# Knowledge Assessment

**Assessment event 1 of 3**

# Trainer & Assessor Marking Guide

## Criteria

### Unit code, name and release number

MSL974017 - Prepare, standardise and use solutions (1)

### Qualification/Course code, name and release number

MSL40118 - Certificate IV in Laboratory Techniques (1)

MSL50118 – Diploma in Laboratory Technology (1)

\*\*Amend the qualification box before distributing to the student. The information here should only contain the qualification the student is enrolled in.\*\*

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For queries, please contact:

Innovative Manufacturing, Robotics and Science SkillsPoint

Hamilton Campus

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This assessment can be found in the: [Learning Bank](https://share.tafensw.edu.au/share/access/searching.do?doc=%3Cxml%2F%3E&in=P7ac4831b-430a-4b8d-8b56-f7b32ed5b9cf&q=&type=standard&sort=rank&dr=AFTER)

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## Assessment instructions

Table 1 Assessment instructions

| Assessment details | Instructions |
| --- | --- |
| **Instructions for the trainer and assessor** | This is a written assessment and will be assessing the student on their knowledge of the unit.  This assessment is in 4 parts:   1. Multiple choice questions (Question 1 - Question 15) 2. True or False questions (Question 16 - Question 30) 3. Short answer questions (Question 31 – Question 47) 4. Assessment feedback   The student may bring into the assessment one A4 sheet of self-prepared study notes related to the Unit. This must be collected at the end of the Knowledge Assessment. Ensure the student name is on the sheet.  The Assessment paper contains in the Appendices a Periodic Table and a Data Sheet that contains basic formulae, valency table and Standard Potentials. The student may choose to detach these sheets for convenience during the assessment, however, the pages must be collected with the completed Assessment Paper.  Model answers, sample responses or a criteria for each question are provided below.  Use these to support your judgement when determining a satisfactory result.  The student’s response to each question must contain the information indicated in this marking guide in order for their response to be correct. However, if a student provides information other than indicated below, and in the professional opinion of the assessor it is appropriate and meets the intent of the question, it may be considered correct.  The assessment feedback page must be signed by both the student and the assessor so the student displays that they have received, understood and accepted the feedback.  Complete the assessment feedback to the student and ensure you have taken a copy of the assessment prior to it being returned to the student.  Ensure the students name appears on the bottom of each page of the submitted assessment. |
| **About this marking guide** | The student’s response to each question must contain the information indicated in this marking guide in order for their response to be correct.  All questions must be answered correctly in order to satisfactorily complete this assessment event.  Assessors will need to make a judgement call as to whether each answer/response meets the criteria based upon the:   * Rules of Evidence:   + Validity – does the answer address the assessment question and does the evidence reflect the four dimensions of competency?   + Sufficiency – is the answer sufficient in terms of length and depth?   + Currency – has the work been done so recently as to be current?   + Authenticity – is this work the student’s own authentic work? * Principles of Assessment:   + Fairness – individual student’s needs are considered in the assessment process   + Flexibility – assessment is flexible to the individual student   + Validity – any assessment decision is justified, based on the evidence of performance of the student   + Reliability – evidence presented for assessment is consistently interpreted and assessment results are comparable irrespective of the assessor conducting the assessment * Dimensions of competency   + Task skills   + Task Management Skills   + Contingency Planning Skills   + Job Role Environment Skills |
| **Student must provide** | Calculator, pens, double sided A4 sheet of student study notes. |
| **Assessor must provide** | Copy of Knowledge Assessment |
| **Time allowed** | 3 hours |

## Multiple choice (Questions 1-15)

Read the question and each answer carefully. Put an X in the table next to your chosen answer.

1. Which of the following sets of data contain an atypical pH value?

Table 2 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 5.0, 4.9, 4.7 |  |
| 1. 5.1, 4.8, 5.0 |  |
| 1. 5.0, 7.6, 4.9 | X |
| 1. 4.9, 5.2, 4.8 |  |

1. The endpoint of a titration occurs when:

Table 3 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Exactly the correct stoichiometric amount of the two reactants are combined |  |
| 1. The first sign of a permanent colour change is observed | X |
| 1. The burette is empty |  |
| 1. The solution turns colourless |  |

1. Which of the following is classified as a weak acid?

Table 4 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. NH4OH |  |
| 1. HCl |  |
| 1. CH3COOH | X |
| 1. HNO3 |  |

1. A buffer solution is a solution that:

Table 5 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Prevents rusting |  |
| 1. Resists changes to pH when acid or base is added | X |
| 1. Changes colour at the equivalence point |  |
| 1. Changes colour at the end point |  |

1. A buffer solution can be prepared by combining a:

Table 6 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Strong base with some indicator |  |
| 1. Strong base and a strong acid |  |
| 1. Strong acid with its conjugate base |  |
| 1. Weak acid with a salt of its conjugate base | X |

1. The mass of NaCl in a 25 mL aliquot of a 5.00g/L standard solution of NaCl is:

Table 7 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 5 x 25 x 1000 g |  |
| 1. (25 / 1000) x 5 g | X |
| 1. (5 x 1000) / 25 g |  |
| 1. 5 / (25 x 1000) g |  |

1. Select the statement that is **true**:

Table 8 Multiple choice

| Answer choices | | Put X next to your answer |
| --- | --- | --- |
| 1. A **reductant** (reducing agent) gains electrons and is itself reduced |  | |
| 1. An **oxidant** (reducing agent) loses electrons and is itself oxidised |  | |
| 1. A **reductant** (oxidising agent) loses electrons and is itself oxidised |  | |
| 1. An **oxidant** (oxidising agent) gains electrons and is itself reduced | X | |

1. Which of the following would be the most accurate piece of equipment for the quantitative transfer of 50 mL of solution?

Table 9 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 50 mL beaker |  |
| 1. 50 mL measuring cylinder |  |
| 1. 50 mL burette | X |
| 1. 50 mL conical flask |  |

1. Which of the following items of personal protection is required at all times during routine laboratory work that involves the dilution of concentrated acids or base solutions?

Table 10 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Safety goggles |  |
| 1. Enclosed footwear |  |
| 1. Laboratory coat |  |
| 1. Rubber gloves |  |
| 1. All of these | X |

1. Which of the following is the most appropriate to measure out approximately 25 mL of solution?

Table 11 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 25 mL measuring cylinder | X |
| 1. 25 mL pipette |  |
| 1. 25 mL volumetric flask |  |
| 1. 100 mL conical flask |  |

1. The sign below is the GHS symbol that would be used for:



Table 12 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. An organic solvent |  |
| 1. Recycled plastics |  |
| 1. Corrosive material | X |
| 1. Detergents |  |

1. The correct balanced equation for the stoichiometric analysis of ethanoic acid (CH3COOH) with sodium hydroxide is:

Table 13 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. CH3COOH + NaOH 🡪 CH3COONa + H2O | X |
| 1. 2CH3COOH + Na2CO3 🡪 2CH3COONa + CO2 + H2O |  |
| 1. H2O + CO2 🡪 H2CO3 |  |
| 1. There is no reaction |  |

1. The redox reaction between iodine and thiosulfate relies on the following two half equations:

I2(aq) + 2 é 🡪 2I-  and

2S2O32-  🡪 S4O62-  + 2 é

The reaction ratio between I2 and S2O32- is:

Table 14 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 2 : 1 |  |
| 1. 1 : 1 |  |
| 1. 1 : 2 | X |
| 1. 2 : 4 |  |

1. The diprotic acid H2SO4 ionises in solution according to the following equations

H2SO4 + H2O 🡪 H3O+  + HSO4-

HSO4-  + H2O 🡪 H3O+ + SO42-

Which of the following species is an amphoteric (amphiprotic) substance

Table 15 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. H2SO4 |  |
| 1. HSO4- | X |
| 1. SO42- |  |
| 1. H3O+ |  |

1. The mass of Ca(OH)2 required to prepare 500 mL of a 0.2M solution is:

Table 16 Multiple choice

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. 7400 g |  |
| 1. 7.4 g | X |
| 1. 5.7 g |  |
| 1. 5.8 g |  |

## True or false (Question 16 – 30)

Read the question and then write **True** or **False** in the space provided.

Table 3 True or false

| Question | Write *True* or *False* |
| --- | --- |
| 1. An amphoteric (amphiprotic) species is one that is able to accept or donate protons in a reaction. | T |
| 1. Technical grade reagent is the most appropriate chemical grade to use as a primary standard. | F |
| 1. The equivalence point of a reaction is when exactly the correct stoichiometric amount of the two reactants are combined. | T |
| 1. All measurements taken in the laboratory are estimates only, as each measuring piece of equipment has a degree of uncertainty. | T |
| 1. The small spill (25 mL) of 5 M HCl would be best cleaned up by sprinkling over the spill sodium hydrogen carbonate powder until the reaction has ceased. | T |
| 1. A secondary standard is one that has had its concentration determined by titration using a primary standard. | T |
| 1. Information regarding the correct disposal of chemical wastes would typically be found in the Standard method or the applicable Safety Data Sheet. | T |
| 1. The actual storage container for all solutions is irrelevant as long as the concentration is correct. | F |
| 1. Repeating a titration until you have three consistent titration values is routine practise to increase the precision of the result. | T |
| 1. The choice of indicator for a titration is irrelevant as they will all change colour. | F |
| 1. A dirty burette is an example of a systematic error that could lead to an incorrect titration volume and therefore an error in the final concentration. | T |
| 1. Solubility of solids and liquids can be increased by increasing the temperature. | T |
| 1. The % v/v concentration of an ethanol solution prepared by diluting 18 mL of ethanol to a final volume of 2545 mL with water is 0.71 %v/v. | T |
| 1. A solution contains 9.00g glucose (C6H12O6) in 150 mL of solution. The % w/v of the final solution is 6 % w/v | T |
| 1. Fe3+ forms because iron gains 3 electrons | F |

## Part 3: Short answer

Read the questions carefully. Your answers should be no longer than 150 words for any part. For all calculation questions show your working.

1. The primary standard sodium carbonate can be used to standardise hydrochloric acid. A technician conducted four titrations using 25.0 mL aliquots of 0.0479M Na2CO3. The average volume of the unstandardized acid was 18.16 mL. The indicator used was screened methyl orange
2. Write the balanced equation for the reaction

Na2CO3 + 2HCl 🡪 2NaCl + H2O + CO2

1. Calculate the concentration of the HCl solution.

(Student should show working. There are a number of methods for getting the final answer. As long as working is shown and concentration is correct response should be deemed satisfactory.

Moles Na2CO3 = 0.0479 x 0.025 = 1.20 x 10-3

؞

Moles HCl = 2 x 1.20 x 10-3= 2.40 x 10-3

[HCl] = 2.40 x 10-3 / 0.01816 = 0.132 M

1. What are three things that a technician should look for when making a visual inspection of stock solutions for signs of deterioration

Student response could include any three of:

Turbidity

Deposits

Crystallisation

Colour change

Expiry dates

Algae growth

(Note: other responses could be provided and the Assessor should make a determination as to the accuracy of these)

1. Explain the characteristics required of a reaction for determining the concentration of a solution using the process of titration?

Criteria used to determine suitable titration reactions include:

**Defined stoichiometry**: there must be a balanced equation that describes the reaction correctly as the reaction ratio is required for the calculations.

**Rapid reaction rate**: so a premature endpoint is not obtained due to a lag in the reaction

**Complete reaction:** to ensure the analyte is completely consumed

**Endpoint detection:** a method of determination is required to accurately determine the equivalence point.

1. What characteristics are required for a chemical to be suitable as a primary standard? (you should provide at least 3)

The primary standard should have:

High purity:

Chemical stability

Absence of hydrate water

Available at reasonable cost

Reasonably high formula mass

(Note: the student should provide at least 3 of these)

1. What is the function of an indicator in titration and how is the appropriate indicator chosen?

An indicator is a chemical that changes colour in response to a change in the chemical nature of a solution. A pH indicator will change colour when there is a particular change in the pH of a solution. The colour change is dependent on the particular indicator and the pH of the solution.

As each indicator changes colour at a different pH it is important to know the pH of the equivalence point of a reaction. A strong acid/strong base will have an equivalence point of 7. The pH change is dramatic, between 4 and 10 upon a very small addition of titrant. Hence an indicator that changes colour in this range would be suitable.

(Phenolphthalein, bromothymol blue and methyl orange would be suitable. This is not asked for in the question but students may offer a suggestion for an indicator).

1. Explain how the equivalence point of a titration reaction can be determined using a pH probe. Use a sketch of the titration of 0.1 M HCl with 0.1 M NaOH solution in your explanation.

The sketch of NaOH as the titrant with the HCl in the beaker is shown below.

Equivalence point

Graphing (either manually or with a data logger) the volume of titrant added vs the pH of the solution in the beaker a dramatic increase in pH with the small addition of the NaOH is observed. The equivalence point is determined as being half way up the vertical jump. In this example the pH of the equivalence point would be at 7.

1. Titration of 20.0 mL 0.100M ammonia with 0.0500 M HCl had the following titration curve:

**Typical pH indicator ranges**

|  |  |  |
| --- | --- | --- |
| Indicator | pH range | Colour (low pH – high pH) |
| Thymol blue (1st change) | 1.2 – 2.6 | Red - yellow |
| Methyl orange | 3.1– 4.4 | Red - yellow |
| Azolitmin | 5.0 – 9.0 | Red - blue |
| Thymol blue (2nd change) | 6.0 – 9.6 | Yellow - blue |
| Phenolphthalein | 8.3 – 10.0 | Colourless – violet |
| Alizarin yellow | 10.7 – 12.0 | Yellow - violet |

1. The volume of the 0.050M HCl required to reach equivalence point is:

40 mL

1. The most suitable indicator for this reaction is and why?

Methyl orange. The equivalence point is approximately pH 5.5

Methyl orange has colour change yellow to red between the ranges 4.4 and 3.1. This is on the vertical change in the graph as shown.

1. If the indicator Alizarin yellow had been used, what colour would it be when the reaction mixture is at a pH of 7.0

Yellow

1. Explain how each of the following pieces of glassware would be prepared and used in this titration and the typical errors associated with each.

**20.0 mL bulb pipette**:

Rinsed with ammonia solution 3 times. Filled using a pipette bulb to above the line on the pipette. Level is adjusted so the bottom of the meniscus sits on the line. The volume is dispensed by allowing the liquid to fall freely into a conical flask. The tip of the pipette is touched to the side of the flask and allowed to drain. The last remaining drops are not forced into the conical flask.

**Burette:**

The burette is rinsed with the HCl, 3 times. It is filled above the 0.0 mL line with the HCl., The tap is closed and the level adjusted so the bottom of the meniscus sits on the 0.0 mL line. Care must be taken to ensure there are no bubbles in the tap area.

**Conical flask (titration vessel):**

Is used clean and dry or rinsed with purified water. It should not be rinsed with the solution to be placed in it.

**Beaker holding the HCl:**

Clean and dry or rinsed with the HCl. It should not be rinsed with water as this will dilute the solution.

**Beaker holding the ammonia:**

Clean and dry or rinsed with ammonia. It should not be rinsed with water as this will dilute the solution.

1. In the following reaction the precipitation of silver bromide is quantitative.

AgNO3(aq) + NaBr(aq) 🡪 AgBr(s) + NaNO3(aq)

If 23.45 mL of 0.0457 M AgNO3(aq) reacts exactly with a 25.0 mL aliquot of NaBr(aq), what is:

1. The concentration of the sodium bromide solution in moles/L?

The reaction ratio is 1:1

؞ moles AgNO3 = 0.02345 x 0.0457 = 1.07 x 10-3

؞ moles NaBr = 1.07 x 10-3

[NaBr] = 1.07 x 10-3 /.025 = 0.0429 mol/L

1. What mass of silver bromide is formed?

Moles AgBr = 1.07 x 10-3

Mass AgBr = 1.07 x 10-3 x 187.8 = 0.201 g

1. Write the name or formula and determine the formula weight for the following elements and compounds.

| Formula | Name | Formula mass/Atomic Mass |
| --- | --- | --- |
| Pb | Lead | 207.2 |
| SO3 | Sulfur trioxide | 80.1 |
| Mg(NO3)2 | Magnesium nitrate | 148.3 |
| Fe2(SO4)3 | Iron III sulfate  (also ferric sulfate) | 399.9 |

1. Explain the difference between the following grades of chemical:

* Analytical reagent
* Technical
* Laboratory
* Spectrograde
* Food Grade

Which would be the most suitable for use as a primary standard.

The most suitable grade to be used as a primary standard would by Analytical Reagent (AR)

**Analytical reagent** has very high purity with extremely low levels of impurities. The levels of contaminants are identified.

**Laboratory grade** has very high level of purity but the levels of impurities are not known.

**Technical grade** contains impurities and is suitable for non-critical tasks.

**Spectrograde**: is spectrally pure for the particular region identified. It may contain impurities that will not interfere in the required region.

**Food Grade:** indicates the chemical is fit for human consumption.

1. A 20.0 ml aliquot of a sample of Na2SO3 is titrated to a colourless endpoint by 17.82 mL 0.0100 M acidified KMnO4. Determine the concentration of the thiosulfate ion in the sample. Show your working.

2MnO4-(aq) + 16H+(aq)  + 10S2O32-(aq) 🡪 2Mn2+(aq) + 8H2O(aq)  + 5S4O62-(aq)

Reaction ratio MnO4- : S2O32-  is 1 : 5

Moles MnO4- = 0.017820x 0.0100 = 1.782 x 10-4

Moles SO32- = moles MnO4- x 5 = 1.782 x 10-4 x 5 = 8.91 x 10-3

[S2O32-] = 8.91 x 10-3 / 0.020 = 0.0446 mol/L

1. Outline the labelling requirements for stock solutions in your workplace.

Each workplace may be slightly different, but generally responses could include:

Workplace must follow GHS system for all hazardous chemicals (noting there are some exceptions).

Labels must be written in English,

Product identifier: unique name, ( IUPAC, or CAS or technical name)

Must have hazard pictograms attached

Hazard statements, signal words

Ingredients

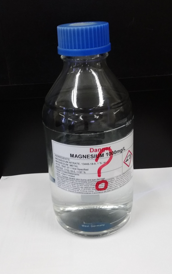
Expiry date if applicable

First aid

1. Use the front and back labels shown on a single bottle identified in a laboratory check to highlight any quality or safety issues.

Front Label Back label

(Magnesium) (Manganese)

As it is a decanted solution the old pre-GHS labels should have been removed.

The front indicates 1000 mg/L Magnesium solution while the back indicates 1000 mg/L Manganese solution. This is a major problem and the solutions should be disposed of as the exact identity is unknown.

If the incorrect identity was chosen then an analysis would be in error.

1. What strategies are used in your laboratory for minimising waste when using chemicals to make solutions and perform tests?

Will be laboratory dependent. Student would be expected to have at least three strategies mentioned. General responses could include:

Determine how much is required rather than just make up a large batch of solution.

Determine if a more concentrated solution could be made and diluted down.

When testing, only the amount of solution required is taken rather than take large amounts of excess that then will have to be disposed of.

Small volumes are decanted off rather than work from the stock bottle, reducing risk of contamination and therefore waste.

Excess volumes are not returned to the stock bottle reducing risk of contamination and waste.

1. Describe the chemical waste disposal system in place in your laboratory.

Chemical waste disposal is guided by the information found in the relevant SDS and standard methods.

Water soluble, non-toxic solutions could be placed down the drain with copious amounts of water.

No toxic solutions are placed in the drain, all are individually collected in labelled waste containers for chemical collection. (Examples silver ions, heavy metal solutions)

Organic solutions are not placed in the drain (Exceptions would be small amounts of water soluble organic solutions such as ethanol)

Solid non toxic wastes can be wrapped in paper and disposed of in the garbage.

Solid toxic waste (such as lead salts) would be placed in labelled waste containers for chemical collection.

1. How would the following be disposed of in your laboratory:

* 500 mL of dilute nitric acid (0.15M)
* 150 mL of silver ion solution
* 75 mL of ethanol
* 125 mL of 0.1 M Pb2+ solution
* 350 mL of 5 % v/v solution of trichloromethane in hexane

Guidelines from laboratory procedures. Typical responses

500 mL dilute nitric acid disposed of down the sink with copious amounts of water

150 mL of silver ion solution would be collected in a labelled waste residue bottle ready for collection

75 mL ethanol could be washed down the drain

125 mL of lead solution would be collected in a labelled waste residue bottle ready for collection

350 mL of 5 % v/v solution of trichloromethane in hexane would be collected in a labelled waste residue bottle ready for collection

1. The following information relates to a sample analysis that was done in triplicate using a titration method. Use the data supplied to explain the following:

* Sources of error in titration,
* Precision
* Accuracy
* Significant figures
* Uncertainty in the measurement

The laboratory technician performed three titrations on a sample using the approved method. A known standard was also run to check the accuracy of the analysis. The required indicator was not available so the technician used a different indicator solution. The label for the titrant indicated the solution was out of date and required restandardisation. The solution was not standardised. The technician calculated and reported the result from the values obtained.

Titration 1 23.9 mL

Titration 2 23.8 mL

Titration 3 23.8 mL

Standard (average) 24.5253 mL Standard expected titration = 29.4 mL

The first obvious thing is the standard value given as 4 decimal places using a burette with an uncertainty value of 0.05 mL. The standard value should only have been recorded to the same limits as the sample titration ie the titrations have 3 significant figures, the standard should also only have 3 significant figures. ie 24.5 mL

The titration values for the sample are close to each other ie they are precise, the absolute precision is 0.05 mL and the relative precision is 0.21 %. That is the technician was able to repeat the technique well.

The standard value shows that there is something wrong with the analysis. The absolute error in the standard value is ± 4.9 mL the relative error is 20%. This indicates the accuracy was poor even though the precision was good.

Sources of error in the analysis could include:

The use of an incorrect indicator solution. It is important that the chosen indicator changes colour near the equivalence point of the reaction.

The solution requiring restandardisation is also a problem. The concentration of the titrant being incorrect would result in an incorrect value.

The technician should have found the correct indicator solution, restandardised the titrant and repeated the analysis.

## Part 4: Assessment Feedback

*NOTE: This section* ***must*** *have the assessor signature and student signature to complete the feedback.*

### Assessment outcome

Satisfactory

Unsatisfactory

### Assessor Feedback

Was the assessment event successfully completed?

If no, was the resubmission/re-assessment successfully completed?

Was reasonable adjustment in place for this assessment event?  
*If yes, ensure it is detailed on the assessment document.*

Comments:

### Assessor name, signature and date:

### Student acknowledgement of assessment outcome

Would you like to make any comments about this assessment?

### Student name, signature and date

***NOTE: Make sure you have written your name at the bottom of each page of your submission before attaching the cover sheet and submitting to your assessor for marking.***

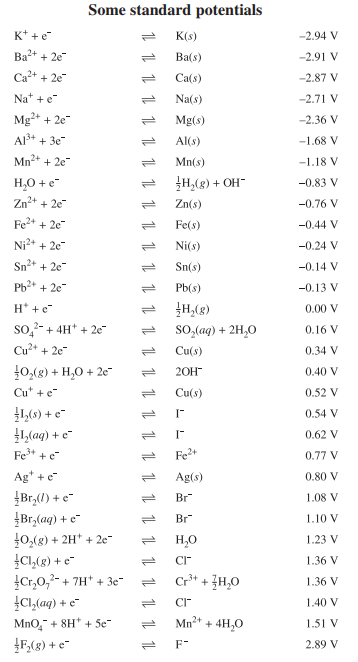
### Appendices

**Data Sheet**

|  |  |
| --- | --- |
| Mass (g) = | Conc x V(L) x Formula mass |
| Molarity = | Mass ÷ V(L) x Formula mass  or  No of mole ÷ V (L) |
| Moles = | Mass / Formula mass  or  C x V (L) |
| Dilution Factor = | Final Volume  Initial Volume |
| Average = | Sum of readings  No. of readings |
| Range = | (highest Value – lowest Value) |
| Absolute precision = | Range  2 |
| Relative precision = | (absolute precision) x 100%  average |
| Accuracy = | [(True Value – Average Value)] ÷ True x 100 |
| % w/w = | (grams of solute / grams of sample) x 100 |
| % v/v = | (mL of solute / mL of solution) x 100 |
| % w/v = | (grams of solute/ mL of solution) x 100 |
| ppm = | (mg of analyte / mL of solution) x 1000 |

***Common ions and their charges***

| +1 | +2 | +3 | +4 | -1 | -2 | -3 |
| --- | --- | --- | --- | --- | --- | --- |
| ammonium  NH4+ | barium  Ba2+ | aluminium  Al3+ | Lead (IV)  Pb4+ | acetate (ethanonate)  CH3COO - | carbonate  CO32- | phosphate  PO43- |
| potassium  K+ | calcium  Ca2+ | iron (III)  Fe3+ | tin (IV)  Sn4+ | bromide  Br - | chromate  CrO42- | phosphide  P3- |
| silver  Ag+ | Copper (II)  Cu2+ |  |  | chlorate  ClO3 - | dichromate  Cr2O72- | nitride  N3- |
| sodium  Na+ | iron (II)  Fe2+ |  |  | chloride  Cl - | oxide  O2- |  |
| Hydrogen  H+ | lead (II)  Pb2+ |  |  | fluoride  F - | peroxide  O22- |  |
|  | magnesium  Mg2+ |  |  | hydrogen carbonate HCO3- | sulfate  SO42- |  |
|  | mercury(II)  Hg2+ |  |  | hydrogen sulfate  HSO4 - | sulfite  SO32- |  |
|  | nickel  Ni2+ |  |  | hydroxide  OH - | sulfide  S2- |  |
|  | tin (II)  Sn2+ |  |  | iodide  I - |  |  |
|  |  |  |  | nitrate  NO3 - |  |  |
|  |  |  |  | nitrite  NO2 - |  |  |
|  |  |  |  | permanganate  MnO4- |  |  |



Aylward and Findlay, SI Chemical Data (5th Edition) is the principal source of data for this examination paper. Some data may have been modified for examination purposes.

## 