Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1142/01

S15-1142-01

ELECTRONICS – ET2

P.M. THURSDAY, 21 May 2015

1 hour 15 minutes

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

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ADDITIONAL MATERIALS

In addition to this examination paper, you will need 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

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

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

Discharging Capacitor

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

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

Alternating Voltages

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

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

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

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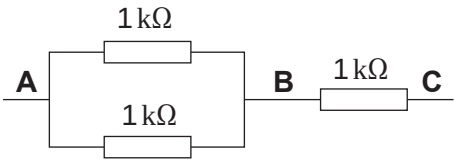
Answer **all** *questions.*

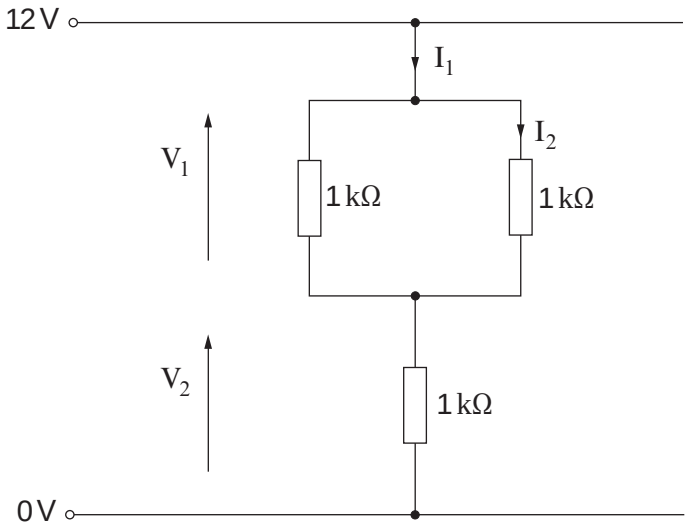
1. *(a)* For the resistor network below calculate the effective resistance between: [2]

(i) points A and B; .....

(ii) points A and C. .....



(b) The resistor network is used in the following circuit.



Determine the values of the quantities listed below. [4]

(i) I_1 .....

.....

(ii) I_2 .....

.....

(iii) V_1 .....

.....

(iv) V_2 .....

.....

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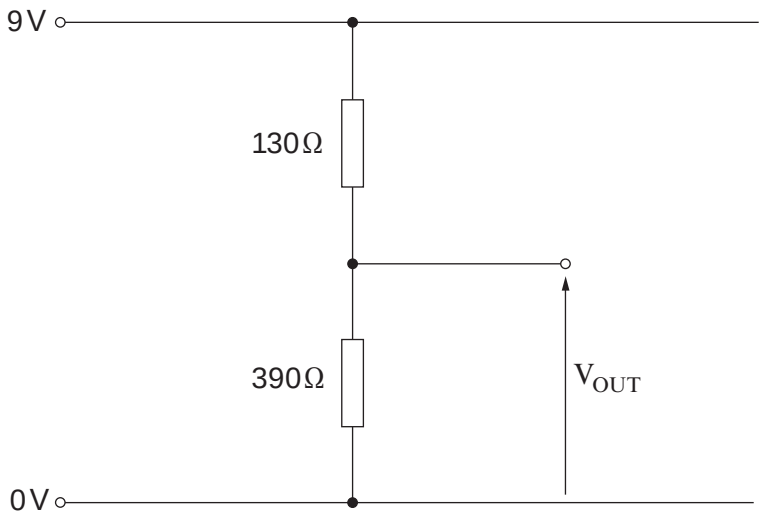
2. *(a)* The following circuit is used as a voltage source.



Thevenin's theorem is used to produce an equivalent circuit. [3]

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

.....

.....

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

.....

.....

(iii) Calculate the equivalent resistance R_O.

.....

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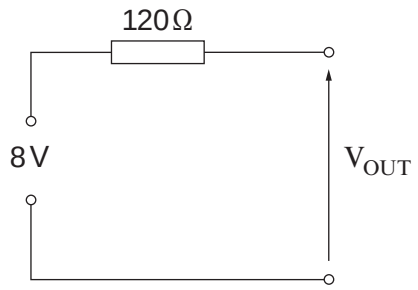
Examiner only

(b) The Thevenin equivalent circuit for a **different** voltage source is shown below.



The output voltage V_{OUT} must not drop below 5 V when a load is connected to the circuit. Determine the minimum allowable load resistance to achieve this. [3]

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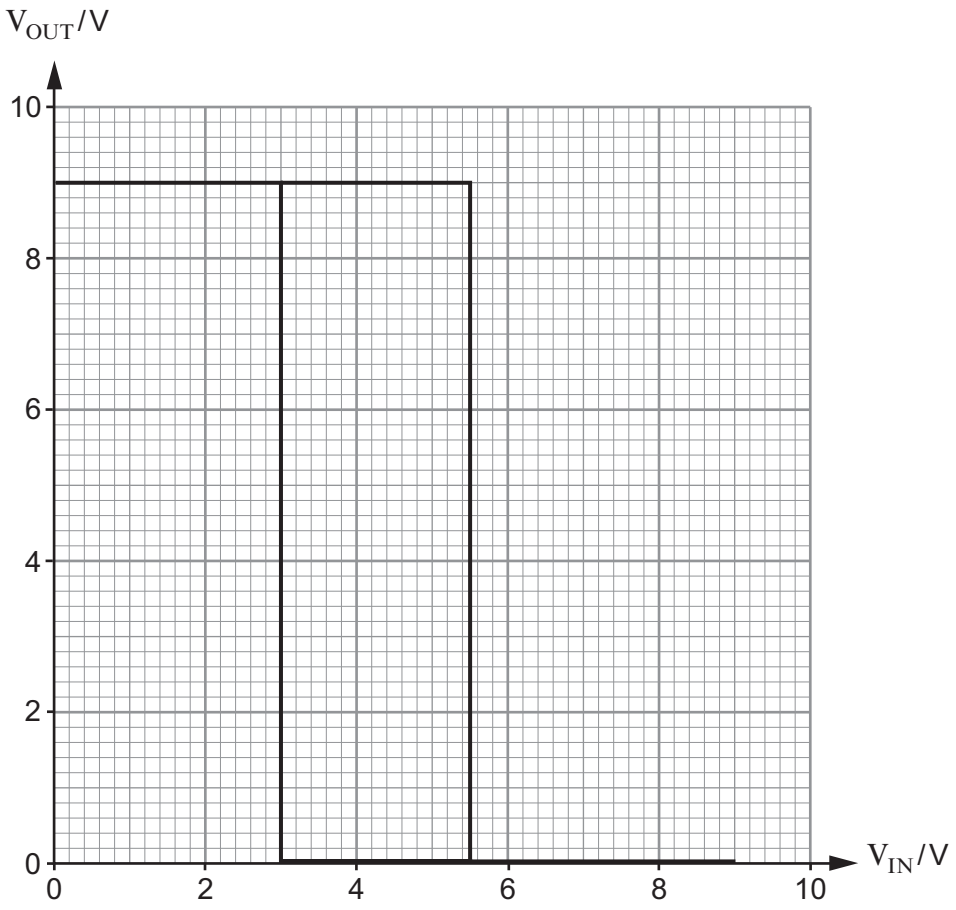
3. *(a)* The graph shows the switching characteristic of a Schmitt inverter.



Determine the input switching threshold for: [2]

(i) an increasing input voltage; .....

(ii) a decreasing input voltage. .....

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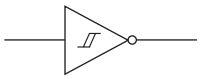
(b) The Schmitt inverter is used as part of an astable circuit.

(i) Complete the circuit diagram for the astable circuit. [2]



0 V

(ii) Use the formula given on page 2 to calculate the values of all components required to produce a frequency of 200 Hz. [2]

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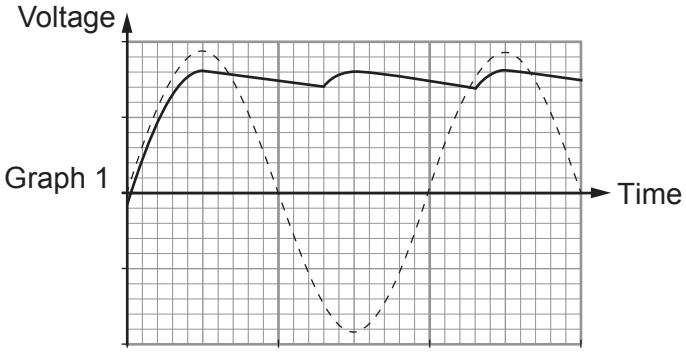
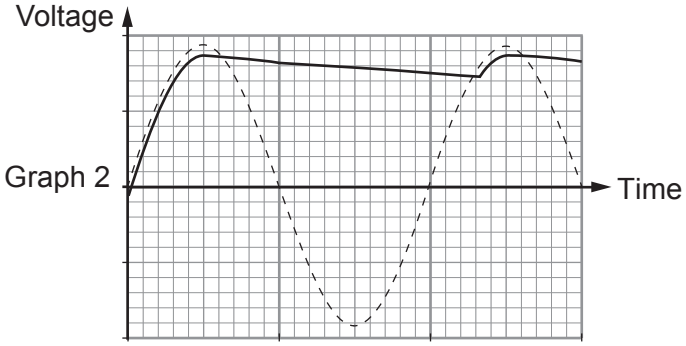
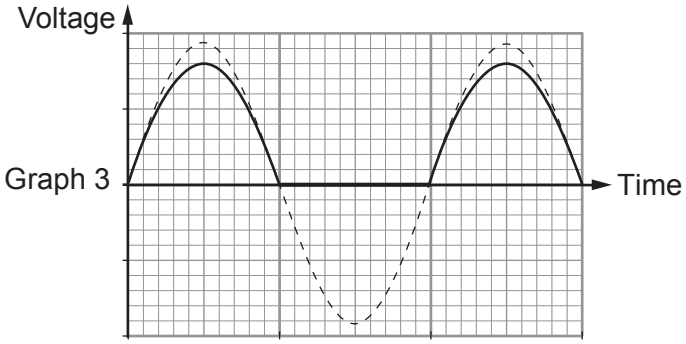
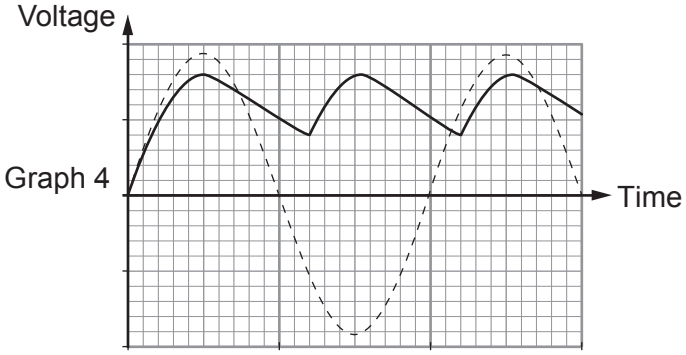
4. *(a)* Here are four waveforms produced by various diode rectifiers. All graphs use identical voltage scales and identical time scales. The AC voltage supplied to the diode rectifier is shown as a dotted waveform.









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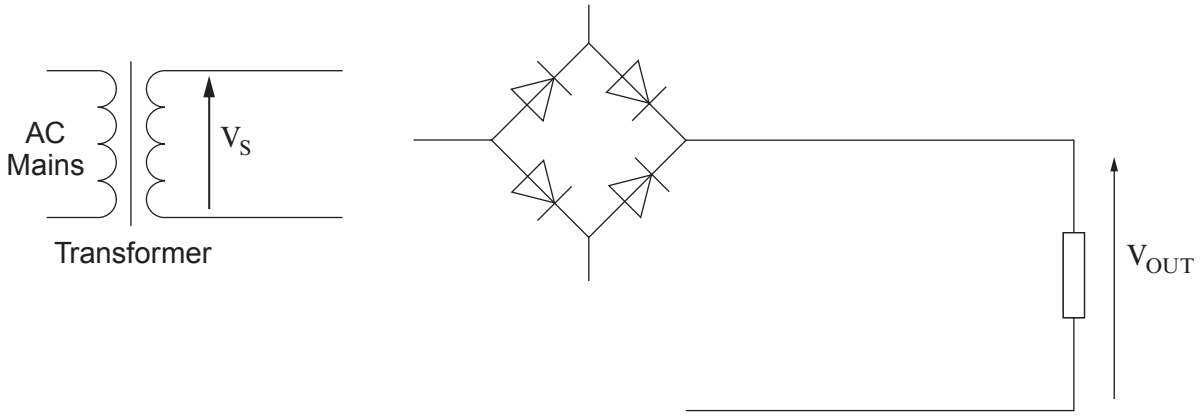
Complete the following statements. [3]

(i) The unsmoothed output of a half-wave rectifier is shown in graph ..... .

(ii) The smoothed output of a full-wave rectifier with a large ripple voltage is shown in graph ..... .

(iii) The smoothed output of a half-wave rectifier with a small ripple voltage is shown in graph ..... .

(b) The following diagram shows an incomplete circuit for a full-wave rectified power supply.



(i) Complete the circuit by adding: [2]

- a smoothing capacitor;
- any missing connections.

(ii) The **peak** value of the secondary voltage of the transformer (V_S) is 18 V. Calculate the **peak** value of the full-wave rectified voltage V_{OUT}. [1]

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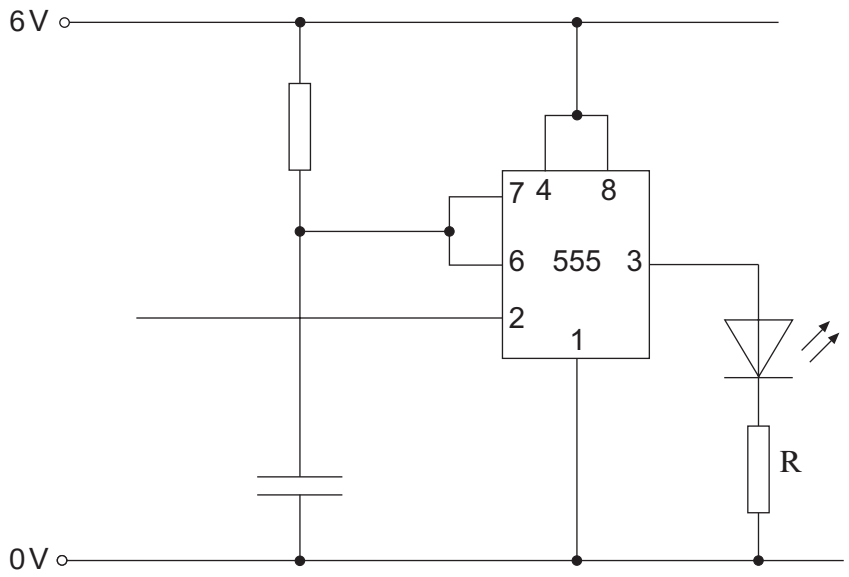
Examiner only

5. The following diagram shows an incomplete circuit for a 555 monostable timer.



(a) Add a switch and any other necessary component to the diagram to provide a falling edge-triggered pulse to activate the monostable. [2]

(b) The timing sub-system consists of a 47 μF capacitor and a 100 $k\Omega$ resistor. Calculate the monostable period. [2]

.....

.....

(c) When the monostable is activated, the output voltage is 6 V. The forward voltage drop across the LED is 2 V.

(i) Calculate the value of resistor R that limits the current through the LED to a maximum of 24 mA. [2]

.....

.....

(ii) Determine a suitable preferred value for R. [1]

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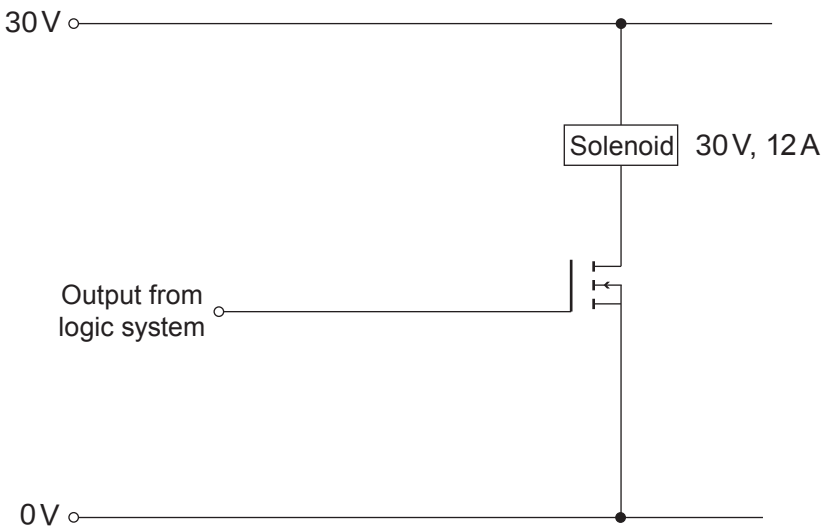
Examiner only

6. A MOSFET is used to interface a logic system to a solenoid rated at 30 V, 12 A.



An extract from the data sheet of the MOSFET is shown below.

V_{DS}/V (max)	V_{GS}/V (max)	I_D/A (max)	P_{TOT}/W (max)	g_M/S (typical)	r_{DS}/Ω (on)
50	15	30	120	2.5	0.13

(a) Add a diode to the circuit diagram to provide protection for the MOSFET when it switches the solenoid off. [1]

(b) Calculate the minimum value of V_{GS} required to allow the solenoid to operate at its rated current. [2]

.....

.....

(c) Calculate the power dissipated in the MOSFET when the solenoid is operating at its rated current. [2]

.....

.....

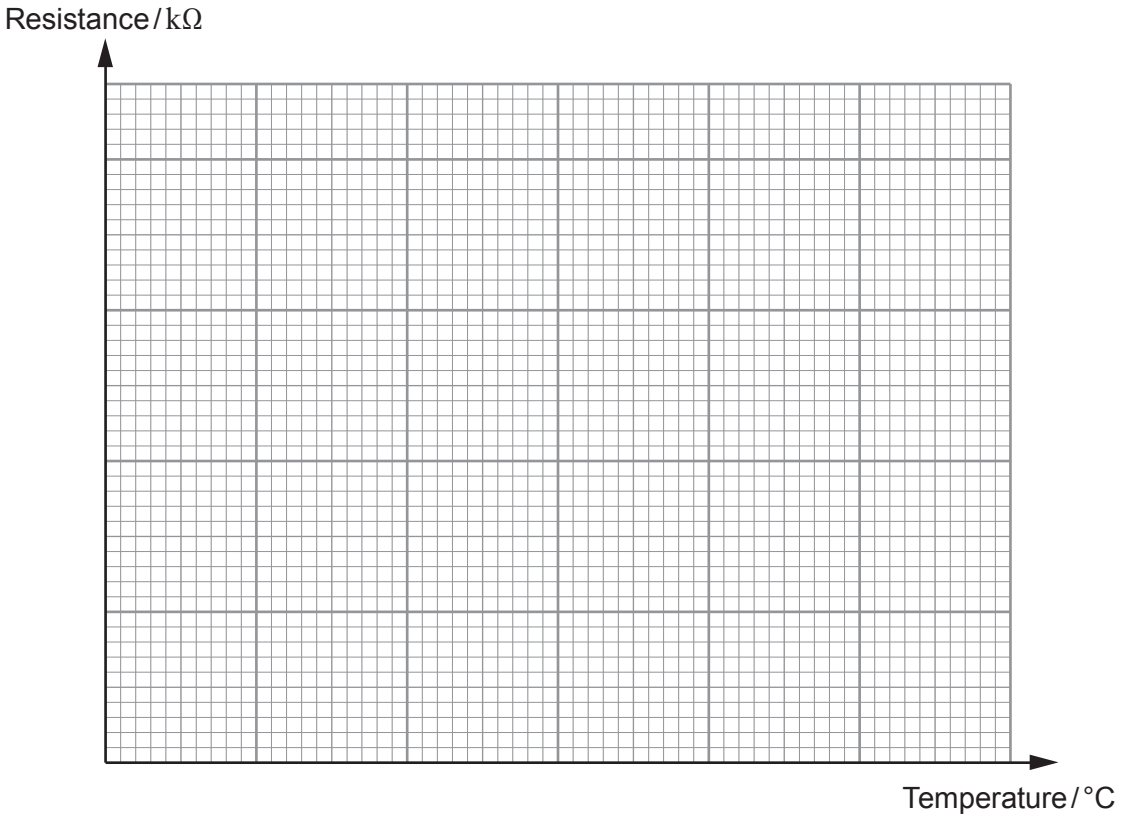
Turn over.

Examiner only

7. *(a)* The table below shows the results obtained when the resistance of a thermistor is measured at different temperatures.

Temperature / °C	Resistance / kΩ
0	8.5
10	5.1
20	3.2
30	1.9
40	1.3
50	0.9
60	0.6

(i) Plot a graph of resistance against temperature on the axes below. Label both axes with your chosen scale. [3]



(ii) Use the graph to determine the resistance of the thermistor at 15 °C. [1]

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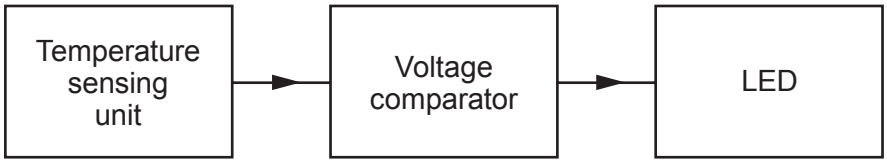
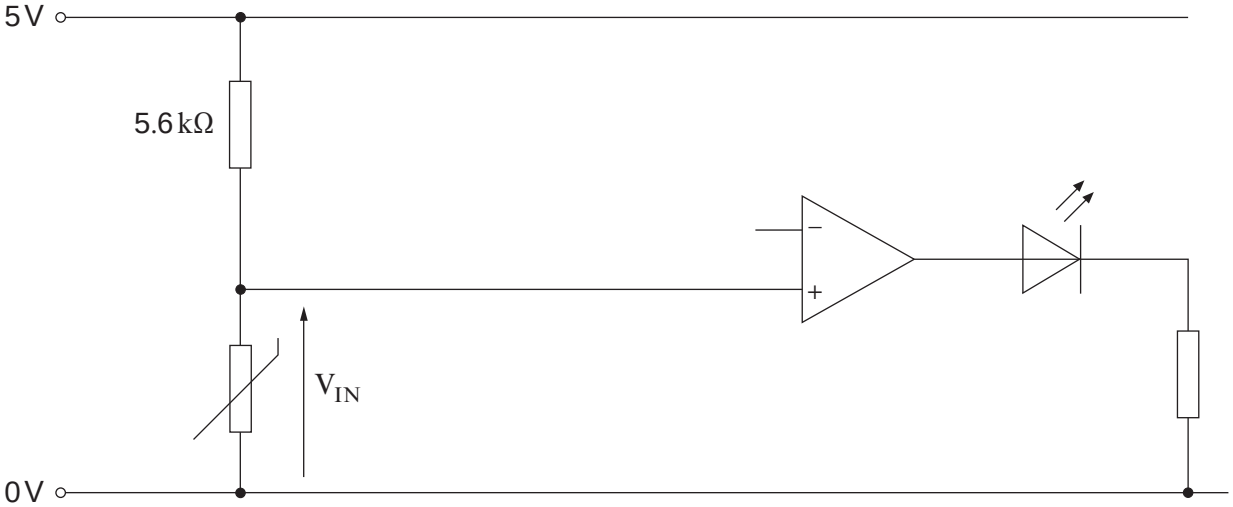
Examiner only

(b) The thermistor is connected to a 5.6 kΩ resistor to form a temperature sensing unit in the following system:



The incomplete circuit diagram for the system is shown below.



(i) Complete the circuit diagram by adding a voltage divider consisting of two 10 kΩ resistors which are used to provide the reference voltage for the comparator. [1]

(ii) Calculate the value of V_{IN} at 15 °C. [1]

.....

(iii) State, giving a reason for your answer, whether the LED will be off or on at 15 °C. [1]

.....

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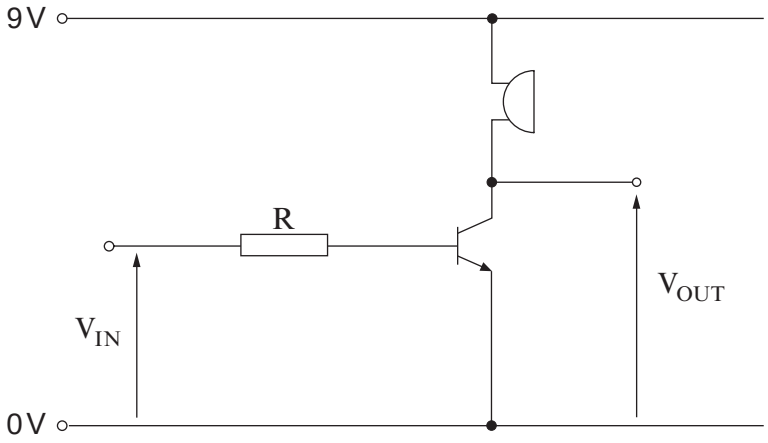
Examiner only

8. Here is a transistor switch used to control a buzzer.



- The transistor has a current gain, h_{FE} = 80.
- The buzzer is rated at 9 V, 120 mA.
- A value of V_{IN} = 3.4 V **just** saturates the transistor.

(a) When V_{IN} = 3.4 V, calculate:

(i) the base current; [1]

.....

(ii) the value of resistor R. [2]

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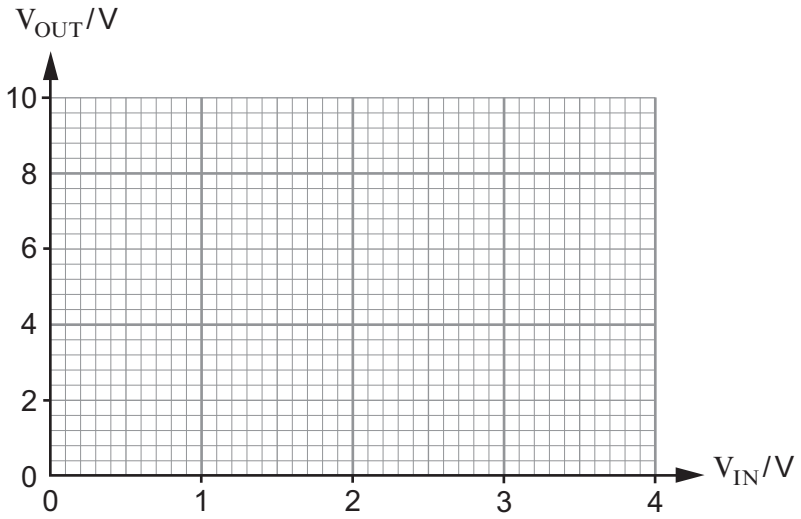
(b) Draw a graph to show how V_{OUT} changes as V_{IN} is increased from 0 to 4 V. [3]



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(c) V_{IN} is 2.5 V and the collector current is 80 mA.

(i) Use the graph to determine the value of V_{OUT}. [1]

.....

.....

(ii) Calculate the power dissipated in the transistor. [1]

.....

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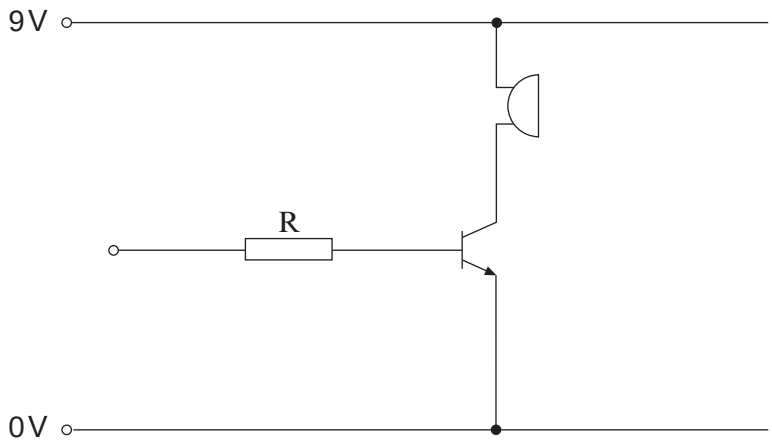
(d) The switching circuit is used by a cricket umpire as a light meter. When the light level gets too low, the buzzer sounds. Add a light sensing sub-system to the circuit diagram below. [2]



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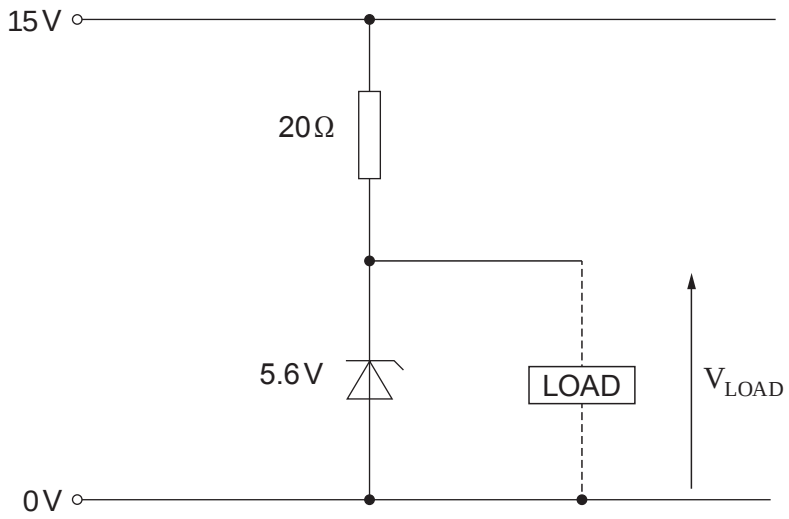
9. The following diagram shows a simple regulated power supply providing an output voltage, V_{LOAD}. The zener diode requires a **minimum** current of 6 mA to maintain the zener voltage.



(a) Calculate the current through the 20 Ω resistor when there is no load connected. [2]

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.....

(b) What is the maximum load current that the power supply can provide whilst still maintaining the zener voltage? [1]

.....

(c) A low resistance load is connected to the power supply. The zener diode ceases to conduct and the load current increases to 600 mA. Calculate the new value of V_{LOAD}. [2]

.....

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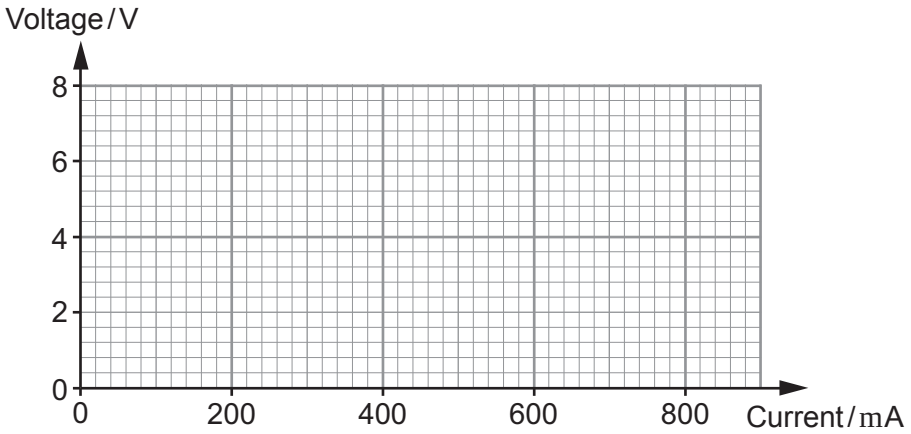
Examiner only

(d) Sketch a graph to show how V_{LOAD} changes as the load current is increased gradually from 0 to 700 mA. [2]



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