2021 VCE VET Laboratory Skills external assessment report

General comments

The 2021 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.

Many students demonstrated a good understanding of the concepts and skills required; however, some students did not perform well on the exam. This could be in part due to interruptions in the school year and lack of opportunities to undertake laboratory work.

Students would find a knowledge of basic theoretical chemistry helpful, such as types of chemical reactions, the pH scale, the principles of titrations and calculations of mass or molarity.

Using the correct terminology for laboratory equipment is important, as is the application of this laboratory equipment to perform laboratory tasks and tests accurately and efficiently.

Students are advised to understand the uses of microscopes in the laboratory, in particular the types of microscopes and their use in measurement and enumeration of cells.

There is still some confusion about the definition of the words sterilisation, disinfection and aseptic. Many students lost marks by incorrectly applying these key terms, for example, a bench top is not sterilised but disinfected with 70 per cent ethanol to maintain aseptic conditions. Methods of sterilisation and disinfection and their applications should be well understood by students.

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** | **% A** | **% B** | **% C** | **% D** | **Comments** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | D | 4 | 28 | 2 | 66 |  |
| 2 | C | 2 | 52 | 34 | 12 | A plastic volumetric flask was the best answer to this question. Some students might have the misunderstanding that the material the flask is made from would alter its accuracy. |
| 3 | A | 29 | 1 | 57 | 13 | The technician’s eyes should be protected from the UV light. Safety goggles and latex gloves are the safest option as the goggles enclose the eyes. A face shield would potentially allow the eyes to be exposed to the UV light. |
| 4 | C | 16 | 9 | 73 | 3 |  |
| 5 | B | 9 | 74 | 8 | 10 |  |
| 6 | A | 47 | 37 | 5 | 11 | Understanding the pH scale and within what range an acid is defined would assist students in answering this question. Adding a strong acid (2 M HCl) would decrease the pH of the solution. |
| 7 | C | 20 | 20 | 25 | 35 | Students should select the most correct answer. D was a possible choice but not the most detailed answer provided as a choice. Answers students gave were spread across all four options. Some students have a general understanding of the operation of an autoclave but not specific information about quality checks used to monitor it. Manufacturers’ guides state: black diagonal lines appear on the tape after 10 minutes at 121°C or 2 minutes at 134°C in a steam steriliser. |
| 8 | D | 1 | 44 | 12 | 43 | It would not be routine practice to report to a supervisor before reading the SOP to check the instructions for cleaning up and disposing of wastes. Many students incorrectly ordered the steps and chose B. Simulated work experiences, either in a laboratory or in a virtual setting, will enable the necessary understanding of work practices. |
| 9 | B | 5 | 74 | 9 | 13 |  |
| 10 | C | 29 | 14 | 47 | 9 | The correct process is to wash the pipette with the solution that is to be measured, to prevent dilution or contamination with other materials. Washing with distilled water would dilute the sample solution, therefore the resulting volume measured would be inaccurate. However, if the conical flask is washed with distilled water this will not alter the molarity of the solution to be tested; the number of moles would remain the same, as the volume measured has already been accurately measured. |
| 11 | D | 23 | 14 | 10 | 54 |  |
| 12 |  |  |  |  |  | As a result of psychometric analysis, all four options were accepted. |
| 13 | D | 26 | 6 | 4 | 64 |  |
| 14 | A | 74 | 10 | 17 | 0 |  |
| 15 | D | 3 | 21 | 12 | 65 |  |
| 16 | C | 11 | 15 | 63 | 12 |  |
| 17 | A | 56 | 15 | 0 | 29 |  |
| 18 | B and C | 8 | 10 | 68 | 15 | Both B and C were accepted as correct answers. As the option neutral was not provided, then inconclusive or weakly acid are both reasonable answers. |
| 19 | C | 31 | 11 | 54 | 4 |  |
| 20 | B | 6 | 31 | 25 | 38 | Phase contrast microscope is an optical microscopy technique that converts phase shifts in light passing through a transparent specimen to brightness changes in the image. This enhances the details of small living specimens such as single cell organisms in pond water. A stereo microscope would only allow the droplet surface to be viewed; a polarised microscope would not give the enhancement of the internal; a compound light microscope would not provide the enhanced details visible under phase contrast light. |

Section B

Question 1a.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 8 | 13 | 32 | 48 | 2.2 |

Correct answers included any three of:

* sharing resources
* energy conservation
* examples of energy conservation (e.g. turn off lights/equipment)
* waste minimisation and correct disposal
* water recycling
* water conservation
* reusable personal protective equipment (PPE)
* recycle waste materials.

Many students repeated an example and so did not achieve the full marks.

Question 1b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 8 | 19 | 44 | 30 | 2.0 |

Correct answers included any three of:

* develop policy statements
* add sustainability practices to standard operating procedures (SOPs)
* quality systems / quality control
* documentation on procedures
* communication (e.g. email, notices, regular meeting with staff, signage)
* staff training
* specific staff with responsibility for sustainability.

Question 1c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 11 | 37 | 51 | 1.4 |

Correct answers included any two of:

* maintain continuous improvement register / suggestions / feedback / staff surveys
* review logbook
* tracking records for reporting data / key performance indicators
* internal audits
* monitoring stocks, costs, expenditures
* reviewing laboratory organisation
* holding meetings to review adherence to work practices
* observation of work practices in the lab.

The question asked students to make their decisions as if they are ‘in charge’, therefore asking a supervisor would not be an acceptable answer.

Question 2a.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 7 | 93 | 0.9 |

Most students correctly identified the corrosive Hazchem sign.

Question 2b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 1 | 3 | 55 | 41 | 2.4 |

Correct responses were any three of:

* lab coat
* safety glasses/goggles
* chemical/nitrile/latex gloves
* closed-toe shoes.

Students should be specific about the type of protective gloves to be worn.

Question 2c.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | Average |
| % | 26 | 8 | 4 | 6 | 5 | 50 | 3.1 |

An example of a correct answer is C1V1 = C2V2 or correct rearrangement.

2.4 × 25 = C2 × 100

C2 = 0.6 M

C2 = 0.6 × 25/100

C2 = 0.15 M

Question 2d.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 20 | 80 | 1.0 |

The correct answer was three. Most students answered this question correctly.

Question 3

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | 4 | Average |
| % | 5 | 18 | 42 | 30 | 4 | 2.1 |

The correct answer was (in no particular order):

* clear the bench of equipment and clutter
* prepare the work area for safe and effective sample transfer by swabbing bench with 70 per cent ethanol
* select and check clean and sterile equipment
* ensure biohazard spill kit is available and topped up
* set up and turn on the Bunsen burner.

Marks were not given for any of the following: wash hands and put on a pair of clean gloves (this is PPE). It is already assumed that the technician will routinely carry out these two steps.

Question 4a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | 4 | Average |
| % | 4 | 15 | 29 | 36 | 17 | 2.5 |

|  |  |
| --- | --- |
| Part of light microscope | Function |
| objective lens | Increase magnification of the specimen on the slide |
| stage with stage clips | Any of:   * flat platform to place slides * stage clamps are used to secure and hold the slide in place * may have attachable knob to move and adjust slide as being viewed |
| diaphragm or iris | Different sized holes used to vary the size of the cone light that is projected upward onto the slide  Change the width of the beam of light, making it larger or smaller  Adjust contrast of sample |
| eye piece | Used to look through at the top of the microscope, placed above the objective lens adds another magnification factor  Can be adjusted for individual eyes  Focuses light into the viewer’s eye |

Not all students had a clear understanding of the functions of important parts of the microscope and how these parts are used to improve the resolution of the microscope. The iris diaphragm can be confused with the diaphragm over the light source or the condenser under the stage.

Question 4b.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 5 | 1 | 19 | 75 | 2.6 |

The correct answer was:

* 4 ×
* 10 ×
* 40 ×
* 100 × (oil)

This question was well answered by most students.

Question 4c.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 28 | 72 | 0.7 |

* The objective will magnify (alter the magnification of) the image.
* The field of view / light intensity will decrease with increasing magnification.

Question 5a.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | 4 | Average |
| % | 9 | 21 | 37 | 0 | 34 | 2.3 |

The correct answer was:

* Sample receipt: 2
* Sample collection: 1
* Client reporting: 5
* Quality control test: 3

There was some confusion about the order of the steps. The sample was *first* collected outside the laboratory then received at specimen reception, *then* it was passed onto the laboratory technicians to be tested.

Question 5b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 16 | 50 | 33 | 1.2 |

Any two of:

* meets quality assurance requirements
* provides confidence to its clients
* tests are reliable, accurate
* procedures are correct and up to date
* regulated audited
* client/result confidentiality is maintained.

Question 5c.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 20 | 9 | 25 | 47 | 2.0 |

855/1500 g × 100 or 0.855/1.5 kg

= 57% w/w

Question 6a.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Average |
| % | 2 | 6 | 17 | 12 | 18 | 26 | 19 | 3.9 |

* Step 1: primary standard, or standard
* Step 2: volumetric flask
* Step 4: burette
* Step 5a: pipette (can have bulb, graduated or volumetric)
* Step 5b: conical, Erlenmeyer
* Step 6: endpoint or colour change

Question 6b.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 40 | 60 | 6.0 |

The correct answer was neutralisation.

Question 6c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 59 | 20 | 22 | 0.6 |

Correct responses mentioned **what occurred** and **how it affected** the concentration of the acid, from the following:

* The technician has read a **lower volume** of the KOH, therefore making **a miscalculation of the concentration**.
* The technician has **read the top of the meniscus**, which has inadvertently led to a **lower volume of KOH**.
* Technician has **incorrectly weighed the KOH**, too much has been added, therefore the **concentration is higher** than expected.
* The **acid was more dilute** than it should be prior to titration (e.g. the pipette was washed in distilled water, therefore **the sample concentration was lower** than expected).
* Technician has **not added sufficient volume of KOH**, so has not reached the endpoint, therefore **miscalculates the acid as a lower concentration**.

Question 6d.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 57 | 43 | 0.4 |

The correct answer was salt + water

Question 6e.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 34 | 66 | 0.6 |

The correct answer was 20 / 700 × 100 = 2.86 % or 2.9% or 3%

Question 7

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Average |
| % | 2 | 11 | 20 | 28 | 18 | 14 | 7 | 3.2 |

Correct responses included the following.

**Autoclave**

Advantage:

* Can be used to sterilise equipment and liquids, kills wide range of contaminate including viruses, bacteria and endospores.
* Does not damage laboratory equipment.
* Large quantities can be sterilised at one time and can be left without supervision.

Disadvantage:

* Cannot be used on heat-sensitive plastics.
* Regular checks must be carried out to ensure the cycles work properly (e.g. temperature is reached for the required duration for the cycle).
* Whole cycle and process takes time including adequate cooling time.
* Expensive to purchase, operate and maintain.
* Takes up a lot of laboratory space.
* Oil-based solutions not easily penetrated by steam.

Example of use in a laboratory:

* sterilising growth plate cultures, media cultures
* sterilising waste for disposal
* glassware
* dissecting equipment

**Membrane filtration**

Advantage:

* absolute sterilisation of media
* does not denature the components of the media
* choice of pore sizes
* easy to use, low-tech
* used for heat-sensitive media

Disadvantage:

* large volumes take time to filter
* single use, environmental wastes plastics
* sterility checks more time consuming
* blood components lost during filtration; thick solutions not easy to filter
* lowers the temperature of the media, which can cause it to set before pouring plates
* can’t be used for equipment sterilisation (e.g. glassware)

Example of use in a laboratory:

* used on media components that are denatured if heated (e.g. antibiotics)

Overall, students had a good understanding of the autoclave but lacked understanding of the membrane filtration technique and its applications in the laboratory setting.

Question 8a.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 49 | 18 | 33 | 0.8 |

* The dead cells will be stained blue.
* The live cells will remain clear or light coloured.

Students should be familiar with both methylene and trypan blue as they are both vital stains that are used in biosciences to selectively colour dead tissues or cells blue. Live cells or tissues with intact cell membranes are not coloured.

Question 8b.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 13 | 8 | 78 | 1.7 |

Number of viable cells = 31

Total number of viable and dead cells 31 + 6 = 37

Percentage cell viability = (31/37) × 100 = 83.78%

Correct rounding up needed to be used, not just removing the decimal points.

This calculation was done well by most students.

Question 8c.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 66 | 2 | 32 | 0.7 |

Cell density = number of viable cells × 104 × dilution factor / number of squares counted

31 × 104 × 10

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in cells per mL

(number of squares counted) 4

= 775,000 cells per mL

The application of a 1:10 dilution factor in a calculation means the concentration is ×10 less, so the number of cells must be multiplied by a factor of 10.

Question 8d.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 22 | 26 | 26 | 27 | 1.6 |

* Cell viability: result was 83% or 84% cell viability; the acceptable requirement was 85%, so result is below the acceptable level by 1% or 2%.
* Cell density: result was 775,000 cells per mL; not acceptable as they are well above 8000.
* Corrective action required as both tests have failed, retest samples, recollect samples, yeast sample not to be used in production.

Question 9

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | Average |
| % | 18 | 28 | 54 | 1.4 |

Any two of the following:

* check that the flask has been washed and cleaned with deionised water
* make up a new control blank
* check the control blank is not contaminated by retesting
* run a known sample through the machine (a positive control)
* check the SOP to see if there are procedural steps that have been missed
* check that the blank control solution is not made with NaCl or similar solvent containing trace amounts of Na+ ions
* check instrument settings and calibration log
* stop the run, record in logbook.

Question 10

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Marks | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | Average |
| % | 1 | 3 | 3 | 14 | 14 | 20 | 21 | 16 | 7 | 5.0 |

|  |  |  |
| --- | --- | --- |
| Laboratory procedure | Area of contamination | Example of good practice |
| Housekeeping at workstation | * Untidy workstation can lead to cross contamination * Reaching over other equipment may lead to dust or aerosols dropping on surfaces and equipment * Media bottles may be in way of being accidentally knocked over * Dust on surfaces is a potential source of contamination | * Have an ergonomic set-up, by having all equipment easily accessible – this reduces the incidence of leaning over equipment to get to other equipment * Put away materials after use * Keep surfaces clean and dry * Remove contaminates by swabbing bench with 70% ethanol |
| Leaving lit Bunsen burner standing on bench | * Aerosols and dust particles potentially carrying microorganisms circulate within the laboratory * These can settle on the equipment, surfaces and agar plates as they are working * By not working within the zone of protection you increase the opportunities for contamination * Bunsen burners left on are a potential fire hazard | * Working in the zone of protection by having a lighted Bunsen, positioned in a central point of the workstation to create a cone of hot air above and around the workstation * This will remove aerosols and dust particles in the air which could potentially carry the contaminating microorganisms * Turn off the Bunsen burner when finished and do not leave it alight and unattended * Leave on orange (visible) flame when not using to heat sterilise loops, etc. |
| Removal of media bottle and petri dish lid | * Removing the lid allows surrounding air to come in contact with the media and agar plate surface * Benches / work surfaces are also sources of contamination | * Minimise the time the lid is lifted from the receptacle * Using one hand hold the petri dish and lift the lid to an angle * If opening a container hold the lid in fingers, do not place on the bench * Flame opening of bottles when lid is removed * Work near the Bunsen burner |
| Sterilise loop in Bunsen burner flame | * Heating the loop quickly can cause the culture to splatter and become airborne while still alive, spreading it in the air * This can contaminate other workstations, surfaces and equipment in the laboratory * Loops can be contaminated from other cultures if not properly sterilised | * Use the Bunsen burner (blue flame) to heat the top of the wire until it goes red, then move the flame up the wire towards the loop at the tip to remove any contaminants * Do not place the loop down once it has been heat-sterilised |

Question 11

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mark | 0 | 1 | 2 | 3 | Average |
| % | 21 | 62 | 13 | 4 | 1.0 |

Any three of the following:

* The standard is used to produce the standard curve/graph to be able to **quantify** the sample.
* Identify the acceptable deviation in results, levels and margins.
* Check **calibration** of the absorption reading machine equipment.
* Used to establish the **accuracy** of the test method/machine.
* **Accuracy of the result** is important as it measures the true value of the mercury concentration.
* Measure an unknown sample **accurately**, make a comparison of standards of known conc. with an unknown sample.

Question 12a.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 9 | 91 | 0.9 |

Any of the following:

* stop the test
* log the error
* check the SOP
* remake the standards
* report to the supervisor
* remove the standard from use (label as contaminated).

Question 12b.

|  |  |  |  |
| --- | --- | --- | --- |
| Mark | 0 | 1 | Average |
| % | 65 | 35 | 0.4 |

The sample will be underestimated.