2020 VCE VET Laboratory Skills examination report

General comments

The 2020 written examination contained a variety of questions, covering content from the following four units of competency:

* MSL933006 Contribute to the achievement of quality objectives
* MSL973014 Prepare working solutions
* MSL973061 Perform aseptic techniques
* MSL973019 Perform microscopic examination.

During the coronavirus (COVID-19) pandemic lockdowns, students were unable to undertake the same amount of practical work in the laboratory as in other years, and this may have affected their understanding of the practical skills.

The questions involving more complex calculations in chemistry were challenging for many students. Students are encouraged to learn the basic mathematical principle of transposing an equation.

Students are reminded to always select the best or most correct answer and avoid guessing or repeating the question stem in the answer.

Students should be taught the correct names and use of standard laboratory equipment as this is essential to the accurate and efficient performance of laboratory tasks and tests.

Microscopes, their parts, and functions should be learnt and understood by students. Students are also advised to learn the techniques used with these important pieces of laboratory equipment, in particular the measurement and enumeration of cells.

Specific information

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

|  |  |  |  |
| --- | --- | --- | --- |
| Question | Correct answer | % of responses correct | Comment |
| 1 | B | 67 |  |
| 2 | D | 31 | Definitions are critical to a student’s understanding of laboratory terminology and its application in the workplace. Not all solvents are aqueous (water-based) and a solute can be a solid, liquid or a gas, which makes D the most correct choice. |
| 3 | C | 67 |  |
| 4 | C | 33 | ‘Job ownership’ means taking charge, or responsibility, of your work task to see it through from start to finish (e.g. cleaning glassware and returning it to the correct place once the work has been completed). The differences between quality control and job ownership are difficult to separate; the first is the formal procedures set by managers and the second is the individual’s role when carrying out daily work tasks. |
| 5 | B | 89 |  |
| 6 | D | 89 |  |
| 7 | C | 62 |  |
| 8 | D | 84 |  |
| 9 | C | 87 |  |
| 10 | B | 13 | Depending on individual laboratory practices, this could be answered several ways. Students should select the most correct answer for all situations. Best practice is to autoclave biohazardous materials before they are disposed of in the general waste. This option would be the safest. |
| 11 | A | 99 |  |
| 12 | D | 17 | The stock bottle of nutrient agar would not be autoclaved repeatedly but remain molten in a warm water bath during the day. The contents would be used to pour multiple batches of plates and control plates made with each batch, poured and incubated, to check the sterility of the agar. Understanding this laboratory process was critical to selecting the correct option. |
| 13 | A | 46 | Most students understood the definition of a positive control as a known substance of various concentrations. It is a good indication that the test works. Hence, positive controls are used to evaluate the validity of a test. |
| 14 | D | 91 |  |
| 15 | A | 42 | Calculation: 0.5 × ~~10~~~~6~~ /2.5 × ~~10~~~~6~~ cells = 0.2 mL |
| 16 | D | 47 | The question refers to the volumes measured in mL; students should be careful to select the correct units of measurement. |
| 17 | B | 17 | Various rules can be applied to a control chart. These rules highlight whether a problem exists with the analysis of the check sample and therefore whether the results for the test samples are reliable or not. The rules used by SimuLab are as follows:  Any value that falls outside the range of acceptance shall cause the run to be rejected.  A run of four or more consecutive values increasing or decreasing shall cause the last run to be rejected.  Sharp changes across the mean from one run to the next shall cause the latter run to be rejected.  A run of five or more consecutive values on one side of the mean shall cause the last run to be rejected. Values should fall around the mean on a random basis. |
| 18 | C | 35 | Students need to be able to convert units of measurement. This is a particularly difficult concept to learn and needs practice. |
| 19 | B | 40 | The action would be to prevent an error occurring during the current analysis. This would be the priority. Adjusting the standard operating procedures (SOP) would be after the completion of the tests being run. |
| 20 | A | 49 | Darkfield microscopy requires a higher intensity of light as there is an opaque disc in the centre of the field of view that blocks most of the light. Only the light around the edge of the disc enters the objective lens. |

Section B – Short-answer questions

Question 1a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 42 | 29 | 29 | 0.9 |

The correct answer was measuring or estimating the size of objects observed using microscopes.One mark was awarded for each key term.

Definitions are important for a student’s understanding of the laboratory.

Question 1bi.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 67 | 33 | 0.3 |

The correct answer was a graduated scale that allows the size of observed images to be measured.

Graticules (located in the ocular lens) are used with micrometres, which are placed on the stage.

Question 1bii.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 81 | 19 | 0.2 |

The correct answer was in the eye-piece or ocular lens.

Many students did not know this important piece of microscopy equipment or understand how it is used.

Question 2a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 3 | 45 | 52 | 1.5 |

Correct responses could have identified the following pieces of safety equipment:

* fume cupboard
* closed toe shoes
* impervious gloves (not heat or latex)
* spill tray or bench protector (absorbent plastic lined material).

Students should understand that an SOP is not a piece of safety equipment; it may contain safety information, but it is not ‘equipment’.

‘Latex gloves’ was not acceptable as a response as they are a poor barrier to organic solvents. Students should select the safety equipment that is suitable for the task.

Question 2b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 41 | 30 | 29 | 0.9 |

C1V1 = C2V2

50 × 90 = C2 × (90 + 230)

C2 = 4500/320 = 14.0625% = 14%

Responses indicated that students need more practice transposing an equation.

Question 2c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 9 | 33 | 58 | 1.5 |

Appropriate actions included:

* soak up spill with spill kit
* refer to material safety data sheet
* dilute with water
* evaporate in fume cupboard
* write a report of the incident
* notify supervisor
* evacuate area, inform other workers nearby
* refer to SOP for safety info
* record the accident in a log.

Steps needed to be in a logical sequence.

Question 2d.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 76 | 24 | 0.2 |

Correct answers were:

* store in flammables cabinet, in a tightly stopped bottle
* store in correct area of the dangerous goods (DG) store.

Disposing of the remaining methanol was not a correct option. The chemical is unused, and therefore it would be a waste of materials to dispose of unused material.

Some responses showed a greater depth of understanding and referred correctly to the flammables section of a DG room or a Class 3 cabinet.

Question 3a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | Average |
| % | 28 | 15 | 20 | 25 | 12 | 1.8 |

There were four appropriate steps to complete the task to prepare the media culture. Steps needed to be in a logical sequential order from:

* Collect equipment and measure quantities
* Mix agar, boil (heat agar until it is completely dissolved)
* autoclave or microwave
* allow to cool (to approximately 56°C)
* add sterile blood and mix well
* Aseptically transfer/dispense/pour into petri dishes
* allow to set completely before moving
* label
* store at 4°C
* SOP signed off.

Students need to correctly apply terms such as ‘aseptic’ or ‘sterilise’ to the tasks or equipment used.

Question 3b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 61 | 10 | 30 | 0.7 |

Responses needed to reference the following points:

* blood would not be added as it contains heat sensitive/liable components (complex proteins)
* the agar is heated then boiled or autoclaved to sterilise it so the heat-sensitive component within the blood would be destroyed or denatured.

Many responses confused the preparation of the blood agar with the uses of it, including describing the streaking technique.

The reason for adding the blood at a point after the agar was heated was also not well understood.

Question 3c.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 9 | 9 | 33 | 50 | 2.2 |

Responses could include three different criteria from the following or equivalent:

* check quantity of medium was within acceptable stock levels
* damage or leakage
* stock rotation
* contamination
* dehydration/condensation
* expiry use-by dates on labels
* appearance
* log book check of batch numbers, sterilisation
* aseptically transferred to petri dish/containers
* SOP has been signed off
* storage condition (e.g. temperature).

Question 4

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Average |
| % | 1 | 1 | 4 | 6 | 14 | 24 | 19 | 18 | 10 | 4 | 5.5 |

Correct answers were:

|  |  |  |
| --- | --- | --- |
| Beaker/graduated beaker | Temporally hold liquids and solids, for containing a chemical reaction, **approximately** measuring liquids and for heating substances | Qualitative work |
| Measuring cylinder/graduated cylinder | Measures a **specific** volume of liquid | Qualitative work |
| Volumetric/bulb pipette | **Precisely** measures and transfers a volume of liquid from one vessel to another | Quantitative work |

This question was about the precision and accuracy of the glassware and the tasks for which they are used. ‘Specific’ is explicit or definite, while ‘precise’ is exact or accurate.

Question 5a.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | Average |
| % | 0 | 0 | 3 | 12 | 26 | 59 | 4.4 |

The five components are:

* Component 1: eye piece or ocular lens
* Component 2: objective lens
* Component 3: iris diaphragm or condenser
* Component 4: light source
* Component 5: fine or course focus control.

There was some confusion about what the focus knobs are used for. They are not a stage height adjuster or mover but used to adjust the sharpness of the image. Microscopes can do this by raising and lowering either the stage or the objective lenses.

Question 5b.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 29 | 71 | 0.7 |

The response could name either of Component 2 Objective lens (the magnification) or Component 5 Focus control.

Question 5c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 8 | 76 | 16 | 1.1 |

The function of Component 5 Focus control is to move through the depth of field and sharpen the image in the field of view.

Students need to be able to distinguish between resolution and clarity or sharpening of an image. Resolution is the shortest distance between two points on a specimen that can still be distinguished by the observer. Focus does not improve resolution, which depends on the numerical aperture value of the objective lens.

Question 5d.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 19 | 55 | 26 | 1.1 |

Either option was accepted if either name or feature is used.

* Option 1: The iris diaphragm regulates the amount of light entering the objective lens and can be used to adjust to change contrast.
* Option 2: The condenser collects the light and focuses it onto the specimen on the stage.

Responses needed to distinguish between the two answers by linking the iris diaphragm with the objective lens aperture and matching the numerical aperture to the objective lens by opening or closing the iris diaphragm.

Question 6

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | Average |
| % | 7 | 6 | 10 | 26 | 52 | 3.1 |

There were four correct waste disposal methods:

**F:** Autoclave waste prior to disposal

**A:** Depending on the waste material, use aqueous or organic solvent waste container

**E:** Neutralise and then flush down the sink with a large quantity of water

**C:** Heavy metals should be collected in residue bottles and disposed according to local regulations.

Question 7a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 25 | 21 | 54 | 1.3 |

*n* = C × V = 0.1 × (250/1000)

= 0.025 mole

High-scoring responses included the correct calculation and also the correct unit in the answer.

Students needed to convert the volume into litres (dm3) to achieve the correct answer.

Question 7b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 31 | 9 | 61 | 1.3 |

*n* = mass / molar mass

So: 0.025 = mass / 180.16

re-arranging: mass = 0.025 × 180.16 = 4.504 g

High-scoring responses included the correct calculation and also the correct unit in the answer.

Consequential marks were given if the answer to 7a. was incorrect but the calculation in 7b. was correct.

Question 7c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 64 | 14 | 22 | 0.6 |

The substance is not pure 1M. The extra amount required to make the correct concentration can be calculated using the factor of 100/95.0 1M.

Correction for purity: 4.504 × (100/95.0) = 4.741 g

Responses needed to include not only the calculation but also an explanation of the answer.

The requirement to add more of the substance to offset the 5% of impurities was not well understood by all students.

Question 8a.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 1 | 7 | 32 | 61 | 2.5 |

The question referred to the actions required when dealing with the client. Students needed to choose three actions from:

* provide a timeline of response back to the client
* check the lab copy of the clients test report
* check data / results logbook / laboratory information management system of results
* contact whoever performed the analysis/test
* check quality control data for the run(s)
* inform supervisor
* check the date of the analysis
* organise a retest if required/requested.

Question 8b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 15 | 20 | 38 | 27 | 1.8 |

The question referred to the internal review of procedures. Students needed to choose three responses from:

* revise the relevant SOP(s) for sample receptions
* send memos to relevant staff
* perform random checks of test samples
* re-train reception/relevant staff
* agenda for laboratory meeting.

Question 9

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Average |
| % | 2 | 2 | 11 | 21 | 41 | 6 | 18 | 3.9 |

Three inappropriate actions could be identified with a corresponding alternative action:

* Inappropriate action step 1: Pipettes should be rinsed with the solution being transferred from them and not distilled water. Alternative: The technician should have rinsed the pipette with hydrochloric acid and not distilled water.
* Inappropriate action step 2: The technician should not have inserted the pipette into the reagent bottle. Alternative: To avoid contamination of the stock solution the technician should have poured the solution from the bottle into a reasonably sized beaker that has been labelled and rinsed with a small amount of that solution and avoid taking more than needed, then pipette from the beaker to the volumetric flask.
* Inappropriate action step 5: The technician should not have returned the unused solution into the reagent bottle. Alternative: Instead, the technician should have discarded it as waste by using the appropriate disposal method.

Question 10a.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 28 | 73 | 0.7 |

The correct answer was blue.

Question 10bi.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 12 | 28 | 22 | 38 | 1.9 |

Either *n* = 4 or *n* = 9 could be used.

Responses should have included the correct substitution into the given formula, the correct calculation and the correct answer.

% cell viability = ((# viable cells)/(total # cells)) × 100

= ((81/(81 + 19)) × 100

= (81/100) × 100 %

= 81% (using *n* = 9)

Or similar for *n* = 4

Acceptable range:

|  |  |  |
| --- | --- | --- |
| **Squares** | **Viable cells** | **Total cells** |
| *n* = 4  *n* = 9 | 28–32  75–85 | 35–42  91–105 |

The range of answers was largely variable. Assessors made allowances for this.

Based on: # blue (non-viable cells) = 19 or 8; # clear (viable cells) = 81 or 30; using *n* = 9 (all nine squares used); minimum of four to be used so *n* = 4.

Question 10bii.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 16 | 34 | 26 | 22 | 1.6 |

900,000 cells/mL or 0.9 × 106 cells/mL

Answers between 850,000 and 950,000 cells/mL acceptable

Answers needed to include the correct dilution factor and the correct number of squares counted, as well as the correct answer.

Either *n* = 4 or *n* = 9 could be used.

Cell density = ((#viable cells) × 10**4** × (d.f.))/*n*

Where d.f. = dilution factor

*n* = # intermediate squares counted

so: Cell dens = ((81 × 10) × 10**4** / 9) = 900,000 cells/mL

A range of possible answers was acceptable, based on the classification of ‘dark’ or ‘clear’ cells or what was included or excluded from grid square boundaries, and *n* value (number of squares counted) used by the students.

Question 11a.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | Average |
| % | 6 | 4 | 34 | 56 | 2.4 |

Three essential pieces of equipment could include:

* pH meter and probe
* measuring cylinder
* transfer or dropper pipette
* volumetric flask
* stirring rod
* magnetic stirrer
* beaker
* flask or Scott bottle
* Bunsen burner
* digital balance.

Question 11b.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 69 | 32 | 0.3 |

Correct answers included:

* filter sterilisation; 0.2 um filter
* boiling
* microwave heating.

Alternatives to autoclaving to achieve sterility are covered in the course materials. These are important as an autoclave is not always available, nor is autoclaving suitable for all media components.

Question 11c.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 33 | 67 | 0.7 |

The pH was measured at 7.4 for 900 mL of distilled water before the components were added. The technician should have adjusted the pH after dilution stage.

Reasons for the change could include any of the following:

* All the components should be added before the pH is tested.
* It could be a faulty pH meter, or pH meter has been recalibrated between tests.
* A change in the solution’s temperature can alter the pH.

Question 12ai.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 36 | 64 | 0.6 |

NATA ensures test results / data are accurate/reliable/compliant. It ensures laboratories are conforming to the Australian standards/guidelines. Most students understood the role of NATA to oversee the functions of all testing laboratories. Some did not understand that it was not a government organisation but fully independent. NATA has more than a safety auditing role. Its primary function is to assess testing quality and management of laboratory operations.

Question 12aii.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 26 | 74 | 0.7 |

NATA is an external independent, non-government regulatory body that will conduct the audit. Students needed to supply an explanation, not just a single-word answer.

Question 12bi.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 49 | 51 | 0.5 |

The parameters given in the question indicate that the pipettor is delivering a sufficiently accurate amount at this setting. The question was about accuracy, not precision. Students needed to explain the reasoning behind their answer. These are important concepts in the laboratory and need to be well understood by students.

Question 12bii.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | Average |
| % | 14 | 7 | 79 | 1.7 |

C.V. = (S/Mean) × 100

= (4.2/199) × 100

= 2.1111

= 2.1%

Answers must be givenwith an appropriate number of significant figures.

Question 12biii.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 74 | 26 | 0.3 |

The pipette is not within the CV range as stated by the manufacturer; therefore, it would not be described as ‘precise’. Students should mention precision status and not just the CV value.

Question 12biv.

|  |  |  |  |
| --- | --- | --- | --- |
| Marks | 0 | 1 | Average |
| % | 39 | 61 | 0.6 |

Precision is defined as a low degree of variation, and repeatability of the result. It is a measure of test or assay reproducibility (i.e. capability of producing the same results when performed on the same specimen under the same conditions; data with high precision has a low standard deviation and a low coefficient of variation).