Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level – LEGACY

1142/01

S19-1142-01

ELECTRONICS – ET2

MONDAY, 20 MAY 2019 – AFTERNOON

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**7**	
2.	**6**	
3.	**8**	
4.	**9**	
5.	**7**	
6.	**7**	
7.	**6**	
8.	**10**	
Total	**60**	

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ADDITIONAL MATERIALS

A calculator.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 60.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

INFORMATION FOR THE USE OF CANDIDATES

Preferred Values for resistors

The figures shown below and their decade multiples and sub-multiples are the E24 series of preferred values.

10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

Standard Multipliers

Prefix	Multiplier
T	$\times 10^{12}$
G	$\times 10^{9}$
M	$\times 10^{6}$
k	$\times 10^{3}$

Prefix	Multiplier
m	$\times 10^{-3}$
μ	$\times 10^{-6}$
n	$\times 10^{-9}$
p	$\times 10^{-12}$

Charging Capacitor

$$V_C = V_0(1 - e^{-t/RC})$$

$$t = -RC\ln\left(1 - \frac{V_C}{V_0}\right)$$

Discharging Capacitor

$$V_C = V_0\ e^{-t/RC}$$

$$t = -RC\ln\left(\frac{V_C}{V_0}\right)$$

Alternating Voltages

$$V_0 = V_{rms}\sqrt{2}$$

Silicon Diode

$$V_F \approx 0.7\ \text{V}$$

Bipolar Transistor

$$h_{FE} = \frac{I_C}{I_B}$$

$$V_{BE} \approx 0.7\ \text{V}$$

MOSFETs

$$I_D = g_M V_{GS}$$

555 Monostable

$$T = 1.1\ RC$$

555 Astable

$$t_H = 0.7(R_A + R_B)C$$

$$t_L = 0.7R_BC$$

$$f = \frac{1.44}{(R_A + 2R_B)C}$$

Schmitt Astable

$$f \approx \frac{1}{RC}$$

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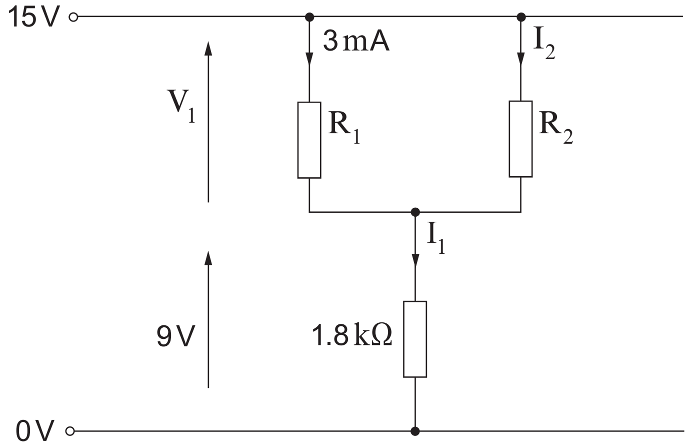
Answer **all** *questions.*

1. Use the information given in the circuit diagram to determine the values of the quantities listed below.



Determine the value of: [7]

(a) V_1 ....

....

(b) R_1 ....

....

(c) I_1 ....

....

(d) I_2 ....

....

(e) R_2 ....

....

(f) What is the combined resistance of the parallel combination R_1 and R_2?

....

....

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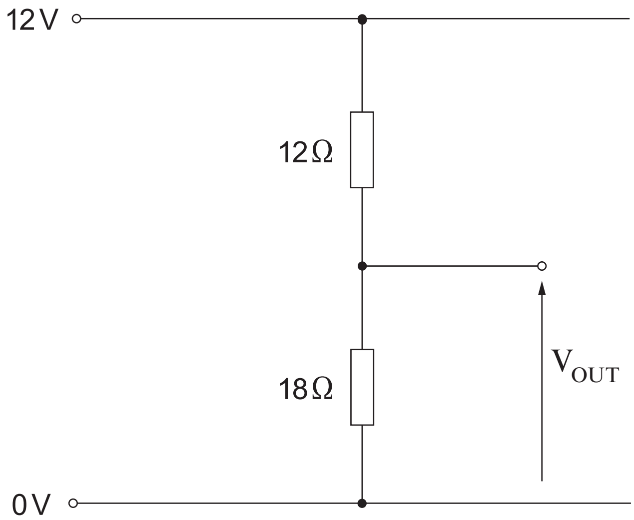
2. The following circuit is used as a voltage source.



(a) Thevenin's theorem is used to produce an equivalent circuit for the voltage source.

(i) Calculate the open circuit voltage V_{OC}. [1]

....

....

(ii) Calculate the short circuit current I_{SC}. [1]

....

....

(iii) Calculate the equivalent resistance R_O. [1]

....

....

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(b) (i) Draw the equivalent circuit with a load resistor connected across the output terminals. [1]

(ii) Use the equivalent circuit to calculate the maximum permissible load current to ensure the output voltage V_{OUT} does not fall below 6.3 V. [2]

....

....

....

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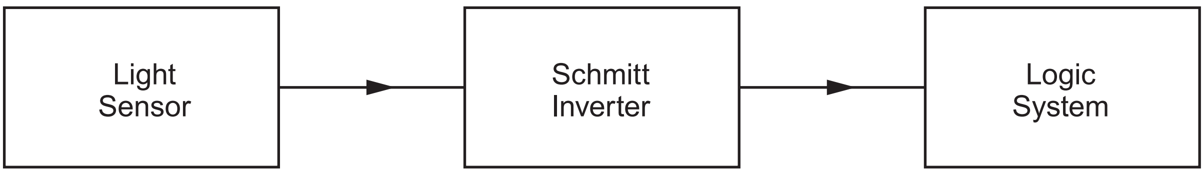
3. *(a)* A Schmitt inverter can be used to condition the signal produced by an analogue sensor. Here is part of the data sheet for a Schmitt Inverter.

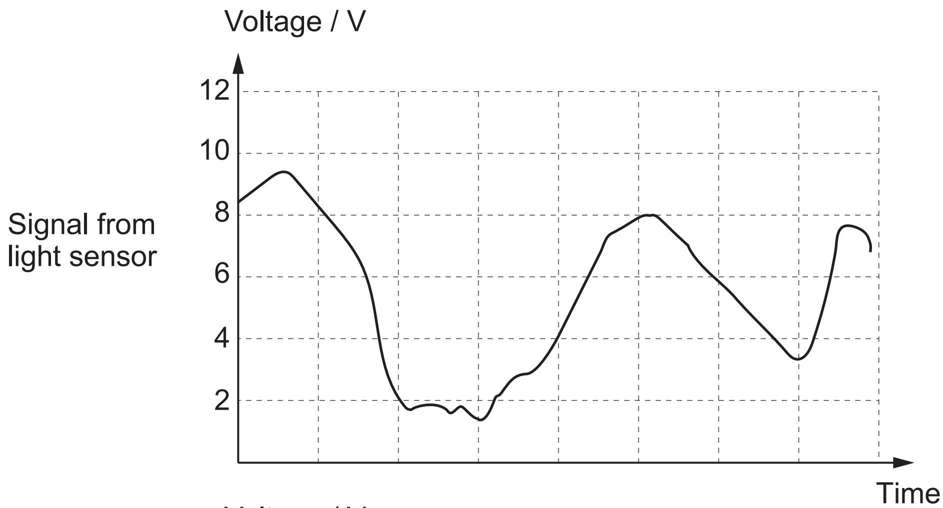
> When connected to a 10 V supply:
>
> - Logic 0 = 0 V
> - Logic 1 = 10 V
> - The output changes from logic 1 to logic 0 when a **rising** input voltage reaches 4 V
> - The output changes from logic 0 to logic 1 when a **falling** input voltage reaches 2 V

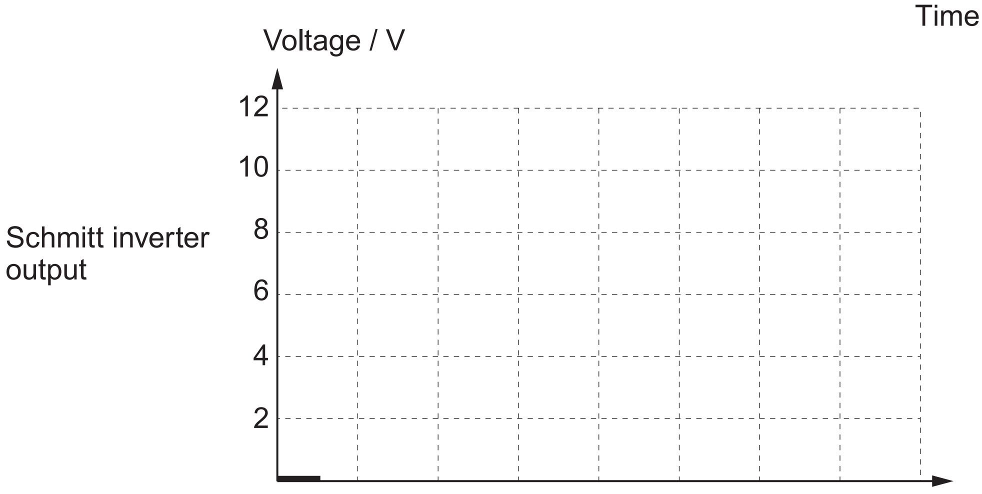
The Schmitt inverter is connected as follows in an electronic system.



The upper graph shows the light sensor output.

Complete the lower graph to show the signal obtained at the output of the Schmitt Inverter. [3]





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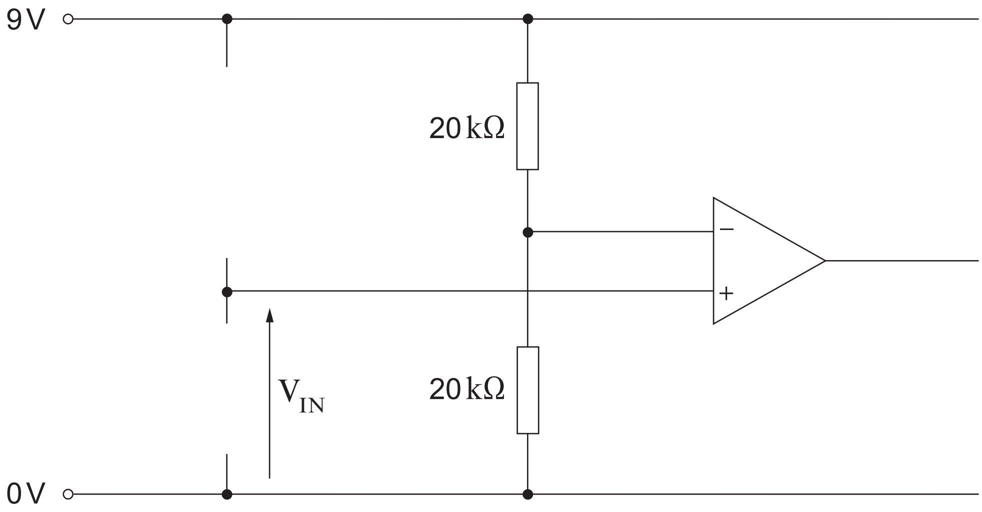
(b) The diagram below shows an incomplete circuit diagram for a different system that gives a warning when the light level in a photography dark room is too high.



(i) Complete the design by adding: [4]

- a LED and protective resistor;
- a LDR;
- a component that will allow the light level that activates the LED to be adjustable.

(ii) What is the smallest value of V_{IN} that turns on the LED? [1]

....

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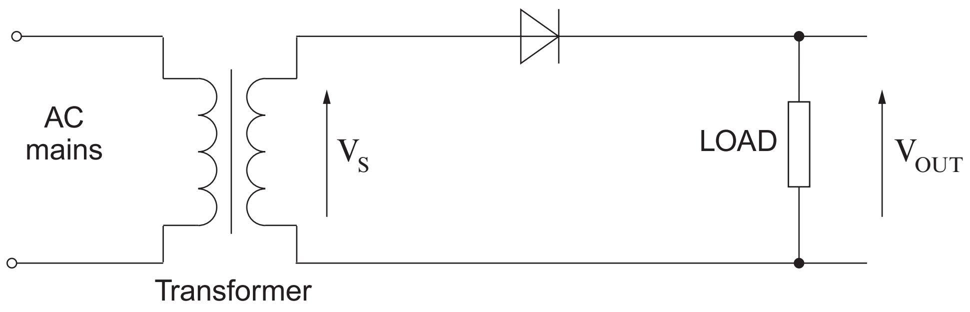
4. The following diagram shows a half-wave rectified power supply without a smoothing capacitor. The power supply is connected to a load that draws a small current from it.



(a) The **peak** value of the secondary voltage V_S is 12 V. Calculate:

(i) the **rms** value of the secondary voltage, [1]

....

....

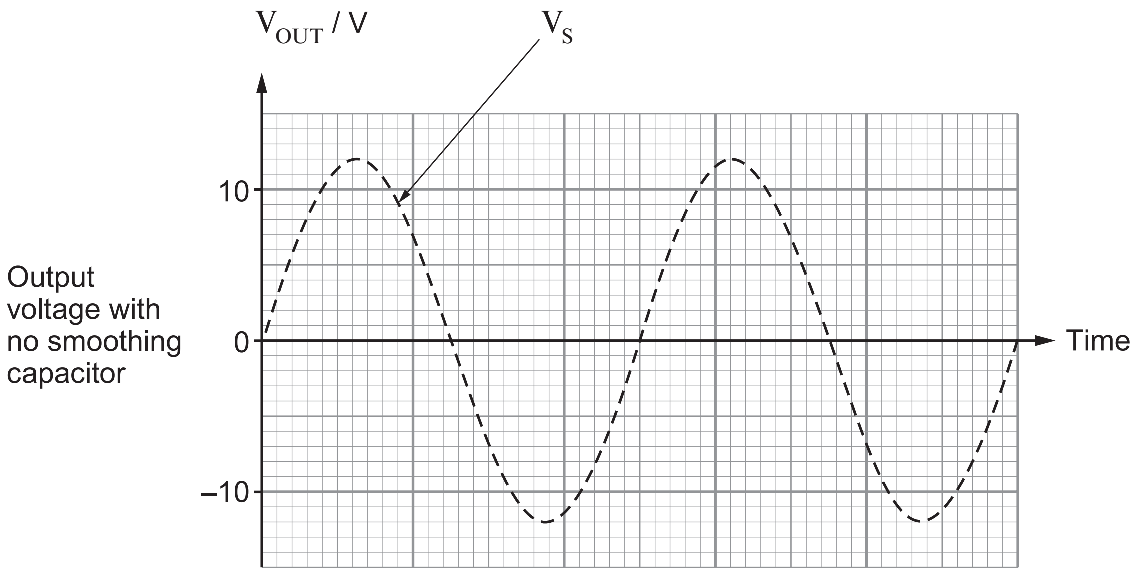
(ii) the **peak** value of the voltage V_{OUT}. [1]

....

(b) A small current flows through the load without a smoothing capacitor in the circuit. On the axes provided below, sketch a graph to show the voltage V_{OUT}.

Label any relevant voltages. [2]

The voltage across the secondary windings of the transformer is shown as a dotted waveform.



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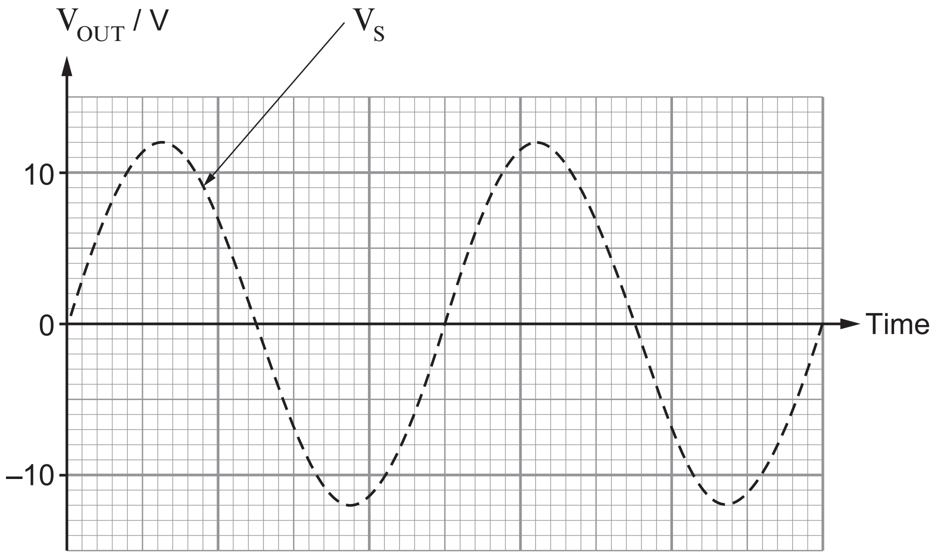
(c) (i) Add a smoothing capacitor to the circuit diagram. [1]

(ii) Show the effect of the smoothing capacitor on the output voltage. Use the next set of axes to sketch V_{OUT} for this modified circuit when a small current flows through the load. [2]

Output voltage with smoothing capacitor



(d) The half-wave rectifier is replaced with a full-wave rectifier. [2]

(i) What is the new **peak** value of the voltage V_{OUT}? ....

(ii) What happens to the amplitude of the ripple voltage? ....

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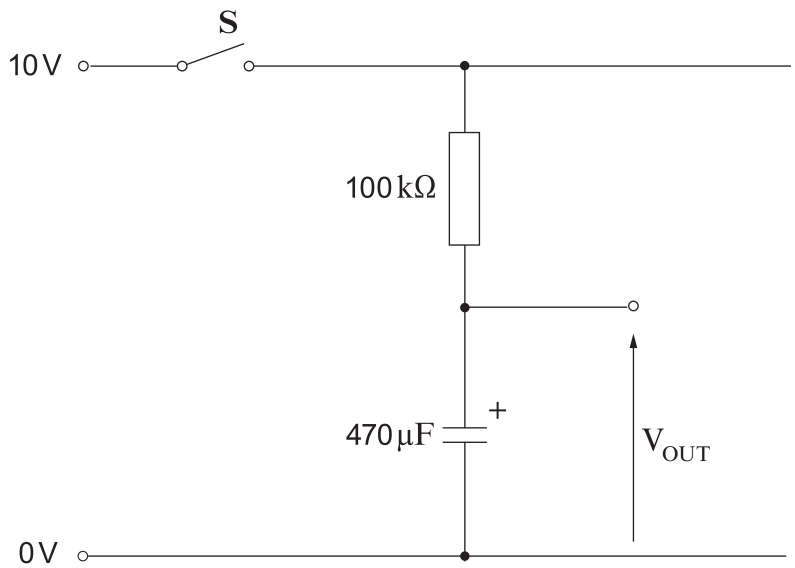
5. The capacitor shown in the following circuit is initially discharged.



(a) Calculate the time constant of the circuit. [2]

....

....

(b) Switch **S** is closed at time t = 0.

(i) Determine the time taken for V_{OUT} to reach 5 V. [2]

....

....

(ii) Calculate the value of V_{OUT} at time t = 10 s. [2]

....

....

....

(iii) Estimate V_{OUT} after switch **S** has been closed for 5 minutes. [1]

....

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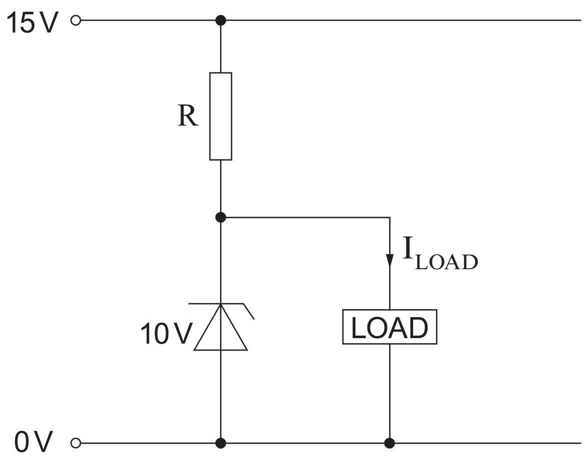
6. The following diagram shows a simple stabilised power supply delivering current I_{LOAD} to a load.



- The power supply **must** be able to supply a load current, I_{LOAD}, of 120 mA.
- The 10 V zener diode requires a current of at least 5 mA to maintain the zener voltage.

(a) Calculate the ideal value of resistor R. [3]

....

....

....

(b) The current through the load is 50 mA. [3]

(i) What is the new value of the current through the zener diode?

....

(ii) Calculate the power dissipated in the zener diode.

....

(c) Select the preferred value of resistor that you would use for R from the E24 series. Give a reason for your choice. [1]

....

....

Turn over.

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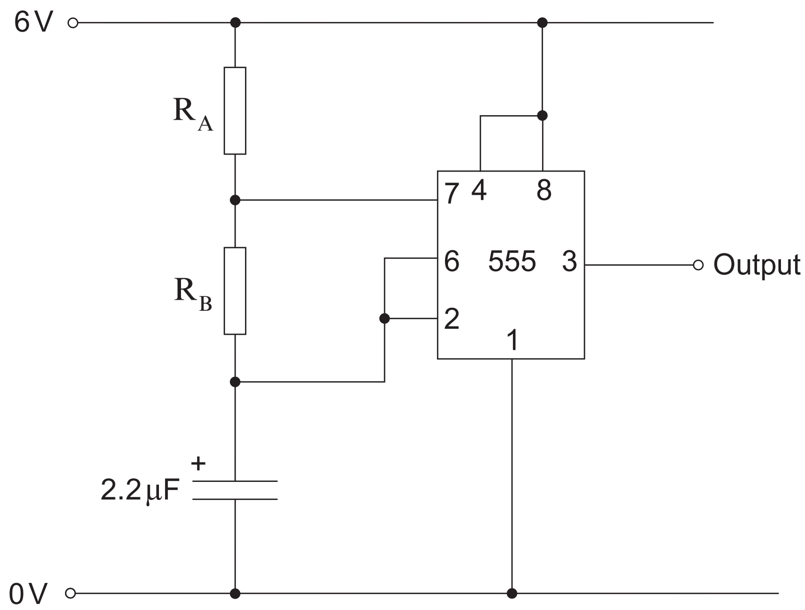
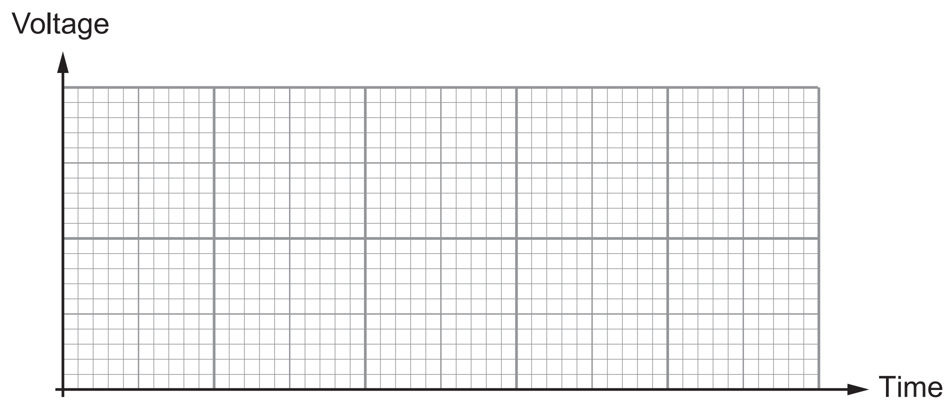
7. The following diagram shows a 555 timer being used in an astable circuit.



(a) The output signal has a mark-space ratio of 2:1. Sketch **two** cycles of the output signal. Label the **mark** T_1 and the **space** T_2. [2]



(b) The space T_2 has a duration of 20 ms. Calculate the value of resistor R_B that will produce this space when C = 2.2 μF. [3]

....

....

....

(c) Determine the value of resistor R_A. [1]

....

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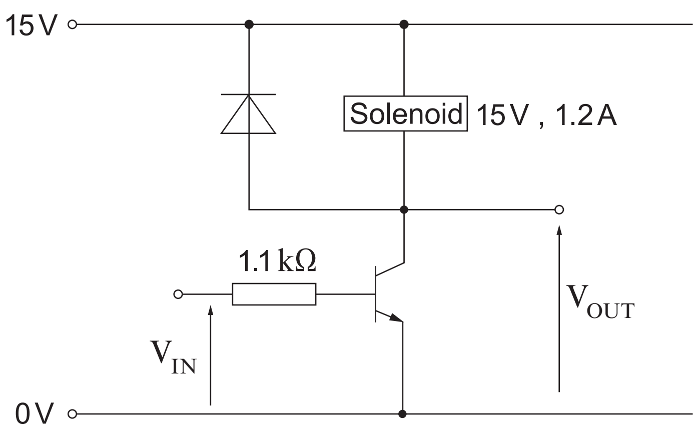
8. The transistor switching circuit shown is used to operate a solenoid.



The transistor has a current gain, h_{FE} = 240.

(a) The value of V_{IN} is sufficient **just** to saturate the transistor. Calculate:

(i) the base current, [2]

....

....

(ii) the value of V_{IN}. [2]

....

....

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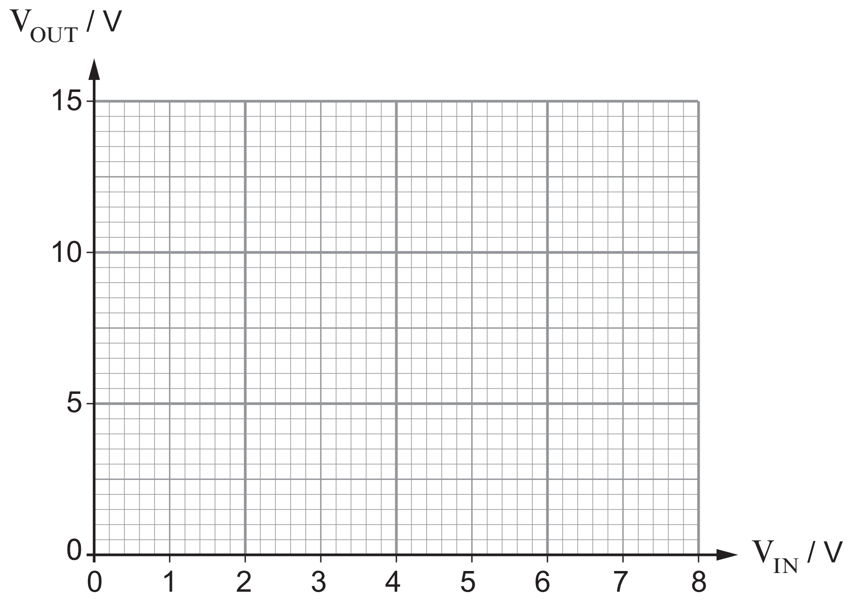
(b) Draw a graph to show how V_{OUT} changes as V_{IN} is increased from 0 to 8 V. [3]



(c) (i) Use the graph to determine the value of V_{OUT}, when V_{IN} = 4.4 V. [1]

....

(ii) Explain the effect this value of V_{OUT} would have on the operation of both the transistor and the solenoid. [2]

....

....

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END OF PAPER