Name: ____________________________________ **Class:** _______

Targets:

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Study Tips - The following summary covers the knowledge and understanding part of the Electronics units. You need to know this material thoroughly - you will be tested on it in the Prelim and Final SQA Exam and this material is your basic starting point for tackling problem solving questions.

Notes - In order to study effectively, it is best to **make your own notes** in some form that allows for self-testing.

How? – Use a Note-taking System
Your objective is to capture on paper the **main facts** and **ideas** so that you can study them thoroughly. Divide an A4 page into a narrow (5 cm) left hand "recall" column and a wide right hand "notes" column. You may also want to leave a margin at the bottom of the page where you can write a one or two sentence summary of all the information contained on that page. The wide column on the right is where you write the notes. Don't crowd them - leave plenty of white space. After completing your notes, read them over and make sure you clearly understand each fact and idea, then, in the narrow column on the left, write a brief, meaningful question (or note down key terms, concepts or formulae).
An alternative is to use a spider diagram (or "Mind Map") as notes or to use "flash cards" with questions on one side and answers and examples on the other. Flash cards are very portable so they are especially useful for testing yourself during spare moments on a bus etc.

It is important to use a method that gets **you** to ask **questions**. The process of asking questions helps you focus on the essential material and helps you understand things more clearly.

How do I remember it all? - Recitation is the most powerful method known for embedding facts and ideas into your memory.
E.g. if you have written notes as suggested:
Cover the notes in the wide column exposing only the questions in the narrow column.
Recite the answers in your own words. Recite over and over again until you get the right answer

What else can I do? - Practice!
A critical component of physics is solving problems. Work at as many problems as possible, especially exam style questions. **Attempt all the questions in this booklet.**

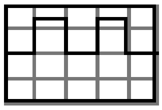
Section 1 Overview

Electrical signals are either **digital** or **analogue**.

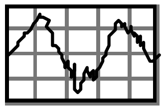
Digital signals only have particular values, usually only two: ON (or 1 or high) and OFF (or 0 or low). Analogue signals can have a continuous series of values.

On an oscilloscope

a digital signal would have a waveform like this:



An analogue signal would have a waveform like this:

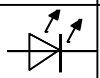
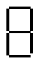
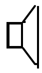
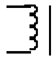
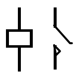


Electronic **systems** consist of three parts: **input, process** and **output**.

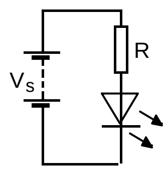
1. Electronic systems consist of three parts: input, output and which other part ?
2. Give an example of an analogue device.
3. Explain the difference between analogue and digital.
4. Draw the pattern seen on an oscilloscope when a digital signal is displayed.
5. Draw the pattern seen on an oscilloscope when an analogue signal is displayed.
6. State how a lamp could be either digital or analogue.
7. In a stereo system the CD player is the input, what is the output device ?
8. Give an example of a digital device.
9. What is the missing word: A compact disc player uses ……….. signals.

Section2 Output Devices.

An output device changes electrical energy from the process part into some other form of energy.

output device	symbol	digital or analogue	energy conversion
LED		digital	electrical to light
7-segment display		digital	electrical to light
Bulb		digital or analogue	electrical to light
Motor		analogue	electrical to kinetic
Loudspeaker		analogue	electrical to sound
Solenoid		digital	electrical to kinetic
Relay		digital	electrical to kinetic

An LED (light emitting diode) will light only if connected as shown. A resistor (R) in series with the LED limits the size of the current. Too high a current will destroy the LED.

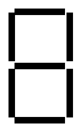


Calculating the value of R.

Example: An LED is used in a circuit with a 5 V supply.
The maximum LED voltage is 2 V and the current is 10 mA.
What value of series resistor is required?

$V_{resistor} = V_{supply} - V_{LED} = 5 - 2 = 3\text{ V}$

$R = \dfrac{V_{resistor}}{I} = \dfrac{3}{0.010} = 300\ \Omega$



7-segment display. Different combinations of seven LEDs can make the numbers 0 to 9. Look at a calculator if you want to find out which LEDs switch on to make the different numbers.

1. What are the missing words :

Device	Analogue or Digital	Energy Changes
Loudspeaker		Electrical to Sound
7 Segment Display		

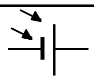
2. LED s normally operate at a voltage of around 2V. What size of current do they usually take ?
3. Why do you need a resistor connected in series with the LED ?
4. Give a suitable output device that we could use as an audible warning when an incubator has become too cold.
5. Draw the symbol for an LED.
6. Indicate on your diagram for question 5 which way the electrons flow.
7. What does LED stand for ?
8. What is a relay?
9. Give a suitable output device we could use in a system to turn a conveyor belt round in a bottling factory.
10. Give a suitable output device for switching on a high current electric motor by using a small current.

Binary numbers. The binary system of counting is used in digital electronics.

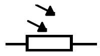
Decimal Number	Binary Number	Decimal Number	Binary Number
0	0000	5	0101
1	0001	6	0110
2	0010	7	0111
3	0011	8	1000
4	0100	9	1001

Section 3 Input Devices.

An input device changes some form of energy into electrical energy so that an electrical signal goes into the process part.

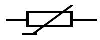
input device	symbol	digital or analogue	energy conversion
thermocouple		analogue	heat to electrical
microphone		analogue	sound to electrical
solar cell		analogue	light to electrical

Other Input Devices:



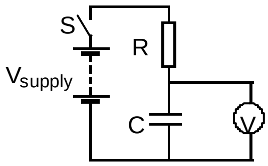
Light dependent resistor (**LDR**). The **resistance** of an LDR **decreases** with **increasing light** intensity.

Thermistor. The **resistance** of a thermistor **decreases** as the **temperature increases**.

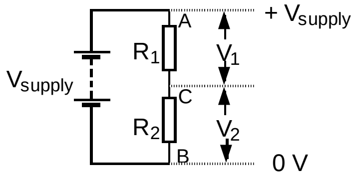


V = IR can be used to calculate the resistance of a thermistor or LDR.

Capacitor. A capacitor stores electrical charge. During charging the voltage across a capacitor increases with time. The time to charge a capacitor depends on the values of the capacitance and the series resistance. The larger the value of C or R, the greater the time it takes to charge C and hence, the more slowly the voltage across the capacitor will rise. The capacitor can be discharged quickly by connecting one side of the capacitor directly to the other. This is often used to **reset** a timing circuit.



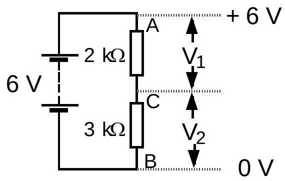
Voltage (or potential) divider.
The voltage measured at point C depends on the values of R1 and R2. The supply voltage is shared across the two resistors. The bigger the resistor, the bigger its share of the voltage.



$$V_1 = V_{supply} \times \frac{R_1}{R_1 + R_2} \quad \textbf{and} \quad V_2 = V_{supply} \times \frac{R_2}{R_1 + R_2}$$

Example: Calculate the voltage across each resistor in the following circuit.

$$V_2 = 6 \times \frac{3}{2 + 3} = 3.6\text{ V}$$



1. What is the energy change that takes place in a solar cell ?

2. Draw the symbol for an LDR.

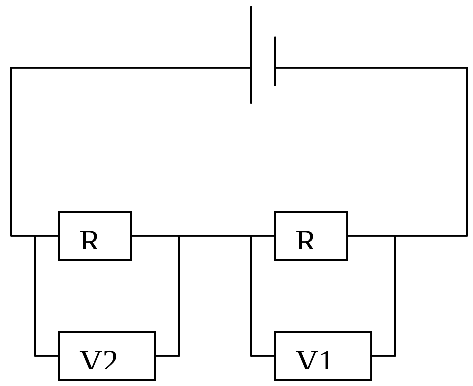
3. What happens to the voltage across a capacitor during the time it is charging ?

4. What is the missing word : The resistance of a thermistor increases as temperature……….

5. The time it takes to charge a capacitor depends on the size or value of the capacitor. What else affects the time to charge ?

6. Draw a circuit which can be used as a voltage divider.

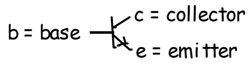
7. State the relationship between R1, R2, V1 and V2 in the circuit below.



8. Sketch a graph of the voltage across a capacitor during the time it is charging.
9. What is the main energy change in a thermistor ?

Section 4 Digital Processes.

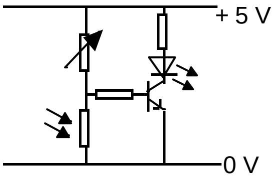
The symbol for a **transistor** is:



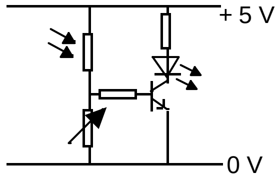
A transistor can be used as a voltage operated switch.
If the voltage at the base is **low** then the transistor does not conduct i.e. it is **off**. If the voltage at the base is **high** then the transistor conducts i.e. it is **on**.

Some transistor switching circuits.

Light Controlled.



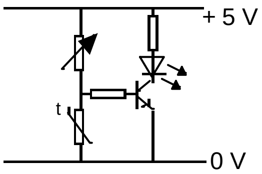
When the LDR is covered, its **resistance increases** so the **voltage** across the LDR **increases** and the transistor switches **on**.



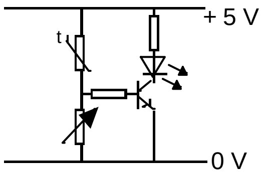
When the LDR is covered, its **resistance increases** so the **voltage** across it **increases** and the voltage across the variable resistor **decreases** and the transistor switches **off**.

INPUT = LDR
PROCESS = TRANSISTOR
OUTPUT = LED

Temperature Controlled.



When the temperature of the thermistor **decreases**, its **resistance increases** so the **voltage** across the thermistor **increases** and the transistor switches **on**.

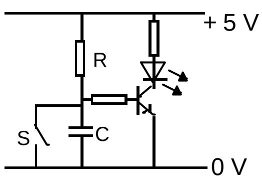


When the temperature of the thermistor **decreases**, its **resistance increases** so the **voltage** across it **increases** and the voltage across the variable resistor **decreases** and the transistor switches **off**.

Note:
The variable resistor has to be set at a value that will allow a change in the resistance of the LDR or thermistor to 'trigger' the transistor.

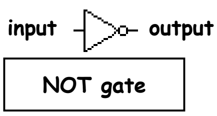
Time delay switch.

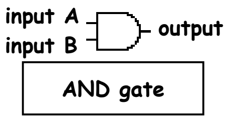
When the switch is closed, the capacitor is discharged, so the voltage across it is zero and the transistor is switched off. When the switch is opened, the capacitor charges and the voltage across the capacitor

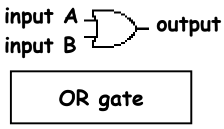


increases. When the voltage is high enough it switches on the transistor. (A large C or R will give a longer time delay).

Logic gates.
Logic gates may have one or more inputs. A truth table shows the outputs for all possible input conditions. **High** voltage = logic '**1**'. **Low** voltage = logic '**0**'.







Truth Tables:

input	output
0	1
1	0

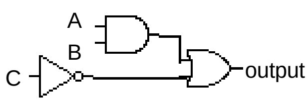
input		output
A	B	
0	0	0
0	1	0
1	0	0
1	1	1

input		output
A	B	
0	0	0
0	1	1
1	0	1
1	1	1

Digital logic gates can be combined with input and output devices to provide solutions to different problems. For example, a warning buzzer can be made to switch on when it is cold AND dark.

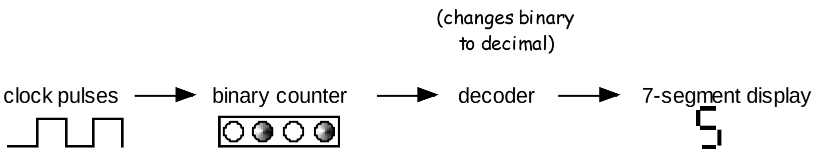
A truth table can be made for a combinational logic circuit. To do this you need to put in all the possible combinations of inputs, then work out the outputs.

Example: The truth table for the circuit below is shown on the right.

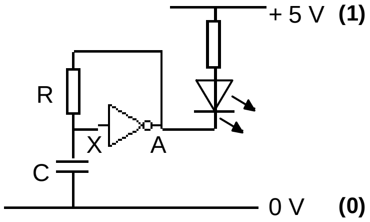


A	B	C	output
0	0	0	1
0	0	1	0
0	1	0	1
0	1	1	0
1	0	0	1
1	0	1	0
1	1	0	1
1	1	1	1

Clock pulses
A digital circuit can produce a series of clock pulses. A counter circuit can count these digital pulses. The output of the counter circuit is in binary. The output of a binary counter can be converted to decimal. A digital watch is an example of a device containing a counter circuit.



Clock pulse generator.



At the start the capacitor is uncharged.
The **voltage** at **X** is **0**.
The **logic level** at **A** will be **1**.
The LED will be **off**.
The **capacitor** will now **charge** up through the resistor R.
The voltage at **X** will **increase** until it is at logic level **1**.
The **output** at A will switch from 1 to **0**.
The LED will be **on**.
The capacitor will now **discharge** through R.
The voltage at X will decrease until it is at logic level 0.
The whole process will now repeat itself. The LED will flash on and off.
The **frequency** of the clock can be changed by changing the values of C or R.

Increasing the value of C or R will give lower frequencies since the capacitor now takes longer to charge and discharge.

1. Draw the symbol for an npn transistor, labelling the terminals.

2. Explain how a transistor operates.

3. Draw the symbol for an AND gate.

4. Draw the truth table for an OR gate.

5. There are circuits which can count digital pulses. In what form is the output of these counter circuits ?

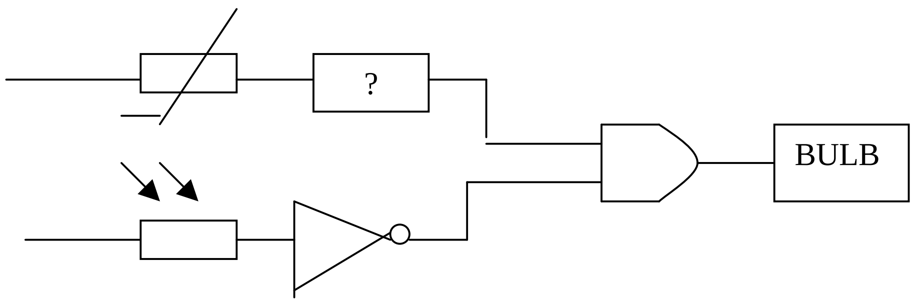
6. The output of a counter circuit can be fed to a seven segment display via a decoder circuit. In what form is the number seen on the seven segment display ?

7. Give an example of a device containing a counter circuit.

8. What is the alternative name for a NOT gate ?

9. Explain how the operation of this gate gives rise to the alternative name.

10. An automatic circuit was designed to switch on a heating bulb in a room when it was cold and dark. Suggest what the missing gate might be.



Section 5 Analogue Processes.

Amplifiers are used in devices such as radios, televisions, intercoms and music centres. The amplifier increases the size of the electrical signal (voltage), e.g. the output signal of an audio amplifier has the same frequency as, but a larger amplitude than, the input signal.

voltage **gain** = $\frac{\text{output voltage}}{\text{input voltage}}$

The power may be calculated from $P = \frac{V^2}{R}$

where V is the voltage and R the resistance of the circuit.

power **gain** = $\frac{\text{output power}}{\text{input power}}$

Note. There is no unit for **gain.**

Example: An amplifier has an output power of 25 W. The input voltage is 15 V and the input resistance is 100 Ω. What is the power gain of the amplifier?

Input power $P = \frac{V^2}{R} = \frac{152}{100} = 2.25$ W **power gain** = $\frac{\text{output power}}{\text{input power}} = \frac{25}{2.25} = \mathbf{11}$

1. What does an amplifier do in an electronic system ?
2. Give two examples of devices which use amplifiers.
3. What is meant by the voltage gain of an amplifier ?
4. What is the equation that links power, voltage and resistance of a circuit ?

5. Describe how you could measure the voltage gain of an amplifier using an oscilloscope.

6. How does the frequency of the output signal from an amplifier compare with that of the input signal to the amplifier ?

7. How does the amplitude of the output signal from an amplifier compare with that of the input signal to the amplifier ?

8. What are the units used to measure power gain.

9. What is meant by the power gain of an amplifier ?

10. Calculate the voltage gain of an amplifier which has an input voltage of 2mV and an out put voltage of 0.4V