HE 2 Detailed Key

Form A | B / C | D

$3Ba(NO_3)_2(aq) + 2Na_3PO_4(aq) \rightarrow Ba_3(PO_4)_2(s) + 6NaNO_3(aq)$

Na^+ and NO_3^- are spectator ions.

$3Ba^{2+} + 2PO_4^{3-} \rightarrow Ba_3(PO_4)_2(s)$ is the net ionic equation.

For the next two questions, consider the reaction between 150.0 mL of 0.300 *M* $Ba(NO_3)_2$ with 120.0 mL of 0.300 *M* Na_3PO_4. Assume the reaction has 100% yield.

$0.1500L\left(\frac{0.300 mol}{L}\right) = 0.0450$ moles $Ba(NO_3)_2$ = 0.0450 moles Ba^{2+} + 0.090 mol NO_3^-

1 | 13 / 10 | 22

1. Which ions are present in solution after the reaction has gone to completion?

$0.1200L\left(\frac{0.300 mol}{L}\right) = 0.036$ mol Na_3PO_4 = 0.036 mol PO_4^{3-} + 0.108 mol Na^+

a) There are no ions in solution after completion.

Let Ba^{3+} and PO_4^{3-} react:

b) Ba^{2+}, NO_3^-, Na^+, and PO_4^{3-} ions are all present after completion.

	$3Ba^{2+}$	$+ 2PO_4^{2-}$	$\rightarrow Ba_3(PO_4)_2(s)$
I	0.0450	0.0360	
C	−0.0450	−0.0300	+0.0150
A	0 limiting	0.0060 excess	0.0150 mol

c) Only Ba^{2+}, NO_3^-, and Na^+ ions present after completion.

d) Only NO_3^- and Na^+ ions are present after completion.

e) Only NO_3^-, Na^+, and PO_4^{3-} ions are present after completion.

Ba^{2+} is limiting and 0.0150 mol of $Ba_3(PO_4)_2(s)$ forms. PO_4^{3-} ions are in excess. ~~Ba~~ Also present will be the Na^+ and NO_3^- spectator ions.

2 | 14 / 11 | 23

2. How many moles of precipitate form after the reaction has gone to completion?

a) 0.0450 mol b) 0.0300mol c) 0.0360mol

d) 0.0150 mol e) 0.0180 mol

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3 | 15 / 12 | 24

3. Consider a substance that has a high vapor pressure. Which of the following is **not** characteristic of a substance with a high vapor pressure?

A substance with weak intermolecular forces will have a high vapor pressure. Also a substance at a high temperature can have a high vapor pressure.

a) The substance is an ionic compound.

Ionic forces are the strongest, so ionic compounds have very low vapor pressures.

T b) The temperature of the substance is relatively high.

T c) The substance is a small, nonpolar covalent compound. will have weak intermolecular forces (only small LD forces).

T d) The substance has a relatively small value for the enthalpy of vaporization (ΔH_{vap}).

If has small ΔH_{vap}, has weak intermolecular forces.

4 | 16 / 13 | 25

4. Consider a strong acid solution. When lead nitrate is added to some of the strong acid solution, a precipitate forms. In a second experiment, 50.0 mL of the strong acid solution requires 201.5 mL of 1.00 *M* KOH for complete reaction. If the 50.0 mL of strong acid solution contains 16.3 g of the strong acid, which of the following is the identity of the strong acid?

$\underbrace{HX}_{acid} + KOH \rightarrow H_2O(l) + KX(aq)$

(Note: all answers are monoprotic acids, so assume unknown is monoprotic)

a) HF b) HCl c) HBr

d) HI e) HNO_3

moles HX = $0.2015L\left(\frac{1.00 mol KOH}{L}\right)\left(\frac{1 mol HX}{1 mol KOH}\right) = 0.2015$ mol HX.

molar mass HX = $\frac{16.3 g HX}{0.2015 mol HX} = 80.9$ g/mol

HBr has a molar mass of 80.9 g/mol.

Form

A	B
C	D

HCl is a polar compound so has dipole forces as well as London dispersion (LD) forces. Ar is a nonpolar substance so only has London dispersion forces. Since Ar and HCl have about the same molar mass, Ar and HCl will have similar strength LD forces.

5	1
22	18

5. Which of the following statements **best** explains why HCl has a higher boiling point than Ar?

a) HCl and Ar have similar strength London dispersion forces, but HCl has additional dipole forces that Ar does not possess.

b) HCl and Ar have similar strength London dispersion forces, but HCl has additional ionic forces that Ar does not possess.

c) HCl and Ar have similar strength London dispersion forces, but HCl has additional hydrogen bonding forces that Ar does not possess.

d) HCl has stronger London dispersion forces than Ar.

e) HCl is a strong electrolyte but Ar is not.

original moles $K^+ = \underline{0.1000 L} \left| \frac{0.875 \text{ mol } K_2CO_3}{L} \right| \frac{2 \text{ mol } K^+}{1 \text{ mol } K_2CO_3} = 0.175 \text{ mol } K^+$

6	2
23	19

6. Consider 100.0 mL of a 0.875 *M* K_2CO_3 solution sitting in an uncovered beaker. Some water from the solution evaporates. After several days, you determine the K^+ concentration in the remaining solution to be 2.334 *M*. What volume of water **evaporated** from the original solution?

Only water was removed, so moles of K^+ did not change.

a) 100.0 mL
b) 80.0 mL
c) 75.0 mL

moles K^+ initially = moles K^+ after evaporation. Let x = volume of final solution (in L)

d) 25.0 mL
e) 10.0 mL

$0.175 \text{ mol } K^+ = x\left(\frac{2.334 \text{ mol } K^+}{L}\right)$, solving: $x = 0.0750 L$

water evaporated = 100.0 mL initially − 75.0 mL final = 25.0 mL H_2O evaporated

7	3
24	20

7. Consider the reaction of 4.60 g of sodium metal with excess oxygen to form Na_2O (molar mass = 61.98 g/mol). The actual yield of the reaction is 5.88 g of Na_2O. What is the percent yield of the reaction? $2Na(s) + \frac{1}{2}O_2(g) \rightarrow Na_2O(s)$

a) 94.8%
b) 63.8%
c) 47.4%

theoretical yield $= 4.60 g \text{ Na}\left(\frac{1 \text{ mol Na}}{22.99 g}\right)\left(\frac{1 \text{ mol } Na_2O}{2 \text{ mol Na}}\right)\left(\frac{61.98 g}{\text{mol } Na_2O}\right) = 6.20 g \ Na_2O$

d) 86.4%
e) 73.8%

% yield $= \frac{\text{actual}}{\text{theoretical}} \times 100 = \frac{5.88 g}{6.20 g} \times 100 = 94.8\%$

8	4
25	21

8. A 0.10 *M* $Ba(NO_3)_2$ solution is added to four separate beakers. The four beakers contain 0.10 *M* Na_2SO_4, 0.10 *M* K_2CO_3, 0.10 *M* NH_4Cl, and 0.10 *M* RbOH. In how many of the four beakers did a precipitate form?

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_4(s)$, $Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3(s)$

a) 0 (none)
b) 1
c) 2
d) 3

e) 4 (A precipitate will form in all four beakers).

No reaction will occur between $Ba(NO_3)_2$ and NH_4Cl and between $Ba(NO_3)_2$ and RbOH. So two precipitates will form [$BaSO_4(s)$ and $BaCO_3(s)$].

Form
A|B
C|D

Between HCl, HBr, and HI, the boiling increases steadily as the molar mass increase. So HI has a higher bp than HBr, while HCl has a bp lower than that of HBr.

9|17
1|14

9. Consider the following four substances: HF can form H-bonding, so it has the highest bp.

HF, HCl, HI, Cl_2

Cl_2 and HBr have similar molar mass, so have similar

How many of these substances have a boiling point that is/are higher than the boiling point for HBr? strength London dispersion forces, but HBr is

a) 0 (none)
b) 1
c) 2
d) 3

polar so HBr has additional dipole forces so HBr has

e) 4 (All of the substances have a higher boiling point than HBr.)

a higher bp than Cl_2. So HF and HI will have a higher bp than HBr; the others shouldn't.

10|18
2|15

10. Air bags are activated when a severe impact causes a steel ball to compress a spring and electronically ignite a detonator cap. This causes sodium azide (NaN_3) to decompose explosively according to the following equation:

$$2\ NaN_3(s) \rightarrow 2\ Na(s) + 3\ N_2(g)$$

$n_{N_2} = \frac{PV}{RT} = \frac{1.00 atm(70.0L)}{0.08206(273K)}$

$n_{N_2} = 3.125$ moles N_2

What mass of $NaN_3(s)$ must be reacted to inflate an air bag to 70.0 L at STP assuming 100% yield?

$3.125 mol\text{-}N_2 \left(\frac{2 mol\ NaN_3}{3\ mol\ N_2}\right)\left(\frac{65.02g}{mol\ NaN_3}\right) = 135\ g\ NaN_3$

a) 203 g
b) 43.8 g
c) 75.0 g
d) 304 g
e) 135 g

11|19
3|16

11. Which of the following net ionic equations will **not** occur?

ok a) $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ ok

ok b) $Hg_2^{2+}(aq) + SO_4^{2-}(aq) \rightarrow Hg_2SO_4(s)$

ok c) $Fe^{2+}(aq) + OH^-(aq) \rightarrow Fe(OH)_2(s)$

ok d) $Mn^{2+}(aq) + CrO_4^{2-}(aq) \rightarrow MnCrO_4(s)$

NO e) $Co^{2+}(aq) + I^-(aq) \rightarrow CoI_2(s)$

does not form

Apply solubility rules to see if the predicted precipitate will form. All are fine except for $CoI_2(s)$. this compound will not form as told by Rule 3 of the solubility rules

12|20
4|17

12. A sample of gas containing 0.50 moles of Kr at 25°C exerts a pressure 0.75 atm. More Kr gas is added to the rigid container and the temperature is increased to 50.°C. The resulting pressure is 2.5 atm. How many moles of Kr were **added** to the rigid container?

a) 0.83 moles
b) 0.33 moles
c) 1.5 moles
d) 1.0 mole
e) 0.50 moles

$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$, $V_1 = V_2$, $n_2 = n_1\left(\frac{P_2}{P_1}\right)\left(\frac{T_1}{T_2}\right) = 0.50 mol\left(\frac{2.5 atm}{0.75 atm}\right)\left(\frac{298K}{323K}\right) = 1.54 mol$

moles Kr added $= 1.54 - 0.50 = 1.04 \approx 1.0$ mol added

Form
A | B
C | D

a. $2.0 \text{ mol } N_2 \left(\frac{3 \text{ mol } H_2}{1 \text{ mol } N_2}\right) = 6.0 \text{ mol } H_2$ required to react with 2.0 mol N_2
Since only 5.0 mol H_2 is present, H_2 is limiting in part a.

b. $60.0 \text{ g } N_2 \left(\frac{1 \text{ mol } N_2}{28.02 \text{ g}}\right)\left(\frac{3 \text{ mol } H_2}{1 \text{ mol } N_2}\right)\left(\frac{2.016 \text{ g } H_2}{\text{mol } H_2}\right) = 13.0 \text{ g } H_2$
Since only 10.0 g H_2 is present, H_2 is limiting in part b.

13 | 5
18 | 11

13. Consider the following **unbalanced** equation:

c. $3.0 \text{ mol } N_2 \left(\frac{3 \text{ mol } H_2}{1 \text{ mol } N_2}\right) = 9.0 \text{ mol } H_2$

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

since only 3.0 mol H_2 is present, H_2 is limiting in part c.

In which of the following cases (a-d) is/are nitrogen the limiting reactant?

a) Reacting 2.0 moles of N_2 with 5.0 moles of H_2.

b) Reacting 60.0 g of N_2 with 10.0 g H_2.

c) Reacting 3.0 moles of N_2 with 3.0 moles of H_2.

$250.0 \text{ g } N_2 \left(\frac{1 \text{ mol } N_2}{28.02 \text{ g}}\right)\left(\frac{3 \text{ mol } H_2}{1 \text{ mol } N_2}\right)\left(\frac{2.016 \text{ g } H_2}{\text{mol } H_2}\right) = 54.0 \text{ g } H_2$ required to react with 250.0 g N_2

d) Reacting 250.0 g of N_2 with 60.0 g of H_2.

Since we have 60.0 g H_2 present, N_2 is limiting in part d.

e) Nitrogen is limiting in at least two of the above cases (a-d).

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mass H in 100.00 g compound = 100.00 − 56.79 g C − 28.37 g O − 8.28 g N = 6.56 g H

14 | 6
19 | 11

14. The compound adrenaline contains 56.79% C, 28.37% O, and 8.28% N by mass, with hydrogen the remaining element in the compound. What is the empirical formula of adrenaline?

$56.79 \text{ g C} \left(\frac{1 \text{ mol C}}{12.01 \text{ g}}\right) = 4.729 \text{ mol C} / 0.591 \text{ mol} = 8 \text{ mol C}$

a) $C_4H_5O_2N$ b) $C_6H_3O_2N$ c) C_2H_5ON

$6.56 \text{ g H} \left(\frac{1 \text{ mol H}}{1.008 \text{ g}}\right) = 6.508 \text{ mol H} / 0.591 \text{ mol} = 11 \text{ mol H}$

$C_8H_{11}O_3N_1$ is empirical formula.

d) $C_6H_5O_2N$ e) $C_8H_{11}O_3N$

$28.37 \text{ g O} \left(\frac{1 \text{ mol O}}{16.00 \text{ g}}\right) = 1.773 \text{ mol O} / 0.591 = 3 \text{ mol O}$

$8.28 \text{ g N} \left(\frac{1 \text{ mol N}}{14.01 \text{ g}}\right) = 0.591 \text{ mol N} / 0.591 = 1 \text{ mol N}$

15 | 7
20 | 12

15. Consider the following four substances:

C−C, C−H bonds are nonpolar, so this compound is nonpolar.

$CH_3-CH_2-CH_2-CH_2-CH_3$, Ar, CH_3-O-CH_3, I_2

Ar: nonpolar; CH_3-O-CH_3: polar; I_2: nonpolar

CH_3OCH_3 is polar, so has additional dipole forces.

How many of these four substances **only** exhibit London dispersion forces (LDF)?

Nonpolar compounds only exhibit LDF. All of the compounds are nonpolar except for CH_3-O-CH_3. this compound has polar C−O bonds which add together to make the CH_3-O-CH_3 molecule polar.

a) 0 (none) b) 1 c) 2 d) 3

e) 4 (All four of these substances only exhibit London dispersion forces.)

16 | 8
21 | 13

16. Some argon gas is collected over water. The wet gas occupies 2.0 L at 60.°C and 783 torr. If the 2.0 L of wet gas contains 0.0144 moles of water, what is the partial pressure Ar in the 2.0 L of wet gas at 60.°C?

$P_{H_2O} = \frac{0.0144 \text{ mol } H_2O (0.08206)(333 \text{ K})}{2.0 \text{ L}} = 0.1967 \text{ atm}$

a) 633 torr b) 150. torr c) 715 torr

d) 762 tor e) 300. torr

$P_{H_2O} = 0.1967 \text{ atm} \left(\frac{760 \text{ torr}}{1 \text{ atm}}\right) = 149.53 \text{ torr}$

$P_{TOT} = P_{Ar} + P_{H_2O}$, $P_{Ar} = P_{TOT} - P_{H_2O} = 783 - 149.53 = 633 \text{ torr}$

Form A|B C|D

Let H_xA = Glutamic acid, where x = 1 (monoprotic acid) or x = 2 (diprotic acid) or x = 3 (triprotic acid).

$H_xA + x\,OH^- \rightarrow x\,H_2O + A^{x-}$

moles OH^- = $0.0170\,L\left(\frac{0.100\text{ mol }Ca(OH)_2}{L}\right)\left(\frac{2\text{ mol }OH^-}{1\text{ mol }Ca(OH)_2}\right) = 0.00340$ mol OH^-

17|21 5|5

17. Glutamic acid, one of the 20 naturally occurring amino acids, has a molecular formula of $C_5H_9O_4N$. A 0.250 g-sample of glutamic acid (molar mass = 147.1 g/mol) dissolved in 75.0 mL of solution requires 17.0 mL of 0.100 *M* $Ca(OH)_2$ to react completely with all of the acid. Which of the following is the best formula for glutamic acid?

Moles glutamic acid = $0.250\,g\left(\frac{1\text{ mol}}{147.1\,g}\right) = 0.00170$ mol glutamic acid

a) $HC_5H_8O_4N$ b) $H_2C_5H_7O_4N$ c) $H_3C_5H_6O_4N$

$\frac{\text{mol }OH^-}{\text{mol glutamic acid}} = \frac{0.00340}{0.00170} = 2$; From balanced equation,

d) $H_4C_5H_5O_4N$ e) $H_6C_5H_3O_4N$

$\frac{\text{moles }OH^-}{\text{moles }H_xA} = \frac{x}{1}$, so x = 2. Glutamic acid is a diprotic acid. formula = $H_2C_5H_7O_4N$

For the next two questions, consider the reaction between 20.00 g of $NH_3(g)$ and 45.00 g of $O_2(g)$ by the following **unbalanced** equation:

$$2NH_3(g) + \tfrac{5}{2}O_2(g) \rightarrow 2\,NO(g) + 3\,H_2O(g)$$

Molar mass: 17.03 32.00 30.01 18.02 g/mol

If NH_3 limiting: $20.0\,g\,NH_3\left(\frac{1\text{ mol }NH_3}{17.03\,g}\right)\left(\frac{2\text{ mol }NO}{2\text{ mol }NH_3}\right)\left(\frac{30.01\,g}{\text{mol }NO}\right) = 35.24$ g NO produced

18|22 6|6

18. What mass of NO(g) can form assuming 100% yield?

If O_2 limiting:

a) 30.41 g b) 33.76 g c) 35.24 g

$45.00\,g\,O_2\left(\frac{1\text{ mol }O_2}{32.00\,g}\right)\left(\frac{2\text{ mol }NO}{2.5\text{ mol }O_2}\right)\left(\frac{30.01\,g}{\text{mol }NO}\right) = 33.76$ g NO produced

d) 42.37 g e) 49.83 g

Since O_2 reacted produces smallest amount of product, O_2 is limiting and 33.76 g NO can form.

19|23 7|7

19. What mass of excess reactant remains after the reaction has gone to completion?

mass NH_3 reacted = $45.00\,g\,O_2\left(\frac{1\text{ mol }O_2}{32.00\,g}\right)\left(\frac{2\text{ mol }NH_3}{2.5\text{ mol }O_2}\right)\left(\frac{17.03\,g}{\text{mol }NH_3}\right) = 19.16\,g\,NH_3$ reacted

a) 0.84 g b) 1.15 g c) 3.14 g

excess NH_3 = 20.00 g NH_3 initially − 19.16 g NH_3 reacted = 0.84 g NH_3 in excess

d) 7.43 g e) 8.62 g

$Ca_3(PO_4)_2$ = calcium phosphate

20|24 8|8

20. Calcium phosphate is an insoluble ionic compound. What is the mass percent of calcium in calcium phosphate?

3(40.08) + 2(30.97) + 8(16.00) = 310.18 g/mol (= molar mass $Ca_3(PO_4)_2$)

a) 21.96% b) 29.68% c) 38.76%

mass % Ca = $\frac{\text{mass Ca} \times 100}{\text{mass }Ca_3(PO_4)_2} = \frac{3(40.08)}{310.18} \times 100 = 38.76\%$ Ca

d) 45.77% e) 55.87%

At constant T + P, V = n. So balanced equation gives mole

21|25 9|9

21. At STP, 1.0 L of $Cl_2(g)$ reacts completely with 5.0 L of $F_2(g)$ to produce $ClF_5(g)$. What volume of $ClF_5(g)$ is produced in this reaction at STP?

ratios, but ~~will~~ also give volume ratios.

a) 1.0 L b) 2.0 L c) 3.0 L d) 5.0 L e) 6.0 L

$1Cl_2 + 5F_2 = 2ClF_5$

From balanced reaction, 1 L of Cl_2 reacts with every 5 L of F_2 to produce 2 L of ClF_5.

Form

A | B
C | D

mass caproic acid + mass O_2 = mass CO_2 + mass H_2O

20.00g + 44.08g = 45.46g + mass H_2O

mass H_2O = 20.00 + 44.08 − 45.46 = 18.62g

mass H in caproic acid = $18.62g\ H_2O \left(\frac{1 mol\ H_2O}{18.02g}\right)\left(\frac{2 mol\ H}{1 mol\ H_2O}\right)\left(\frac{1.008g\ H}{1 mol\ H}\right) = 2.083g\ H$

22 | 9
14 | 1

22. Caproic acid has an odor that is often associated with dirty socks; it is composed of C, H, and O. A 20.00 g-sample of caproic acid reacts with 44.08 g of O_2 to produce 45.46 g of CO_2 and some H_2O. What is the mass percent of hydrogen in caproic acid? Hint: Mass is conserved in a chemical reaction.

mass % H = (2.083g H / 20.00g caproic acid) x100 = 10.42%

a) 7.25% H b) 10.4% H c) 3.36% H

mass C in caproic acid = $45.46g\ CO_2 \left(\frac{1 mol\ CO_2}{44.01 g}\right)\left(\frac{1 mol\ C}{1 mol\ CO_2}\right)\left(\frac{12.01g}{mol\ C}\right) = 12.41g\ C$

d) 5.21% H e) 4.73% H

mass O in caproic acid = 20.00g − 2.083g H − 12.41g C = 5.51g O

23 | 10
15 | 2

23. Caproic acid has an odor that is often associated with dirty socks; it is composed of C, H, and O. A 20.00 g-sample of caproic acid reacts with 44.08 g of O_2 to produce 45.46 g of CO_2 and some H_2O. What is the empirical formula of caproic acid? Hint: ~~Mass is~~ conserved in a chemical reaction.

$12.41g\ C\left(\frac{1 mol\ C}{12.01g}\right) = 1.033\ mol\ C / 0.344 = 3 mol\ C$

C_3H_6O is the empirical formula.

a) C_2H_4O b) C_4H_2O c) $C_2H_6O_3$

$2.083g\ H\left(\frac{1 mol\ H}{1.008g}\right) = 2.066\ mol\ H / 0.344 = 6\ mol\ H$

d) C_3H_6O e) $C_2H_3O_2$

$5.51g\ O\left(\frac{1 mol\ O}{16.00g}\right) = 0.344\ mol\ O / 0.344 = 1\ mol\ O$

24 | 11
16 | 3

24. Consider the following four statements (I-IV) regarding real gases:

True I. Gases behave most ideally at high temperatures and low pressures.

True II. Real gas molecules have a volume and do exert intermolecular forces.

True III. In the van der Waals gas equation, a term is added to the measured pressure to correct for the intermolecular forces exerted by a real gas.

True IV. In the van der Waals gas equation, the "b" constant in the equation helps correct for the volume taken up by the gas particles themselves.

$$\left(P + \frac{an^2}{V^2}\right)(V - nb) = nRT$$

How many of the above four statements (I-IV) is/are **true**? Hint: refer to the van der Waals gas equation on the constants page. All statements are true.

a) 0 (none) b) 1 c) 2 d) 3

e) 4 [All of the statements (I-IV) are true].

25 | 12
17 | 4

25. Which of the following 1.0 *M* solutions is the **worst** conductor of electricity?

a) $SrCl_2$ — soluble ionic compd, strong electrolyte
b) HF — weak acid, weak electrolyte
c) CH_3OH — covalent compound, not an acid, nonelectrolyte.
d) NH_4NO_3 — soluble ionic compd, strong electrolyte
e) $CuSO_4$ — soluble ionic compd, strong electrolyte

The solution with no ions is the worst conductor of electricity. This will be the solution of CH_3OH, a nonelectrolyte.

Form

A	B
C	D

$$\frac{\text{rate } CH_4}{\text{rate } O_2} = \sqrt{\frac{M_{O_2}}{M_{CH_4}}} = \sqrt{\frac{32}{16}} = \sqrt{2} = 1.41$$

$\text{rate } O_2 = \frac{0.32 \text{ moles } O_2}{10 \text{ mins}}$ $\text{rate } CH_4 = \frac{X \text{ mol}}{10 \text{ mins}}$ Let X = mol CH_4 that effuse

26|26
26|26

26. Over a ten minute period, 0.32 moles of oxygen gas effuses from a container. How many moles of methane (CH_4) gas will effuse from the same container in 10 minutes?

a) 0.64 moles b) 0.32 moles c) 0.23 moles d) 0.16 moles e) 0.45 mol

$\frac{X \text{ mol}/10 \text{ mins}}{0.32/10 \text{ mins}} = 1.41$, X = 0.45 mol CH_4 will effus in 10 minutes

27|27
27|27

27. Which of the following gas samples (a-d) has the same average kinetic energy as nitrogen gas at 232 K? Any other gas at 232K will have the same average kinetic energy ($KE_{Ave} = \frac{3}{2}RT$).

a) $O_2(g)$ at 200 K b) Ar(g) at −41°C c) Ne(g) at 41°C d) $CO_2(g)$ at 200 K

−41°C ; 273 − 41 = 232 K

e) None of these gases have the same average kinetic energy as $N_2(g)$ at 232 K.

Ar(g) at −41 °C (=232K) has the same average KE as N_2 at 232K.

The higher the temp, the faster the average velocity. The smaller the gas particle, the faster the average velocity.

28|28
28|28

28. Which of the following gas samples has the fastest average velocity?

a) $O_2(g)$ at 200 K (32g/mol) b) Ar(g) at −41°C (40g/mol) c) Ne(g) at 41°C (20 g/mol)

d) $CO_2(g)$ at 200 K (44 g/mol) e) $N_2(g)$ at 232 K (28g/mol)

Ne(g) has the smallest molar mass. With all gases at the same temp., Ne would have fastest average velocity. The Ne(g) sample is also at the highest temp. So Ne has fastest average velocity.

29|29
29|29

29. Consider the reaction between 100.0 mL of 0.200 M KOH and 100.0 mL of 0.200 M $Mg(NO_3)_2$. Calculate the concentration of Mg^{2+} ions in solution after the reaction has gone to completion. $0.100\,L\left(\frac{0.200 \text{ mol}}{L}\right) = 0.0200 \text{ mol KOH} + 0.0200 \text{ mol } Mg(NO_3)_2$

Let Mg^{2+} (0.02 moles) react with OH^- (0.02 moles) to form $Mg(OH)_2(s)$.

a) 0 M b) 0.00500 M c) 0.0100 M

d) 0.0150 M e) 0.0200 M

	Mg^{2+}	+ $2OH^-$	→ $Mg(OH)_2(s)$
I	0.02 mol	0.02 mol	0
C	−0.01 mol	−0.02 mol	+0.01 mol
A	0.01 mol	0	0.01 mol

$M_{Mg^{2+}} = \frac{0.0100 \text{ mol } Mg^{2+} \text{ in excess}}{0.100 L + 0.100 L}$ = 0.00500 M

30|30
31|30

30. Consider two steel containers with the same volume and at the same temperature. You have 25 g of Ar(g) in one of the tanks producing a pressure of 1.0 atm. In the other tank, you have 20. g of a gas which produces a pressure of 2.0 atm. Which of the following could be the gas in the second container?

At constant V+T, P∝n. So 2.0 atm container must have twice as many moles of gas as the 1.0 atm container.

a) CH_4 b) N_2 c) He

$\text{mol Ar} = 25 g Ar\left(\frac{1 \text{ mol Ar}}{39.95 g}\right) = 0.626 \text{ mol Ar}$

d) O_2 e) SO_2

Must have 2(0.626) = 1.25 mol in 2.0 atm container. molar mass = $\frac{20.\text{ g}}{1.25 \text{ mol}}$ = 16 g/mol this is CH_4.

31. ~~My answers for this Chemistry 102 exam~~ should be graded with the answer sheet associated with:

a) Form A b) Form B c) Form C d) Form D e) Form E