# Knowledge Assessment

**Assessment event 1 of 2**

# Trainer & Assessor Marking Guide

## Criteria

### Unit code, name and release number

MSL973014 - Prepare working solutions (1)

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

MSL30118 - Certificate III in Laboratory Skills (1)

MSL40118 - Certificate IV in Laboratory Techniques (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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## 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.  The assessment is in four sections:   1. Multiple choice questions (Questions 1 – 17) 2. True or False questions (Questions 18 – 39) 3. Short answer questions (Questions 40 – 59) 4. Assessment feedback (student facing only).   The student has been provided with Appendices comprising a Periodic Table, A table of common ions and a data sheet of common calculations. They are permitted to remove this from the Assessment Tasks for ease of use. The three pages if removed must be collected with the Assessment Task.  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, student study notes |
| **Assessor must provide** | Assessment task, SDS for Sodium hydroxide, 1 M hydrochloric acid, trichloromethane |
| **Time allowed** | Three hours |

## Part 1: Multiple choice

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

1. Which one of the following is a measure of the accuracy of a result?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Error | X |
| 1. Uncertainty |  |
| 1. Repeatability |  |
| 1. Traceability |  |

1. An analytical balance can measure up to ± 0.0001 g. This is a measure of -

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Traceability |  |
| 1. Repeatability |  |
| 1. Uncertainty | **X** |
| 1. Error |  |

1. Which of the following is a measure of the precision of a result?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Uncertainty |  |
| 1. Repeatability | X |
| 1. Traceability |  |
| 1. Error |  |

1. If the SOP states “to accurately weigh approximately 1 gram of NaCl” it means to use:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. a top pan balance and weigh exactly 1.00 gram of NaCl. |  |
| 1. an analytical balance and weigh exactly 1.000 gram of NaCl. |  |
| 1. a top pan balance and weigh close to but not necessarily 1.00 g of NaCl. |  |
| 1. an analytical balance and weigh close to but not necessarily 1.000 g of NaCl and record the exact amount taken | X |

1. If the SOP states to prepare “standard” solutions of 0.1000g of potassium hydrogen phthalate it means to use:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. a top pan balance to weigh the analyte and use a volumetric flask to make up the solution with deionised water. |  |
| 1. an analytical balance and use a volumetric flask to make up the solution with deionised water. | X |
| 1. a top pan balance to weigh the analyte and use a volumetric flask to make up the solution with tap water. |  |
| 1. an analytical balance and use a volumetric flask to make up the solution with tap water. |  |

1. After you have obtained your reagents and solvents to make up solutions, you find that you have a small amount of excess which you no longer need. What do you with it?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Always be put back into the original reagent container(s) and store as per laboratory protocol to save money. |  |
| 1. Discard the excess as per laboratory protocol. | X |
| 1. Save them in separate containers, re-label as original and store as per laboratory protocol for later use. |  |
| 1. Use the excess to make up more solutions as per laboratory protocol just in case you have a need for them in the future. |  |

1. What would you do when you have finished using glassware such as pipettes, beakers and volumetric flasks for the day?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Leave them on the bench for other technical staff to clean up. |  |
| 1. Leave them soaking in the sink until the next day or when you have the time. |  |
| 1. Rinse well with tap water, allow to soak in tubs for specific glassware if required and load onto the commercial glassware washer and when finished, dry and store. | X |
| 1. Rinse then well with tap water and detergent, dry in an oven at 80-100 oC and then put away in the cupboard. |  |

1. The PPE you ***always*** have to wear in a chemical laboratory?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Laboratory coat, fully enclosed non porous shoes, safety glasses disposable gloves. |  |
| 1. Laboratory coat and fully enclosed non porous shoes. |  |
| 1. Laboratory coat, fully enclosed non porous shoes, disposable gloves. |  |
| 1. Laboratory coat, fully enclosed non porous shoes, safety glasses. | X |

1. How should you dispose of 150 mL 0.1M HCl?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Down the sink followed with copious amounts of tap water. | X |
| 1. In a capped solvent reagent waste bottle next to the sink. |  |
| 1. In a labelled capped solvent waste bottle in the fume cupboard. |  |
| 1. In a reagent capped solvent bottle and then dispose in the waste bin. |  |

1. How should you dispose of used or excess trichloromethane (chloroform) solvent?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Pour down the sink followed with copious amounts of tap water. |  |
| 1. Pour in a solvent waste bottle next to the sink. |  |
| 1. Pour in a labelled solvent waste bottle in the fume cupboard. | X |
| 1. Pour in a reagent capped solvent bottle and then dispose in the waste bin. |  |

1. The atomic number of an element is the number of:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Protons | X |
| 1. Neutrons |  |
| 1. Electrons |  |
| 1. Protons and neutrons combined |  |

1. Cations are formed by:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. gaining a proton |  |
| 1. gaining an electron |  |
| 1. losing an electron | X |
| 1. losing a proton |  |

1. Non-metals are mostly found:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. on the right-hand side of the periodic table | X |
| 1. on the left-hand side of the periodic table |  |
| 1. in elements numbers 58 to 103 |  |
| 1. in Group 1 |  |

1. The formula for iron II sulfate is:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. FeSO4 | X |
| 1. Fe2SO4 |  |
| 1. Fe2(SO4)3 |  |
| 1. Fe(SO4)3 |  |

1. The following table contains a selection of cations and anions

|  |  |
| --- | --- |
| cations | anions |
| Fe3+ | NO3- |
| Ag+ | SO42- |
| Cu2+ | PO43- |

The set of correct formulas derived from these ions is:

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Fe2(SO4)3 Ag2NO3 Cu3(PO4)2 |  |
| 1. AgNO3 Fe2(SO4)3 CuPO4 |  |
| 1. CuSO4 Ag3PO4 Fe3NO3 |  |
| 1. Ag2SO4 FePO4 Cu(NO3)2 | X |

1. Potassium hexacyanoferrate has the formula K3Fe(CN)6. Which of the following statements is correct?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. There are four different elements in the compound | X |
| 1. There are only three different elements in the compound |  |
| 1. Potassium makes up one third of the mass of the substance |  |
| 1. In one molecule of the substance there are six iron atoms |  |

1. If used correctly which of the following has only quantitative volumetric glassware?

| Answer choices | Put X next to your answer |
| --- | --- |
| 1. Volumetric flask, beaker, bulb pipette |  |
| 1. Bulb pipette, burette, conical flask |  |
| 1. Conical beaker, measuring, cylinder, volumetric flask |  |
| 1. Burette, volumetric flask, bulb pipette | X |

## Part 2: True or false

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

Table 3 True or false

| Question | Write *True* or *False* |
| --- | --- |
| 1. All measurements are estimates. | True |
| 1. As you increase temperature, you increase the solubility of solids, gases and liquids. | False |
| 1. If you want to dissolve an ionic substance such as CaCO3 you should use a relatively non-polar organic solvent such as hexane because substances of opposite polarities attract and dissolve in each other. | False |
| 1. Aqueous and organic solvents tend to be different in polarity. | True |
| 1. pH is a measure of how acidic or basic a solution is. | True |
| 1. The pH scale goes from 1 to 10. | False |
| 1. pH is expressed as log [H+]. | False |
| 1. pH below 7 generally indicates an alkaline solution. | False |
| 1. A compound is composed of more than one type of element chemically combined in a fixed ratio. | True |
| 1. A solution that resists change to pH when an acid or base is added to it is termed a buffer. | True |
| 1. As a technician, you have received an unlabelled reagent solution from which you have to prepare working solutions. You need to reject and not use this. | True |
| 1. As long as you complete your laboratory task as required it is not important to consider the ethnic and religious differences of work colleagues. | False |
| 1. A measuring cylinder is just as accurate as using a volumetric flask when making up a solution. | False |
| 1. The correct equipment to quantitatively prepare 100 mL of 25 mg/L HCl from a 100 mg/L HCl solution would be a 25.0 mL bulb pipette and a 100 mL volumetric flask. | True |
| 1. A graduated pipette is more accurate than a bulb pipette when preparing solutions. | False |
| 1. The ash analysis for a sample of coal gave a value of 12.5% w/w. This means there would be 125 kg of ash in one tonne of coal | True |
| 1. A 15% w/v solution of NaCl would contain 7.5 g NaCl in 500 mL of solution. | False |
| 1. A salt is an ionic compound formed from a cation such as potassium and an anion such as sulfate. | True |
| 1. When making up working solutions, one can use tap water as a solvent as they need not need to have exact molarities. | False |
| 1. A neutralisation reaction is one where an acid and a base react together completely. | True |
| 1. The International system of units (SI) is important is recognised around the world for reporting laboratory results | True |
| 1. Safety Data Sheets (SDS) are a legal requirement for every chemical located in the laboratory and should be consulted prior to working on any chemical in the laboratory. | True |

## Part 3: Short answer

Read the question carefully. Your responses can be up to 150 words for each question or part of a question.

1. Metrology is the study of measurement. The function of a laboratory is to measure something and report a result. How are the following relevant to your laboratory?
2. Sources of error: Error is defined as the difference between the true value and the reported value. The laboratory will always endeavour to reduce the error. Errors can be random or systematic. Random errors are unpredictable and cannot be corrected for. An example would be the measurement of the correct level in a pipette in the reading of the meniscus and hence the delivery of the liquid volume. These can be minimised by running a number of samples and averaging the result. Systematic errors are those that repeatable each time the analysis is done. They could be due to incorrect calibration of equipment such as balance weighing consistently high or low. These may be adjusted for by running a QC sample at the same time and making a correction.
3. Uncertainty: is the range of values in which the expected value is expected to lie. A laboratory may report the result as 0.106 ± 0.0013 mol L-1. This means the actual value lies between 0.1047 and 0.1073 mol L-1 .
4. Precision: is how close a number of results for a tested sample are to each other. A result may be precise but not accurate if there is a consistent error in the procedure or equipment.
5. Repeatability: is the variation in a replicate measurements determined by a single person using the same method and equipment. It is a measure of precision.
6. Accuracy: is how close the measured measurement is to the true measurement. A laboratory would endeavour to be accurate and precise.
7. Significant figures: these are values that have real meaning in relation to the actual measurement. A calculator could give many decimal places but many of these values would have no meaning for an actual reported result. In the laboratory significant figures are the number of digits that have meaning in relation to the actual measurement process. The number of significant figures reported is generally limited by the measurement step with the least number of significant figures.
8. Give two sources of error when weighing Na2SO4 using an analyticalbalance in your laboratory.

Two reasonable responses could include two of the following:

Na2SO4 not being kept dry

Na2SO4 not being at room temperature

Balance not being level

Balance not calibrated

Air movement around the balance

Vibrations in balance bench

1. Give two sources of error possible when making up a quantitative dilution of 1.00 M NaOH using quantitative glassware.

Two reasonable responses could include two of the following:

Pipette dirty or burette (if used) or volumetric flask

Not using purified water (deionised/distilled)

Incorrect meniscus level

Not shaking the initial and final solutions

Incorrect draining of pipette

1. A technician prepared two 200 mg/100 mL ascorbic acid solutions labelled “A” and “B”. He tested each solution three times using the same instrument and obtained the following results for the solutions.

|  |  |  |
| --- | --- | --- |
|  | Conc Ascorbic Acid (mg/100 mL) | |
|  | **A** | **B** |
| **1** | 188 | 210 |
| **2** | 190 | 200 |
| **3** | 191 | 190 |
| **Range** | 3 | 20 |
| **Relative Precision %** | 0.8 | 5 |
| **Relative Error %** | 5 | 0 |

1. Which solution, A or B is the most accurate and why?

Solution B is the most accurate as it has the lowest relative error, 0.

1. Which solution, A or B is the more precise and why?

Solution A is the most precise as the relative precision is the lowest of the two solutions, 0.8 as opposed to 5 for solution B

1. The Globally Harmonised System (GHS) of classification is now an important consideration in all laboratories. Briefly explain how this system determines how a chemical should be labelled.

The GHS system is an International System for labelling of hazardous chemicals. It is regulated under WHS regulations in Australia. The language must be in English, product identifier, a business address, hazardous pictograms displayed , signal words, first aid, emergency procedures, expiry date if applicable.

It provides a visual input that does not rely on language by using the pictograms and signal words

1. You discover a solution in the storeroom of your laboratory and the label has fallen off the bottle. There is a label sitting on the bench nearby. There are a number of other solutions (all labelled) on the bench with the unlabelled bottle. What should you do?

Notify your supervisor. Using full PPE remove the bottle from the area. You should not assume the label on the floor belongs to the unlabelled bottle. Isolate the bottle and wait on instructions from your super visor.

1. What action should you take if someone working close to you gets acid on their skin or in their eyes?

Raise the alarm. Ensure your safety. If safe to continue take person to the eyewash station or safety shower. Allow copious amounts of water to wash the area. Reassure the person. Report the incident according to workplace priorities.

1. Explain why it is extremely dangerous to add water to a concentrated acid.

An exothermic reaction (releasing lots of heat) occurs when the two mix. If water is added to acid the reaction is extremely vigorous and could result in boiling liquid being splashed onto the person mixing.

1. What is the difference between aqueous and organic solutions?

Aqueous solutions are those that have water as the solvent. Organic solutions do not have water as the solvent.

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

|  |  |  |
| --- | --- | --- |
| Formula | Name | Formula weight |
| Ag | Silver | 107.9 |
| NO2 | Nitrogen dioxide | 46 |
| Mg(NO3)2 | Magnesium nitrate | 148.3 |
| CuSO4 | Copper II sulfate | 159.6 |
| PCl3 | Phosphorous trichloride | 137.3 |

1. Jonah is a lab assistant at a food processing factory. He is required to prepare 0.5 L of 1 M sodium hydroxide solution, starting from solid sodium hydroxide. He has access to a copy of the Safety Data Sheet.

His SI Data book indicates the molar mass of sodium hydroxide is 40.

Answer the following questions:

a) How many grams of sodium hydroxide are required?

Mass NaOH = Volume (L) x FW = 0.5 \* 40 = 20 g of NaOH

b) What safety measures must be taken when preparing this solution?

NaOH is caustic and is corrosive

Gloves may be worn

NaOH should be added to water, **not** water to NaOH

PPE should be worn

c) Jonah has 1 L of 0.5 M sodium hydroxide already prepared. Could he prepare the required solution by diluting what he has? Explain.

Yes

Jonas could dilute the 0.5M NaOH quantitatively by a factor of 10

Ie he pipettes 100 mL of the 0.5 M sodium hydroxide and makes this up to 500 mL

1. You need to make up 250.0 mL of 0.200 M solution from a stock of 0.500 M solution. What volume of the 0.500 M solution do you need to place into the 250 mL volumetric flask (show or explain working)?

The dilution factor from 0.5 M to 0.2 M = 0.5/0.2 = 2.5

Therefore the volume required to be taken from the 0.500M solution and made up to 250 mL = 250/2.5 = 100 mL

or

C1V1 = C2V2  the volume of the 0.500M solution required = 250\*0.200/0.5 = 100 mL

1. What is the percentage by volume of ethanol in the final solution when 75 ml of ethanol is diluted to a volume of 500 ml with distilled water? Show your working.

%v/v = 75/500 \*100 = 15%

1. Why is tap water generally not appropriate for making up solutions for chemical analysis?

Tap water is a mixture and will contain things other than water.eg metal ions, chloride etc These may cause a problem with any analysis

1. Why is solvent purity important when making up solutions in your laboratory?

Particular analysis may require certain purity of solvent depending on the detection limit of the process. If analysing for lead in very low concentration (ppb or trace levels) the method may ask for the acid to be Unistar, which is ultra pure and extremely low in metal contaminants.

Spectrograde solvents may be asked for particular tests.

There is considerable difference in cost between the grades of solvents.

1. Describe the procedure you follow to monitor the shelf life of working solutions in your laboratory.

The response should indicate that routine inspections are conducted on the solutions and out of date solutions removed. It maybe that there is a LIMS that will indicate when a solution may be nearing its shelf life.

1. Describe the approved method for disposal of used solutions in your laboratory

Responses will vary according to the type of laboratory. Responses may include:

Aqueous solutions may be placed down the sink with copious amounts of water, assuming it is not poisonous or toxic.

There may be licensing requirements for certain solutions such as heavy metal solutions eg lead solutions and these would be placed into specialised containers for specialised removal

Organic materials are placed into individual containers for disposal

1. What methods can be used to determine if old solutions are still fit for purpose.

Visual appearance of the solution ie has it gone cloudy, are solids present, does it appear to have ‘growth’, has it changed colour.

Run a test to see if it is contaminated eg take a small amount of solution and test eg run a UV analysis on solution to determine if there is nitrate contamination or add a small amount of silver nitrate solution to a solution to see if there is chloride contamination.

1. List two environmentally sustainable practises that all laboratory technician should practise.

Any two of the following or similar responses would be adequate.

Observe the correct practices for disposal of chemicals

Only take limited quantities of reagents, thus reducing the amount of waste.

Turn off electrical appliances not in use, is safe to do so.

Conserve the use of all reagents including water.

Considering shelf life when preparing large volumes of reagents

1. Good Laboratory Practice is to ensure traceability of a sample and all the processes it is subjected to prior to a test result being released. Explain how solutions can be traced in your workplace.

Each solution prepared is logged either manually or into the LIMS.

Samples can be matched to method and the solutions used in their analysis at a later date.

**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- |  |  |

