THE COPPERBELT UNIVERSITY
SCHOOL OF MATHEMATICS AND NATURAL SCIENCES
DEPARTMENT OF CHEMISTRY

CHEMISTRY (CH 110/ FO 130) TUTORIAL SHEET 1 TERM ONE YEAR 2023

1. Discuss the various steps involved in the scientific method
2. Convert each of following:

   (a) 450 cm^3 to dm^3 (b) 0.54 m to Å (c) 9 nm to cm (d) 1 gcm^{-3} to gdm^{-3}

   (e) 0.2 kg to mg (f) 8 cm^3 to m^3

3. For each of the following pairs, determine which quantity is larger:

   (a) 500 cm or 0.56 m (b) 5 dm^3 or 3.2 m^3 (c) 0.8 nm or 8 Å (d) 1 kg/m^3 or 10 g/cm^3
4. In connection with scientific measurements, explain the
   (a) Two parts of a quantitative measurement
   (b) Difference between a qualitative and quantitative measurement
   (c) Difference between accuracy and precision
   (d) Difference between systematic and random errors
5. A foundry releases 800 kg of gas into the atmosphere per day. The gas contains 3.2 % sulfur dioxide by mass. What mass of sulfur dioxide is released by the foundry every week?
6. Analysis shows that 20.0 mL of concentrated hydrochloric acid of density 1.18 g/ml contains 8.36 g HCl.
   (a) Calculate the mass of HCl per ml of acid solution
   (b) Calculate the percent by mass of HCl in the concentrated acid.
7. What is the specific gravity of a liquid if 225 cm^3 of the liquid has the same mass as 396 cm^3 of water?
8. Cesium atoms are the largest naturally occurring atoms. Each has a radius of 2.62 Å. How many atoms of cesium would have to be laid side by side to a row of cesium atoms 0.1 cm long, assuming the atoms are spherical?
9. The proton is thought to have a radius of 1.30×10^{-13} cm and a mass of 1.67×10^{-12} g. Determine its density assuming it is spherical.

10. Indicate the number of protons, neutrons and electrons in each of the following species.

    (a) $^{31}P_{15}$ (b) $^{236}U_{92}$ (c) $^{25}Mg_{12}^{2+}$

11. Sketch a mass spectrometer and discuss the importance of the main components (Ion source, Analyser and detector) of a mass spectrometer. O
12. Discuss how the field effects and particle effects affect the separation of ions in a mass spectrometer.
13. If an element consists of 37.50 % atoms with a mass of 184.9530 amu each and 62.50 % atoms with a mass of 185.9560 amu each, what is the atomic mass of the element?
14. Consider the following ions $^{16}O_8^+$, $^{17}O_8^+$, $^{16}O_8^{2+}$, $^{17}O_8^{2+}$, which are produced in a mass spectrometer. Which ion`s path would be deflected most by a magnetic field? justify your answer
15. Arrange the following in order of increasing ratio of charge to mass (e/m):
    $^{12}C^+$, $^{12}C^{2+}$, $^{13}C^+$, $^{13}C^{2+}$
16. Provide the systematic name of each of the following compounds:

    (a) IF_5 (b) $HClO_4$ (c) $NaHCO_3$ (d) NaOCl (e) P_2O_5 (f) SF_6

17. Provide the chemical formula of each of the following compounds:

    (a) Cobalt(II) iodide (b) Diphosphorus pentasulfide (c) Chloric acid

    (d) Potassium permanganate (e) Strontium phosphide (f) Titanium(IV) oxide.

THE END$_{FM2023}$

TUTORIAL SHEET 1

Q1. i) Making Observations
ii) Formulating hypotheses
iii) performing experiments

Q2. (a) $450cm^3$ to dm^3

$= 450cm^3 \times \frac{1dm^3}{1000cm^3}$

$= 0.45dm^3$

* $1dm = 10cm$, $1dm^3 = 1000cm^3$

(b) $0.5m$ to $\AA$

$= 0.5m \times \frac{1\AA}{1\times10^{-10}m}$

$= 5.0\times10^{9}\AA$

(c) $9nm$ to cm

$9nm \times \frac{1\times10^{-7}cm}{nm}$

$= 9\times10^{-7}cm$

* $1nm = 1\times10^{-9}m$

(d) $1g/cm^3$ to g/dm^3

$\frac{1g}{cm^3} = \frac{1g}{0.001dm^3}$

$= 1000g/dm^3$

* $1cm^3 = 0.001dm^3$

(e) $0.2Kg$ to mg

$0.2Kg \times \frac{10000mg}{Kg}$

$= 2000mg$

* $1Kg = 10000mg$

(f) $8cm^3$ to m^3

$= 8cm^3 \times \frac{m^3}{1000000dm^3}$

$= 8\times10^{-6}m^3$

* $1m^3 = 1000000cm^3$

Q3. (a) 500cm or 0.56m

=> 500cm is greater

(b) $5dm^3$ or $3.2m^3$

=> $3.2m^3$ is greater

proof: $5dm^3 \times \frac{1m^3}{1000dm^3}$

$= 0.005m^3$

* $1m = 10dm$

$1m^3 = 10dm \times 10dm \times 10dm$

$= 1000dm^3$

(a) 0.8nm or 8Å

⇒ SAME

proof: $8\text{Å} \times \frac{1\times10^{-10}\,m}{1\,\text{Å}}$

$= 8\times10^{-10}\,m$

$0.8\text{nm} \times \frac{1\times10^{-9}\,m}{1\,nm}$

(c) 0.8nm or 8Å

⇒ SAME

proof: Change both to metres

$0.8\text{nm} \times \frac{1\times10^{-9}\,m}{1\,nm} = 8\times10^{-10}\,m$

$8\text{Å} \times \frac{1\times10^{-10}\,m}{1\,\text{Å}} = 8\times10^{-10}\,m$

Same

(d) $1\,kg/m^3$ or $10\,g/cm^3$

⇒ $10\,g/cm^3$ is greater

proof: $\frac{1\,kg}{m^3} = \frac{1000\,g}{1\,000\,000\,cm^3}$

$1\,kg/m^3 = 0.001\,g/cm^3$

Q4. (a) Two parts of a quantitative measurement:

⇒ Number and Unit

(b) Difference btw qualitative and quantitative

⇒ Qualitative is about what the substance consists of / what makes up the substance e.g colour, smell, taste, bonds etc while quantitative is about how much, in terms of numbers and units, is contained by the substance (Quantitative is about the amount/quantity of the components contained) e.g ~~moles~~ # of moles, mass, # of particles etc.

(c) Difference btw accuracy and precision

⇒ Accuracy is the degree of closeness of the measured value to the true or acceptable value where as

Precision is the degree of agreement or closeness among the several measured values (it is the degree of reproducibility

(d) Difference btn Systematic and random errors

⇒ Systematic (Determinate) errors are errors caused ~~by~~ due to faulty Instruments, wrong method used or operation challenges whereas Random (Indeterminate) errors are those caused/brought about due to experimental uncertainty (These are caused by unknown and unpredictable changes in the experiment)

Q5 $\frac{3.2}{100} \times 800kg \times 7 days$

$= 3.2 \times 8 \times 7$

$= 179.2 kg$

Q6.

Q6. (a) $\frac{8.36g}{20.0ml}$

$= 0.418 g/ml$

(b) % by mass

Total mass: $m = \rho \times V$

$= 1.18 g/ml \times 20.0ml$

$= 23.6g$

$\frac{8.36g}{23.6g} \times 100\%$

$= 35.4\%$

Q7. Specific Gravity $= \frac{\text{Density of Substance}}{\text{Density of water}}$

$\frac{m/225cm^3}{m/396cm^3} = \frac{m}{225cm^3} \times \frac{396cm^3}{m}$

$= 1.76$

Q8. Diameter = 2 × radius
= 2 × 2.62 Å
= 2 × 2.62 Å × 10^{-10} m (Changing to metres)
= 5.24 × 10^{-10} m × $\frac{100\text{cm}}{\text{m}}$ (Changing to cm)
= 5.24 × 10^{-8} cm

# of atoms = $\frac{0.1\text{ cm}}{5.24 \times 10^{-7}\text{ cm}}$
= 1.91 × 10^{5} atoms

Q9. Density (ρ) = m/v
$v = \frac{4}{3}\pi r^3$
= $\frac{4}{3} \times \frac{22}{7} \times (1.30 \times 10^{-13})^3$
= 9.2 × 10^{-39}

$\rho = \frac{1.67 \times 10^{-12}\text{ g}}{9.2 \times 10^{-39}\text{ cm}^3}$
= 1.815 × 10^{26} g/cm³

Q10. (a) $^{31}P_{15}$ (b) $^{236}U_{92}$ (c) $^{26}Mg^{2+}_{12}$

P – 15	P – 92	P – 12
N – 16	N – 144	N – 13
E – 15	E – 92	E – 10

Q11. Sample mist → Ion Source → Analyzer → Detector → Display System

- Ion Source is for producing gaseous ions from the substance being studied
- Analyzer is for resolving the ions into their characteristics mass components according to their mass-to-charge ration
- Detector is for detecting the ions and recording the relative abundance of each of the resolved ion species

Q12. – The magnetic field bends the path of ions, the stronger the magnetic field the more bent the path is.
– The lighter the ion the larger the deflection.
The ions with higher masses are least deflected.

Q13. Atomic mass $= \left(\frac{37.50}{100} \times 184.9530\right) + \left(\frac{62.50}{100} \times 185.9560\right)$

$= (0.375 \times 184.9530) + (0.625 \times 185.9560)$

$= 69.357375 + 116.2225$

$= \underline{185.579875}$

Q14. ${}^{16}_{8}O^{2+}$ is deflected more due to smaller mass / charge (m/e) ratio and more electrons discharged.

$m/e = \frac{16}{2} = 8$

Q15. ${}^{13}C^{+}$, ${}^{12}C^{+}$, ${}^{13}C^{2+}$, ${}^{12}C^{2+}$

Q16. (a) IF_5 – Iodine pentafluoride

(b) $HClO_4$ – Perchloric acid

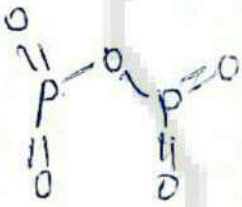
$HClO_3$ – Chloric acid

$HClO_2$ – Chlorous acid

$HClO$ – Hypochlorous acid

Q16 (c) $NaHCO_3$ – Sodium hydrogen Carbonate.

(d) $NaOCl$ – Sodium hypochlorite

(e) P_2O_5 – Diphosphorous pentoxide 

(f) SF_6 – Sulfur hexafluoride

Q17. (a) CoI_2 (b) P_2S_5 (c) $HClO_3$

(d) $KMnO_4$ (e) Sr_3P_2 (f) TiO_2