2019 VCE VET Integrated Technologies examination report

General comments

The 2019 VCE VET Integrated Technologies examination consisted of two sections: Section A, which comprised 20 multiple-choice questions, and Section B, which comprised nine questions that required students to give written explanations and show working.

Students were required to use correct engineering prefixes and state the correct units of measurements for the given problems. Some drawing of printed circuit boards and completing electrical circuit diagrams was required 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	% No Answer	Comments
1	2	2	88	7	0	Wherever possible remaining on the ground is always the preferred option for safety reasons.
2	23	16	33	28	0	The electrical wires strippers are set by adjusting the screw to the desired depth to only cut into the surface of the plastic insulation, thus not damaging the conductive copper wire.
3	30	16	7	47	0	The photodiode is shown with arrows pointing inward as receiving light into the component. The LED symbol is similar but as it gives off light the arrows point outwards.
4	37	12	5	47	0	Looking at an Australian power socket active is on the left, consequently the view of this plug has the active pin on the right.

5	37	30	0	33	0	The only option of a pan-head screw is option B.
6	0	0	53	47	0	Mb denotes mega bits which is the most commonly used data transfer term. MB denotes mega bytes. A byte is larger and equal to 8 bits.
7	5	47	2	42	5	Bluetooth ® is a wireless short distance (<10 m) data transfer technology which is known as a PAN – personal area network.
8	16	65	2	16	0	
9	67	23	9	0	0	
10	5	60	30	5	0	The transformer is being supplied with a steady 10 V DC (direct current). Transformers require a pulsating DC or AC supply to function, consequently an output of 0 V would occur. Only if the supply was 10 V AC would 1 V AC be produced on the secondary winding.
11	30	37	26	7	0	All capacitors are 10 µF/10 V in this configuration. Two capacitors of the same value in series result in a halving of the capacitance, while the voltage rating is the sum of both. Subsequently connected in parallel is the sum of the two, however, the voltage rating remains unchanged.
12	35	14	26	26	0	P – P = 40 V + 40 V = 80 V f = 1/T = 1/0.04 = 25 Hz
13	14	58	28	0	0	
14	5	2	79	14	0	1039 Ω is within the expected error range of a 1k Ω 5% tolerance resistor.
15	16	12	56	14	2	
16	0	88	12	0	0	
17	49	7	42	2	0	The pin sequence for a 14-pin IC is determined from the notch as shown.
18	5	26	63	5	2	
19	0	12	74	14	0	
20	9	58	9	23	0	

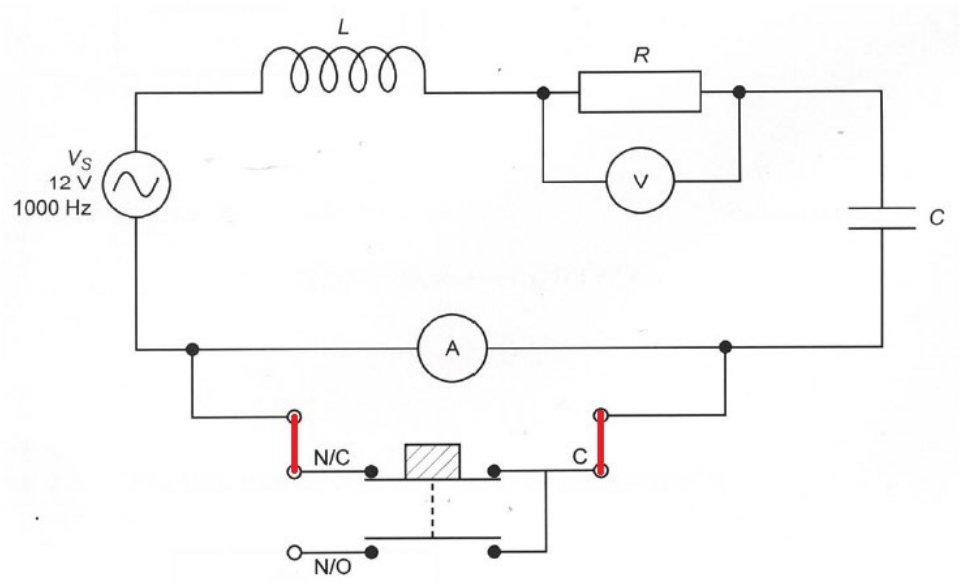
Section B

Students showed capability and strength in applying and completing ohm's law problems in a great variety of contexts.

Question 1ai.

Marks	0	1	Average
%	71	29	**0.3**

The connections from the circuit diagram to the appropriate terminals were as follows.



Question 1aii.

Marks	0	1	2	Average
%	86	1	13	**0.3**

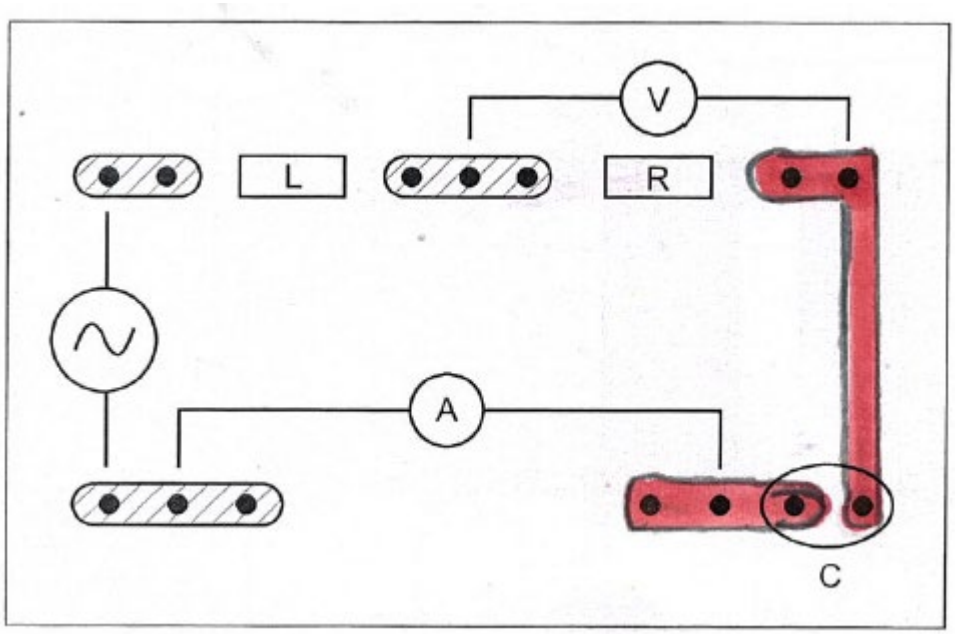
When activated (pressed), the N/C switch opens allowing full current to flow via the ammeter which would display the current in amperes.

A common error was students directly connecting one side of the ammeter (input) to both the N/C and N/O connections; and the other connection from C to the second ammeter connection. This incorrect configuration would effectively make the switch always closed, whether it is activated or not.

Question 1b.

Marks	0	1	2	3	4	Average
%	43	9	44	2	1	1.1

The correct response was as follows.



The question was attempted by most students. Students needed to draw in the substantial artwork of the missing copper tracks, but many only responded with fine lines as drawn in the circuit schematic diagram provided. The wiring connections of the AC supply, meters and switch were provided through the provision of pin holes in the PCB where wires could be inserted.

Question 1c.

Marks	0	1	2	Average
%	56	31	13	**0.6**

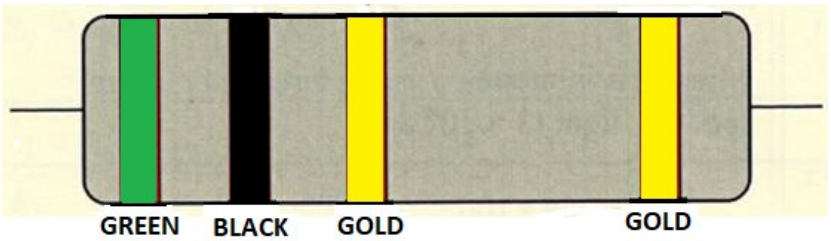
Any two of the following were accepted:

- wider tracks reduce power loss and provide low electrical resistance
- increase the soldering area ensuring good electrical connection between the PCB and inserted components
- environmentally better, quicker and cleaner with reduced copper removal
- may provide increased RF shielding.

Question 1di.

Marks	0	1	2	Average
%	81	6	13	**0.3**

The correct labels were as follows.



Many students incorrectly provided the colour code for 5 Ω, +/- 5% tolerance as black, green, black, gold and were awarded no marks. Students need to know how to apply negative indices multiples as with the gold (10–1) and silver (10–2) in the multiplier bands.

Page 4 of the formula sheet insert provided full details of how to determine a resistor value from the colour code.

1st Band	2nd Band	Multiplier	Tolerance
Green (5)	Black (0)	Gold (× 10–1)	Gold (+/- 5%)

Question 1dii.

Marks	0	1	2	Average
%	55	6	40	**0.9**

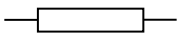
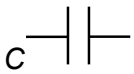
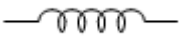
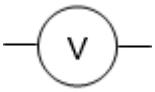
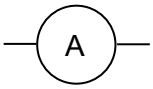
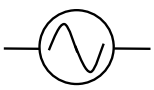
+/- 5% of 5 Ω = +/- 0.2 5 Ω

This question was well answered. Students who stated the resistance acceptable tolerance range is 4.75 Ω – 5.25 Ω were also awarded full marks.

Question 1e.

Marks	0	1	2	3	4	5	Average
%	21	13	15	20	27	5	**2.4**

This question was generally well answered. A common mistake was not to state the base unit of measurement in terms of a SI unit. The AC power supply afforded an acceptable range of responses.

Component	Name of component	Base unit of measurement	Letter(s)/symbol used for base unit of measurement
R 	*resistor*	*ohm*	Ω
 *C*	capacitor	farad/s	F
L 	inductor	henry/s	H
 V	voltmeter	volt/s	V
 A	ammeter	ampere/s or amps/s	A
	AC power supply	volt/s, AC volt/s amp/s, watt/s or frequency	V, A, W or Hz

Question 2a.

Marks	0	1	2	Average
%	42	12	47	**1.1**

The correct calculation was as follows.

R_{total} = R_1 + (R_2/R_3) + R_4

= 10 + (20/20) + 10

= 10 + 10 + 10

= 30 Ω

Question 2b.

Marks	0	1	2	Average
%	38	12	50	**1.1**

I_{total} = V/R_T

= 60/30

= 2 amps

Question 2c.

Marks	0	1	2	Average
%	67	2	30	**0.7**

The simplified circuit is 3 × 10 Ω resistors in series across 60 V.

Across one 10 Ω resistor, the meter voltage is calculated as follows.

V = 60/3
= 20 volts

Or

V = I R
= 2 × 10
= 20 volts

Question 3a.

Marks	0	1	2	Average
%	98	2	0	**0**

Given that state regulation requires unlicenced people (students) for electrical safety reasons to only work with extra-low voltage (ELV), it was apparent that students were unaware of the mandated maximum voltages specified.

- AC voltage = 50 V
- DC voltage = 120 V

In Victoria, the relevant legislation for electrical safety is the *Electricity Safety Act 1998* and associated regulations. Only persons who hold an appropriate current electrical licence are permitted to carry out electrical work on products or equipment that require voltage greater than 50 volts AC or 120 volts ripple-free DC. This requirement means that students are not permitted to

carry out any electrical work on electrical products or equipment that operate above these voltages.

Question 3b.

Marks	0	1	Average
%	42	58	**0.6**

This question was generally well answered. Either of the following was accepted.

- a transformer
- a step down transformer

Question 3c.

Marks	0	1	Average
%	60	40	**0.4**

It functions as an electromechanical tap to open or close the water value.

This question was well answered with a variety of good responses.

Question 3di.

Marks	0	1	Average
%	44	56	**0.6**

Given one solenoid valve 24 V_{AC} draws 1.2 A:

2 × 1.2 A = 2.4 A

Question 3dii.

Marks	0	1	2	3	Average
%	50	6	1	43	**1.4**

The power used by two solenoid valves is found as follows.

P = VI
= 24 × 2.4
= 57.6 watts or 57.6 W

Question 3diii.

Marks	0	1	2	Average
%	60	34	6	**0.5**

The reasons why only two solenoids would be operating at a time relate to the possible limitations of both the water and electrical supply.

- The volume of water supply could be a factor if more than two valves were open.
- The water pressure could drop significantly if more than two valves were open.
- The rating of the transformer may only be capable of supplying two solenoids.

Question 3ei.

Marks	0	1	Average
%	26	74	**0.8**

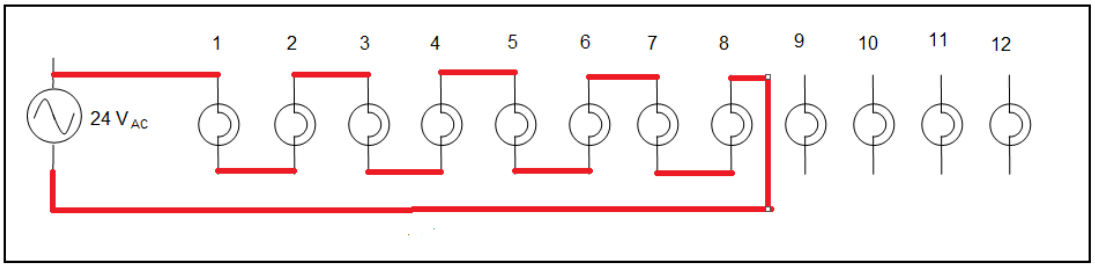
The number of 3 V filament globes to be connected is determined as follows.

Number of globes = 24/3
= 8

Question 3eii.

Marks	0	1	2	3	Average
%	33	29	1	37	**1.5**

The filament globes were required to be connected in series for the required number determined in Question 3ei (8).



Question 3fi.

Marks	0	1	2	Average
%	70	0	30	**0.6**

The calculation of the resistance of a single filament globe could be determined by different methods. The question stated that each 3 volt filament globe was rated at 2.25 watts. Using ohm's law, students could have adopted the method of first finding the current drawn by the globe and then proceeding to find the resistance.

Students need to be able to undertake simple ohm's law calculations in a range of contexts. Marks can be awarded for partial completion of calculations even when the question has not been fully resolved. Responses to this question had no middle ground. Some students used the given formulas and applied the stated values to find the answer; others had difficulty in finding a way to proceed.

The resistance of one filament globe is determined as follows.

$R = V^2/P$
$= (3 \times 3)/2.25$
$= 9/2.25$
$= 4\ \Omega$

Or

$I = P/V$
$= 2.25/3$
$= 0.75$ A

$R = V/I$
$= 3\ V/0.75$
$= 4\ \Omega$

Question 3fii.

Marks	0	1	Average
%	57	43	**0.5**

The performance would be decreased as all the lamps would be dull and not providing 2.25 W of light.

Question 3fiii.

Marks	0	1	2	Average
%	86	3	10	**0.3**

The current that would be drawn by all 12 filament globes could be calculated as follows.

I = V/*R*
= 24/(12 × 4)
= 24/48
= 0.5 A

Or

24/12 = 2 V per lamp, therefore:

I = V/*R*
= 2/4
= 0.5 A

Question 3fiv.

Marks	0	1	2	3	4	Average
%	40	22	20	10	8	**1.3**

Students needed to show their understanding of the different fundamental characteristics of both series and parallel circuits. This relates to series circuits potentially having a higher voltage with lower current, while parallel circuits potentially have a lower voltage and higher current. Many students chose not to respond directly. Students should be encouraged to attempt questions, as marks may be awarded for responses that show some understanding of the key concepts, even if not well expressed.

Any two of the following advantages of a series circuit were accepted.

- reduced amount of wiring
- can allow for the incorporation of a flasher globe which will flash all the globes in the circuit
- overall the current can be significantly lower, as the circuit can be supplied with a higher voltage.

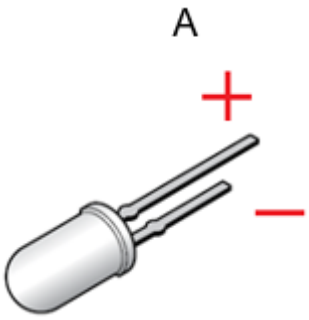
Disadvantages of a series circuit (any two of):

- faults diagnosis can be more difficult if a single globe is blown in a long string
- one small fault usually results in the entire string of bud lighting not working
- long strings of bud lighting are likely to get tangled and the last globe has to have a single long wire returning to the supply
- the higher supply voltage required can potentially be more hazardous.

Question 4a.

Marks	0	1	2	Average
%	47	34	20	**0.8**

Students needed to identify the polarity and the anode (A) connection, as follows.



Question 4b.

Marks	0	1	2	3	4	Average
%	45	33	13	7	2	**0.9**

The following shows correct descriptions for each feature.

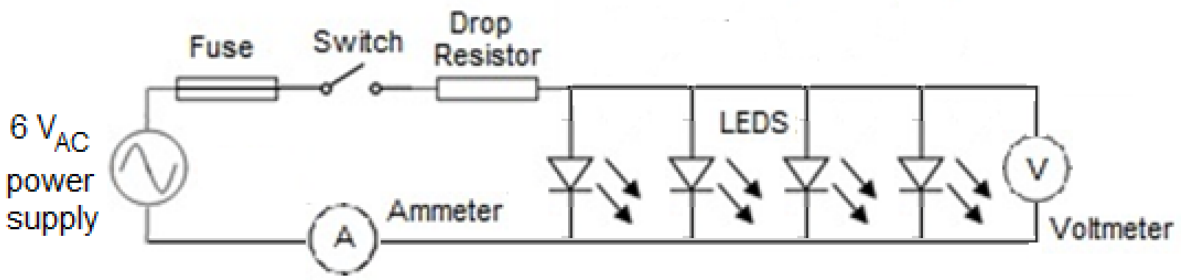
Feature	Description
Ø 5 mm package	Standard 5 mm round lens package
untinted, non-diffused lens	A clear uncoloured lens which does not disperse or significantly spread the produced light.
ESD withstanding voltage – up to 4KV	The LED can withstand an electrostatic discharge of up to 4000 V.
Zener diode circuit protection	An internal Zener diode has a breakdown voltage set to the level in order to protect the LED should a higher voltage be accidently applied.

Question 5a.

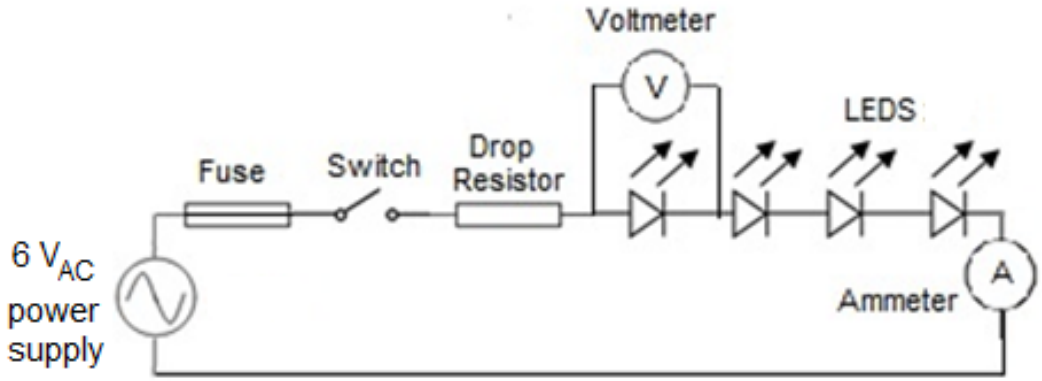
Marks	0	1	2	3	4	5	Average
%	20	3	3	14	22	37	**3.3**

Possible solutions were either a parallel or a series circuit as shown below. The direction of the LEDs is completely optional as it is supplied by an AC power supply.

A parallel circuit



A series circuit



Question 5b.

Marks	0	1	2	Average
%	43	12	45	**1.0**

If the supply was changed from 6 V_{AC} to 12 V_{AC}, the drop resistor resistance value would need to be increased to maintain the selected V_d across the LEDs as they were designed for a 6 V_{AC} supply. Depending on the circuit design, the drop resistor resistance value could be doubled.

Many students suggested that the fuse current rating would need to be increased. While not necessarily required, it could be increased if the circuit were totally redesigned for the 12 V_{AC} supply, although if redesigned, an increase in voltage would normally result in a lower current being drawn. Therefore, a lower current fuse could potentially be used in such applications.

Question 5c.

Marks	0	1	2	Average
%	70	13	17	**0.5**

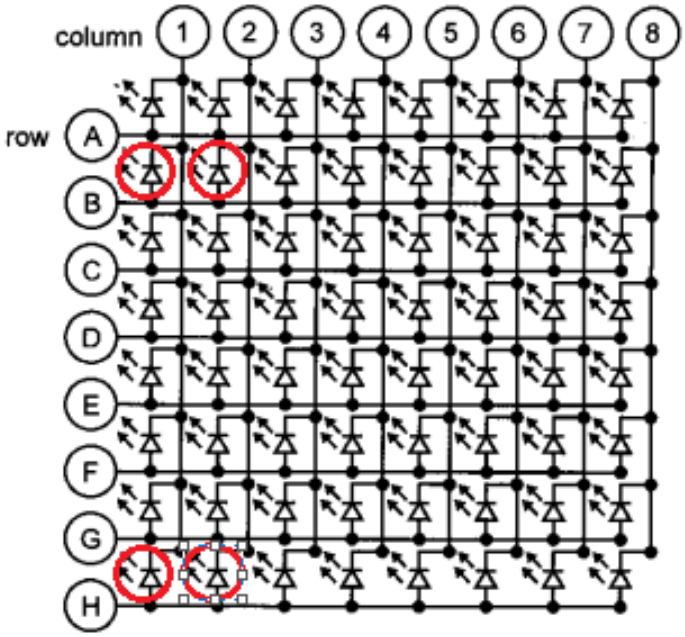
Supply is changed from 6 V_{AC} to 6 V_{DC}.

- With either 6 V_{AC} or 6 V_{DC} the effective electrical energy is the same, so potentially no changes may be required, although in this case when operating on AC the LEDs would be only conducting for half a cycle.
- There is a need to ensure the polarity of the LEDs are correct for conduction when connected to a DC supply.

Question 6a.

Marks	0	1	2	Average
%	70	2	28	**0.6**

LEDs that are ‘on’ are B1, B2, H1, H2, as shown in the following diagram.



Question 6b.

Marks	0	1	2	3	4	Average
%	63	14	6	2	14	**1.0**

A great range of options is possible where multiplexing technology is used, including the following.

Application	Explanation
Computer keyboard	• Multiplexing technology converts user key presses on keyboard to signals interpreted by the computer. • The keyboard on a computer uses a small number of multiplexed wires rather than 105 individual connections to the keys.
Electronic train timetable noticeboard	• Multiplexing technology is used in the wiring to provide timetabling data to be displayed. • The noticeboard would use multiplexing to light the required segments in order to display the information.
Variable speed traffic control signs	• Multiplexing technology used in the wired or wireless inputs to the sign, providing the real-time data for the variable speed limits. The number digits would be created with multiplexed inputs to the display.
Phone systems	• Multiplexing technology is used to reduce the required wiring.

Question 7

Questions related to the microcontroller proved to be challenging and student responses were consistently poor. The questions were asked in a context that is widely applicable.

Question 7a.

Marks	0	1	2	Average
%	81	18	1	**0.3**

The motor cannot be directly driven from the microcontroller because:

- the microcontroller output pins have insufficient current available to directly drive the motor
- the back EMF produced when the motor is turned could potentially damage the microcontroller if it were directly connected.

Question 7b.

Marks	0	1	Average
%	80	20	**0.3**

A suitable interface device between the microcontroller and the motor can be:

- a motor drive IC or circuit
- H drive circuit
- a relay.

Question 7c.

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

Apart from low RPM, other features of the motor include:

- high torque output
- difficulty in manually rotating the motor.

Question 7di.

Marks	0	1	2	Average
%	73	2	24	**0.6**

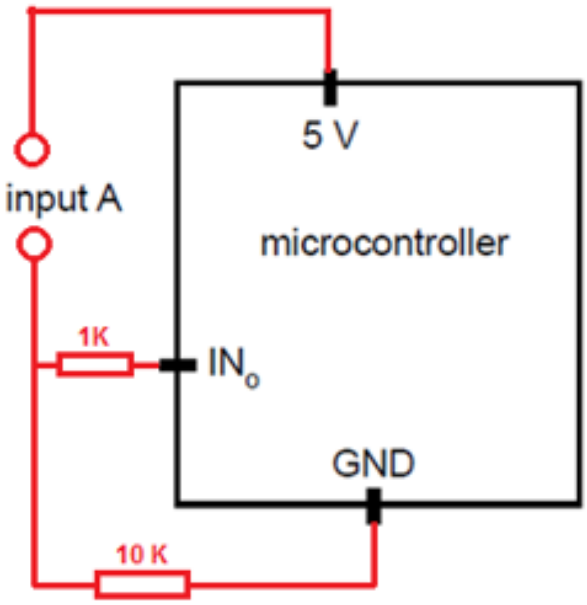
A range of switching options to make and break were possible, including:

- a micro-switch
- an optical device
- a reed switch (magnetic proximity).

Question 7dii

Marks	0	1	2	3	4	Average
%	83	10	2	4	1	**0.4**

Students were required to draw and label the component identified in the previous question. This could be completed as shown in the following diagram. Although a range of solutions were acceptable, this question was not well answered.



Question 7diii.

Marks	0	1	2	Average
%	90	5	5	**0.2**

The IN_0 should be kept low because the input would be prone to false triggers and possible interference if left ‘floating’.