SO-O=SO 57/107/116 107/116

Name_____ **KEY**

Please read all the questions VERY carefully before answering. If you do not understand any question, please ask. Use the reverse side of the question paper as scratch. Use the periodic table and constant chart in the last page. No outside paper is allowed. Total points = 50+(22x3=)66=116

SHORT ANSWER. Please write the set-up equation first, then insert the raw data with units in the equation before doing your calculations. Points will be deducted if your answer is not clear.

1) Draw the Lewis structures (4 pts. each) of the following compounds and predict the electronic geometry of the molecule (3 pts each) . (Tot. pts. = 14)

1) _____

(a) H_3O+

$3(1)+1(6)-1=8$

$8-3(2)=2$

Lewis structure

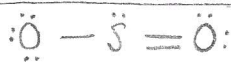$$\left[H - \overset{\cdot\cdot}{O} - H \right]^+$$
with H below O

electron geometry → tetrahedral
molecular shape → trigonal pyramidal ✓

(b) SO_2

$6+2(6)=18$

$18-2(2)=14$

Lewis structure

$$\overset{\cdot\cdot}{\underset{\cdot\cdot}{O}} - \overset{\cdot\cdot}{S} = \overset{\cdot\cdot}{O}:$$

electron geometry → trigonal planar ✓
molecular shape → bent

2) Calculate the number of atoms in 39.7 g of naturally occuring Iodine solid (Note the formula of Iodine). (6 pts.)

2) 1.88×10^{23} I atoms ✓

$I_2 \rightarrow 2(126.9)$
$= 253.8g$

$$= \frac{39.7 \text{ g } I_2}{1} \times \frac{1 \text{ mol } I_2}{253.8 \text{ g } I_2} \times \frac{2 \text{ mol } I}{1 \text{ mol } I_2} \times \frac{6.022 \times 10^{23} \text{ I atoms}}{1 \text{ mol } I}$$

$= 1.88395 \times 10^{23}$

$= \boxed{1.88 \times 10^{23} \text{ I atoms}}$

3) Calculate the amount (in grams) of oxygen in a 42.7 gram sample of potassium nitrate. (10 pts.)

3) $20.3 \text{ g } O$ ✓

KNO_3
$39.098 +$
$14.007 +$
$3(16)$
$= 101.105g$

$$\frac{42.7 \text{ g } KNO_3}{1} \times \frac{1 \text{ mol } KNO_3}{101.105 \text{ g } KNO_3} \times \frac{3 \text{ mol } O}{1 \text{ mol } KNO_3} \times \frac{16 \text{ g } O}{1 \text{ mol } O}$$

$= 20.27199$

$= \boxed{20.3 \text{ g } O}$

4) Show your calculation to determine the empirical formula of a compound that is composed   4) $\underline{C_3H_4O_3}$ ✓
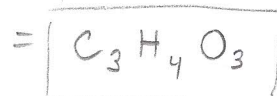40.92% C, 4.58% H, and 54.50% O. (8 pts.) C (12.011g), H (1.008g), O (16g)

$$\frac{40.92g\ C}{1} \times \frac{1\ mol\ C}{12.011\ g\ C} = 3.407\ mol\ C$$

$$\frac{4.58g\ H}{1} \times \frac{1\ mol\ H}{1.008\ gH} = 4.544\ mol\ H$$

$$\frac{54.50g\ O}{1} \times \frac{1\ mol\ O}{16\ g\ O} = 3.406\ mol\ O$$

$$C_{\frac{3.407}{3.406}}\ H_{\frac{4.544}{3.406}}\ O_{\frac{3.406}{3.406}}$$

$$= (C_1\ H_{1.33}\ O_1) \times 3$$

$$= \boxed{C_3\ H_4\ O_3}$$

5) Using only periodic table,   5) $\underline{16 < 15 < 33}$ ✓
(a) List atomic numbers 15, 16, 33 in order of increasing atomic size (6 pts.)

Biggest

$$16 < 15 < 33$$

6) An inflated baloon has a volume of 6.0 L at 1.0 atm pressure and at 22°C. Calculate its   6) $\underline{11\ L}$ ✓
volume when it ascends to an altitude where the pressure is 0.45 atm and the temperature
is - 21°C. (6 pts.)

$V_1 = 6.0L$

$P_1 = 1\ atm$

$t_1 = 22°C$

$V_2 = ?$

$P_2 = 0.45\ atm$

$T_2 = -21°C$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \implies V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$$

$$V_2 = \frac{1\ atm \times 6.0\ L \times (-21+273)K}{(22+273)K \times 0.45\ atm}$$

$$= 11.3898\ L$$

$$= \boxed{11\ L}$$

$$\begin{array}{r} 273 \\ +22 \\ \hline 295 \end{array}$$

MULTIPLE CHOICE. On scantron, answer the questions starting from number 8. Choose the one alternative that best completes the statement or answers the question. (3 poins each)

7) What is the mass percent of chlorine in hydrochloric acid?   7) $\underline{C}$
A) 35.5
B) 2.8
C) 97.2
D) 70.1
E) none of the above

$HCl \to 1(1.008) + 1(35.453) = 36.461$

$$mass\ percent = \frac{mass\ of\ solute}{mass\ of\ solute + mass\ of\ solvent} \times 100$$

$$= \frac{35.453}{1.008 + 35.453} = .972 \times 100 = 97.2\%$$

2

8) One mole of $(NH_4)_2HPO_4$ contains how many moles of hydrogen atoms?   8) ___A___

    A) 9

    B) 8

    C) 4

    D) 2

    E) none of the above

$$\frac{1\ mol\ (NH_4)_2HPO_4}{1} \times \frac{9\ mol\ H}{1\ mol\ (NH_4)_2HPO_4} = 9\ mol\ H$$

9) You have 10.0 g each of Na, C, Pb, Cu and Ne. Which contains the smallest number of moles?   9) ___C___

    A) Ne   B) Na   C) Pb   D) C   E) Cu

(22.99 12.011 207.2 63.546 20.180)

$$\frac{10g\ Na}{1} \times \frac{1\ mol}{22.999\ Na}$$

10) How many moles of carbon are in 3.5 moles of calcium carbonate?   10) ___B___

    A) 7

    B) 3.5

    C) 100.09

    D) 10.5

    E) none of the above

$$\frac{3.5\ mol\ CaCO_3}{1} \times \frac{1\ mol\ C}{1\ mol\ CaCO_3} = 3.5\ mol\ C$$

11) What would the empirical formula be for the molecular compound $C_6H_9O_4$?   11) ___E___

    A) CH_3O_2 ✗

    B) $C_3H_9O_4$ ✗

    C) $C_2H_3O_2$ ✗

    D) $C_3H_6O_2$ ✗

    E) none of the above

12) Increasing the intermolecular forces of a liquid will do which of the following?   12) ___E___

    A) increase the surface tension ✓

    B) decrease the vapor pressure ✓

    C) decrease the evaporation rate ✓

    D) increase the viscosity ✓

    E) all of the above

IMF ↑ = ↓ vapor pressure

IMF ↑ = ↑ boiling point

13) How many joules of heat are needed to completely vaporize 24.40 grams of water at its boiling point   13) ___B___

Given ΔH_{vap} = 40.6 kJ/mol

    A) 29.98

    B) 5.50×10^4

    C) 3.00×10^4

    D) 54.97

    E) none of the above

$q = \Delta H_{vap} \times$ moles of substance

$$= 40.6\ kJ/mol \times 24.4\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.016\ g\ H_2O}$$

$= 54.986\ kJ$

$= 54.97\ kJ \times 1000j = 54970j = 5.50 \times 10^4\ joule$

H_2O

$2(1.008) +$

16

$= 18.016g$

14) Which intermolecular force is due to the formation of an instantaneous dipole?   14) ___D___

    A) X-forces

    B) dipole-dipole forces

    C) hydrogen bonding

    D) dispersion forces

    E) none of the above

15) Substance A is a molecular compound that dissolves in gasoline but not in water. The molecules of A are very likely: *[handwritten: covalent (nonpolar) ... polar]*   15) **D**
   A) nonmetallic.
   B) polar.
   C) metallic.
   D) nonpolar. *(circled)*
   E) none of the above

16) Which of these compounds would you expect to be *least* soluble in water?   *[handwritten: nonpolar   polar]*   16) **C**
   A) NaCl
   B) CH_3OH *[handwritten: polar]*
   C) N_2 *[handwritten: nonpolar ✓]* *(circled)*
   D) NH_3
   E) not enough information

17) Which of the following statements is TRUE for gases?   *[handwritten: $PV = nRT$]*   17) **C**
   1. The temperature of a gas is inversely proportional to its pressure.
   2. The volume of a gas is directly proportional to the pressure in torr. *[handwritten: ✗]*
   3. The pressure of a gas is due to collisions of the gas molecules. *[handwritten: ✓]*
   A) 2 only
   B) 1 only
   C) 3 only *(circled)*
   D) 1 and 2 only
   E) 1 and 3 only

[handwritten: ? circled in left margin]

18) If each of the following gas samples have the same temperature and pressure, which sample has the greatest volume?   18) **B**
   A) 1 gram of O_2 *[handwritten: × $\frac{1\,mol\,O_2}{32\,g}$]*
   B) 1 gram of H_2 *[handwritten: × $\frac{1\,mol}{1.008\,g}$]* *(circled)*
   C) all have the same volume
   D) 1 gram of Ar *[handwritten: × $\frac{1\,mol}{39.9\,g}$]*
   E) not enough information

   [handwritten: $PV = nRT$]

19) What is the final volume of a 500.0 mL gas container that increased in temperature from 299 K to 333 K while the pressure increased from 1.00 atm to 1.54 atm?   19) **C**
   A) 1.45 L
   B) 2.77 L
   C) 0.362 L *(circled)*
   D) 0.691 L
   E) none of the above

   [handwritten work:
   $V_2 = ?$
   $V_1 = 500\,mL$
   $T_1 = 299\,K$
   $T_2 = 333\,K$
   $P_1 = 1.00\,atm$
   $P_2 = 1.54\,atm$

   $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$

   $V_2 = \frac{1.00\,atm \times 500\,mL \left(\frac{1L}{1000\,mL}\right) \times 333\,K}{299\,K \times 1.54\,atm} = 0.36159\,L$
   $= 0.362\,L$ *]*

20) Which of the following diatomic elements would have a mass of 19.08 grams stored in a 3.82 L container at 3,632 mm Hg and 100°C?   20) **B**
   A) F_2
   B) O_2 *(circled)*
   C) Br_2
   D) H_2
   E) not enough information.

   [handwritten: $PV = nRT$]

   [handwritten work:
   molecular weight = $\frac{\text{measured weight of sample}}{\text{mole # gas sample}}$

   $= \frac{19.08\,g}{0.5961\,mol} = 32.00 \rightarrow O_2 \quad 2(16) = 32$

   $n = \frac{PV}{RT} = \frac{\left(3632\,mmHg \times \frac{1\,atm}{760\,mmHg}\right) \times 3.82\,L}{0.0821 \times (100 + 273)\,K} = 0.5961\,mol$ *]*

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21) Which of the following substances is NOT a solution?
   A) vodka
   B) brass
   C) air
   D) copper
   E) All of the above are solutions.

21) _D_

TRUE/FALSE. On scantron, choose "A" for a true answer and "B" for wrong answer. (3 points each)

22) The mass of 2.0 moles of H_2O is greater than the mass of 1.0 mole of CO_2. ↗ 12.011+2(16) = 44.011 FALSE

$\dfrac{2.0\ mol\ H_2O}{1} \times \dfrac{18.016\ g\ H_2O}{1\ mol\ H_2O} = 36.032\ g\ H_2O$ { $\dfrac{1.0\ mol\ CO_2}{1} \times \dfrac{44.011\ g\ CO_2}{1\ mol\ CO_2} = 44.011\ g\ CO_2$

22) _B_

23) Intermolecular forces are the attractive forces between atoms (within) a compound. NO.

23) ~~A~~ B

24) Pressure depends on how many gas particles are in a container.

24) _A_

25) Absolute zero refers to $0°C$. OK   False

25) _B_

26) The volume of a gas and the number of particles is inversely proportional. FALSE
   pressure

26) _B_

27) The minor component in a solution is called the solvent.
   solute

27) _B_

28) Ionic solutes typically dissolve in nonpolar solvents. False
   polar

28) _B_

$PV = nRT$

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