Practice questions yr 12

Question 1

Serotonin ($C_{10}H_{12}N_2O$; molar mass = 176 g mol^{-1}) is a compound that conducts nerve impulses in the brain and muscles. A sample of spinal fluid from a volunteer in a study was found to contain a serotonin concentration of 1.5 ng L^{-1} (1.5 nanograms per litre).
How many molecules of serotonin are there in one millilitre of the spinal fluid?
A. 5.13×10^{9}
B. 9.03×10^{11}
C. 5.13×10^{27}
D. 9.03×10^{29}

1.5 ng L^{-} = $1.5 \text{ X } 10^{-9}$ gL^{-}

=> $1.5 \text{ X } 10^{-9}$ g in 1000 mL

=> $1.5 \text{ X } 10^{-9}$ g / 1000 mL = $1.5 \text{ X } 10^{-12}$ g of serotonin in one mL of spinal fluid

=> formula mass of serotonin 176$gmol^{-}$

=> $(1.5/176) \text{ X } 10^{-12}$ mol

=> $(1.5/176) \text{ X } 10^{-12} \text{ X } 6.02 \text{ X } 10^{23}$

=> $5.13 \text{ X } 10^{9}$ molecules

Question 2

Xylose is a compound that has five carbon atoms in each molecule and contains 40% carbon by mass.
What is the molar mass of xylose?
A. 30
B. 67
C. 150
D. It cannot be determined without further information.

The atomic mass of carbon is 12.0 g mol^{-}.

= > each xylose molecule contains 5 carbons. Hence 1 mol of xylose contains 5 mol of carbon.

= > $60/Fm_{xylose}$ X 100 = 40%

= > $60/0.4 = Fm_{xylose}$

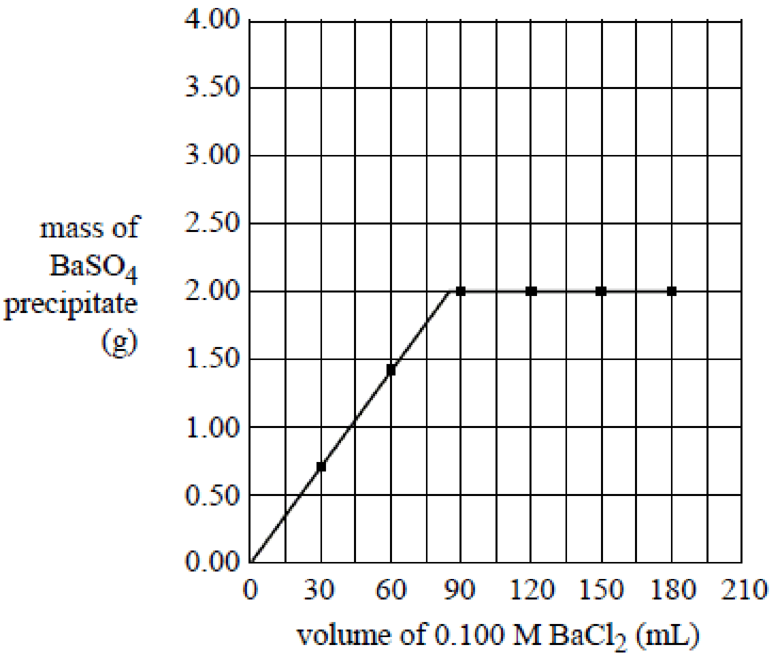
Question 3
The percentage purity of powdered, impure magnesium sulfate, $MgSO_4$, can be determined by gravimetric analysis. Shown below is the method used in one such analysis.
Method
• 32.50 g of the impure magnesium sulfate is dissolved in water and the solution is made up to 500.0 mL in a volumetric flask.
• Different volumes of 0.100 M $BaCl_2$(aq) are added to six separate 20.00 mL samples of this solution. This precipitates the sulfate ions as barium sulfate. The equation for the reaction is
$Ba^{2+}(aq) + SO_4^{2-}(aq) \rightarrow BaSO_4(s)$
• The precipitate from each sample is filtered, rinsed with de-ionised water and then dried to constant mass.
The results of this analysis are shown on the next page

Results

Mass of impure magnesium sulfate = 32.50 g
Volume of volumetric fl ask = 500.0 mL
Volume of magnesium sulfate solution in each sample = 20.00 mL

Sample	1	2	3	4	5	6
volume of $BaCl_2$(aq) added (mL)	30.0	60.0	90.0	120	150	180
mass of $BaSO_4$(s) precipitated (g)	0.704	1.41	2.00	2.00	2.00	2.00

These results are shown on the graph below.



a. Why is it necessary to rinse the precipitate with de-ionised water before drying?

A variety of responses are acceptable. Responses must indicate that the removal of soluble impurities is achieved by rinsing.

b. Explain why the amount of $BaSO_4$(s) precipitated remains constant for the last four samples tested even though more $BaCl_2$(aq) is being added.
Responses such as:
- all the SO_4^{2-} is used up;

- $BaCl_2$ is in excess.

C Calculate

i. the amount, in mole, of SO_4^{2-}(aq) in the 500.0 mL volumetric fl ask.

$$n(SO_4^{2-}) \text{ in } 20.00 \text{ mL sample} = n(BaSO_4)$$
$$= \frac{2.00}{233.4}$$
$$= 8.57 \times 10^{-3}$$
$$n(SO_4^{2-}) \text{ in } 500 \text{ mL} = \frac{8.57 \times 10^{-3}}{20} \times 500$$
$$= 0.214 \quad (\text{mol})$$

ii. the percentage, by mass, of magnesium sulfate in the powder.

$$m(MgSO_4) = 0.214 \times 120.4$$
$$= 25.8 \text{ g}$$
$$\%MgSO_4 = \frac{25.8}{32.50} \times 100$$
$$= 79.4\%$$

Question 4

A 1.22 g sample of impure lead nitrate was dissolved in 40.0 mL of distilled water and analysed by gravimetric analysis to determine the percentage of lead by mass present. Sodium sulphate was delivered from a burette to precipitate the lead ions as lead sulphate. Sodium sulphate was added until no more precipitate was seen to form. At this point several drops of sodium sulphate were allowed to drop from the burette into the sample. The precipitate was filtered, washed and dried before been weighed. When weighed, the precipitate had a mass of 1.44 g

a. Write an equation for the reaction
   $Pb(NO_3)_2(aq) + Na_2SO_4(aq) => PbSO_4(aq) + 2NaNO_3(aq)$

b. Calculate the moles of lead sulphate precipitated

   1.44 g / (207.2 + 32.0 (4 X 16.0)) = 0.00475

c. Calculate the mass of lead present

   0.00475 X 207.2 = 0.984 g

d. Calculate the percentage composition of lead in the original sample

   0.9884 / 1.22 = 80.7%

e. Which of the following is not critical for the analysis? Give a brief explanation
   i) Thorough washing of the precipitate.
   ii) Reading the burette to 2 decimal places after adding the sodium sulphate.
   iii) Addition of extra sodium sulphate.
   iv) Accurately weigh the filter paper before filtering the precipitate.

An accurate titration is not necessary. Excess sodium sulphate is used to precipitate out all the lead as lead sulphate.