VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY

Victorian Certificate of Education 2010

SUPERVISOR TO ATTACH PROCESSING LABEL HERE

STUDENT NUMBER

									Letter
Figures									
Words									

VCE VET ELECTROTECHNOLOGY

Written examination

Thursday 4 November 2010

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	10	10	80
			Total 100

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

Materials supplied
- Question and answer book of 20 pages including a formula sheet on page 20.
- 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.
- 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.

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.

Question 1

How many individual cells are contained in a 9 V alkaline battery?

A. 2
B. 3
C. 6
D. 10

Question 2

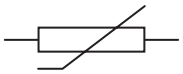


Figure 1

The device represented by the symbol in Figure 1 is a

A. diode.
B. thermistor.
C. potentiometer.
D. light-dependent resistor.

Question 3

When two AA alkaline battery cells are connected in parallel with positive to positive and negative to negative, the result is

A. an increase in voltage.
B. an increase in ampere-hour capacity.
C. the voltages cancel each other.
D. there are no changes.

Question 4

What determines the power rating of a resistor?

A. physical size
B. the colour of the last band
C. the number of colour bands
D. the colour of the resistor casing

Question 5

What decimal number is represented by the hexadecimal number 1FH?

A. 8
B. 15
C. 31
D. 255

Question 6

The value of the binary number 101101 in decimal is

A. 45
B. 70
C. 89
D. 102

Question 7

A transformer with a secondary winding with the same number of turns as its primary winding is referred to as a

A. current transformer.
B. step-up transformer.
C. isolation transformer.
D. step-down transformer.

Question 8

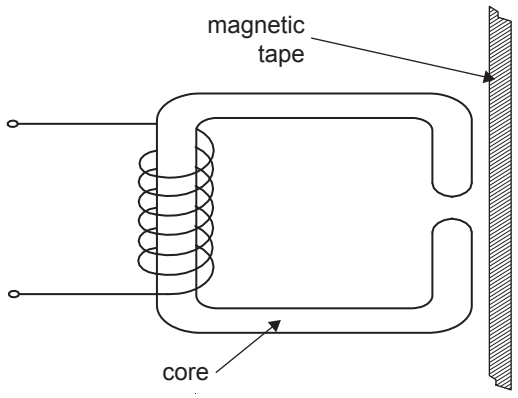


Figure 2

The core of the recording head in Figure 2 forms a magnetic circuit.

The purpose of the core material is to

A. protect the coil from overheating.
B. stabilise the current of the power supply.
C. decrease the current of the power supply.
D. confine the magnetic flux within the cross section of the core.

Question 9

Figure 3 shows a small DC permanent magnet motor with the motor housing and armature (also known as a rotor) disassembled.

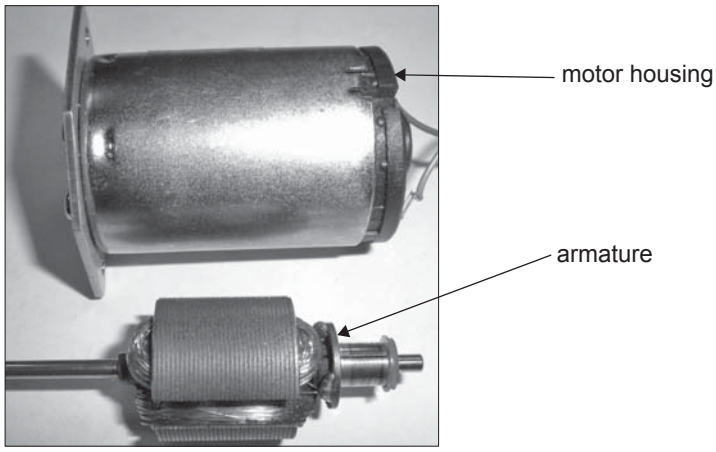


Figure 3

What is the function of the laminations on the armature core?

A. to reduce commutator wear due to brush arcing

B. to increase the magnetic flux density of each core

C. to reduce eddy currents flowing in the armature core

D. to prevent the armature rubbing the permanent magnet housing when operating

Question 10

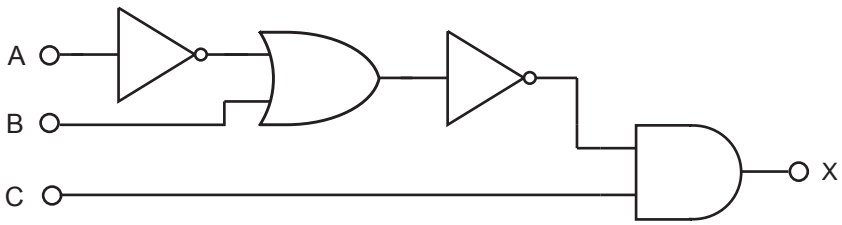


Figure 4

The logic circuit in Figure 4 has the Boolean expression

A. $X = \bar{A} \bullet B + C$

B. $X = (A + B) \bullet \bar{C}$

C. $X = (A + \bar{B}) + C$

D. $X = \overline{\bar{A} + B} \bullet C$

Question 11

Linear integrated circuits can be used to

A. amplify analogue signals.

B. decode binary data.

C. convert parallel data to serial.

D. convert digital signals to analogue.

Question 12

If you find a person who you suspect is in contact with a live mains electrical wire, the **best** action is to

A. switch off the power source.

B. remove the wire wearing a rubber glove.

C. knock the arm of the person with a metal rod.

D. pull the person from the wire by grabbing them by the armpits.

Question 13

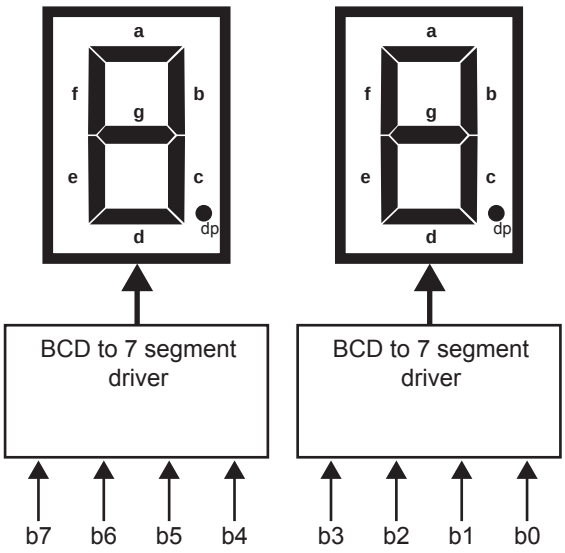


Figure 5

Figure 5 shows 2 seven segment displays on the entrance of an elevator, displaying the floor location of the elevator.

The elevator stops on the 29th floor.

What would be the binary code on the inputs of the BCD to seven segment drivers?

A. 00101001

B. 00011011

C. 11010110

D. 01001001

Question 14

Where new electrical work is carried out in an existing dwelling a Residual Current Device (RCD) must be fitted. The RCD shown in Figure 6 also incorporates a 16 amp circuit breaker (MCB).

Figure 6

The RCD will disconnect power from the circuit when

A. current flows in the earth.

B. an appliance without an earth is connected to the power outlet.

C. a fault occurs, causing the active and neutral wires to short together.

D. a current imbalance greater than 30 mA is detected between the active and neutral wires.

Question 15

A protection wrist strap is shown in Figure 7.

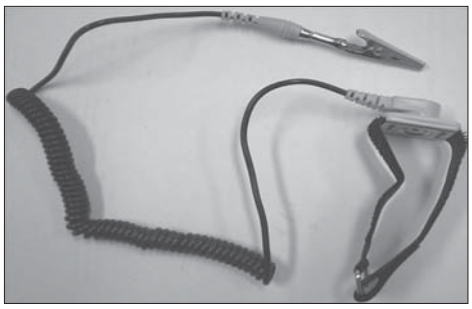


Figure 7

This strap is worn by a service technician

A. to minimise the effect of static charge.

B. to trip the RCD in a hazardous situation.

C. when working on high-voltage equipment.

D. to protect the technician from electric shock.

Question 16

A four-band resistor has the colour code: brown, black, green, gold.

The resistance value is

A. 100 Ω

B. 106 Ω

C. 1 MΩ

D. 10 kΩ

Question 17

In Figure 8 the switch is initially open.

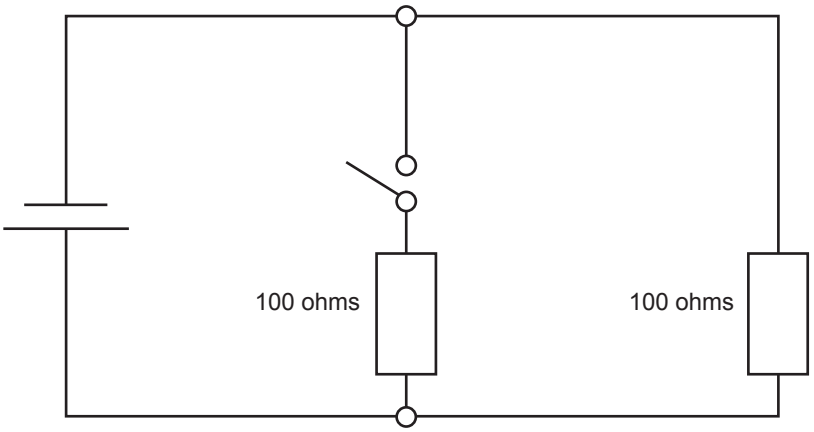


Figure 8

By closing the switch the supply current will

A. halve.

B. double.

C. decrease.

D. stay the same.

Question 18

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

A. silver

B. water

C. carbon

D. Nichrome

Question 19

For an open circuit condition, which one of the following statements is true?

A. The resistance in the circuit is zero.

B. The current flow in the circuit is zero.

C. The current flow in the circuit increases.

D. The power dissipated by the circuit increases.

Question 20

Which one of the materials listed below is the **best** insulator?

A. mica

B. copper

C. carbon

D. silicon

END OF SECTION A
TURN OVER

SECTION B

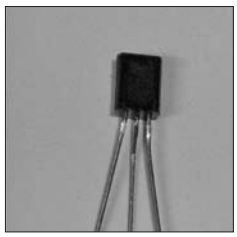
Instructions for Section B

Answer **all** questions in the spaces provided.
State all formulas and calculations.
All units must be specified in the answers.

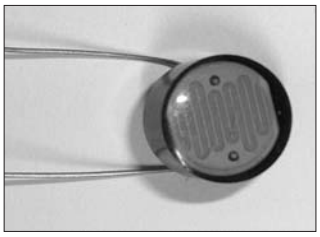
Question 1

Complete the table below with the corresponding circuit pictures (**A.–D.**) and the circuit symbol (**i.–iv.**).

A.



B.

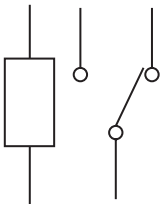


C.

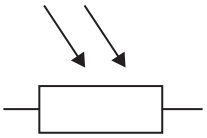
D.

i.

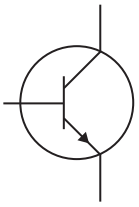
ii.



iii.



iv.



component	picture	symbol
relay		
electrolytic capacitor		
transistor		
light-dependent resistor		

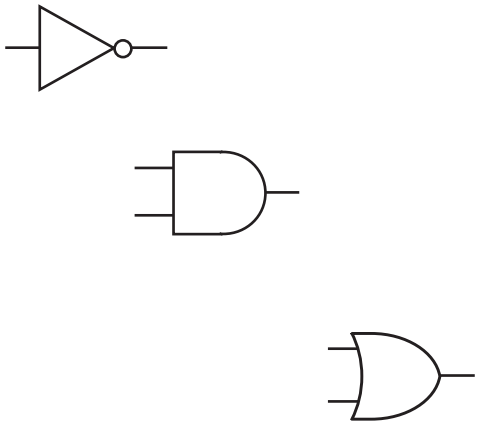
8 marks

Question 2

a. Using the gates shown below, draw the circuit for the logic function

$$X = \bar{A} \bullet B + C$$

Label A, B, C and X on the diagram.



3 marks

b. Fill in the truth table of this logic function.

A	B	C	X
0	0	0	0
0	0	1	
0	1	0	1
0	1	1	
1	0	0	
1	0	1	1
1	1	0	0
1	1	1	

4 marks

Question 3

You are in the process of designing a robotics vehicle that will perform the following functions: move forwards, move backwards, move left and right, follow a black line, and move away from solid objects. The vehicle will have two 6 V DC motors, each drawing an average current of 300 mA. A microcontroller board will operate from the same power source as the motors. The microcontroller board draws an average current of 50 mA. You are required to select suitable batteries for this project.

a. How many alkaline cells would you need to operate the vehicle?

_____

2 marks

b. How many nickel metal hydride cells would you need to operate the vehicle?

_____

2 marks

You decide to use nickel metal hydride cells.

c. State whether these are primary or secondary cells and give the reason for your choice.

_____

_____

2 marks

d. If each of the cells is rated at 2 ampere-hour capacity, for how long would the vehicle operate before the batteries require a recharge? Assume the batteries are fully charged prior to operation. Both motors are operating continuously. Show your working.

_____

2 marks

e. Name one advantage and one disadvantage of using nickel metal hydride cells over alkaline cells.

Advantage _____

Disadvantage _____

2 marks

Question 4

You have been asked to design a circuit to control the direction of rotation of a DC motor. Figure 1 is a partially completed schematic diagram showing SW1 as the master on/off and SW2 as the direction control.

a. Complete the schematic diagram by drawing the connecting lines onto the circuit so that it will work as described.

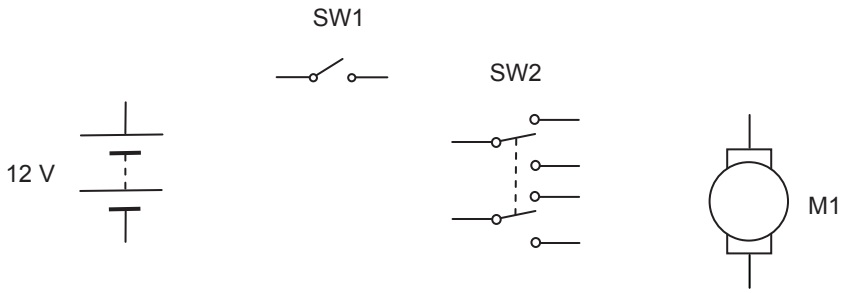


Figure 1

3 marks

b. When connecting a DC motor to a microcontroller, the output of the microcontroller is unable to supply sufficient current to power the motor.

Which electronic component could be placed between the microcontroller and the motor to provide sufficient current to operate the motor?

_____

1 mark

c. Which of the following switch types are used in the circuit in Figure 1?

SPST SPDT DPST DPDT

SW1 _____

SW2 _____

2 marks

Question 5

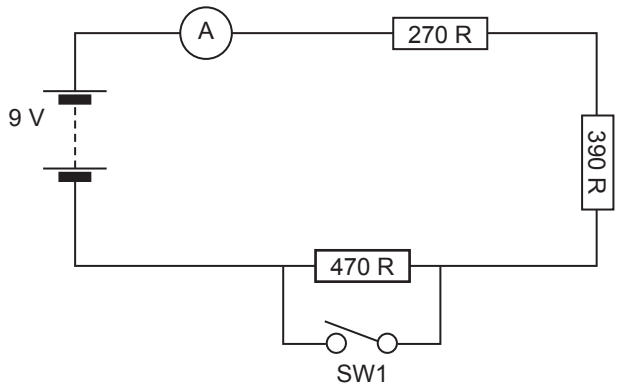


Figure 2

a. Calculate the total resistance of the circuit in Figure 2. Assume that SW1 is in the 'open' position.

_____

2 marks

b. With SW1 in the 'open' position, calculate the ammeter reading.

_____

2 marks

c. With SW1 in the 'closed' position, calculate the ammeter reading.

_____

3 marks

d. Which type of fault condition is simulated by the operation of SW1?

_____

1 mark

Question 6

a. Name one personal safety risk associated with working in an electronics workshop and one control measure that could be used to either control or eliminate the risk.

Risk _____

Control measure _____

2 marks

b. List **three** safety precautions you would take before using a pedestal drill to drill a hole in a metal face plate.

_____

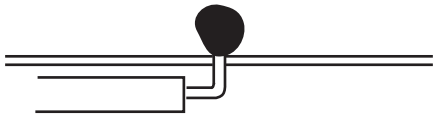
_____

_____

_____

3 marks

i.



ii.

c. State which solder joint shown above is a 'bad' solder joint and give a reason for your choice.

Choice _____

Reason _____

_____

2 marks

d. Describe two features of a 'good' solder joint.

_____

_____

2 marks

Question 7

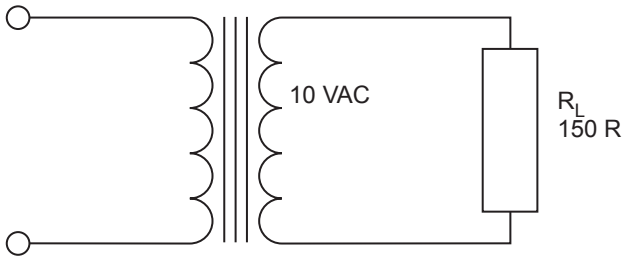


Figure 3

The step-down transformer in Figure 3 has 960 primary turns and 80 secondary turns.

a. Calculate the primary voltage.

2 marks

b. Calculate the secondary current.

2 marks

c. Calculate the primary current.

2 marks

d. Calculate the power dissipated by the resistor R_L.

2 marks

Question 8

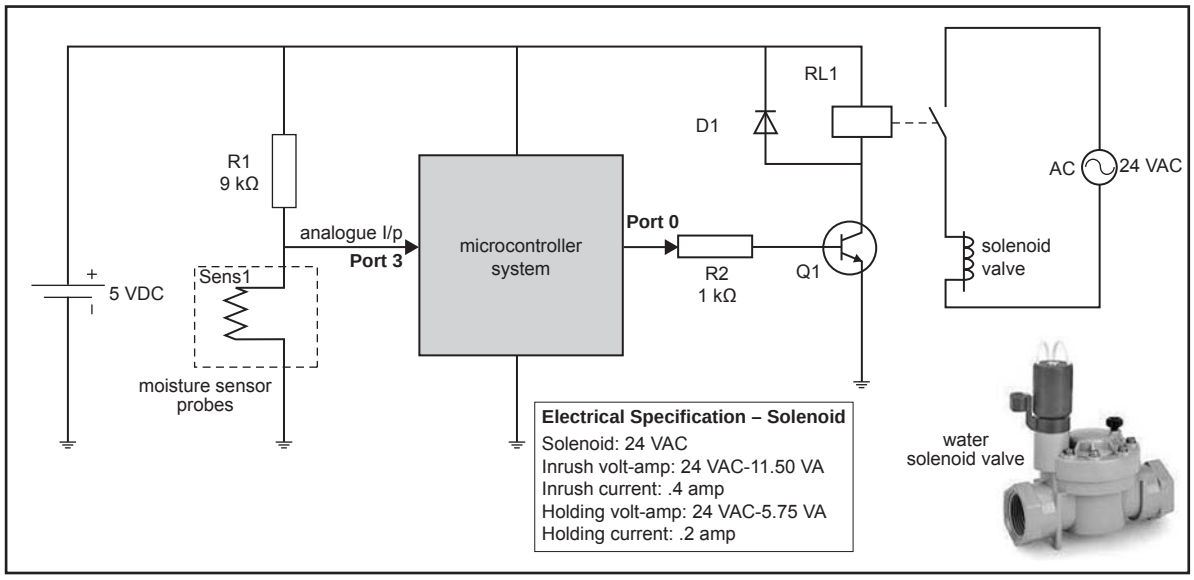


Figure 4

For the microcontroller-based irrigation system shown in Figure 4, the following conditions apply.

- Sensor probes (Sens1) monitor the soil moisture.
- In dry soil, the moisture sensor resistance is high.
- In moist soil, the moisture sensor resistance is low.
- When the soil is dry, the microcontroller relay RL1 and its 'NO' contact closes to activate the water solenoid, allowing the garden to be watered.
- When the soil becomes moist, the microcontroller de-energises relay RL1.

a. What logic level is required on output Port 0 to activate relay RL1?

_____

1 mark

b. What is the function of diode D1?

_____

_____

1 mark

c. The coil of relay RL1 has an operating current of 40 mA and is driven by Q1.

i. What is the power dissipated by RL1 in the 'ON' state?

_____

ii. Assuming relay RL1 is energised, what will the current be through Q1?

_____

2 + 1 = 3 marks

d. When the moisture sensor resistance drops to 1 kΩ, what will the analogue input voltage be on Port 3?

_____

2 marks

e. To modify the system to only water the garden at night, what type of sensor (transducer) might you connect to the input of the microcontroller?

_____

1 mark

Question 9

An analogue to digital convertor (ADC) is used in a microcontroller system (Figure 5) to convert analogue voltages to digital. The digital values can be stored in the microcontroller's RAM for later use.

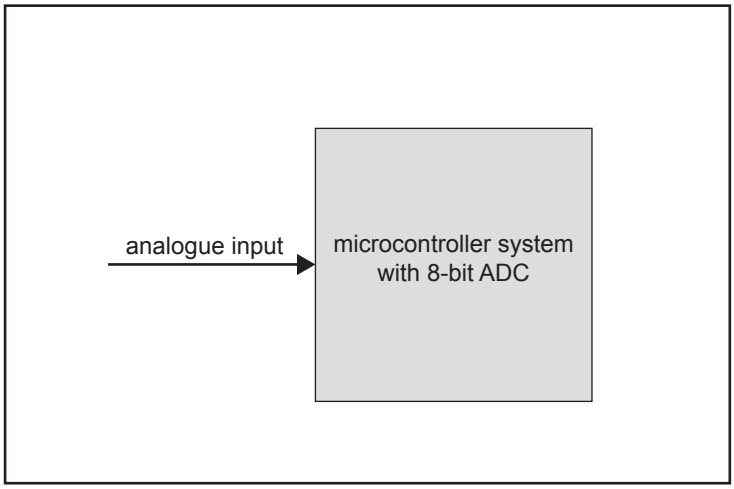


Figure 5

The waveform in Figure 6 shows a signal being fed to the analogue input of the 8-bit ADC. The analogue input of the ADC accepts voltages from 0 volts to 5.1 volts, producing 00000000 to 11111111 binary at the ADC output. The minimum input step voltage required to change the digital output is 0.02 volts.

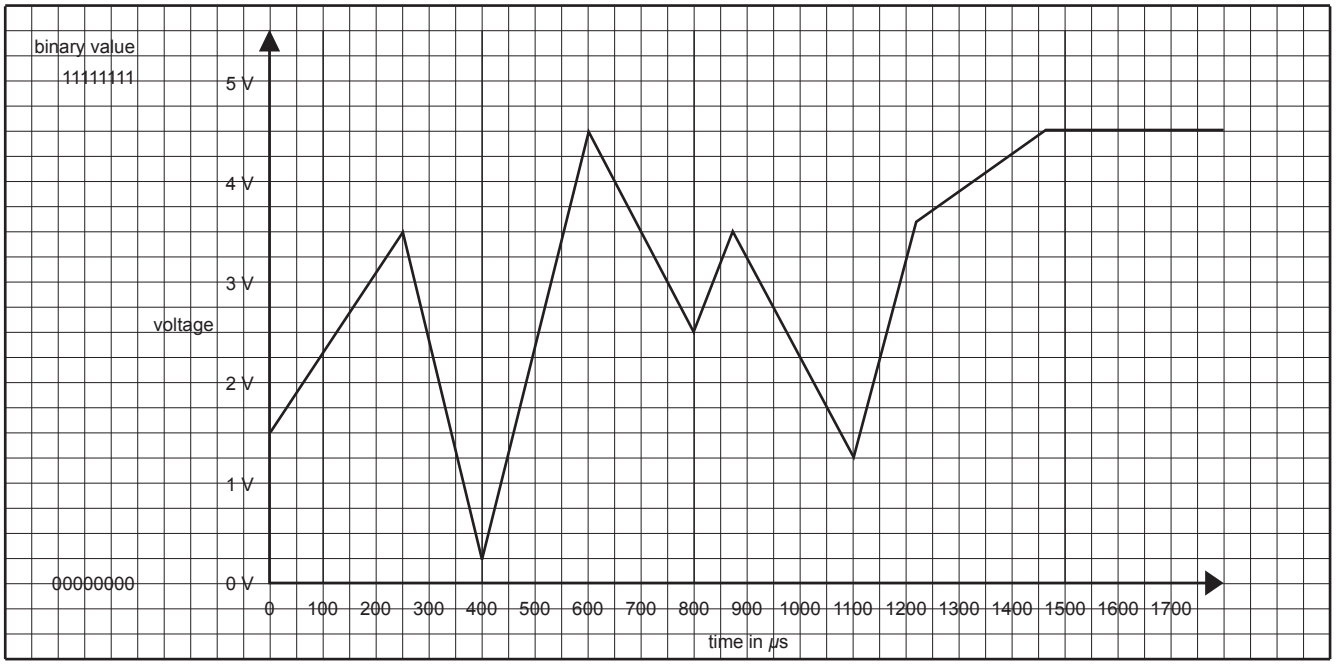


Figure 6

a. What is the resolution of the ADC?

_____

1 mark

b. Calculate the change in the input voltage required to change the binary output from 00000000 to 00000101.

_____

2 marks

c. In Figure 6, the ADC carries out a conversion (sample) of the analogue waveform every 100 μs.
In the table below, record the analogue voltage level of the waveform, its decimal equivalent and the resultant binary output for the sample point shown.

Sample point	Analogue voltage	Decimal equivalent	Binary output
800 μs			

3 marks

d. The analogue voltage from a microphone is converted to digital before being transmitted.
Describe **one** other practical example of analogue to digital conversion.

_____

_____

1 mark

Question 10

The microcontroller-based variable speed limit road sign in Figure 7 sends serial data to a road control centre via a wireless transmitter.

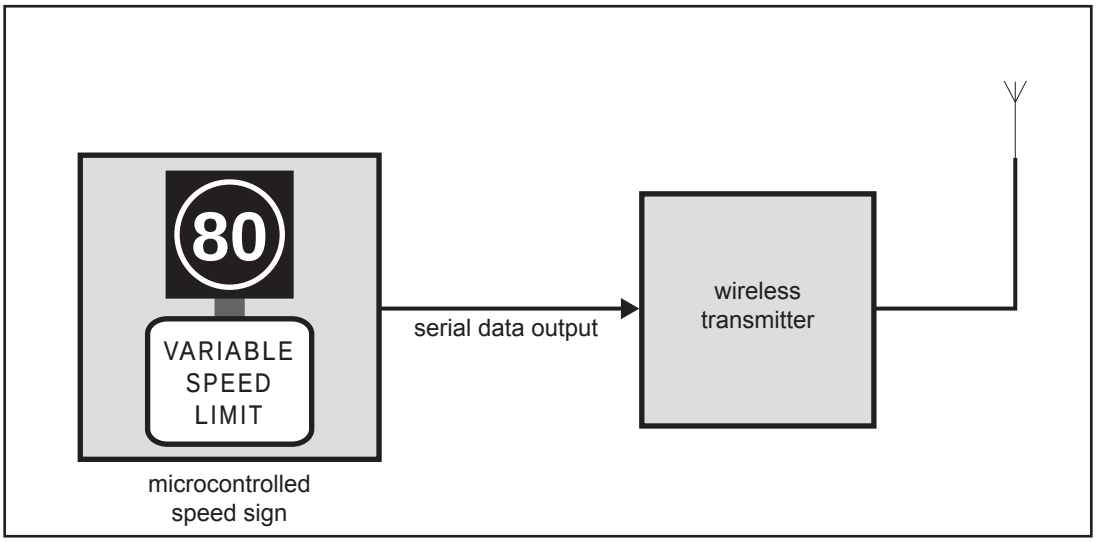


Figure 7

The serial data is transmitted asynchronously in ASCII format, with each character being framed with a start bit and a stop bit. An ASCII code chart is provided in Figure 8.

ASCII code chart

Most significant nibble \ Least significant nibble	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

Figure 8

Figure 9 shows the timing diagram of the serial data output. Two characters are being sent to the wireless transmitter.

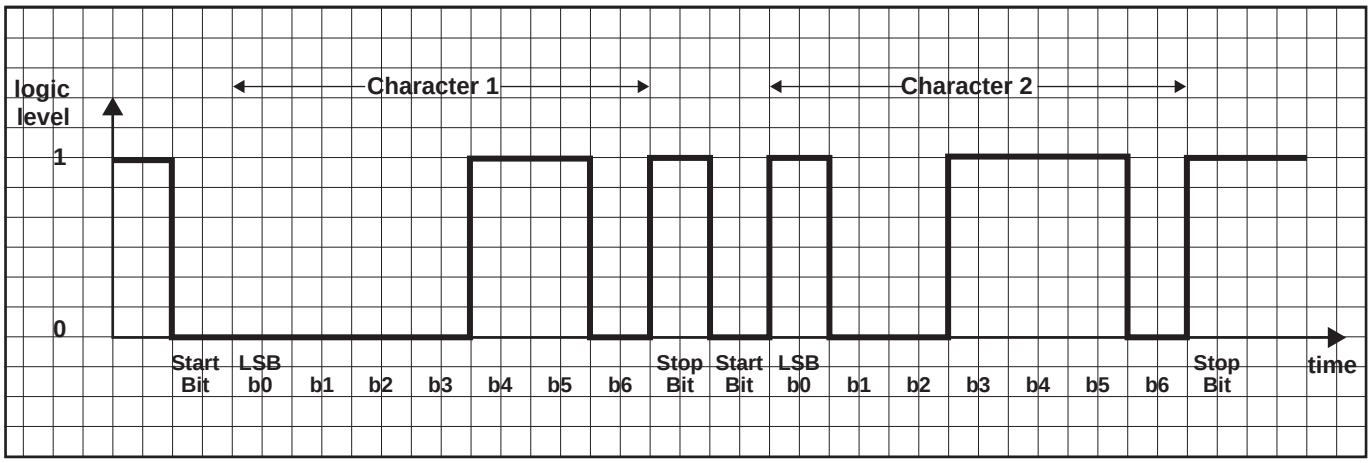


Figure 9

a. Using the ASCII code chart in Figure 8 and the timing diagram in Figure 9, complete the table below showing the binary number, hexadecimal number and character for each of the characters being transmitted.

Data	Binary number	Hexadecimal number	Character
Character 1			
Character 2			

6 marks

b. If a data bit is transmitted every 100 μs, what is the data transmission speed in bits per second (bps)?

_____

2 marks

c. Name one type of serial interface that may be found on your personal computer.

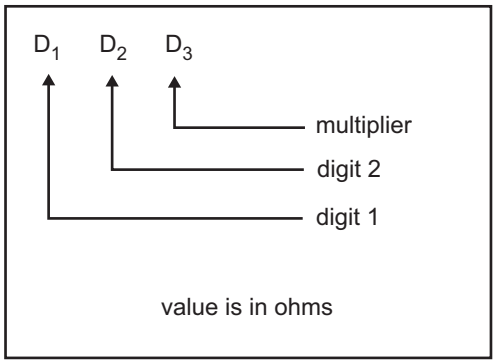
_____

1 mark

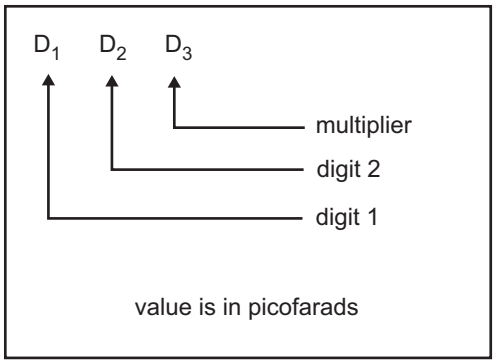
END OF SECTION B
TURN OVER

Formula sheet

resistor code



capacitor code



$$R_T = R_1 + R_2 + R_3$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$V = I \times R$$

$$P = V \times I$$

$$V_X = V_S\left(\frac{R_X}{R_T}\right)$$

$$V_{PK} = \sqrt{2} \times V_{RMS}$$

$$\text{Turns ratio} = \frac{N1}{N2}$$

$$\frac{V_{primary}}{V_{secondary}} = \frac{N_{primary}}{N_{secondary}} = \frac{I_{secondary}}{I_{primary}}$$

$$f = \frac{1}{T}$$

$$V_{STEP} = \frac{V_{max}}{2^n - 1}$$

Resistor colour code

0 black
1 brown
2 red
3 orange
4 yellow
5 green
6 blue
7 violet
8 grey
9 white

END OF QUESTION AND ANSWER BOOK