

Answer Mesa
 San Diego College
 Key

IA												VIII A					
1 H 1.008	IIA										5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18	
3 Li 6.941	4 Be 9.012											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
11 Na 22.99	12 Mg 24.31	IIIB	IVB	VB	VIB	VIB	VIIIB	VIIIB	VIIIB	IB	II B	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.30
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	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
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	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
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						
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 (cm³)
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
 λ = wavelength
1 Hertz (Hz) = $1 \text{ s}^{-1} = 1/\text{s}$
1 eV = 1.602×10^{-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 = 9.58×10^7 C/kg
Proton charge = 1.60×10^{-19} C.
Mass of electron = 9.1×10^{-31} kg

1 gram = 10 decigrams (dg)
1 gram = 10^2 centigrams (cg)
1 gram = 10^3 milligrams (mg)
1 gram = 10^6 micrograms (μg)
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)

$$K = ^\circ\text{C} + 273$$

1 mole = 6.022×10^{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, mi², and ft² are all units of area:
1 acre = 43,560 square feet (ft²)
1 square mile (mi²) = 640 acres

Answer
Key

Mesa
San Diego College

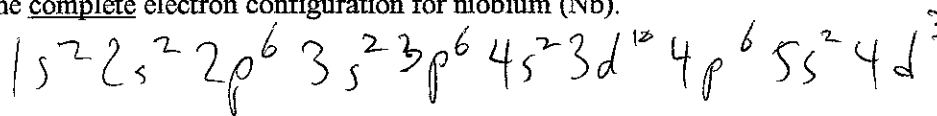
1. [3 pts] The complete electron configuration for manganese is:

- a. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^5$
b. $1s^2 2s^2 2p^6 3s^2$
c. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^5$
d. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$

2. [3 pts] The abbreviated electron configuration for gallium is:

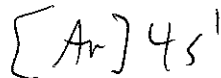
- a. $[Ar] 4s^2 3d^{10} 4p^1$
b. $[Ar] 4s^2 3d^{10} 4p^2$
c. $[Kr] 4s^2 3d^{10} 4p^1$
d. $[Kr] 4s^2 3d^{10} 4p^2$

3. [3 pts] Write the complete electron configuration for niobium (Nb).



① sequence
② $4e^-$
③ ending

4. [3 pts] Write the abbreviated electron configuration for potassium.



① Noble gas
② ending
③ $4e^-$

5. [3 pts] Which element has the larger atomic radius, Mg or Al? (Circle the correct answer.)

6. [3 pts] Which element has the smaller ionization energy, O or S? (Circle the correct answer.)

7. [3 pts] A liter is approximately equal to

- a. one gallon
b. one quart
c. one fluid ounce
d. one pint

8. [3 pts] What is the mass in grams of 25 cm^3 of benzene (C_6H_6) if its density is 0.88 g/cm^3 ?

- a. 16 g
b. 28 g
c. 0.035 g
d. 22 g

$25 \text{ cm}^3 \times \left(\frac{0.88 \text{ g}}{1 \text{ cm}^3} \right) =$

9. [3 pts] You are told to use some sodium bromide. The bottle is labeled with the formula only. Circle the correct formula.

SBr₂

Na₃B

S₃B₂

NaBr

10. [6 pts] How many protons, neutrons, and electrons are in a particle with the following isotopic symbols:

$^{92}_{42}\text{Mo}^{2+}$

Protons =

42

Neutrons =

50

Electrons =

40

① each

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

- 20
- a. Hypochlorous acid HClO (4 each)
 - b. Hydrosulfuric acid H_2S
 - c. Copper (I) phosphate Cu_3PO_4
 - d. Dinitrogen tetraoxide N_2O_4
 - e. Cobalt (III) acetate $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_3$

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

- 20
- a. K_2SO_4 potassium sulfate (4 each)
 - b. P_2O_4 diphosphorus tetraoxide
 - c. $(\text{NH}_4)_3\text{PO}_3$ ammonium phosphite
 - d. FeS iron (II) sulfide
 - e. NaOH sodium hydroxide

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

8
5 a. Use unit conversions to calculate the molar mass of the element in grams per mole.

$$\left(\frac{3.818 \times 10^{-23} \text{ g}}{1 \text{ atom}} \right) \left(\frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mole}} \right) = 22.99$$

- 1 b. Write the name of the element. sodium
- 1 c. Write the atomic symbol of the element. Na
- 1 d. Write the atomic number of the element. 11

1 Ans
1 SF
1 units
(11)

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

28

Complete Isotopic Symbol	Element Name	Number of protons	Number of neutrons	Number of electrons
${}_{19}^{35}\text{K}^+$	Potassium	19	16	18
${}_{23}^{59}\text{V}$	Vanadium	23	36	23
${}_{10}^{21}\text{Ne}^-$	neon	10	11	11

$5 \times 2 = 10$

$4 \times 2 = 8$

$5 \times 2 = 10$

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?

$$\frac{(70.00\%) (6.015 \text{ g/mol}) + (30.00\%) (7.016 \text{ g/mol})}{(100.00\%)}$$

$$= 6.315 \text{ g/mol}$$

AW
 SF

16. [3 pts] An electron moving within an atom from the $n=3$ level to the $n=2$ level is

- a. Absorbing energy.
- b. Emitting energy.
- c. Falling back to the ground state.
- d. 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:

- a. Gain 1 electron
- b. Gain 2 electrons
- c. Gain 3 electrons
- d. Lose 1 electron
- e. Lose 2 electrons
- f. Lose 3 electrons

40

3
D
18. [3 pts] Two atoms with same number of protons, but a different number of neutrons are ____.

- a. Elements
- b. Ions
- c. Allotropes
- d. Isotopes
- e. Families

3
B
19. [3 pts] Two atoms with same number of protons, but a different number of electrons are ____.

- a. Elements
- b. Ions
- c. Allotropes
- d. Isotopes
- e. Families

3
C
20. [3 pts] J. J. Thompson devised the plum-pudding model of the atom to accommodate which newly-discovered subatomic particle?

- a. Neutron
- b. Proton
- c. Electron
- d. Alpha particle
- e. Positron

3
B
21. ³⁸⁹[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:

- a. The ability to transform atoms of any element into gold.
- b. A dense, positively-charged nucleus at the atom's center.
- c. Electrons embedded in a positively-charged matrix.
- d. Electrons orbiting the nucleus in shells at specific energies.
- e. Orbitals of various shapes, grouped into sublevels at specific energy levels.

6
22. [6 pts] Calculate the mass of 5.00 moles of $(\text{NH}_4)_3\text{PO}_4$. — Molar mass = 14.01×3
 $+ 1.008 \times 12$
 $+ 30.97$
 $+ 16.00 \times 4$
 $\underline{\hspace{1cm}}$
 149.096 g/mol

$5.00 \text{ mol} \left(\frac{149.096 \text{ g}}{1 \text{ mol}} \right) = \boxed{745 \text{ g}}$

Ans
 SF
 Units

6
23. [6 pts] Calculate the mass percent of nitrogen in $(\text{NH}_4)_3\text{PO}_4$.

$\% \text{ N} = \frac{(14.01 \times 3)}{(149.096)} \times 100 = \boxed{28.197\%}$

Ans
 SF

12 24 [12 pts] The total volume of the Earth's hydrosphere (oceans, lakes, rivers, etc.) is 1.4×10^9 cubic kilometers (km^3) and its average density is 1.08 grams per cubic centimeter (g/cm^3). Assuming the hydrosphere consists of pure dihydrogen monoxide, calculate the number of molecules in the Earth's hydrosphere.

Plan: $\text{km}^3 \rightarrow \text{m}^3 \rightarrow \text{cm}^3 \rightarrow \text{g} \rightarrow \text{mol} \rightarrow \text{molecules}$

① Molar mass $\text{H}_2\text{O} = (1.008 \times 2) + 16.00 = 18.02 \text{ g/mol}$

① $1.4 \times 10^9 \text{ km}^3 \left(\frac{1000 \text{ m}}{1 \text{ km}} \right)^3 \left(\frac{100 \text{ cm}}{1 \text{ m}} \right)^3 \left(\frac{1.08 \text{ g}}{1 \text{ cm}^3} \right) \left(\frac{1 \text{ mol}}{18.02 \text{ g}} \right) \left(6.022 \times 10^{23} \frac{\text{molecules}}{1 \text{ mol}} \right) = 5.1 \times 10^{46} \text{ molecules}$

Ans ①
 SF ①

6 25 [6 pts] Calculate the number of oxygen atoms in 5.00×10^{19} molecules of sodium sulfate.

① $5.00 \times 10^{19} \text{ molecules Na}_2\text{SO}_4 \times \left(\frac{4 \text{ atoms O}}{1 \text{ molecule}} \right) = 2.00 \times 10^{20} \text{ atoms O}$

① SF

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 _____. Assume 100g

- a. N_2O_4
- b. N_4O_2
- c. NO_2
- d. N_2O
- e. NO

$30.4 \text{ g N} \left(\frac{1 \text{ mol N}}{14.01 \text{ g}} \right) = 2.1699 / 2.1699 = 1$

$69.6 \text{ g O} \left(\frac{1 \text{ mol O}}{16.00 \text{ g}} \right) = 4.350 / 2.1699 = 2$

NO_2

$\frac{14.01 + 16.00 \times 2}{46.01 \text{ g/mol}}$

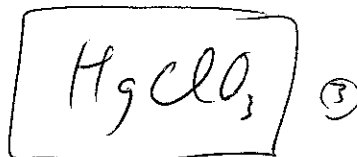
10 27. [10 pts] An unknown chemical compound contains 70.62% mercury (Hg), 12.48% chlorine, and 16.90% oxygen. What is the empirical formula of this compound?

Assume 100g

$70.62 \text{ g Hg} \times \left(\frac{1 \text{ mol Hg}}{200.6 \text{ g}} \right) = .3520 \text{ mol Hg} / .3520 = 1$

$12.48 \text{ g Cl} \times \left(\frac{1 \text{ mol Cl}}{35.45 \text{ g}} \right) = .3520 \text{ mol Cl} / .3520 = 1$

$16.90 \text{ g O} \times \left(\frac{1 \text{ mol O}}{16.00 \text{ g}} \right) = 1.056 \text{ mol O} / .3520 = 3.0007$



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?

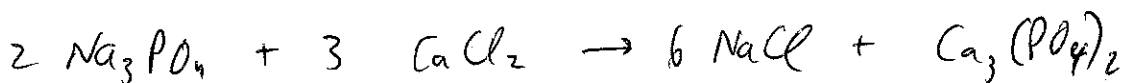
$HgClO_3 \rightarrow 200.6$ (1) (2)
 35.45
 3×16.00 ~~16.00~~
 $284.05 g/mol$
 $\frac{568.1}{284} = 2$
 Hg_2ClO_6

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.

② each x 10

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



$PO_4^{3-} = 2$

$Cl^- = 2$

$Na^+ = 1$

$Ca^{2+} = 1$

$Box 1 = 2$

subscript + 1 = 4

~~scribbles~~