

Name:
AP Chemistry
Date:
Period:

Unit 2 Exam – Atomic Theory, The Periodic Table, and Nutrition Labels

Enter all of the answers to the multiple choice and calculations questions into the appropriate google form. All short answers should be written on the test document, before being entered into the google form (excluding essays). You will have 90 minutes to complete the exam. You can use a Periodic Table, AP Equation Sheet, and scientific calculator, but no other notes may be used. Good luck 😊!

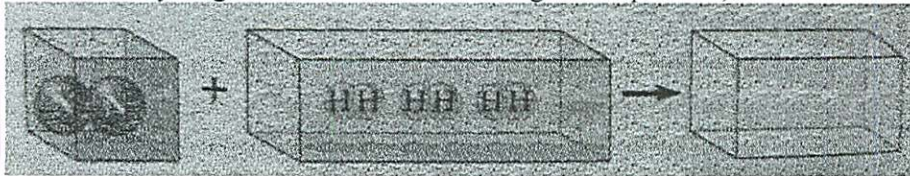
Section I – Multiple Choice and Calculations

LT 2.1:

1. A sample of chloroform is found to contain 12.00 g of carbon, 106.4g of chlorine, and 1.011 g of hydrogen. If a second sample of chloroform is found to contain 30.00 g of carbon, what is the total mass of chloroform in the second sample?

- a. 358.2 g
- b. 300.0 g
- c. 312.4 g
- d. 119.4 g
- e. 42.00 g

2. Observations of the reaction between nitrogen gas and hydrogen gas show us that 1 volume of nitrogen reacts with 3 volumes of hydrogen to make 2 volumes of gaseous product, as shown below:



Determine the formula of the product:

- a. $\text{N}(\text{OH})_2$
- b. NH^{-2}
- c. NH_2^-
- d. NH_3
- e. NH_4^+

3. Hydrazine, ammonia, and hydrogen azide all contain only nitrogen and hydrogen. The mass of hydrogen that combines with 1.00 g of nitrogen for each compound is 1.44×10^{-1} g, 2.16×10^{-1} g, and 2.40×10^{-2} g. What are the formulas for each of these compounds?

- a. NH_2^- , NH_3 , NH_4^+
- b. N_2H_4 , NH_3 , N_3H
- c. NH_3 , NH_4 , N_3H
- d. NH , N_2H , N_3H

LT 2.2-2.3:

4. Four Fe^{2+} ions are key components of hemoglobin, the protein that transports oxygen in the blood. Assuming that the ions are $^{55}\text{Fe}^{2+}$, how many protons and neutrons are present in each nucleus, and how many electrons are present in each ion?

- a. 26 protons, 27 neutrons, and 24 electrons
- b. 26 protons, 53 neutrons, and 26 electrons
- c. 53 protons, 26 neutrons, and 26 electrons
- d. 26 protons, 27 neutrons, and 26 electrons
- e. 26 protons, 29 neutrons, and 24 electrons

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CONSUME KNOWLEDGE

5. Which of the following is (are) correct?

- a. $^{40}\text{Ca}^{2+}$ contains 20 protons and 18 electrons
- b. Rutherford created the cathode-ray tube and was the founder of the charge-to-mass ratio of an electron.
- c. An electron is heavier than a proton
- d. The nucleus contains protons, neutrons, and electrons
- e. Anions is the term what chemists use to refer to positively charged atoms

6. The isotope of an unknown element, X, has a mass number of 79. The most stable ion of the isotope has 36 electrons and forms a binary compound with sodium having a formula of Na_2X . What might element X be?

- a. Se
- b. S
- c. Br
- d. Ge
- e. As

7. Only two isotopes of copper occur naturally, ^{63}Cu (atomic mass = 62.9296 amu; abundance 69.17%) and ^{65}Cu (atomic mass = 64.9278 amu; abundance 30.83%). Calculate the atomic weight (average atomic mass) of copper. **DON'T FORGET SIG FIGS!**

$$\frac{62.9296 \times 0.6917 + 64.9278 \times 0.3083}{20.02} = 63.55 \text{ g}$$

LT 2.4 and 2.9:

8. When a potassium atom becomes a monoatomic ion, how many electrons does it lose or gain? What noble gas atom has the same number of electrons as a potassium ion?

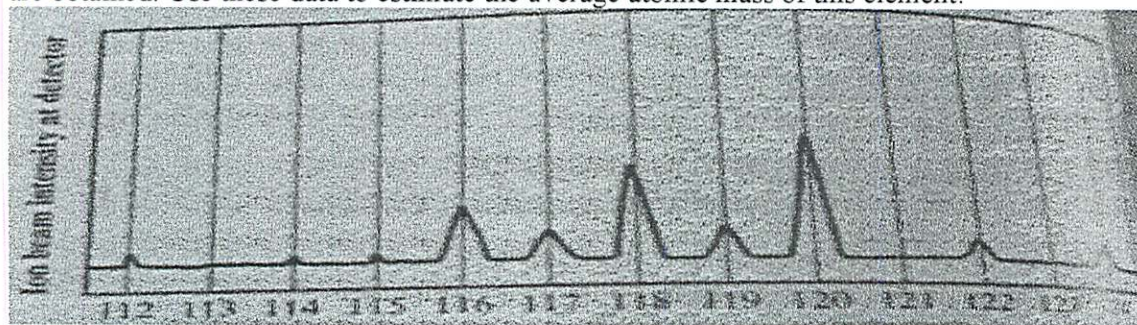
- a. 1; Ar
- b. 2; Ne
- c. 1; Ne
- d. 2; Ar
- e. 1; Kr

9. An element's most stable ion forms an ionic compound with bromine, having the formula XBr_2 . If the ion of element X has a mass number of 230 and 86 electrons, what is the identity of, and how many neutrons does it have?

- a. Protactinium; 140
- b. Protactinium; 139
- c. Radium; 142
- d. Radium; 141

LT 2.5:

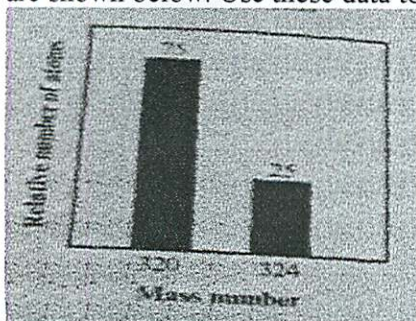
10. When a sample of an unknown element is vaporized and injected into a mass spectrometer, the results shown below are obtained. Use these data to estimate the average atomic mass of this element:



- (a) 117 amu
- (b) Between 117 and 118 amu
- (c) Between 118 and 119 amu
- (d) Between 119 and 120 amu

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11. An unnamed element with an atomic number of 130 is vaporized and injected into a mass spectrometer. The results are shown below. Use these data to calculate the average atomic mass of this element.



$$\begin{array}{r} 240 \\ + 81 \\ \hline 321 \end{array}$$

- (a) 320 amu
- (b) 321 amu
- (c) 322 amu
- (d) 324 amu

12. Naturally occurring magnesium has the following isotopic abundances:

Isotope	Abundance (%)	Atomic Mass (amu)
²⁴ Mg	78.99	23.98504
²⁵ Mg	10.00	24.98584
²⁶ Mg	11.01	25.98259

$$\begin{array}{r} 12.2 \\ 18.95 \\ 2.499 \\ 2.860 \\ \hline 24.309 \end{array}$$

Calculate the average atomic mass of Mg? *DON'T FORGET SIG FIGS!*

$$\boxed{24.309}$$

LT 2.6

Use the following answer choices to answer questions 13 – 16

- A. Dalton's Atomic Model
- B. Rutherford's Nuclear Model
- C. Democritus' Atomic Model
- D. Bohr's Model of the Atom
- E. Thomson's Plum Pudding Model

13. Developed this idea upon realizing that most of the atom was empty space after bombarding gold foil with alpha particles B
14. Developed to respond to the emission spectrum that was observed for hydrogen. D
15. The results of the cathode-ray tube experiment lead to this model, and depicted the atom as a glob of positive charges containing newly discovered small negative charges throughout. E
16. Used this model to account for the laws of definite and multiple proportions A
17. Milikan determined the charge on the electron by studying the static charges on oil drops falling in an electric field. A student carried out this experiment using several oil drops for her measurements and calculated the charges on the drops. She obtained the following data:

Droplet	Calculated Charge (C)
A	1.60×10^{-19}
B	3.15×10^{-19}
C	4.81×10^{-19}
D	6.31×10^{-19}

What is the actual charge of the electron located in the oil drops and how many electrons does Droplet D contain?

- (a) 1.60×10^{-19} ; 4
- (b) 3.15×10^{-19} ; 2
- (c) 4.81×10^{-19} ; 1.5
- (d) 6.31×10^{-19} ; 1
- (e) 8.00×10^{-20} ; 8

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Answer 18-21 using this guide – for each of the following sets of elements, label each as either:

- a. noble gases
- b. halogens
- c. alkali metals
- d. alkaline earth metals
- e. transition metals

18. Ti, Fe, Ag e
 19. Mg, Sr, Ba d
 20. Li, K, Rb c
 21. F, Br, I b

Answer 22-24 using this guide – for each of the following sets of elements, label each as either:

- a. At
- b. Te
- c. S
- d. Ar
- e. Br
- f. Sr
- g. K
- h. Cl
- i. Rb
- j. Kr

22. A member of the same family as oxygen whose most stable ion contains 54 electrons b
 23. A member of the alkali metal family whose most stable ion contains 36 electrons ei
 24. A noble gas with 18 protons in the nucleus d
 25. A halogen with 85 protons and 85 electrons a

LT 2.8 and 2.12:

26. The simplest form for a compound made from element X (molar mass = 79.0 g/mol) that is 21.0% nitrogen by mass is:

- a. XN
 - b. XN₂
 - c. X₂N₃
 - d. X₃N₂
 - e. X₂N
- $79 + 14$
 $79 + 28$
 $158 + 42 =$

27. Nicotine, a poisonous compound found in tobacco leaves, is 74.0% C, 8.65% H, and 17.35% N. Its molar mass is 162 g/mol. What are the empirical and molecular formulas of nicotine, respectively?

- a. C₁₀H₁₄N₂ and C₅H₇N
 - b. C₁₂H₁₄N and C₆H₇N
 - c. C₆H₁₂N₆ and CH₂N
 - d. C₅H₇N₂ and CHN
 - e. C₃H₉N₂ and C₃H₉N₂
- $119 - C$
 $14 - H$
 $N - 28$

LT 2.9 and 2.11:

The recommended daily allowance (RDA) of iron for women 19-30 years old is 18 mg.

28. Calculate how many moles this is: 0.00032
 29. Calculate how many atoms: 1.9×10^{20}

$$18 \text{ mg} \times \frac{1 \text{ g}}{1000 \text{ mg}} = 0.018 \text{ g} \times \frac{1 \text{ mol}}{55.84 \text{ g}} = 0.00032 \text{ mol}$$

$$0.00032 \text{ mol} \times \frac{6.022 \times 10^{23}}{1 \text{ mol}} = 1.9 \times 10^{20} \text{ atoms}$$

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30. What is the correct name for CaCl_2 ?

- a. calcium chloride
- b. calcium chlorine
- c. calcium chlorite
- d. calcium (II) chloride

31. What is the correct name for Fe_2S_3 ?

- a. diiron trisulfide
- b. iron sulfide
- c. iron (II) sulfide
- b. iron (III) sulfide

32. What is the correct name for NO_2 ?

- a. Nitrite
- b. nitrogen oxide
- c. nitrogen dioxide
- d. dinitrogen monoxide

Handwritten calculations for empirical formulas:
 $\text{C}_4 - 12 - 48$
 $\text{H}_4 - 1 - 4$
 $\text{O}_4 - 16 - 64$

 6
 $\text{C}_5 - 12 - 60$
 $\text{H}_5 - 1 - 5$
 $\text{O}_5 - 16 - 80$

 Fe^{3+} S^{2-}

 $\text{C}_3 - 12 - 36$
 $\text{H}_3 - 1 - 3$
 $\text{O}_3 - 16 - 48$

 $\text{C}_2 - 24$
 $\text{H}_2 - 2$

Section II – Free Response Questions

33. Complete the following tables:

Empirical Formula	Molar Mass (g/mol)	Molecular Formula
CH	26.0	C_8H_2
CHO	116.1	$\text{C}_4\text{H}_4\text{O}_4$
CH_2	112.01	C_8H_{16}

Empirical Formula	Molar Mass (g/mol)	Molecular Formula
$\text{C}_2\text{H}_3\text{O}_3$	150.0	$\text{C}_4\text{H}_6\text{O}_6$
C_3H_8	44.1	C_3H_8
B_2H_5	53.2	B_4H_{10}

34. Calculate the mass percent of copper in CuS , copper (II) sulfide. If you wish to obtain 10.0 g of copper metal from copper (II) sulfide, what mass of CuS (in grams) must you use?

Handwritten calculations:
 $\text{Cu} - 63.546$
 $\text{S} - 32.066$
 > 95.612
 $\text{Cu} - 66.462\% - 66.5\%$
 $10.0 = (0.6625) (x)$
 $x = \frac{10.0 \text{ g}}{0.6625} = 15.09 \text{ g}$
~~15.09 g~~ 15.0462 g

35. Complete the following table:

Atom/Ion	Protons	Neutrons	Electrons
$^{120}\text{Sn}_{50}$	50	70	50
$^{25}\text{Mg}^{2+}_{12}$	12	13	10
$^{56}\text{Fe}^{2+}_{26}$	26	30	24
$^{79}\text{Se}_{34}$	34	45	34
$^{35}\text{Cl}_{17}$	17	18	17
$^{63}\text{Cu}_{29}$	29	34	29

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CONSUME KNOWLEDGE

36. What are the formulas of the compounds that correspond to the names given in the following table?

Compound Name	Formula
Carbon tetrabromide	CBr_4
Cobalt (II) phosphate	$Co^{2+} PO_4^{3-}$ $Co_3(PO_4)_2$
Magnesium chloride	$MgCl_2$
Nickel(II) acetate	$Ni(CH_3CO_2)_2$
Calcium nitrate	$Ca(NO_3)_2$

What are the names of the compounds that correspond to the formulas given in the following table?

Formula	Compound Name
$Co(NO_2)_2$	Cobalt (II) Nitrite
AsF_5	Arsenic penta fluoride
$LiCN$	Lithium cyanide
K_2SO_3	Potassium sulfite
Li_3N	Lithium nitride
$PbCrO_4$	Lead (II) Chromate

37. Identify the following decay as alpha, beta, or gamma radiation. Explain what is going on in the nucleus during this decay.



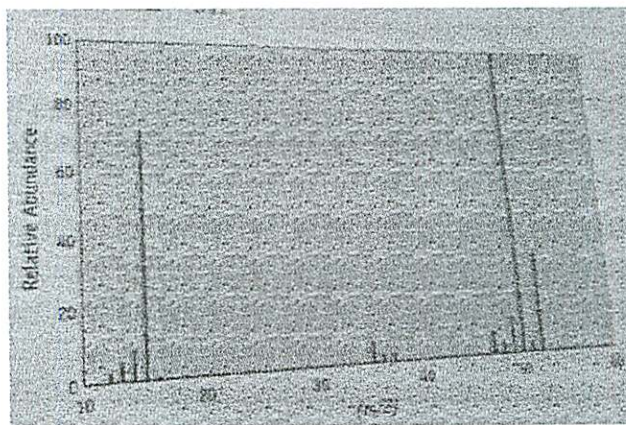
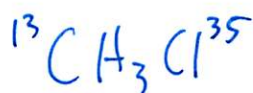
The nucleus' mass is too large to maintain and shoots off a helium molecule to stabilize it.

38. The mass spectrum of CH_3Cl is illustrated here. You know that carbon has two stable isotopes, ^{12}C and ^{13}C with relative abundances of 98.9% and 1.1% respectively, and chlorine has two isotopes, ^{35}Cl and ^{37}Cl with abundances of 75.77% and 24.23%, respectively.

(a) What molecular species gives rise to the lines at m/Z of 50 and 52 about 1/3 the height of the line at 50?



(b) What species might be responsible for the line at $m/Z = 51$?



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CONSUME KNOWLEDGE

39. Five of the boxes in the following periodic table are colored. Predict the charge on the ion associated with each of these elements.

Yellow Box: $+1$
Blue Box: $+2$
Black Box: $+3$
Red Box: -1
Green Box: -2

40. The development of atomic theory required the contributions of numerous scientists. In this class we have discussed the contributions of Dalton, Thomson, Rutherford, and Bohr in the modern model of the atom. In a short essay, discuss the contributions that each man made towards the modern model of the atom. You should discuss (1) the model that was proposed by each scientist, (2) the specific discoveries each scientist contributed to the final model, and (3) any problems that their models contained (if applicable).

EXTRA SPACE TO ANSWER PROBLEMS

- a. 5th period
- b. Lunch
- c. 1st period
- d. Tuesday/Thursday/After school

5. When is the best time for you to come in and get help (circle all that work best for you):

4. Would Saturday sessions help you in your overall performance?

3. Has the website/emails been a useful way of accessing the content? How could it be improved?

2. On a scale of 1-10 how well do you feel you know this material?

1. Give one suggestion that you have that would help you learn more in this class. Please note that we cannot slow down the material since there is a lot to get through, so try to think of things that we could do to work around in class.

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Survey: