Given the following data on the reaction of phosphorous with oxygen to form phosphorous oxides:

- Mass of phosphorous = 0.372 g
- Mass of the phosphorous oxide obtained = 0.660 g
-

Given that the molar mass of P=31.0 and for O=16.0 g/mol. The empirical formula (PxOy) of the resulting phosphorous oxide would be

Select one:

- PO2
- P2O3 ✔
- P5O2
- P3O2
- P4O10

[1]

| | P | O |
|---|---|---|
| mass | 0.372 | (0.66 - 0.372) |
| mol | $\frac{0.372}{31}$ | $\frac{0.66-0.372}{16}$ |

$\left(\frac{0.012}{0.012} = 1 \qquad \frac{0.018}{0.012} = 1.5\right) \times 2 \longrightarrow P_2O_3$



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A 20.00 mL sample of vinegar was titrated to the end point with 31.70 mL of 0.15 M NaOH solution. Given that the molar mass of acetic acid = 60.1 g/mol, and the density of the vinegar solution is 1.10 g/mL, then the mass % of acetic acid in vinegar is equal to

Select one:

a. 1.3%

b. 3.2%

c. 2.1% ✗

d. 1.8%

e. 1.5%

[2] $$CH_3COOH\% = \frac{M * M.W}{d * 10}\ \%$$

$$= \frac{((0.15 * 0.0317)/0.02) * 60.1}{1.10 * 10}\ \%$$

$$= 1.3\%$$



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In determining the molar mass of a volatile liquid, an excess sample of the liquid was heated in a 240. mL flask at the boiling point of water (96 oC), at 714 mmHg atmospheric pressure. If the mass of the condensed vapor was 0.54 g, then the molar mass of the volatile liquid (in g/mol) is

Select one:

- a. 73 ✔
- b. 94
- c. 32
- d. 85
- e. 46

[3] $$M.w = \frac{m \cdot R \cdot T}{P \cdot V}$$

$$= \frac{0.54 \cdot 0.082 \cdot (96+273)}{(714/760) \cdot 0.24}$$

$$= 73 \text{ g/mol}$$



Scanned with CamScanner

A 20.00 mL sample of a bleach solution was added into excess of KI, HCl and water mixture, then the resulting solution was titrated to the end point with 15.20 mL of 0.15 M Na2S2O3 solution. The molar concentration of NaClO (molar mass = 74.4 g/mol) in the bleach sample is equal to

Select one:

- a. 0.057 ✔
- b. 0.044
- c. 0.034
- d. 0.030
- e. 0.029

[4] $2 mol\ ClO^- = mol\ S_2O_3^-$

$$M_{ClO^-} = \frac{0.15 * 0.0152}{2 * 0.02}$$

$$= 0.057\ M$$



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A 1.08 g sample mixture of BaCl2.2H2O (Molar mass = 244.3 g/mol) and Na3PO4.12H2O (Molar mass = 380.2 g/mol) was dissolved in 150 mL water, and after filtration and drying, the resulting barium phosphate precipitate Ba3(PO4)2(Molar mass = 601.9 g/mol) weighed 0.56 g. If a drop of sodium phosphate solution added to the filtrate yielded a precipitate, then the mass % of the limiting reactant in the sample mixture is equal to:

Chemical

$$3BaCl_{2(aq)} + 2Na_3PO_{4(aq)} -$$

Select one:

- 45
- 66
- 34 ✗
- 25
- 72

[5] mass of $Na_3PO_4$ = $n_{Ba(PO_4)_2} * 2 * 380.2$

$$= \frac{0.56}{601.9} * 2 * 380.2$$

$$= 0.707\ g$$

$$\%\ I.R = \frac{0.707}{1.08} * 100\%$$

$$= 66\%$$



Scanned with CamScanner

Which of the following statements is incorrect in relation to bleach analysis?

Select one:

- Starch reacts with iodide ions ($I^-$) to form a blue complex
- The reaction is carried out in acidic solution
- ✓ KI is added in excess so that $ClO^-$ acts as the limiting reactant, and also to dissolve $I_2$ into $I_3^-$
- $I_3^-$ ion acts as an oxidizing agent ✗
- both $I^-$ and $S_2O_3^{2-}$ are reducing agents

You have accidentally broken a beaker and spilled a chemical on the bench. Which of the following best explains what you should do?

Select one:

Most of the chemical in the 109 lab are safe and so there is no worry

Throw the glass into the nearest waste basket and let the spill air-dry

Use water and paper towels to clean up the spill; place the broken glass in the disposal container specified by the teacher

✔

Warn your lab partners to avoid the area while you inform the teacher of the small accident

✔

Quickly dispose of the glass, wipe up the spill with the nearest cloth, and hope nobody notices

Given the following two reactions (1 and 2), with the corresponding enthalpy changes (ΔH):

- $N_2(g) + O_2(g) \rightarrow 2 NO(g)$ $\Delta H_1 = +180$ kJ
- $NO_2(g) \rightarrow NO(g) + \frac{1}{2} O_2(g)$ $\Delta H_2 = +56$ kJ

Calculate ΔH for the following reaction:

- $N_2(g) + 2 O_2(g) \rightarrow 2 NO_2(g)$ $\Delta H_3 = ?$

Select one:

- + 159
- + 68
- - 159
- + 236
- + 124 ✖
- - 236
- - 68

[8] $N_2 + O_2 \rightarrow 2NO \quad , \Delta H = 180\ kJ$

$\left(NO_2 \rightarrow NO + 1/2\ O_2 \quad , \Delta H = 56\ kJ\right) \times -2$

$N_2 + 2O_2 \rightarrow 2NO_2 \quad , \Delta H = +68\ kJ$



Scanned with CamScanner

In the standardization of NaOH solution, a 0.21 g sample of potassium hydrogen phthalate (KHP) was dissolved in 50.0 mL of distilled water, the initial burette volume is 2.50 mL and the end point reading is 9.80 mL of the NaOH solution. Given that the molar mass of KHP = 204.2 g/mol, the molar concentration of the NaOH solution is equal to

Select one:

- 0.40 M
- 0.12 M
- 0.21 M
- 0.14 M ✔
- 0.25 M

[9] mol KHP = mol NaOH

$$\frac{0.21}{204.2} = M(9.80 - 2.50) * 10^{-3}$$

$$M = 0.14$$



Scanned with CamScanner

The mass% of NaClO in a stock bleach solution is 5.0%. The molarity of a diluted sample of this solution is 0.050 M. Given that the molar mass of NaClO = 74.4 g/mol and the density of the stock solution = 1.10 g/mL, the dilution factor of the sample would be about to

Select one:

- a. 16
- b. 19
- c. 20
- d. 15 ✔
- e. 17
- f. 14
- g. 18

[10] 5.0% = $\frac{M \times 74.4\%}{10 \times 1.1}$

M(original) = 0.74

0.74 = 0.05 × the dilution Factor

d.f = 15



Scanned with CamScanner

In the titration of 20.0 mL vinegar solution in a flask with aqueous NaOH, which of the following actions would result in an overestimate of the mass% of acetic acid in vinegar?

Select one:

- a.
  Adding distilled water to the vinegar solution in the flask
  ✗
- b.
  Rinsing the burette with NaOH solution
- ✓ c.
  Rinsing the flask with vinegar
- d.
  Losing some of the flask content during titration
- e.
  Adding 2 drops of the indicator rather than 4

Two aqueous solutions: 100.0 mL of 0.40 M HCl and 100.0 mL of 0.40 M NaOH were mixed in a cup calorimeter. The temperature of the mixture increased by 6.4 oC. Given that the density of the solution is 1.00 g/mL, its specific heat = 4.11 J/g.oC, and the cup calorimeter has negligible (مهمل) heat capacity. Calculate the molar enthalpy of acid-base neutralization (ΔH in kJ/mol $H_2O$ produced).

Select one:

- - 413
- + 413
- ✔ - 132
- + 132 ✖
- + 175
- - 175

Which of the following statements is incorrect in relation to the experiment on limiting reactants?

Select one:

An underestimate of the limiting reactant mass% is obtained on loss of part of the precipitate

Na3PO4.12H2O is the limiting reactant, if addition of aqueous Na3PO4.12H2O to the filtrate yields a precipitate

An overestimate of the limiting reactant mass% is obtained on incomplete drying of the precipitate

✗

BaCl2.2H2O is the limiting reactant, if addition of aqueous BaCl2 to the filtrate yields a precipitate

✓

Na3PO4.12H2O is the limiting reactant, if addition of aqueous BaCl2 to the filtrate yields a precipitate

**Note: Answer each of the following questions and mark the correct answer's letter, on the cover page, with X.**

**Q1:** Which one of the following statements is **correct**?

a) If chemicals get in your eye, you have to report this accident to your instructor and then wash your eye with the eye wash fountain
b) Drinking water is allowed in the lab
c) All chemical waste can be discarded in the sink.
d) There is no harm if corrective lenses are worn during the experiment
e) Long hair must be tied back to keep it away from flames and chemicals

**Q2:** Which one of the following is **not** considered as protective tool in the lab?

a) The fume hood
b) Laboratory coat
c) Fire blanket
d) Safety goggles
e) Face mask

**Q3:** Which of the following statements is **incorrect** in relation to laboratory safety rules?

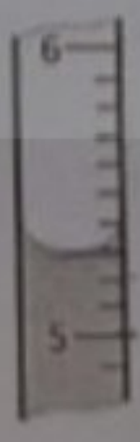
a) Avoid drawing chemicals directly from their source bottles
b) Treat lab acid spills with weak bases (sodium or calcium carbonate or bicarbonates)
c) Water can be used for extinguishing all types of fire
d) Treat lab base spills with weak acids (citric acid, vinegar or sodium bisulfate)
e) To properly light a Benson burner, open the gas inlet, ignite and then adjust the air inlet

**Q4:** Which of the following tools is **most precise** in measuring small volumes of liquids?

a) Graduated flask
b) 100 mL graduated cylinder
c) Graduated beaker
d) Pipets and burettes
e) 200 mL graduated cylinder

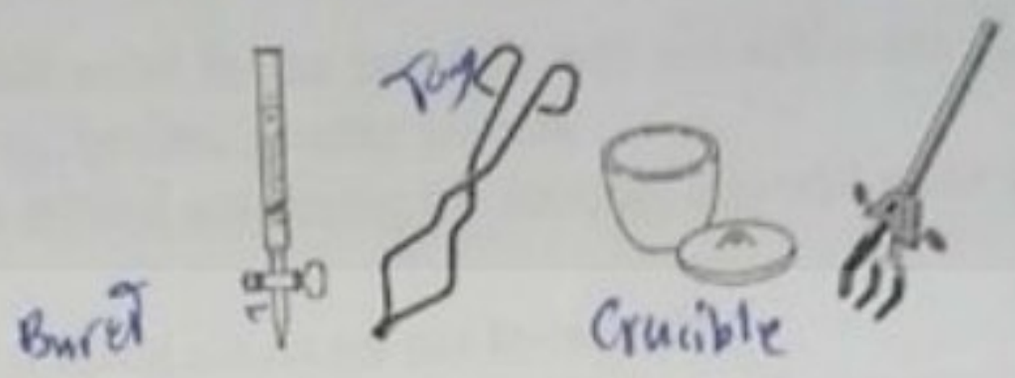
**Q5:** In the shown segment of a 10 mL graduated cylinder, the volume of the liquid is:

a) $5.20 \pm 0.05$ mL
b) $5.30 \pm 0.05$ mL
c) $5.40 \pm 0.05$ mL
d) $5.50 \pm 0.05$ mL
e) $5.60 \pm 0.05$ mL




10mL

**Q6:** What is the name of each of the following apparatus from left to right?




a) Buret, crucible tong, crucible, clamp
b) Clamp, crucible tong, crucible, Buret
c) Pipet, crucible, crucible tong, clamp
d) Buret, crucible tong, clamp, crucible
e) Pipet, crucible tong, crucible, clamp

**Q7:** Given the following set of data for the determination of the density of glass balls?

- Number of glass balls = 5
- Mass of empty beaker = 28.14 g
- Mass of empty beaker + the 5 balls = 45.80 g
- Initial volume of water in the graduated cylinder = 15.5 mL
- Final volume of water in the graduated cylinder = 16.8 mL

Calculate the density of the glass balls in $g/cm^3$.

a) $1.3\times10$ b) 13.6 c) 13.58 d) 13.585 e) 14

$\rho = \frac{mass}{Volume} = \frac{45.8-28.14}{16.8-15.5} = 13.58$ g/mL

$1.3 \times 10$ g/cm$^3$

**Q8:** Given the following set of data for the determination of the formula of hydrate:

- Mass of empty crucible = 35.71g
- Mass of (crucible + alum) = 36.74 g
- Mass of (crucible + anhydrous) after the final heating = 36.36 g
- Molar mass of the anhydrous = 159.6 g/mole
- Molar mass of water = 18.0 g/mole

Calculate the hydration number (X) of the alum.

a) 4 b) 5 c) 6 d) 7 e) 8

$H_2O$ = alum − anhyd = 0.38

$\frac{0.38}{18} = 0.021$

$\frac{0.65}{159.6} = 4.07 \times 10^{-3}$

$X = 5.1$

**Q9:** Which of the following statements is **correct**?

a) Volatile materials exist in the crucible will not affect the X value because they will be burned out during the first heating process

b) If some alum is spilled out during the heating, this will make the calculated X smaller than the true value

c) Hydrates are alums but alums are not hydrates ✗

d) In our experiment, the hydration number (X) can take integer and non-integer values

e) Non-volatile impurities will affect the hydration number leading to larger X value

**Q10:** Given the following set of data for the determination of empirical formula of magnesium oxide:

- Mass of empty crucible = 17.46 g
- Mass of crucible + magnesium = 18.70 g
- Mass of crucible + magnesium oxide= 19.34 g
- Molar mass (g / mol): Mg = 24.4; O = 16.0

$m\% = \frac{M\ Mw}{1000} \times 100$

The molar ratio of Mg to O is

a) 0.88 b) 1.1 c) 1.4 d) 1.3 e) 0.98

Mg $1.24 \rightarrow \frac{1.24}{24.4} = 0.0508$

MgO $1.88 \rightarrow \frac{1.88}{40.4} = 0.0465 = 1.1$

**Q11:** Given the following set of data:

- Mass of salt mixture = 0.93 g
- Mass of $Ba_3(PO_4)_2$ precipitate = 0.43 g
- Molar mass of $Ba_3(PO_4)_2$ = 601.9 g/mole
- Molar mass of $Na_3PO_4.12H_2O$ = 380.2 g/mole
- Molar mass of $BaCl_2.2H_2O$ = 244.2 g/mole
- When a drop of $Ba^{2+}$ solution was added to the filtrate a white precipitate was formed.

Calculate the mass% of the limiting reagent in the original salt mixture
Given, the balanced chemical equation is:

$$2\,Na_3PO_{4(aq)} + 3\,BaCl_{2(aq)} \rightarrow Ba_3(PO_4)_{2(s)} + 6\,NaCl_{(aq)}$$

a) 40% b) 50% c) 55% d) 60% e) 45%

$n = \frac{mass}{mw} = \frac{0.43}{601.9} = 7.144 \times 10^{-4}$

mol $Na_3PO_4$ $7.144 \times 10^{-4} \times 2 = 1.435 \times 10^{-3}$

**Q12:** Which of the following statements is **incorrect**?

a) The precipitate was washed with two portions of 5 mL of hot water to rinse all soluble reagents and products
b) If the precipitate was not dried properly, this will lead to a higher mass% of the limiting reagent in the salt mixture
c) The filter paper was washed with ethanol to facilitate the drying process
d) The solution mixture is not allowed to flow over the edge of the filter paper during filtration because some precipitate will be lost
e) The salt mixture must be dissolved in exactly 150.0 mL of water as a first step

**Q13:** A sample of 1.69 g of KHP (molar mass=204.2 g/mole) dissolved in 50 mL of water, was titrated with 15.50 mL of NaOH solution to the end point. Calculate the molar concentration of sodium hydroxide solution.

a) 0.455 M b) 0.534 M c) 0.623 M d) 0.474 M e) 0.391 M

$M = n \times V(L)$ $\frac{1.69}{204.2} = 8.276 \times 10^{-3}$ $n = M \times V$

$M = \frac{m}{Mw} = \frac{1.69}{204.2}$

$8.276 \times 10^{-3}$ (g)

**Q14:** In determining the mass percent (mass %) of acetic acid ($CH_3COOH$, molar mass = 60.0 g/mol) in vinegar, 10.0 mL of vinegar solution were titrated to the end point with 28.0 mL of 0.300 M NaOH. Given that the density of the vinegar solution is 1.03 g/mL, then the mass % of acetic acid in the vinegar solution is

a) 2.94% b) 3.88% c) 2.19% d) 4.89% e) 4.24%

$m\% = \frac{m \; Mw}{density} = \frac{2760}{1.03}$

$n = M \times V$

$= 8.4 \times 10^{-3}$

$= M * V$

$X = L$

**Q15:** Which of the following statements is **incorrect**?

a) The buret should be rinsed with NaOH solution before titration
b) If air bubbles existed in the buret, this will affect the results leading to a higher concentration of acetic acid than the true value
c) Adding water on the measured volume of vinegar in the flask will not affect the calculated molarity of the acetic acid
d) Titration must be conducted until the first pink color appears, which means the end point has been reached
e) The titration flask should be rinsed with vinegar solution before titration with NaOH solution.

Q1 : e) is correct

Q2 : a) The fume hood

Q3 : c) is incorrect

Q4 : d) pipets and burettes

Q5 : b) $5.30 \mp 0.05$ ml

Q6 : a) Buret, crucible toung, crucible, clamp

Q7 : Density = $\frac{\text{mass}}{\text{volume}} = \frac{45.80 - 28.14}{16.8 - 15.5} = 13.6$ g/ml

[1 ml = 1 $cm^3$] $\rightarrow$ 13.6 g/$cm^3$

28.1 $\rightarrow$ 14 g/$cm^3$ * e



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Q8: mass of $H_2O$ = mass of alum − mass of anhydrous

$= (36.74 - 35.71) - (36.36 - 35.71)$

$= 0.38g$

$X$ = moles of $H_2O$ / moles of anhydrous $= \frac{(0.38g / 18g/mol)}{(0.65g / 159.6g/mol)}$

$= 5$ #b

Q9: a) is correct

Q10: mass of Mg = 18.70 − 17.46 = 1.24g

mass of MgO = 19.34 − 17.46 = 1.88g

mass of O = 1.88 − 1.24 = 0.64g

$\rightarrow \frac{\text{mol Mg}}{\text{mol O}} = \frac{1.24 / 24.4}{0.64 / 16} = 1.3$ # d

Q11: $BaCl_2$ : I.R

mass of $BaCl_2$ : $3 \times n\, Ba_3(PO_4)_2 \times 244.2$

$3.\left[\frac{0.43}{601.9}\right].244.2$

$= 0.523g$

mass% I.R = $\frac{0.523}{0.93} * 100\%$

$= 56\%$



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Q12: C) is incorrect

Q13: mol ICHp = mol NaoH

$$\frac{1.69}{204.2} = M \times 0.0155$$

$$M = 0.534 \quad \# b$$

Q14: mass% $CH_3COOH = \frac{M \times M.w}{d \times 10}\% = \frac{0.84 * 60}{1.03 * 10}\%$

$= 4.89\%$ d#

$M\ CH_3COOH = \frac{0.3 * 0.028}{0.01}$

$= 0.84$

Q15: e) is incorrect



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