

IA 1 H 1.008																	VIIIA 2 He 4.002
	IIA											IIIA	IVA	VA	VIA	VIIA	
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIB	IVB	VB	VIB	VIB	VIIIB	VIIIB	VIIIB	IB	IIB	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.30
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (97.9)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr 223.0	88 Ra 226.0	89 Ac 227.0															

57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
89 Ac 227.0	90 Th 232.0	91 Pa 238.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)

### Exam Rules & Guidelines

- For any problem that requires a calculation, you must show how you got your answer, using a clear, step-by-step solution. In most cases, this means that you need to show conversion factors with units cancelling. For molar mass calculations (only), you may omit the units, although it's a good idea to write "g/mol" after each molar mass that you calculate.
- You do not need to show your calculations for multiple-choice questions (although, for your benefit, it would be wise to write out the calculations anyway).
- You may not use any calculator or device that can accommodate text entry and/or that has the letters A through Z on the front.
- No books, notes, or scratch paper.
- Please do not wear hats, hoods, headphones/earphones or sunglasses.
- Please sit at separate tables if possible.
- Please put a  or  around each calculated answer.
- Good luck!

1 decagram (dag) = 10 gram (g)  
1 hectogram (hg) =  $10^2$  g  
1 kilogram (kg) =  $10^3$  g  
1 megagram (Mg) =  $10^6$  g  
1 gigagram (Gg) =  $10^9$  g  
1 teragram (Tg) =  $10^{12}$  g  
1 petagram (Pg) =  $10^{15}$  g  
1 exagram (Eg) =  $10^{18}$  g  
1 zettagram (Zg) =  $10^{21}$  g  
1 yottagram (Yg) =  $10^{24}$  g

1 pound (lb) = 453.6 grams  
1 ton = 2000 lb  
1 gallon (gal) = 3.785 liters (L)  
1 inch (in) = 2.54 centimeters (cm)  
1 milliliter (mL) = 1 cubic centimeter (cm<sup>3</sup>)  
1 gallon = 4 quarts (qt)  
1 quart = 2 pints (pt)  
1 pint = 2 cups  
1 cup = 8 fluid ounces (fl.oz.)  
1 fl.oz. = 2 tablespoonsful (tbsp.)  
1 tbsp. = 3 teaspoonsful (tsp.)

Speed of light =  $c = \lambda f = 3.00 \times 10^8$  m/s  
Planck's constant =  $h = 6.626 \times 10^{-34}$  J·s  
Energy:  $E = hf = hc/\lambda$   
 $f$  = frequency  
 $\lambda$  = wavelength  
1 Hertz (Hz) =  $1 \text{ s}^{-1} = 1/\text{s}$   
1 eV =  $1.602 \times 10^{-19}$  J  
1 J =  $1 \text{ kg} \cdot \text{m}^2/\text{s}^2$   
The Coulomb (C) is a unit of charge.  
Proton charge-to-mass ratio =  $9.58 \times 10^7$  C/kg  
Proton charge =  $1.60 \times 10^{-19}$  C.  
Mass of electron =  $9.1 \times 10^{-31}$  kg

1 gram = 10 decigrams (dg)  
1 gram =  $10^2$  centigrams (cg)  
1 gram =  $10^3$  milligrams (mg)  
1 gram =  $10^6$  micrograms ( $\mu\text{g}$ )  
1 gram =  $10^9$  nanograms (ng)  
1 gram =  $10^{12}$  picograms (pg)  
1 gram =  $10^{15}$  femtograms (fg)  
1 gram =  $10^{18}$  attograms (ag)  
1 gram =  $10^{21}$  zeptograms (zg)  
1 gram =  $10^{24}$  yoctograms (yg)

1 mile (mi) = 5280 feet (ft)  
1 foot = 12 in  
1 year = 365.25 days  
1 hour (hr) = 60 minutes (min)  
1 min = 60 seconds (s)  
  
1 atmosphere (atm) = 760 torr  
1 torr = 1 millimeter of mercury (mm Hg)

$$K = ^\circ C + 273$$

1 mole =  $6.022 \times 10^{23}$  things  
Molar mass is grams per mole  
Density is mass divided by volume  
 $PV = nRT$   
 $R = 0.0821 \text{ (L} \cdot \text{atm)/(K} \cdot \text{mol)}$   
 $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

Acres, mi<sup>2</sup>, and ft<sup>2</sup> are all units of area:  
1 acre = 43,560 square feet (ft<sup>2</sup>)  
1 square mile (mi<sup>2</sup>) = 640 acres

- [3 pts] The complete electron configuration for manganese is:
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
  - $1s^2 2s^2 2p^6 3s^2$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^5$
  - $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$
- [3 pts] The abbreviated electron configuration for gallium is:
  - $[\text{Ar}] 4s^2 3d^{10} 4p^1$
  - $[\text{Ar}] 4s^2 3d^{10} 4p^2$
  - $[\text{Kr}] 4s^2 3d^{10} 4p^1$
  - $[\text{Kr}] 4s^2 3d^{10} 4p^2$
- [3 pts] Write the complete electron configuration for niobium (Nb).
- [3 pts] Write the abbreviated electron configuration for potassium.
- [3 pts] Which element has the larger atomic radius, Mg or Al? (Circle the correct answer.)
- [3 pts] Which element has the smaller ionization energy, O or S? (Circle the correct answer.)
- [3 pts] A liter is approximately equal to
  - one gallon
  - one quart
  - one fluid ounce
  - one pint
- [3 pts] What is the mass in grams of  $25 \text{ cm}^3$  of benzene ( $\text{C}_6\text{H}_6$ ) if its density is  $0.88 \text{ g/cm}^3$ ?
  - 16 g
  - 28 g
  - 0.035 g
  - 22 g
- [3 pts] You are told to use some sodium bromide. The bottle is labeled with the formula only. Circle the correct formula.

$\text{SBr}_2$                    $\text{Na}_3\text{B}$                    $\text{S}_3\text{B}_2$                    $\text{NaBr}$
- [6 pts] How many protons, neutrons, and electrons are in a particle with the following isotopic symbols:

$^{92}_{\text{Mo}}\text{Mo}^{2+}$           Protons =                  Neutrons =                  Electrons =

11. [20 pts] Write the formulas for the following compounds:

- a. Hypochlorous acid
- b. Hydrosulfuric acid
- c. Copper (I) phosphate
- d. Dinitrogen tetroxide
- e. Cobalt (III) acetate

12. [20 pts] Write names for the following compounds:

- a.  $K_2SO_4$
- b.  $P_2O_4$
- c.  $(NH_4)_3PO_3$
- d. FeS
- e. NaOH

13. [8 pts] One atom of a particular element has a mass of  $3.818 \times 10^{-23}$  grams.

- a. Use unit conversions to calculate the molar mass of the element in grams per mole.
- b. Write the name of the element.
- c. Write the atomic symbol of the element.
- d. Write the atomic number of the element.

14. [28 pts] Complete the following table with the appropriate numbers, names, and isotopic symbols (including charge, if applicable).

Complete Isotopic Symbol	Element Name	Number of protons	Number of neutrons	Number of electrons
	Potassium		16	18
${}^{59}_{23}\text{V}$				
		10	11	11

15. [6 pts] A sample of enriched lithium (enriched means that the percentage of one of the isotopes has been increased to above its natural abundance) contains 70.00%  ${}^6\text{Li}$  (6.015 g/mol) and 30.00%  ${}^7\text{Li}$  (7.016 g/mol). What is the average atomic mass of the sample?
16. [3 pts] An electron moving within an atom from the  $n=3$  level to the  $n=2$  level is
- Absorbing energy.
  - Emitting energy.
  - Falling back to the ground state.
  - Moving closer to the nucleus.
17. [3 pts] In order to become isoelectronic with (have the same number of electrons as) a neon atom, a nitrogen atom must:
- Gain 1 electron
  - Gain 2 electrons
  - Gain 3 electrons
  - Lose 1 electron
  - Lose 2 electrons
  - Lose 3 electrons

18. [3 pts] Two atoms with same number of protons, but a different number of neutrons are \_\_\_\_.
- Elements
  - Ions
  - Allotropes
  - Isotopes
  - Families
19. [3 pts] Two atoms with same number of protons, but a different number of electrons are \_\_\_\_.
- Elements
  - Ions
  - Allotropes
  - Isotopes
  - Families
20. [3 pts] J. J. Thompson devised the plum-pudding model of the atom to accommodate which newly-discovered subatomic particle?
- Neutron
  - Proton
  - Electron
  - Alpha particle
  - Positron
21. [3 pts] Rutherford used his gold foil experiment to study the distribution of electrons in Thompson's model of the atom. Based on his results, Rutherford proposed a new atomic model that included:
- The ability to transform atoms of any element into gold.
  - A dense, positively-charged nucleus at the atom's center.
  - Electrons embedded in a positively-charged matrix.
  - Electrons orbiting the nucleus in shells at specific energies.
  - Orbitals of various shapes, grouped into sublevels at specific energy levels.
22. [6 pts] Calculate the mass of 5.00 moles of  $(\text{NH}_4)_3\text{PO}_4$ .
23. [6 pts] Calculate the mass percent of nitrogen in  $(\text{NH}_4)_3\text{PO}_4$ .

24. [12 pts] The total volume of the Earth's hydrosphere (oceans, lakes, rivers, etc.) is  $1.4 \times 10^9$  cubic kilometers ( $\text{km}^3$ ) and its average density is 1.08 grams per cubic centimeter ( $\text{g}/\text{cm}^3$ ). Assuming the hydrosphere consists of pure dihydrogen monoxide, calculate the number of molecules in the Earth's hydrosphere.
25. [6 pts] Calculate the number of oxygen atoms in  $5.00 \times 10^{19}$  molecules of sodium sulfate.
26. [3 pts] The molecular formula for the compound containing 30.4% nitrogen and 69.6% oxygen by mass and having a molar mass of 46 g is \_\_\_\_\_.  
a.  $\text{N}_2\text{O}_4$   
b.  $\text{N}_4\text{O}_2$   
c.  $\text{NO}_2$   
d.  $\text{N}_2\text{O}$   
e.  $\text{NO}$
27. [10 pts] An unknown chemical compound contains 70.62% mercury (Hg), 12.48% chlorine, and 16.90% oxygen. What is the empirical formula of this compound?

28. [4 pts] The molar mass of the compound in the previous problem is 568.1 grams per mole. What is the molecular formula of the compound?

29. [20 pts] Please use the box to the left of each statement to answer T (if the statement is true) or F (if the statement is false) for each of the following statements. Ambiguous letters will be assumed to be incorrect.

	When combined with $H^+$ , anions that end in "-ite" become acids that end in "-ous".
	Phosphorus and nitrogen are in the same family (group) on the periodic table.
	To determine the molar mass of ionic substances, the mass of the electrons gained or lost does not need to be considered.
	The mass of one magnesium atom is greater than 10.0 grams.
	The ionization energy of sulfur is lower than the ionization energy of sodium.
	In general, metals gain electrons more easily than nonmetals.
	Lithium is an alkaline earth metal.
	Argon is isoelectronic with the $Na^+$ ion.
	The empirical formula for sodium oxalate is $NaCO_2$ .
	One mole of carbon dioxide molecules contains the same number of gaseous particles as one mole of argon atoms.

30. [10 pts, plus optional 2 pts] Write the chemical equation for the reaction of sodium phosphate and calcium chloride to produce sodium chloride and calcium phosphate. For extra credit, balance the equation.