VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2018

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

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

VCE VET INTEGRATED TECHNOLOGIES

Written examination

Thursday 15 November 2018

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	9	9	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 26 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

When using a ladder in a workplace, which one of the following WorkSafe rules should be followed?

A. Use wooden chocks to straighten a ladder placed on soft ground.

B. Always maintain three points of contact when ascending, descending or standing on a ladder.

C. Always use a drop sheet underneath the ladder in case paint cans or other items fall.

D. Working from the top rung of a ladder is acceptable if you hold on to something above you with one hand for stability.

Question 2

The screwdriver shown below has a plastic sleeve covering the entire screwdriver shaft, except for the tip.

Source: Woody Alec/Shutterstock.com

What is the purpose of the plastic sleeve covering the screwdriver shaft?

A. to colour match the screwdriver shaft to the handle

B. to allow a smooth slipping surface for the user's hand

C. to provide electrical insulation to protect the user from shock

D. to provide mechanical strength and prevent the steel from rusting

Question 3

Which one of the following symbols represents an electric cell in a circuit diagram?

A. 

B. 

C. 

D. 

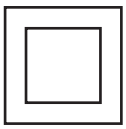
Question 4

Which of the following gives the standard wiring colour code for an Australian power lead?

	Active	Neutral	Earth
A.	red	black	green
B.	brown	blue	green/yellow stripe
C.	blue	brown	green/yellow stripe
D.	blue	black	green/yellow stripe

Question 5

The symbol shown below is found on a mains power appliance.



This symbol indicates that a mains power appliance

A. can be scanned at a checkout as the symbol is part of the barcode.

B. has an earth pin that should be square in shape.

C. can only be used safely indoors.

D. is double insulated.

Question 6

Which one of the following expresses full-high-definition screen resolution?

A. 720p (1280 × 720 pixels)

B. 1080p (1920 × 1080 pixels)

C. 1440p (2560 × 1440 pixels)

D. 2160p (3840 × 2160 pixels)

Question 7

HDMI stands for

A. high-definition multimedia interface.

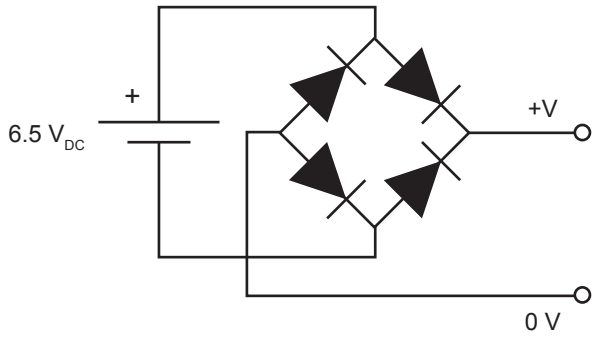
B. huge display multiplex input.

C. highly defined media input.

D. high-demand mixer input.

Question 8

The circuit diagram below shows a 6.5 V_{DC} power supply that includes a diode bridge.



The main purpose of this diode bridge is to

A. convert AC input to DC output.

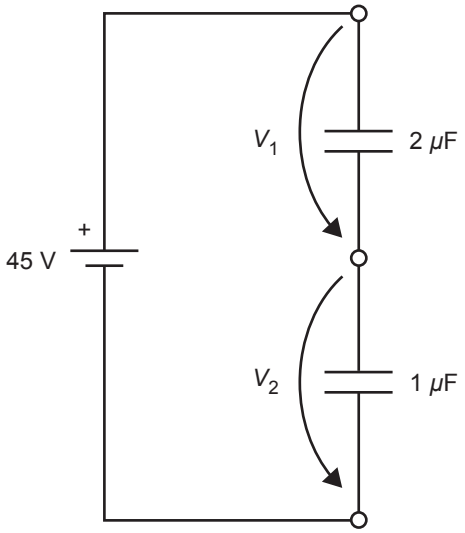
B. regulate the current to a connected device.

C. protect against reverse polarity being accidentally supplied.

D. provide a step-up voltage to compensate for the voltage drop.

Question 9

Consider the circuit diagram below.



The most likely values for the voltages V_1 and V_2 are

A. V_1 = 15 V and V_2 = 30 V

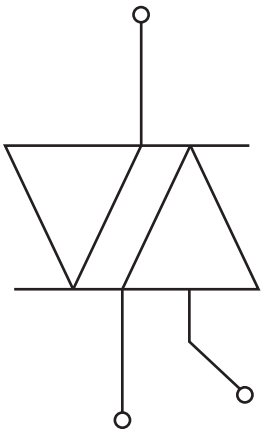
B. V_1 = 30 V and V_2 = 15 V

C. V_1 = 45 V and V_2 = 45 V

D. V_1 = 22.5 V and V_2 = 22.5 V

Question 10

The diagram below shows an electronic symbol.



This symbol is used in a circuit diagram to represent a

A. diac.

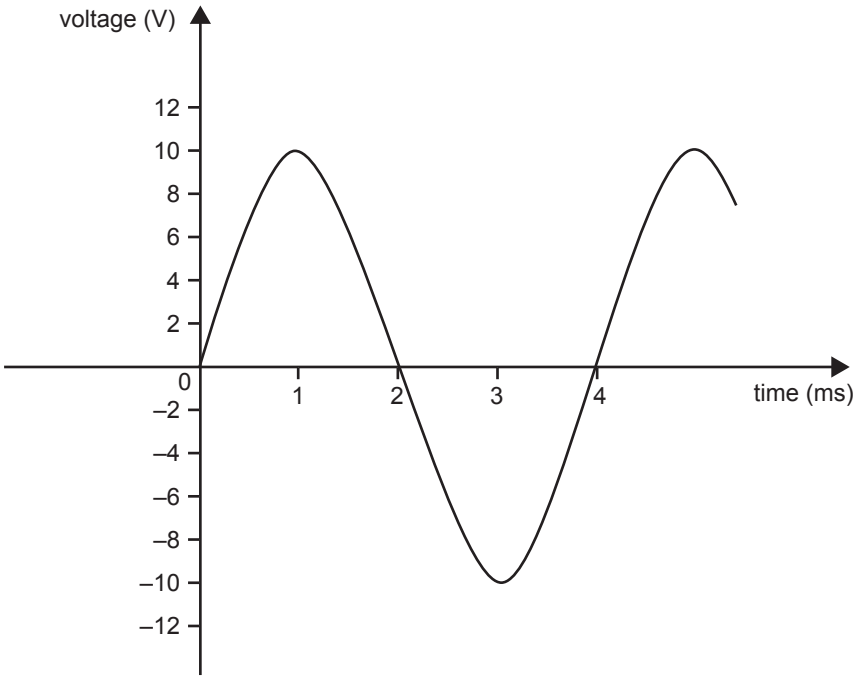
B. triac.

C. thyristor.

D. transistor.

Question 11

The diagram below shows a signal displayed by an oscilloscope.



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

A. 20 V and 250 Hz

B. 10 V and 250 Hz

C. 20 V and 40 Hz

D. 10 V and 4 Hz

Question 12

The function of a transistor is to

A. act as a photo detector.

B. act as a magnetic sensor.

C. perform voltage divisions.

D. amplify and switch signals.

Question 13

An inverter is used in a circuit to convert

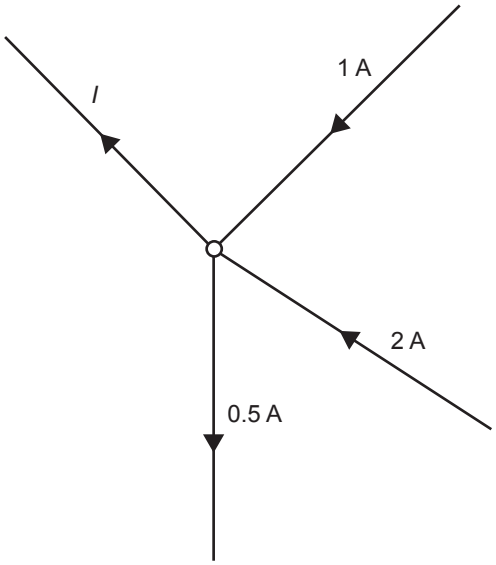
A. AC to AC.

B. AC to DC.

C. DC to DC.

D. DC to AC.

Question 14



The current, *I*, in the diagram above is

A. 1.0 A

B. 1.5 A

C. 3.5 A

D. 2.5 A

Question 15

Which one of the following metals is the **best** electrical conductor?

A. silver

B. copper

C. nichrome

D. aluminium

Question 16

Which item of personal protective equipment (PPE) **must** be used when soldering?

A. earplugs

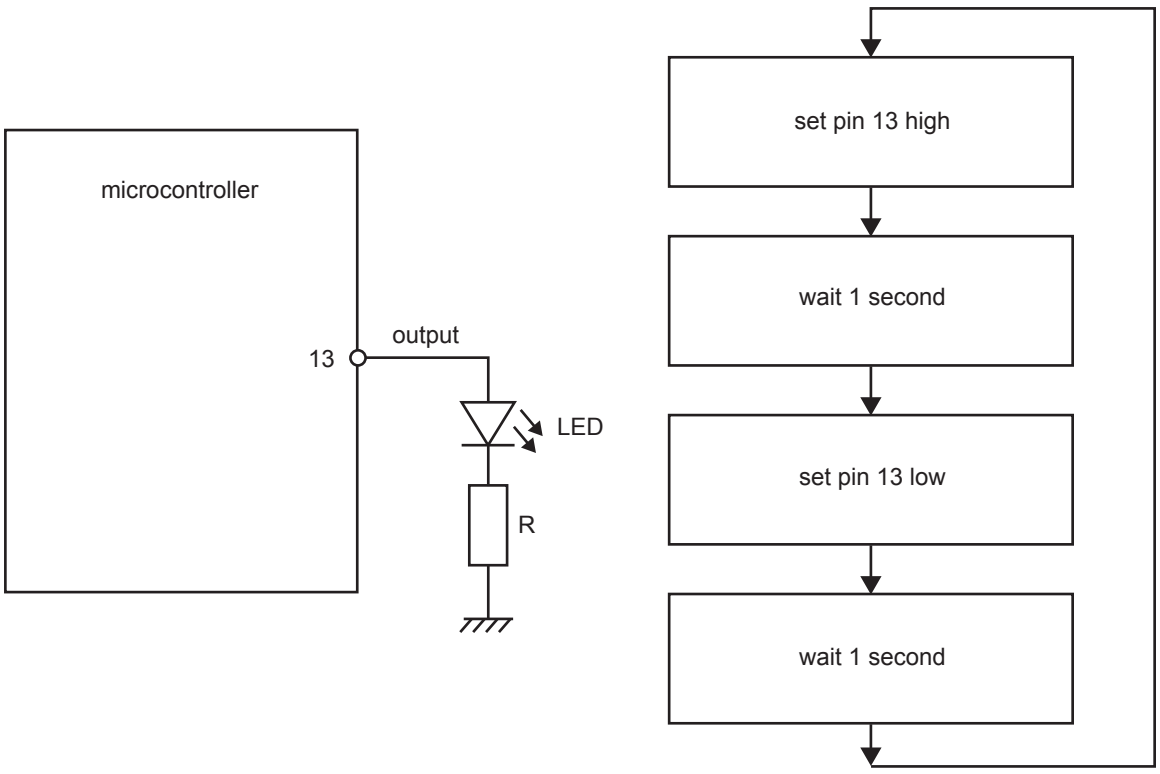
B. safety glasses

C. leather gloves

D. disposable rubber gloves

Question 17

The diagram below shows a light-emitting diode (LED) that is connected to one of the outputs of a microcontroller. The microcontroller has had a code uploaded to it, as set out in the flow chart shown below.



Which one of the following gives the best description of the behaviour of the LED when it is functioning?

A. The LED will remain constantly off.

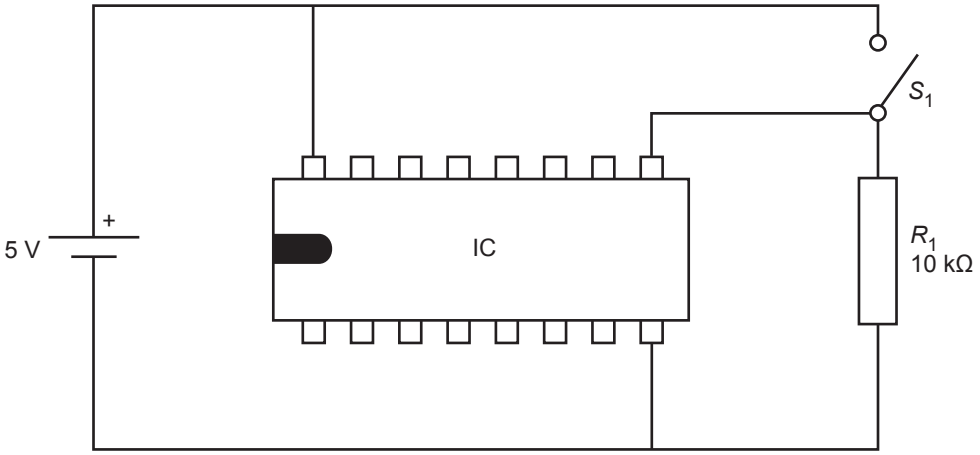
B. The LED will remain constantly on.

C. The LED will be on for one second, then off for one second.

D. The LED will fade in and out over a period of two seconds.

Use the following information to answer Questions 18 and 19.

The diagram below shows a digital integrated circuit (IC).



Question 18

The function being performed by the 10 kΩ resistor, R_1, would indicate that it is a

A. shunt resistor.

B. switch resistor.

C. pull-up resistor.

D. pull-down resistor.

Question 19

Which combination of pins supplies the IC with power?

A. 5 V pin 9 and 0 V pin 8

B. 5 V pin 8 and 0 V pin 9

C. 5 V pin 16 and 0 V pin 8

D. 5 V pin 8 and 0 V pin 16

Question 20

An isolated environmental research station is powered by energy from solar panels. The electrical energy accumulates in a 100 Ah battery during the day. The RF transmission of data each night requires 2 A.

What is the maximum number of hours for data transmission, assuming the battery is fully charged?

A. 1 hour

B. 2 hours

C. 50 hours

D. 4000 hours

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 (5 marks)
Figure 1 shows the schematic diagram of an electronic circuit.

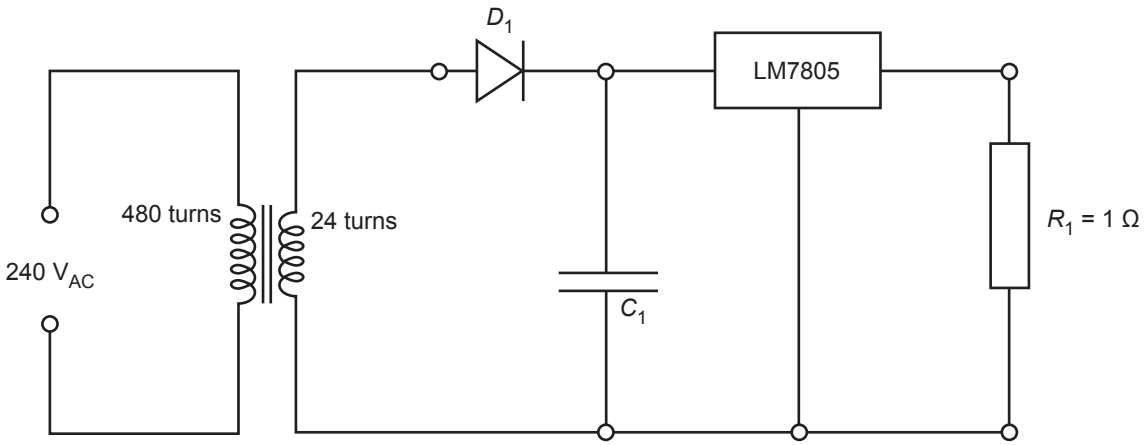


Figure 1

a. What is the main purpose of the electronic circuit shown? 1 mark

b. Calculate the voltage of the secondary winding. Show your working. 2 marks

c. Identify the component labelled LM7805. 1 mark

d. What is the output voltage provided by the electronic circuit? 1 mark

Question 2 (6 marks)

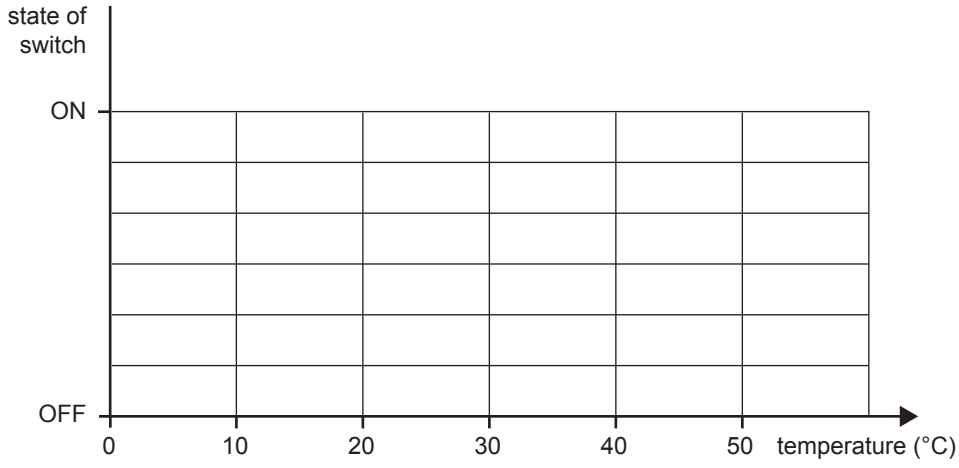
An incubator with a constant temperature is to be designed. The incubator will have a 120 V_{AC} power supply and will provide 240 W. The heating elements to be used are rated 60 V, 60 Ω.

a. Determine the minimum number of heating elements required to build the incubator system described above. Show your working. 2 marks

b. In the space provided below, draw the wiring diagram for the number of heating elements determined in **part a.** 2 marks

c. A temperature controller switch is used to avoid overheating when the temperature in the incubator rises above 40 °C.

Draw the required characteristic of the temperature controller switch on the grid provided below. 2 marks



Question 3 (9 marks)

Figure 2 shows the schematic diagram of an electronic circuit that includes four 20 Ω resistors.

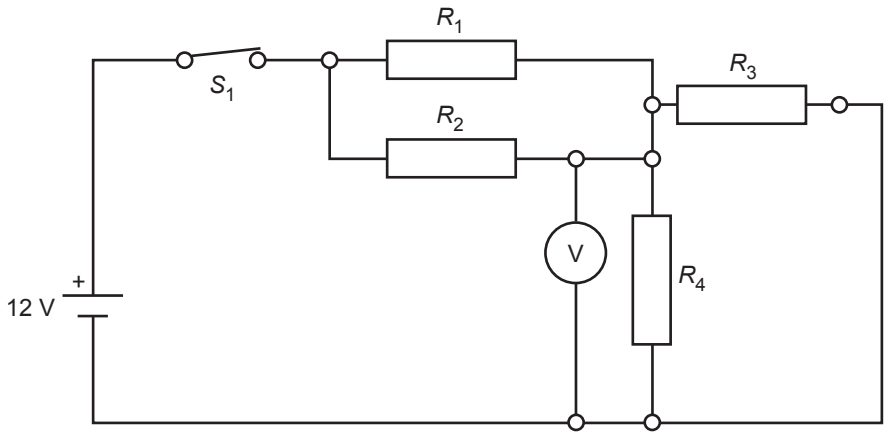


Figure 2

a. Calculate the total resistance of the circuit. Show your working. 3 marks

b. Calculate the voltage shown by the voltmeter. Show your working. 3 marks

c. Find the power dissipated by resistor R_4. Show your working. 3 marks

Question 4 (6 marks)

Figure 3 shows the schematic diagram of an electronic circuit.

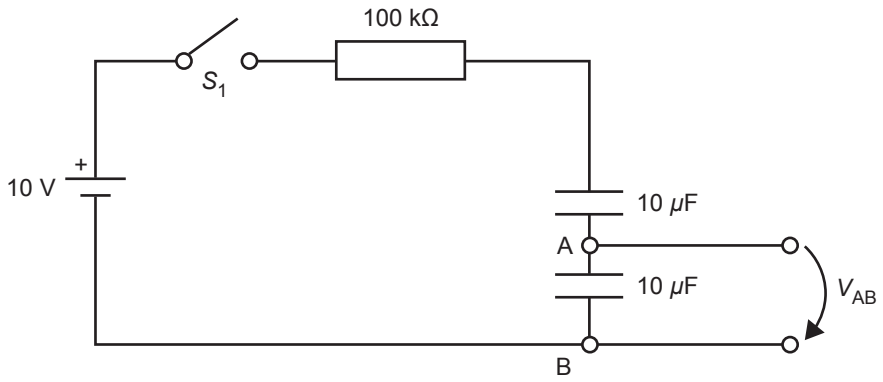
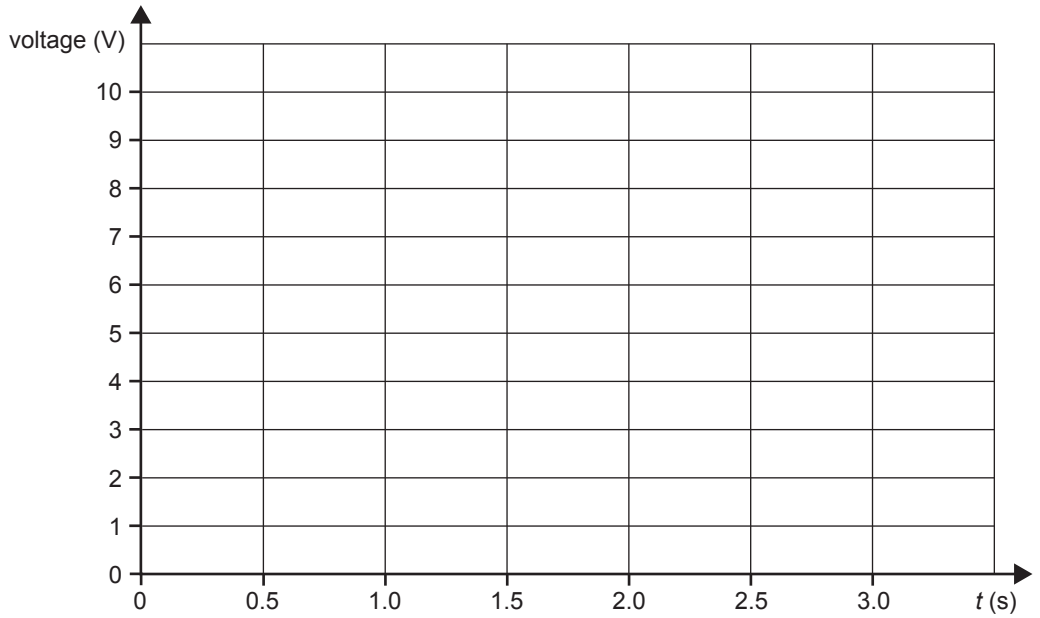


Figure 3

a. Calculate the time constant of the circuit. Show your working. 3 marks

b. On the grid provided below, draw the voltage V_{AB} as it changes over time. Take time $t = 0$ at the origin when the switch is turned on. The two capacitors are initially discharged. 3 marks



Question 5 (9 marks)

Figure 4 shows the schematic diagram of an electronic circuit.

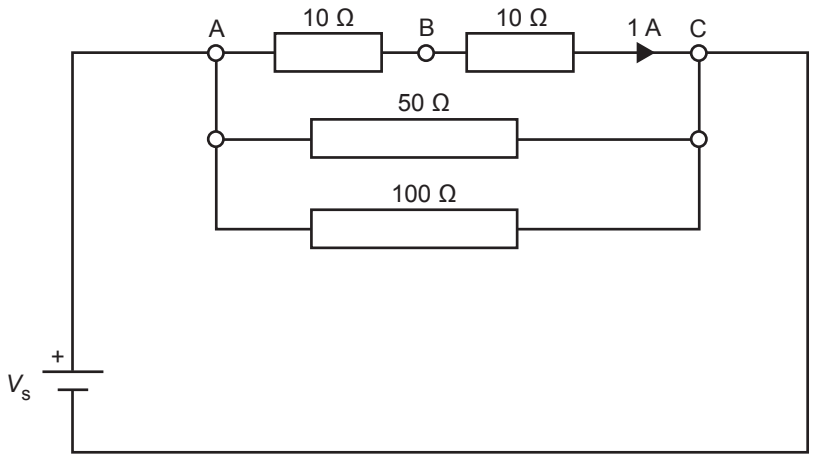


Figure 4

a. Calculate the total resistance of the circuit. Show your working. 3 marks

b. Determine V_s. Show your working. 2 marks

c. Calculate the current through the 100 Ω resistor. Show your working. 2 marks

d. Calculate the total power of the circuit. Show your working. 2 marks

Question 6 (10 marks)

Figure 5 shows the schematic diagram of an electronic circuit.

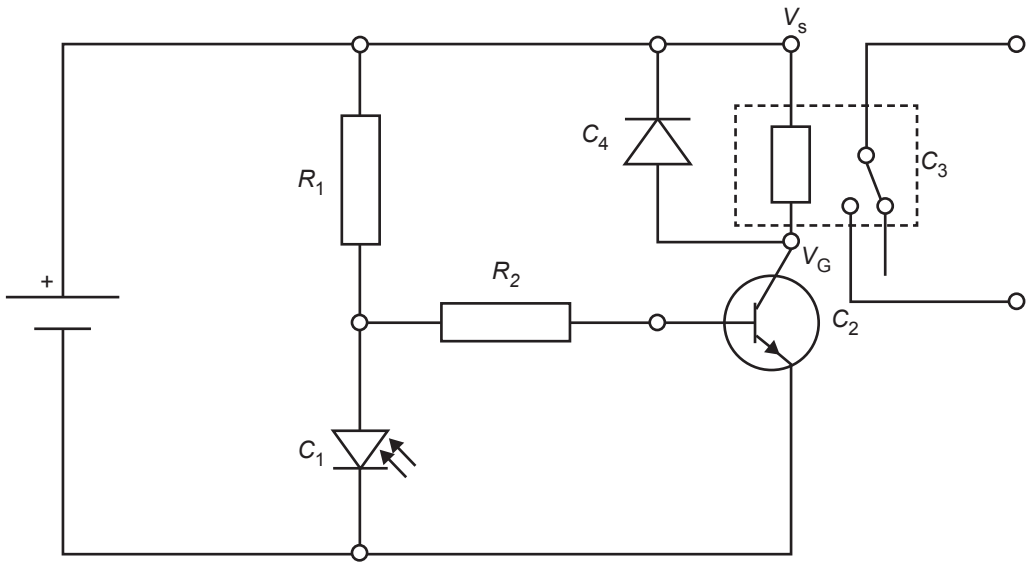


Figure 5

a. Some of the electronic components in Figure 5 are given in the table below.

Name and describe the general function of each component. 4 marks

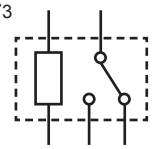
Component	Name	Description of general function
C_1 		
C_2 		
C_3 		
C_4 		

Figure 6 below shows incomplete printed circuit board (PCB) artwork for the electronic circuit in Figure 5.

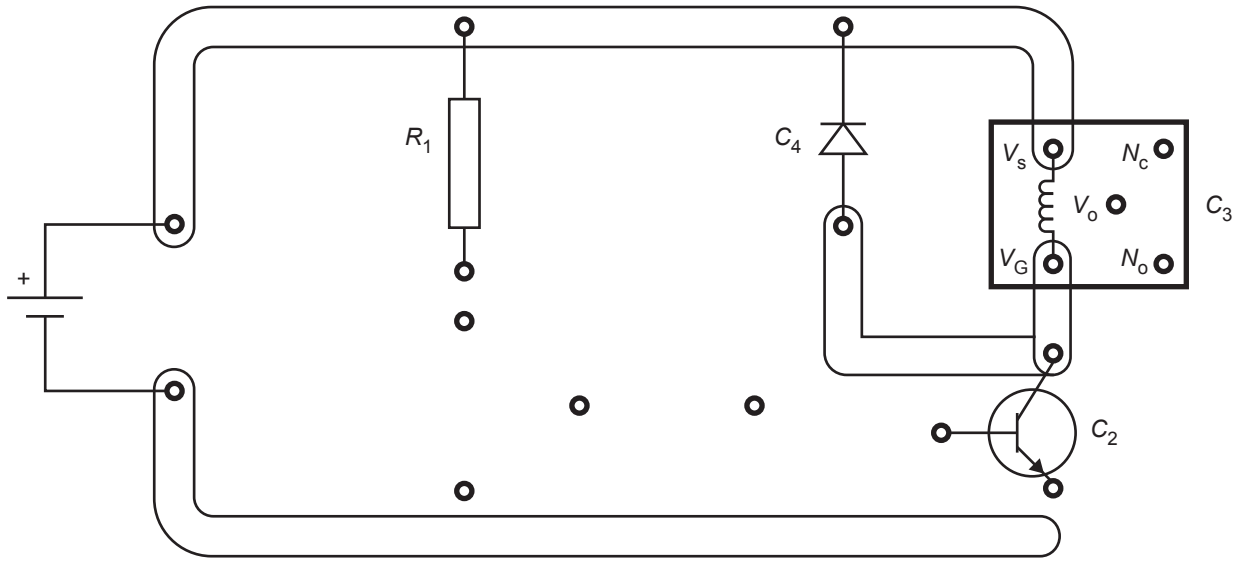


Figure 6

b. On Figure 6 above, draw the four missing PCB connections that would be required for the correct operation of the circuit. 4 marks

c. Explain in detail how component C_4 works as it is connected in Figure 5. 2 marks

Question 7 (10 marks)

A building has roller shutters installed on all of its external windows. For security reasons, the roller shutters are manually closed in the evening and reopened each morning.

Automation of the shutters has been proposed.

Figure 7 below shows the wiring diagram for one shutter.

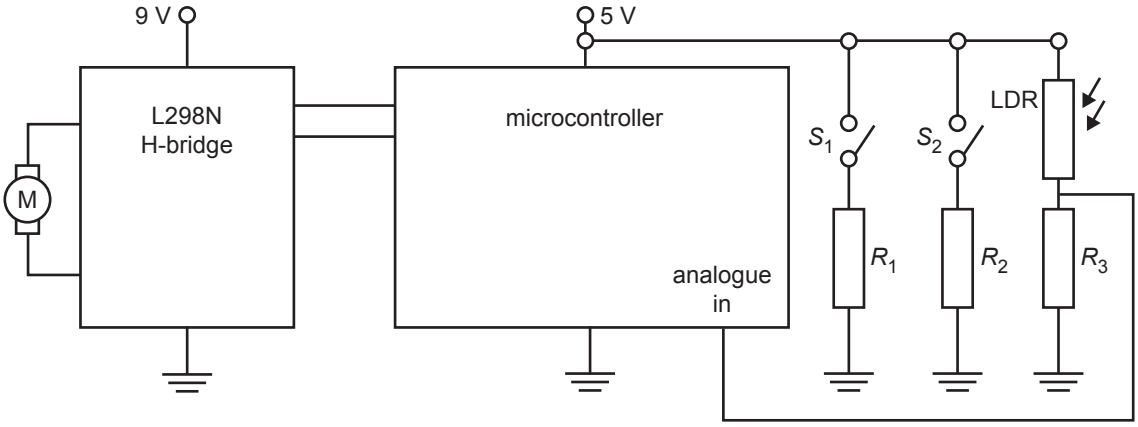


Figure 7

A number of high-torque, low-RPM, 9 V, brushed DC motors will be used to open or close the roller shutters. Two limit switches, S_1 and S_2, will be installed for each shutter, such that one switch will be closed if the shutter is fully open, while the other switch will be closed if the shutter is fully closed. A light-dependent resistor (LDR) will be used to activate closing the shutter when it gets dark and also to activate opening the shutter once it is light again.

The motor is driven clockwise (CW) to close the shutter and anticlockwise (ACW) to open the shutter.

a. What is **one** characteristic of high-torque motors? 1 mark

b. Describe the function of the limit switches. 1 mark

c. A simple light sensor (LDR) will be the input to the automated system.

Identify two potential unintended consequences that may be encountered when the automated roller shutters are operating independently. 2 marks

1. _____

_____

2. _____

_____

d. What is the main function of the L298N H-bridge circuit shown in Figure 7? 2 marks

_____

_____

_____

_____

e. During periods of high winds, flying debris (rubbish) may cause damage to the windows.

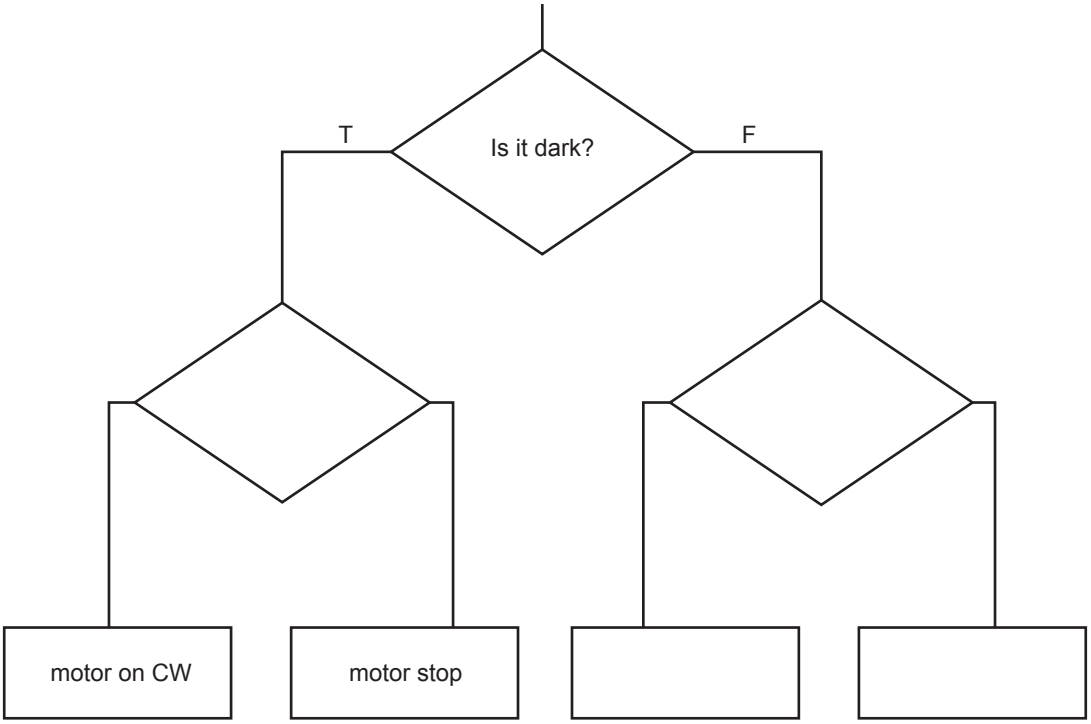
Propose an additional device that can be connected to the input of the microcontroller to prevent wind damage. 1 mark

_____

_____

f. A partial flow chart for the control of the roller shutters is shown below.

Complete the partial flow chart by labelling the missing parts to show the microcontroller's programmed logic functioning correctly, as intended for this scenario. 3 marks



CONTINUES OVER PAGE

Question 8 (13 marks)

An artificially heated greenhouse utilises a simple, mains-connected (230 V_{AC}), three-position switch that provides three heat settings (low, medium and high) to control each of two heating elements, A and B.

The table below gives the circuit operation and power used for the three heat settings for Heating element A and Heating element B.

Setting	Heating element A	Heating element B	Circuit operation	Power (watts)
low	yes	yes	both elements connected in series	
medium	yes	no	Heating element A only	2875
high	yes	yes	both elements connected in parallel	5750

a. On the **medium** heat setting, only one element is used.

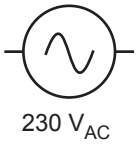
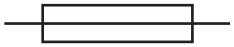
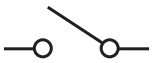
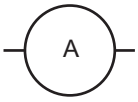
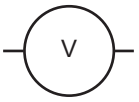
Calculate the current, in amperes, that would be drawn by the single Heating element A when supplied with mains power. Show your working, including any formulas used. 2 marks

b. On the **low** heat setting, Heating element A and Heating element B are connected together in series and supplied with mains power.

Draw a wiring diagram for the low heat setting in the space provided on page 21. Your diagram should include the following features:

- Heating element A and Heating element B connected in series
- mains power supplied via a fuse and mains switch
- current meter positioned to measure the total current drawn by the circuit
- voltage meter required to show the voltage across Heating element A

Use the symbols provided in the table on page 21 to draw your wiring diagram. 4 marks

Power supply		
Components		
		
Meters		

Wiring diagram for low heat setting in greenhouse

c. Calculate the power, in watts, that would be used by the two heating elements, A and B, when they are connected in series. Show your working. 3 marks

d. The greenhouse manager is considering replacing the simple three-position switch with a fully microprocessor-controlled heating system.

i. Identify two reasons for retaining the simple three-position switch. 2 marks

1.

2.

ii. Give two advantages of replacing the simple three-position switch with a fully microprocessor-controlled heating system. 2 marks

1.

2.

CONTINUES OVER PAGE

Question 9 (12 marks)

A student's microcontroller project uses a force-sensitive resistor circuit. The microcontroller can process only digital signals and therefore the force-sensitive resistor circuit cannot be directly connected. A proposed prototype has a force-sensitive resistor connected to the microcontroller, wired via an MCP3008 integrated circuit (IC).

Figure 8 shows the design of the microcontroller.

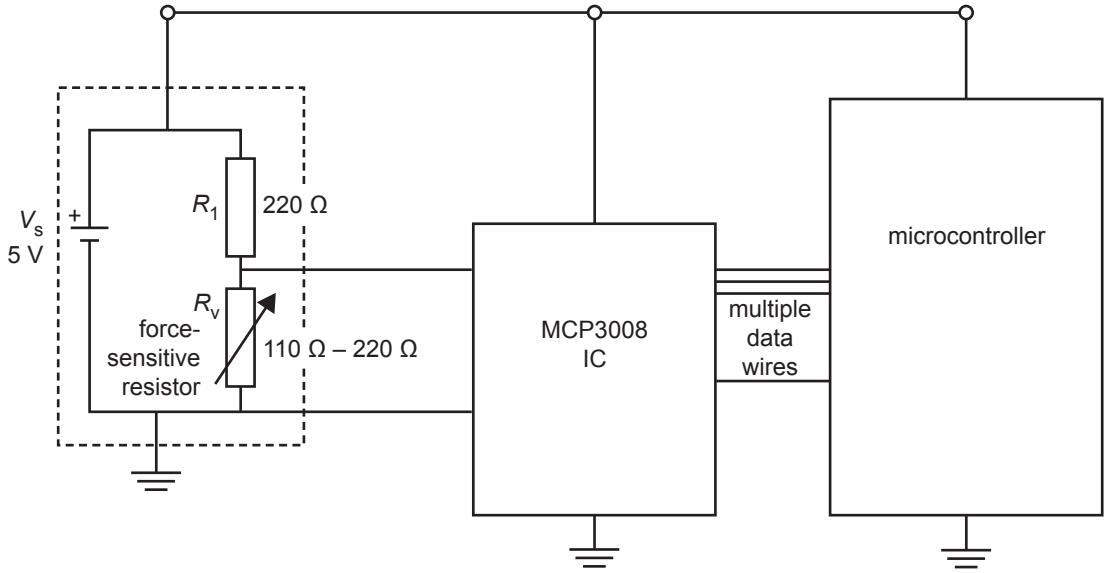


Figure 8

a. The force-sensitive resistor circuit can be represented as shown in Figure 9.

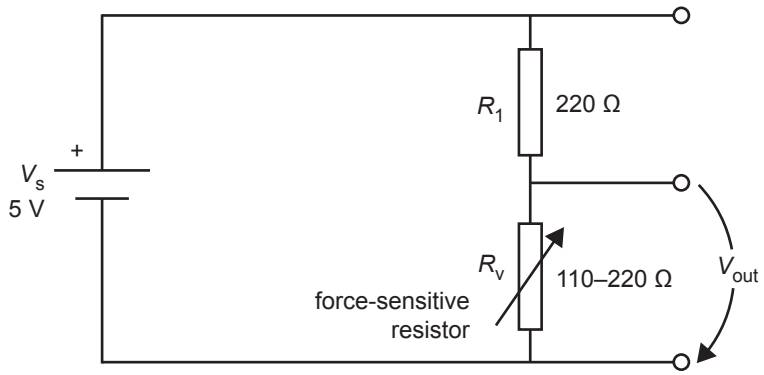


Figure 9

i. What is the name given to the configuration of the resistor circuit in Figure 9? 1 mark

_____

ii. The resistance of the fixed resistor R_1 is 220 Ω, ± 2% tolerance.

Clearly label the relevant band colours for fixed resistor R_1 on the diagram below. 1 mark

iii. The value of the fixed resistor R_1 is 220 Ω, the range of the variable force-sensitive resistor R_v is 110 Ω to 220 Ω and the voltage of the source V_s is 5 V.

Determine the output voltage range provided to the IC. Show your working. 2 marks

V_{out} minimum value _____

_____

V_{out} maximum value _____

_____

b. The MCP3008 IC is part of the input circuit.

i. What is the function of the MCP3008 IC? 2 marks

ii. The MCP3008 IC generates the decimal number 0 (zero) at 0 V input and the decimal number 1023 at 5 V input.

What is the size, in bits, of each register on the MCP3008 IC? 2 marks

iii. Calculate the step voltage provided by the MCP3008 IC. 2 marks

c. After testing, it is found that the prototype works as intended. The student decides to produce a PCB for the final product.

Describe two key processes that would be involved when using a software package to create the PCB artwork. 2 marks

1.

2.

END OF QUESTION AND ANSWER BOOK

VCE VET INTEGRATED TECHNOLOGIES

Written examination

FORMULA SHEET

Instructions

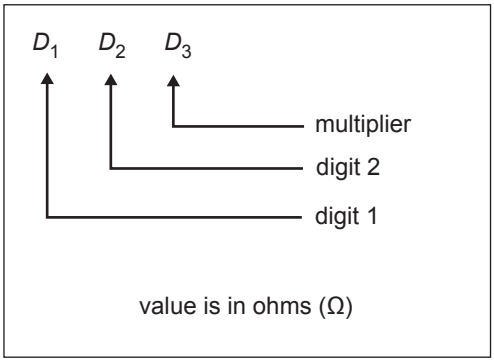
Please remove from the centre of this book during reading time.
This formula sheet is provided for your reference.

VCE VET Integrated Technologies formulas

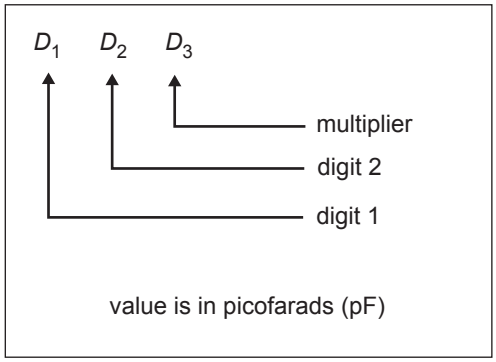
$R_T = R_1 + R_2 + R_3$	$f = \frac{1}{T}$
$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$	$\tau = C \times R$
$R_T = \frac{R_1 R_2}{R_1 + R_2}$	$A = \frac{\pi d^2}{4}$
$R = \frac{\rho l}{A}$	$C = \frac{\varepsilon A}{d}$
$V = I \times R$	$C_T = C_1 + C_2 + C_3$
$P = V \times I$	$\frac{1}{C_T}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

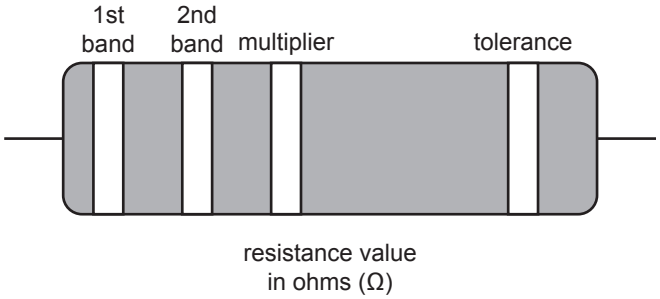


ASCII code chart (in hexadecimal)

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