VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2022

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

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

VCE VET INTEGRATED TECHNOLOGIES

Written examination

Thursday 27 October 2022

Reading time: 11.45 am to 12.00 noon (15 minutes)
Writing time: 12.00 noon to 1.30 pm (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	10	10	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 30 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.

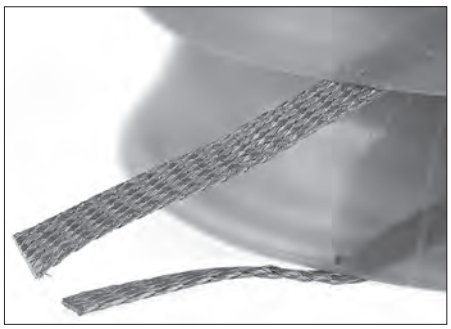
SECTION A – Multiple-choice questions

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

The image below shows solder wick (braided copper).



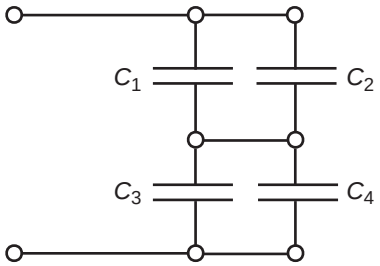
Source: Teodor Costachioiu/Shutterstock.com

Solder wick is principally used

A. for high current supply cables.
B. to provide electrical shielding within plastic circuit housing.
C. to remove solder from joints and printed circuit board (PCB) tracks.
D. as a heat wick, to prevent burning when heat-shrink insulation is used.

Question 2

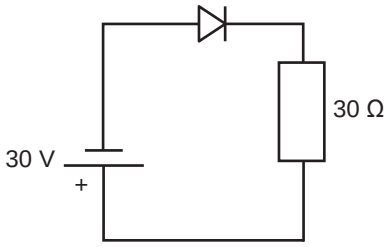
Four capacitors rated 10 nF, 15 V are connected in a network, as shown below.



The equivalent capacitance and voltage rating for a single replacement capacitor is

A. 10 nF, 30 V
B. 20 nF, 15 V
C. 20 nF, 30 V
D. 40 nF, 60 V

Question 3



The current that would be expected to flow through the circuit diagram shown above is

A. 0 A
B. 0.977 A
C. 1 A
D. 30 A

Question 4

When converted to a decimal, the hexadecimal number AB_{16} has a value of

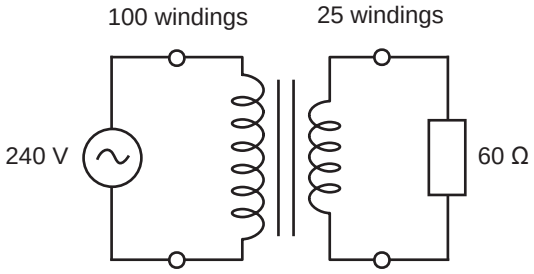
A. 12
B. 171
C. 1011
D. 1100

Question 5

The nominal resistance and tolerance value of the resistor shown above is

A. 22 kΩ, 5%
B. 2200 Ω, 10%
C. 222 Ω, 5%
D. 2k2 Ω, 5%

Question 6



The current flowing through the 60 Ω resistor shown in the circuit diagram above is

A. 1 A
B. 4 A
C. 25 A
D. 60 A

Question 7

An optical fibre is commonly made from

A. glass.
B. copper.
C. aluminium.
D. frosted acrylic.

Question 8

A compressed image file would have which one of the following file extensions?

A. .bmp
B. .raw
C. .jpg
D. .svg

Question 9

What is one significant advantage of using a USB-Type C connector?

A. It is limited to specialist devices only.
B. It can support charging currents over 10 A at a voltage of 5 V.
C. It has a proprietary connection standard owned by Apple.
D. The connector is reversible, which means it cannot be inserted incorrectly.

Question 10

The binary-coded decimal (BCD) equivalent of the decimal number 853 is

A. 0011 0101 0101
B. 1011 0111 0101
C. 1000 0101 0011
D. 355H

Question 11

The SI unit for frequency is

A. alternating current (AC).

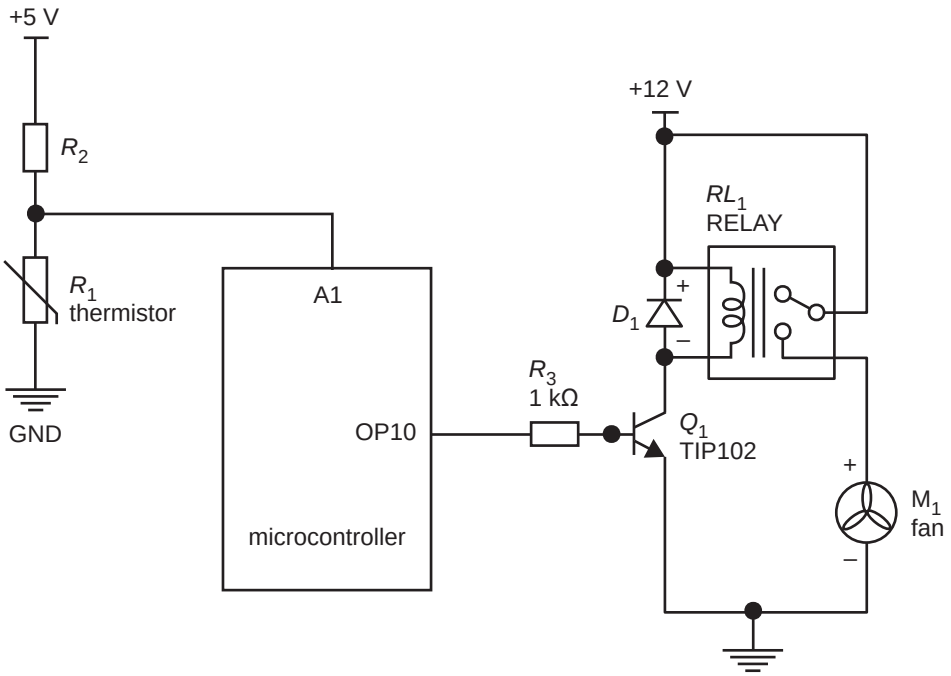
B. cycles per second (CPS).

C. oscillations.

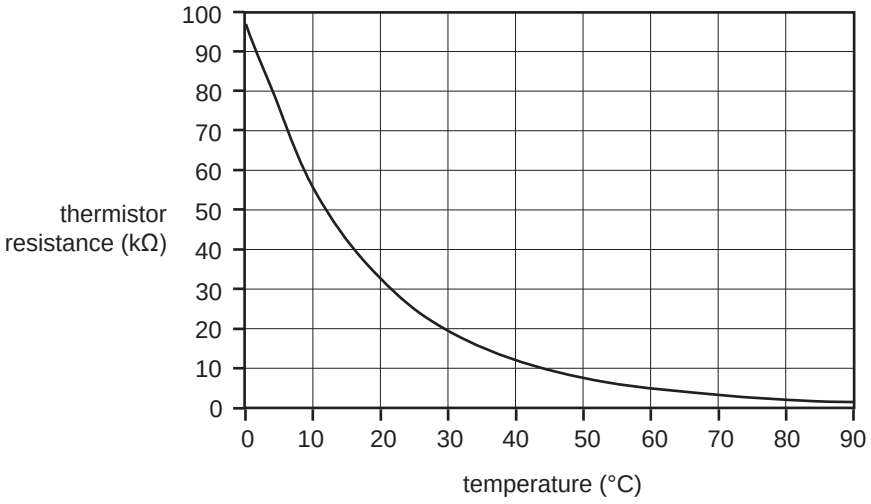
D. hertz (Hz).

Use the following information to answer Questions 12–14.

The diagram below shows a microcontroller circuit with the input connected via a voltage divider configuration using a thermistor and fixed resistor connected to the analogue input (A1) of the microcontroller.



The characteristic curve of the thermistor is shown below.



Question 12

Given that the resistance of R_2 is 20 kΩ, what is the voltage at the analogue input (A1) when the thermistor is at 30 °C?

A. 0.25 V

B. 0.8 V

C. 1.0 V

D. 2.5 V

Question 13

The voltage input to pin A1 ranges from 0 V to 5 V. The function 'analogueRead (A1)' produces a digital value between 0 and 255, with 0 representing 0 V and 255 representing 5 V. 'analogueRead (A1)' is a linear function.

If the voltage input to pin A1 is 2 V, the digital value at 'analogueRead (A1)' will be

A. 0

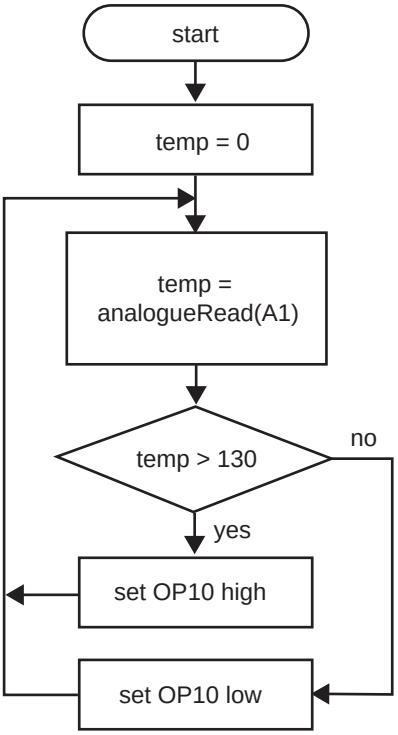
B. 2

C. 51

D. 102

Question 14

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



The program is running.

It would be observed that the fan

A. turns off when the value of 'temp' is above 130.

B. turns on when the value of 'temp' is above 130.

C. turns faster as the temperature of the thermistor increases.

D. will turn on when the temperature of the thermistor rises above 130 °C.

Question 15

A good general working temperature for the tip of a temperature-controlled soldering iron is

A. 100–150 °C

B. 200–250 °C

C. 300–350 °C

D. 400–450 °C

Question 16

Source: imagedb.com/Shutterstock.com

The tool shown above is

A. an allen key.

B. a chuck key.

C. a bike seat adjustment tool.

D. a heavy-gauge scriber.

Question 17

One benefit of using a USB flash drive is that

A. it is not easily lost.

B. it has an unlimited storage capacity.

C. its memory is immune to electromagnetic interference.

D. when shared among different users it still provides complete virus protection.

Question 18

What does 'to populate a PCB' refer to?

A. Install a PCB in a device.

B. Install and fit PCB components.

C. Test a PCB and confirm that it is ready for a mass production run.

D. Convert the PCB to the type of communications and surveillance PCB circuits used in populated areas.

Question 19

With a cable that has a known power rating, if the supply voltage is increased, it follows that the required cross-sectional thickness (gauge) of the conducting cable could

A. be decreased.

B. be increased.

C. remain the same.

D. remain the same, but the thickness of the required insulation could be reduced.

Question 20

A capacitance measurement of 2n2 F can be expressed as

A. 2.2 pF

B. 0.220 F

C. 0.02200 μF

D. 0.0000000022 F

END OF SECTION A

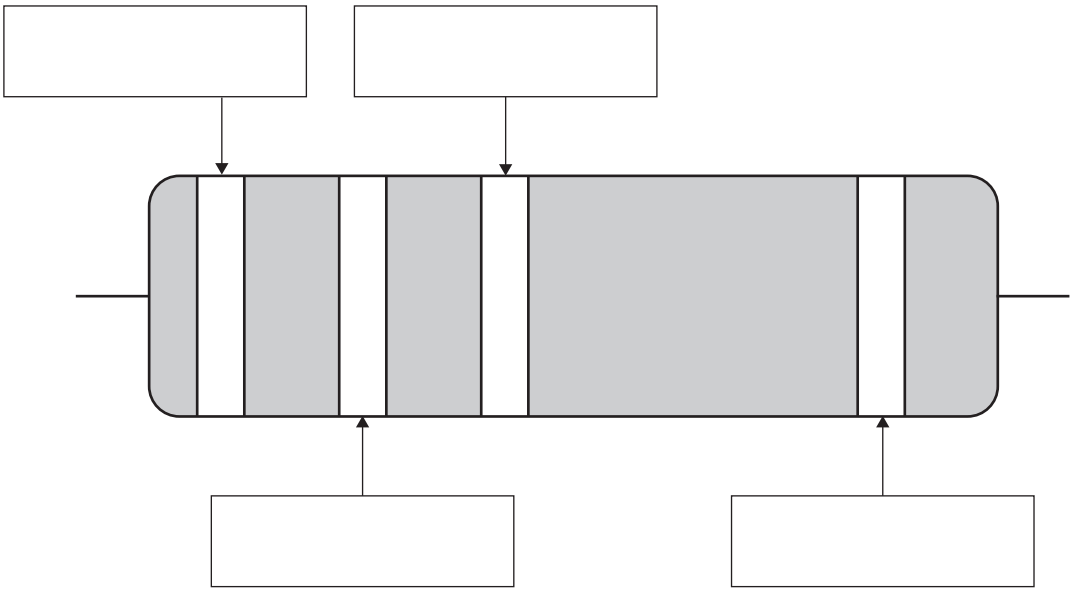
SECTION B

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 (2 marks)
The diagram below represents a four-band 12 Ω, 2% tolerance resistor.

Write the correct colours for the resistor in the spaces provided on the diagram.



Question 2 (8 marks)

A student has two working digital multimeters (DMMs) that are directly connected to a 30 V power supply, as shown in Figure 1 below.

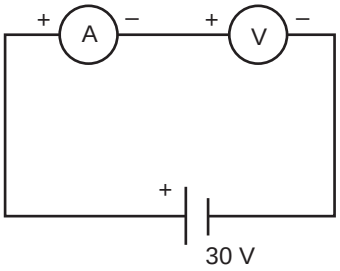
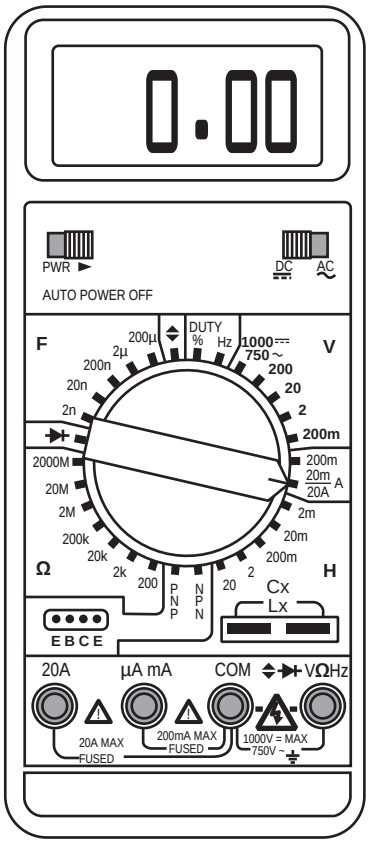


Figure 1

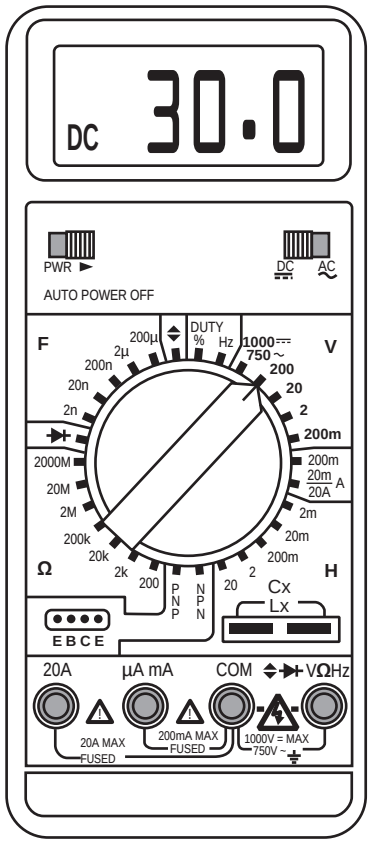
When the circuit is connected and turned on, the DMMs read 0.00 A and 30 V.

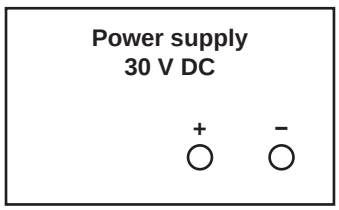
a. Draw the three wiring connections from the power supply to the correct terminals of the two DMMs provided below to create the circuit as shown in Figure 1. 3 marks

Current meter



Voltage meter





b. Explain in detail why these DMM readings are correct meter readings for the circuit shown in Figure 1. 3 marks

c. Another DMM had been tagged as 'faulty'. In testing the DMM, the dial was turned to the 2 kΩ setting and the DMM displayed 0.00 with open leads. 0.00 is not a valid DMM reading for the 2 kΩ setting.

What reading should be displayed on this DMM and why? 2 marks

Question 3 (8 marks)

Figure 2 shows a circuit diagram where $R_1 = 10\ \Omega$, $R_2 = 10\ \Omega$, $R_3 = 5\ \Omega$ and $R_4 = 5\ \Omega$.
The current through R_1 and the ammeter A is 2 A.

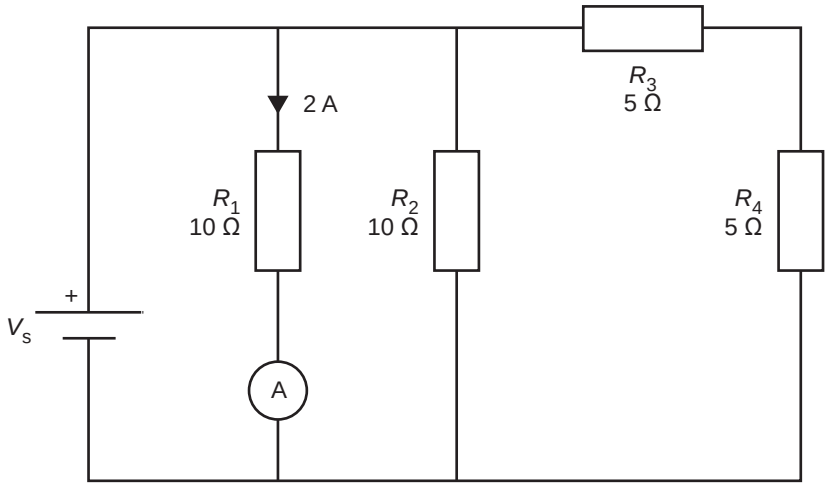


Figure 2

a. Calculate the total resistance of the circuit, R_{total}, as seen by V_S, to two decimal places. Show your working and include the correct unit in the answer box provided. 3 marks

b. Calculate the voltage of the power supply. Show your working and include the correct unit in the answer box provided. 2 marks

c. Calculate the total current of the circuit, I_{total}. Show your working and include the correct unit in the answer box provided. 3 marks

Question 4 (5 marks)

Source: Smile Fight/Shutterstock.com

The image above shows a mechanic testing the nominal output from a car battery using a DMM. The engine is off.

a. How many individual cells are contained within a standard 12 V lead-acid car battery? 1 mark

The DC voltage test shows 12.82 V available.

b. From this DMM reading, what can be concluded about the battery's state of charge and its serviceability? 2 marks

c. A DC voltage test is not a fully conclusive test to check the performance of a car battery.

Identify and describe **one** other appropriate test to check the performance of a car battery and provide a reason why this alternative test would be a more conclusive indicator of the battery's condition. 2 marks

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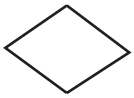
Question 5 (10 marks)

a. Complete the table below by naming each flow chart symbol shown. 4 marks

Flow chart symbol	Name of symbol
	
	
	
	

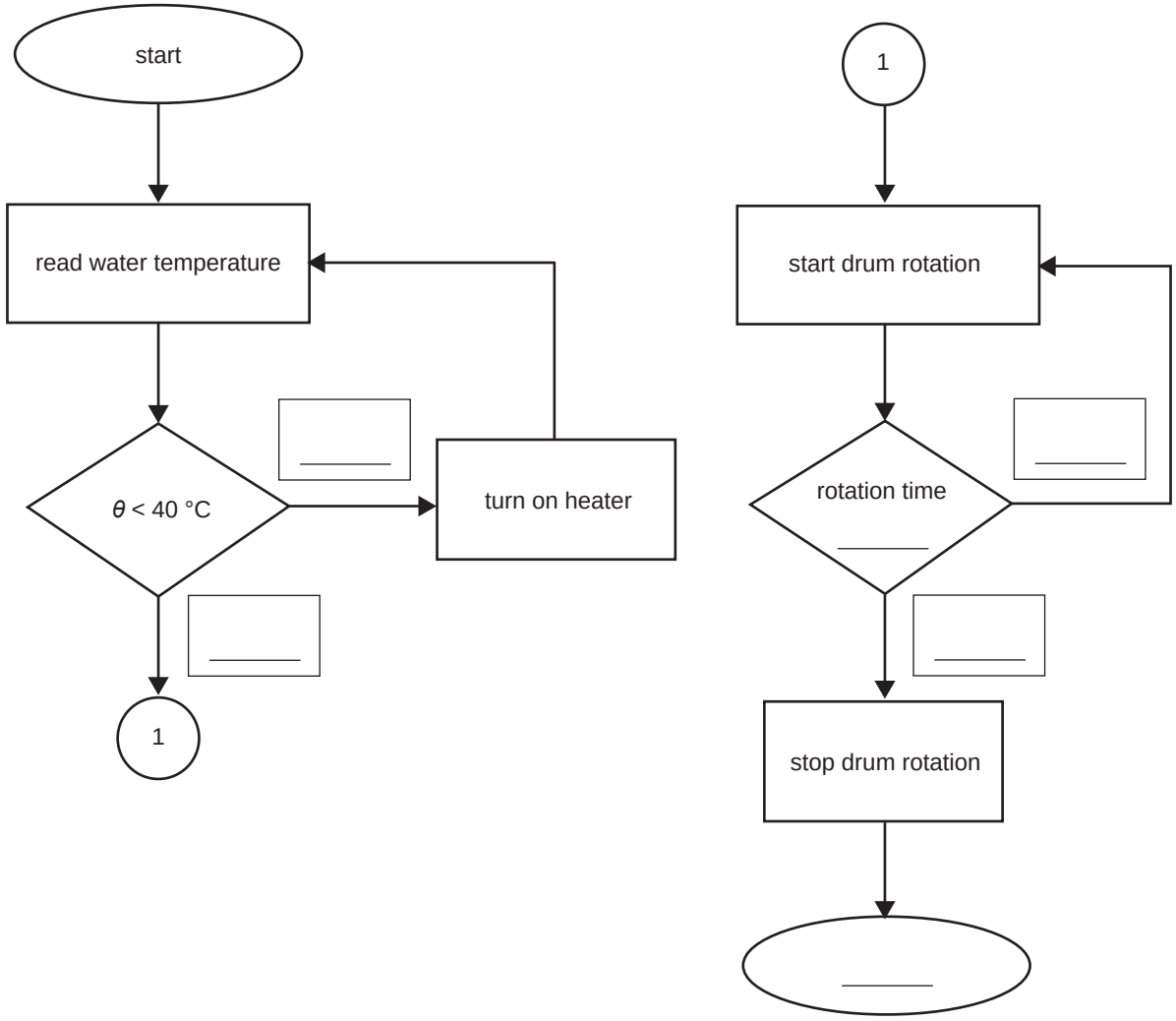
b. Name a suitable computer application to draw flow charts. 1 mark

_____

c. The following statement describes the washing cycle function of a washing machine: 'When the water temperature (θ) reaches 40 °C, the washing cycle will commence and the drum will rotate for a time (t) of 20 minutes and then stop.'

The flow chart below shows this process.

In the flow chart, fill in the missing instructions in the spaces provided. 5 marks



Question 6 (6 marks)

a. Name a device that uses an ADC within its operation. 1 mark

b. What do the letters ADC stand for? 1 mark

Figure 3 shows an 8-bit ADC.

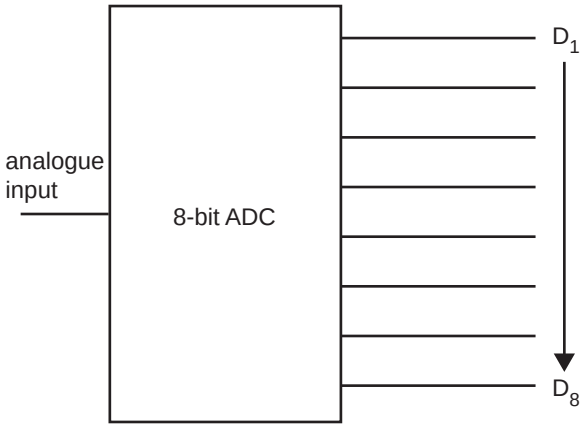


Figure 3

c. Determine the total number of different analogue input levels that the ADC could detect. Show your working and include the correct unit in the answer box provided. 2 marks

d. Determine the ADC voltage resolution if the analogue input ranges from 0 V to 12 V. Show your working and include the correct unit in the answer box provided. 2 marks

Question 7 (10 marks)

An electrotechnology design team needs a prototype of an acrylic plastic block for a small project to be quickly produced in the workshop. The design team was rushed and did not provide enough information on its drawing to complete the job. The workshop immediately sent back the drawing to the design team, saying it could not proceed because the dimensions were missing.

a. On Figure 4 below, only two of the six dimension lines are shown.

Draw in the four missing dimension lines with arrows, together with the associated projection lines, to produce a suitable drawing to return to the design team so that measurements can be entered. All edges are parallel and squared to each other. 4 marks

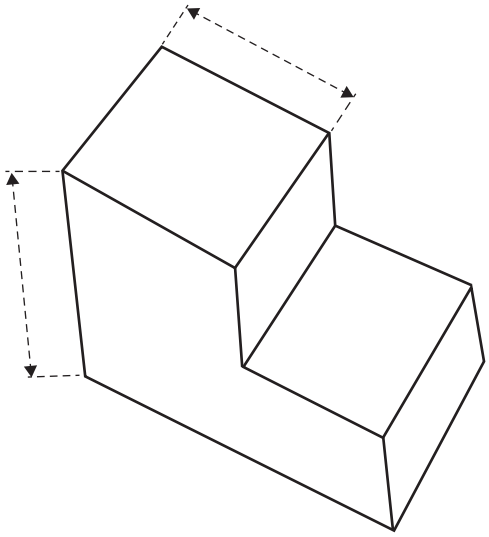


Figure 4

b. When the design team enters the measurements on the drawing, what SI unit of measurement would it use? 1 mark

_____

c. What is a prototype and why is a prototype used? 2 marks

_____

_____

_____

d. To speed up the production process, it was suggested that the design team should use newer technology to produce the acrylic plastic block.

i. What specific newer technology could be used for this product? 1 mark

ii. Provide **one** way that using newer technology would speed up the production process and explain how this would benefit the prototype design. 2 marks

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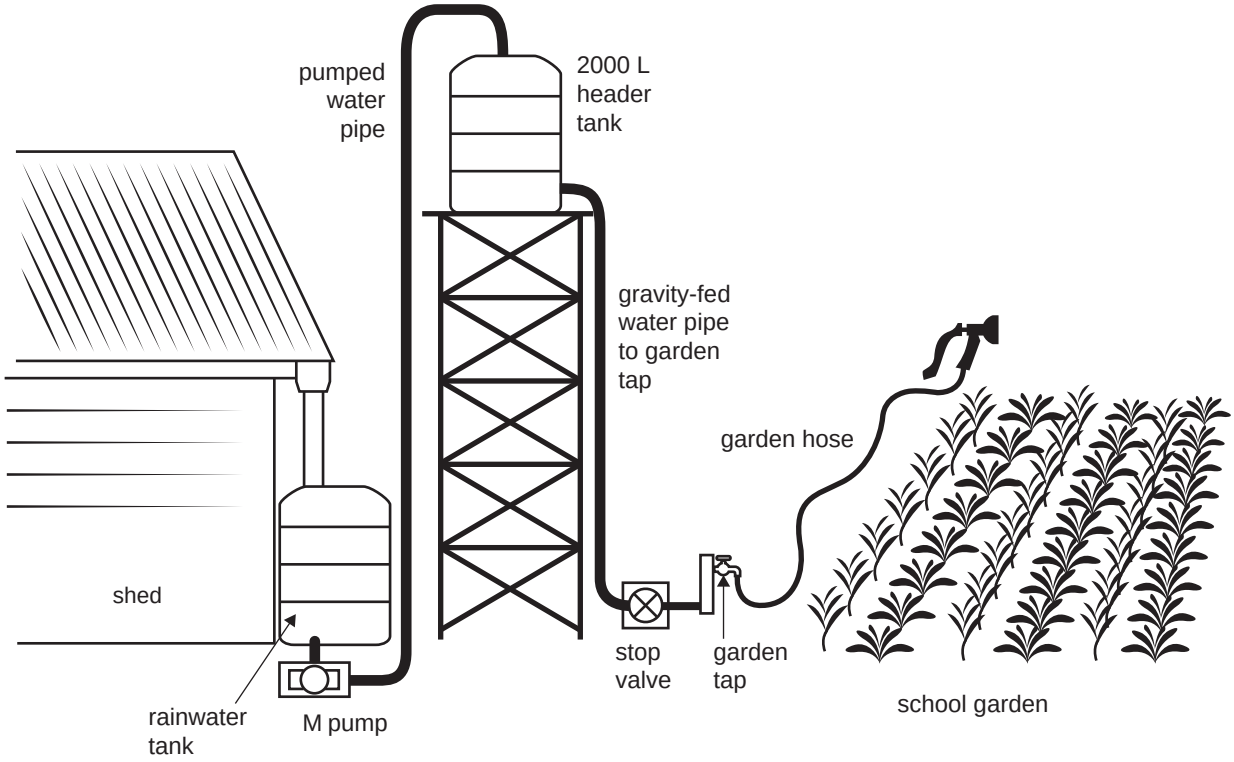
Use the following information to answer Questions 8–10.



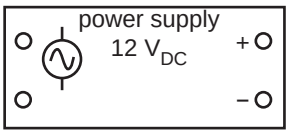
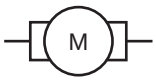
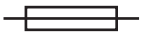
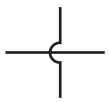
An ‘eco garden’ in a school has a gravity-fed handheld garden hose supplied from a 2000 L header tank. A 230 V_{AC} mains-connected power supply provides the 12 V_{DC} power to run the water pump that fills the header tank, which is manually turned on and off at the mains outlet. If the pump is regularly not turned off, the header tank will overflow.

Question 8 (6 marks)

In the 'Circuit diagram' box below and using only the symbols in the table of symbols provided, draw a circuit to supply power to the pump. In your circuit diagram:

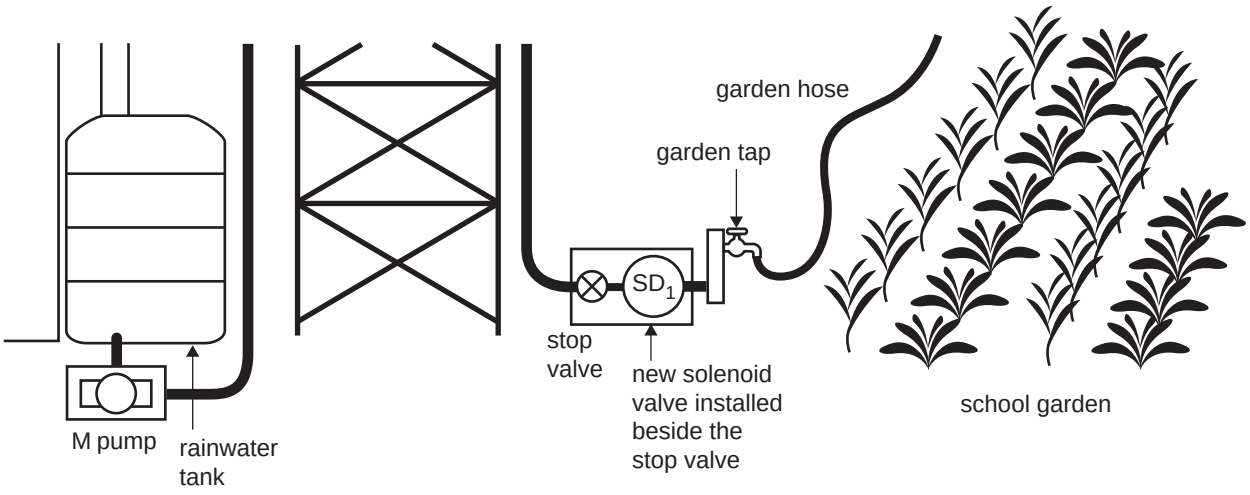
- the mains AC supply and switch should be shown as two items in the circuit
- the fuse is to be placed on the DC side of the circuit.

Table of symbols

230 V_{AC} supply	SPST switch	power supply (230 V_{AC} to 12 V_{DC})	motor pump	fuse	wiring
					 (as required)

Circuit diagram

Question 9 (15 marks)



To improve the irrigation system described on page 22, the Integrated Technologies students at the school propose replacing the handheld hose system with an automated system to fill the tank and water the garden. They have designed the microprocessor circuit shown in Figure 5 to undertake both functions.

Schematic diagram for pump motor and solenoid controller circuit

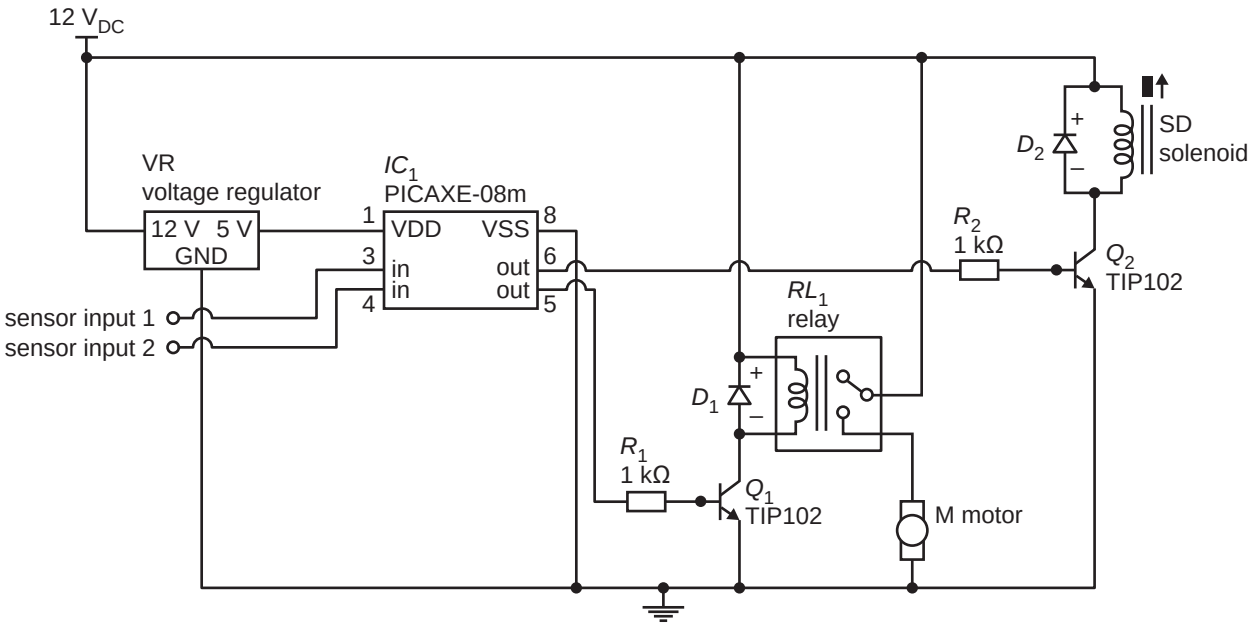


Figure 5

The pump motor, M, and the solenoid, SD, are controlled by a microcontroller when activated via the inputs.

Figure 6 shows the printed circuit board (PCB) artwork that has been created based on the schematic diagram in Figure 5.

For ease of understanding, the PCB artwork tracks on Figure 6 are shown as viewed from the component side.

a. Complete the four missing tracks for the microcontroller on the PCB artwork below, noting that no PCB tracks are to cross over one another. 4 marks

Pump motor and solenoid microcontroller PCB

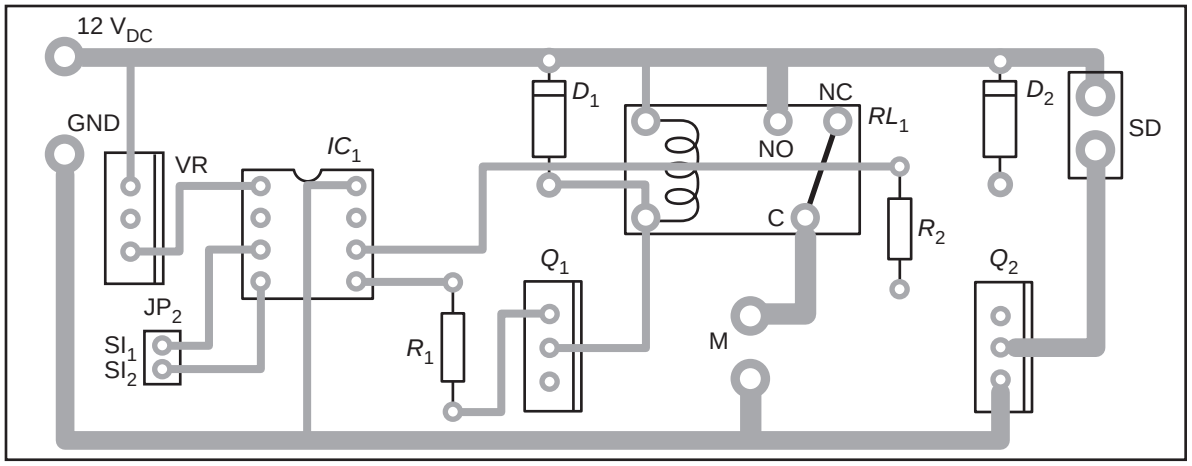


Figure 6

b. On Figure 6, the PCB 12 V_{DC} and GND tracks are wider, with large 'doughnut' pad connection points for cable connections to the motor, M, and the solenoid, SD.

Why was this done? 2 marks

The microprocessor's electrical input parameters, which indicate if the soil is dry or moist, have not been specified.

c. Suggest an appropriate electrical input parameter that could be used within the soil moisture probe to inform the microcontroller of the soil's moisture level and briefly explain how the parameter could work. 2 marks

d. In the box provided below, draw a possible design for a soil moisture probe that could be used to inform the microcontroller of the soil's moisture level. Label the components of the probe that are included in your design. 2 marks

The diodes D_1 and D_2 on Figure 5 are routinely placed in a reverse bias connection across the relay and the solenoid.

e. What is a reverse bias connection? 1 mark

f. Describe the function and purpose of the diodes, and explain why the diodes are reverse biased for this application. 2 marks

A 12 V DC solenoid

water solenoid valve

g. Describe the main electrotechnological principles in the operation of the water solenoid valve shown above. 2 marks

Question 10 (10 marks)

A further upgrade was proposed by the Integrated Technologies students at the school to make the garden and watering system even more sustainable by using only renewable energy for the operation of the microcontroller circuit, pump motor and solenoid valve. The roof of the shed has space for two 150 W PV panels to be installed, providing power for 12 V_{DC} battery storage, as shown in Figure 7.

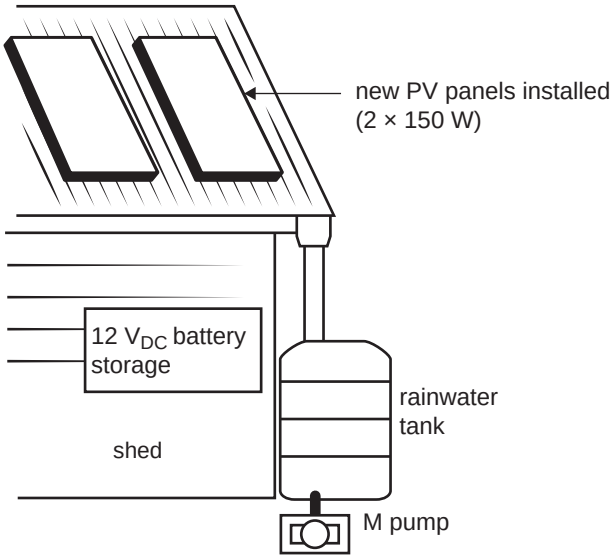


Figure 7

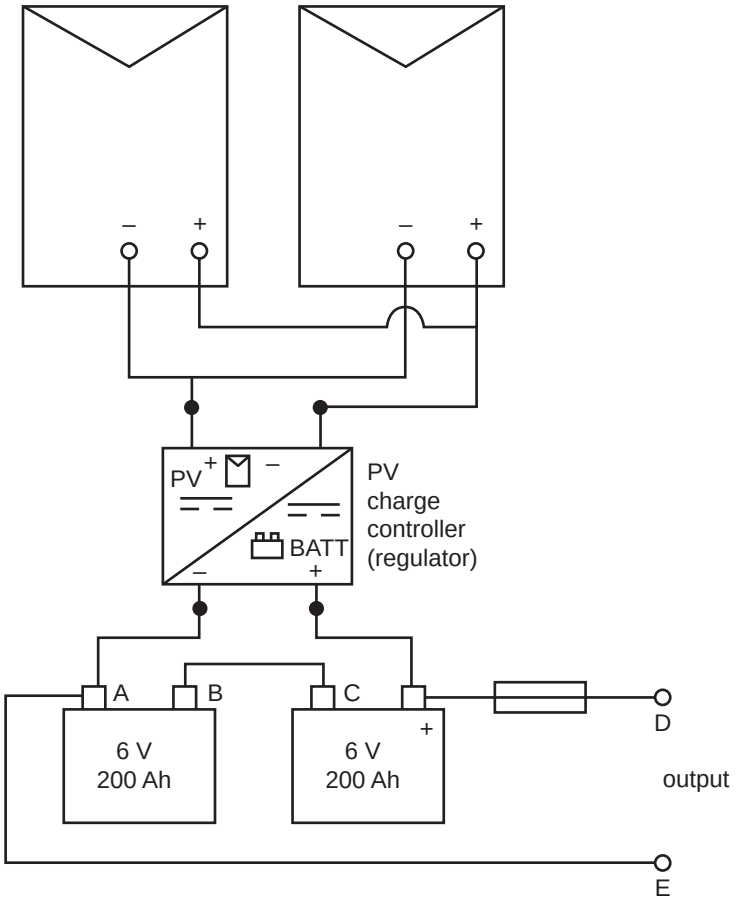


Figure 8

Figure 8 shows a 12 V_{DC} PV power supply.

a. On Figure 8, label the points A, B, C, D and E with the correct battery polarity for the required 12 V_{DC} supply for the microcontroller circuit, pump motor and solenoid valve. 2 marks

b. What is the name for the electrical configuration used to connect the two batteries and why is this configuration required in this application? 2 marks

Projects using integrated technologies often make trade-offs between environmental benefits and performance or efficiency gains. In this case, the power supply from the PV panels would provide environmental benefits, and performance and efficiency gains.

c. Provide one environmental benefit and one performance or efficiency benefit of adopting the PV panel and 12 V_{DC} battery storage system over the previous mains-connected power supply. 2 marks

Environmental benefit _____

_____

_____

Performance or efficiency benefit _____

_____

_____

d. What is the maximum PV power that can be delivered to the PV charge controller and when would this power be delivered? 2 marks

_____

_____

e. Describe the function of the PV charge controller. 2 marks

_____

_____

_____

END OF QUESTION AND ANSWER BOOK

VCE VET INTEGRATED TECHNOLOGIES

Written examination

FORMULA SHEET

Instructions

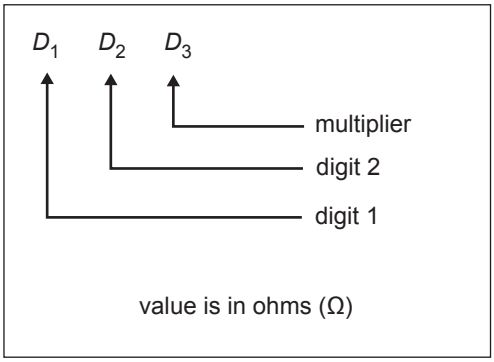
Please remove from the centre of this book during reading time.
This formula sheet is provided for your reference.

VCE VET Integrated Technologies formulas

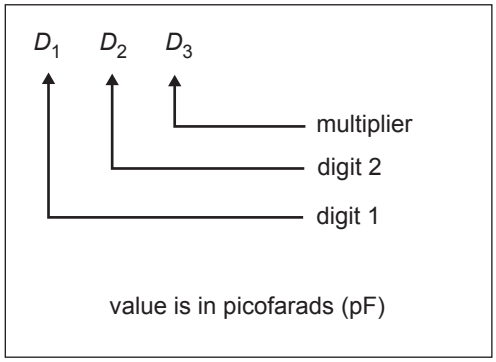
$R_T = R_1 + R_2 + R_3$	$f = \frac{1}{T}$
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$\tau = C \times R$
$R_T = \frac{R_1 R_2}{R_1 + R_2}$	$A = \frac{\pi d^2}{4}$
$R = \frac{\rho l}{A}$	$C = \frac{\varepsilon A}{d}$
$V = I \times R$	$C_T = C_1 + C_2 + C_3$
$P = V \times I$	$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$
$V_X = V_S\left(\frac{R_X}{R_T}\right)$	$Q = V \times C$
$V_{max} = V_{peak}$	$W = \frac{1}{2}CV^2$
$V_{step} = \frac{V_{max}}{2^n - 1}$	$W = P\,t$
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

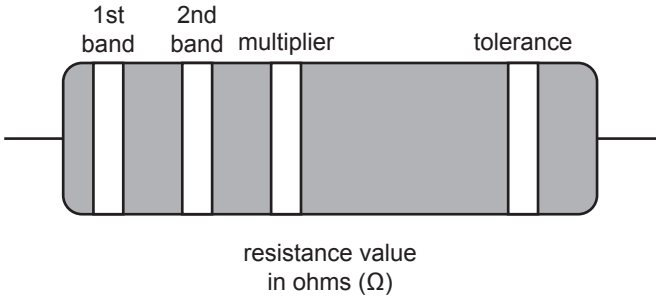


ASCII code chart (in hexadecimal)

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