2017 VCE VET Laboratory Skills examination report

General comments

Students' overall performance on the 2017 VCE VET Laboratory Skills examination demonstrated a good understanding of laboratory skills.

Student responses showed a good knowledge of aseptic technique principles, but there was some weakness in the correct technique for safely flaming a wire loop during sterilisation. Also, waste disposal was an area that presented some problems, with students being overcautious about disposing of waste products – in particular, sterilised biological waste materials, suggesting these items are still biohazardous after treatment.

There was some confusion identifying the difference between a dilution and a dilution factor in the mathematical calculations.

There were some good responses for identification of problems in the workplace, with creative possible solutions.

Students need to take care to read the instruction for each question carefully before answering. For example, a response to a question asking for a labelled arrow or line needs to have labelling.

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

The table below indicates the percentage of students who chose each option. The correct answer is indicated by shading.

Question	% A	% B	% C	% D	Comments
1	69	0	3	28	Single-use lens cleaning paper is the item of choice when cleaning a microscope lens, as it is a high-grade material that does not scratch the lens surface. A soft clean cloth may leave fibres on the lens after cleaning. A solvent such as 70% ethanol is not used for cleaning water-soluble dust from lenses but for oil and other non-water-soluble materials.
2	7	5	17	71	

Question	% A	% B	% C	% D	Comments
3	64	2	10	24	Decreasing the amount of solvent is sustainable, as there is less material to dispose of afterwards and less resources and energy required in the manufacture, transport and purchase of new solvent. Disposing of items based on age rather than usability or quality leads to more waste in landfill and more resources and energy used in replacing the equipment.
4	95	0	0	5	
5	3	93	2	2	
6	7	67	17	9	
7	0	95	5	0	
8	12	19	62	7	Poor technique when performing a titration is the only answer that can solely be attributed to the operator. Use of a reagent containing an impurity cannot be classified as an operator error as, for example, the impurity may be dissolved in the reagent and not be visible so the operator would not be aware of the issue.
9	9	59	22	10	This question asked for a ‘delivery vessel’, which is an item delivering a liquid to another container. This rules out the beaker and volumetric flask. A bulb or volumetric pipette is of higher measurement accuracy than a measuring cylinder so is the correct choice.
10	79	9	0	12	
11	5	12	9	74	
12	2	38	50	10	The established method for flaming loops is to start from the handle end and gradually move the heat along to the more contaminated loop end. On the way, the bacterial culture will slowly evaporate and become incinerated as the heating has a gradual affect. If placing the wire loop end containing culture straight into the flame, it may splutter on rapid heating and release aerosols into the surrounding area. This is a WHS issue.
13	7	2	91	0	

Question	% A	% B	% C	% D	Comments
14	36	50	9	5	A prion is an infectious protein particle similar to a virus but lacking nucleic acid/genetic material. Prions are not cellular like the other choices for this question so are least affected by chemical disinfectant.
15	3	2	2	93	
16	7	17	47	29	Students should be aware that Pasteur pipettes do not dispense measurable volumes of liquid. All the other pipettes listed in the answers are scored with volumetric increments so can measure accurately. A bulb pipette is also known as a volumetric pipette. Pasteur pipettes are commonly used when handling blood samples so some students may have misread the part about accurate results and saw instead a list of pipettes for blood sampling.
17	5	9	72	14	The three figures are not accurate as the required amount is 1 gram. They are, however, precise, as they are within 0.0014 grams, which is good when the required weight is 1 gram with no decimal places.
18	72	9	16	3	
19	3	52	36	9	The established method for disposing of sterile autoclaved liquid waste in laboratories is down a sink. A liquid microbiological sample is a biological hazard and autoclaving until sterile renders it non-hazardous. Use of specialist toxic waste collectors is costly and a waste of resources if non-hazardous material is being treated as hazardous.
20	72	3	14	10	

Section B – Short-answer questions

Question 1a.

Marks	0	1	2	3	Average
%	14	3	13	71	**2.4**

Possible answers included arrows labelled with any three of:

- back
- leaning posture on the arms
- back of the neck
- eyes/eye strain
- shoulders.

It was important to label the arrows with the area of potential strain as asked in the question.

Question 1b.

Marks	0	1	2	3	Average
%	1	16	42	41	**2.2**

Possible answers included (any three of):

- pull chair forward so sitting closer to bench without leaning forward
- bring the microscope closer to the person so not leaning on arms
- raise the workstation bench
- change to a standing workstation
- raise the microscope
- take regular breaks between samples
- move arms.

Lowering the chair was not suitable as this would put strain on the knees.

Question 2a.

Marks	0	1	2	Average
%	7	21	72	**1.7**

Possible answers included (any two of):

- Bunsen burner
- wire or inoculating loop
- swab.

Question 2b.

Marks	0	1	2	Average
%	1	14	85	**1.9**

Possible answers included (any two of):

- date
- name of culture or *Escherichia coli*
- initials/identifier of technician
- sample ID.

Question 2c.

Marks	0	1	Average
%	22	78	**0.8**

- streaking or streak dilution
- streak plate or lawn culture

Question 2d.

Marks	0	1	2	Average
%	3	25	72	**1.7**

Possible answers included (any two of):

- flame loops between plates
- flaming mouth of culture vessel on opening/closing lid of broth
- decontamination of laboratory benches
- replacing lids on agar plates
- using a new swab between plates.

Some students missed that the question asked for procedures ‘between’ the streaking of individual plates and wrote about steps within the streak dilution technique.

Overall, this question was answered well by students with responses showing a good knowledge of aseptic techniques in laboratories.

Question 3a.

Marks	0	1	2	Average
%	15	36	49	**1.4**

Possible answers included (any two of):

- inform the supervisor
- record in the equipment log
- check the oil immersion lens has been cleaned properly prior to using
- check the other lenses for potential problems.

Question 3b.

Marks	0	1	2	Average
%	1	50	49	**1.5**

Possible answers included (any two of):

- gloves
- safety glasses
- laboratory coat/gown
- respirator.

Some students incorrectly suggested a facemask. A facemask creates a physical barrier between the mouth/nose of the wearer and potential contaminants such as dust in the immediate environment. It does not protect the user from chemical fumes, which is why the word ‘respirator’ was accepted but ‘facemask’ was not.

Question 3c.

Marks	0	1	2	Average
%	4	39	57	**1.6**

Possible answers included (any two of):

- cleaners may come into contact with hazardous chemicals
- fumes from xylene may permeate the room
- xylene is flammable so it is not appropriate to put in a general waste bin with items that could ignite, such as paper or burnt matches
- tissue contains hazardous chemicals.

To answer this question well, students needed to understand that xylene was the hazard and not a potential biological contaminant.

Question 3d.

Marks	0	1	Average
%	72	28	**0.3**

The technician should have left it in the fume cupboard to evaporate off the xylene or in a sealed hazardous waste container for collection by a chemical waste company.

Many students assumed that the optical tissue was biohazardous and suggested biohazardous waste disposal methods. Not all oil immersion work is with biohazardous materials, for example, prepared slides. It is not good practice to put waste in a biohazardous bin if it is not a biohazard

and there was not enough information in the question to suggest the lens had recently been used for biological material.

Question 4a.

Marks	0	1	2	Average
%	16	14	70	**1.6**

- high temperature or 121 ºC
- high pressure or 100 kPa/15 psi

Question 4b.

Marks	0	1	Average
%	29	71	**0.7**

Possible answers included:

- bacteria culture plates/streak plates
- bacteria culture broths
- microbiological/biological waste
- culture media waste.

Answers needed to include an example of waste material, with autoclaving as the method used.

Question 4c.

Marks	0	1	2	3	Average
%	11	16	33	40	**2.1**

Possible answers included (any three of):

- reduced contact time
- incorrect concentration of disinfectant used (either too concentrated or too dilute)
- disinfectant past use-by date
- high microbial load
- high or low pH of the environment
- non-smooth surfaces
- surfaces with organic matter/dirt
- incorrect temperature of water used to dilute disinfectant
- type of organisms being disinfected, for example, spore-forming versus non-spore-forming bacteria.

To answer this question well, students needed to list a factor with enough detail to indicate that effectiveness of disinfection is reduced. Single-word answers, such as ‘bacteria’, were not sufficient.

Question 5a.

Marks	0	1	2	Average
%	27	47	26	**1**

Objective: ×100

Eyepiece lens: ×10

The lenses are described by their magnification. A few students answered this question incorrectly using other descriptions such as objective lens order on the revolving nosepiece and binocular/monocular for the eyepiece lens.

Question 5b.

Marks	0	1	2	Average
%	8	3	89	**1.8**

Table 1, as it has inconsistent results. Four tests are Gram –ve and two are Gram +ve.

Question 5c.

Marks	0	1	2	Average
%	18	39	43	**1.3**

Possible answers included (any two of):

- inform the supervisor
- repeat the testing for bottles 3 and 6
- check for contamination.

Question 5d.

Marks	0	1	Average
%	47	53	**1.8**

Autoclave until sterile, then flush the broth down a sink according to local regulations.

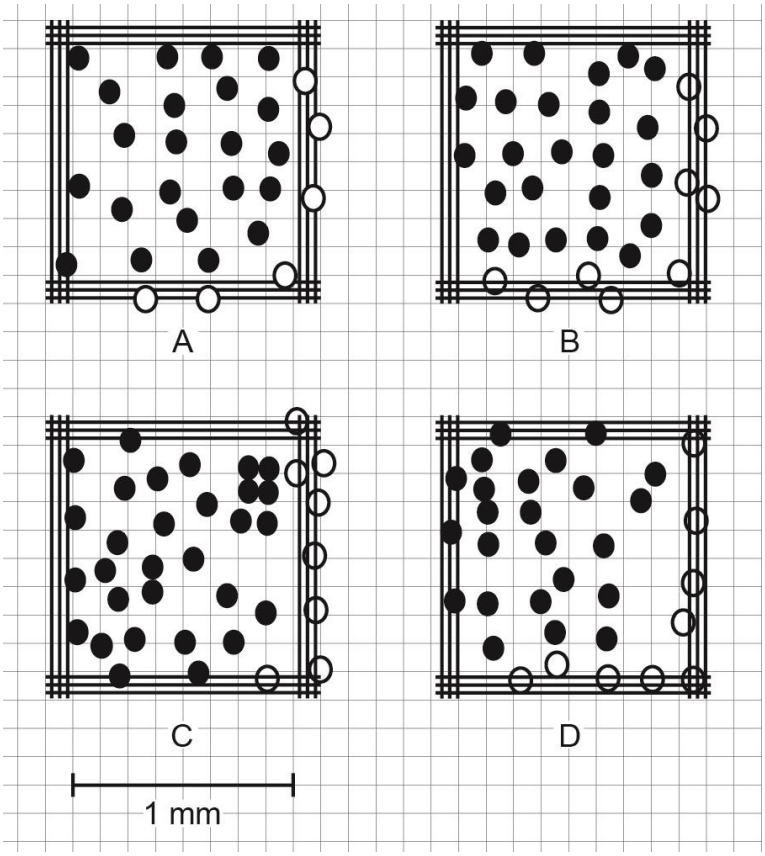
Many students correctly chose to autoclave the broths, then incorrectly placed the sterilised bottles in the biohazardous waste. Autoclaving waste until sterile makes the waste non-hazardous so it is not appropriate to place this material in the biohazardous waste area.

Question 6ai.

Marks	0	1	2	3	4	Average
%	27	12	14	21	27	2.1

Question 6aii.

Marks	0	1	Average
%	35	65	0.7



All cells positioned on lines on the right and bottom three borders of each grid should not have been counted.

Grid	WBC
A	22 (20–24)
B	24 (22–26)
C	28 (26–30)
D	24 (22–26)
Total	98 (90–106)

When counting cells in each of the four grids, the border-counting rules need to be consistently followed in order to calculate the correct numbers of cells. While the expected count is listed for each grid, any answer within the range in brackets was accepted.

Question 6b.

Marks	0	1	2	Average
%	54	13	33	**0.8**

$\frac{98 \times 10^4 \times 20}{4} = 4.9 \times 10^6$ cells/mL ($4.5 \times 10^6 – 5.3 \times 10^6$)

Most students could complete the equation provided for the total number of cells and number of corner squares but had difficulty converting the provided ratio of 1:20 to a dilution factor. Due to the large number of cells expected in blood, the blood was diluted. Any sample that has been diluted must be multiplied by that factor when calculating the final result.

The dilution factor is calculated by using the reciprocal of the dilution, so for a dilution of 1 in 20 or 1/20 the dilution factor is 20/1 = 20. The number 20 needed to be used in the equation, not 1/20 = 0.05 as many students used.

Question 7a.

Marks	0	1	Average
%	3	97	**1**

Program	Input	Process	Output
2	urine sample	SOP II: Preparation of standard glucose solution	absorption reading

Question 7b.

Marks	0	1	2	3	Average
%	44	20	11	24	**1.2**

The following is a possible answer:

- Suggested program: By regularly asking for customer feedback, laboratories can better understand customer priorities and try to improve their customer service processes to meet customer expectations more appropriately.
- Input: customer feedback on laboratory services
- Process: customer satisfaction survey
- Output: customer satisfaction data/quality control team meeting minutes.

This question had many possible answers. Students were awarded full marks if the suggested program was shown to improve laboratory customer services and the input, process and output suggested were adequately explained.

Question 8a.

Marks	0	1	2	Average
%	16	39	45	**1.3**

Possible answers included (any two of):

- check buffer is within expiry date
- check equipment log for calibration history and any comments that have been entered
- check fluid level inside electrode
- check glass bulb of electrode is not chipped/damaged
- conduct an overall visual check of electrode
- check buffers are fresh, with no contamination
- check correct buffers are being used
- check electrode is submerged in buffer
- check settings are for correct buffer.

Types of pH meters/electrodes are widely variable, so there were many possible outcomes for this question.

Question 8b.

Marks	0	1	Average
%	35	65	**0.7**

No. The calibration should include buffers in the expected working range of the solutions to be tested, for example, pH 7–10.

Students answered this question well, with a justification of their decision.

Question 8c.

Marks	0	1	2	Average
%	35	12	52	**1.2**

Possible answers included one of:

- Agitate the buffer – for example, using a magnetic stirrer – while the instrument is taking the reading. This will ensure the most reliable and accurate measurements are taken.
- Rinse the electrode with distilled water and blot dry the probe before placing in the next calibration buffer. This will prevent cross-contamination between buffers.
- Record results of buffer testing on a pH meter calibration record so previous results from buffer calibrations can be checked for trends.

This question had many possible answers. Students were awarded full marks if the suggested change was an improvement to the SOP and explained using scientific reasoning.

Question 9

Marks	0	1	2	3	Average
%	3	3	69	24	2.2

	Type of error		
Error	**Operator**	**Equipment**	**Method**
loss of a substance when transferring materials during weighing	✓		
analytical scale is not weighing accurately		✓	
use of a reagent that is past its use-by date	✓		

The use of a reagent past its use-by date is an operator error, because use-by dates of materials should be checked by the analyst before use.

Question 10a.

Marks	0	1	2	Average
%	10	48	43	1.4

Possible answers included (any two of):

- the temperature is checked only once a day
- the fridge will be opened throughout the day and may go above the required temperature
- manual logs have the risk of operator error when recording results
- 9.00 am is not the hottest part of the day
- changes in temperature throughout the day may not be detected.

Question 10b.

Marks	0	1	2	Average
%	14	37	50	1.4

Possible answers included:

- manual checks done routinely throughout the day
- temperature data logger recording over a 24-hour period to ensure the required temperature is maintained
- temperature data logger transferring data directly to a computer, replacing the manual log.

Answers needed to address the inadequacies listed in Question 10a.

Identifying a potential continuous improvement opportunity and suggesting possible solutions are important parts of laboratory work.

Question 11a.

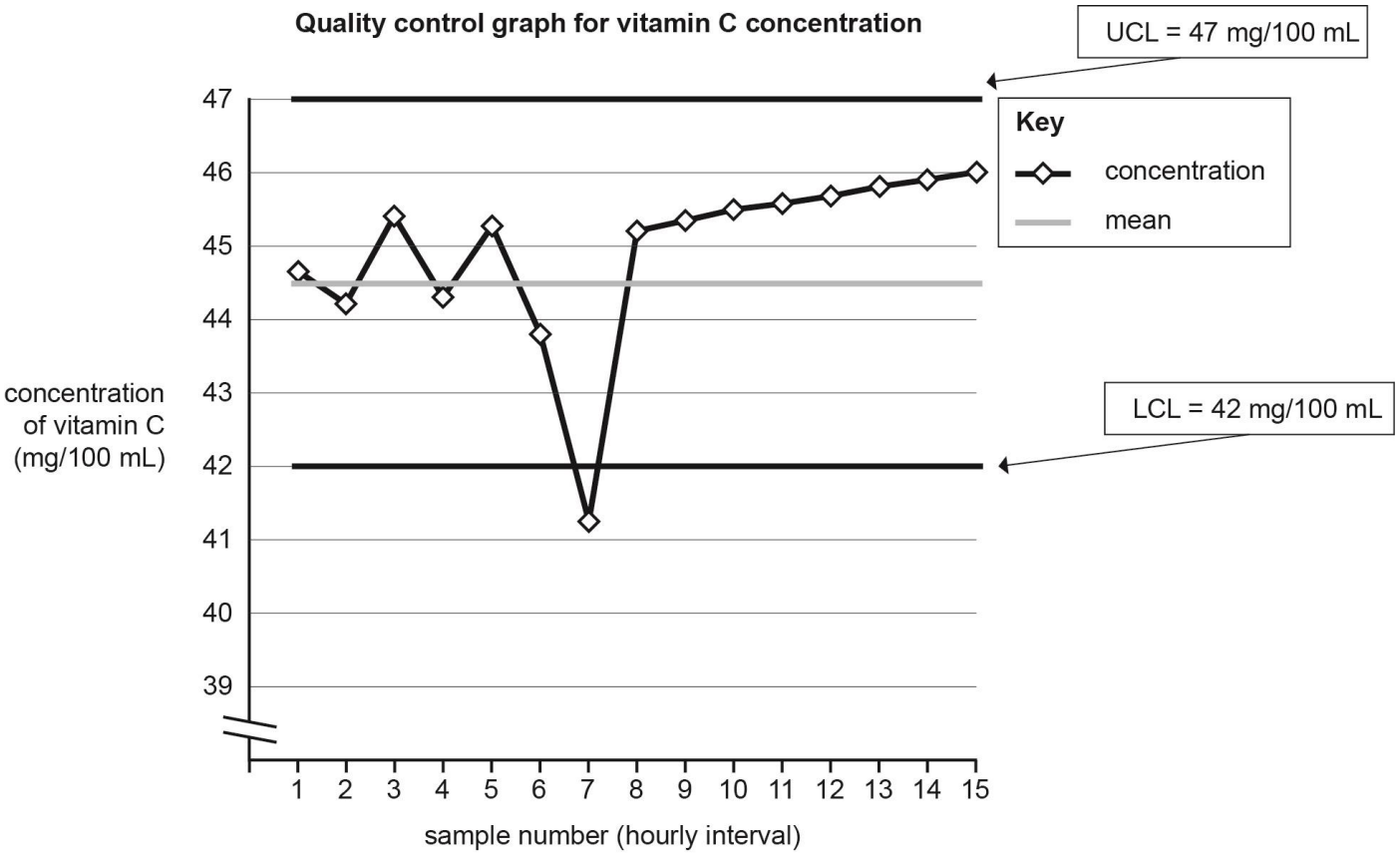
Marks	0	1	Average
%	15	85	0.9

44.5 mg/100 mL

It is important that students report scientific results with the correct units.

Question 11b.

Marks	0	1	2	Average
%	0	13	87	1.9



It was necessary to label the lines on the graph with UCL and LCL.

Question 11c.

Marks	0	1	2	Average
%	14	62	24	1.1

Sample 7, which is outside the lower control limit (LCL), and samples 8–15 due to the trend of increasing values

Question 11d.

Marks	0	1	Average
%	50	50	**0.5**

Samples 8–15

Question 12a.

Marks	0	1	Average
%	5	95	**1**

One of:

- 24.65, 24.65 and 24.60 mL
- 24.65, 24.60 and 24.55 mL.

Question 12b.

Marks	0	1	Average
%	16	84	**0.9**

One of:

- 24.63 mL
- 24.60mL.

This was based on the answer for Question 12a.

It was also acceptable to calculate the average titre volume using all of the titres in the table; however, the assumption was that the average would be calculated from the titre volumes in Question 12a.

Question 12c.

Marks	0	1	Average
%	28	72	**0.7**

$HCL_{(aq)} + NaOH_{(aq)} \Longrightarrow NaCL_{(aq)} + H_2O_{(l)}$

While including states such as (aq), (l) in balanced equations is best practice, balanced equations that did not include states were also accepted as the question did not ask students to include states.

Question 12di.

Marks	0	1	Average
%	58	42	**0.4**

Read to within half of the smallest increment of 0.1 mL, therefore 0.05 mL, or read from the bottom of the meniscus.

Question 12dii.

Marks	0	1	Average
%	65	35	**0.4**

Two decimal places

Question 12e.

Marks	0	1	2	Average
%	20	43	37	**1.2**

No, 25.38 mL has been estimated, as it is not possible to read a burette to this accuracy. The last decimal place should be a 5 or a 0, so 25.35 or 25.40 mL.

Another acceptable response was: 25.38 mL is outside the concordant titre volumes in the Question 12 table so it is an inaccurate value.

Question 13a.

Marks	0	1	2	3	Average
%	20	3	2	76	**2.3**

- Solution A = 0.5 M (20/100 × 5 M)
- Solution B = 0.05 M (20/100 × 0.5 M)
- Solution C = 0.005 M (20/100 × 0.05 M)

All answers required units of M, as the question asked for a concentration. A number alone was not sufficient.

Question 13b.

Marks	0	1	Average
%	39	61	**0.6**

10, or 1 in 10

Dilution factor is the amount you need to multiply the end result by to get back to the original concentration. The dilution factor that is the reciprocal of the dilution of 20 mL/200 mL is 200/20 = 10.

Question 13c.

Marks	0	1	2	Average
%	35	41	24	**0.9**

Possible answers included (any two of):

- visual inspection that glassware is transparent and not opaque/cloudy
- glassware is not wet
- glassware is not cracked
- pipette is rinsed with the NaOH solution of use prior to use
- volumetric flask is rinsed with distilled water prior to use
- all glassware is washed, rinsed with distilled water and dried prior to use.

A number of students misread the question where it asked about steps to be taken before performing ‘the’ serial dilution, which implies the serial dilution in the original question. The serial dilution in Question 13 is of chemicals. Serial dilutions are also used for diluting microbiological samples and some of the answers received were related to this, for example, autoclave pipettes. Contaminants are not only biological and can be chemical.

The answer needed to refer to the serial dilution in part a.

Answers relating to glassware used in microbiological testing, for example autoclaving pipettes, were not accepted as Question 13 referred to serial dilution of chemicals, not bacterial samples.

Question 14a.

Marks	0	1	2	Average
%	39	11	50	**1.1**

$C_1 \times V_1 = C_2 \times V_2$

$C_1 = 11.6$ m

$V_1 = ?$

$C_2 = 0.1$ M

$V_2 = 20 \times 10^3$ mL

$$V_1 = \frac{0.1\ \text{M} \times 20 \times 10^3\ \text{mL}}{11.6\ \text{M}}$$

$V_1 = 172$ mL

Question 14b.

Marks	0	1	Average
%	63	37	**0.4**

One of:

- yes, because the molarity of the concentrated HCl is approximate
- yes, because the HCl is not a primary standard
- yes, because of the error factor involved in measuring solutions
- yes, because the HCl is volatile and unstable.

Question 14c.

Marks	0	1	2	Average
%	13	17	70	**1.6**

Hazard control measures could be any one of substitution, engineering, administrative or PPE controls from the hierarchy list. Elimination was incorrect, as the technician has been asked to prepare a standard HCl solution.

Possible answers included the following:

Hazard control	Control measures
Engineering controls	• Prepare the standard solution using a fume cupboard. • Concentrated HCl to be handled in a well-ventilated area to eliminate risk of respiratory irritation.
Substitution	Use a less concentrated stock solution of HCL to prepare the standard solution.
Administrative controls	• Spill kits to be available during use. • Follow SOP. • Dilute the concentrated HCl slowly as it is an exothermic reaction. Never add the HCl stock directly to water.
Personal protective equipment	• Wear face shield/goggles/safety glasses. • Wear gloves to prevent skin burns. • Wear laboratory coat for protection.