Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A Level

1142/01

S17-1142-01

ELECTRONICS – ET2

THURSDAY, 25 MAY 2017 – AFTERNOON

1 hour 15 minutes

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

1142
010001

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

$$V_F \approx 0.7\ V$$

Bipolar Transistor

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

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

MOSFETs

$$I_D = g_M V_{GS}$$

555 Monostable

$$T = 1.1\ RC$$

555 Astable

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

$$t_L = 0.7R_BC$$

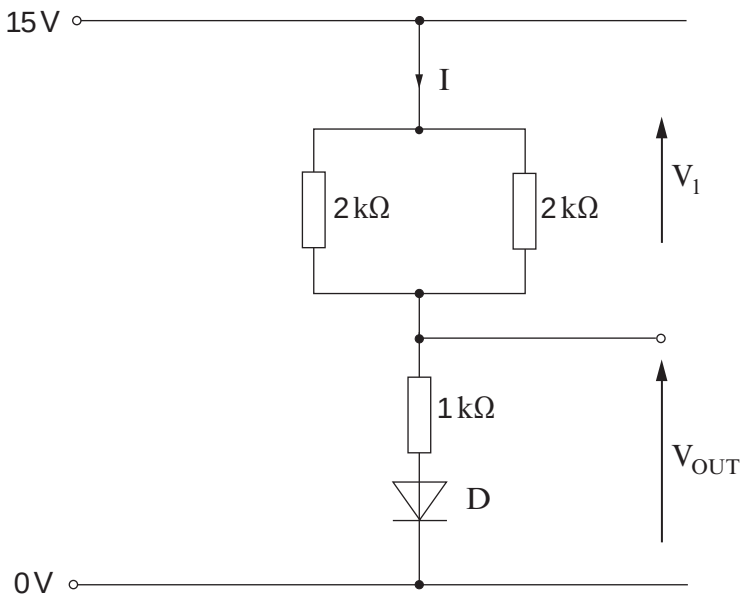
$$f = \frac{1.44}{(R_A + 2R_B)C}$$

Schmitt Astable

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

Answer **all** *questions.*

1. In the following circuit, D is a silicon diode.



Determine the values of the quantities listed below.

(a) The combined resistance of the two 2 kΩ resistors. [1]

.....

(b) The combined resistance of all three resistors. [1]

.....

(c) I ..... [2]

.....

.....

(d) V_1 ..... [1]

.....

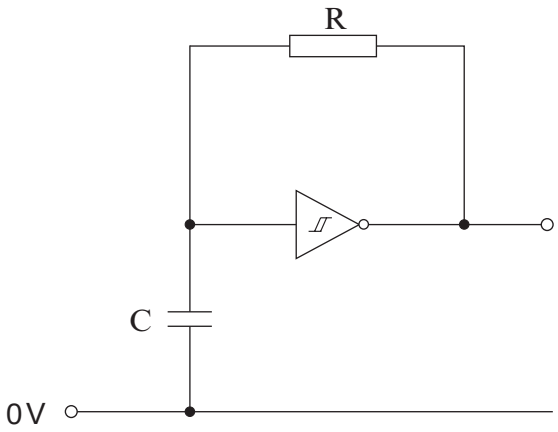
(e) V_{OUT} ..... [1]

.....

Examiner only

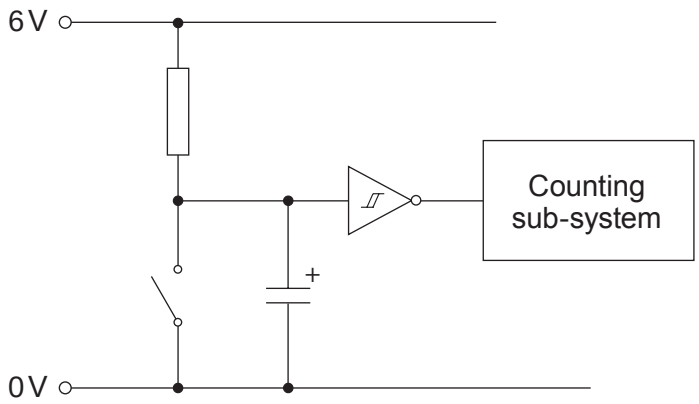
2. Schmitt inverters are used in many applications of electronics.

(a) (i) What is the name of the Schmitt inverter application shown in the circuit diagram?



Application: ..... [1]

(ii) What is the purpose of the capacitor and Schmitt inverter in the counting system shown?



Purpose: ..... [1]

.....

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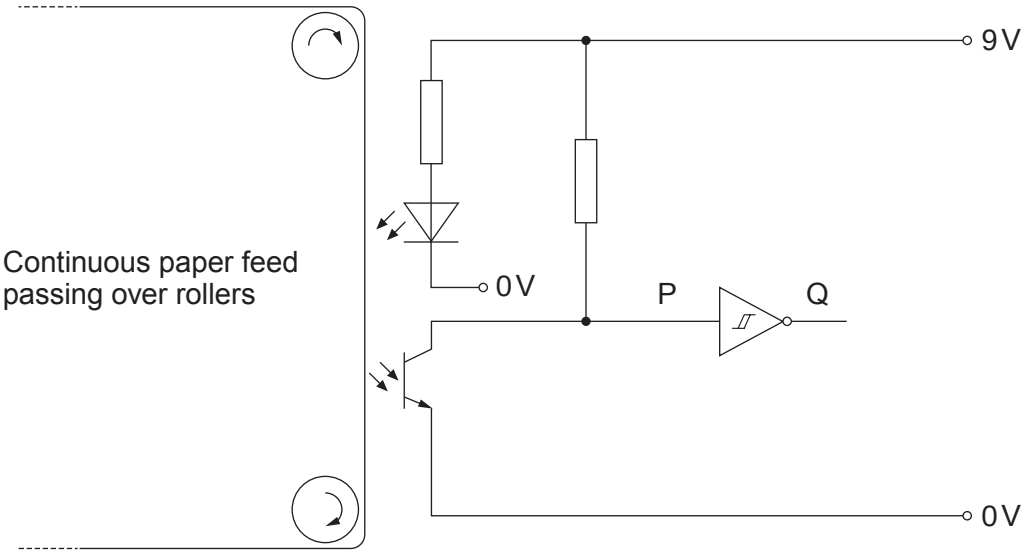
(b) Another application for a Schmitt trigger is shown below.

A continuous paper feed system uses a phototransistor and Schmitt inverter to check for the presence of paper.



(i) What is the purpose of the Schmitt inverter in this system? [1]

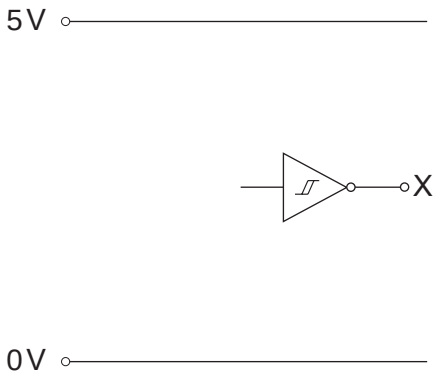
.....

.....

(ii) State whether the logic levels at P and Q are high or low when paper is present. [1]

P = ... Q = ...

(c) A temperature sensing sub-system should be connected to the input of a Schmitt inverter. Add any components necessary such that the output, X, changes from logic 0 to logic 1 when the temperature drops below a certain value. [2]



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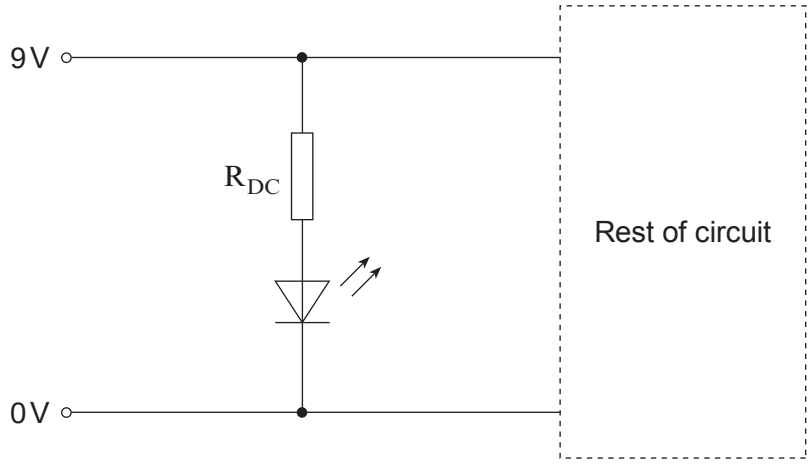
3. A *power-on* indicator for a DC circuit is shown below.



(a) (i) The forward voltage drop across the LED is 2 V.
Calculate the value of R_{DC}, required to limit the current through the LED to a maximum of 20 mA.

.....

.....

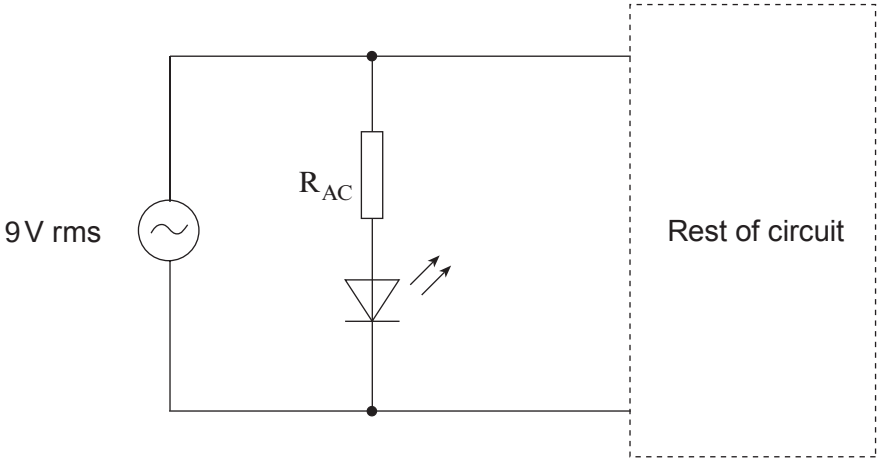
(ii) Select the preferred value for R_{DC} from the E24 series.

.....

[3]

(b) A *power-on* indicator is needed for a 9 V rms AC circuit.

(i) Complete the circuit diagram by adding a component to protect the LED from the reverse polarity of the AC supply.



(ii) Determine the value of R_{AC} required to provide approximately the same level of illumination as the DC ***power-on*** indicator.

.....

[3]

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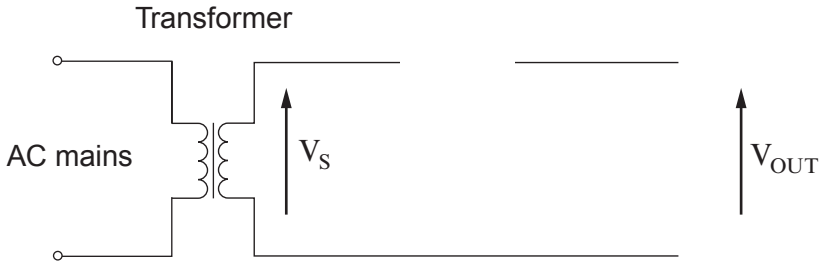
4. The following diagram shows part of the circuit of a half-wave rectified power supply.



(a) Complete the circuit by adding: [3]

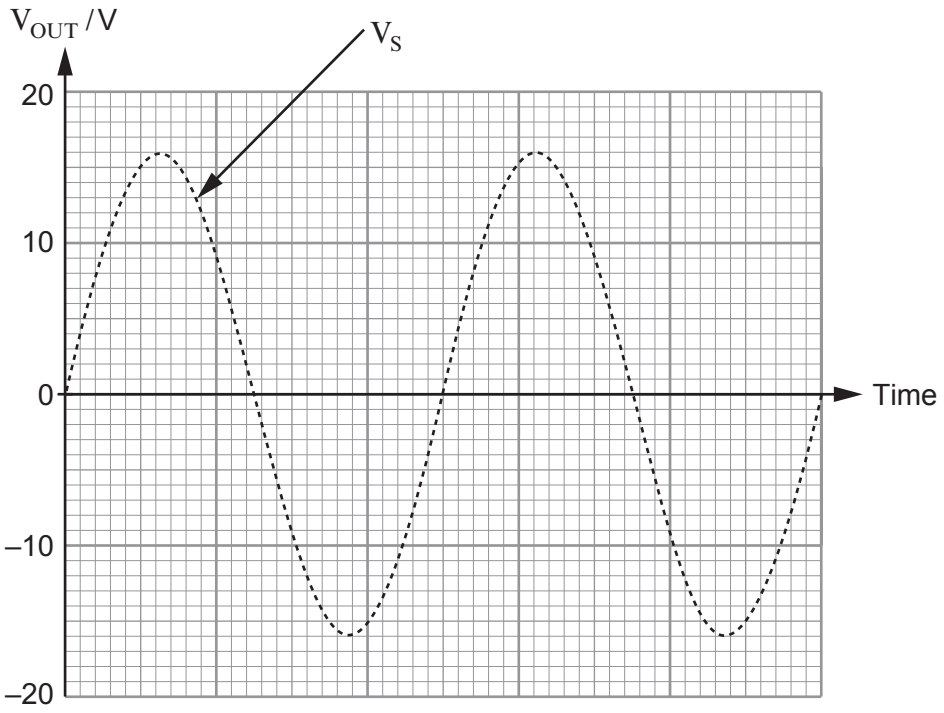
- a diode to produce the half-wave rectification;
- a capacitor to smooth the output;
- a load resistor.

(b) In the graph below the voltage across the secondary windings of the transformer (V_S) is shown as a dashed waveform.

(i) What is the peak value of the voltage V_S? [1]

.....

(ii) Use the graph to show the voltage V_{OUT} when the load draws a large current. [3]



(c) The amplitude and frequency of V_S remain unchanged.

State **one** way in which the amplitude of the ripple voltage can be reduced in this half-wave rectified power supply. [1]

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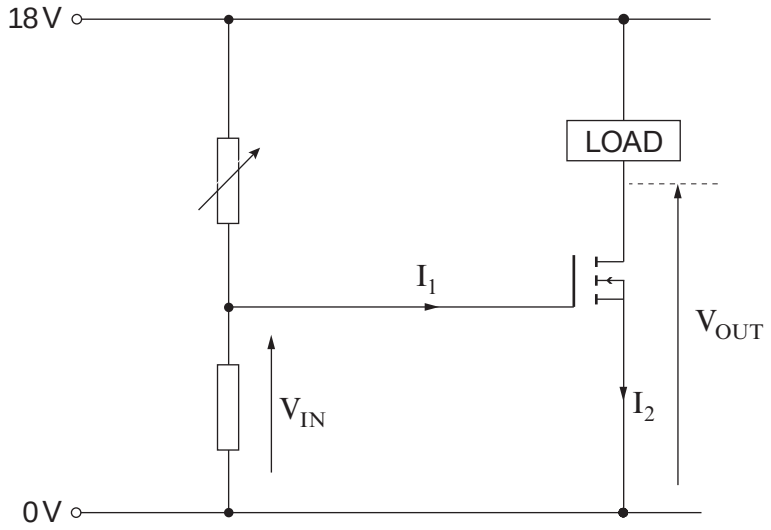
5. An engineer sets up the following circuit to check some parameters of a MOSFET.



The variable resistor is adjusted until the MOSFET is just saturated. The following results are obtained.

V_{IN} / V	V_{OUT} / V	I_2 / A
4.5	1.3	10.8

(a) Estimate the value of I_1 when the load current is 10.8 A. ..... [1]

(b) Use the results provided in the table to calculate the value of r_{DSon}. [1]

.....

.....

(c) Calculate the power dissipated in the MOSFET when the load current is 10.8 A. [1]

.....

.....

(d) An interface is required to connect a logic system with a maximum available output current of 40 mA to a 20 A load. Explain why a MOSFET would be a better choice than an npn transistor for this application. [2]

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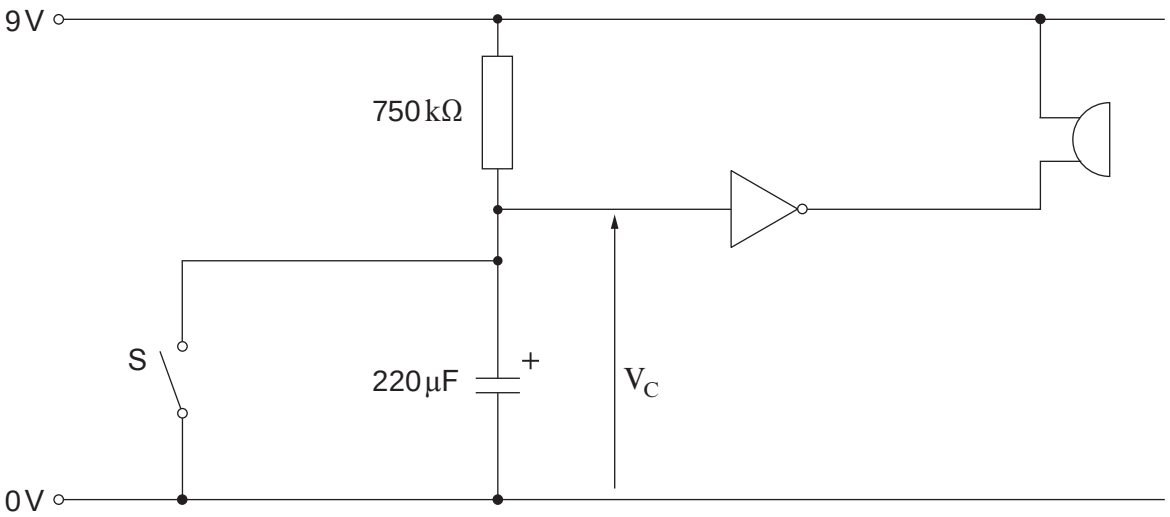
6. The following diagram shows a *fridge door alarm* based on a simple monostable circuit. It warns that the fridge door has been left open.
Switch S opens when the fridge door is opened.



The CMOS inverting buffer (NOT gate) has the following parameters when connected to a 9 V power supply:

Parameter	Value
Input switching threshold	4.5 V
Input impedance	∞ (infinite)
Logic 0 output voltage level	0 V
Logic 1 output voltage level	9 V
Output current capability	40 mA

(a) Calculate the time constant of the RC network. [1]

.....

.....

(b) Switch S is opened at time t = 0. Determine the time then taken for V_C to reach 4.5 V. [2]

.....

.....

Examiner only

(c) The fridge door is left open for three minutes and then closed. Describe what happens to the buzzer over this period of time. Your answer should make specific references to timings. [3]

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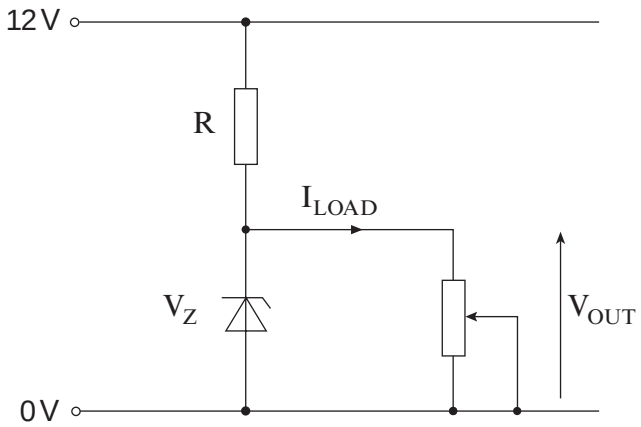
Turn over.

7. A simple regulated power supply is shown below.



The table below shows the results obtained when the output voltage of the power supply is measured at different values of load current:

Load current (mA)	**Output voltage (V)**
0	3.95
50	3.94
100	3.93
150	3.92
200	3.91
250	3.91
300	3.04
350	1.44
400	0.00

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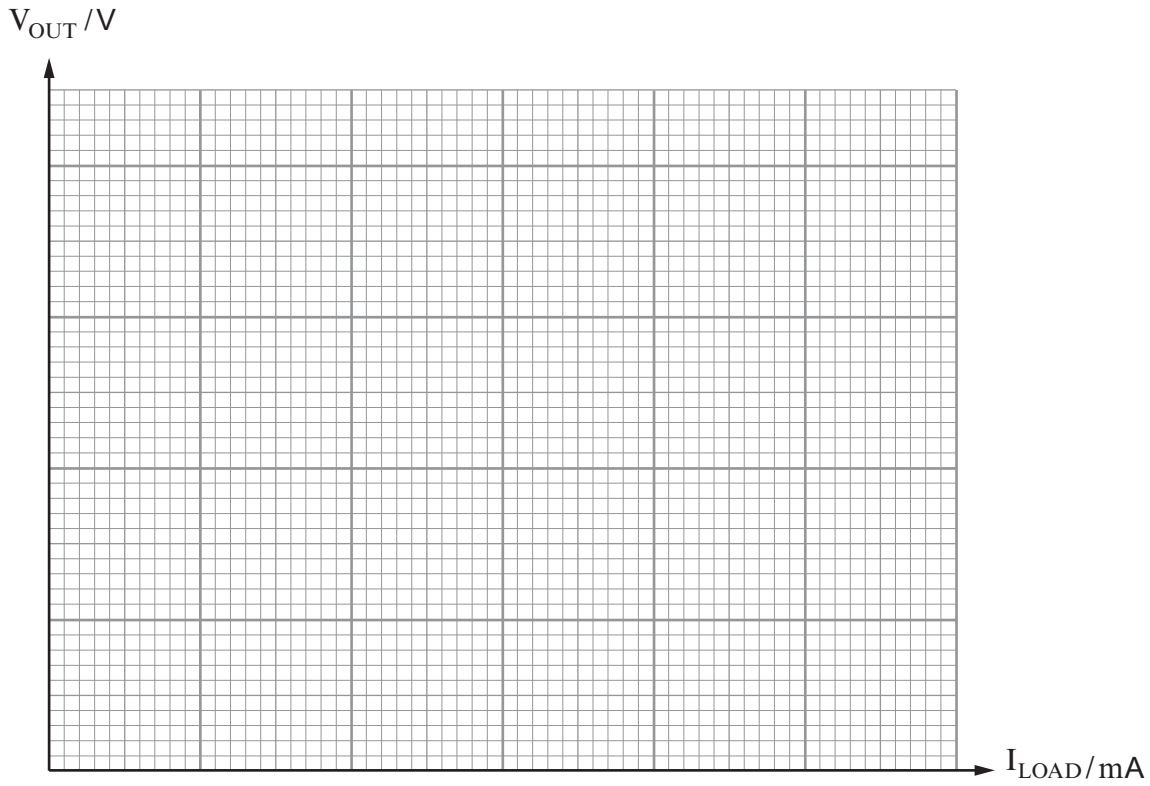
(a) Plot a graph of V_{OUT} against I_{LOAD} on the axes below. Label both axes with your chosen scale. [2]



(b) Use the graph to determine:

(i) the zener reference voltage V_Z ..... [1]

(ii) the maximum load current that the power supply can provide whilst still maintaining the zener voltage. [1]

.....

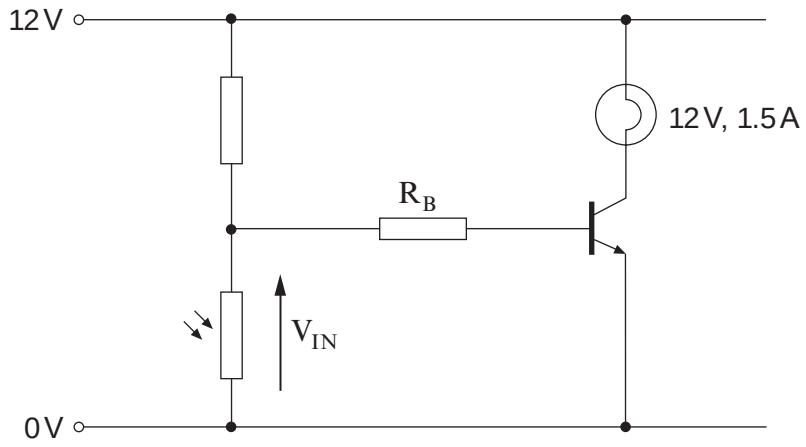
(c) Calculate the resistance of resistor R. [2]

.....

.....

Examiner only

8. A system is required to switch on a lamp in a small display cabinet when the light level falls to 100 lux. The initial design uses the following circuit.



The transistor has a current gain of 500 (h_{FE} = 500).

(a) The input voltage V_{IN} is 5.2 V and the transistor is just saturated.

Determine:

(i) the base current [2]

.....

.....

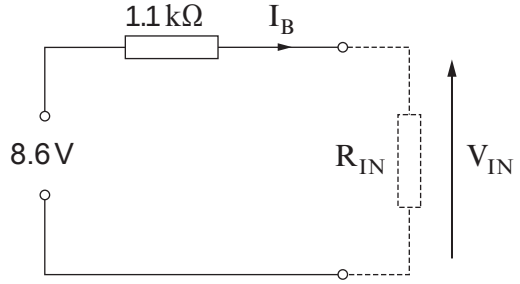
(ii) the value of the base resistor R_B. [2]

.....

.....

(b) There is a concern that the circuit will not function correctly due to the transistor input loading the light sensing sub-system.

The Thevenin equivalent circuit for the light sensing sub-system at an illumination level of 100 lux is shown connected to the transistor input R_{IN}.



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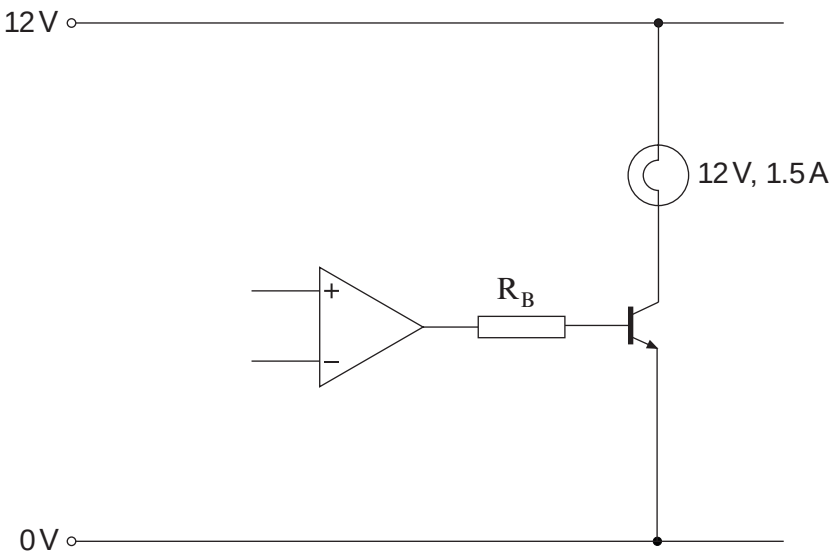
Use the equivalent circuit to show by calculation whether the transistor is saturated at 100 lux.

[Hint: You will need to consider whether the **new voltage** V_{IN} ,is sufficient to saturate the transistor when providing the base current calculated in part *(a)* opposite.] [3]

(c) The system design is improved by adding a comparator sub-system.



Complete the circuit diagram for the system by adding:

- the light sensing sub-system;
- the component(s) required to provide a reference voltage sub-system;
- a facility for adjusting the light level at which the lamp comes on. [3]

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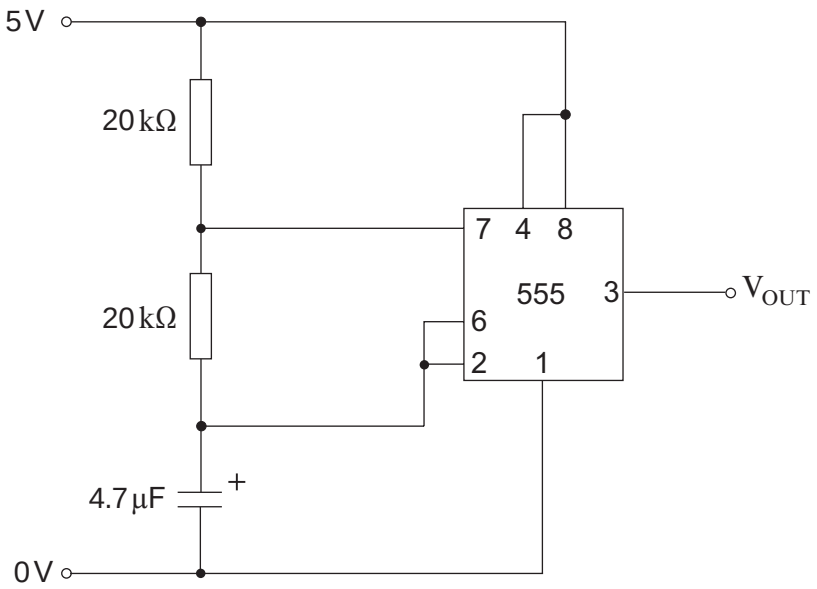
9. The diagram shows a 555 astable circuit.



(a) Calculate the value of the mark and space for the astable. [3]

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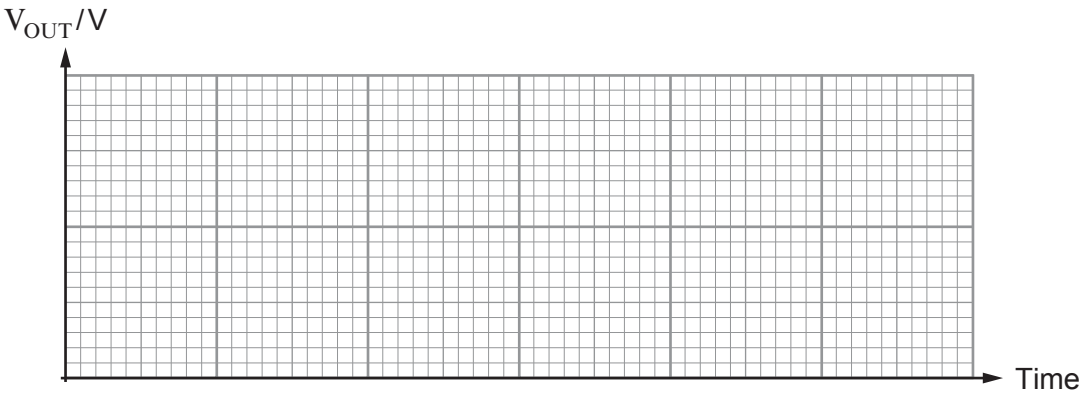
Examiner only

(b) Sketch a graph to illustrate the shape of **two** complete cycles of the output waveform. [2]



(c) Calculate the frequency of the output waveform, V_{OUT}. [2]

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