen
Li ⁺¹ Lithium	Be ⁺² Beryllium	Al ⁺³ Aluminum	Si ⁺⁴ Silicon(IV)	As ⁺⁵ Arsenic (V)
Na ⁺¹ Sodium	Mg ⁺² Magnesium	Ga ⁺³ Gallium	Ge ⁺⁴ Germanium(IV)	Bi ⁺⁵ Bismuth(V)
K ⁺¹ Potassium	Ca ⁺² Calcium			
Rb ⁺¹ Rubidium	Sr ⁺² Strontium			
Cs ⁺¹ Cesium	Ba ⁺² Barium			
Fr ⁺¹ Francium	Ra ⁺² Radium			

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NEGATIVE IONS: - periodic table connections

-4	-3	-2	-1
Group 14	Group 15	Group 16	Group 17
Carbon	Nitrogen	Oxygen	Halogen
C ⁻⁴ Carbide	N ⁻³ Nitride P ⁻³ Phosphide	O ⁻² Oxide S ⁻² Sulfide Se ⁻² Selenide	F ⁻¹ Fluoride Cl ⁻¹ Chloride Br ⁻¹ Bromide I ⁻¹ Iodide

VARIABLE CHARGES/TRANSITION METALS:

Iron (II) or (III)	+2 or +3
Copper (I) or (II)	+1 or +2
Mercury (I) or (II)	+1 or +2
Tin (II) or (IV)	+2 or +4
Lead (II) or (IV)	+2 or +4
Cobalt (II) or (IV)	+2 or +4
Manganese (II) or (IV)	+2 or +4
Chromium (II) or (III)	+2 or +3
Hydrogen	+1 or -1

NO ROMAN NUMERALS

Silver	+1
Zinc	+2
Cadmium	+2
Nickel	+2

POLYATOMICS IONS

+1

Ammonium	NH ₄ ⁺
Hydronium	H ₃ O ⁺

-1

Acetate	C ₂ H ₃ O ₂ ⁻¹ or CH ₃ COO ⁻¹	Hydroxide	OH ⁻¹
Azide	N ₃ ⁻¹	Nitrate	NO ₃ ⁻¹
Bromate	BrO ₃ ⁻¹	Nitrite	NO ₂ ⁻¹
Cyanide	CN ⁻¹	Perchlorate	ClO ₄ ⁻¹
Dihydrogen phosphate	H ₂ PO ₄ ⁻¹	Chlorate	ClO ₃ ⁻¹
Bicarbonate		Chlorite	ClO ₂ ⁻¹
Hydrogen carbonate		Hypochlorite	ClO ⁻¹
Bisulfate	HSO ₄ ⁻¹	Iodate	IO ₃ ⁻¹
Hydrogen sulfate		Permanganate	MnO ₄ ⁻¹
		Thiocyanate	SCN ⁻¹

-2

Carbonate	CO ₃ ⁻²	Oxalate	C ₂ O ₄ ⁻²
Chromate	CrO ₄ ⁻²	Silicate	SiO ₃ ⁻²
Dichromate	Cr ₂ O ₇ ⁻²	Tetraborate	B ₄ O ₇ ⁻²
Hydrogen phosphate	HPO ₄ ⁻²	Peroxide	O ₂ ⁻²
Sulfate	SO ₄ ⁻²	Selenate	SeO ₄ ⁻²
Sulfite	SO ₃ ⁻²	Tartrate	C ₄ H ₄ O ₆ ⁻²
Thiosulfate	S ₂ O ₃ ⁻²		

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-3

Phosphate	PO_4^{-3}
Phosphite	PO_3^{-3}
Arsenate	AsO_4^{-3}
Borate	BO_3^{-3}

*Reminder NH_3 = ammonia

Prefixes for naming molecular (covalent) compounds – Greek

1= mono-	5= penta-	9= nona-
2= di-	6= hexa-	10= deca-
3= tri-	7= hepta-	
4= tetra-	8= octa-	

Elements that exist as diatomic molecules

Br	I	N	Cl	H	O	F
Other weirdos	P ₄ and S ₈					

Naming Acids

Binary acids – named after anion

Hydro-(element)-ic acid Ex. HBr hydrobromic acid

Oxyacids – named after polyatomic anion, no hydro prefix

-ate becomes -ic acid Ex. H_3PO_4 phosphoric acid

-ite becomes -ous acid Ex. H_2SO_3 sulfurous acid

Strong acids: There are 8 common strong acids:

HCl - hydrochloric acid	HBr - hydrobromic acid	HI - hydriodic acid
HClO_4 – perchloric acid	HNO_3 – nitric acid	HIO_4 – periodic acid
H_2SO_4 – sulfuric acid	HClO_3 – chloric acid	

“Strong” means that that are dissociated in aqueous solution. All other acids are weak acids (especially remember CH_3COOH , acetic acid and HF, hydrofluoric acid as weak acids). You should immediately be able to distinguish an acid as weak or strong.

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ADDENDUMS: Requirements for the course and things to think about!!

SHOW YOUR WORK

What does SHOW YOUR WORK even mean? You see it everywhere. It means different things to different people. But when in Chemistry, SHOW YOUR WORK means something very specific.

When showing work, you're describing a narrative, giving a step by step recipe for solving a problem. Even if you know how to solve the problem in your head, SHOW YOUR WORK means that you need to know how to express that know-how onto paper. It's a way of explaining your thought processes- even the ones you don't realize that you have. It is a systematic way of describing your work. And on top of that, if a person grading your work does not understand what it is you're trying to do, they will give up and you won't get to take part in any of that sweet partial credit everyone always talks about. Often times, poorly shown work will even result in a loss of credit, all because SHOW YOUR WORK is a very specific statement.

I'll use an example, and you may not understand the problem, but the step by step process is how to solve it.

How many moles of Sodium are in a 120.0g sample of Sodium?

Step 1: Identify Variables and Constants

To perform this calculation, write out what you're given and identify what dimension the value measures. Include units and give the number as written (to keep significant figures).

Mass = 120.0 g

Also, other information is provided. Though you will learn about it this year, with the periodic table, knowing that the substance is sodium will give you that the Molar Mass of Sodium is 22.99 g/mol. Even though this isn't a variable, it is a constant (or tabulated value) so you should list it as well:

Mass = 120.0 g Molar Mass = 23.0 g/mol (we always round our molar masses to one decimal)

Last, identify what it is you're trying to find. You can do this by writing the dimension you're looking for and signal it's the missing one with a "?".

Mass = 120.0 g Molar Mass = 23.0 g/mol (moles) = ??

So now you've listed out your 'givens,' you can either use this to identify what equation to use, or you can simply state the equation. Write the equation out that you're going to use.

Mass = 120.0 g Molar Mass = 23.0 g/mol (moles) = ??	Molar Mass = mass/moles
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In this case, we're using the Molar Mass equation where Molar Mass equals mass over moles.

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Now, beneath the used equation, rearrange the equation to solve for the unit you're trying to find. Do this BEFORE you input your numbers in, so that you can see the proper rearrangement of the equation before it becomes a mess:

Mass = 120.0 g	Molar Mass = mass/moles
Molar Mass = 23.0 g/mol	Moles = mass/molar mass
n (moles) = ??	

This requires algebra, but it's easier to do algebra with letters than with numbers and units.

Once you have the variables declared and the equation solved for the variable you want to find, plug the numbers in:

Mass = 120.0 g	Molar Mass = mass/moles	Molar
Mass = 23.0 g/mol	Moles = mass/molar mass	n
(moles) = ??	Moles = $\frac{120.0 \text{ g}}{23.0 \text{ g/mol}}$	

With the problem clearly described, the numbers clearly entered, it is time to check your work by checking the units. This is a form of dimensional analysis. If your units don't come out right, then something went wrong.

To check this, cross out the units that cancel out in the numerator and denominator. In this case, grams cancels with grams and moles is left in the denominator of a denominator (This means it goes to the numerator. Check your algebra books for this if this confuses you.)

Mass = 120.0 g	Molar Mass = mass/moles	Molar
Mass = 23.0 g/mol	Moles = mass/molar mass	n
(moles) = ??	Moles = $\frac{120.0 \text{ g}}{23.0 \text{ g/mol}}$	

Finally, give your answer to the correct number of significant figures (in this case, 4 based on the measurement given in the original problem) and the correct unit.

Mass = 120.0 g	Molar Mass = mass/moles	Molar
Mass = 23.0 g/mol	Moles = mass/molar mass	n
(moles) = ??	Moles = $\frac{120.0 \text{ g}}{23.0 \text{ g/mol}}$	
moles Na		Moles = 5.217391304347 = 5.217

Often times, units should include substances. Think logically on these counts. If you say "5.220 moles," the question is 'moles of what?' Say moles of Sodium or "mol Na" to be clear.

SHOW YOUR WORK FAQ

Q: Do I have to show my work all the time?

A: When there is math or conversions involved, yes, it is appropriate to show your work.

Q: If I don't, can I lose points?

A: Frequently, and this also goes for work that is not coherent and clear. Don't make a grader search for the answer.

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Q: What if that's how I solve a problem?

A: Unfortunately, SHOW YOUR WORK doesn't include the following:

- Cross multiplying. This is not work, it's unsolved algebra problems
- Long division or addition/subtraction/multiplication that is written out. Use a calculator for these.
- Show me what the operation is neatly and then grab the calculator.
- A mess of numbers and lines that Pablo Picasso couldn't make sense of. Just writing it on the page doesn't count. Again: Don't make the grader search for the answer. **Better yet, put a box around your answer.**

Q: Is this always how I should show my work?

A: Different teachers may expect different things from students, but this is the clearest and most evident way of showing your thought process, so you should get used to it.

Q: Should every number have a unit?

A: Yes. Always.* A number without a unit is nothing.

*There are exceptions to this rule, but you will be directed to when this is the case.



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DESIRED QUALITIES OF AP STUDENT

In addition to the OHS “habits of mind” (intellectual curiosity, academic persistence, metacognition) the following are other habits that you should cultivate.

❖ **Intelligence**

This quality is not just about being “smart”. It is being “smart” enough to identify what you do not know or understand and then actively seeking sources of help. This also includes knowing when you “get it”, and when you need to stay after/ask for help.

❖ **Self-Motivation**

This quality describes your attitude. Enrollment in this class is voluntary. Your desire to learn the material should be your chief motivation. You understand that the teacher will not cajole, plead, beg, etc. an AP level student to do the assigned work. You should be ready and willing to learn each day.

❖ **Integrity / Character**

This quality is about doing the right thing in all situations. If you have integrity, you do not cheat on any assignment, be it a test, quiz, project or homework. You do your own work. If you have integrity it means you do not help others to cheat, be it providing homework for someone to copy or providing the questions / answers for a test or quiz in class or for another class.

❖ **Work Ethic / Industriousness**

This quality means that the work you turn in is of your highest quality. You show complete and organized work on all assignments (tests, quizzes, homework, projects) clearly identifying how you arrived at the solutions. Showing just answers does not show any work ethic at all and is unacceptable.

Industriousness means that you use all available time to learn and improve. This could simply be starting your homework if there is time left in class. It could mean asking questions about a concept of which you are unsure. When given an extended problem / project / reading assignment industriousness means that you start on the assignment promptly and not wait until the night before the test or due date. This quality means you do not do work for another class or play games on your calculator during class time.

❖ **Safety**

AP students treat the lab and lab materials with respect. While they may not yet know all the safety regulations, they do know that horsing around or misbehaving in the lab can potentially cause injury or worse to themselves and their peers. AP students do not need to be told how to behave properly in a lab, or when to appropriately observe safe and correct lab techniques. AP students ensure the lab is cleaner than when they found it. Labs should be read, at a minimum, the night before. You should highlight and write notes on your procedure. All pre-lab assignments should be done promptly and if there are questions you should discuss those with me BEFORE the class period in which you are supposed to perform the lab.

❖ **Inquisitiveness**

This quality means that if you have a question you ask the question as soon as possible. An honors student does not just sit there and take notes, they think: Did I understand? Does it make sense? What if? Do not make the mistake of assuming that a concept you do not understand now in class will all make sense later on. Being inquisitive also means taking advantage of all opportunities to help yourself including your teacher in class, your teacher OUT of class, and your textbook, and other students who may have a grasp of the concept.

❖ **Ingenuity**

This quality is about applying knowledge, not just rote memorization. An honors student is able to devise solutions to problems they have never seen before. They are able to take what they have cumulatively learned in this class and all of their current and previous classes and apply it toward the solution of a new problem.

Name_____

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Period _____ Date ____/____/____

Writing Formulas and Naming Compounds – Do WITHOUT an ion chart! You need to have these memorized. DO THIS ASSIGNMENT NEATLY ON A SEPARATE SHEET OF PAPER.

1. Name each of the following compounds:

- | | | |
|----------------------------|---------------------------------|--------------------------------------|
| a. NaCl | h. AlI_3 | o. BaSO_3 |
| b. Rb_2O | i. Al_2O_3 | p. KMnO_4 |
| c. FeBr_3 | j. ZnCl_2 | q. Sr_3P_2 |
| d. Cr_2O_3 | k. Li_3N | r. $\text{Ca}_3(\text{PO}_4)_2$ |
| e. CaBr_2 | l. Ag_2S | s. $\text{Pb}(\text{NO}_3)_2$ |
| f. CsF | m. KClO_4 | t. NaNO_2 |
| g. CaS | n. $\text{Al}_2(\text{SO}_4)_3$ | u. $\text{K}_2\text{Cr}_2\text{O}_7$ |

2. Name each of the following compounds:

- | | | |
|-------------------|---------------------------|---------------------------|
| a. NI_3 | d. ICl_3 | g. P_2S_5 |
| b. PCl_3 | e. SF_2 | h. N_2O_4 |
| c. SO_2 | f. N_2F_4 | |

3. Name each of the following compounds:

- | | |
|----------------------------|----------------------------|
| a. HCl | d. HNO_2 |
| b. H_3PO_4 | e. HI |
| c. HIO_3 | f. H_2SO_3 |

4. Name each of the following compounds:

- | | | |
|--------------------------------------|---------------------------------|---------------------------------|
| a. HgO | j. ICl | s. NH_4NO_3 |
| b. CuI | k. $\text{Pb}_3(\text{PO}_4)_2$ | t. H_2SO_4 |
| c. CuI_2 | l. KIO_3 | u. Sr_3N_2 |
| d. CoI_2 | m. $\text{Ca}(\text{OH})_2$ | v. $\text{Al}_2(\text{SO}_3)_3$ |
| e. Na_2CO_3 | n. CoS | w. SnO_2 |
| f. NaHCO_3 | o. S_3N_4 | x. Na_2CrO_4 |
| g. $\text{HC}_2\text{H}_3\text{O}_2$ | p. SF_6 | y. HClO |
| h. NH_4NO_2 | q. NaClO | z. NO |
| i. Co_2S_3 | r. BaCrO_4 | |

5. Write the formula name for each of the following compounds:

- Cesium bromide
- Barium sulfate
- Chlorine trifluoride
- Ammonium chloride
- Beryllium oxide
- Chlorine monoxide
- Magnesium fluoride
- Sulfur difluoride
- Sulfur hexafluoride
- Sodium dihydrogen phosphate
- Silicon tetrachloride
- Lithium nitride

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- m. Chromium (III) carbonate
- n. Tin (II) fluoride
- o. Ammonium acetate
- p. Ammonium hydrogen sulfate
- q. Cobalt (III) nitrate
- r. Copper (I) sulfide
- s. Potassium chlorate
- t. Lithium tartrate

6. Write the formula for each of the following compounds:

- a. sodium oxide
- b. Copper(I) chloride
- c. Sodium peroxide
- d. Cadmium selenide
- e. Potassium cyanide
- f. Zinc sulfide
- g. Copper (II) nitrate
- h. Ammonium hydrogen phosphate
- i. Silicon tetrafluoride
- j. Hydrobromic acid
- k. Lead (II) sulfide
- l. Bromous acid
- m. Lead (IV) sulfide
- n. Perchloric acid

Matter and Measurement

- Which physical state of matter exhibits the greatest change in volume with changes in temperature or pressure?
a) solid b) liquid c) gas
- According to the Kinetic Molecular Theory particles of a solid
 - are bound in a regular array and do not move.
 - float freely within an array occupying various positions relative to neighbors.
 - have no relationship to the microscopic structure of the solid.
 - vibrate back and forth but do not move past immediate neighbors.
 - float freely in the inside but do not move on the surface.
- What volume of a liquid having a density of 1.48 g/cm^3 is needed to supply 5.00 grams of the liquid?
 - 0.296 cm^3
 - 1.48 cm^3
 - 2.26 cm^3
 - 3.38 cm^3
 - 7.40 cm^3
- The density of aluminum is 2.70 g/cm^3 . If a cube of aluminum weighs 13.5 grams, what is the length of the edge of the cube?
 - 5.00 cm
 - 1.71 cm
 - 1.25 cm
 - 0.312 cm
 - 0.200 cm
- Which temperature change is the smallest?
 - 10°C to 20°C
 - 10 K to 20°C
 - 10 K to 20 K
 - 10°F to 20°C
 - 10°F to 20°F
- The number of significant figures in 0.06060×10^{-5} is
 - 2
 - 3
 - 4
 - 5
 - 6

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7. The number, three hundred and fifty thousand, written in scientific notation is best written as
- a) 350 d) 3.50×10^5
b) 3.5×10^6 e) 3.50×10^{-5}
c) 3.5×10^5
8. The mass of a sample weighted on an electronic balance that is sensitive to ± 0.3 mg is 1.2300 g. The number of significant figures in this measurement is
- a) 1 d) 4
b) 2 e) 5
c) 3
9. What is the numerical value of:
- $1.5 \text{ cm} - 7.222 \times 10^{-1} \text{ cm}$
- a) 0.7778 cm d) 0.8 cm
b) 0.778 cm e) $7.072 \times 10^{-1} \text{ cm}$
c) 0.78 cm
10. Four samples were weighed using three different balances. (All are as accurate as the precision below indicates.) The masses are 0.94 kg, 58.2 g, 1.55 g, and 250 mg. This total mass should be reported as
- a) 1000.000 g d) $1.00 \times 10^3 \text{ g}$
b) 1000.0 g e) $1.0 \times 10^3 \text{ g}$
c) $1.000 \times 10^3 \text{ g}$
11. The temperature of the room is 75°F . What is its temperature in Celsius degrees?
- a) 24°C d) 43°C
b) 27°C e) 43°C
c) 30°C
12. The symbols for a metal, a non-metal and a noble gas in that order are
- a) Ag, Ga, Xe d) Ba, P, Ar
b) Ce, Ge, Ne e) P, Pb, Kr
c) Ca, Sn, Ks

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13. Which of the following elements is a non-metal?
- a) Ca
 - b) Cr
 - c) Co
 - d) Cl
 - e) Cs
14. A good example of an ionic compound is
- a) water
 - b) sugar
 - c) dry ice
 - d) sodium chloride
 - e) natural gas
15. When a pure solid substance was heated, a student obtained another solid and a gas, each of which was a pure substance. From this information which of the following statements is ALWAYS a correct conclusion?
- a) The original solid is not an element.
 - b) Both products are elements.
 - c) The original solid is a compound and the gas is an element.
 - d) The original solid is an element and the gas is a compound.
 - e) Both products are compounds.
16. Classify each observation as a physical or a chemical property and tally them.
- Observation 1: Bubbles form on a piece of metal when it is dropped into acid.
- Observation 2: The color of a crystalline substance is yellow.
- Observation 3: A shiny metal melts at 650°C.
- Observation 4: The density of a solution is 1.84 g/cm³
- a) 2 chemical properties and 2 physical properties
 - b) 3 chemical properties and 1 physical properties.
 - c) 1 chemical properties and 3 physical properties
 - d) 4 chemical properties
 - e) 4 physical properties
17. To convert a value in kilograms to centigrams one should
- a) multiply by 10⁵
 - b) multiply by 10³
 - c) multiply by 10⁻³
 - d) divide by 10⁵
 - e) divide by 10⁻¹

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18. How many cm^2 are in an area of 4.21 in^2 ?
- a) 10.7 cm^2 d) 1.66 cm^2
b) 114 cm^2 e) 1.14 cm^2
c) 27.2 cm^2
19. When the prefix micro (μ) is used in the metric system, a fundamental unit of measurement is multiplied by a factor of
- a) 10^{-9} d) 10^3
b) 10^{-6} e) 10^9
c) 10^{-3}
20. Of the masses 86.30 g , 0.0863 kg and $8.630 \times 10^5 \text{ mg}$, which (if any) is the largest?
- a) 86.30 d) they are the same
b) 0.0863 kg e) two are the same,
c) $8.630 \times 10^5 \text{ mg}$ f) one is smaller
21. The element chlorine is obtained for commercial use by the following method:
- a) Isolation from gas pockets in the earth's crust.
b) Separation from air by a high pressure technique.
c) Filtration of brine (NaCl) solutions.
d) Electrolysis of aqueous NaCl solutions.
e) Mixing sulfur and argon in equal quantities.
22. Consider a brass alloy which contains 66% copper and 34% zinc. How many grams of zinc are present in 125 kg of the alloy?
- a) 2.4 g d) $2.4 \times 10^4 \text{ g}$
b) 42 g e) $4.2 \times 10^4 \text{ g}$
c) 83 g

Atoms and Elements

- Certain properties are characteristic of metals. Which property means that you can pound the substance into a foil?
a) ductility c) sectility
b) conductivity d) malleability
- Which of the following is a metalloid?
a) As b) Ag c) S d) Pb e) He
- Which of the following is a transition metal?
a) Cl b) Ni c) P d) Ca e) C
- Which of the following is an alkali metal?
a) Mg b) Kr c) K d) Al e) H
- Which of the following is an lanthanide?
a) Xe b) Eu c) Cd d) P e) W
- Which element has the highest melting point?
a) Pb b) Au c) Os d) W e) Hg
- Cathode rays start at the
a) negative electrode c) positive electrode
b) power source d) gas inside the tube
- In a cathode ray tube, electrons are bent toward
a) a positively charged plate.
b) a negatively charged plate.
- Listed below are the charges and masses of four particles. Which one will be deflected the **least** in a mass spectrometer?
a) +2, 2 amu c) +1, 1 amu
b) +4, 4 amu d) +1, 4 amu

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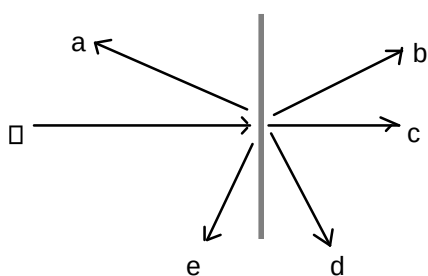
10. In a Millikan oil drop type experiment, the charge on four oil drops (in Coulombs) was found to be:

- 3.33 Coulombs
- 8.88 Coulombs
- 6.66 Coulombs
- 11.10 Coulombs

What is the charge on the electron according to this experiment?

- a) 1.11 Coulomb
- b) 2.22 Coulomb
- c) 4.44 Coulomb
- d) 11.10 Coulomb

11. Pictured below is a schematic of the Rutherford experiment. Which scattered α -particle gives the best evidence for the nuclear atom?



- a) a
- b) b
- c) c
- d) d
- e) e

12. Which of the following is an isotope of the element with 20 protons ($p=20$) and 22 neutrons ($n=22$)?

- a) titanium-22
- b) zirconium-40
- c) calcium-40
- d) titanium-48

13. The imaginary element X has the following natural abundances and isotopic masses. What is the atomic mass of X?

$^{24}_{12}\text{X}$	24.02 amu	40.0%
$^{26}_{12}\text{X}$	26.10 amu	60.0%

Show your work:

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For questions 14 - 17, use the following key:

(each answer may be used once, more than once,

or not at all)

- a) alpha
- b) beta
- c) gamma
- d) alpha and beta, but not gamma

- 14. A high energy form of light :
- 15. Two protons & two neutrons :
- 16. A high speed electron :
- 17. Used by Ernest Rutherford as a “probe” :

For questions 18 - 22, use the following key:

(each answer may be used once, more than once,

or not at all.)

- a) John Dalton
- b) Ernest Rutherford
- c) J.J. Thomson
- d) Democritus

- 18. His model of the atom has been called the “plum pudding” Model.
- 19. His model of the atom has been called the “billiard ball” model.
- 20. He studied matter in cathode ray tubes.
- 21. His philosophical idea included the term “atomos”.
- 22. He added to the atomic theory the idea that atoms had positive and negative parts.
- 23. Consider the following notation: $^{220}_{86}\text{Rn}$

Which statement below is correct?

- a) This particle contains 86 protons
- b) This particle has a mass number of 86
- c) This particle has an atomic number of 220
- d) This particle contains 220 neutrons

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24. Which elements did Mendeleev leave spaces for in his periodic table?

25. If copper metal is a mixture two isotopes, Cu-63, mass = 62.9298 u and Cu-65, mass = 64.9278 u. The molar mass of copper is 64.546 g/mole. Calculate the % abundances of the two isotopes of copper. Show your work.

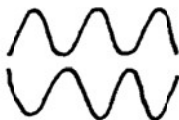
Atomic Structure & Periodicity

$A = 2.18 \times 10^{-18} \text{ J}$		$h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
$R = 1.097 \times 10^7 \text{ m}^{-1}$	$c = 3.00 \times 10^8 \text{ m}\cdot\text{s}^{-1}$	mass of an electron = $9.11 \times 10^{-31} \text{ kg}$

- What wavelength corresponds to a frequency of $8.22 \times 10^9 \text{ Hz}$?
a) 0.307 m d) 0.110 m
b) 0.0365 m e) 27.4 m
c) 0.122 m
- A radio station transmits at 110 MHz ($110 \times 10^6 \text{ Hz}$). What wavelength is this radio wave?
a) $3.65 \times 10^{-5} \text{ m}$ c) $3.81 \times 10^{-5} \text{ m}$
b) 3.30 m d) 2.73 m
- Which one of the following is NOT a proper unit for frequency?
a) Hz c) $\text{m}\cdot\text{s}^{-1}$
b) s^{-1} d) $\frac{1}{\text{sec}}$
- Calculate the wavelength of the fourth line in the Balmer series (the visible series) of the hydrogen spectrum.
a) 0.12334 m d) $4.1029 \times 10^{-7} \text{ m}$
b) 24.373 m e) 36.559 m
c) $2.7353 \times 10^{-7} \text{ m}$
- What is the relationship between the energy of a photon of light and its frequency?
a) $E = v$ d) $E = 1/hv$
b) $E = h/v$ e) $E = v/h$
c) $E = hv$
- What is the energy needed to raise an electron in the hydrogen atom from the second energy level to the third energy level?
a) $1.52 \times 10^4 \text{ J}$ d) $4.48 \times 10^{-19} \text{ J}$
b) $3.63 \times 10^{-19} \text{ J}$ e) $3.03 \times 10^{-19} \text{ J}$
c) $2.18 \times 10^{-19} \text{ J}$
- What is the de Broglie wavelength of an electron moving at 80.0% the speed of light.
a) $3.03 \times 10^{-12} \text{ m}$ c) $3.30 \times 10^{11} \text{ m}$
b) $2.42 \times 10^{-12} \text{ m}$ d) $1.59 \times 10^{-25} \text{ m}$

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8. What resultant is expected from the interference of the two waves shown below?

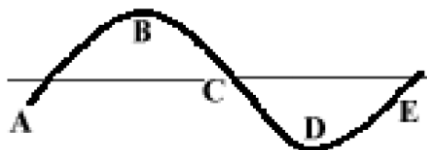


- a)  c) 
- b)  d) 

9. Which quantum number determines the subshell occupied by an electron (s, p, d, f, etc.)?

- a) n c) m_l
b) ℓ d) m_s

10. What position on the standing wave shown below corresponds to a crest?



- a) A b) B c) C d) D e) E

11. How many orbitals make up the **4d** subshell?

- a) 0 b) 1 c) 3 d) 5 e) 7

12. The value of ℓ that is related to the following orbital is:



- a) 0 b) 1 c) 2 d) 3 e) 4

13. The correct electron configuration for nitrogen is

- a) $1s^2 2s^2 2p^6 3s^2 3p^2$
b) $1s^2 2s^2 2p^6 2d^4$
c) $1s^2 2s^2 2p^3$
d) $1s^2 2s^2 3s^2 4s^1$
e) $1s^2 1p^5$

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14. The electron configuration of the indicated atom in the ground state is correctly written for which atom?
- Ga $[\text{Ar}] 3d^{12} 4s^2$
 - Ni $[\text{Ar}] 3d^{10}$
 - Ni $[\text{Ar}] 3s^2 3p^8$
 - Cu $[\text{Ar}] 3d^{10} 4s^1$
15. Which of the following sets of quantum numbers is possible for a **3d** electron?
- $n = 3, \ell = 3, m_\ell = -2, m_s = +\frac{1}{2}$
 - $n = 2, \ell = 1, m_\ell = +1, m_s = -\frac{1}{2}$
 - $n = 3, \ell = 1, m_\ell = 0, m_s = -\frac{1}{2}$
 - $n = 3, \ell = 2, m_\ell = -2, m_s = +\frac{1}{2}$
 - $n = 4, \ell = 1, m_\ell = +1, m_s = +\frac{1}{2}$
16. In what section of the periodic table is the **4f** subshell being filled?
- period 4
 - transition elements Y to Cd
 - noble gases
 - group IA
 - lanthanides
17. Which one of the following elements has 3 electrons in a **p** subshell?
- Sb
 - Na
 - Sc
 - V
 - Nd
18. Which of the following distributions of electrons is correct for three electrons in p-subshell?
- $\begin{array}{|c|c|c|} \hline \uparrow & \uparrow & \uparrow \\ \hline \end{array}$
 - $\begin{array}{|c|c|c|} \hline \uparrow\downarrow & \uparrow & \text{ } \\ \hline \end{array}$
 - $\begin{array}{|c|c|c|} \hline \uparrow & \uparrow & \downarrow \\ \hline \end{array}$
 - $\begin{array}{|c|c|c|} \hline \uparrow & \uparrow\downarrow & \text{ } \\ \hline \end{array}$
 - $\begin{array}{|c|c|c|} \hline \uparrow\uparrow & \uparrow & \text{ } \\ \hline \end{array}$
19. Which of the following particles would be most paramagnetic?
- P
 - Ga
 - Br
 - Cl^-
 - Na^+

AP Chemistry Summer Assignment

20. Which of the following correctly represents the ionization of an atom?
- $\text{Cl(g)} + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$
 - $\text{Na(g)} \rightarrow \text{Na}^+(\text{g}) + \text{e}^-$
 - $\text{Na(s)} - \text{e}^- \rightarrow \text{Na}^+(\text{g})$
 - $\text{Cl}_2(\text{g}) \rightarrow 2 \text{Cl(g)}$
21. Which of the following is likely to have the largest atomic radius?
- H
 - Mn
 - Cl
 - Rb
 - Ag
22. Which one of the following isoelectronic species has the smallest radius?
- Mg^{2+}
 - Na^+
 - Ne
 - F^-
 - O^{2-}

NOTE: explain your reasoning on the last page.

23. Which of the following has the greatest ionization energy?
- K
 - Ca
 - Fe
 - Ga
 - Br
24. Which of the following has the lowest ionization energy?
- Li
 - Na
 - K
 - Rb
 - Cs
25. The successive ionization energies for one of the period three elements is listed below. Which element is referred to?

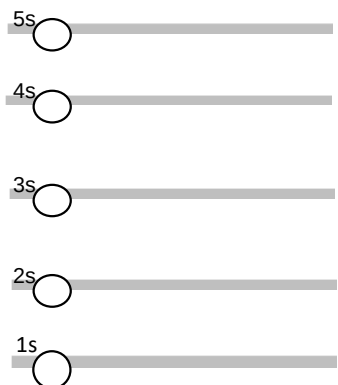
E1	577.4 kJ/mol
E2	1,816 kJ/mol
E3	2,744 kJ/mol
E4	11,580 kJ/mol
E5	15,030 kJ/mol

- Na
- Mg
- Al
- Si
- P

NOTE: explain your reasoning on the last page.

AP Chemistry Summer Assignment

26. Draw the **orbital diagram** for a neutral Ag atom:



Write the **electron configuration** for silver:

27. Long form:

28. Short form:

29. **Explain** your answer to question 22.

Which one of the following isoelectronic species has the smallest radius?

- a) Mg^{2+}
- b) Na^+
- c) Ne
- d) F^-
- e) O^{2-}

AP Chemistry Summer Assignment



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Explain your answer to question 25.

The successive ionization energies for one of the period three elements is listed below. Which element is referred to?

E1	577.4 kJ/mol
E2	1,816 kJ/mol
E3	2,744 kJ/mol
E4	11,580 kJ/mol
E5	15,030 kJ/mol

f) Na b) Mg c) Al d) Si e) P

Electron Configurations & Periodicity

- Write the electron configurations of the following elements using the shorthand notation for the noble gas cores.
 - phosphorus
 - nickel
 - osmium
 - californium
 - titanium
- Which orbital is filled following these orbitals?
 - 3d
 - 4s
 - 5p
 - 5f
- How many electrons can be accommodated in
 - d subshell
 - set of f orbitals
 - $n = 4$ shell
 - 7s orbital
 - p_x orbital?
- What is wrong with the following ground state electron configurations?

a.	3d 	4s ↑↓	4p
b.	3d ↑↓ ↑↓ ↑↓ ↑↓ ↑↓	4s ↑	4p ↑ ↑ ↑
c.	3d ↑↓ ↑↓ ↑↓ ↑↓ ↑↓	4s ↑↑	4p ↑ ↑ ↑
d.	3d ↑ ↑ ↑ ↑ ↑	4s ↑	4p
e.	3d ↑↓ ↑↓ ↑↓ ↑↓ ↑↓	4s ↑↓	4p ↑↓
- How many unpaired electrons are there in
 - a nitrogen atom
 - an iodine atom
 - a nickel (II) cation
 - an oxide ion?

AP Chemistry Summer Assignment

6. Which of the following sets of quantum numbers describe an impossible situation? Explain why.
 - a. $n = 2, l = 1, m_l = 2, m_s = +\frac{1}{2}$
 - b. $n = 5, l = 2, m_l = 1, m_s = -\frac{1}{2}$
 - c. $n = 6, l = 5, m_l = 0, m_s = 0$
 - d. $n = 3, l = 3, m_l = 1, m_s = -\frac{1}{2}$
 - e. $n = 4, l = 2, m_l = 1, m_s = +\frac{1}{2}$
7. Arrange the elements S, Ge, P, and Si in order of increasing atomic size.
8. Arrange the ions Na^+ , K^+ , Cl^- , and Br^- in order of increasing size.
9. Arrange the elements Be, Ca, N, and P in order of increasing ionization energy.
10. Which one of each of the following pairs would you expect to have the higher electron affinity?
 - a. Cl or Cl^-
 - b. Na or K
 - c. Br or I
11. Which elements fit the following descriptions?
 - a. the smallest alkaline earth metal
 - b. has a valence shell configuration $4f^{14} 5d^{10} 6s^1$
 - c. the halogen with the lowest ionization energy
 - d. has 13 more electrons than argon
 - e. the smallest non metal
 - f. the Group 4A element with the largest ionization energy
 - g. its $3+$ ion has the electron configuration $[\text{Kr}] 4d^{10}$

Main Group Elements

- Of the elements N, P, As, Sb, and Bi, which one has the most metallic character?
 - N
 - P
 - As
 - Sb
 - Bi
- Which method is useful in the laboratory preparation of hydrogen?
 - metal + acid
 - carbonate + acid
 - acid + base
 - acid + alcohol
 - all of these
- Oxides of the alkaline earth family form
 - basic solutions
 - acidic solutions
 - gases with water
 - noble gas compounds
 - soluble sulfides
- Oxides of nitrogen are known which have the following positive oxidation numbers.
 - +2, +4
 - +2, +4, +6
 - +1, +3, +5
 - +2, +4, +5
 - +1, +2, +3, +4, +5
- The Ostwald process is useful for the preparation of
 - ammonia from nitrogen and hydrogen
 - sulfur from iron sulfide
 - nitric acid from ammonia
 - oxygen from sand
 - lead from lead sulfide
- Which is NOT attacked by nitric acid?
 - Fe
 - Ti
 - Au
 - Cu
 - Co

AP Chemistry Summer Assignment

7. All of the following statements about the main group metals are true EXCEPT:
- a) most metal oxides are basic
 - b) the metals have positive reduction potentials
 - c) most metals are dense solids at 400K
 - d) the metals are good heat conductors
 - e) the metals are good electrical conductors
8. All would be expected to function as reducing agents EXCEPT:
- a) H_2
 - b) NH_3
 - c) Sn^{2+}
 - d) Mg
 - e) Al^{3+}
9. Tin has the oxidation states of +2 and +4. The expected oxidation states for antimony are
- a) +3 and +5
 - b) +1 and +3
 - c) +2 and +3
 - d) +2 and +4
 - e) +1 and +5
10. All of the following are true statements about bases EXCEPT
- a) they have a bitter taste
 - b) they react with salts to form weaker or more volatile acids and a new salt.
 - c) they have a slippery feeling
 - d) they change the colors of many indicators
 - e) they react with acids to form salts and water

Molecules and Compounds

- What is the formula of the ionic compound formed between Mg and Br?
 - MgBr
 - Mg₂Br
 - MgBr₂
 - Mg₂Br₂
 - Mg₂Br₃
- What is the formula of the ionic compound formed between Ca and P?
 - Ca₂P₃
 - CaP
 - Ca₅P₁₀
 - Ca₂P
 - Ca₃P₂
- What is the name of the SO₃²⁻ ion?
 - sulfate
 - nitrate
 - sulfite
 - sulfur trioxide
 - hydrogen sulfate
- What is the correct formula and charge for the chromate ion?
 - CrO₄²⁻
 - CrO₄⁻
 - Cr₂O₇²⁻
 - Cr₂O₇⁻
 - Cr³⁺
- Which one of the following elements forms ions with two different valences?
 - calcium
 - arsenic
 - iron
 - fluorine
- The correct name for CCl₄ is
 - carbon(I) chloride
 - carbon chloride
 - carbon tetrachloride
 - monocarbon chloride(IV)
 - carbochlorinate

AP Chemistry Summer Assignment

7. The correct formula for hydrogen telluride is
- a) HTe
 - b) H_2Te
 - c) H_3Te
 - d) HTe_2
8. The correct formula for dinitrogen tetroxide is
- a) NO_2
 - b) N_2O_4
 - c) N_2O_5
 - d) NO_3^-
 - e) $(\text{N}_2\text{O})_4$
9. The correct name for S_2Cl_2 is
- a) sulfur dichloride
 - b) sulfur(I) chloride
 - c) sulfur(II) chloride
 - d) disulfur dichloride
 - e) sulfur chloride
10. The correct name for NO_2 is
- a) nitrogen dioxide
 - b) nitrite
 - c) nitrogen oxide
 - d) nitrogen(II) oxide
 - e) nitrate
11. The molar mass of $(\text{NH}_4)_2\text{S}$ is closest to:
- a) 50 g/mol
 - b) 82 g/mol
 - c) 68 g/mol
 - d) 100 g/mol
12. How many atoms are in 12 molecules of glucose, $\text{C}_6\text{H}_{12}\text{O}_6$?
- a) 24
 - b) 288
 - c) 2160
 - d) 7.22×10^{24}
13. Calculate the number of atoms in 4.0×10^{-5} g of aluminum.
- a) 8.9×10^{17}
 - b) 4.6×10^{19}
 - c) 6.5×10^{20}
 - d) 3.8×10^{23}



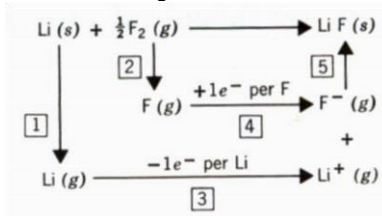
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14. Which of the following samples contains the smallest number of atoms?
- a) 1 g H₂ c) 1 g O₃
- b) 1 g O₂ d) 1 g Cl₂
15. What is the mass of **one molecule** of octane, C₈H₁₈?
- a) 114 g c) 1.10×10^{-22} g
- b) 1.89×10^{-22} g d) 4.32×10^{-23} g
16. What is the percent nitrogen (by mass) in ammonium carbonate, (NH₄)₂CO₃?
- a) 14.53% c) 29.16%
- b) 27.83% d) 33.34%
17. Of the following, the only empirical formula is
- a) N₂F₂ c) H₂C₂
- b) N₂F₄ d) HNF₂

Bonding & Molecular Structure

- The correct Lewis symbol for ground state carbon is
a) $\cdot\ddot{\text{C}}\cdot$ b) $:\text{C}:$ c) $:\ddot{\text{C}}:$ d) $\cdot\ddot{\text{C}}\cdot$ e) $:\ddot{\text{C}}\cdot$
- The correct Lewis symbol for ground state aluminum is
a) $\cdot\dot{\text{Al}}\cdot$ b) $:\dot{\text{Al}}\cdot$ c) $:\dot{\text{Al}}$ d) $:\ddot{\text{Al}}\cdot$ e) $\ddot{\text{Al}}$
- Using the picture below, what process corresponds to the lattice energy?



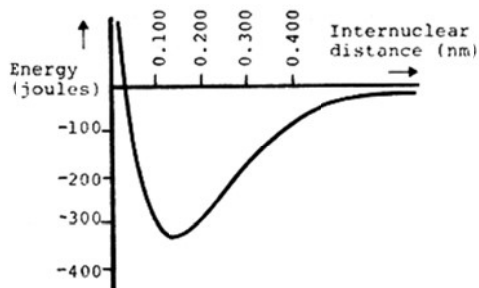
- 1
 - 2
 - 3
 - 4
 - 5
- Which of the following favors formation of an ionic compound?
a) low ionization energy for metal
b) high electron affinity for non metal
c) high lattice energy
d) all of a-c above
e) none of a-c above
 - Which of the atoms below is least likely to violate the octet rule?
a) Be b) P c) S d) B e) F
 - How many electrons are shown in the Lewis structure of perchlorate ion, ClO_4^- ?
a) 30 b) 31 c) 32 d) 50 e) 51

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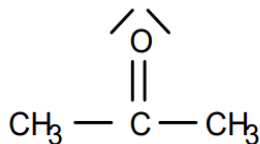


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Questions 7 - 9 refer to the following energy diagram:



7. What is the energy of the two isolated atoms?
- a) -400 J d) 0.100 nm
b) -335 J e) -155 J
c) 0 J
8. What is the bond length of the bond between the two atoms?
- a) 0.020 nm d) 0.330 nm
b) 0.140 nm e) 2.00 nm
c) 0.400 nm
9. What is the bond energy (bond strength) of the bond?
- a) 0 J d) -330 J
b) -110 J e) -422 J
c) -10 J
10. What is the bond order of the C–O bond in acetone?



- a) 4 b) 1.5 c) 0.5 d) 1 e) 2

AP Chemistry Summer Assignment

11. Which of the following is the correct Lewis structure for SOCl_2 ? (Consider formal charge)

- a) $\begin{array}{c} \text{O} \\ | \\ \text{Cl}-\text{S}-\text{Cl} \\ | \\ \text{O} \end{array}$ d) $\begin{array}{c} \text{Cl}-\text{Cl}-\text{S}-\text{O} \\ | \quad \quad | \\ \text{O} \end{array}$
- b) $\begin{array}{c} \text{Cl}-\text{S}-\text{Cl} \\ | \\ \text{O} \end{array}$ e) $\begin{array}{c} \text{Cl}-\text{S}-\text{Cl} \\ || \\ \text{O} \end{array}$
- c) $\text{Cl}-\text{S}-\text{Cl}-\text{O}$

12. As the bond order of a carbon-carbon bond increases, which one of the following decreases?

- a) # of electrons between the carbon atoms
b) vibrational frequency of bond vibrations
c) bond energy (bond strength)
d) bond length

13. In which of the following is the actual compound a resonance hybrid of Lewis structures?

- a) NO_2 d) CCl_4
b) H_2O e) none of these
c) O_3

14. Which of the following bonds is most polar?

- a) $\text{N}-\text{Cl}$ d) $\text{Br}-\text{Br}$
b) $\text{C}-\text{N}$ e) $\text{S}-\text{O}$
c) $\text{S}-\text{S}$

15. Which one of the following molecules is a polar molecule?

- a) $\text{Cl}-\text{Cl}$ c) $\begin{array}{c} \text{O}=\text{C}=\text{O} \\ | \\ \text{Cl} \end{array}$
- b) $\begin{array}{c} \text{N} \\ / \quad \backslash \\ \text{F} \quad \text{F} \end{array}$ d) $\begin{array}{c} \text{Cl} \\ | \\ \text{C} \\ / \quad | \quad \backslash \\ \text{Cl} \quad \text{Cl} \quad \text{Cl} \end{array}$

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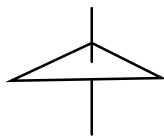
16. Which of the following molecular shapes has six atoms joined to a central atom?

- a) linear
- b) tetrahedral
- c) octahedral
- d) trigonal bipyramid
- e) planar triangular

17. Which molecular shape has bond angles which are not all the same?

- a) linear
- b) tetrahedral
- c) octahedral
- d) planar triangular
- e) trigonal bipyramid

18. What molecular shape is pictured below?



- a) linear
- b) tetrahedral
- c) octahedral
- d) planar triangular
- e) trigonal bipyramid

19. The molecule BrF_3 has how many lone pairs of electrons on the central atom?

- a) 0
- b) 1
- c) 2
- d) 3

20. What is the geometrical arrangement of electron pairs in H_2O ?

- a) linear
- b) bent
- c) octahedral
- d) trigonal bipyramidal
- e) tetrahedral

21. What is the shape of BrI_3 ?

- a) square planar
- b) T-shaped
- c) distorted tetrahedral
- d) pyramidal
- e) bent

22. What is the shape of the IF_4^- ion?

- a) square planar
- b) tetrahedral
- c) square pyramidal
- d) octahedral
- e) T-shaped

AP Chemistry Summer Assignment

23. Which of the following is a polar species?

- a) CO_2
- b) PCl_5
- c) ICl_2^-
- d) TeCl_4
- e) CCl_4

24. Among those listed below, which element will have the strongest tendency to form double bonds?

- a) S b) B c) Al d) O

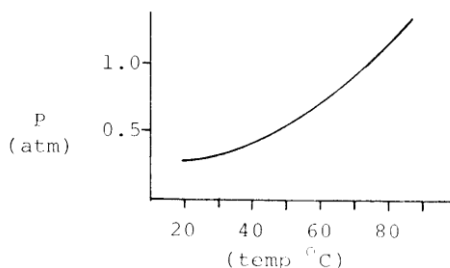
Electronegativity Values							
H 2.1							He ---
Li 1.0	Be 1.5	B 2.0	C 2.5	N 3.0	O 3.5	F 4.0	Ne ---
Na 0.9	Mg 1.2	Al 1.5	Si 1.8	P 2.1	S 2.5	Cl 3.0	Ar ---
K 0.8	Ca 1.0	Ga 1.6	Ge 1.8	As 2.0	Se 2.4	Br 2.8	Kr ---
Rb 0.8	Sr 1.0	In 1.7	Sn 1.8	Sb 1.9	Te 2.1	I 2.5	Xe ---
Cs 0.7	Ba 0.9	Tl 1.8	Pb 1.8	Bi 1.9	Po 2.0	At 2.2	Rn ---
Fr 0.7							

IMF's, Liquids, and Solids

- Surface tension in a liquid is due to the fact that
 - surface molecules are pulled toward the interior
 - liquids tend toward lowest energy
 - PE is increased for molecules at the surface
 - interior molecules are attracted in all directions
 - all of the above
- In which one of the following will dipole-dipole attractions play the most significant role as the intermolecular attraction?
 - HCl
 - NaCl
 - Kr
 - H₂O
 - NH₃
- With which type of substances do London dispersion forces play the most significant role?
 - polar molecules
 - metals
 - ionic compounds
 - non-polar molecules
 - network compounds
- The heat of vaporization of H₂S, at its boiling point (−61°C) is 18.8 kJ/mol. What mass of H₂S can be vaporized (at its boiling point) with 100 kJ of energy?
 - $100 \times \frac{61}{18.8}$
 - $34.1 \times \frac{18.8}{100}$
 - $61 \times 18.8 \times 100 \times 34.1$
 - $18.8 \times \frac{61}{34.1}$
 - $100 \times \frac{34.1}{18.8}$
- Which one of the following substances exhibits the strongest intermolecular forces of attraction?
 - CH₄
 - C₂H₆
 - C₃H₈
 - CH₃OH
 - CH₃Cl
- For which substance would you predict the highest heat of vaporization?
 - F₂
 - H₂O
 - HF
 - NaCl
 - Br₂

AP Chemistry Summer Assignment

7. Which of the following will change the equilibrium vapor pressure of a liquid?
- Heat up or cool down the liquid
 - Increase the Volume of the container
 - Change the pressure above the liquid
- I only
 - I and II only
 - I, II, and III
 - I and III only
 - II and III only
8. Which of the following statements describes a substance above its critical point?
- the substance can be liquefied
 - the vapor and liquid phase become indistinguishable
 - the substance experiences no intermolecular interactions
 - there is a distinct phase boundary between the liquid and vapor
 - all of the above
9. At what temperature will the liquid (whose vapor pressure is shown below) boil if the air pressure is reduced to 380 mmHg?

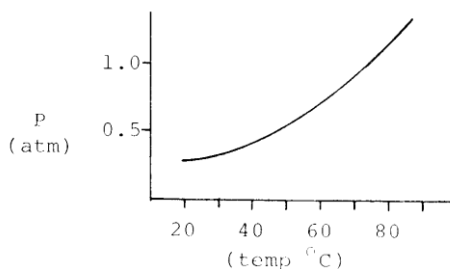


- 30°C
 - 50°C
 - 70°C
 - 100°C
 - the liquid will not boil at this pressure
10. Which one of the following is linked with the correct intermolecular force of attraction?
- NH₃ dipole-dipole
 - AlH₃ London dispersion forces
 - H₂ hydrogen bonding
 - C₂H₄ covalent bonding
 - HCl ionic

AP Chemistry Summer Assignment

Ms. Natalie

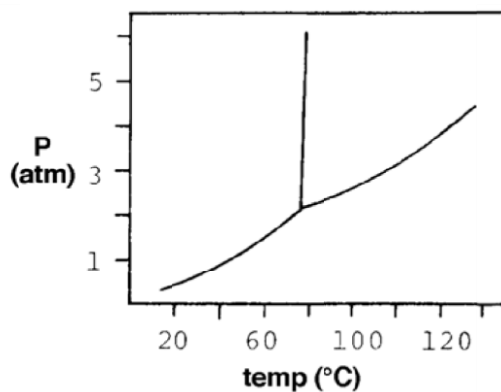
11. The vapor pressure graph of an unknown liquid is shown below. Which of the following statements about this liquid is/are true?



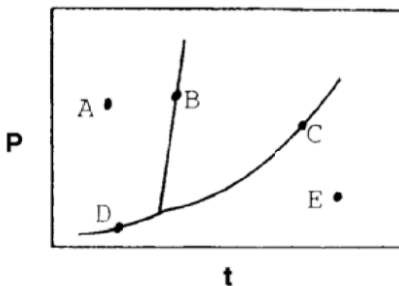
- I. This liquid has weaker IMF's than water.
 - II. The liquid's normal boiling point is around 75°C.
 - III. The liquid boils at room temperature when the pressure is dropped to about 0.25 atm.
- a) II and III only d) I only
 - b) II only e) I, II, and III
 - c) I and III
12. How much energy does it require to melt 25.0 g benzene, C₆H₆? The heat of fusion of benzene is 2.37 kJ/mol. [molar mass = 78.0 g/mol]
- a) 8.25 kJ d) 0.759 kJ
 - b) 59.3 kJ e) none of these
 - c) 4625 kJ
13. What type of solid(s) can contain covalent bonds?
- a) molecular d) network
 - b) metallic e) all but "b"
 - c) ionic
14. Which type of solid generally has the highest melting point?
- a) metallic c) molecular
 - b) ionic d) network
15. Which substance below exhibits the weakest IMFs?
- a) IF₃ b) SO₂ c) CO₂ d) SiO₂ e) PH₃
16. During the condensing of a liquid, the kinetic energy _____ and the potential energy _____.
- a) stays the same, increases
 - b) increases, decreases
 - c) increases, increases
 - d) decreases, stays the same
 - e) stays the same, decreases

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17. The phase diagram of a substance is given below. What occurs when the substance is heated from 100° C to 120° C at 3 atm pressure?



- a) it melts
b) it sublimes
c) it boils
d) it freezes
e) no phase change occurs
18. A typical phase diagram for a substance is given below. At what point on the diagram do solid and liquid exist at equilibrium?



- a) A b) B c) C d) D e) E
19. Which one of the following as solids has a crystal structure containing discrete (separate) molecules?
- a) potassium d) carborundum, SiC
b) glass e) hydrogen
c) quartz
20. The heat of sublimation of a compound equals
- a) heat of fusion plus heat of vaporization
b) heat of ionization plus heat of crystallization
c) heat of vaporization minus heat of fusion
d) heat of vaporization plus heat of crystallization
e) heat of crystallization plus heat of vaporization

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21. The normal boiling point of a liquid
- is 100 °C at 1 atm pressure.
 - is the temperature at which the vapor pressure is 1 atm.
 - is the temperature at which liquid and vapor are in equilibrium.
 - is the temperature at which the vapor pressure equals the external pressure.
 - is the temperature at which there is a continuous formation of gaseous bubbles in the liquid.
22. The vapor pressure of a liquid increases with an increase of temperature. Which of the following best explains this increase?
- The average kinetic energy of molecules is greater, thus more molecules can enter the gaseous state.
 - The number of gaseous molecules above the liquid remains constant but these molecules have greater average kinetic energy.
 - the faster moving molecules in the liquid exert a greater pressure.
 - All the molecules have greater kinetic energies.
 - The intermolecular forces between the molecules becomes less at higher temperatures.
23. Which of the following indicates very strong intermolecular forces of attraction in a liquid? a) A very low boiling point.
- A very low critical temperature.
 - A very low heat of vaporization.
 - A very low vapor pressure.
 - A very low surface tension.
24. The compounds Br₂ and ICl have almost identical molecular weights, yet ICl boils at 97°C and Br₂ boils at 59 °C. The best explanation for the difference is
- ICl is an ionic compound and Br₂ is covalent.
 - ICl is a nonpolar molecule and Br₂ is polar.
 - ICl has a longer bond than that in Br₂.
 - ICl has a measurable dipole moment (is polar) and Br₂ does not (is nonpolar).
 - ICl has a stronger bond than that in Br₂.
25. In some compounds the hydrogen atom is covalently bonded to one atom and simultaneously attracted to another atom in another molecule by an electrostatic interaction. This interaction can occur when hydrogen is bonded to
- Cl b) Si c) N d) C e) Br
26. Which of the following compounds shows an abnormal boiling point due to hydrogen bonding?
- CH₃NH₂ d) CH₃Cl
 - CH₃OCH₃ e) HCl
 - CH₃SH

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27. Which of the following has the **lowest** boiling point?
- a) H_2O d) H_2Te
b) H_2S e) NH_3
c) H_2Se
28. Which of the following would be expected to have the highest heat of vaporization?
- a) H_2O c) HF
b) NH_3 d) all three are the same
29. Which element is considered a covalent/network solid?
- a) Cr b) O c) Xe d) B e) Na
30. Which one of the following compounds has intermolecular forces different than the others?
- a) quartz, SiO_2 d) C(graphite)
b) C(diamond) e) silicon carbide, SiC
c) carbon dioxide, CO_2
31. A compound consists of the following elements by weight percent:
carbon - 40.0% , oxygen - 53.3%, hydrogen - 6.7%
The ratio of carbon : oxygen : hydrogen in the empirical formula is
- a) 1:2:1 c) 1:1:2
b) 1:1:1 d) 2:1:2
32. An organic compound which has the empirical formula CHO has a molar mass of 232. Its molecular formula is:
- a) CHO c) $\text{C}_4\text{H}_4\text{O}_4$
b) $\text{C}_2\text{H}_2\text{O}_2$ d) $\text{C}_8\text{H}_8\text{O}_8$
33. When $\text{CaSO}_4 \cdot y \text{H}_2\text{O}$ is heated, all of the water is driven off. If 34.0 g of CaSO_4 [molar mass = 136] is formed from 43.0 g of $\text{CaSO}_4 \cdot y \text{H}_2\text{O}$, what is the value of y?
- a) 1 c) 3
b) 2 d) 4

Orbitals and hybridization

Exercise 1:

- (a) Draw the Lewis electron-dot structures for CO_3^{2-} , CO_2 , and CO , including resonance structures where appropriate.
- (b) Which of the three species has the shortest C-O bond length? Explain the reason for your answer.
- (c) Predict the molecular shapes for the three species. Explain how you arrived at your predictions.

Exercise 2:

Use simple structure and bonding models to account for each of the following.

- (a) The bond length between the two carbon atoms is shorter in C_2H_4 than in C_2H_6 .
- (b) The H-N-H bond angle is 107.5° , in NH_3 .
- (c) The bond lengths in SO_3 are all identical and are shorter than a sulfur-oxygen single bond.
- (d) The I_3^- ion is linear.

Exercise 3:



Nitrogen is the central atom in each of the species given above.

- (a) Draw the Lewis electron-dot structure for each of the three species.
- (b) List the species in order of increasing bond angle. Justify your answer.
- (c) Select one of the species and give the hybridization of the nitrogen atom in it.
- (d) Identify the only one of the species that dimerizes and explain what causes it to do so.

Exercise 4:

Explain each of the following observations in terms of the electronic structure and/or bonding of the compounds involved.

- (a) At ordinary conditions, HF (normal boiling point = 20°C) is a liquid, whereas HCl (normal boiling point = -114°C) is a gas.
- (b) Molecules of AsF_3 are polar, whereas molecules of AsF_5 are nonpolar.
- (c) The N-O bonds in the NO_2^- ion are equal in length, whereas they are unequal in HNO_2 .
- (d) For sulfur, the fluorides SF_2 , SF_4 , and SF_6 are known to exist, whereas for oxygen only OF_2 is known to exist.

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Exercise 5:

Consider the molecules PF_3 and PF_5 .

- (a) Draw the Lewis electron-dot structures for PF_3 and PF_5 and predict the molecular geometry of each.
- (b) Is the PF_3 molecule polar, or is it nonpolar? Explain.
- (c) On the basis of bonding principles, predict whether each of the following compounds exists. In each case, explain your prediction.
 - (i) NF_5
 - (ii) AsF_5

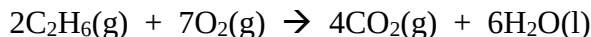
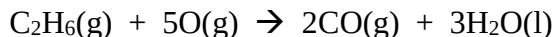
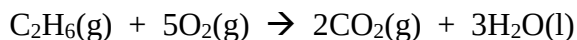
Chemical Equations and Stoichiometry

1. Balance the following equations:

- $\text{C}_4\text{H}_6(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- $\text{NH}_3(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- $\text{PCl}_3(\text{l}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_3\text{PO}_3(\text{aq}) + \text{HCl}(\text{aq})$
- $\text{Ca}_3\text{P}_2(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{aq}) + \text{PH}_3(\text{g})$
- $\text{C}_4\text{H}_8(\text{OH})_2(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- $\text{NH}_3(\text{g}) + \text{NO}(\text{g}) \rightarrow \text{N}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- $\text{KClO}_3(\text{s}) \rightarrow \text{KCl}(\text{s}) + \text{O}_2(\text{g})$
- $\text{Ca}(\text{OH})_2(\text{s}) + \text{H}_3\text{PO}_4(\text{aq}) \rightarrow \text{Ca}_3(\text{PO}_4)_2(\text{s}) + \text{H}_2\text{O}(\text{l})$
- $\text{C}_3\text{H}_8(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$
- $\text{N}_2\text{O}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{NO}_2(\text{g})$
- $\text{Al}_4\text{C}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Al}(\text{OH})_3(\text{aq}) + \text{CH}_4(\text{g})$
- $\text{CS}_2(\text{l}) + \text{Cl}_2(\text{g}) \rightarrow \text{CCl}_4(\text{l}) + \text{S}_2\text{Cl}_2(\text{l})$
- $\text{C}_2\text{H}_5\text{OH}(\text{l}) + \text{PCl}_3(\text{l}) \rightarrow \text{C}_2\text{H}_5\text{Cl}(\text{l}) + \text{H}_3\text{PO}_3(\text{l})$
- $\text{ZnS}(\text{s}) + \text{O}_2(\text{g}) \rightarrow \text{ZnO}(\text{s}) + \text{SO}_2(\text{g})$
- $\text{Ag}(\text{s}) + \text{H}_2\text{S}(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{Ag}_2\text{S}(\text{s}) + \text{H}_2\text{O}(\text{l})$

3. When asked to balance the equation:

$\text{C}_2\text{H}_6(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l})$ the following suggestions were made:



Which answer is correct and what is wrong with the others?

4. Write balanced chemical equations for the following reactions:

- The decomposition of ammonium nitrate to nitrogen gas, oxygen gas, and water vapor.
- The reaction of sodium bicarbonate with sulfuric acid to produce sodium sulfate, water, and carbon dioxide.
- The treatment of phosphorus pentachloride with water to produce phosphoric acid and hydrogen chloride.

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5. If the maximum amount of product possible is formed in the following reactions, what mass of the specified product would you obtain?
 - a. 10 grams of sodium chloride is treated with excess silver nitrate:

$$\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$$
 How much silver chloride is precipitated?
 - b. 12 grams copper metal is treated with excess dilute nitric acid:

$$3\text{Cu}(\text{s}) + 8\text{HNO}_3(\text{aq}) \rightarrow 3\text{Cu}(\text{NO}_3)_2(\text{aq}) + 2\text{NO}(\text{g}) + 4\text{H}_2\text{O}(\text{l})$$
 How much nitric oxide gas (NO) is produced?
 - c. 60 grams propane gas is burned in excess oxygen:

$$\text{C}_3\text{H}_8(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 3\text{CO}_2(\text{g}) + 4\text{H}_2\text{O}(\text{l})$$
 How much water is produced?
6. A furniture dealer put together a special deal for the annual sale—an entire dining room set comprising a table, six dining chairs, two bookshelves, a china cabinet, and a sideboard for \$999. The dealer had in stock 280 tables, 1750 chairs, 550 bookshelves, 300 china cabinets, and 325 sideboards. He asked his assistant to figure out how many dining room sets they could sell, how much money they would make if they sold all the sets possible, and what they would have left that could not be sold as part of the deal.
7. Hydrazine reacts with dinitrogen tetroxide according to the equation:

$$2\text{N}_2\text{H}_4(\text{g}) + \text{N}_2\text{O}_4(\text{g}) \rightarrow 3\text{N}_2(\text{g}) + 4\text{H}_2\text{O}(\text{g})$$
 50.0 grams of hydrazine is mixed with 100.0 grams of dinitrogen tetroxide. How much nitrogen gas was produced?
9. 7.321 mg of an organic compound containing carbon, hydrogen, and oxygen was analyzed by combustion. The amount of carbon dioxide produced was 17.873 mg and the amount of water produced was 7.316 mg. Determine the empirical formula of the compound.
10. 0.1101 gram of an organic compound containing carbon, hydrogen, and oxygen was analyzed by combustion. The amount of carbon dioxide produced was 0.2503 gram and the amount of water produced was 0.1025 gram. A determination of the molar mass of the compound indicated a value of approximately 115 grams/mol. Determine the empirical formula and the molecular formula of the compound.
13. Sodium metal reacts vigorously with water to produce a solution of sodium hydroxide and hydrogen gas:

$$2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq}) + \text{H}_2(\text{g})$$
 What mass of hydrogen gas can be produced when 10 grams of sodium is added to 15 grams of water?
14. Nitrous oxide reacts with oxygen to produce nitrogen dioxide according to the equation:

$$2\text{N}_2\text{O}(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 4\text{NO}_2(\text{g})$$
 What mass of nitrogen dioxide can be made from 42 grams of nitrous oxide and 42 grams of oxygen?
15. If only 75 grams of nitrogen dioxide was produced in the reaction described in the previous question, what was the % yield?