Chemistry Practice
Placement Exam

Choose the best possible answer for each question. This is *not* the placement exam, but it gives you an idea of the kind of questions one can expect in the exam.

1. Expressed in μL, the volume 6.35×10^{-4} L is:
   a. 63.5
   b. 6.35
   c. 635.
   d. 0.635
   e. 0.00635
2. Expressed in scientific notation, the number 1234567890 is:
   a. $1.234567890 \times 10^{9}$
   b. $1.234567890 \times 10^{8}$
   c. $1.234567890 \times 10^{10}$
   d. 1.23456789×10^{9}
   e. 1.23456789×10^{8}
3. Expressed in mm^3, the volume 4.23×10^{-9} m^3 is:
   a. 4.23
   b. 42.3
   c. 423.
   d. 0.423
   e. 0.0423
4. If the density of a substance is 1.43 lb/ft^3, the mass of 4.35 in^3 of the substance in *grams* is: [1 *ft* = 12 *in*; 1 *lb* = 453.59 *g*]
   a. 235.13
   b. 12.43
   c. 23.70
   d. 1.63
   e. 1.25
5. Simplified, the expression $(8.9 \times 10^5 \div 2.348 \times 10^2) + 121$ is:
   a. 3911.46
   b. 3900
   c. 3910
   d. 3911
   e. 3911.5
6. Rounded to four significant figures, the number 0.009650901 becomes:
   a. 0.009650
   b. 0.00965
   c. 0.0097
   d. 0.009651
   e. 0.0096509

7. Consider the following list of substances and classify each of them as an element (E), a compound (C), a homogeneous mixture (HM), or a heterogeneous mixture (HTM): Apple juice, Chocolate Sundae, Baking Soda (Sodium hydrogen carbonate), Sulfur, Clean Air.
    a. C, HM, C, E, HTM
    b. HM, HM, C, E, HTM
    c. HM, HTM, C, E, HM
    d. HM, HTM, C, E, HTM
    e. C, HTM, C, E, HM
8. Classify the following three processes as physical or chemical changes: flammability of propane gas, volatility of liquid propane, compression of gaseous propane into a liquid.
    a. Physical, Chemical, Physical
    b. Chemical, Physical, Chemical
    c. Chemical, Chemical, Physical
    d. Chemical, Physical, Physical
    e. Physical, Physical, Chemical
9. An energy bill indicates that the customer used 955 kWh in November. How many joules did the customer use? [1 kWh = 3.60×10^6 J]
    a. 3.44×10^9
    b. 3.44×10^{-9}
    c. 3.44×10^3
    d. 3.44×10^{-3}
    e. 2.65×10^8
10. What is the temperature change in 500 *mL* of water when it absorbs 25 *kJ* of heat? [Specific heat capacity of water = 4.18 *J/g-°C*; Density of water = 1.0 *g/cc*.]
    a. 11°C
    b. 12°C
    c. 210°C
    d. 4.8°C
    e. 0.21°C
11. In iceboxes, ice is used to cool drinks. This is accomplished because ice melts, absorbing heat from the drink. When ice melts, it absorbs 0.33 *kJ* per gram. How much ice is required to cool a 12.0-*oz* drink from 75°F to 35°F, if the heat capacity of the drink is 4.18 *J/g*-°C? (Assume that heat transfer is 100% efficient; 1 *oz* = 28.35 *g*)
    a. 1.97 *g*
    b. 0.84 *g*
    c. 671. *g*
    d. 18. 7 *kg*
    e. 19.2 *g*
12. Acetic acid or vinegar, CH_3COOH, is synthesized by the reaction of methanol and carbon monoxide.

    $CH_3OH_{(l)} + CO_{(g)} \rightarrow CH_3COOH_{(l)}$; $\Delta H_{rxn} = -355.9$ kJ/mol CH_3COOH .

    Is this reaction endothermic or exothermic? If the density of the acid is 1.044 *g/mL*, what is the quantity of heat involved in the synthesis of 1.00 *L* of acetic acid?
    a. Endothermic, + 6.19 *MJ*
    b. Exothermic, – 6.19 *MJ*
    c. Endothermic, + 22.29 *kJ*
    d. Exothermic, – 22.29 *kJ*
    e. Endothermic, + 6.19 *J*

13. Gallium has two naturally occurring isotopes: Ga-69 with mass 68.9256 *amu* and a natural abundance of 60.11% and Ga-71 with mass 70.9247 *amu*. Calculate the atomic mass of gallium in *amu*.
    a. 69.72
    b. 70.13
    c. 84.06
    d. 55.79
    e. 72.03
14. How many electrons are present in ${}_{33}As^{3-}$ ion?
    a. 33
    b. 30
    c. 36
    d. 39
    e. 27
15. Rutherford's experiments used a certain kind of particles on gold foil. What were they?
    a. Beta-particles
    b. Gamma-particles
    c. Delta-particles
    d. Alpha-particles
    e. Eta-particles
16. The compound nickel(II) bromate has the formula:
    a. $Ni(BrO_2)_2$
    b. $Ni(BrO_3)_2$
    c. $NiBrO_2$
    d. $NiBrO_3$
    e. Ni_2BrO_3
17. The compound $Pb(SO_4)_2$ is named:
    a. Lead(II) sulfide
    b. Lead(II) sulfate
    c. Lead(IV) sulfate
    d. Lead(IV) sulfite
    e. Lead(II) sulfite
18. The compound $(NH_4)_2CrO_4$ is named:
    a. Ammonia chromate
    b. Ammonia dichromate
    c. Ammonium dichromate
    d. Diammonium chromate
    e. Ammonium chromate
19. The compound SF_6 is named:
    a. Sulfur hexafluoride
    b. Sulfur pentafluoride
    c. Sulfur tetrafluoride
    d. Sulfur fluoride
    e. Sulfide pentafluorine
20. The compound dinitrogen trioxide has the formula:
    a. NO_2
    b. N_2O_6
    c. N_2O_3
    d. N_3O_2
    e. N_3O_6

21. The compound phosphoric acid has the formula:
    a. H_2PO_4
    b. H_2PO_3
    c. H_3PO_3
    d. H_3PO_4
    e. $H_3(PO_4)_2$
22. The compound H_2SO_3 has the name:
    a. Hydrosulfuric acid
    b. Sulfuric acid
    c. Sulfurous acid
    d. Hydrosulfurous acid
    e. Hydrogen sulfite acid
23. What is the sum of the coefficients of the following equation?
    $\_Na_3PO_{4(aq)} + \_Ba(NO_3)_{2(aq)} \rightarrow \_Ba_3(PO_4)_{2(s)} + \_NaNO_{3(aq)}$.
    a. 9
    b. 10
    c. 12
    d. 14
    e. 16
24. The coefficients of the following equation, *a, b,* and *c* have the value:
    $\underline{a}NH_4NO_3 \rightarrow \underline{b}N_2O + \underline{c}H_2O$
    a. 1, 2, 2
    b. 1, 1, 2
    c. 2, 1, 2
    d. 2, 1, 1
    e. 1, 1, 1
25. The sum of the coefficients of the following equation, *a, b, c,* and *d* have the value:
    $\underline{a}NH_{3(g)} + \underline{b}O_{2(g)} \rightarrow \underline{c}NO_{(g)} + \underline{d}H_2O_{(g)}$
    a. 4, 5, 5, 6
    b. 4, 5, 4, 6
    c. 4, 4, 4, 6
    d. 6, 5, 6, 9
    e. 6, 5, 6, 8
26. The sum of the coefficients of the following reaction is:
    $\_Fe^{3+}{}_{(aq)} + \_SO_{2(g)} + \_H_2O_{(l)} \rightarrow \_Fe^{2+}{}_{(aq)} + \_H_3O^{+}{}_{(aq)} + \_SO_4^{2-}{}_{(aq)}$
    a. 15
    b. 13
    c. 14
    d. 12
    e. 16
27. Acidified water (due to acid rain, primarily nitric acid) is neutralized by a process called *liming*, which is the addition of limestone (calcium carbonate) to water. The sum of the coefficients of the balanced molecular equation of this reaction is:
    a. 6
    b. 5
    c. 4
    d. 7
    e. 8

28. Combustion of hexane (C_6H_{14}) in air (O_2) results in the formation of carbon dioxide and water. The sum of the coefficients of the balanced chemical equation depicting this reaction is:
    a. 33
    b. 45
    c. 31
    d. 35
    e. 47
29. What are the products when aqueous solutions containing 2 moles of hydroiodic acid and 1 mole of barium hydroxide are mixed with each other?
    a. 1 mole of water and 1 mole of aqueous BaI
    b. 1 mole of water and 1 mole of solid BaI_2
    c. 2 moles of water and 1 mole of aqueous BaI_2
    d. 1 mole of water and 1 mole of aqueous BaI_2
    e. 2 moles of water and 1 mole of solid BaI
30. What is the balanced net ionic equation when aqueous solutions of sodium phosphate and copper(II) chloride are mixed?
    a. $Cu^{2+}{}_{(aq)} + PO_4^{2-}{}_{(aq)} \rightarrow CuPO_{4(s)}$
    b. $2Cu^{+}{}_{(aq)} + PO_3^{2-}{}_{(aq)} \rightarrow 2(Cu)PO_{3(s)}$
    c. $3Cu^{2+}{}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow 3(Cu)2(PO_4)_{(s)}$
    d. $2Cu^{2+}{}_{(aq)} + 3PO_4^{3-}{}_{(aq)} \rightarrow Cu_2(PO_4)_{3(s)}$
    e. $3Cu^{2+}{}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Cu_3(PO_4)_{2(s)}$
31. What is the balanced net ionic equation when aqueous hydrobromic acid is mixed with potassium hydrogen sulfite?
    a. $H^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow H_2SO_{3(l)}$
    b. $H^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow H_{2(g)} + SO_{3(g)}$
    c. $H^{+}{}_{(aq)} + HSO_4^{-}{}_{(aq)} \rightarrow H_2O_{(l)} + SO_{3(g)}$
    d. $H_3O^{+}{}_{(aq)} + HSO_4^{-}{}_{(aq)} \rightarrow H_2O_{(l)} + SO_{3(g)}$
    e. $H_3O^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow 2H_2O_{(l)} + SO_{2(g)}$
32. Consider the reaction:
    $2K_{(s)} + Br_{2(l)} \rightarrow 2KBr_{(s)}$
    Which of the species is oxidized, and which is reduced? Answers are shown as (oxidized species, reduced species).
    a. K, Br_2
    b. KBr, Br_2
    c. K, KBr
    d. KBr, K
    e. Br_2, K
33. Classify the following reaction:
    $Ca(s) + 2\ HF(aq) \rightarrow CaF_2(s) + H_2(g)$
    a. Precipitation
    b. Acid-base
    c. Redox
    d. Decarbonation
    e. Fulmination

34. A solution contains one or more of the following ions: Ag^+, Ca^{2+}, and Cu^{2+}. When sodium chloride is added to the solution, no precipitate occurs. When sodium sulfate is added to the solution, a white precipitate occurs. The precipitate is filtered off and sodium carbonate is added to the remaining solution, producing a precipitate. Which ions were present in the original solution?
    a. Ag^+ and Ca^{2+}
    b. Ca^{2+} and Cu^{2+}
    c. Ag^+ and Cu^{2+}
    d. All three of them
    e. None of them
35. How many moles of O are present in 5.00 *g* of tin(IV) oxide?
    a. 0.066
    b. 0.033
    c. 0.074
    d. 0.037
    e. 0.017
36. How many *g* of Cl are present in 4.35 *mol* of $Ca(ClO_2)_2$?
    a. 154.
    b. 1.76
    c. 308.
    d. 42.9
    e. 2.27
37. A laboratory analysis of vanillin, the flavoring agent of vanilla, determined the following mass percent composition of: 63.15% C, 5.30% H, and the rest O. If the molar mass of vanillin is 152.16 *g/mol*, the molecular formula for vanillin is:
    a. $C_{10}H_{16}O$
    b. $C_7H_4O_4$
    c. $C_5H_{12}O_5$
    d. $C_9H_{12}O_2$
    e. $C_8H_8O_3$
38. How many atoms does 7.8 *g* of W contain?
    a. 2.6×10^{23}
    b. 2.4×10^{25}
    c. 7.0×10^{20}
    d. 1.6×10^{22}
    e. 2.4×10^{23}
39. A mothball, composed of naphthalene ($C_{10}H_8$), has a mass of 1.32 *g*. How many atoms of H does it contain?
    a. 4.96×10^{22}
    b. 6.20×10^{21}
    c. 1.61×10^{24}
    d. 5.85×10^{25}
    e. 6.20×10^{22}
40. Iron is found in earth's crust as the ore siderite (iron(II) carbonate). What is the mass in kilograms of the amount of siderite that contains 1.0×10^3 *kg* of iron?
    a. 960
    b. 2100
    c. 480
    d. 6500
    e. 1000

<u>The following *five* questions concern the synthesis of ammonia:</u>

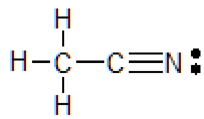
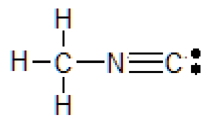
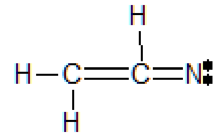
Ammonia is synthesized in a gas-phase process involving the reaction of nitrogen monoxide with hydrogen gas. The reaction also releases water vapor as a by-product.

41. What is the sum of the coefficients of the balanced chemical equation representing the process?
    a. 9
    b. 10
    c. 11
    d. 12
    e. 13
42. How many moles of ammonia can be synthesized from 6.0 *mol* of hydrogen gas?
    a. 2.0
    b. 2.4
    c. 1.7
    d. 15.0
    e. 4.0
43. How many grams of ammonia can be synthesized from 15.0 *g* of nitrogen monoxide?
    a. 26.4
    b. 2.6
    c. 136.4
    d. 13.6
    e. 8.5
44. If 45.8 *g* of nitrogen monoxide and 12.4 *g* of hydrogen are mixed together, which is the limiting reactant, and what is the theoretical yield of ammonia in grams?
    a. Hydrogen, 26.0
    b. Nitrogen monoxide, 26.0
    c. Hydrogen, 41.8
    d. Nitrogen monoxide, 41.8
    e. None of the above
45. If the actual yield of ammonia is 19.0 *g*, what is the percentage yield (in %)?
    a. 160.8
    b. 45.5
    c. 136.8
    d. 73.1
    e. 63.4

<u>Questions 46 and 47 are related to each other</u>.

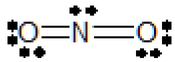
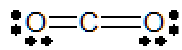
46. For mines, if the oxygen supply becomes limited or if the air becomes toxic, a worker can use an emergency breathing apparatus to breathe while exiting the mine. The reaction involves potassium superoxide (KO_2), and produces O_2, and absorbs CO_2, a product of respiration.
$$4KO_{2(s)} + 2CO_{2(g)} \rightarrow 2K_2CO_{3(s)} + 3O_{2(g)}$$
What minimum amount (in *grams*) of KO_2 is required for the apparatus to produce enough oxygen to allow the user to breath for 15 minutes? Assume approximately 5.00 *mg* of oxygen per second of normal breathing?
    a. 0.22
    b. 1.52
    c. 2.03
    d. 3.04
    e. 13.3
47. How much potassium carbonate (in *grams*) is accumulated in the filter at the end of 15 minutes?
    a. 19.0 b. 3.09 c. 13.0 d. 4.12 e. 26.8

48. The Lewis structure of C_2H_3N is:

a.  b.  c. 

d. a and *c* *e. a* and *b*

49. Which of the following Lewis structures are acceptable?

a.  b.  c. 

d. b and *c* only e. *a, b,* and *c*

50. What is the molecular geometry (shape) of N_2O?

a. Trigonal Planar
b. Bent
c. Linear
d. Tetrahedral
e. Trigonal Pyramidal

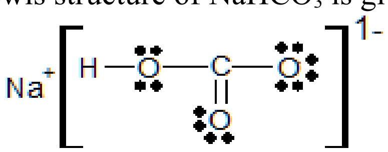
51. Which of the molecules are non-polar? I) H_2O II) NH_2OH III) CCl_4

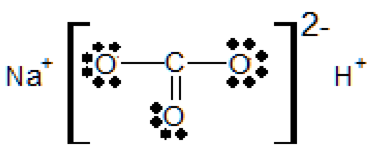
a. I only
b. II only
c. III only
d. I and II only
e. All of them are polar

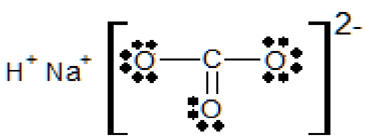
52. The shape of the molecule, $H_3C–O–CH_3$. , around each central atom is given by:

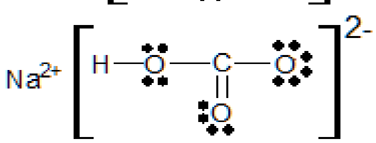
a. Tetrahedral, tetrahedral, tetrahedral
b. Bent, tetrahedral, bent
c. Trigonal Planar, bent, Trigonal planar
d. Tetrahedral, bent, tetrahedral
e. Bent, bent, bent

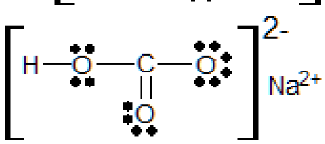
53. The Lewis structure of $NaHCO_3$ is given by:

a. 

b. 

c. 

d. 

e. 

54. Aluminum metal reacts with oxygen gas to form aluminum oxide. How many moles of aluminum oxide can be produced from 5.00 *mol* O_2?
    a. 10.0
    b. 7.50
    c. 3.33
    d. 1.67
    e. None of the above
55. The formula for aluminum oxide is:
    a. AlO
    b. AlO_2
    c. Al_2O
    d. AlO_3
    e. Al_2O_3
56. What is the symbol of the metal potassium?
    a. P
    b. Os
    c. K
    d. Pt
    e. As
57. What is the formula of methane?
    a. CO_3
    b. CH_2
    c. CH_3
    d. CH_4
    e. None of the above
58. Which of the following statements are inconsistent with Dalton's atomic theory?
    a. All carbon atoms are identical.
    b. An oxygen atom combines with 1.5 hydrogen atoms to form a water molecule.
    c. Two oxygen atoms combine with a carbon atom to form a carbon dioxide molecule.
    d. Carbon and nitrogen have different sizes.
    e. Helium can be split into two hydrogen atoms.
59. How many grams of N and O are present in 4.55 *g* of dinitrogen monoxide?
    a. 1.65, 2.90
    b. 1.52, 3.03
    c. 3.03, 1.52
    d. 2.90, 1.65
    e. None of the above
60. What are the name and formula of the compound formed between indium and nitrate ion?
    a. Indium nitrate, $In(NO_3)$
    b. Indium(III) nitrate, $In_3(NO_3)$
    c. Indium nitrate, $In(NO_3)_2$
    d. Indium(III) nitrate, $In(NO_3)_3$
    e. None of the above

Periodic Table of the Elements

Speed of light, c = 2.99792458 × 10^{8} m/s
Planck's Constant, h = 6.626069 × 10^{-34} J•s
Avogadro's Number = 6.022142 × 10^{23} particles/mol

IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIIIB			IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 **H** 1.0079																	2 **He** 4.002602
3 **Li** 6.941	4 **Be** 9.012182											5 **B** 10.81	6 **C** 12.011	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.998403	10 **Ne** 20.180
11 **Na** 22.9897693	12 **Mg** 24.305											13 **Al** 26.981539	14 **Si** 28.0855	15 **P** 30.973762	16 **S** 32.06	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.0983	20 **Ca** 40.08	21 **Sc** 44.95591	22 **Ti** 47.867	23 **V** 50.9415	24 **Cr** 51.996	25 **Mn** 54.93804	26 **Fe** 55.845	27 **Co** 58.93320	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.90585	40 **Zr** 91.224	41 **Nb** 92.90638	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.90550	46 **Pd** 106.42	47 **Ag** 107.8682	48 **Cd** 112.41	49 **In** 114.818	50 **Sn** 118.71	51 **Sb** 121.760	52 **Te** 127.60	53 **I** 126.90447	54 **Xe** 131.29
55 **Cs** 132.905452	56 **Ba** 137.33	57 **La*** 138.9055	72 **Hf** 178.49	73 **Ta** 180.94788	74 **W** 183.84	75 **Re** 186.207	76 **Os** 190.23	77 **Ir** 192.217	78 **Pt** 195.08	79 **Au** 196.966567	80 **Hg** 200.59	81 **Tl** 204.3833	82 **Pb** 207.2	83 **Bi** 208.98040	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac†** (227)	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (272)	107 **Bh** (273)	108 **Hs** (276)	109 **Mt** (279)	110 **Ds** (281)	111 **Rg** (273)	112 **Cn** (285)	113 (287)	114 (289)	115 (291)	116 (292)		118 (294)

*	58 **Ce** 140.116	59 **Pr** 140.90765	60 **Nd** 144.242	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.964	64 **Gd** 157.25	65 **Tb** 158.92535	66 **Dy** 162.500	67 **Ho** 164.93032	68 **Er** 167.259	69 **Tm** 168.93421	70 **Yb** 173.05	71 **Lu** 174.9668
†	90 **Th** 232.03806	91 **Pa** 231.03588	92 **U** 238.02891	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** (261	103 **Lr** (264

2007-09

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1. Expressed in μL, the volume 6.35×10^{-4} L is:
   a. 63.5
   b. 6.35
   c. 635.
   d. 0.635
   e. 0.00635
2. Expressed in scientific notation, the number 1234567890 is:
   a. 1.234567890×10^9
   b. 1.234567890×10^8
   c. $1.234567890 \times 10^{10}$
   d. 1.23456789×10^9
   e. 1.23456789×10^8
3. Expressed in mm^3, the volume 4.23×10^{-9} m^3 is:
   a. 4.23
   b. 42.3
   c. 423.
   d. 0.423
   e. 0.0423
4. If the density of a substance is 1.43 lb/ft^3, the mass of 4.35 in^3 of the substance in *grams* is: [1 *ft* = 12 *in*; 1 *lb* = 453.59 *g*]
   a. 235.13
   b. 12.43
   c. 23.70
   d. 1.63
   e. 1.25
5. Simplified, the expression $(8.9 \times 10^5 \div 2.348 \times 10^2) + 121$ is:
   a. 3911.46
   b. 3900
   c. 3910
   d. 3911
   e. 3911.5
6. Rounded to four significant figures, the number 0.009650901 becomes:
   a. 0.009650
   b. 0.00965
   c. 0.0097
   d. 0.009651
   e. 0.0096509

7. Consider the following list of substances and classify each of them as an element (E), a compound (C), a homogeneous mixture (HM), or a heterogeneous mixture (HTM): Apple juice, Chocolate Sundae, Baking Soda (Sodium hydrogen carbonate), Sulfur, Clean Air.
   a. C, HM, C, E, HTM
   b. HM, HM, C, E, HTM
   c. HM, HTM, C, E, HM
   d. HM, HTM, C, E, HTM
   e. C, HTM, C, E, HM
8. Classify the following three processes as physical or chemical changes: flammability of propane gas, volatility of liquid propane, compression of gaseous propane into a liquid.
   a. Physical, Chemical, Physical
   b. Chemical, Physical, Chemical
   c. Chemical, Chemical, Physical
   d. Chemical, Physical, Physical
   e. Physical, Physical, Chemical
9. An energy bill indicates that the customer used 955 kWh in November. How many joules did the customer use? [1 kWh = 3.60×10^6 J]
   a. 3.44×10^9
   b. 3.44×10^{-9}
   c. 3.44×10^3
   d. 3.44×10^{-3}
   e. 2.65×10^8
10. What is the temperature change in 500 *mL* of water when it absorbs 25 *kJ* of heat? [Specific heat capacity of water = 4.18 *J/g-°C*; Density of water = 1.0 *g/cc*.]
    a. 11°C
    b. 12°C
    c. 210°C
    d. 4.8°C
    e. 0.21°C
11. In iceboxes, ice is used to cool drinks. This is accomplished because ice melts, absorbing heat from the drink. When ice melts, it absorbs 0.330 *kJ* per gram. How much ice is required to cool a 12.0-*oz* drink from 75.0°F to 35.0°F, if the heat capacity of the drink is 4.18 *J/g*-°C? (Assume that heat transfer is 100% efficient; 1 *oz* = 28.35 *g*)
    a. 1.97 *g*
    b. 95.8 *g*
    c. 671. *g*
    d. 310. *g*
    e. 19.2 *g*
12. Acetic acid or vinegar, CH_3COOH, is synthesized by the reaction of methanol and carbon monoxide.

    $$CH_3OH_{(l)} + CO_{(g)} \rightarrow CH_3COOH_{(l)}; \qquad \Delta H_{rxn} = -\ 355.9 \text{ kJ/mol } CH_3COOH\ .$$

    Is this reaction endothermic or exothermic? If the density of the acid is 1.044 *g/mL*, what is the quantity of heat involved in the synthesis of 1.00 *L* of acetic acid?
    a. Endothermic, + 6.19 *MJ*
    b. Exothermic, – 6.19 *MJ*
    c. Endothermic, + 22.29 *kJ*
    d. Exothermic, – 22.29 *kJ*
    e. Endothermic, + 6.19 *J*

13. Gallium has two naturally occurring isotopes: Ga-69 with mass 68.9256 *amu* and a natural abundance of 60.11% and Ga-71 with mass 70.9247 *amu*. Calculate the atomic mass of gallium in *amu*.
    a. 69.72
    b. 70.13
    c. 84.06
    d. 55.79
    e. 72.03
14. How many electrons are present in ${}_{33}As^{3-}$ ion?
    a. 33
    b. 30
    c. 36
    d. 39
    e. 27
15. Rutherford's experiments used a certain kind of particles on gold foil. What were they?
    a. Beta-particles
    b. Gamma-particles
    c. Delta-particles
    d. Alpha-particles
    e. Eta-particles
16. The compound nickel(II) bromate has the formula:
    a. $Ni(BrO_2)_2$
    b. $Ni(BrO_3)_2$
    c. $NiBrO_2$
    d. $NiBrO_3$
    e. Ni_2BrO_3
17. The compound $Pb(SO_4)_2$ is named:
    a. Lead(II) sulfide
    b. Lead(II) sulfate
    c. Lead(IV) sulfate
    d. Lead(IV) sulfite
    e. Lead(II) sulfite
18. The compound $(NH_4)_2CrO_4$ is named:
    a. Ammonia chromate
    b. Ammonia dichromate
    c. Ammonium dichromate
    d. Diammonium chromate
    e. Ammonium chromate
19. The compound SF_6 is named:
    a. Sulfur hexafluoride
    b. Sulfur pentafluoride
    c. Sulfur tetrafluoride
    d. Sulfur fluoride
    e. Sulfide pentafluorine
20. The compound dinitrogen trioxide has the formula:
    a. NO_2
    b. N_2O_6
    c. N_2O_3
    d. N_3O_2
    e. N_3O_6

21. The compound phosphoric acid has the formula:
    a. H_2PO_4
    b. H_2PO_3
    c. H_3PO_3
    d. H_3PO_4
    e. $H_3(PO_4)_2$
22. The compound H_2SO_3 has the name:
    a. Hydrosulfuric acid
    b. Sulfuric acid
    c. Sulfurous acid
    d. Hydrosulfurous acid
    e. Hydrogen sulfite acid
23. What is the sum of the coefficients of the following equation?
    $\_Na_3PO_{4(aq)} + \_Ba(NO_3)_{2(aq)} \rightarrow \_Ba_3(PO_4)_{2(s)} + \_NaNO_{3(aq)}$.
    a. 9
    b. 10
    c. 12
    d. 14
    e. 16
24. The coefficients of the following equation, *a, b,* and *c* have the value:
    $\underline{a}NH_4NO_3 \rightarrow \underline{b}N_2O + \underline{c}H_2O$
    a. 1, 2, 2
    b. 1, 1, 2
    c. 2, 1, 2
    d. 2, 1, 1
    e. 1, 1, 1
25. The sum of the coefficients of the following equation, *a, b, c,* and *d* have the value:
    $\underline{a}NH_{3(g)} + \underline{b}O_{2(g)} \rightarrow \underline{c}NO_{(g)} + \underline{d}H_2O_{(g)}$
    a. 4, 5, 5, 6
    b. 4, 5, 4, 6
    c. 4, 4, 4, 6
    d. 6, 5, 6, 9
    e. 6, 5, 6, 8
26. The sum of the coefficients of the following reaction is:
    $\_Fe^{3+}{}_{(aq)} + \_SO_{2(g)} + \_H_2O_{(l)} \rightarrow \_Fe^{2+}{}_{(aq)} + \_H_3O^{+}{}_{(aq)} + \_SO_4{}^{2-}{}_{(aq)}$
    a. 15
    b. 13
    c. 14
    d. 12
    e. 16
27. Acidified water (due to acid rain, primarily nitric acid) is neutralized by a process called *liming*, which is the addition of limestone (calcium carbonate) to water. The sum of the coefficients of the balanced molecular equation of this reaction is:
    a. 6
    b. 5
    c. 4
    d. 7
    e. 8

28. Combustion of hexane (C_6H_{14}) in air (O_2) results in the formation of carbon dioxide and water. The sum of the coefficients of the balanced chemical equation depicting this reaction is:
    a. 33
    b. 45
    c. 31
    d. 35
    e. 47
29. What are the products when aqueous solutions containing 2 moles of hydroiodic acid and 1 mole of barium hydroxide are mixed with each other?
    a. 1 mole of water and 1 mole of aqueous BaI
    b. 1 mole of water and 1 mole of solid BaI_2
    c. 2 moles of water and 1 mole of aqueous BaI_2
    d. 1 mole of water and 1 mole of aqueous BaI_2
    e. 2 moles of water and 1 mole of solid BaI
30. What is the balanced net ionic equation when aqueous solutions of sodium phosphate and copper(II) chloride are mixed?
    a. $Cu^{2+}{}_{(aq)} + PO_4^{2-}{}_{(aq)} \rightarrow CuPO_{4(s)}$
    b. $2Cu^{+}{}_{(aq)} + PO_3^{2-}{}_{(aq)} \rightarrow 2(Cu)PO_{3(s)}$
    c. $3Cu^{2+}{}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow 3(Cu)2(PO_4)_{(s)}$
    d. $2Cu^{2+}{}_{(aq)} + 3PO_4^{3-}{}_{(aq)} \rightarrow Cu_2(PO_4)_{3(s)}$
    e. $3Cu^{2+}{}_{(aq)} + 2PO_4^{3-}{}_{(aq)} \rightarrow Cu_3(PO_4)_{2(s)}$ ☼
31. What is the balanced net ionic equation when aqueous hydrobromic acid is mixed with potassium hydrogen sulfite?
    a. $H^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow H_2SO_{3(l)}$
    b. $H^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow H_{2(g)} + SO_{3(g)}$
    c. $H^{+}{}_{(aq)} + HSO_4^{-}{}_{(aq)} \rightarrow H_2O_{(l)} + SO_{3(g)}$
    d. $H_3O^{+}{}_{(aq)} + HSO_4^{-}{}_{(aq)} \rightarrow H_2O_{(l)} + SO_{3(g)}$
    e. $H_3O^{+}{}_{(aq)} + HSO_3^{-}{}_{(aq)} \rightarrow 2H_2O_{(l)} + SO_{2(g)}$ ☼
32. Consider the reaction:
    $2K_{(s)} + Br_{2(l)} \rightarrow 2KBr_{(s)}$
    Which of the species is oxidized, and which is reduced? Answers are shown as (oxidized species, reduced species).
    a. K, Br_2
    b. KBr, Br_2
    c. K, KBr
    d. KBr, K
    e. Br_2, K
33. Classify the following reaction:
    $Ca(s) + 2\ HF(aq) \rightarrow CaF_2(s) + H_2(g)$
    a. Precipitation
    b. Acid-base
    c. Redox
    d. Decarbonation
    e. Fulmination

34. A solution contains one or more of the following ions: Ag^{+}, Ca^{2+}, and Cu^{2+}. When sodium chloride is added to the solution, no precipitate occurs. When sodium sulfate is added to the solution, a white precipitate occurs. The precipitate is filtered off and sodium carbonate is added to the remaining solution, producing a precipitate. Which ions were present in the original solution?
    a. Ag^{+} and Ca^{2+}
    b. Ca^{2+} and Cu^{2+}
    c. Ag^{+} and Cu^{2+}
    d. All three of them
    e. None of them
35. How many moles of O are present in 5.00 *g* of tin(IV) oxide?
    a. 0.066
    b. 0.033
    c. 0.074
    d. 0.037
    e. 0.017
36. How many *g* of Cl are present in 4.35 *mol* of $Ca(ClO_2)_2$?
    a. 154.
    b. 1.76
    c. 308.
    d. 42.9
    e. 2.27
37. A laboratory analysis of vanillin, the flavoring agent of vanilla, determined the following mass percent composition of: 63.15% C, 5.30% H, and the rest O. If the molar mass of vanillin is 152.16 *g/mol*, the molecular formula for vanillin is:
    a. $C_{10}H_{16}O$
    b. $C_7H_4O_4$
    c. $C_5H_{12}O_5$
    d. $C_9H_{12}O_2$
    e. $C_8H_8O_3$
38. How many atoms does 7.8 *g* of W contain?
    a. 2.6×10^{23}
    b. 2.4×10^{25}
    c. 7.0×10^{20}
    d. 1.6×10^{22}
    e. 2.4×10^{23}
39. A mothball, composed of naphthalene ($C_{10}H_8$), has a mass of 1.32 *g*. How many atoms of H does it contain?
    a. 4.96×10^{22}
    b. 6.20×10^{21}
    c. 1.61×10^{24}
    d. 5.85×10^{25}
    e. 6.20×10^{22}
40. Iron is found in earth's crust as the ore siderite (iron(II) carbonate). What is the mass in kilograms of the amount of siderite that contains 1.0×10^{3} *kg* of iron?
    a. 960
    b. 2100
    c. 480
    d. 6500
    e. 1000

The following *five* questions concern the synthesis of ammonia:

Ammonia is synthesized in a gas-phase process involving the reaction of nitrogen monoxide with hydrogen gas. The reaction also releases water vapor as a by-product.

41. What is the sum of the coefficients of the balanced chemical equation representing the process?
    a. 9
    b. 10
    c. 11
    d. 12
    e. 13
42. How many moles of ammonia can be synthesized from 6.0 *mol* of hydrogen gas?
    a. 2.0
    b. 2.4
    c. 1.7
    d. 15.0
    e. 4.0
43. How many grams of ammonia can be synthesized from 15.0 *g* of nitrogen monoxide?
    a. 26.4
    b. 2.64
    c. 136.4
    d. 13.6
    e. 8.51
44. If 45.8 *g* of nitrogen monoxide and 12.4 *g* of hydrogen are mixed together, which is the limiting reactant, and what is the theoretical yield of ammonia in grams?
    a. Hydrogen, 26.0
    b. Nitrogen monoxide, 26.0
    c. Hydrogen, 41.8
    d. Nitrogen monoxide, 41.8
    e. None of the above
45. If the actual yield of ammonia is 19.0 *g*, what is the percentage yield (in %)?
    a. 160.8
    b. 45.5
    c. 136.8
    d. 73.1
    e. 63.4

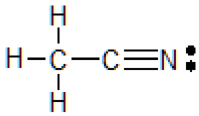
Questions 46 and 47 are related to each other.

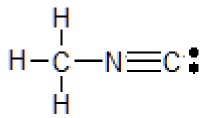
46. For mines, if the oxygen supply becomes limited or if the air becomes toxic, a worker can use an emergency breathing apparatus to breathe while exiting the mine. The reaction involves potassium superoxide (KO_2), and produces O_2 , and absorbs CO_2, a product of respiration.

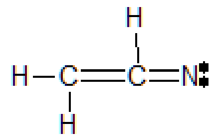
$$4KO_{2(s)} + 2CO_{2(g)} \rightarrow 2K_2CO_{3(s)} + 3O_{2(g)}$$

    What minimum amount (in *grams*) of KO_2 is required for the apparatus to produce enough oxygen to allow the user to breath for 15 minutes? Assume approximately 5.00 *mg* of oxygen per second of normal breathing?
    a. 0.22
    b. 1.52
    c. 2.03
    d. 3.04
    e. 13.3
47. How much potassium carbonate (in *grams*) has accumulated at the end of 15 minutes?
    a. 19.0 b. 3.09 c. 13.0 d. 4.12 e. 26.8

48. The Lewis structure of C_2H_3N is:

a. 

b. 

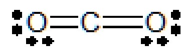
c. 

d. *a* and *c*   *e.* *a* and *b*

49. Which of the following Lewis structures are acceptable?

a. 

b. 

c. 

d. *b* and *c* only   e. *a, b,* and *c*

50. What is the molecular geometry (shape) of N_2O?

a. Trigonal Planar
b. Bent
c. Linear
d. Tetrahedral
e. Trigonal Pyramidal

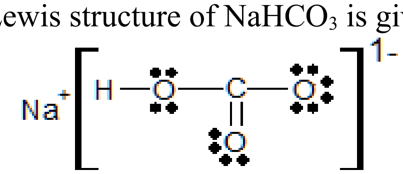
51. Which of the molecules are non-polar? I) H_2O II) NH_2OH III) CCl_4

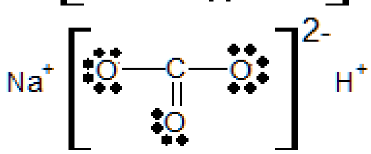
a. I only
b. II only
c. III only
d. I and II only
e. All of them are polar

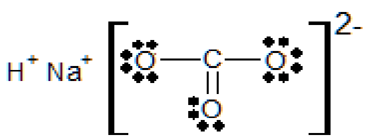
52. The shape of the molecule, $H_3C–O–CH_3$. , around each central atom is given by:

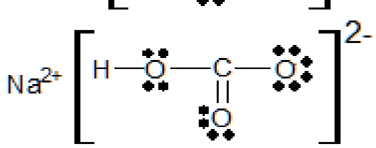
a. Tetrahedral, tetrahedral, tetrahedral
b. Bent, tetrahedral, bent
c. Trigonal Planar, bent, Trigonal planar
d. Tetrahedral, bent, tetrahedral
e. Bent, bent, bent

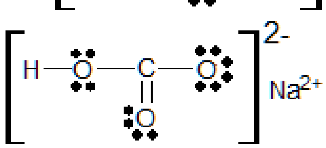
53. The Lewis structure of $NaHCO_3$ is given by:

a. 

b. 

c. 

d. 

e. 

54. Aluminum metal reacts with oxygen gas to form aluminum oxide. How many moles of aluminum oxide can be produced from 5.00 *mol* O_2?
    a. 10.0
    b. 7.50
    c. 3.33
    d. 1.67
    e. None of the above
55. The formula for aluminum oxide is:
    a. AlO
    b. AlO_2
    c. Al_2O
    d. AlO_3
    e. Al_2O_3
56. What is the symbol of the metal potassium?
    a. P
    b. Os
    c. K
    d. Pt
    e. As
57. What is the formula of methane?
    a. CO_3
    b. CH_2
    c. CH_3
    d. CH_4
    e. None of the above
58. Which of the following statements are inconsistent with Dalton's atomic theory?
    a. All carbon atoms are identical.
    b. An oxygen atom combines with 1.5 hydrogen atoms to form a water molecule.
    c. Two oxygen atoms combine with a carbon atom to form a carbon dioxide molecule.
    d. Carbon and nitrogen have different sizes.
    e. Helium can be split into two hydrogen atoms.
59. How many grams of N and O are present in 4.55 *g* of dinitrogen monoxide?
    a. 1.65, 2.90
    b. 1.52, 3.03
    c. 3.03, 1.52
    d. 2.90, 1.65
    e. None of the above
60. What are the name and formula of the compound formed between indium and nitrate ion?
    a. Indium nitrate, $In(NO_3)$
    b. Indium(III) nitrate, $In_3(NO_3)$
    c. Indium nitrate, $In(NO_3)_2$
    d. Indium(III) nitrate, $In(NO_3)_3$
    e. None of the above

Periodic Table of the Elements

Speed of light, c = 2.99792458×10^{8} m/s
Planck's Constant, h = 6.626069×10^{-34} J•s
Avogadro's Number = 6.022142×10^{23} particles/mol

IA	IIA	IIIB	IVB	VB	VIB	VIIB		VIIIB		IB	IIB	IIIA	IVA	VA	VIA	VIIA	VIIIA
1 **H** 1.0079																	2 **He** 4.002602
3 **Li** 6.941	4 **Be** 9.012182											5 **B** 10.81	6 **C** 12.011	7 **N** 14.0067	8 **O** 15.9994	9 **F** 18.998403	10 **Ne** 20.180
11 **Na** 22.9897693	12 **Mg** 24.305											13 **Al** 26.981539	14 **Si** 28.0855	15 **P** 30.973762	16 **S** 32.06	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.0983	20 **Ca** 40.08	21 **Sc** 44.95591	22 **Ti** 47.867	23 **V** 50.9415	24 **Cr** 51.996	25 **Mn** 54.93804	26 **Fe** 55.845	27 **Co** 58.93320	28 **Ni** 58.693	29 **Cu** 63.546	30 **Zn** 65.38	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.798
37 **Rb** 85.4678	38 **Sr** 87.62	39 **Y** 88.90585	40 **Zr** 91.224	41 **Nb** 92.90638	42 **Mo** 95.96	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.90550	46 **Pd** 106.42	47 **Ag** 107.8682	48 **Cd** 112.41	49 **In** 114.818	50 **Sn** 118.71	51 **Sb** 121.760	52 **Te** 127.60	53 **I** 126.90447	54 **Xe** 131.29
55 **Cs** 132.905452	56 **Ba** 137.33	57 **La*** 138.9055	72 **Hf** 178.49	73 **Ta** 180.94788	74 **W** 183.84	75 **Re** 186.207	76 **Os** 190.23	77 **Ir** 192.217	78 **Pt** 195.08	79 **Au** 196.966567	80 **Hg** 200.59	81 **Tl** 204.3833	82 **Pb** 207.2	83 **Bi** 208.98040	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** (226)	89 **Ac†** (227)	104 **Rf** (265)	105 **Db** (268)	106 **Sg** (272)	107 **Bh** (273)	108 **Hs** (276)	109 **Mt** (279)	110 **Ds** (281)	111 **Rg** (273)	112 **Cn** (285)	113 (287)	114 (289)	115 (291)	116 (292)		118 (294)

*	58 **Ce** 140.116	59 **Pr** 140.90765	60 **Nd** 144.242	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.964	64 **Gd** 157.25	65 **Tb** 158.92535	66 **Dy** 162.500	67 **Ho** 164.93032	68 **Er** 167.259	69 **Tm** 168.93421	70 **Yb** 173.05	71 **Lu** 174.9668
†	90 **Th** 232.03806	91 **Pa** 231.03588	92 **U** 238.02891	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** (261	103 **Lr** (264

2007-09