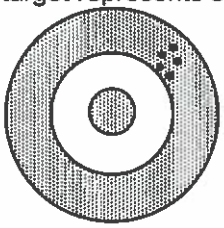
1. The following target represents someone who is:



a) accurate, but not precise
b) precise, but not accurate
c) both precise and accurate
d) neither precise, nor accurate

2. How close a measurement is to the true value is the _____ of the measurement and is communicated as _____

a) accuracy, % error
b) accuracy, ± notation
c) precision, % error
d) precision, ± notation

3. Consider the following data:

mass of slab	35.24 g
length of slab	35.14 cm
width of slab	15.85 cm
height of slab	0.68 cm

What is the density of the slab? Show work.

$D = \frac{m}{V}$ $V = 35.14(15.85)(0.68) = 378.7$ (2SF) $D = 35.24/378.7 = 0.093\ g/cm^3$

4. Which one of the following elements is diatomic?

a) Cl
b) S
c) Mg
d) C

5. Convert 0.00527 km into cm. Show work.

$0.00527\ km \left|\frac{1000m}{1\ km}\right|\frac{100cm}{1m} = 527\ cm$

6. The accepted value for the density of aluminum is 2.70 g/cm³. Your measurements indicate that the density is 2.80 g/cm³. Is this an indication of the accuracy or precision of the measurement?

Accuracy → How far from target

7. The measured density of aluminum is actually 2.80 ± 0.03 g/cm³. Is the ± value an indication of the accuracy or precision of the measurement?

Precision → calibration of instrument

8. Write the following in scientific notation with correct sig figs:

5000 g — 5×10^3 g
0.00350 L — 3.50×10^{-3} L
45.8 kg — 4.58×10^1 kg
0.0000000262 km — 2.62×10^{-8} km
375 x 10³ mL — 3.75×10^5 mL

9. What gas is formed when Zn metal is mixed with hydrochloric acid, HCl?

$Zn + 2HCl \rightarrow H_2 + ZnCl_2$ SR

a) CO_2
b) He
c) O_2
d) H_2

10. Which property is always conserved during a chemical reaction?

a) mass
b) volume
c) pressure
d) solubility

11. A cylinder is weighed empty and with a liquid.

Cylinder with liquid	51.85 g
Cylinder, empty	40.11 g
Volume of liquid in cylinder	7.0 mL

$m = 51.85 - 40.11 = 11.74$

What is the density of the liquid?

$D = \frac{11.74}{7.0}$ $D = 1.7\ g/mL$

a) 13 g/mL
b) 7.4 g/mL
c) 5.7 g/mL
d) 1.7 g/mL

CHEMICAL EQUATIONS

12. Which set of coefficients balances the equation for the complete combustion of ethane, C_2H_6?

$2\ C_2H_6 + 7\ O_2 \rightarrow 4\ CO_2 + 6\ H_2O$

a) 1,3,2,3
b) 1,6,2,6
c) 2,6,4,5
d) 2,7,4,6

13. When this expression is balanced,
$\_2\_ C_3H_6 + \_9\_ O_2 \rightarrow \_6\_ CO_2 + \_6\_ H_2O$
what is the coefficient of oxygen, O_2?

a) 6 c) 12
b) 9 d) 18

14. An acid was neutralized by the following reaction:
$NaOH + HCl \rightarrow NaCl + H_2O$
This reaction would be classified as...

a) synthesis - 2 cmpds make 2 new cmpds
b) decomposition
c) double replacement
d) single replacement

15. Which reaction below would be classified as a decomposition reaction?

a) $NaHCO_3 \rightarrow NaOH + CO_2$ - 1 reactant makes 2+ products.
b) $2\ H_2 + O_2 \rightarrow 2\ H_2O$
c) $2\ AgNO_3 + Cu^\circ \rightarrow Cu(NO_3)_2 + 2\ Ag^\circ$
d) $Ba(OH)_2 + H_2SO_4 \rightarrow BaSO_4 + 2\ H_2O$

16. The complete combustion of ethane, C_2H_6, produces

a) C_2H_5OH c) CO_2 and H_2
b) CH_3COOH d) CO_2 and H_2O

combustion ^ products of hydrocarbon is always $CO_2 + H_2O$

17. Of the three particles; protons, neutrons, and electrons, which one(s) are responsible for most of the **mass** of an atom? - e^- has no mass compared to p^+ & n°

a) the protons only
b) the electrons only
c) the neutrons only
d) the protons and neutrons
e) the protons and electrons

Questions 18 - 21 refer to the following terms. Each answer may be used once, more than once, or not at all.

a) proton c) electron
b) neutron d) proton and neutron

18. Moves very quickly around the nucleus. e^- (c)
19. Has a mass of 1 amu. p^+ (a)
20. Has a charge of -1. e^- (c)
21. Defines the volume of the atom. p^+ & n° (d)

Questions 22 – 25 refer to an isotope with a mass number of 31, 16 protons, and a charge of 2-.

22. The atomic number is ___.

a) 14 b) 15 c) 16 d) 18
number of p^+

23. The isotope contains ___ electrons.

a) 14 b) 15 c) 16 d) 18
charge of -2 ⇒ 2 more e^- than p^+

24. The nucleus contains ___ neutrons.

a) 14 b) 15 c) 16 d) 18
mass # = $p^+ + n^\circ$

25. The element is ___.

a) Si b) P c) S d) Ar
p^+ = atomic # which identifies element.

Thermochemistry

Exothermic and endothermic

26. Classify each statement as talking about an [EXO]thermic or [ENDO]thermic reaction:

exo surroundings get hot
exo energy is a product
endo ΔH is positive
exo reactants have more energy than products 
endo surroundings get cold
endo products have more energy than reactants 
endo energy is a reactant

Heat Calculations

27. A 45.0 mL sample of water is heated from 15.0°C to 35.0°C. How many joules of energy have been absorbed by the water?

$\Delta T = 35.0 - 15.0 = 20.0$
$c_{H_2O} = 4.184\ \frac{J}{g \cdot °C}$

$q = 45.0\ (4.184)(20.0)$
$3760\ J$

___ surroundings get cold ✓

___ products have more energy than reactants

___ energy is a reactant

Heat Calculations

27. A 45.0 mL sample of water is heated from 15.0°C to 35.0°C. How many joules of energy have been absorbed by the water?

See previous page

28. If 5430 J of energy is used to heat 1.25 L of room temperature water (23.0°C), what is the final temperature of the water?

$q = mc\Delta T$

$q = mc(T_f - T_i)$

$T_f - T_i = \frac{q}{mc}$

$T_f = \frac{q}{mc} + T_i$

$\left(\frac{5430}{1250(4.184)}\right) + 23.0$

$T_f = 24.0\,°C$

1.25 L = 1250 mL

29. A 100. gram sample of aluminum (specific heat = 0.900 $J \cdot g^{-1} \cdot °C^{-1}$) in boiling water is added to an insulated cup containing 50.0 grams of water at 5.00°C. What will the final temperature of the mixture be?

$T_f < 100°C$

$T_f > 5.00°C$

$q_{Al} = q_{H_2O}$

$100(0.900)(100 - x) = 50(4.184)(x - 5.00)$

$90(100 - x) = 209.2(x - 5.00)$

$9000 - x = 209.2x - 1046$

$10046 = 210.2x$

$x = 47.8\,°C$

Heat of Fusion/Vaporization

30. How much energy (in kJ) is absorbed by 45.0 g of ice as it melts?

$\Delta H_{fus} = 0.334\ \frac{kJ}{g}$

$q = m\Delta H_{fus}$

$q = 45.0\,(0.334)$

15.03 J

31. What mass of ice can be melted with 75.0 kJ of energy?

$\Delta H_{fus} = 0.334$ kJ

$q = m\Delta H_{fus}$

$m = \frac{q}{\Delta H_{fus}} = \frac{75.0}{0.334}$

= 224 g

Hess's Law

31. Iron ore can be converted to iron metal with CO gas. Calculate the Heat of reaction for the equation below using the following mechanism. All heats are given in kJ.

$FeO(s) + CO(g) \rightarrow Fe(s) + CO_2(g)$

(1) $3Fe_2O_3(s) + CO(g) \rightarrow 2Fe_3O_4(s) + CO_2(g)$ $\Delta H = -47$ flip

(2) $Fe_2O_3(s) + 3CO(g) \rightarrow 2Fe(s) + 3CO_2(g)$ $\Delta H = -25$ x 3

(3) $Fe_3O_4(s) + CO(g) \rightarrow 3FeO(s) + CO_2(g)$ $\Delta H = 19$ flip x 2

$2Fe_3O_4 + CO_2 \rightarrow 3Fe_2O_3 + CO$ 47

$3Fe_2O_3 + 6CO \rightarrow 6Fe + 6CO_2$ (-25) 3

$6FeO + 2CO_2 \rightarrow 2Fe_3O_4 + 2CO$ (-19) 2

$\div 6\left[6FeO + 6CO \rightarrow 6Fe + 6CO_2\right]$ $\frac{-66\ kJ}{6}$

-11 kJ

Heats of Reaction

Use the following heats of reactions to answer questions 32-34.

Substance	ΔH_f (kJ/mol)
CO_2 (g)	-393.5
H_2O (g)	-241.8
C_5H_{12} (l)	-173.1
C_2H_5OH (l)	-277.6
$C_{10}H_8$ (s)	X

32. Calculate the ΔH_{comb} for pentane, C_5H_{12}.

$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

$\Delta H_{comb} = [5\Delta H_{CO_2} + 6\Delta H_{H_2O}] - [1\cdot\Delta H_{C_5H_{12}} + 8\Delta H_{O_2}]$ ($\Delta H_{O_2} = 0$)

$[5(-393.5) + 6(-241.8)] - [-173.1]$

$= -3245.2$ kJ

33. Calculate the ΔH_{comb} for ethanol, C_2H_5OH.

$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$

$\Delta H_{comb} = [2\Delta H_{CO_2} + 3\Delta H_{H_2O}] - [1\cdot\Delta H_{C_2H_5OH} + 3\Delta H_{O_2}]$

$[2(-393.5) + 3(-241.8)] - [-277.6]$

-1234.8 kJ

34. The ΔH_{comb} for naphthalene, $C_{10}H_8$, is -5156.3 kJ/mol. What is the heat of formation of naphthalene?

$C_{10}H_8 + 12O_2 \rightarrow 10CO_2 + 4H_2O$

$-5156.3 = [10\Delta H_{CO_2} + 4\Delta H_{H_2O}] - [\Delta H_{C_{10}H_8} + 12\Delta H_{O_2}]$ ($\Delta H_{O_2} = 0$)

$-5156.3 = [10(-393.5) + 4(-241.8)] - X$

$-5156.3 = -3935 - 967.2 - X$

$X = 254.1$ kJ

GAS LAWS

35. For an ideal gas, which pair of variables are inversely proportional to each other (if all other factors remain constant)? $P_1V_1 = P_2V_2$

a) P, V
b) P, T
c) V, T
d) n, P

36. A real gas would act most ideal at — High temps & low press

a) 10 atm and 546 K
b) 10 atm and 273 K
c) 0.5 atm and 546 K
d) 0.5 atm and 273 K

36. One mole of hydrogen, H_2, occupies 61.2 L at — $PV = nRT$; plug values in & solve for 61.2 L

a) 100 °C and 1.00 atm
b) 200 °C and 1.00 atm
c) 0 °C and 0.500 atm
d) 50 °C and 0.500 atm
e) 100 °C and .500 atm

37. A 31.0 mL sample of gas is collected at a temperature of 37 °C and pressure of 720 mmHg. What is its volume at 17 °C and 580 mmHg.

a) 23 mL
b) 27 mL
c) 36 mL
d) 41 mL
e) 58 mL

$\frac{31.0(720)}{310} = \frac{580X}{290}$

$X = 36$ mL

38. The coldest possible temperature of a gas is:

a) 0 °C b) 273 K c) -273 K d) -273 °C

0 K = -273 °C

39. The pressure of 4.0 L of an ideal gas in a flexible container is decreased to one-third of its original pressure and its absolute temperature is decreased by one-half. The volume then is

a) 1.0 L b) 4.0 L c) 6.0 L d) 8.0 L e) 24 L

$\frac{4.0(1)}{1} = \frac{X(\frac{1}{3})}{\frac{1}{2}}$

$X = 6$ L.

40. A given mass of gas in a rigid container is heated from 100 °C to 300 °C. Which of the following best describes what will happen to the pressure of the gas? The pressure will…
    a) decrease by a factor of three.
    b) increase by a factor of three.
    c) increase by a factor less than three.
    d) decrease by a factor greater than three.

$\frac{1}{373} = \frac{X}{573}$

As temp increases @ const volume the pressure increases due to more collisions

41. What is the pressure exerted by some nitrogen gas collected in a tube filled with water on a day when the room temperature is 18.0 °C and the room pressure is 750.0 mmHg? [The partial pressure of water at 18 °C is 15.5 mmHg.]
    a) 15.5 mmHg
    b) 750.0 mmHg
    c) 734.5 mmHg
    d) 760.0 mmHg
    e) 732.0 mmHg

$P_{TOT} = P_{H_2O} + P_{N_2}$
$750.0 = P_{N_2} + 15.5$

42. As the average kinetic energy of the molecules of a sample increases, the temperature of the sample
    a) decreases
    b) increases
    c) remains the same

$KE = \frac{3}{2}RT$

43. If a gas that is confined in a rigid container is heated, the pressure of the gas will…
    a) increase
    b) decrease
    c) remain the same

More KE means particles hit w/ more force ∴ higher pressure.

44. If a gas has a pressure of 2.0 atm, which one of the following equations will express its pressure after...
    - the number of moles has been increased to three times the original amount,
    - the absolute temperature (K) has been reduced to half, and
    - the volume has been tripled?

    a) $P_2 = 2.0\text{ atm} \times \frac{1}{3} \times \frac{2}{1} \times \frac{4}{1}$
    b) $P_2 = 2.0\text{ atm} \times \frac{3}{1} \times \frac{1}{2} \times \frac{1}{3}$
    c) $P_2 = 2.0\text{ atm} \times \frac{3}{1} \times \frac{2}{1} \times \frac{1}{3}$
    d) $P_2 = 2.0\text{ atm} \times \frac{1}{3} \times \frac{1}{4} \times \frac{3}{1}$

$\frac{2V}{nT} = \frac{P_2 3V}{3n \cdot \frac{1}{2}T}$

$P_2 = 2.0 \cdot \frac{3}{1} \cdot \frac{1}{2} \cdot \frac{1}{3}$

45. A sample of gas occupies 30.0 L at 0.800 atm and 298 K. How many moles of gas are in the sample?
    a) 22.4
    b) 0.981
    c) 1.02
    d) 2.23
    e) none of these

$n = \frac{PV}{RT}$

$\frac{0.800(30.0)}{0.0821(298)}$

$n = 0.981$

46. When ammonium nitrite (NH_4NO_2) undergoes decomposition, only gases are produced according to the equation:

$NH_4NO_2(s) \rightarrow N_2(g) + 2H_2O(g)$

128 g → X L → Y L @ 819 K 1.00 atm
64.05 g → 67.2 L → 134.5

Solved using PV=nRT

What is the total volume of gases produced at 819K and 1.00 atm pressure when 128 g of ammonium nitrite undergoes the above decomposition reaction?

$\frac{128\text{ g}}{64.05\text{ g}} = \frac{X\text{ L}}{67.2\text{ L}}$ $\quad X = 134.4\text{ L}$

$\frac{128\text{ g}}{64.05} = \frac{Y\text{ L}}{134.5\text{ L}}$ $\quad Y = 268.8\text{ L}$

$V_{TOT} = 403.2\text{ L}$

47. At STP, it was found that 1.12 L of a gas had a mass of 2.78 g. Its molar mass is

$n = \frac{1.12(1.00)}{0.0821(273)}$

$n = 0.4997$

$MM = \frac{g}{mol} = \frac{2.78}{0.4997} = 55.6$

a) 2.78 g/mol
b) 27.8 g/mol
c) 55.6 g/mol
d) 111 g/mol

48. A mixture of gases, nitrogen, oxygen, and carbon dioxide at 27 °C and 0.50 atmospheres pressure occupied a volume of 492 mL. How many moles of gas are there in this sample?

$n = \frac{0.50(0.492)}{300(0.0821)}$

$n = 0.010$

a) 0.010
b) 1/9
c) 7.6
d) 10

49. A given mass of a gas occupies 5.00 L at 65 °C and 480 mmHg. What is the volume of the gas at 630 mmHg and 85 °C?

$\frac{5.00(480)}{338} = \frac{630\,V_2}{358}$

$V_2 = 5.00 \cdot \frac{358}{338} \cdot \frac{480}{630}$

a) $5.00 \times \frac{65}{85} \times \frac{480}{630}$
b) $5.00 \times \frac{338}{358} \times \frac{480}{630}$
c) $5.00 \times \frac{358}{338} \times \frac{480}{630}$
d) $5.00 \times \frac{358}{338} \times \frac{630}{480}$
e) $5.00 \times \frac{338}{358} \times \frac{630}{480}$

50. Which statement best explains why a confined gas exerts pressure?
a) the molecules are in random motion
b) the molecules travel in straight lines
c) the molecules attract each other
d) the molecules collide with the container walls

51. CH_4 gas and O_2 gas are together in a container. Which statement correctly describes the **average kinetic energy** of the two molecules.
a) The two molecules have the **same** average KE.
b) The AKE of CH_4 is **twice** that of O_2.
c) The AKE CH_4 is greater , but **not twice as great** as the O_2.
d) The AKE of O_2 is **greater** than the CH_4.

Iodine-131 undergoes "beta decay". What other particle is produced?
(A) Xe-131
(B) Te-131
(C) I-130
(D) Sb-127

$^{131}_{53}I \rightarrow {}^{0}_{-1}e + {}^{131}_{54}Xe$

52. What is the charge carried by a beta particle?
(A) -1 (B) 0 (C) +1 (D) +2

53. What type of radiation is simply a very energetic form of light?
(A) alpha
(B) beta
(C) gamma
(D) positron

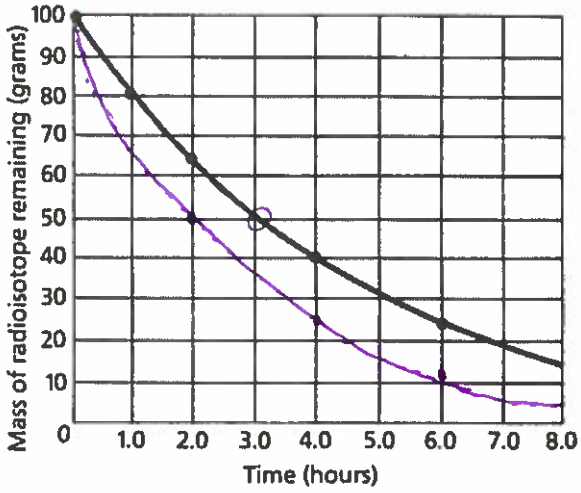
54. Md-256 decays spontaneously with a half-life of 1.5 hours. Which one of the following statements is true about Md-256 after 3.0 hours?
(A) All of the Md-256 will be decayed.
(B) 75% of the Md-256 will remain.
(C) 50% of the Md-256 will remain.
(D) 25% of the Md-256 will remain.

100 → 50 → 25 (1.5, 3.0)

55. In a decay series of Th-232, the first three steps involve an alpha decay and then two beta decays. What is the result of these decays?
(A) Th-228
(B) Rn-228
(C) Fr-224
(D) Pb-207

$^{232}_{90}Th \rightarrow {}^{4}_{2}He + 2\,{}^{0}_{-1}\beta + {}^{228}_{90}Th$

Questions 56 - 58 refer to this graph:



56. According to the above data, what is the half-life of the substance?
(A) 1.0 hrs (C) 3.0 hrs
(B) 2.3 hrs (D) 8.0 hrs

57. What percent of the original sample remains after 4 hours?
(A) 80% (C) 60%
(B) 75% (D) 40%

58. Sketch on the graph above, a curve for a substance whose half-life is 2.0 hrs.

59. Iodine-131 has a half-life of 8 days. What percent of a sample remains after 24 days? 3 cycles
(A) 75% (C) 50% (B) 25% (D) 12.5%
100 → 50 → 25 → 12.5

60. Which of the following describes what occurs in the fission process?
(A) a heavy nucleus is fragmented into lighter ones.
(B) a neutron is split into a proton and an electron.
(C) two light nuclei are combined into a heavier one.
(D) a particle and an anti-particle turn completely into energy.

61. The "control rods" in a nuclear reactor are designed to absorb _____.
(A) energy
(B) uranium atoms
(C) alpha particles
(D) neutrons

62. Which of the following is a fission reaction?
a) $^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U$
b) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}K + 3{}^{1}_{0}n$
c) $^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$
d) $^{1}_{1}p + {}^{0}_{-1}e \rightarrow {}^{1}_{0}n$

63. Which of the following is a fusion reaction?
a) $^{238}_{92}U + {}^{1}_{0}n \rightarrow {}^{239}_{92}U$
b) $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{56}Ba + {}^{94}_{36}K + 3{}^{1}_{0}n$
c) $^{2}_{1}H + {}^{3}_{1}H \rightarrow {}^{4}_{2}He + {}^{1}_{0}n$
d) $^{1}_{1}p + {}^{0}_{-1}e \rightarrow {}^{1}_{0}n$

64. In the nuclear equation, $^{238}_{92}U \rightarrow {}^{A}_{Z}X + {}^{4}_{2}He$ * mass & charge must be conserved.
the letters Z and A are, respectively
(A) 90 and 242 (C) 94 and 234
(B) 94 and 242 (D) 90 and 234

65. Radioactive C-14 has a half-life of about 5,000 years. If a fossil is only about 6% as radioactive as expected for living tissue of the same mass, the age of the fossil is about:
(A) 5,000 yrs (C) 20,000 yrs
(B) 10,000 yrs (D) 40,000 yrs
$6 = \frac{100}{2^n}$ $\log\left(\frac{100}{6}\right)$ / $\log 2$ $n = 4.05$ $4.05 \times 5 = 20$

66. A sample of neptunium-234, with a half-life of 4.40 days, is allowed to decay for 7.10 days. What percent of the original sample remains?
(A) 19.9% (C) 30.6%
(B) 61.9% (D) 32.7%
$\% = \frac{100}{2^{1.61}}$ $n = \frac{7.10}{4.40}$
$= 32.7\%$ $n = 1.61$