VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2019

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER | | | | | | | | | Letter |

VCE VET INTEGRATED TECHNOLOGIES

Written examination

Thursday 14 November 2019

Reading time: 9.00 am to 9.15 am (15 minutes)
Writing time: 9.15 am to 10.45 am (1 hour 30 minutes)

QUESTION AND ANSWER BOOK

Structure of book

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	20	20	20
B	7	7	80
			Total 100

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers and one scientific calculator.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied
- Question and answer book of 25 pages
- Detachable insert of miscellaneous formulas in the centrefold
- Answer sheet for multiple-choice questions

Instructions
- Write your **student number** in the space provided above on this page.
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

At the end of the examination
- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the detached insert.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

SECTION A – Multiple-choice questions

Instructions for Section A

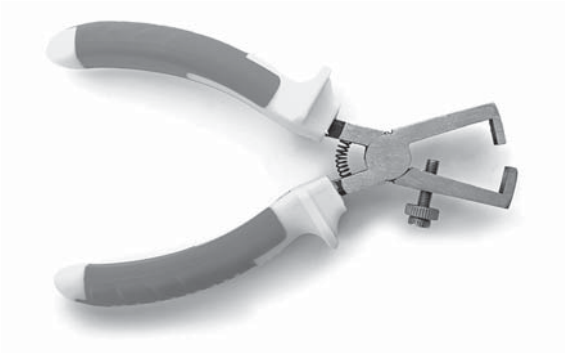
Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1; an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.
Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1

What is WorkSafe Victoria's recommendation regarding the prevention of falls?

A. Consider if giving someone a lift up or a shoulder ride will be adequate to complete a small job.
B. Consider if stretching up to get to the job is an option if the job is just out of reach.
C. Consider if the job can be undertaken from the ground with extension tools.
D. Consider standing on a milk crate.

Question 2



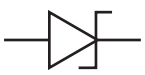
Source: Pixel-Shot/Shutterstock.com

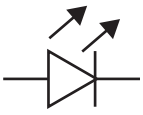
The pliers shown above are specifically used to

A. crimp cables into rectangular connection blocks.
B. punch small holes in square ducting.
C. strip insulation from wires.
D. hold wiring looms.

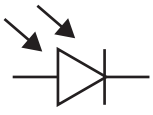
Question 3

Which one of the following symbols represents a photodiode?

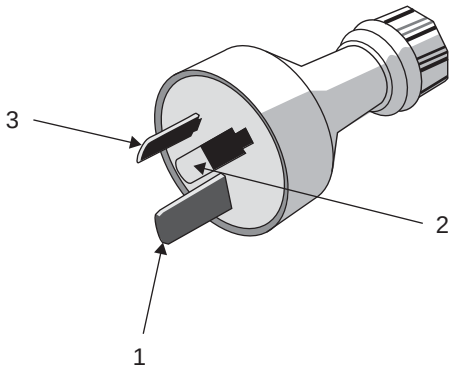
A. 

B. 

C. 

D. 

Question 4



Which of the following gives the standard pin connections for an Australian mains plug?

	Active	Neutral	Earth
A.	3	2	1
B.	3	1	2
C.	1	2	3
D.	2	3	1

Question 5

The screw shown above is best described as a

A. 10 mm metal thread.
B. pan-head, self-tapping.
C. plasterboard fixing screw.
D. countersinking wood screw.

Question 6

With reference to National Broadband Network (NBN) data download speeds, 44 Mbps refers to

A. 44 million bytes per second.
B. 44 multiple bypass system.
C. 44 megabytes per second.
D. 44 megabits per second.

Question 7

A PAN is created when using Bluetooth® for data transfer.

What does PAN stand for?

A. protocol action navigation

B. private activated network

C. priority acted network

D. personal area network

Question 8

Which one of the following technologies could provide the fastest data transfer rate?

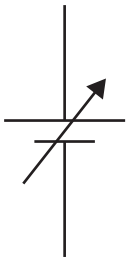
A. wi-fi

B. optical fibre

C. twisted-pair copper wire

D. frequency modulation (FM) transmission

Question 9



What does the electrical symbol shown above represent?

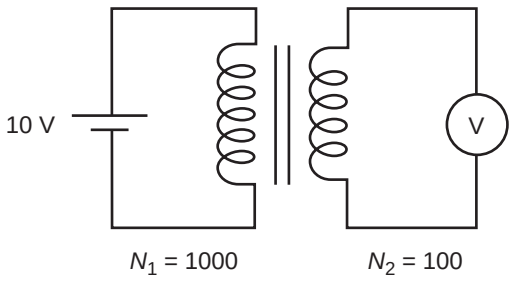
A. a variable DC power supply

B. a variable AC power supply

C. a variable capacitor

D. a variable resistor

Question 10



What is the voltage that would be displayed by the voltmeter V in the circuit above?

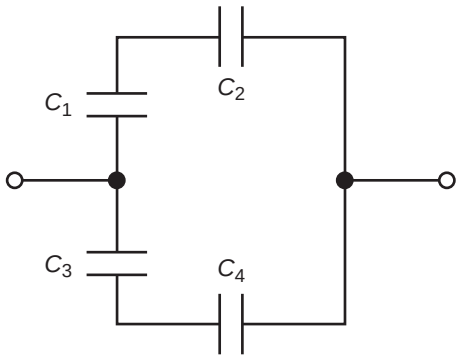
A. 0 V

B. 1 V

C. 10 V

D. 100 V

Question 11



Four capacitors rated 10 μF, 10 V are connected in a network, as shown above.

What is the equivalent capacitance and voltage rating for a single replacement capacitor?

A. 10 μF, 20 V

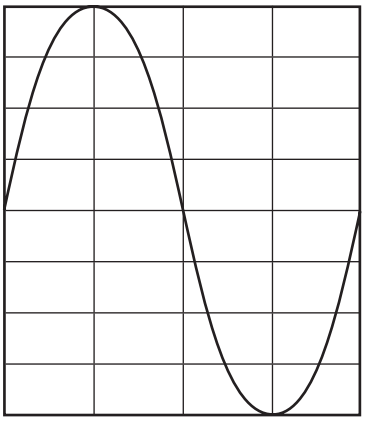
B. 40 μF, 40 V

C. 20 μF, 20 V

D. 80 μF, 40 V

Question 12

An oscilloscope has the settings 10 V/division and 10 ms/division. It displays the input voltage shown in the diagram below.



What are the peak-to-peak voltage and the frequency of this signal?

A. 80 V, 25 Hz

B. 40 V, 25 Hz

C. 80 V, 50 Hz

D. 40 V, 50 Hz

Question 13

What is the decimal equivalent of the binary number 101101?

A. 4

B. 45

C. 64

D. 101101

Question 14

A resistor measures 1039 Ω on a multimeter.

What would be the expected colour code of this resistor?

A. red, red, red, red

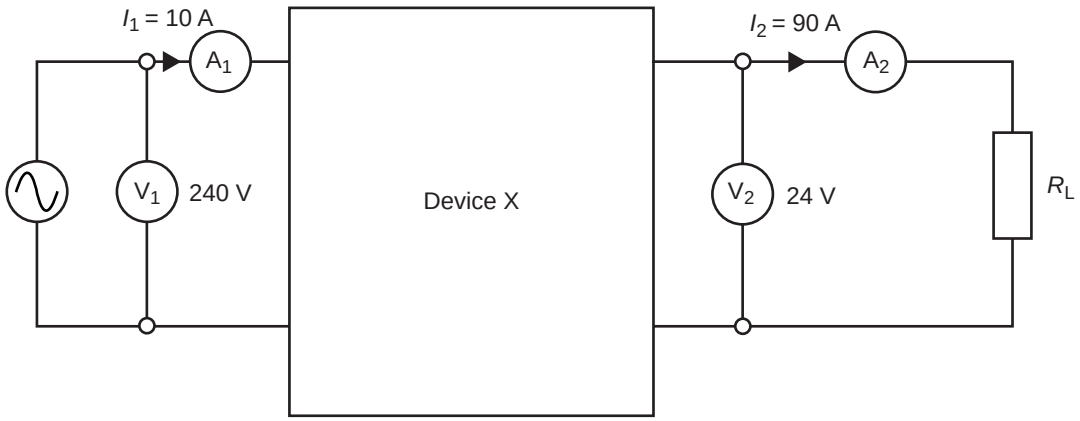
B. red, brown, red, red

C. brown, black, red, gold

D. red, brown, brown, gold

Question 15

A circuit diagram that includes an unknown component, Device X, is shown below.



What is the efficiency of Device X in the circuit above?

A. 50%

B. 80%

C. 90%

D. 100%

Question 16

Which piece of personal protective equipment (PPE) **must** be worn when using a cordless drill?

A. leather apron

B. safety glasses

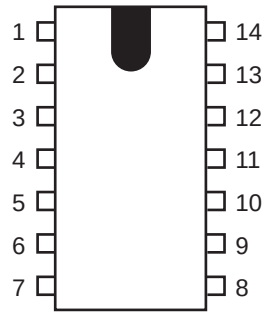
C. steel-capped boots

D. disposable rubber gloves

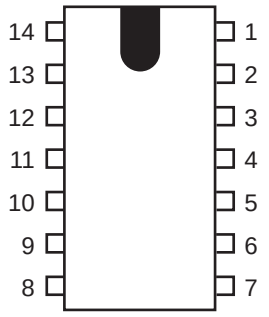
Question 17

Which one of the following shows the correct numbering sequence for a 14-pin integrated circuit (IC)?

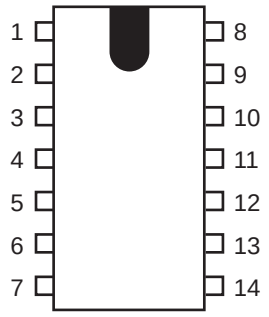
A.



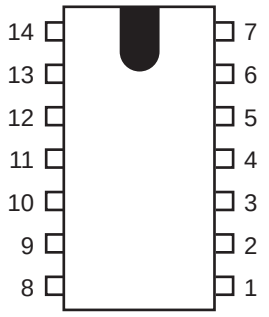
B.



C.



D.



Question 18

A rural golf club uses a 12 V battery to run backup lighting. The lights draw 11.5 A when operating.

What would be the minimum capacity required for this battery to run the lights continuously for 13 hours without recharging?

A. 100 Ah

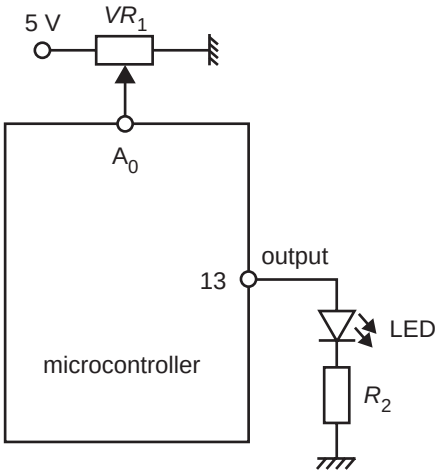
B. 140 Ah

C. 150 Ah

D. 160 Ah

Use the following information to answer Questions 19 and 20.

The diagram below shows a microcontroller circuit with the input connected via a linear potentiometer set to 50% and the output connected to a light-emitting diode (LED).



Question 19

Given that the potentiometer, VR_1, is set to 50%, what is the voltage at the analogue input (A_0)?

A. 0 V

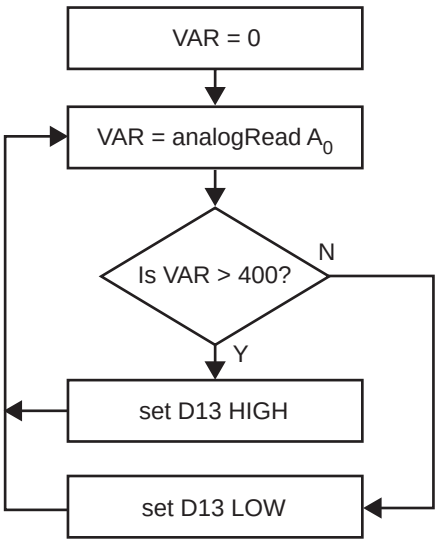
B. 1.33 V

C. 2.5 V

D. 6 V

Question 20

The program shown in the flow chart below is uploaded to the microcontroller.



When the program is run, which LED output will be observed?

A. The LED will flash once every second.

B. The LED will turn on when the value of VAR rises above 400.

C. The LED will turn off when the value of VAR rises above 400.

D. The LED will become brighter and dimmer as the potentiometer is adjusted.

END OF SECTION A

CONTINUES OVER PAGE

SECTION B

Instructions for Section B

Answer **all** questions in the spaces provided.

Formulas must be relevant to the calculations. Calculations must be shown.

All units must be specified in correct engineering notation in the answers.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Question 1 (18 marks)

Figure 1 shows an incomplete circuit diagram. The symbol for a push-button switch is shown below the circuit diagram.

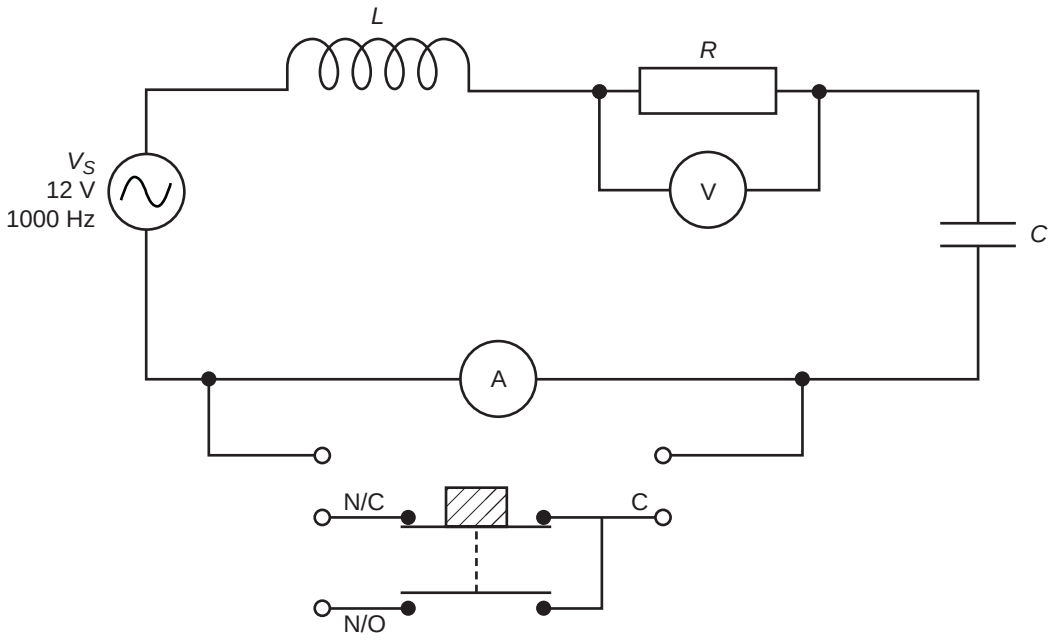


Figure 1

The ammeter has the push-button switch wired in parallel across it. The ammeter needs to display only when the button is pushed. The push-button switch has three terminals, N/O, C and N/C, as shown in Figure 1.

a. i. On Figure 1, draw the connections from the circuit diagram to the appropriate terminals on the push-button switch. 1 mark

ii. Give your reasoning for the connections drawn in **part a.i.** 2 marks

The incomplete printed circuit board (PCB) artwork or layout design for the circuit in Figure 1 is shown in Figure 2.

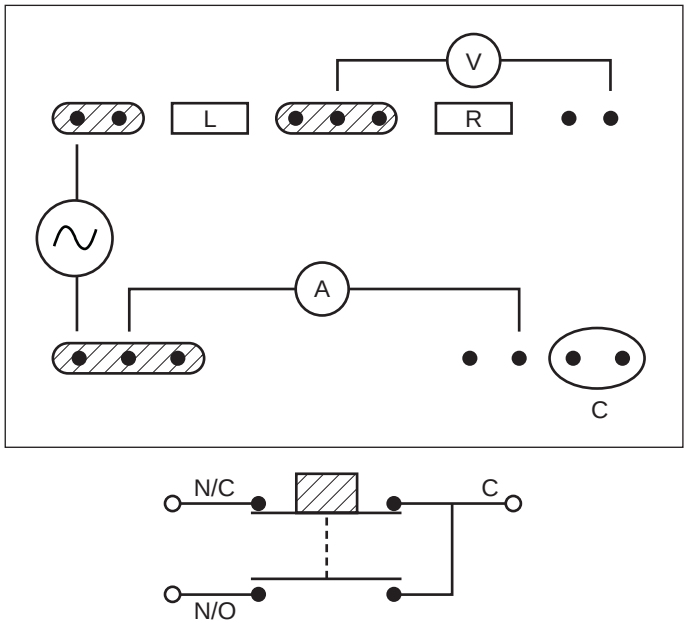


Figure 2

b. On Figure 2, complete the PCB artwork or layout design, ensuring all components, including the meters and the switch, can be connected correctly. Add any additional pin holes for the required wires or component leads. 4 marks

c. Well-designed PCBs are often produced with computer numeric control (CNC) routers that minimise the removal of copper from the surface of the PCB.

Give two reasons why it is good design practice to minimise the removal of copper from the surface of the PCB. 2 marks

1. _____

2. _____

d. The resistance of resistor *R* is 5 Ω, ± 5% tolerance.

i. Clearly label the relevant band colours for resistor *R* (5 Ω, ± 5% tolerance) on the diagram below. 2 marks

ii. The 5 Ω resistor has a ± 5% tolerance of the stated value.

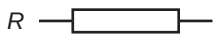
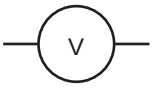
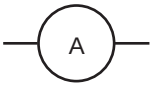
Determine the amount of resistance, in ohms, that the resistor could vary by in order to remain within the ± 5% tolerance. Show your working. 2 marks

_____

_____

±	Ω

e. Complete the table below by naming each component, the base unit of measurement for each component and the letter(s) or symbol used for the base unit of measurement. The first line has been completed as an example. 5 marks

Component	Name of component	Base unit of measurement	Letter(s)/symbol used for base unit of measurement
	*resistor*	*ohm*	*Ω*
			
			
			
			
			

Question 2 (6 marks)

Figure 3 shows a circuit diagram where V_S = 60 V, R_1 = 10 Ω, R_2 = 20 Ω, R_3 = 20 Ω and R_4 = 10 Ω.

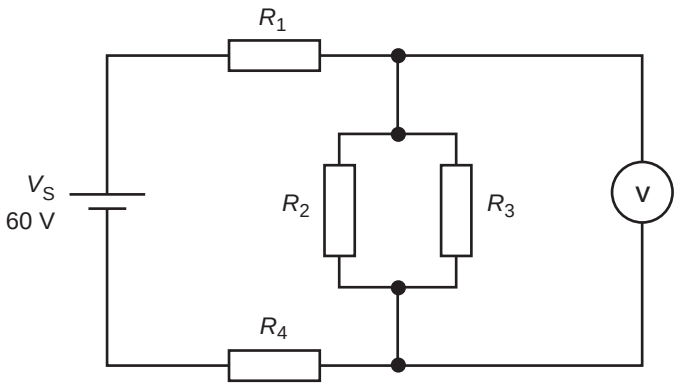


Figure 3

a. Calculate the total resistance, R_{total}, of the circuit. Show your working. 2 marks

b. Calculate the total current, I_{total}, of the circuit. Show your working. 2 marks

c. Determine the voltage that would be displayed on the voltmeter V. Show your working. 2 marks

Question 3 (23 marks)

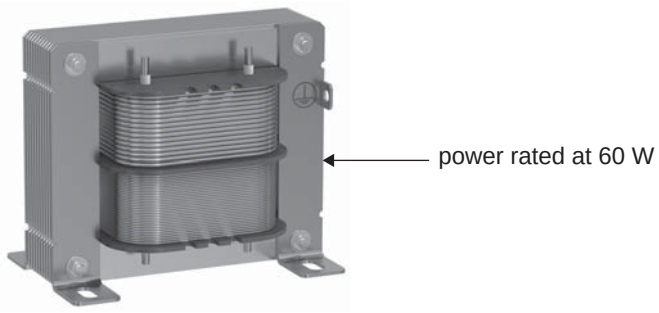
A landscape gardener installed an extra-low voltage (ELV) automated irrigation system and lighting system in a large garden. Both systems are initially powered by mains power 230 V_{AC}, which is within the low voltage (LV) standard range. The mains voltage is stepped down to the safe working ELV of 24 V_{AC} that is supplied to both systems.

a. State the maximum AC and DC voltage for ELV, according to the *Electricity Safety Act 1998* (Vic) and regulated by Energy Safe Victoria (ESV). 2 marks

AC voltage _____

DC voltage _____

b. The electrical device shown in Figure 4 is used to step down the 230 V_{AC} to 24 V_{AC} in order to power the irrigation system and the lighting system.



Source: AlexLMX/Shutterstock.com

Figure 4

Name the electrical device shown in Figure 4. 1 mark

_____

c. The irrigation system uses 24 V_{AC} solenoid valves to control the flow of water.

Describe the basic function of a solenoid valve. 1 mark

_____

_____

d. The gardener intends to use eight solenoid valves to supply water sprinklers in the irrigation system for the large garden. Each solenoid valve is powered by 24 V_{AC} and draws 1.2 A. Only two solenoid valves should operate at once.

i. Determine the current that would be drawn when two solenoid valves operate together. Include the correct unit. 1 mark

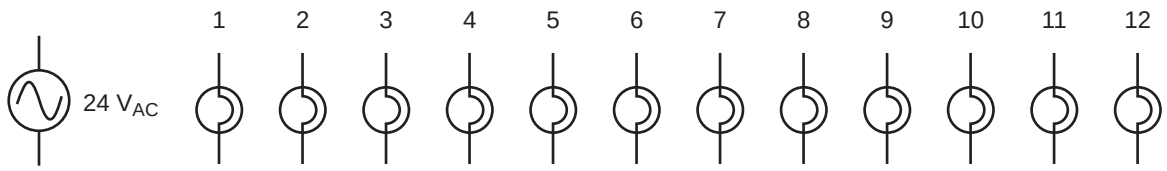
ii. Find the power used by two solenoid valves. Show your working and include the correct unit. 3 marks

iii. Explain possible reasons why it would be necessary to have only two solenoid valves operating at any time. 2 marks

The lighting system uses a separate 24 V_{AC} power supply. Strings of bud lighting consisting of 3 V filament globes are connected in series across the power supply.

e. **i.** Determine the number of 3 V filament globes to be connected in series to the 24 V_{AC} power supply. 1 mark

ii. Draw the 24 V_{AC} series connections for the **required number** of filament globes determined in **part e.i.** on the diagram below. 3 marks



f. Each filament globe is rated 2.25 W.

i. Determine the resistance of **one** filament globe. Show your working. 2 marks

ii. Describe the expected performance of all 12 filament globes if the filament globes were connected in series to the 24 V_{AC} power supply. 1 mark

iii. Calculate the current that would be drawn by all 12 filament globes connected in series. Show your working. 2 marks

iv. What are two advantages and two disadvantages of using strings of bud lighting that are connected in series? 4 marks

Advantage 1

Advantage 2

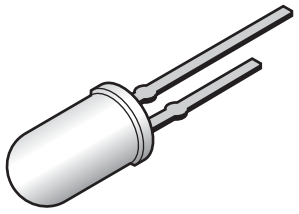
Disadvantage 1

Disadvantage 2

Question 4 (6 marks)

A data sheet for an ultra-bright white light-emitting diode (LED) is shown in Figure 5.

UBWL10k – LED
Ultra-bright white LED



Description

The UBWL10k is a clear, non-diffused, 5 mm LED suitable for high-end applications where high luminous intensity is required.

Utilising new technology, the LED performs well in all applications.

The lens viewing angle is optimised to provide the best performance for light output and visibility.

Features

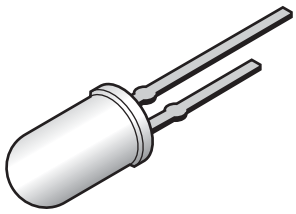
- Ø 5 mm package
- untinted, non-diffused lens
- very high luminous intensity
- ESD withstanding voltage – up to 4 kV
- Zener diode circuit protection

Applications

- interior and exterior lighting
- outdoor LED panels
- PV battery-powered footpath and bike path lighting
- instrument and front panel indicators
- replacement of incandescent lamps
- light guide compatible

Figure 5

a. Label the anode and the polarity on the LED leads in the diagram below. 2 marks



b. The LED shown in the data sheet on page 18 has a number of features. Some of these features are listed in the table below.

Complete the table by providing a short description of each feature. 4 marks

Feature	Description
Ø 5 mm package	
untinted, non-diffused lens	
ESD withstanding voltage – up to 4 kV	
Zener diode circuit protection	

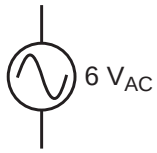
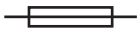
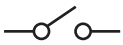
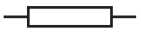
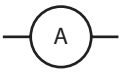
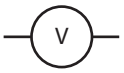
Question 5 (9 marks)

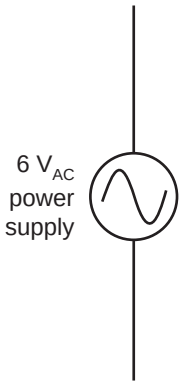
A lighting system is to be designed for the foyer of a new hotel. Groups of four LEDs need to be connected to provide the maximum light output. The circuit must be connected to a 6 V_{AC} power supply via a fuse and a switch. An ammeter and a voltmeter are to be included.

a. In the space provided below, draw the circuit for one group of four LEDs, including a fuse, an on/off switch, a current-limiting resistor, an ammeter and a voltmeter. The power supply has been provided. In this circuit:

- connect the ammeter so that it measures the total current
- place the voltmeter so that it reads the voltage across any one of the LEDs in the circuit.

Use the component symbols provided below. 5 marks

6 V_{AC} power supply (already placed)	fuse	LEDs (×4)	switch (on/off)	resistor (current limiting)	ammeter	voltmeter
						



b. If the 6 V_{AC} power supply were changed to a 12 V_{AC} power supply, what change should be made to the circuit and why? 2 marks

c. If the 6 V_{AC} power supply were changed to a 6 V_{DC} power supply, would any changes need to be made to the circuit? Give your reasoning. 2 marks

Question 6 (6 marks)

An electronic scoreboard is to be designed for a tennis club. Figure 6 shows a prototype for part of the electronic scoreboard. The prototype uses an 8 × 8 matrix of LEDs that can be controlled by a microcontroller.

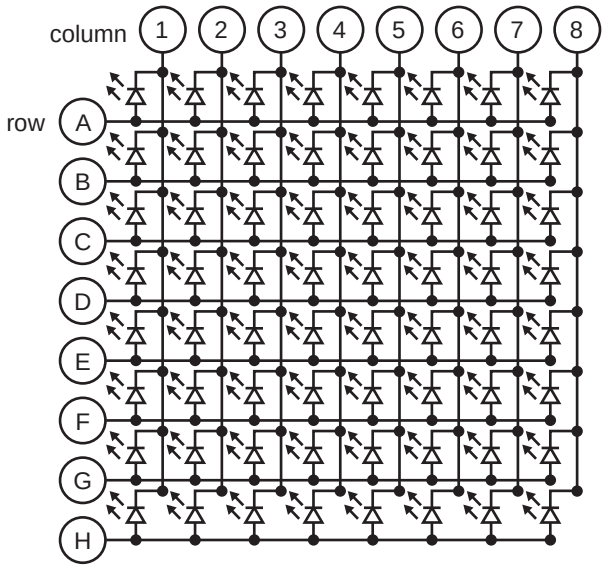


Figure 6

a. Pins B and H are set to HIGH and columns 1 and 2 are set to LOW. Assume all other pins are disconnected.

On Figure 6, circle the LEDs that are 'on'. 2 marks

b. An electronic scoreboard is one application of multiplexing technology.

What is another application that uses multiplexing technology? Explain how multiplexing technology would work in this particular application. 4 marks

Application _____

Explanation _____

_____

_____

_____

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CONTINUES OVER PAGE

Question 7 (12 marks)

A lawn needs to be watered regularly. The lawn is irrigated by four separate sprinklers. In order to distribute the water evenly across the four sections, a water-distributing device has been designed. Figure 7 shows a simplified design of the device.

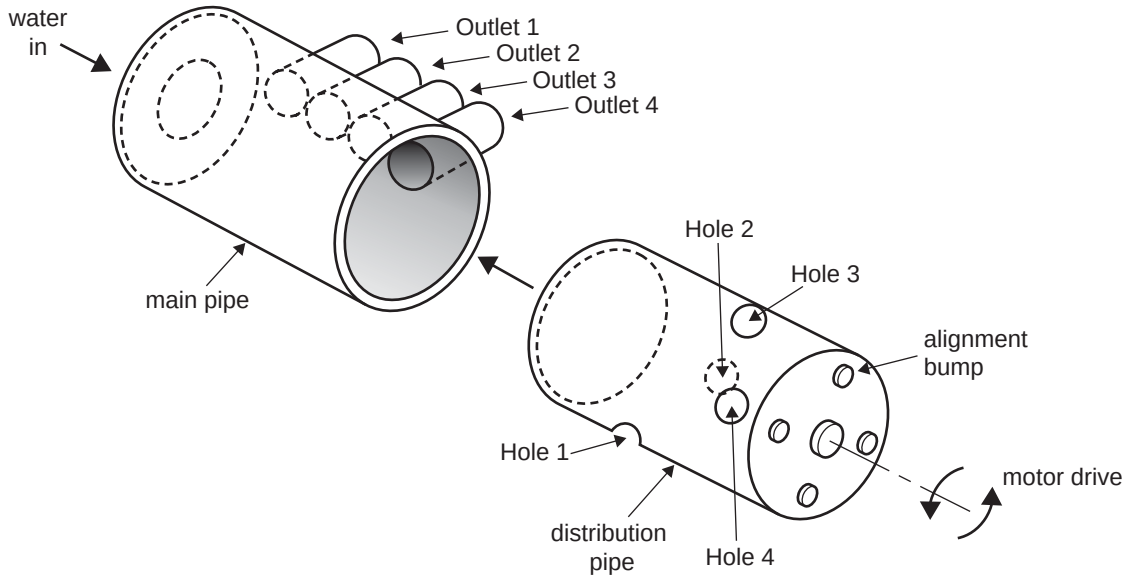

Figure 7

The device is designed to allow water to enter the main pipe, from where the water is then directed to one of four outlets for distribution to one of the four sprinklers.

For the water to flow via Outlet 1, Hole 1 on the distribution pipe must align with Outlet 1. A similar alignment is required for water to flow via Outlets 2, 3 and 4.

A motor slowly rotates the distribution pipe inside the body of the main pipe. The motor is controlled via a microcontroller and an interface device. The holes in the distribution pipe are positioned every 90°.

The initial design was trialled using the microcontroller to pulse the motor for a set time period in order to rotate the distribution pipe 90° with each timed pulse.

a. Give **two** reasons why the motor turning the distribution pipe cannot be driven directly from the microcontroller. 2 marks

_____

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b. Name an interface device that could be used between the microcontroller and the motor. 1 mark

_____

c. Apart from rotating at a low speed, identify another common property of a low revolutions per minute (RPM) motor. 1 mark

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d. In order to properly align the holes with the outlets, four alignment bumps were placed on the end of the distribution pipe shown in Figure 7. When a particular hole is aligned with its corresponding outlet, the matching bump triggers a signal to the microcontroller to stop the motor.

i. Identify a suitable component that will generate a signal when the bump is aligned and describe how this component works. 2 marks

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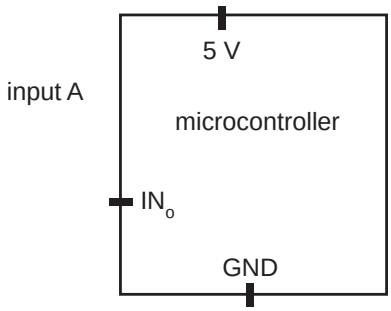
ii. On the diagram below, draw and label the component identified in **part d.i.**, and show how it should be connected to the microcontroller. Include any additional components required. 4 marks



iii. Explain why the input voltage, IN_o, has to be kept low when not in a triggered state, rather than left 'floating'. 2 marks

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END OF QUESTION AND ANSWER BOOK

VCE VET INTEGRATED TECHNOLOGIES

Written examination

FORMULA SHEET

Instructions

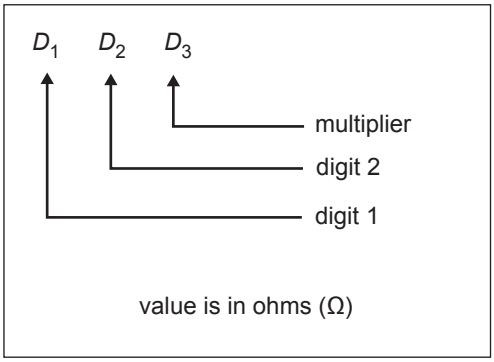
Please remove from the centre of this book during reading time.
This formula sheet is provided for your reference.

VCE VET Integrated Technologies formulas

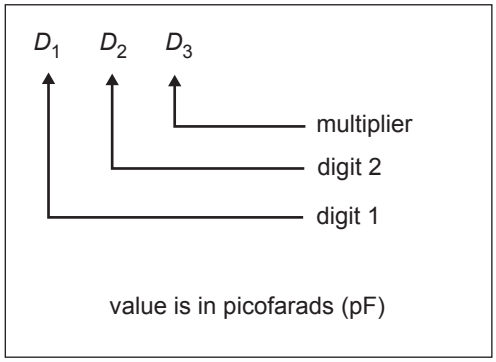
$R_T = R_1 + R_2 + R_3$	$f = \frac{1}{T}$
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$\tau = C \times R$
$R_T = \frac{R_1 R_2}{R_1 + R_2}$	$A = \frac{\pi d^2}{4}$
$R = \frac{\rho l}{A}$	$C = \frac{\varepsilon A}{d}$
$V = I \times R$	$C_T = C_1 + C_2 + C_3$
$P = V \times I$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
$V_X = V_S\left(\frac{R_X}{R_T}\right)$	$Q = V \times C$
$V_{max} = V_{peak}$	$W = \frac{1}{2}CV^2$
$V_{step} = \frac{V_{max}}{2^n - 1}$	$W = P\,t$
turns ratio = $\frac{N_1}{N_2}$	1 ampere hour (Ah) = 1 A of amount drawn for one hour
$v = V_{max} \sin\theta$	$i = I_{max} \sin\theta$
$V_{av} = 0.637 \times V_{max}$	$V_{RMS} = 0.707 \times V_{max}$ $\quad V_{RMS} = \frac{V_{max}}{\sqrt{2}}$
$f = \frac{1}{t}$	$L_T = L_1 + L_2 + L_3$
$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3}$	$f_0 = \frac{1}{2\pi\sqrt{LC}}$ Hz (resonant frequency)

transformer ratios $\frac{V_S}{V_P} = \frac{N_S}{N_P} = \frac{I_P}{I_S}$	$\lambda = \frac{c}{f}$ m where λ is in metres, f is in Hertz and c is the speed of light (3×10^8 ms^{-1})
$\eta = \frac{\text{pin} - \text{losses}}{\text{pin}} \times 100$ (η = efficiency in %)	$\eta = \frac{\text{power out} \times 100}{\text{power in}}$ %
$\tau = \frac{L}{R}$	

Resistor codes



Capacitor codes

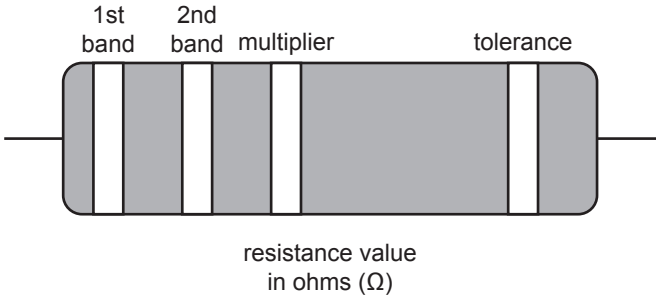


ASCII code chart (in hexadecimal)

Least significant nybble

Most significant nybble	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**A**	**B**	**C**	**D**	**E**	**F**
0	NUL	SOH	STX	ETX	EOT	ENQ	ACK	BEL	BS	HT	LF	VT	FF	CR	SO	SI
1	DLE	DC1	DC2	DC3	DC4	NAK	SYN	ETB	CAN	EM	SUB	ESC	FS	GS	RS	US
2	SP	!	"	#	$	%	&	'	(	)	*	+	,	-	.	/
3	0	1	2	3	4	5	6	7	8	9	:	;	<	=	>	?
4	@	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
5	P	Q	R	S	T	U	V	W	X	Y	Z	[	\	]	^	_
6	`	a	b	c	d	e	f	g	h	i	j	k	l	m	n	o
7	p	q	r	s	t	u	v	w	x	y	z	{	|	}	~	DEL

Resistor colour codes



Colour	Value	Multiplier	Tolerance
black	0	10^0	
brown	1	10^1	1%
red	2	10^2	2%
orange	3	10^3	
yellow	4	10^4	
green	5	10^5	0.5%
blue	6	10^6	0.25%
violet	7	10^7	0.1%
grey	8	10^8	0.05%
white	9	10^9	
gold		10^{-1}	5%
silver		10^{-2}	10%

END OF FORMULA SHEET