Victorian Certificate of Education
2008

STUDENT NUMBER

Letter

Figures

Words

VCE VET ELECTROTECHNOLOGY
Written examination

Thursday 6 November 2008

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	11	11	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 21 pages including a formula sheet on page 21.
- 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

A residual current detector (RCD), when connected to a switchboard, will activate when

A. the current being drawn by the active and neutral is out of balance.

B. the circuit is overloaded.

C. there is a short circuit between the active and neutral.

D. there is an open circuit in the cable.

Question 2

A fault in a piece of mains-operated electrical equipment causes a very low resistance path between active and neutral.

The most likely consequence is

A. the equipment will continue to operate.

B. the RCD circuit breaker will operate.

C. the overload circuit breaker will activate.

D. the equipment will stop working but the circuit breaker will not activate.

Question 3

You are about to use a power drill and notice that the lead is damaged, exposing the wires.

What is the **most** appropriate action to take?

A. repair the lead before using

B. use another power drill

C. place insulation tape around the lead before using

D. tag the drill as faulty and report the fault to your supervisor

Question 4

What is the approximate cell voltage of a fully charged Nickel-Cadmium battery?

A.   3 V

B. 1.2 V

C. 1.5 V

D. 2.1 V

Question 5

An electric scooter is powered by a rechargeable battery. The scooter motor draws an average of 6 amps of current when operating. The scooter is operated for up to three hours at a time between charges.

The most suitable type of battery for this application is

A. a NiCad 'D' cell battery pack.

B. a lithium battery.

C. a sealed lead-acid battery.

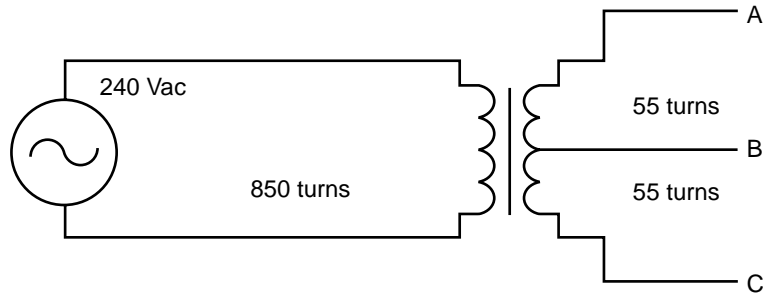**D.** an alkaline lantern-type battery.

Question 6

Figure 1

Given the primary turns, secondary turns and input voltage shown in Figure 1 above, what is the approximate output voltage between points A and B?

A.   25 V

B.   15.5 V

C.   110 V

D.   55 V

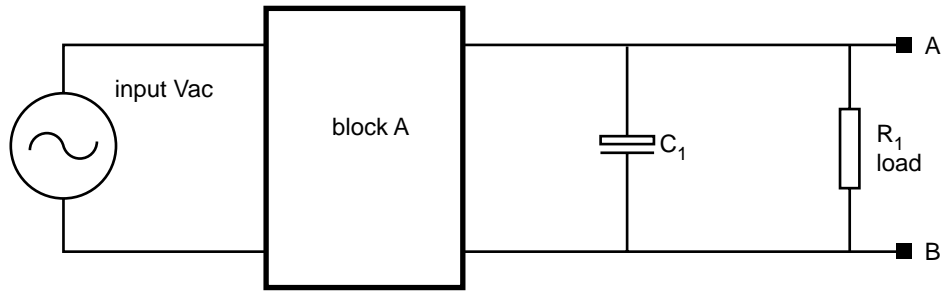*Use the following information to answer Questions 7–10.*

Figure 2a
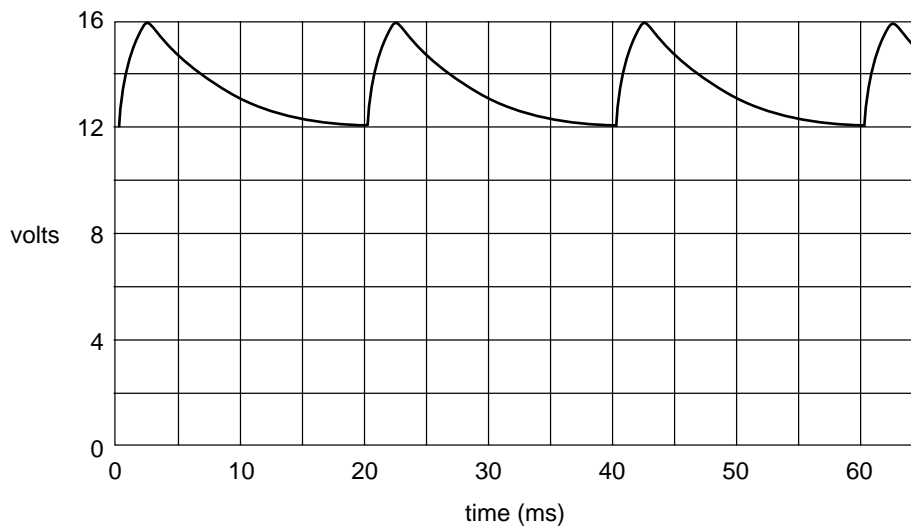
Waveform across load resistor R_1

Figure 2b

Question 7

An oscilloscope is connected across R_1 and the output waveform is represented by Figure 2b.

The frequency of the waveform across R_1 is

- **A.**   100 Hz
- **B.**   50 Hz
- **C.**   60 Hz
- **D.**   120 Hz

Question 8

If the input voltage to the circuit has a frequency of 50 Hz, what type of rectifier is represented by block A?

- **A.**   half-wave
- **B.**   full-wave bridge
- **C.**   full-wave centre tapped
- **D.**   double-wave

Question 9

What will happen to the peak-to-peak voltage of the waveform if the capacitance value of C_1 is increased?

A. It would increase.

B. It would decrease.

C. It would invert.

D. It would remain the same.

Question 10

What is the most likely consequence if R_1 becomes an open circuit?

A. The average DC output voltage will decrease.

B. The average DC output voltage will increase.

C. Capacitor C_1 will overheat.

D. The output voltage will drop to 0 V.

Use Figure 3 to answer Questions 11 and 12.

Figure 3

Question 11

What is the name of the device represented by the letter A in Figure 3?

A. LED

B. transistor

C. resistor

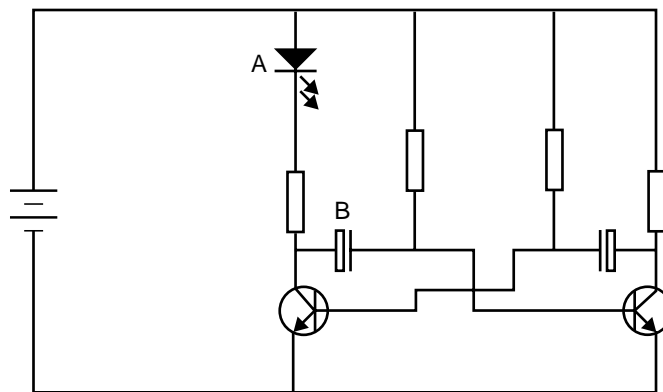**D.** electrolytic capacitor

Question 12

What is the name of the device represented by the letter B in Figure 3?

A. LED

B. transistor

C. resistor

D. electrolytic capacitor

Question 13

When testing an unidentified resistor with a multimeter the following results are recorded.

Temperature in °C	Measured resistance (ohms)
10	110
25	100
40	90

You conclude from the results that the resistor is

A. a carbon film resistor.

B. a thermistor with a positive temperature coefficient.

C. a thermistor with a negative temperature coefficient.

D. faulty.

Question 14

Which of the following capacitors is polarised?

A. tantalum

B. ceramic

C. polyester

D. polystyrene

Question 15

You require a 15 R 5% resistor for a project.

The colour bands required are

A. Brown   Green   Brown   Brown.

B. Red   Blue   Black   Gold.

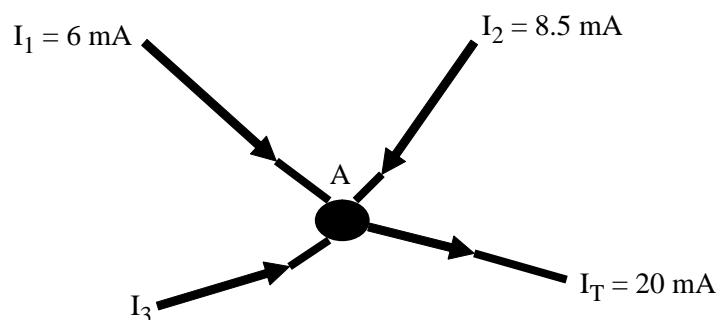C. Red   Green   Black   Silver.

D. Brown   Green   Black   Gold.

Question 16

Figure 4

In the circuit of Figure 4 above, point A is a junction.

What is the value of current I_3?

A. 14.5 mA

B.   5.5 mA

C.   20 mA

D. 34.5 mA

Question 17
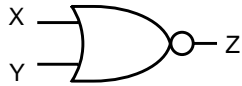
Figure 5

Which truth table summarises the logical operation of the gate in Figure 5 above?

A.

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	1

B.

X	Y	Z
0	0	0
0	1	1
1	0	1
1	1	0

C.

X	Y	Z
0	0	1
0	1	0
1	0	0
1	1	0

D.

X	Y	Z
0	0	1
0	1	1
1	0	1
1	1	0

Question 18

The value of the hexadecimal number 2F, in decimal, is

A.   17

B.   47

C.   215

D.   74

Question 19

The Power-on Self-Test (POST) program in a PC system resides in

A.   DDR RAM.

B.   Flash memory.

C.   CMOS.

D.   Cache.

Question 20

One of the purposes of having a battery on the motherboard is

A.   to back up the main system memory.

B.   to power the CPU.

C.   to maintain real-time clock operation.

D.   to power remote devices.

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

a. List **two** dangers associated with **lead-acid batteries**. For each danger, list the precaution you would take.

Danger	Precaution

4 marks

b. A burglar alarm requires a supply voltage of 6 V. Calculate the minimum number of Nickel-Cadmium cells required to achieve this voltage.

2 marks

c. List **two** reasons for using a Nickel-Metal Hydride (Ni-MH) battery instead of an alkaline battery in an MP3 player.

2 marks

Question 2

The component-side view of a printed circuit board layout is shown in Figure 1.
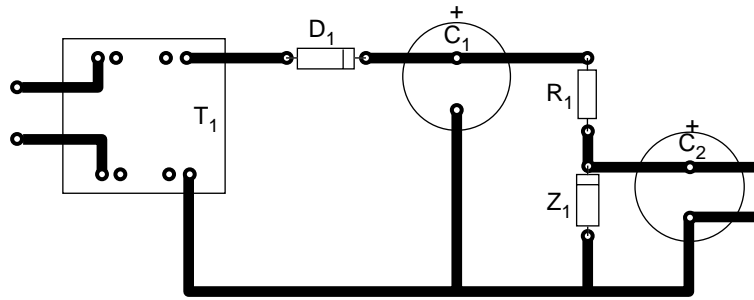
Figure 1

a. Complete the schematic diagram for this circuit board on the diagram below.
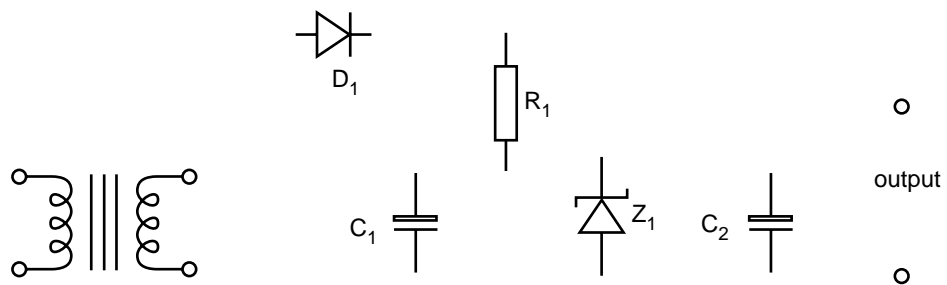
5 marks

b. Explain the function of D_1.

_____

_____

1 mark

c. Name the component Z_1.

_____

1 mark

d. Explain the function of C_1.

_____

_____

1 mark

e. What is the likely outcome of reversing the polarity of capacitor C_1?

_____

_____

_____

1 mark

Question 3
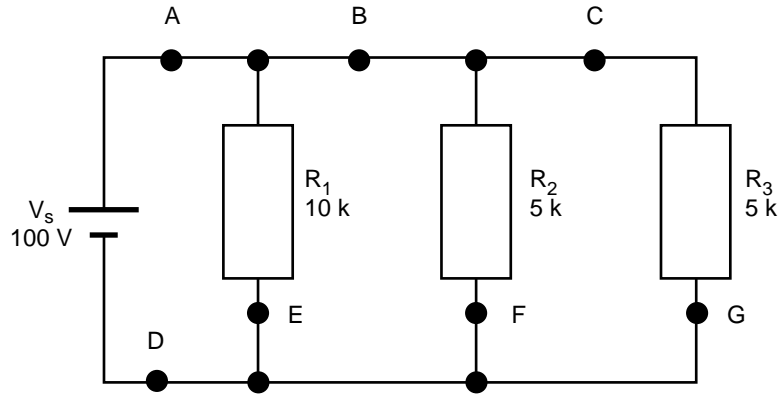
Figure 2

a. Calculate the total resistance of the circuit.

_____

_____

_____

2 marks

b. Calculate the current (I_S) drawn from the supply.

_____

_____

_____

2 marks

R_2 becomes an open circuit.

c. What will happen to the voltage across R_3?

_____

_____

1 mark

d. At which point can the current through R_2 be measured?

_____

1 mark

e. List two points where a circuit breaker can be inserted to protect the complete circuit against excess current.

i. _____

ii. _____

2 marks

Question 4

Complete the table below by giving an example of a transducer which will achieve the energy conversion described.

Energy conversion	Transducer
Sound to electrical	
Temperature to electrical	
Pressure to electrical	
Weight to electrical	
Magnetic flux density to electrical	

5 marks

Question 5

As an environmental project for your school, you were part of a team that carried out a water-usage audit. As a result of the audit your team recommended the installation of a 5000 litre rainwater tank, water pump and microcontroller system to provide rainwater to the toilet flushing systems (cisterns) in the school toilets.

Figure 3 below shows the system, which consists of the following components.

1. microcontroller system
2. rainwater tank
3. water pump
4. water tank level sensor
5. toilet water pressure sensor
6. water filter
7. mains/tank water valve

Figure 3

Figure 4 is a flowchart detailing the operation of the rainwater tank system.

```
                          ┌─────────┐
                          │  Start  │
                          └─────────┘
                               │
                               ▼
              ┌──────────────────────────────┐
              │   Initialise microcontroller  │
              │       water pump off          │
              │   inlet valve to mains water  │
              └──────────────────────────────┘
                               │
                               ▼
                   ╱───────────────────╲
                  ╱   Read water         ╲
                  ╲   tank level          ╱
                   ╲   sensor            ╱
                    ╲─────────────────╱
                               │
                               ▼
                        ╱───────────╲
                       ╱  Is water    ╲
              Yes     ╱  level below    ╲
         ◄───────────╱   minimum?        ╲
                     ╲                   ╱
                      ╲───────────────╱
                               │ No
                               ▼
    ┌──────────────┐   ┌──────────────┐
    │ Switch water │   │ Switch water │
    │ inlet valve  │   │ inlet valve  │
    │ to mains     │   │ to water tank│
    │ water        │   └──────────────┘
    └──────────────┘          │
                              ▼
                    ╱─────────────────╲
                   ╱  Has toilet been   ╲   No
                  ╱   flushed             ╲────►
                  ╲  (toilet water        ╱
                   ╲ pressure sensor low)?╱
                    ╲─────────────────╱
                             │ Yes
                             ▼
                      ┌──────────────┐
                      │ Turn on pump │
                      └──────────────┘
                             │
                             ▼
            Yes      ╱────────────────╲
         ◄──────────╱  Is filter clogged?╲
                    ╲                    ╱
                     ╲──────────────────╱
                             │ No
                             ▼
    ┌──────────────┐   ╱─────────────────╲
    │ Turn off pump│  ╱  Has cistern filled ╲  No
    └──────────────┘  ╲  (toilet water       ╱──►
           │          ╲  pressure sensor high)?╱
           ▼           ╲─────────────────╱
    ┌──────────────┐          │ Yes
    │ Switch water │          ▼
    │ inlet valve  │   ┌──────────────┐
    │ to mains     │   │ Turn off pump│
    └──────────────┘   └──────────────┘
           │
           ▼
    ┌──────────────┐
    │ Turn on filter│
    │ alarm LED     │
    │(filter        │
    │ replacement)  │
    └──────────────┘
           │
           ▼
     ┌─────────┐
     │  Stop   │
     └─────────┘
```
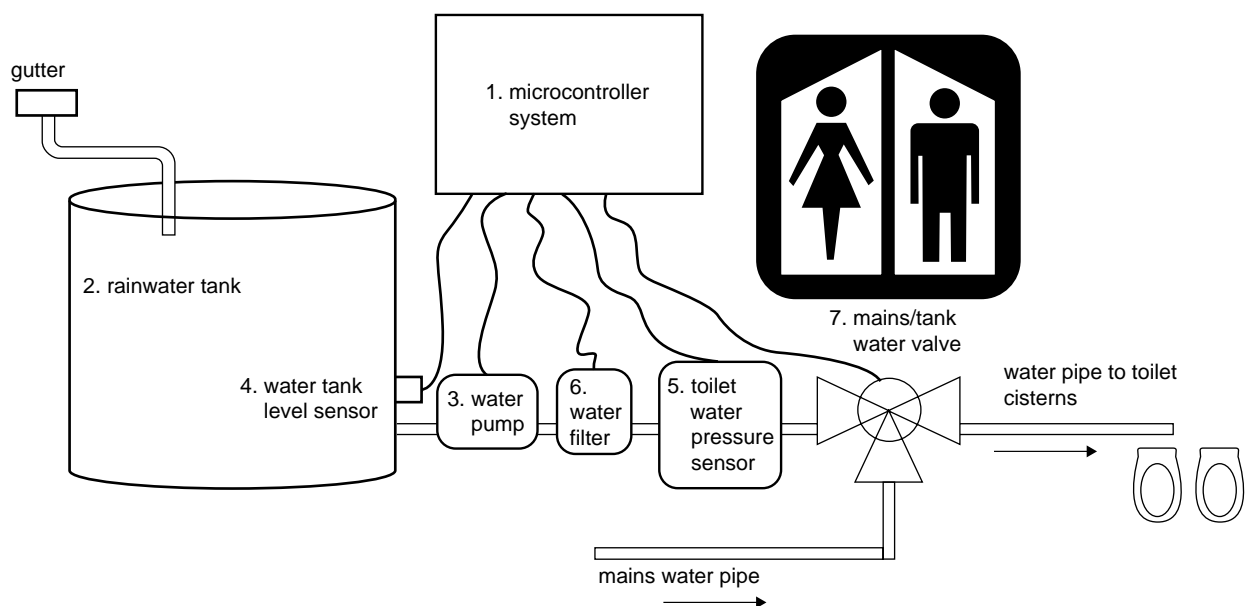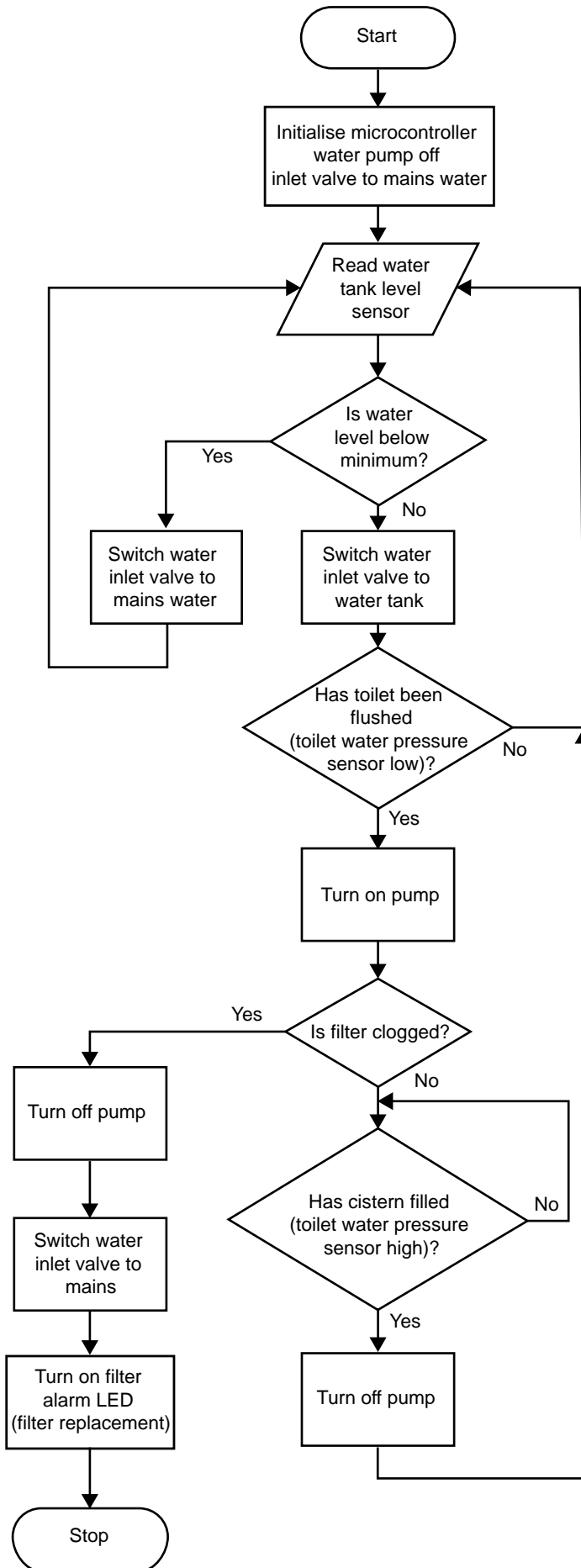
Figure 4

a.   When the toilet cistern is flushed, describe the operation of the system.
Assume that the water inlet is connected to the tank and the filter is not clogged.

_____

_____

_____

_____

_____

5 marks

b.   If the water filter is clogged, describe what action you might take to get the system working.

_____

_____

2 marks

c.   The pump continues to operate after the toilet cistern has filled.

   i.   What effect will this cause to the system?

_____

_____

1 mark

   ii.   Suggest **two** ways to fix this situation.

_____

_____

_____

_____

2 marks

Question 6

You have been asked to design a simple alarm system for a client. The alarm has three inputs. The first input, E, enables the alarm and must be logic 'high' for the alarm to operate. Input A is a window sensor and input B is a motion sensor. When either input A or B is activated 'high', and input E is 'high', the alarm will operate. Output S is connected to a siren and must be 'high' for the siren to sound.

a. From the description given, complete the truth table for the alarm.

Note: All inputs and outputs for this system are active high.
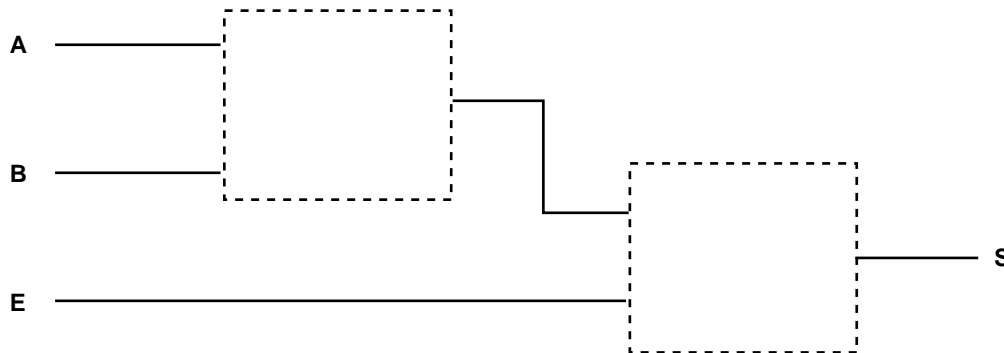
Input A = window sensor
Input B = motion sensor
Input E = enable
Output S = siren

E	A	B	S
0	0	0	
0	0	1	0
0	1	0	
0			0
1			0
1	0	1	
1	1	0	1
1	1	1	

6 marks

b. In the space below, draw the logic symbols that represent the alarm system as represented in the truth table.

2 marks

c. Write the Boolean expression for the logic circuit you have drawn.

_____

2 marks

Question 7

Your electrotechnology team has been asked to create a small business network for a small marketing business.

You are required to connect this company to the Internet via a DSL.
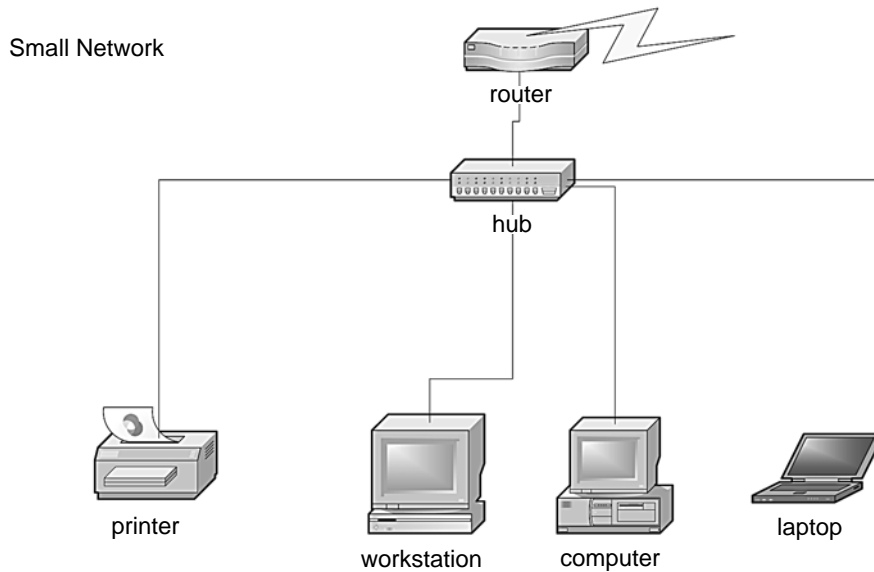

Figure 5

a. What type of typology is shown in the network diagram in Figure 5?

_____

_____

1 mark

b. Figure 5 shows all devices connected to a hub using RJ45 connectors. Name the type of cable used to carry out this connection.

_____

_____

1 mark

c. Which devices in this network are fitted with an 'NIC'? Explain the function of an NIC.

_____

_____

2 marks

d. Describe **one** advantage of having all the devices in this small business networked.

_____

_____

1 mark

Question 8

ASCII code chart   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

Most significant nibble (rows labelled 0–7 at left)

Data is being transmitted from a solar panel inverter on the roof of your school to an alphanumeric display in the foyer of the reception area, to show the amount of power being produced by the photovoltaic cells. The display is connected to the inverter by an RS485 interface.

The data is transferred in ASCII format.

Shown below is a typical block of 7 bytes of data being received by the display.

a. In the space provided, write the ASCII code in hexadecimal form for each byte of data.

Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7
SOH	**0**	**3**	**5**	**9**	**W**	**EOT**

2 marks

b. Show Byte 1 as a binary value.

_____

_____

2 marks

The number above (0359) could also be displayed on a seven segment display. In the display electronics, the data would be converted to BCD.
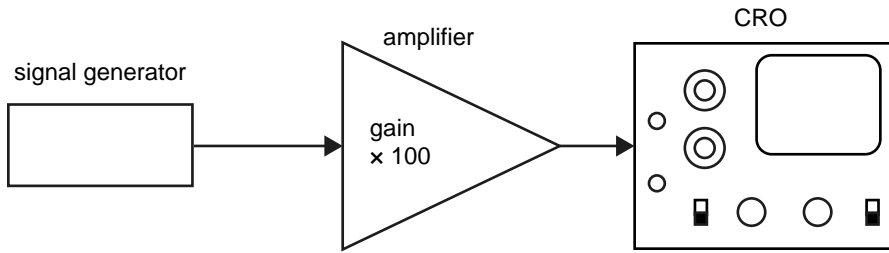
c. Convert the number 359 to BCD.
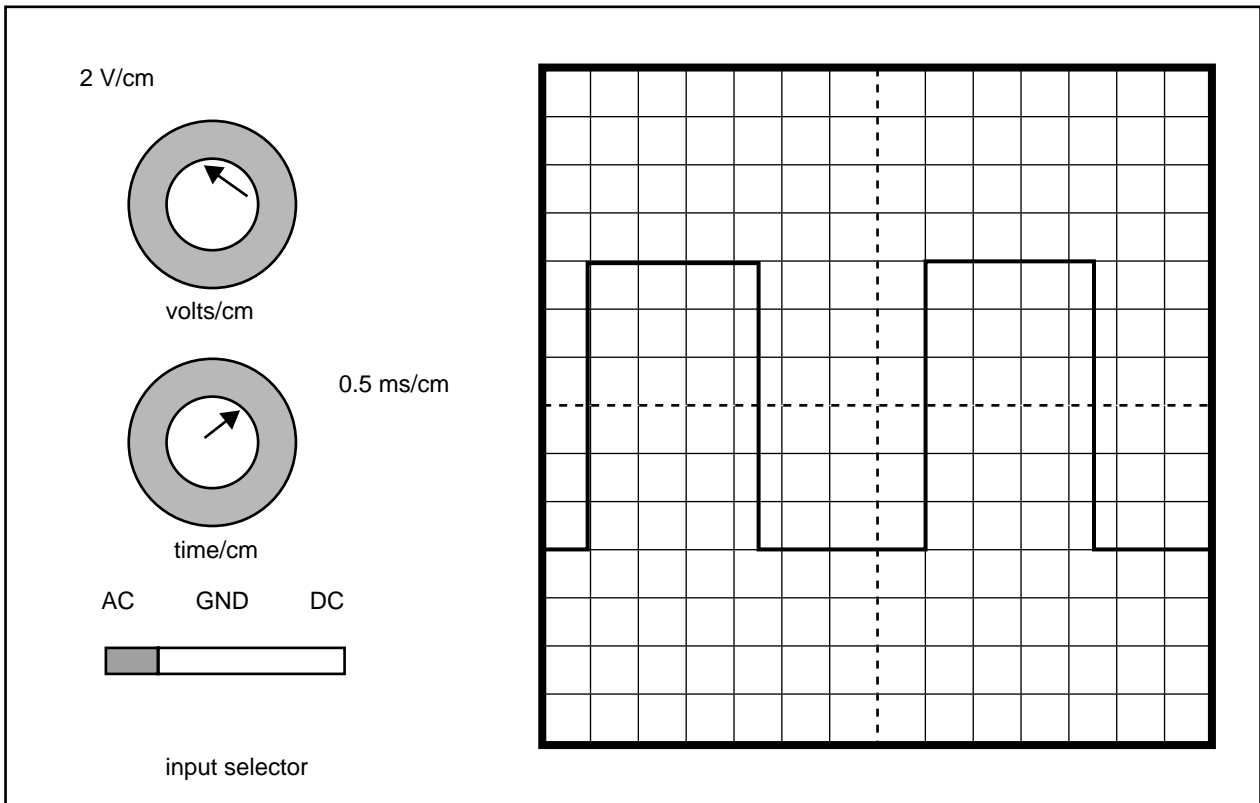
_____

_____

3 marks

Question 9

Figure 6a

Figure 6b

a. Determine the approximate peak-to-peak voltage on the oscilloscope display.

_____

_____

_____

2 marks

b. Determine the frequency of the signal on the oscilloscope display.

_____

_____

_____

3 marks

c. What is the approximate peak-to-peak voltage of the signal from the signal generator?
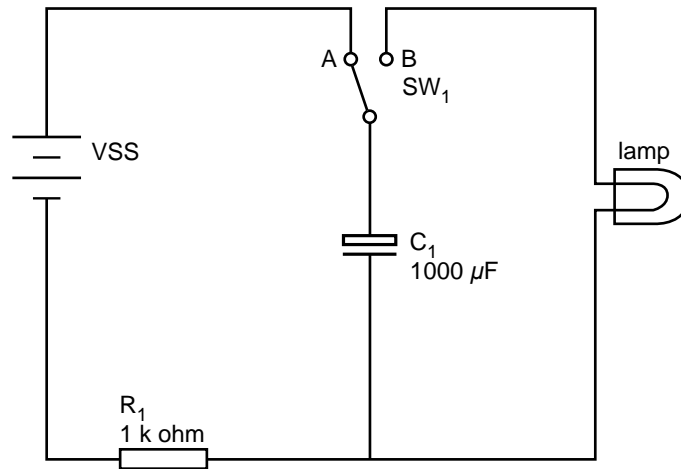
_____

_____

1 mark

d. What is the period of the signal from the signal generator?

_____

_____

1 mark

Question 10

You have been asked to design an electronic flash for a camera and you have been given the circuit in Figure 7 as the starting point for your design.

Figure 7

a.   Calculate the time constant for charging the capacitor.

_____

_____

_____

2 marks

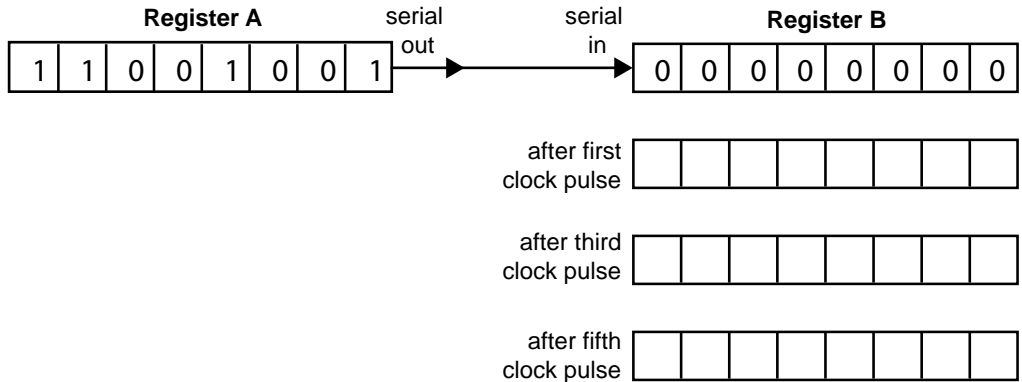b.   Calculate the time required to fully charge the capacitor.

_____

_____

1 mark

c.   Describe what happens when the switch is moved to position B.

_____

_____

_____

_____

2 marks

Question 11

High-speed serial data transmission has become the preferred means of transferring data in computer information systems. To achieve this, data is shifted from a register at the transmission end to a register at the receive end. The data is shifted (clocked) out of one register and clocked in to the other.

a. Determine the data in Register B after clock pulses 1, 3 and 5. Write your answer in the boxes provided.

Register A								serial out	serial in	Register B							
1	1	0	0	1	0	0	1			0	0	0	0	0	0	0	0

after first
clock pulse

after third
clock pulse

after fifth
clock pulse

3 marks

b. How many clock pulses are required to shift one byte of data between Register A and Register B?
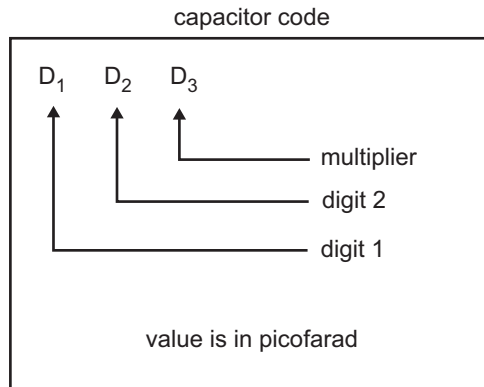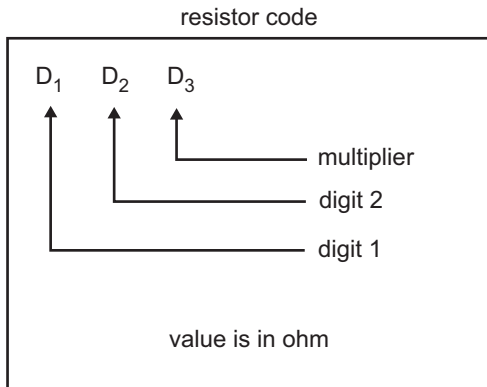
_____

1 mark

c. Give two practical examples of where serial communication is used in computer and information systems.

    i. _____

    ii. _____

2 marks

END OF SECTION B

Formula sheet

resistor code

D_1 D_2 D_3

— multiplier

— digit 2

— digit 1

value is in ohm

capacitor code

D_1 D_2 D_3

— multiplier

— digit 2

— digit 1

value is in picofarad

$$R_T = R_1 + R_2 + R_3$$

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

$$V = I \times R$$

$$P = V \times I$$

$$Q = C \times V$$

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

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

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

$$V_{REG} = V_{IN} - V_{OUT}$$

$$\text{Time constant } \tau = R \times C$$

$$\text{Time constant } \tau = \frac{L}{R}$$

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

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