2018 VCE VET Integrated Technologies examination report

General comments

The 2018 VCE VET Integrated Technologies examination consisted of two sections: Section A, which comprised 20 multiple-choice questions (20 marks), and Section B, which comprised nine questions (80 marks) that required students to give written explanations and show working.

Students were required to use correct engineering prefixes when providing answers where a value was required and complete electrical circuits showing connections in some questions.

Specific information

This report provides 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	13	79	0	2	
2	0	0	100	0	
3	71	0	29	0	The cell is always represented with a larger line being positive, whereas one third of students incorrectly selected the polarised capacitor, which has both lines the same size.
4	25	54	13	8	The Australian standard for power leads is brown: active, blue: neutral and earth: green with yellow stripe.
5	0	0	4	96	
6	0	88	8	4	
7	88	4	8	0	
8	25	8	67	0	
9	25	42	29	4	In the series capacitor divider circuit, given that Q = VC, V1 2μF and V2 1μF, the larger capacitor will have the lower voltage and the smaller capacitor the higher voltage.
10	13	54	29	4	The triac symbol appears as back-to-back diodes with a third lead gate input.
11	38	21	29	13	+10 V and –10 V = 20 V peak-to-peak F = 1/t = 1/0.004 = 250 Hz

Question	% A	% B	% C	%D	Comments
12	0	4	33	63	
13	0	42	4	54	An inverter is specific circuitry for converting DC to AC.
14	13	8	13	67	
15	46	42	4	8	Silver has a lower resistivity than copper.
16	0	83	13	4	
17	0	0	79	21	
18	21	42	8	29	As the resistor is tied to the negative, it is a pull-down resistor.
19	25	13	38	25	IC supply +5 V to pin 16 and 0 V to pin 8. Students needed to know the pin numbering sequence of ICs.
20	4	0	96	0	

Section B

Some students completed Section B to a high standard. Some students had difficulty in applying Ohm's law in a basic circuit.

Question 1a.

Marks	0	1	Average
%	51	49	0.5

A DC power supply

Question 1b.

Marks	0	1	2	Average
%	27	10	63	1.4

- Turns ratio = N1/N2 = 480/2 = 20 turns
- 240/20 = 12 V (V or volts needed to be specified)

Question 1c.

Marks	0	1	Average
%	71	29	0.3

+5 V DC voltage regulator

Question 1d.

Marks	0	1	Average
%	71	29	0.3

+5 V DC

Question 2a.

Marks	0	1	2	Average
%	63	8	29	0.7

Application of Ohm's law

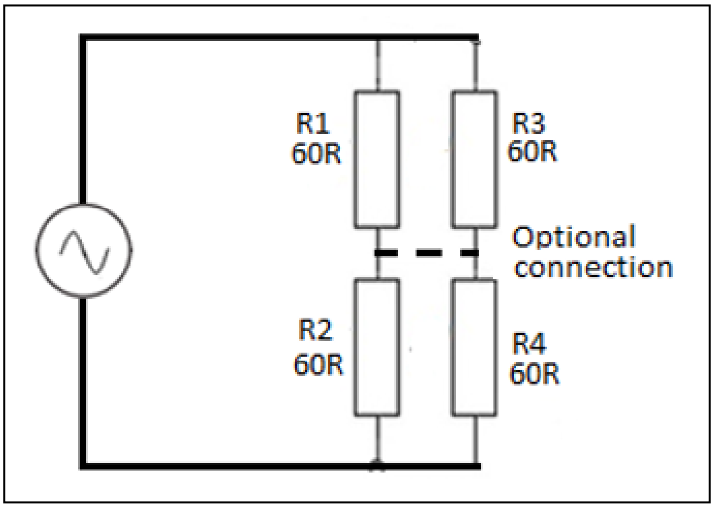
- I = V/R = 60/60 = 1 A
- P = VI = 60 × 1 = 60 W

Therefore, 240 W = 60 W × 4 elements

Alternatively, $P = V^2/R$ was used by some students.

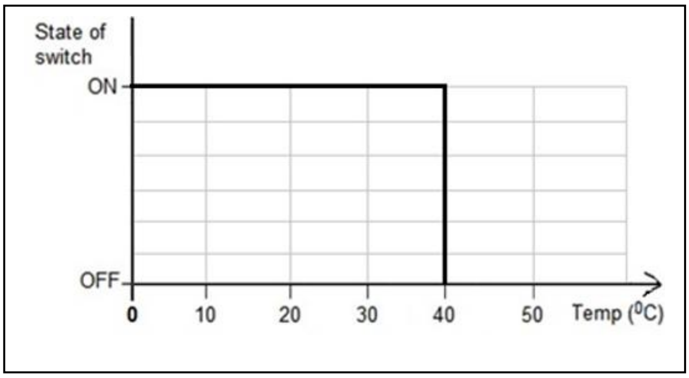
Question 2b.

Marks	0	1	2	Average
%	83	10	6	0.3



Question 2c.

Marks	0	1	2	Average
%	54	0	46	0.9



Question 3a.

Marks	0	1	2	3	Average
%	50	4	0	46	1.4

- $R_1//R_2$ 20//20 = 10 Ω
- $R_3//R_4$ 20//20 = 10 Ω
- $R_1//R_2 + R_3//R_4$ = 10 + 10 = 20 Ω

Question 3b.

Marks	0	1	2	3	Average
%	79	0	4	17	0.6

- Vx = Vs (Rx/RT)
- voltmeter = 6 volts (V or volts needed to be specified)

Question 3c.

Marks	0	1	2	3	Average
%	81	4	2	13	0.5

- I = V/R = 6/20 = 0.3 A
- P = V I = 6 × 0.3 = 1.8 watts (W or watts needed to be specified)

P = V^2/R was used by some students.

Question 4a.

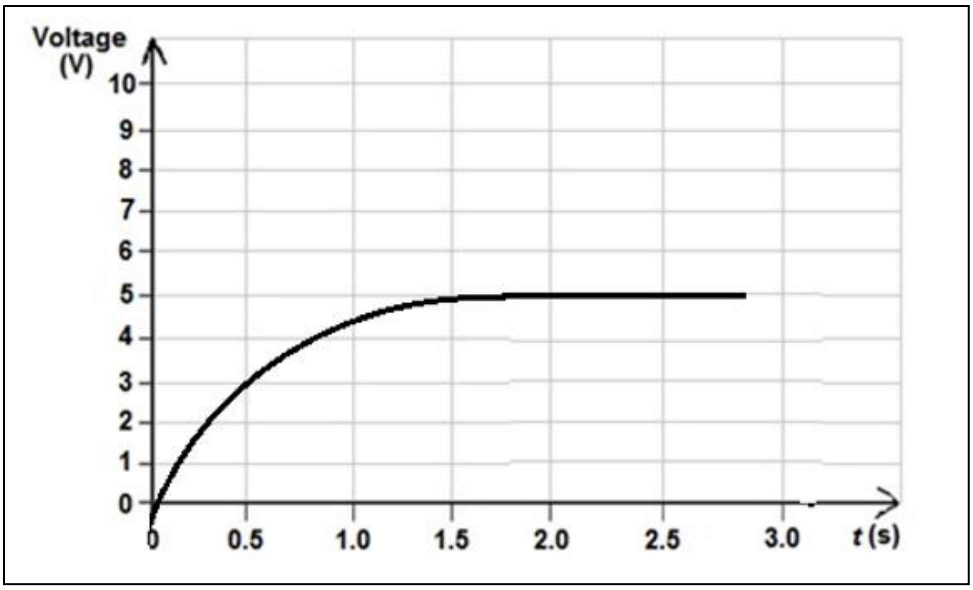
Marks	0	1	2	3	Average
%	79	4	4	13	0.5

- 2 × 10 μF in series = 5 μF
- τ = C × R = (5 × 10^{-6}) × 100 kΩ (from the provided formula sheet)
- τ = 0.5 sec or 500 mS (S or sec needed to be specified)

Some students had difficultly applying the formula and using correct SI units.

Question 4b.

Marks	0	1	2	3	Average
%	83	15	2	0	0.2



Curve shape showing a charging cap.

- the cap should be fully charged at 1.5 sec
- charged to 5 V only

- transient regime shown across at least 5 time constants

Question 5a.

Marks	0	1	2	3	Average
%	38	10	2	50	1.7

- Two resistors in series: 10 +10 = 20 Ω
- Three resistors in parallel: 20//50//100 = 12.5 Ω
- $1/R_T = 1/R_1 + 1/R_2 + 1/R_3$
- $= 1/20 + 1/50 + 1/100$
- $\therefore R_T = 12.5\Omega$

The formula sheet provided formulas for both series and parallel resistor circuits.

Question 5b.

Marks	0	1	2	Average
%	67	4	29	0.7

V = IR = 1 × 20 = 20 V (V or volts needed to be specified)

Question 5c.

Marks	0	1	2	Average
%	50	33	17	0.7

I = V/R = 20/100 = 0.2 A or 200 mA

Question 5d.

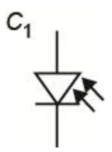
Marks	0	1	2	Average
%	75	0	25	0.5

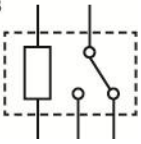
- V = IR = 1 × 20 = 20 V P = VI = (20 × 1) = 20 W
- 20 W + 8 W + 4 W = 32 watts

$P_T = V_s^2 / R_T$ was used by some students.

Question 6a.

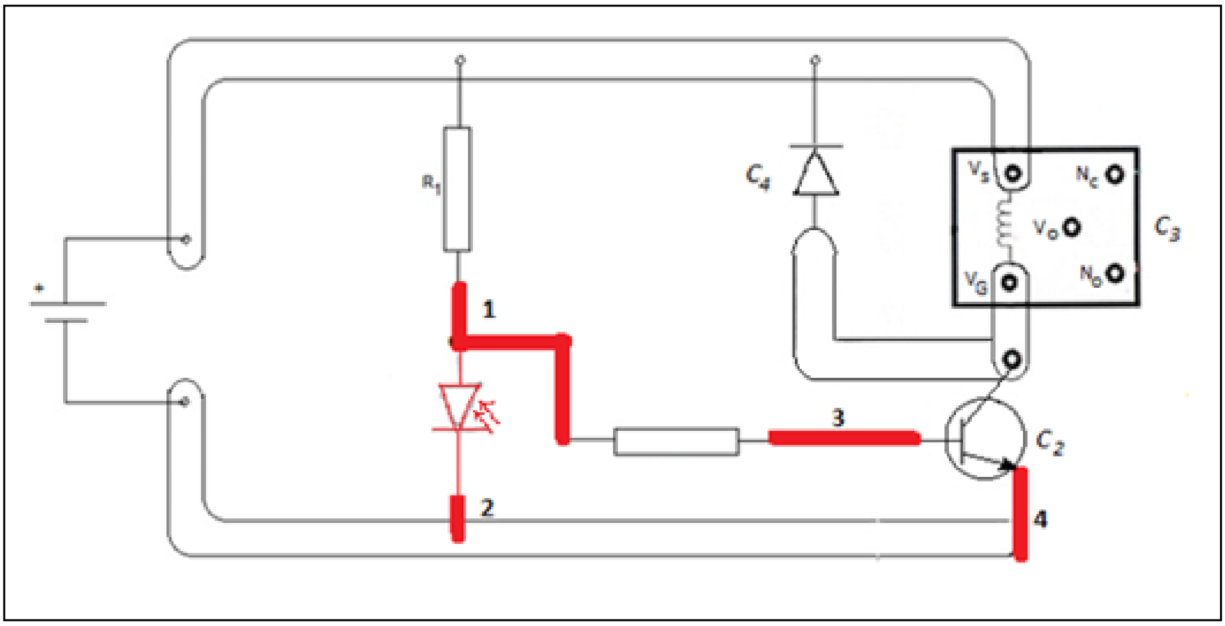
Marks	0	1	2	3	4	Average
%	38	23	19	15	4	1.3

Component	Name	Description of general function
	Photodiode	Conducts as a diode when visible light falls on it

C_2 	NPN transistor	• used as a switch (to activate and enegise the relay when triggered on by the photodiode) • used to amplify
C_3 	electromechanical relay	used as an electromechanical switch (to switch the main power on and off on the external light or device)
C_4 	power diode	allows current to flow in one direct only

Question 6b.

Marks	0	1	2	3	4	Average
%	27	21	6	8	38	2.1



Question 6c.

Marks	0	1	2	Average
%	85	10	4	0.2

It is placed in reverse bias to allow the collapsing field of the relay coil to dissipate any energy and so protects the circuit.

Question 7a.

Marks	0	1	Average
%	54	46	0.5

The motor provides high rotational power and will not stall and can start turning while under load.

Question 7b.

Marks	0	1	Average
%	75	25	0.3

These limit switches operate the limits of the screens being fully open or fully closed and activate to inform the controller circuit. These switches set the upper and lower limits for the door position.

Question 7c.

Marks	0	1	2	Average
%	43	26	32	0.9

Many potential unintended consequences could occur, including:

- The shutters will also operate on weekends and holiday periods.
- Dull or overcast conditions could trigger the shutters to close automatically.
- Dirt on the sensor may affect performance.
- Car headlights cause windows to open at night.

Question 7d.

Marks	0	1	2	Average
%	55	13	32	0.8

The L298N H-bridge has multiple functions, including:

- to enable a digital circuit to control the analogue motor
- to step up the voltage to drive the motor
- 5 V digital circuit stepped up to 9 V to drive the motor
- to protect the microcontroller from possible back EMF and electrical noise from the motor
- the motor driver electrically isolates microcontroller from the motor using an electronic component called an opto-coupler.

Question 7e.

Marks	0	1	Average
%	45	55	0.6

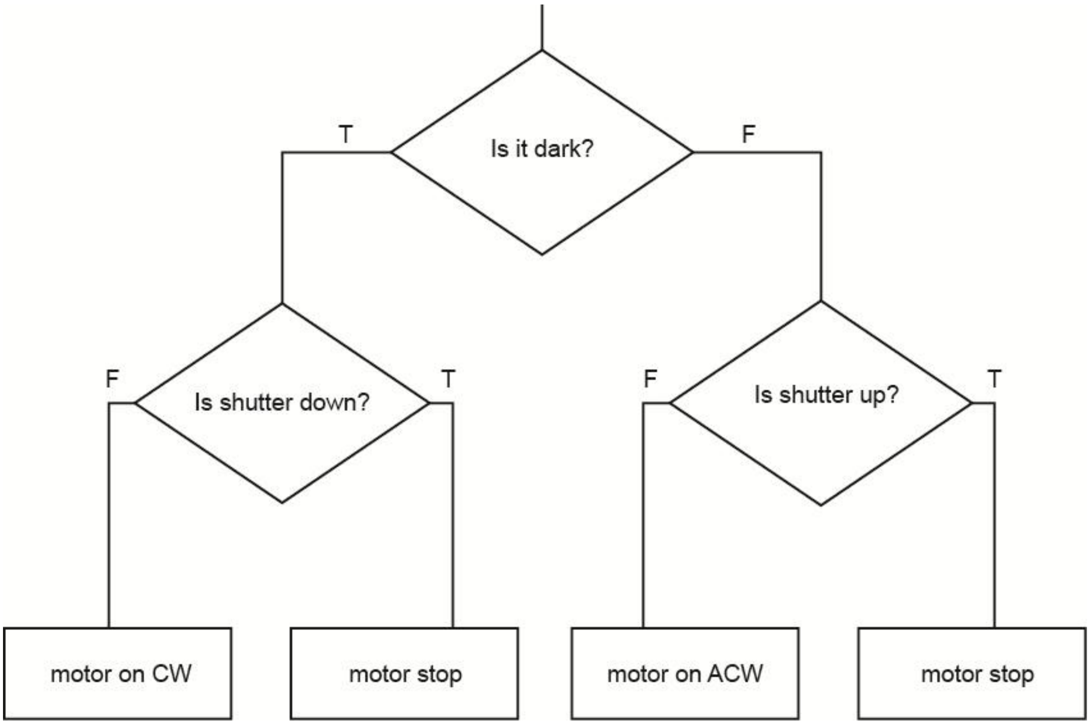
Many options are possible for additional devices that could be connected to the input of the controller, including:

- The installation of a wind speed meter that could provide a level that would trigger the controller to close the shutters, until the wind level subsides.
- Addition to circuit of a high wind sensor. Once the wind exceeds a set speed the windows would go into a close operation.
- Addition of an Internet of Things (IoT) enabled controller. The IoT controller could check wind warning levels from a weather service provider and the system would close the door while any such wind warning was current.

Most students identified devices that could physically measure wind speed as the input rather than considering a wind conditions feed from the internet.

Question 7f.

Marks	0	1	2	3	Average
%	40	19	14	27	1.3



Some minor variations in the flow chart were possible.

Question 8a.

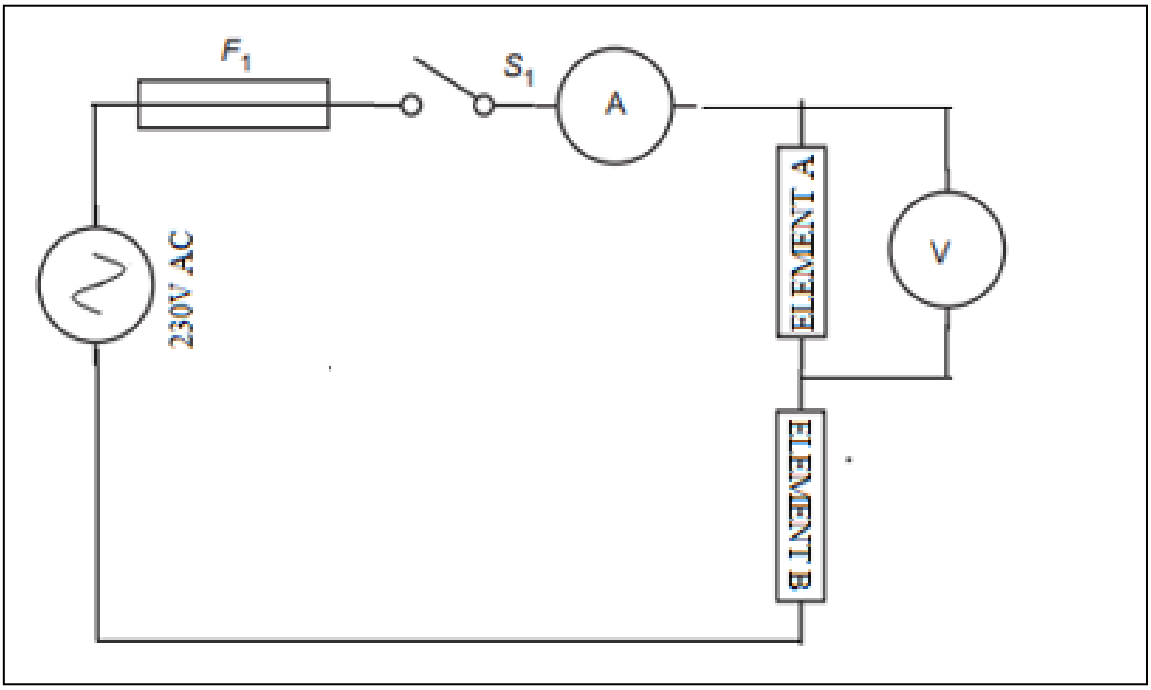
Marks	0	1	2	Average
%	33	8	58	1.3

Medium heat setting. Heating element A only = 2875 watts.

- I = P/V = 2875/230 = 12.5A (A or amps needed to be specified)

Question 8b.

Marks	0	1	2	3	4	Average
%	29	2	6	17	46	2.5



Question 8c.

Marks	0	1	2	3	Average
%	73	10	0	17	0.6

Find the resistance:

- R = V/I = 230/12.5 = 18.4 Ω

Find the two elements in series:

- 18.4 + 18.4 = 36.8 Ω

Find the power:

- $P = V^2/R = (230 \times 230) / 36.8 = 1437.5$ W

Question 8di.

Marks	0	1	2	Average
%	27	27	46	1.2

The reasons to retain the three-setting switch relate the simple operation, which is undertaken quite effectively. Possible answers included:

- very simple to operate
- it is used 80 per cent of the time
- very reliable and straightforward operation
- it's working well in a very harsh environment
- does the job well.

Question 8dii.

Marks	0	1	2	Average
%	31	44	25	1

The advantages in replacing the simple three-setting switch with a fully microprocessor-controlled heating system relate to the increased capital cost and also increased efficiencies in operation. Some possible answers are:

- increased control and accuracy
- increased efficiency
- will be able to adapt, develop and include other monitoring
- save operational costs
- save water
- save power
- increased plant production

Question 9ai.

Marks	0	1	Average
%	96	4	0.1

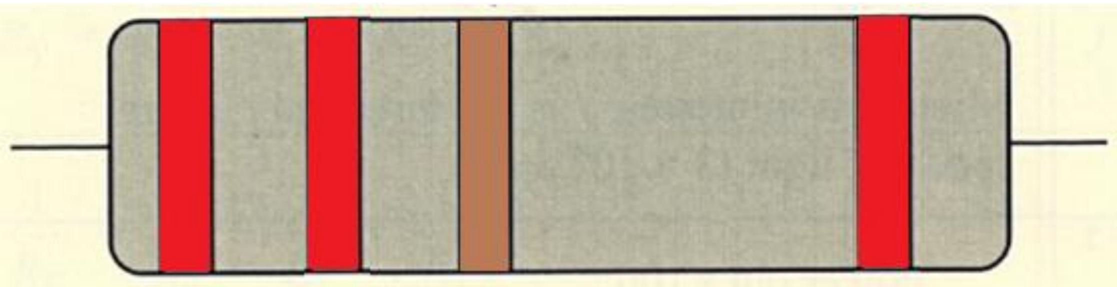
The resistors are configured as a voltage divider circuit.

Students who stated that the resistors were connected in series needed to go further with their explanation.

Question 9aii.

Marks	0	1	Average
%	54	46	0.5

The resistance of the fixed resistor R_1 is 220Ω +/- 2% tolerance.



Red Red Brown Red

Students should refer to the formula sheet and apply the rules to find the correct colour codes.

Question 9aiii.

Marks	0	1	2	Average
%	77	13	10	0.4

The output voltage range provided to the IC is:

- $R_V = 110\ \Omega \Rightarrow V_{out} = \frac{5}{3} = 1.6V$
- $R_V = 220\ \Omega \Rightarrow V_{out} = \frac{5}{2} = 2.5V$

Question 9bi.

Marks	0	1	2	Average
%	64	2	34	0.7

The function of the MCP3008 IC is an ADC (analogue to digital converter), which provides accurate reading of an analogue signal on a device and sends out digital signals.

Question 9bii.

Marks	0	1	2	Average
%	83	4	13	0.3

The size of each register in each register on the MPC3008 IC is 10 bits.

The circuit generates the number decimal 0 (zero) at 0V input and the decimal number 1023 at 5V input.

$2^{10} = 1024$ (steps)

Question 9biii.

Marks	0	1	2	Average
%	81	10	8	0.3

The voltage step provided by the MPC3008 IC is:

- $V_{step} = V_{max} / (2^n - 1)$
  $= 5 / (2^{10} - 1)$
  $= 5 / 1023$
  ≈ 5 mV

Question 9c.

Marks	0	1	2	Average
%	56	19	25	0.7

Possible key processes that would be involved when using a software package to create the PCB artwork include:

- drawing the circuit
- circuit simulation and testing
- resolving circuit paths
- PCB layout
- exporting file formats suitable for different manufacturing processes

Many processes were relevant; this not a conclusive list.