OFFICE OF TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

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External Assessment 2021

ELECTRONICS

ELT315114

Section A

Pages	13
Questions	6
Information Sheets	1

Preparation time: 15 minutes

Suggested working time: 45 minutes

Instructions

- Attempt **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of the exam booklet. Indicate in the box provided if you have used the spare diagrams.
- A TASC approved scientific calculator can be used throughout the exam.
  - Show your working in answers to numerical questions.
- All answers must be written in **English**.
- You **must** make sure your answers address:
  - Criterion 1 apply knowledge and skills in designing, testing, building, and experimenting with circuits.

Marker use	
C1	45

Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Section A	6	6	45 minutes	45
Section B	7	7	45 minutes	45
Section C	6	6	45 minutes	45
Section D	7	7	45 minutes	45
Total	**26**	**26**	**180 minutes (3 hours)**	**180**

Additional Instructions

When you are asked to “show that”:

- You should calculate your own answer to three significant figures and use this subsequently.
- If you are unable to determine the required value, you should use the value given by the examiner in subsequent questions.

A spare set of diagrams has been provided at the back of the exam paper for you to use if required.

If you use the spare diagrams, you **must** indicate you have done so by ticking the box provided next to each original diagram.

Section A

- Answer **all** questions in this section.
- This section assesses **Criterion 1**.

Question 1

Marker use

Several devices are used to protect people and property from the adverse effects of electricity. These include RCDs, fuses, and circuit breakers.

a) Explain the difference in mode of operation between a fuse and an RCD. **2**

.....

.....

.....

.....

b) A household electrical circuit is protected by both a 10 A fuse and a 5 mA RCD. **3**

Consider two different scenarios.

i. Person 1 uses a power board to connect too many appliances to the circuit.

ii. Person 2 standing on the floor accidently touches the active wire of an electrical appliance.

Giving reasons, which safety device (fuse or RCD) will likely trigger in each scenario?

i. .....

.....

ii. .....

.....

c) In mains circuits, a circuit breaker is now commonly used in place of a fuse. Explain the advantage of using a circuit breaker over the fuse. **2**

.....

.....

Total Q1 **7**

Section A continues

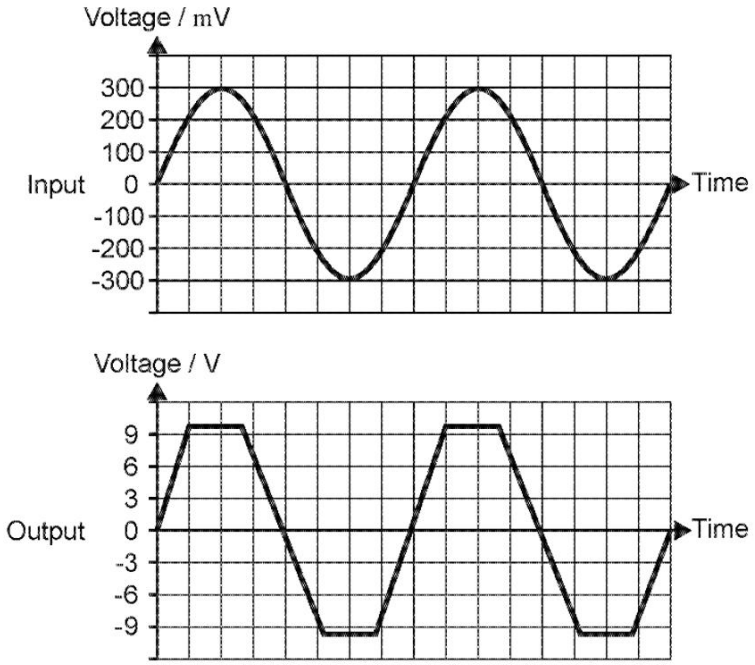
Marker use

Question 2

In analysing an amplifier circuit, a student put a sinusoidal wave into the input.

Here is a representation of an Oscilloscope trace for the input and output signals.

The time base is set at 0.5 ms/div.



a) For the input signal, determine:

i. the period

.....

ii. the frequency

.....

iii. the peak-to-peak voltage, V_{pp}

.....

3

The output is not sinusoidal but has noticeable flattening of the peaks.

b) What is the term to describe this flattening of the peaks?

.....

1

c) What are two ways to remedy this?

.....

.....

2

Total Q2

6

Section A continues

Marker use

Question 3

A student is designing an alarm system for her grandfather's electric mobility scooter.

She includes an audible alarm, a motion switch, an oscillator, and a power amplifier. It is powered by the scooter's battery and is activated by a key-operated switch.

a) Sketch a block diagram to represent this design.

/3

When the motion of the scooter stops, the alarm stops immediately. The student wishes to keep the alarm sounding even when the scooter stops moving.

b) What component would achieve this?

/1

.....

A problem now arises that the alarm will sound continuously and may flatten the battery. The student wishes the alarm to reset after 5 mins.

c) What component will achieve this?

/1

.....

d) Redraw your block diagram with these modifications.

/3

Total Q3

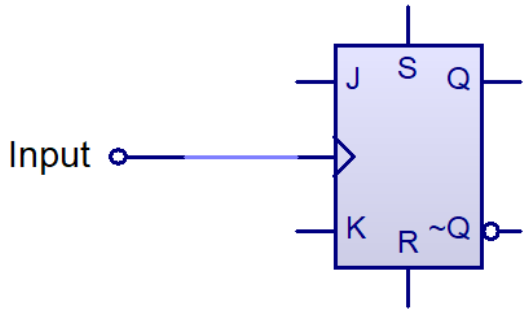
/8

Section A continues

Marker use

Question 4

In this CMOS JK flip-flop, the R and S inputs will not be used.



Spare diagram used (✓) ☐

a) Explain why unused CMOS inputs are vulnerable to stray input signals. **2**

.....

.....

.....

b) On the diagram above, show necessary connections to the R and S inputs to ensure reliable operation. Include any other relevant symbols. Explain your reasoning. **2**

.....

.....

.....

In a digital counting circuit with a push-button mechanical switch, “switch bounce” may be an issue.

c) What is the likely effect of switch bounce on the circuit.? **2**

.....

.....

d) Three major types of flip-flop circuit are astable, monostable and bistable. Which type would be suitable to reduce switch bounce issues in a mechanical push-button switch? Justify your answer. **2**

.....

.....

.....

Total Q4 **8**

Section A continues

Marker use

Question 5

The digital multimeter (DMM) is a very useful tool for analysing and troubleshooting electronic circuits. Its three main settings are voltage (**V**), current (**A**) and resistance (**R**). The DMM is usually protected by a fuse.

a) Explain why the fuse of a DMM is more likely to "blow" when on **A** setting than on **V**.

3

.....

.....

.....

.....

b) In analysing a powered electronic circuit, why is **V** setting much more useful than **A**?

2

.....

.....

.....

.....

Question 5 continues

Marker use

c) A student constructed the following electronic circuit but it did not function properly.

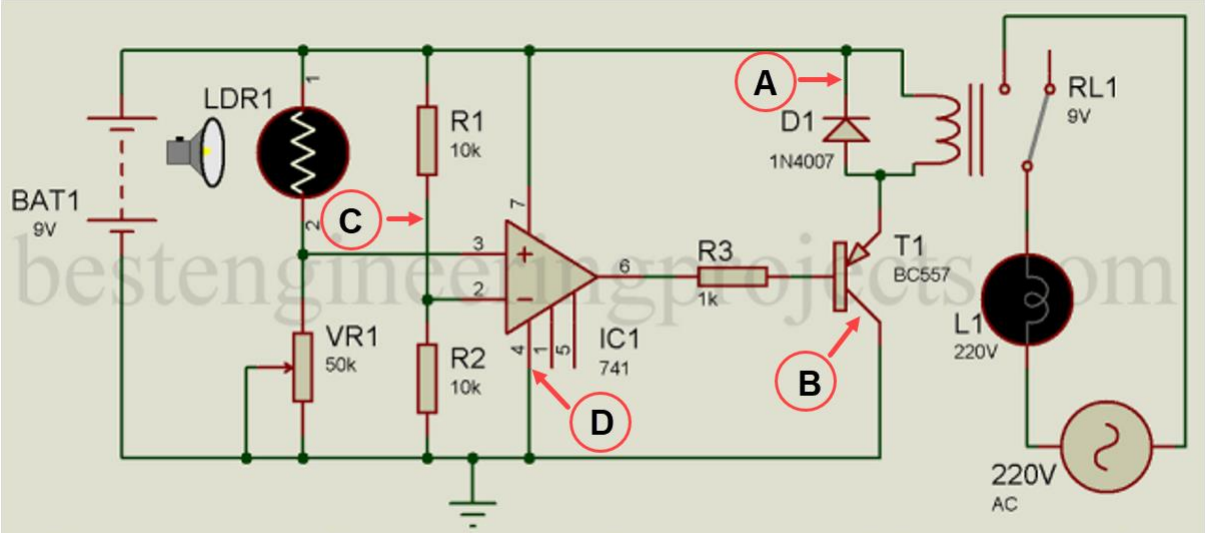


Figure 1: Light Sensor Switch Circuit using LDR and 741 IC

Source: https://bestengineeringprojects.com/light-sensor-switch-circuit-using-ldr-and-741-ic/

The student made several voltage measurements on the constructed circuit at points as shown above. Note: ALL measurements are relative to the earth.

On the table below, some **possible** measurements are shown. For each of the measurements state whether it likely indicates a fault and, if so, what that fault might be.

/ 4

Point	Voltage reading (volts)	Fault? Y/N	Likely problem
A	0		
B	0.7		
C	3		
D	0		

Spare diagram used (✓) ☐

Total Q5

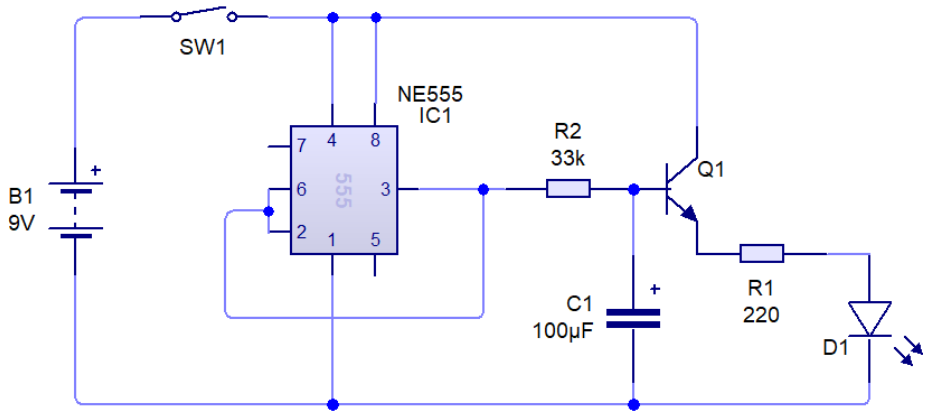
/ 9

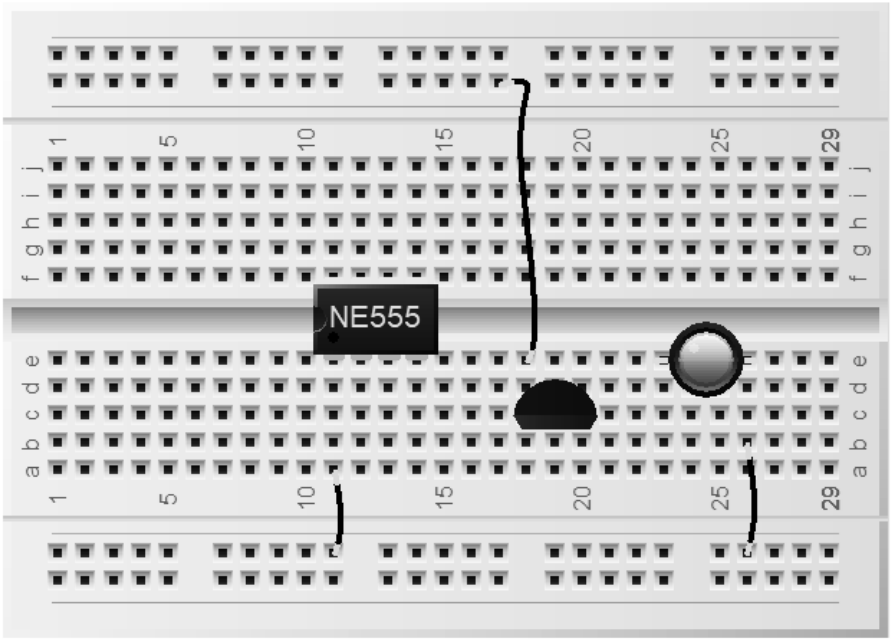
Section A continues

Marker use

Question 6

A student is testing this circuit on a solderless breadboard. The 555 IC, the transistor, the LED and three connecting leads have already been inserted on the breadboard.





Spare diagram used (✓)

☐

Complete the insertion of ALL the components and connecting wires. Ensure that the components are clearly identifiable.

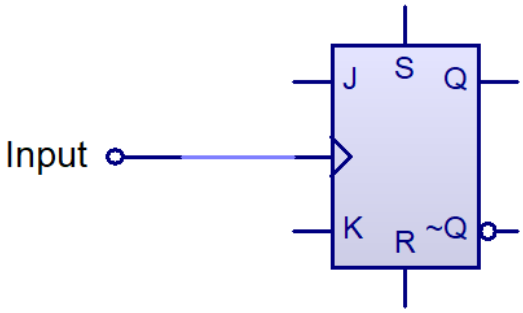
7

Total Q6

7

Spare Diagrams

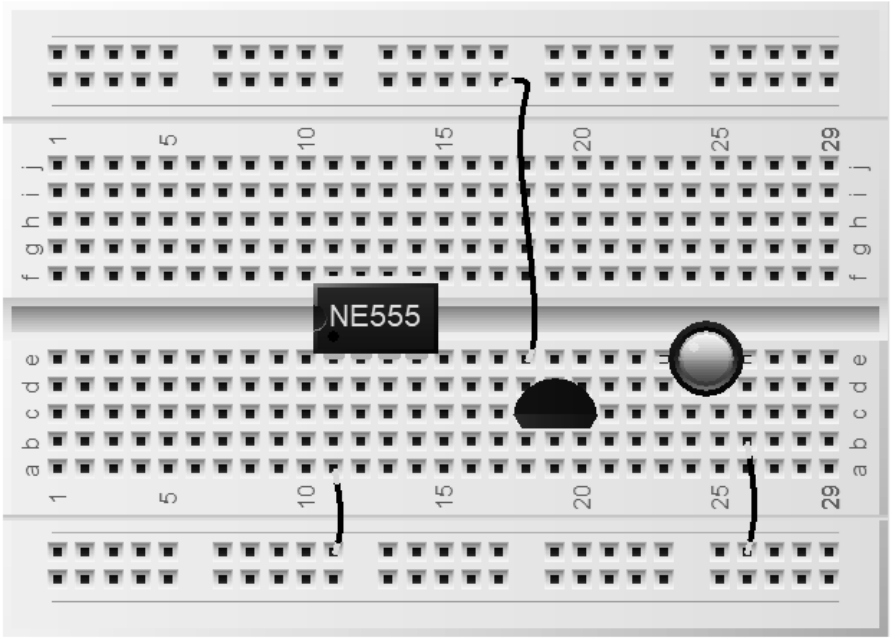
Question 4 b)



Question 5 c)

Point	Voltage Reading (volts)	Fault? Y/N	Likely problem
A	0		
B	0.7		
C	3		
D	0		

Question 6



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End of Section A

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External Assessment 2021

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ELECTRONICS

ELT315114

Section B

Pages	16
Questions	7
Information Sheets	1

Suggested working time: 45 minutes

Instructions

- Attempt **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of the exam booklet. Indicate in the box provided if you have used the spare diagrams.
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  - Show your working in answers to numerical questions.
- All answers must be written in **English**.
- You **must** make sure your answers address:

  Criterion 4 apply knowledge and understanding of digital and analogue circuits and their components.

Marker use	
C4	45

Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Section A	6	6	45 minutes	45
Section B	7	7	45 minutes	45
Section C	6	6	45 minutes	45
Section D	7	7	45 minutes	45
Total	**26**	**26**	**180 minutes (3 hours)**	**180**

Additional Instructions

Marker use

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Section B

- Answer **all** questions in this section.
- This section assesses **Criterion 4**.

Question 7

Spare diagram used (✓) ☐

Marker use

a) Give the colour codes for the following E12 resistors.

2

E12 Resistor Value	Colour code of resistor
270K ±5%	
68R ±1%	

b) Complete this table of capacitor values.

3

pF Code	nF	µF
	3n9	
		0.068
	470	
104		

Spare diagram used (✓) ☐

Total Q7

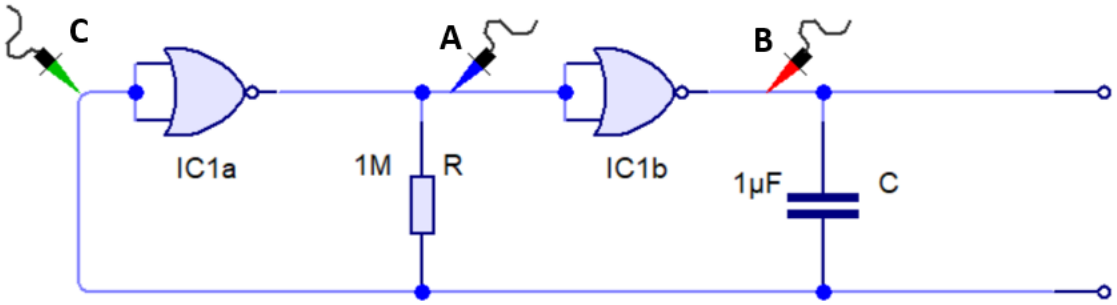
5

Section B continues

Marker use

Question 8

Consider the digital circuit below. **A**, **B** and **C** are voltage probes which connect to an oscilloscope.
Note: the supply voltage connections are not shown.



a) What are the two components IC1a and IC1b and what do the **a** and **b** indicate?

.....

.....

.....

2

b) This circuit is an astable multivibrator. Briefly describe the role of components **R** and **C** in its operation and how they determine the frequency of the astable. Actual calculations are not required.

.....

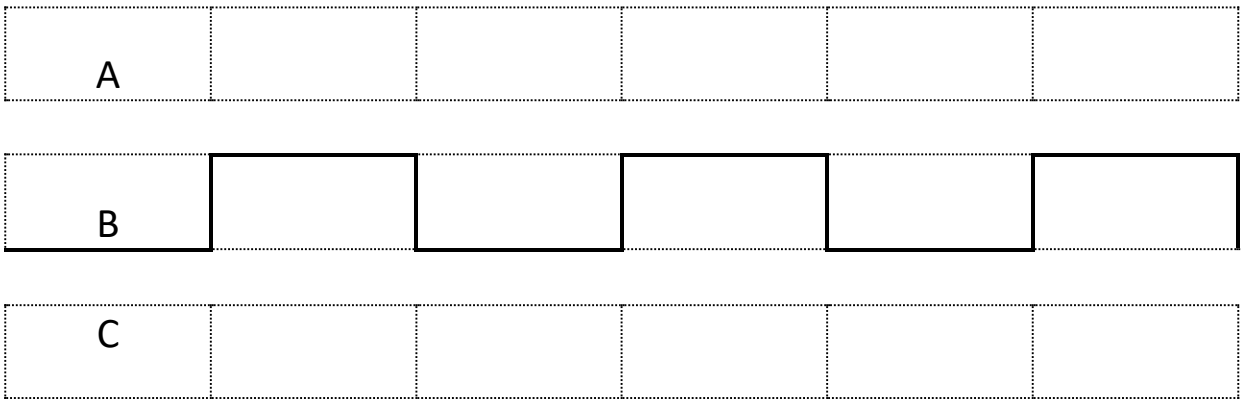
.....

.....

2

c) The voltage pattern at **B** is shown below. In the spaces allotted, sketch the expected voltage patterns at probes **A** and **C**.

3



Spare diagram used (✓) ☐

Total Q8

7

Section B continues

Marker use

Question 9

An “ideal” operational amplifier (op amp) has infinite input impedance, zero output impedance and infinite gain.

a) Explain briefly the benefits of:

i. high input impedance

/ **2**

.....

.....

ii. low output impedance

.....

.....

b) A practical amplifier has negative feedback which reduces the gain considerably. Give **two (2)** benefits of negative feedback in an amplifier.

/ **2**

.....

.....

.....

.....

Total Q9

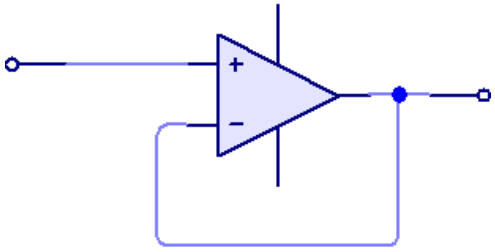
/ **4**

Section B continues

Marker use

Question 10

A voltage follower is an electronic circuit with a voltage gain of 1. The circuit diagram for a voltage follower is shown.



a) What is the benefit of such a circuit, even though its output voltage is the same magnitude as its input?

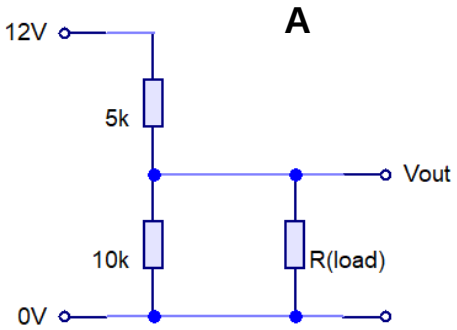
2

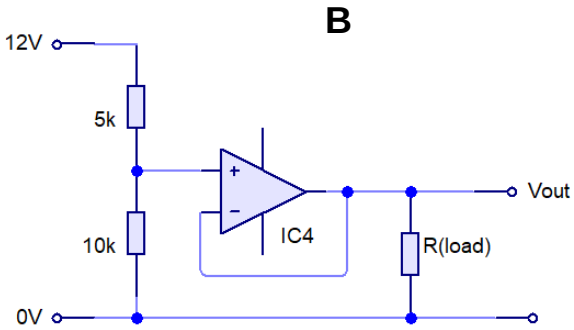
.....

.....

b) In **A**, a voltage divider is driving a load R(load) which varies. In **B**, a voltage follower is added as shown.

2





Explain how the voltage follower improves the operation of the circuit under varying load.

.....

.....

.....

Total Q10

4

Section B continues

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Exam continues over the page

Marker use

Question 11

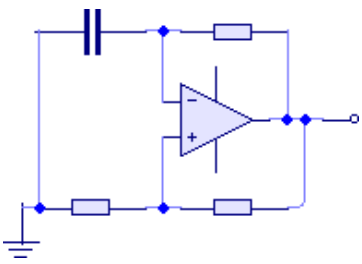
a) State **one (1) advantage** and **one (1) disadvantage** of an active filter as compared to a passive filter. /2

Advantage: .....

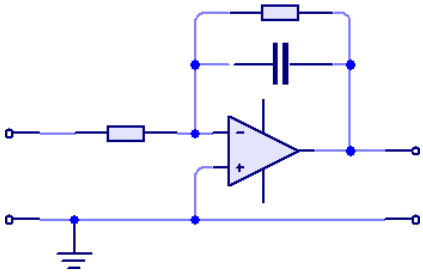
Disadvantage: .....

b) Here are several circuit diagrams based on the op amp. Which of them would be for a high-pass filter? Explain your reasoning. /3

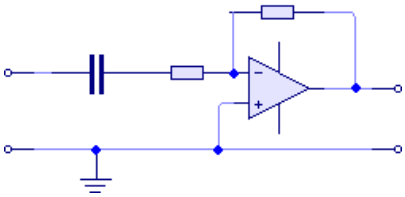
A



B



C



.....

.....

A high-pass filter with a cut-off frequency of 75 Hz has an input signal of 1.5V and variable frequency. At high frequencies, the voltage gain is 2.0 and 500 mW of power is delivered from the filter.

c) Sketch a V_{out} ~ frequency graph for this filter showing all relevant features. /2

Spare diagram used (✓)

☐

Question 11 continues

Marker use

d) At the cut-off frequency, what is:

i. the output power?

.....

1

ii. the output voltage?

.....

1

Total Q11

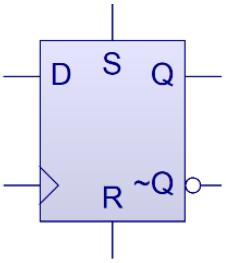
9

Section B continues

Marker use

Question 12

This is the symbol for a D flip-flop.



Spare diagram used (✓)

☐

a) **D** is a **synchronous** input, while **S** is an **asynchronous** input.

Explain the difference between these two types of input. **3**

.....

.....

.....

.....

b) Carefully explain the mode of operation of the clock input. **2**

.....

.....

.....

c) By drawing on the diagram above and adding a suitable logic gate, show how the D flip-flop can be wired to function as a T flip-flop. (Ignore the S and R inputs) **2**

Total Q12 **7**

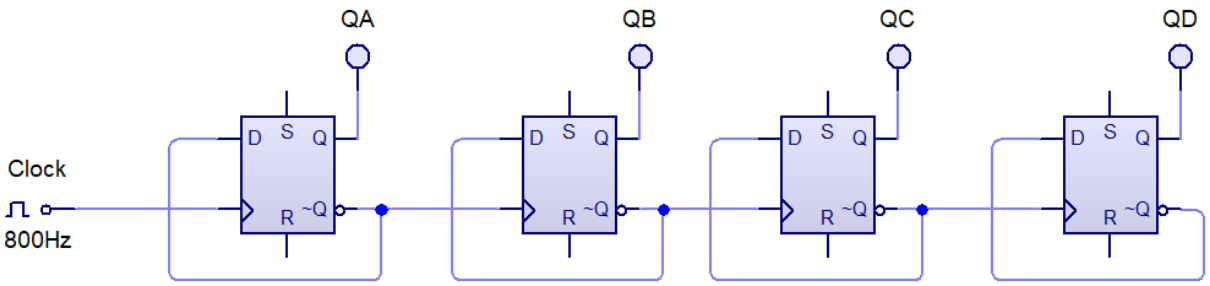
Section B continues

Marker use

Question 13

Spare diagram used (✓) ☐

Shown is a binary ripple up-counter built using D flip-flops.



a) What is meant by the term **ripple counter**? 1

.....

.....

b) How many output states are possible? 1

.....

c) What is the most significant bit (msb)? 1

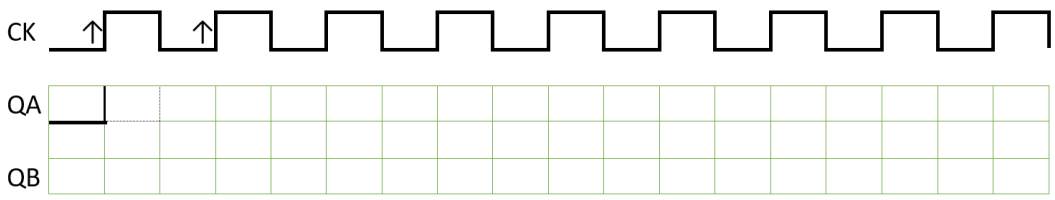
.....

d) With the settings shown, what is the frequency of output QB? 1

.....

e) On the graph below, the clock pulses are shown. Fill out the pulse pattern expected for output QB. 2

Spare diagram used (✓) ☐



f) You wish to use this as a decimal counter. Suggest how this could be achieved. By adding and wiring a suitable logic gate, show how this counter could be appropriately modified. 3

.....

.....

.....

Total Q13 9

Spare Diagrams

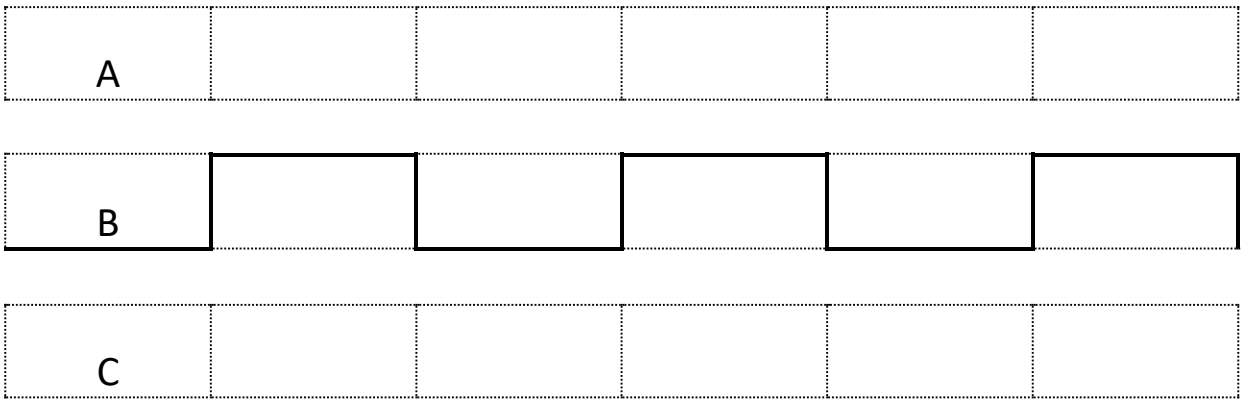
Question 7 a)

E12 Resistor Value	Colour code of resistor
270K ±5%	
68R ±1%	

Questions 7 b)

pF Code	nF	µF
	3n9	
		0.068
	470	
104		

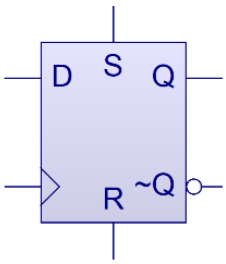
Question 8 c)



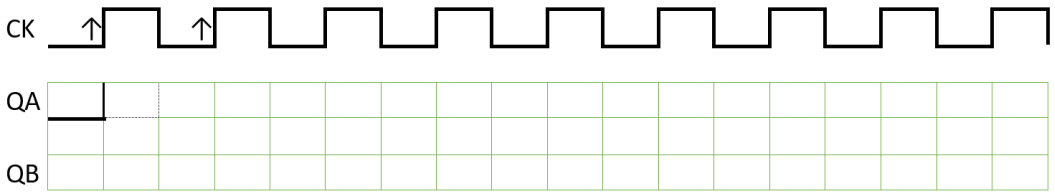
Question 11 c)

Spare Diagrams

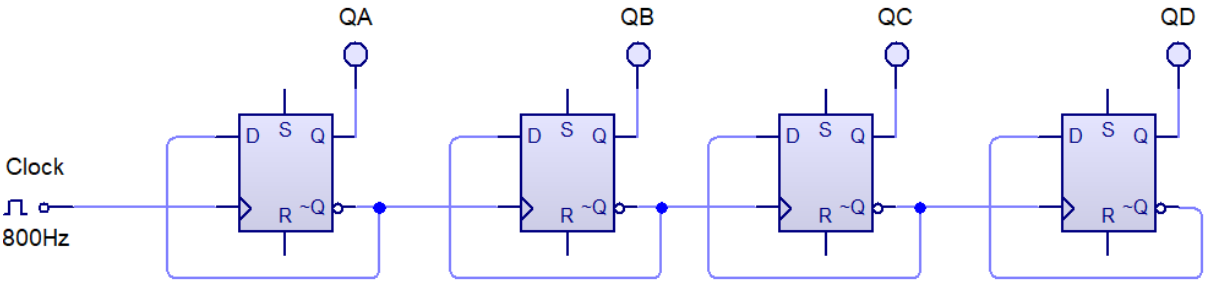
Question 12 c)



Question 13 e)



Question 13 f)



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End of Section B

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External Assessment 2021

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ELECTRONICS

ELT315114

Section C

Pages	20
Questions	6
Information Sheets	1

Suggested working time: 45 minutes

Instructions

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  - Show your working in answers to numerical questions.
- All answers must be written in **English**.
- You **must** make sure your answers address:
  - Criterion 5 apply knowledge of digital and analogue systems in describing the function and operation of components and circuits.

Marker use	
C5	45

Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Section A	6	6	45 minutes	45
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Section C	6	6	45 minutes	45
Section D	7	7	45 minutes	45
Total	**26**	**26**	**180 minutes (3 hours)**	**180**

Additional Instructions

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Section C

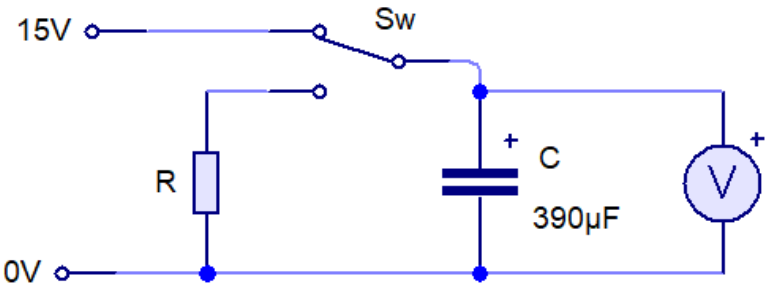
- Answer **all** questions in this section.
- This section assesses **Criterion 5.**

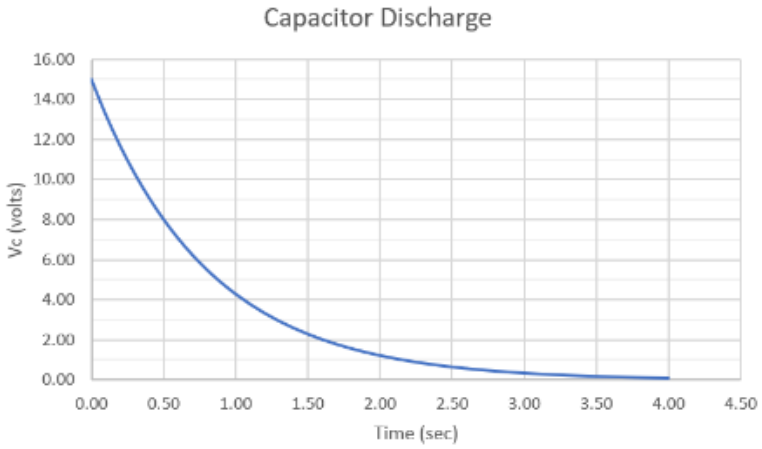
Question 14

Marker use

Shown below is an RC combination and a discharge curve for this circuit. The capacitor was initially charged at t = 0, the switch was moved downwards.

Spare diagram used (✓) ☐





a) Determine the approximate time constant for this circuit, using the graph or other means. Show this clearly on the graph. / 2

.....

b) The value of R is now **doubled**.

i. What is the new time constant? / 1

.....

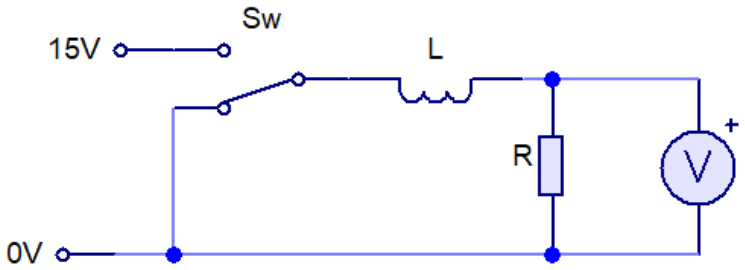
ii. On the graph above, carefully sketch the new discharge curve. / 2

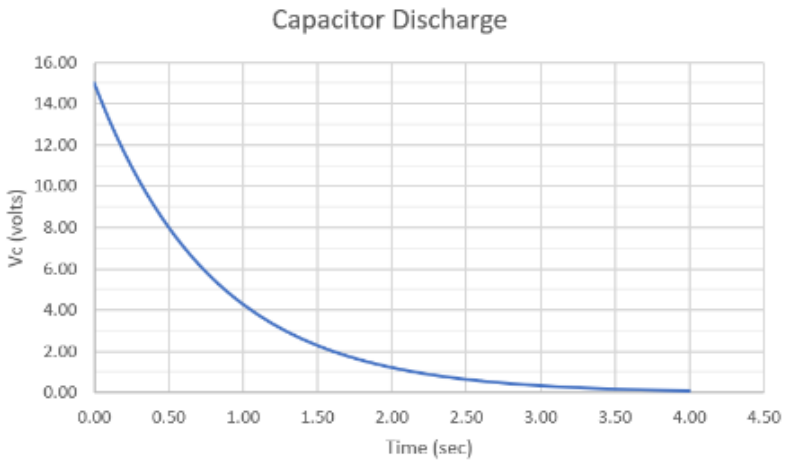
Question 14 continues

Marker use

2

c) An RL conductor combination is then connected as shown. It has the same time constant as the original RC combination. The switch is initially in the **down** position and V = 0. At t = 0, the switch is moved **upwards**. The graph below shows the original RC curve. On the same axes, carefully sketch the voltage curve after the switch is moved up.





Spare diagram used (✓)

☐

Total Q14

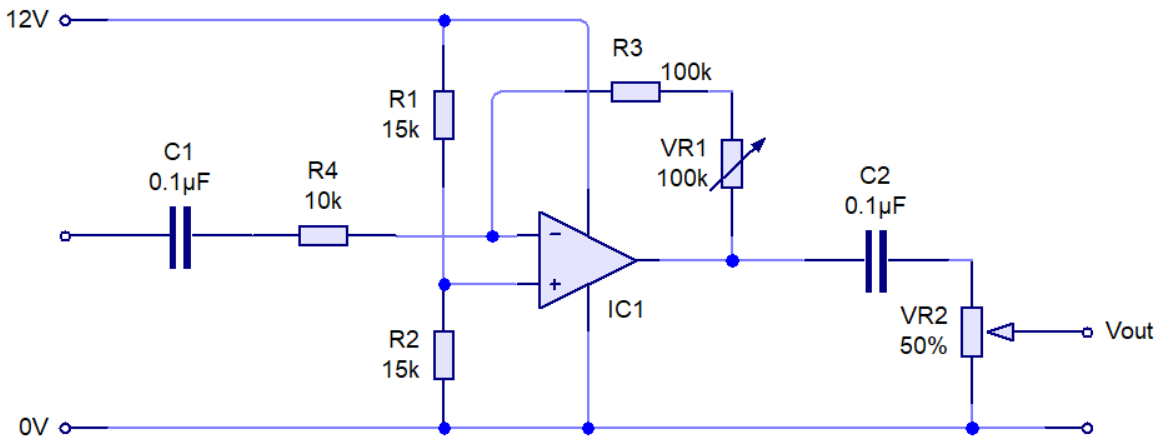
7

Section C continues

Section C continued

Question 15

This is a simple pre-amplifier circuit designed to run off a single voltage.



a) What is **one (1) advantage** and **one (1) disadvantage** of running an op amp from a single-voltage supply? / **2**

Advantage: .....

.....

Disadvantage: .....

.....

b) What is the function of capacitors C1 and C2? / **2**

.....

.....

c) What is the purpose of the resistors R1 and R2? / **2**

.....

d) Calculate the gain of this pre-amplifier when VR1 is set at mid-value. / **1**

.....

Total Q15 / **7**

Section C continues

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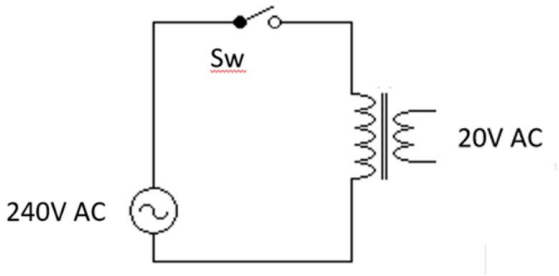
Exam continues over the page

Section C continued

Question 16

Shown is a step-down transformer for a power supply.



a) What is the transformer step-down ratio and hence the winding ratio N_P:N_S?

1

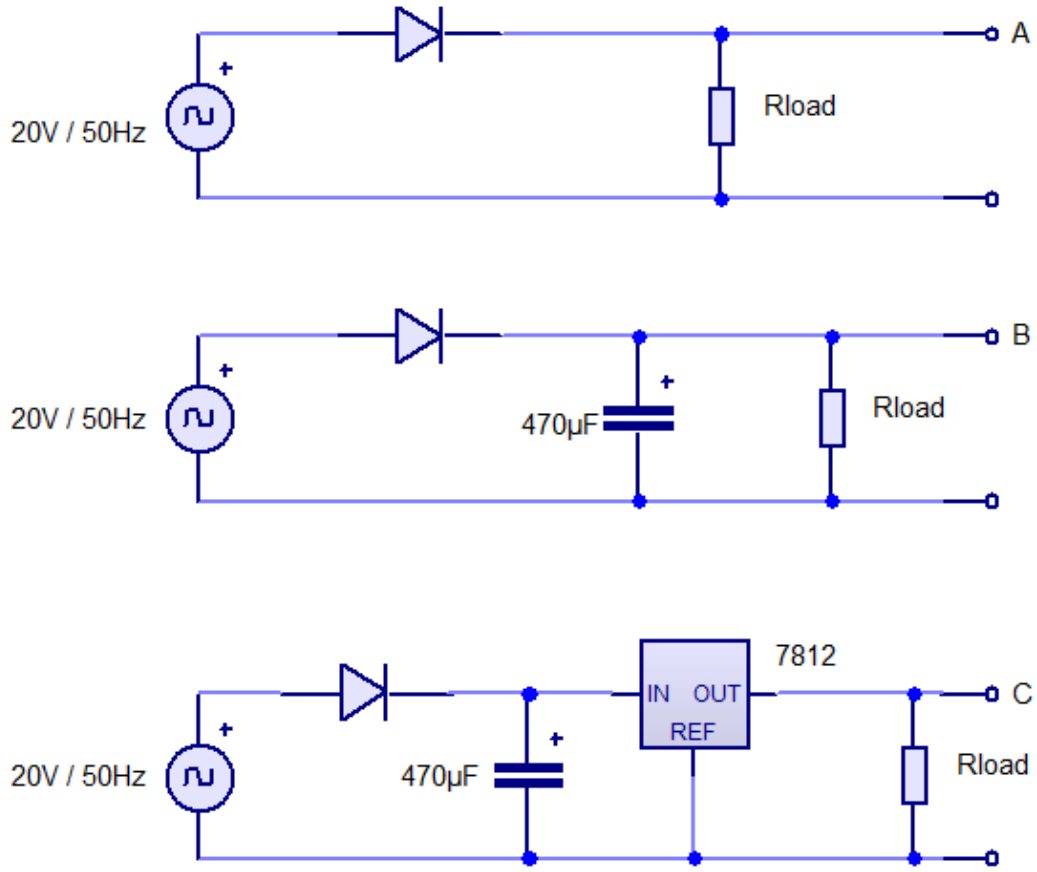
.....

.....

Question 16 continues

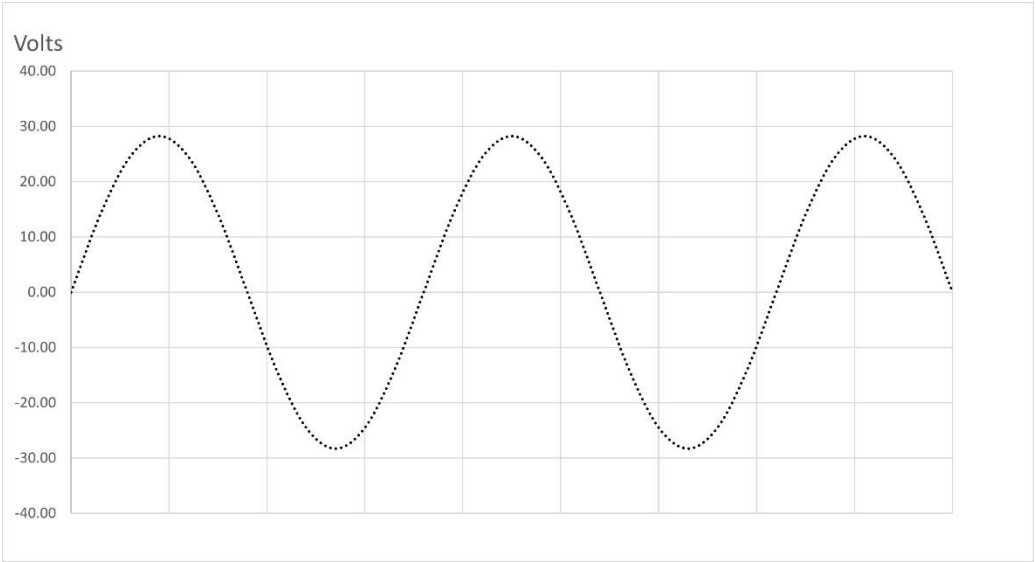
Marker use

b) The 20V AC output from the transformer is then fed into three different circuits as shown below. Note: the 7812 is a 12V voltage regulator.



On the axes below, sketch clearly and accurately the expected signals at each point **A**, **B** and **C**. Label each curve. The 20V input signal is shown.

4



Spare diagram used (✓) ☐

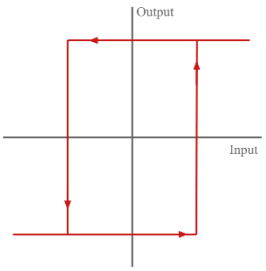
Total Q16

5

Marker use

Question 17

a) A circuit produces the following Output ~ Input graph.

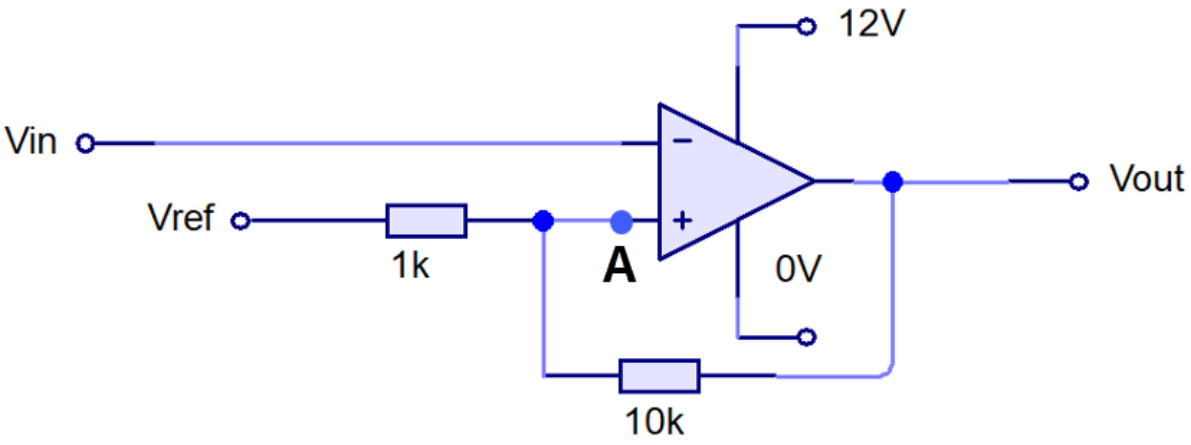


What circuit property does this graph illustrate?

.....

1

A student constructed the following test circuit.



b) What is the function of this circuit?

.....

1

c) What type of feedback is employed in the design?

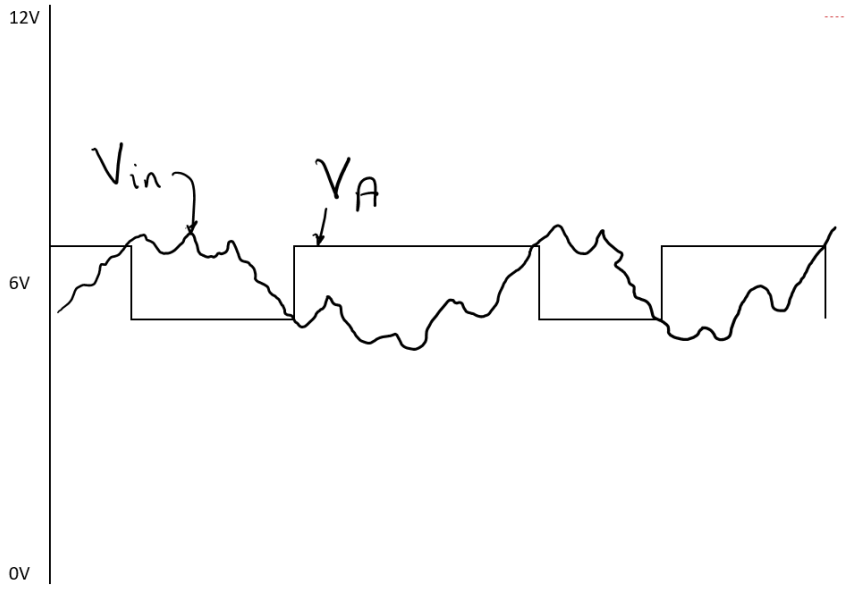
.....

1

Question 17 continues

Question 17 continued

V_{ref} is set to 6V and V_{in} is then varied as shown on the graph of V ~ t below. The voltage at Point **A** is also shown on the graph.



Spare diagram used (✓)

☐

d) On the graph show and label the expected waveform for V_{out}. **2**

e) In what practical setting might this circuit be used and why is it useful? **2**

.....

.....

.....

.....

Total Q17 **7**

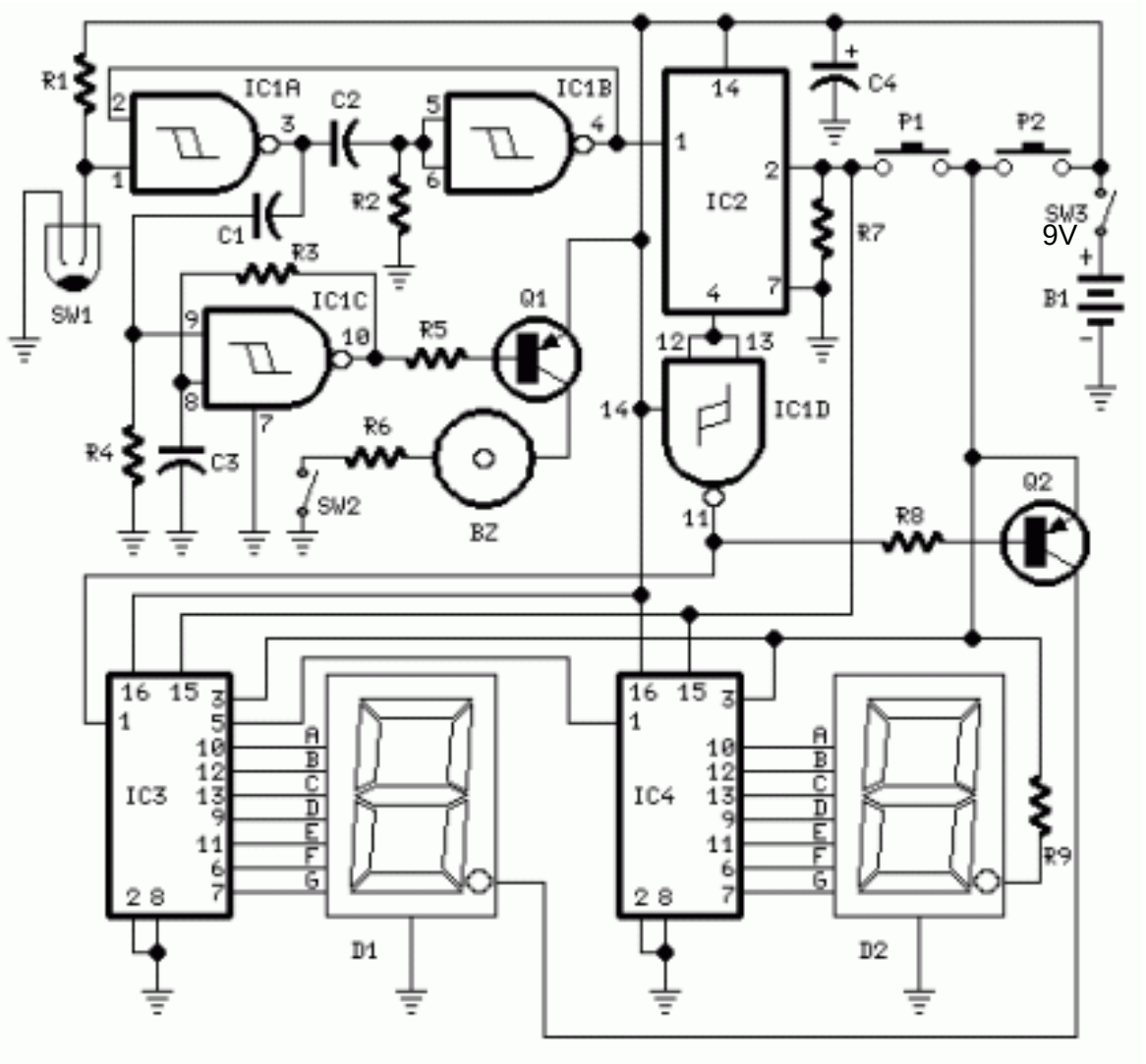
Section C continues

Section C continued

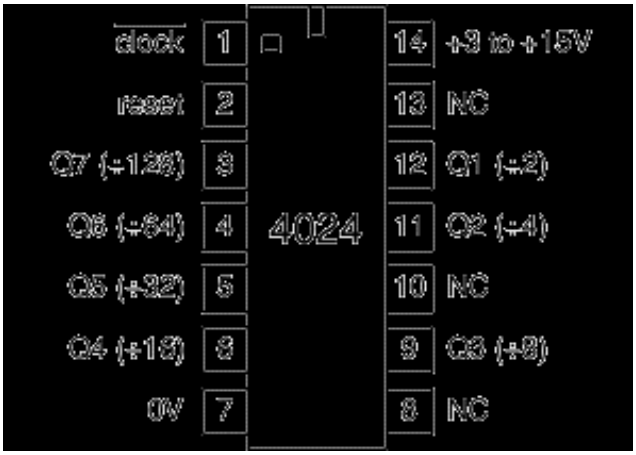
Question 18

This is a proposed design for a simple step-counter. The battery powers the system when SW3 is closed. With each step the motion switch SW1 closes, triggering pulses which are counted.

Source: http://www.circuit-finder.com/categories/digital/87/digital-step-km-counter



IC2 is a 4024 7-stage ripple counter.



Question 18 continues

Question 18 continued

a) Are the 7-segment displays common anode or common cathode? Justify your answer.

.....

/2

b) What polarity are the transistors Q1 and Q2?

.....

/1

c) What is the purpose of C4?

.....

/1

d) How does the walker reset the counter?

.....

/1

e) How many steps are required before one pulse is sent to the display?

.....

/1

f) How would IC1 be described?

.....

.....

/1

g) Consider IC1A.

i. When the person is motionless, what is the voltage at Pin 1?

.....

/1

ii. What is the function of the combination of IC1A and IC1B?
[Hint: the motion switch may close multiple times for each step.]

.....

/1

h) What is a possible purpose of IC1D?

.....

.....

/1

i) In what mode is IC1C operating and how is it interacting with Q1 and BZ?

.....

.....

/2

Total Q18

/12

Section C continues

Section C continues

Question 19

HiFi speakers have different frequencies at which they operate most effectively. A crossover network directs different frequencies to the most appropriate speaker. The crossover circuit can be either passive or active.

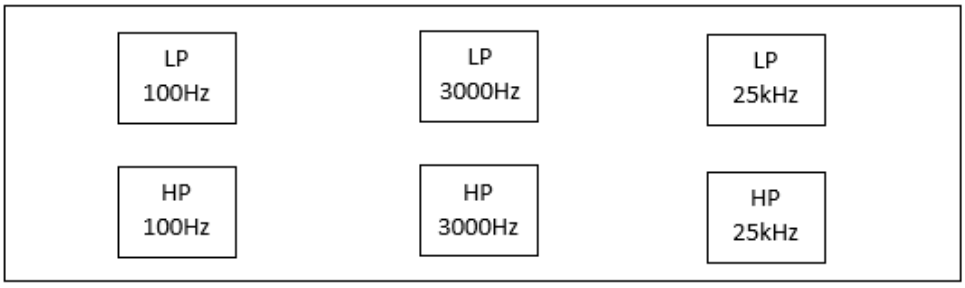
a) A simple crossover system can have a high-pass filter, a band pass, and a low-pass filter.

Sketch here the shape of the Gain ~ freq graphs for each of these. Identify each graph but no other annotations nor calculations are required.

/ 3

Spare diagram used (✓) ☐

b) A system is to have tweeters (HF speakers), woofers (LF) and mid-range speakers. The crossover system is be designed using only high-pass and low-pass active filters. Those available are shown here with their cut-off frequencies.



Use some or all of these to complete a block diagram of a suitable crossover system

Spare diagram used (✓) ☐

/ 3

c) It is also important to block DC from the speakers. Suggest a passive component which could achieve this.

.....

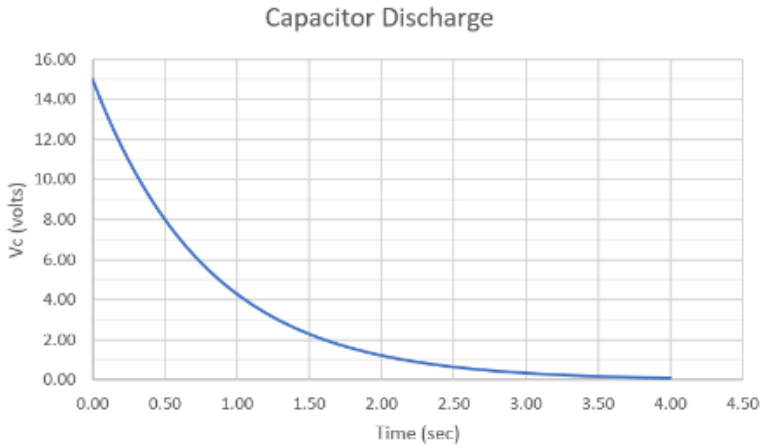
/ 1

Total Q19

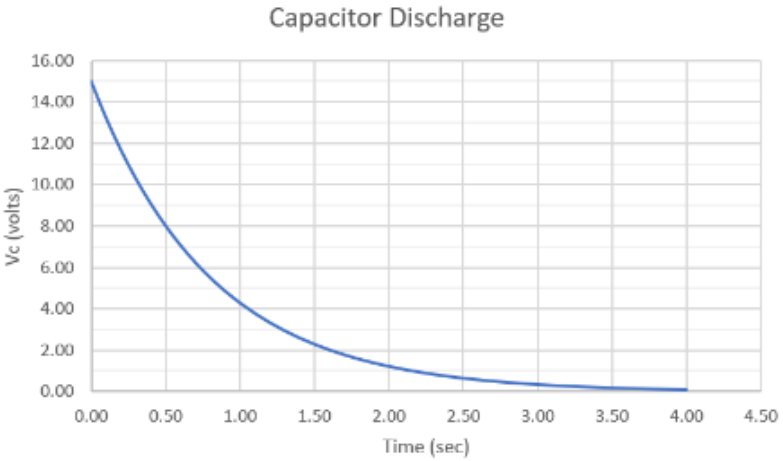
/ 7

Spare Diagrams

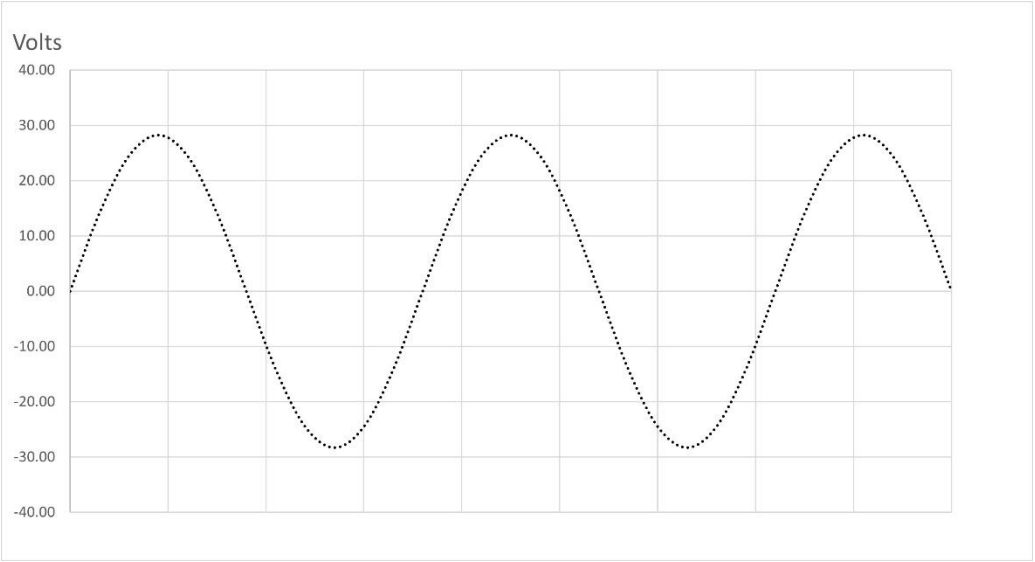
Question 14 b) ii.



Question 14 c)

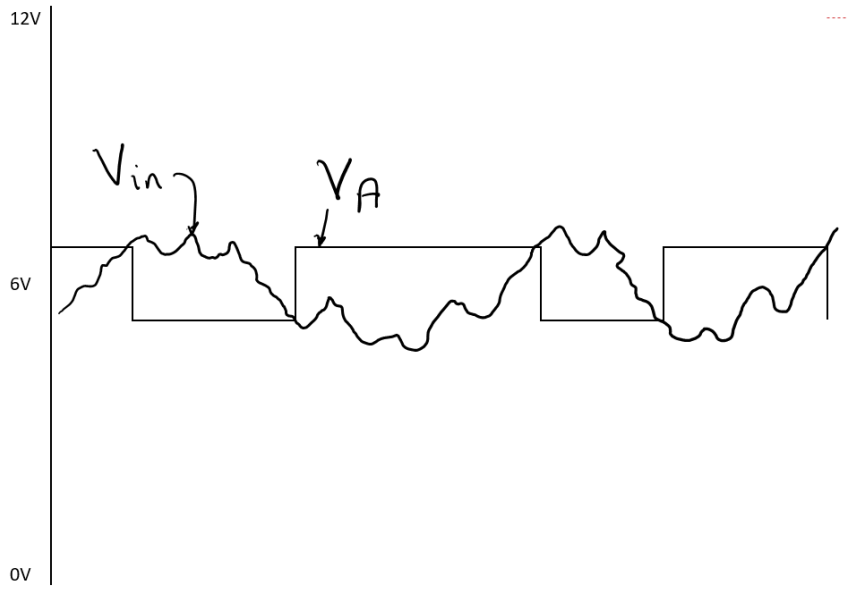


Question 16



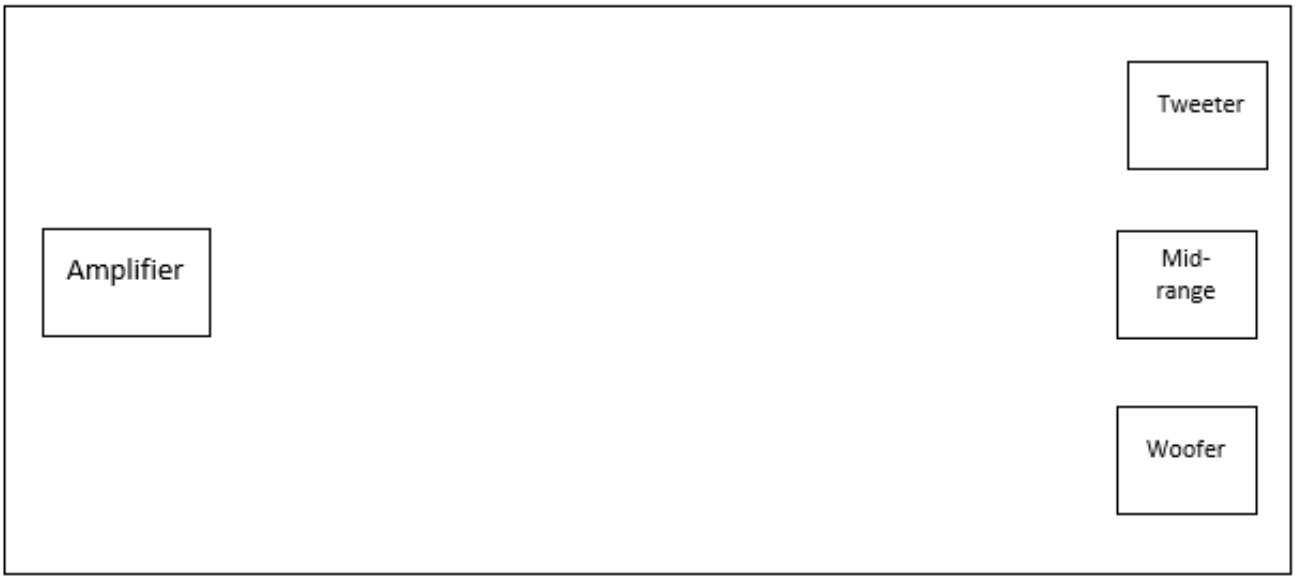
Spare Diagrams

Question 17 d)



Question 19 a)

Question 19 b)



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End of Section C

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ELECTRONICS

ELT315114

Section D

Pages	15
Questions	7
Information Sheets	1

Suggested working time: 45 minutes

Instructions

- Attempt **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of the exam booklet. Indicate in the box provided if you have used the spare diagrams.
- A TASC approved scientific calculator can be used throughout the exam.
  - Show your working in answers to numerical questions.
- All answers must be written in **English**.
- You **must** make sure your answers address:
  - Criterion 7 apply knowledge and understanding of mathematical concepts in electronics.

Marker use	
C7	45

Guide to Exam Structure

	Questions available	How many questions to answer	Suggested working time	Marks available
Section A	6	6	45 minutes	45
Section B	7	7	45 minutes	45
Section C	6	6	45 minutes	45
Section D	7	7	45 minutes	45
Total	**26**	**26**	**180 minutes (3 hours)**	**180**

Additional Instructions

When you are asked to “show that”:

- You should calculate your own answer to three significant figures and use this subsequently.
- If you are unable to determine the required value, you should use the value given by the examiner in subsequent questions.

A spare set of diagrams has been provided at the back of the exam paper for you to use if required.

If you use the spare diagrams, you **must** indicate you have done so by ticking the box provided next to each original diagram.

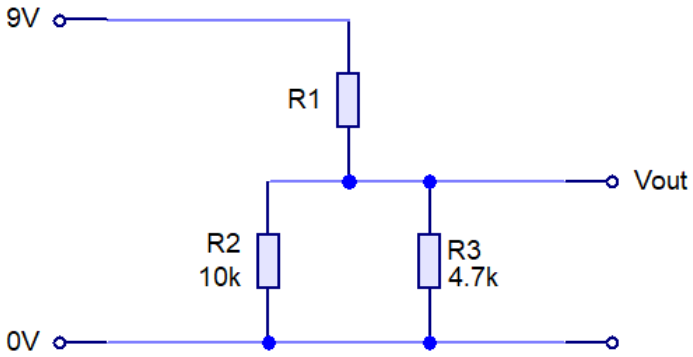
Section D

- Answer **all** questions in this section.
- This section assesses **Criterion 7**.

Question 20

Marker use

Consider the following resistor array.



a) Show that the resistance of the parallel combination is approximately 3K2.

.....

.....

3

b) If V_{out} is to be 2.5V, determine the nearest E12 value of R1.

.....

.....

.....

3

Total Q20

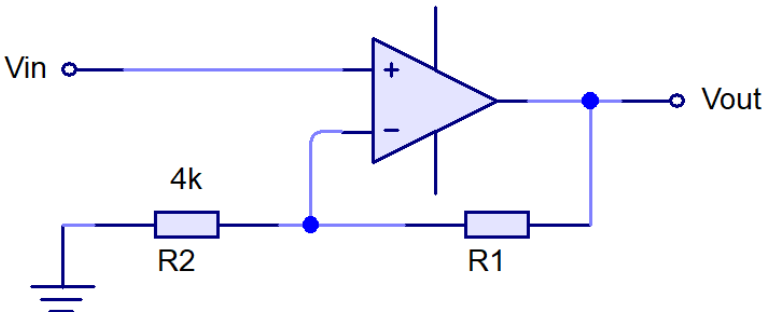
6

Section D continues

Section D continued

Question 21

This amplifier circuit has a voltage gain of +5. A steady AC signal is to be fed into the input.



a) Determine the value of R1.

3

.....

.....

.....

b) If the input voltage has an RMS value of 500 mV, calculate the peak value of the output signal.

3

.....

.....

.....

.....

Total Q21

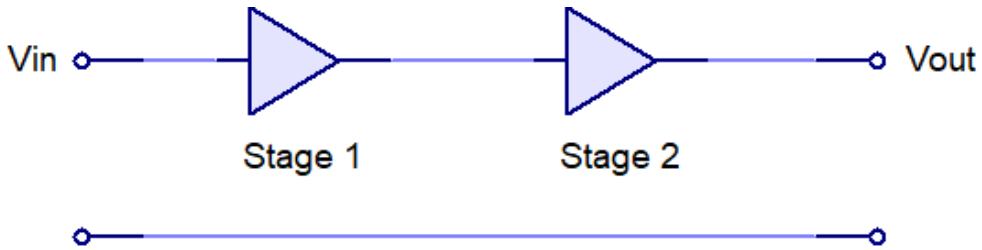
6

Section D continues

Section D continued

Question 22

This two-stage amplifier has an input voltage of 2.0 mV and produces an output voltage of 8.5 V. The input and output impedance for each stage of the amplifier is 1000 Ω.



a) Show that the overall power gain of this amplifier is approximately 73 dB.

.....

.....

.....

.....

2

b) Calculate the power delivered to a 1000 ohm load.

.....

.....

2

c) If the power input into Stage 2 is 36 μW, calculate the power gain, in dB, of Stage 2.

.....

.....

2

Total Q22

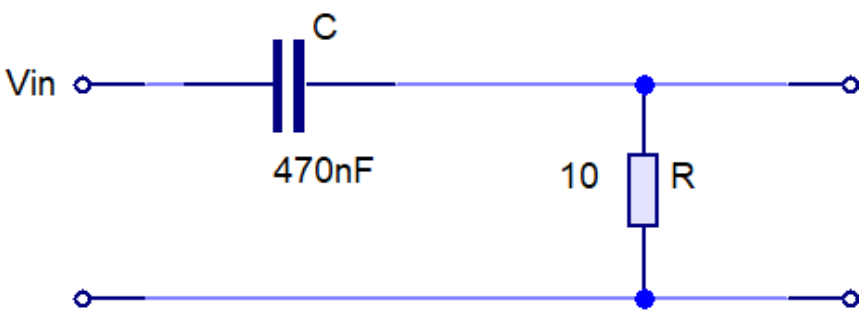
6

Section D continues

Marker use

Question 23

This is an RC filter circuit. The input is a 12V RMS sinusoidal signal.



a) Calculate the frequency at which the reactance of the capacitor equals the resistance of the resistor. 2

.....

.....

b) Show that the total impedance at that frequency is approximately 14 ohms. 2

.....

.....

.....

c) Calculate V_{out} at this frequency. 3

.....

.....

.....

d) Explain why V_{out} does not equal ½ V_{in} at this frequency. 2

.....

.....

Total Q23 9

Section D continues

Section D continued

Question 24

You must show your working for this question.

a) Convert the binary number 10 1011_2 to:

i. octal

.....

.....

1

ii. hexadecimal

.....

.....

1

iii. decimal

.....

.....

1

b) This number, 10 1011_2, is to be added to the number 1101_2. Use binary addition to add the numbers and show that the answer (in decimal value) is correct.

.....

.....

.....

.....

3

Total Q24

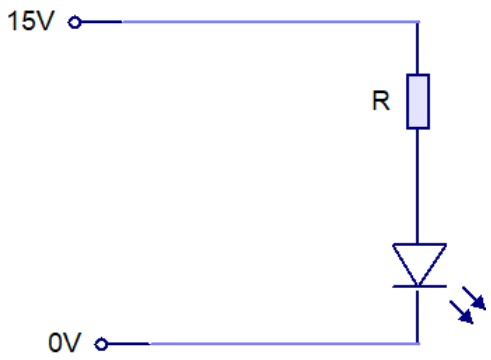
6

Section D continues

Section D continued

Question 25

A technician is connecting a green LED to a 15V supply. The LED has a forward voltage drop of 2.8V and a maximum current rating of 30 mA.



a) When the LED is glowing, what is the voltage drop across the resistor?

.....

1

b) Determine the minimum required value of the dropper resistor and hence its minimum E12 value.

.....

.....

.....

3

c) Calculate the power dissipation in this E12 resistor.

.....

.....

2

Total Q25

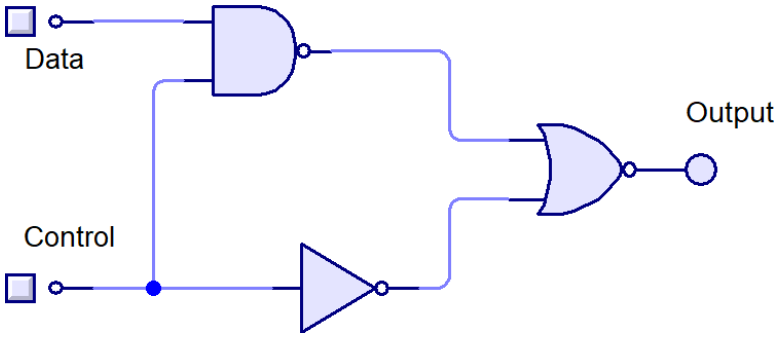
6

Section D continues

Section D continued

Question 26

This logic circuit functions as a simple control of data flow.



a) Write a Boolean expression for this circuit.

.....

1

b) Complete the **Output** column on the logic table for this circuit.

Spare diagram used (✓) ☐

2

D	C				O
Data	**Control**				**Output**
0	0				
0	1				
1	0				
1	1				

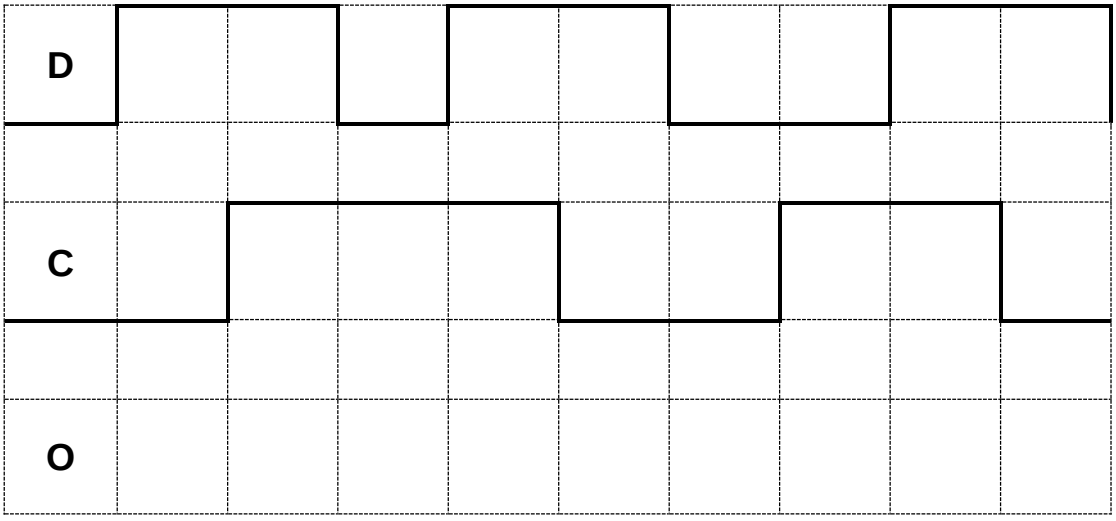
c) Using the logic table, write a simplified Boolean expression for this circuit.

1

.....

d) For the input waveforms shown below, complete the expected output in the grid below.

2



Spare diagram used (✓) ☐

Total Q26

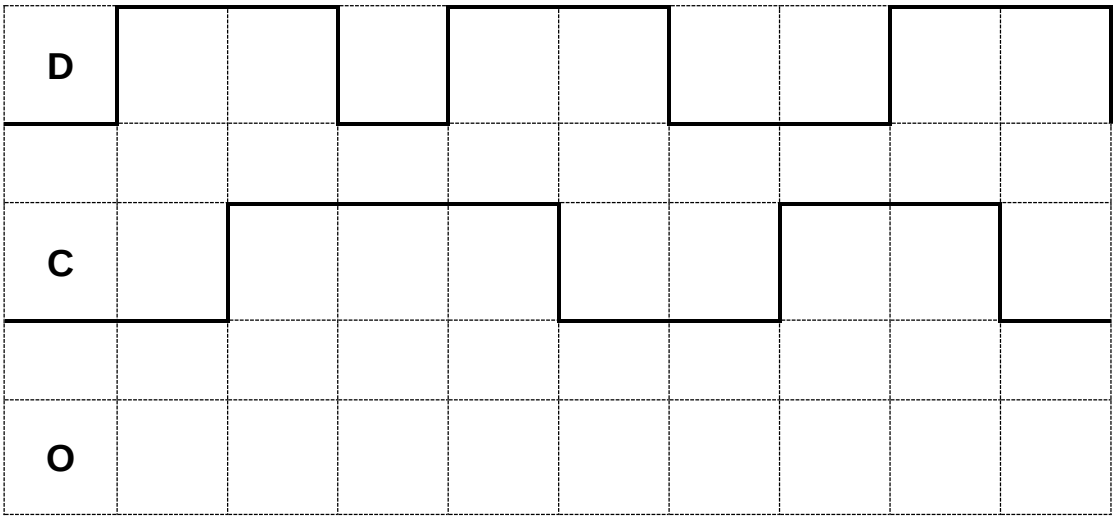
6

Spare Diagrams

Question 26 b)

D	C				O
Data	**Control**				**Output**
0	0				
0	1				
1	0				
1	1				

Question 26 d)



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End of Section D

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