Surname	Centre Number	Candidate Number
Other Names		2

GCE AS/A level

1142/01

S16-1142-01

ELECTRONICS – ET2

P.M. THURSDAY, 26 May 2016

1 hour 15 minutes

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

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

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

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

$$t_L = 0.7R_B C$$

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

Schmitt Astable

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

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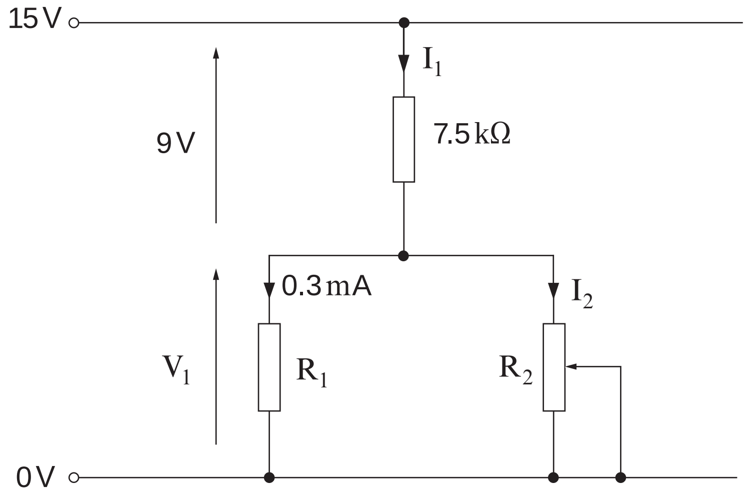
Answer **all** *questions.*

1. Use the information given in the circuit diagram to determine the values of the quantities listed below. [6]



(a) I_1 ....

....

(b) V_1 ....

....

(c) R_1 ....

....

(d) I_2 ....

....

(e) The resistance of variable resistor R_2.

....

....

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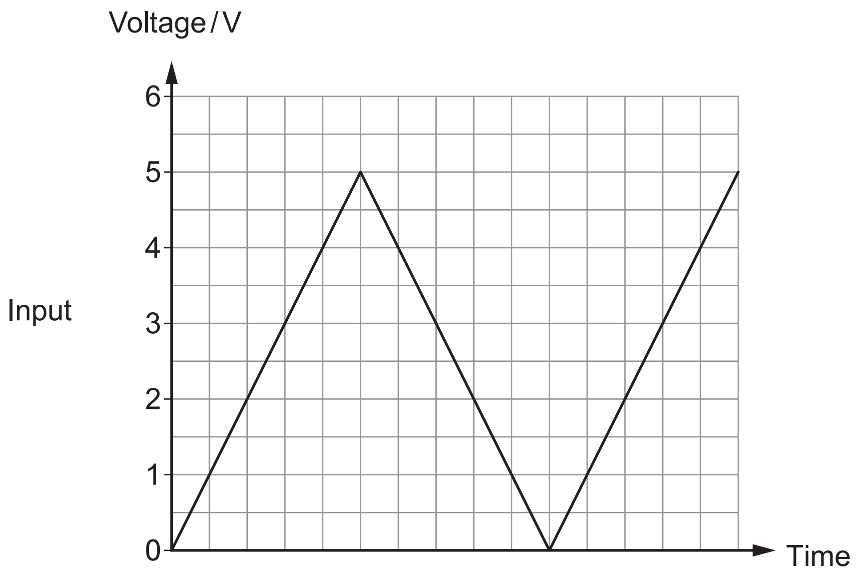
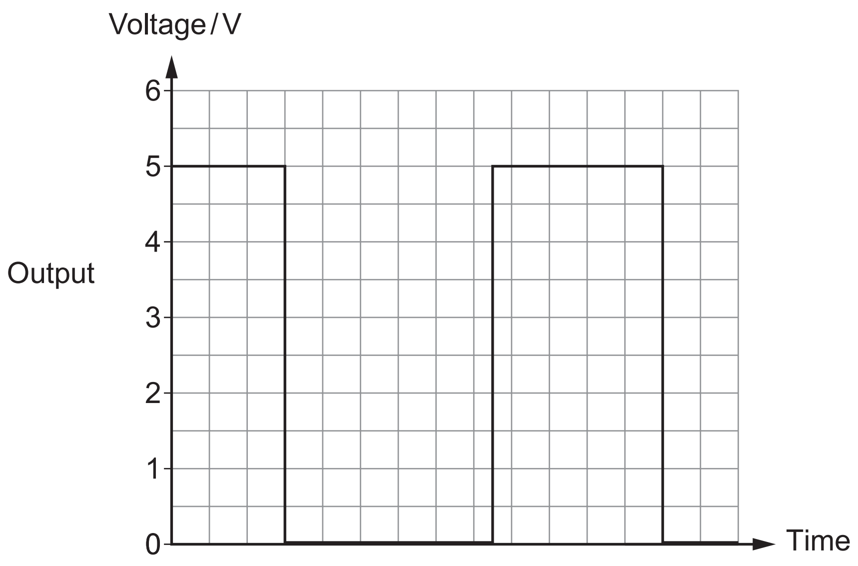
2. The performance of a Schmitt inverter is checked by applying a triangular waveform to the input. The graphs of the input and output signals are shown below.





(a) Determine the input switching threshold for: [2]

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

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

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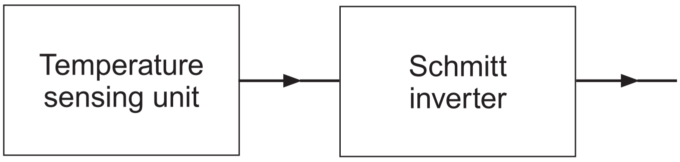
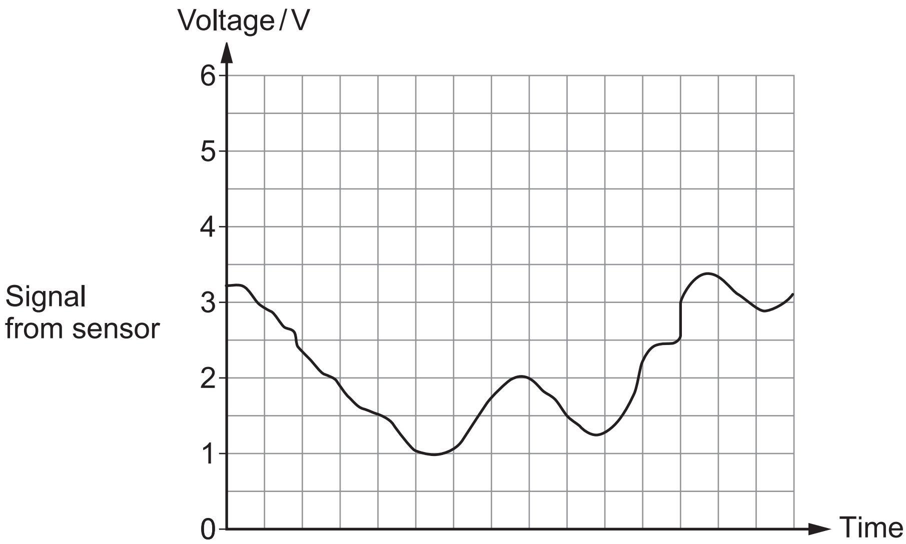
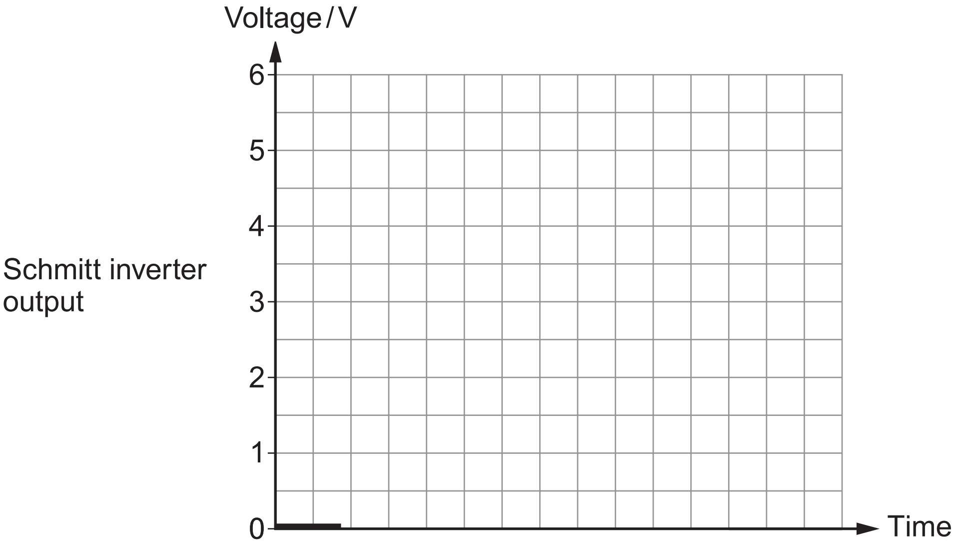
(b) The Schmitt inverter is used to condition the signal produced by a temperature sensing unit.



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





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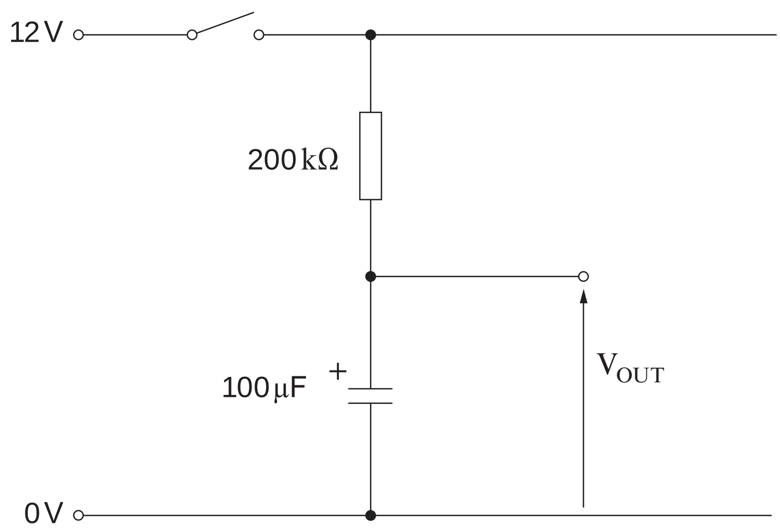
3. The capacitor shown in the following circuit is initially discharged.



(a) The switch is closed at time t = 0.

(i) Determine the time taken for V_{OUT} to increase to 6 V. [2]

....

....

(ii) Calculate the value of V_{OUT} at time t = 30 s. [2]

....

....

(iii) Estimate the time taken for V_{OUT} to reach approximately 12 V. [1]

....

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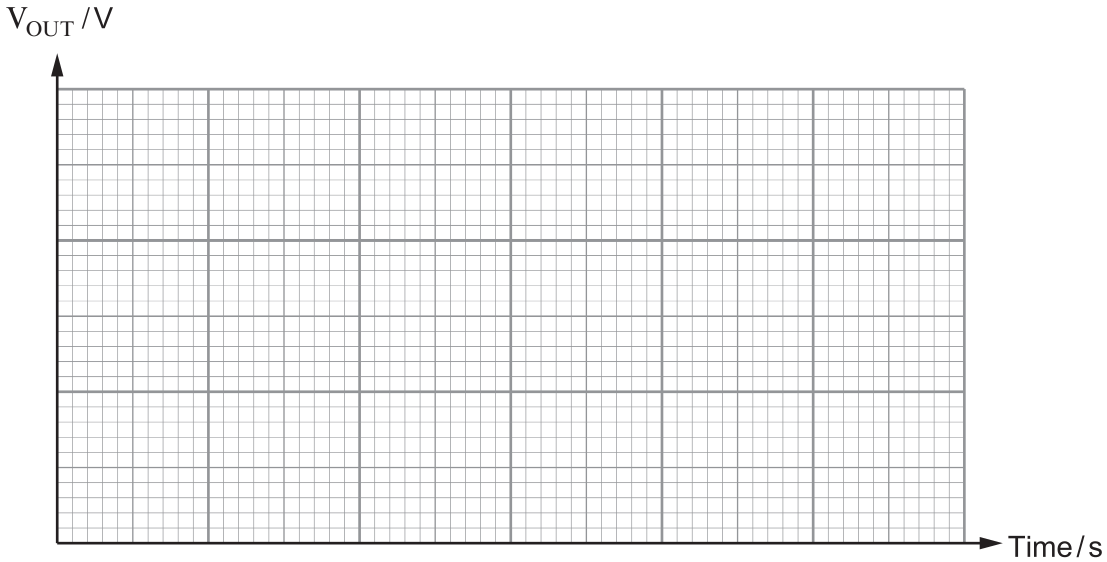
(b) (i) Use your answers to part *(a)* to complete the graph of V_{OUT} against time on the axes below. Label both axes with your chosen scale. [2]



(ii) Use the graph to estimate the time taken for V_{OUT} to reach 8 V. [1]

....

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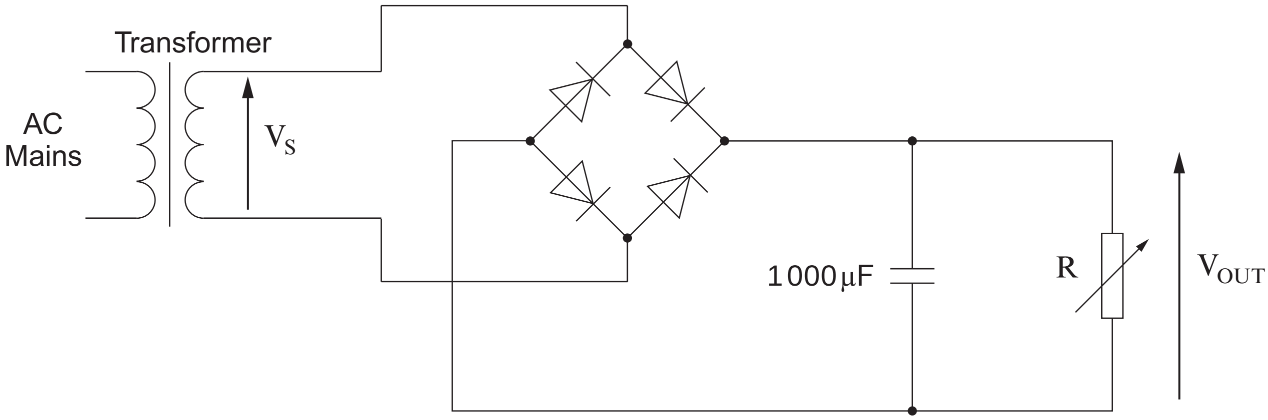
4. The following diagram shows the circuit of a full-wave rectified power supply connected to the 240 V, 50 Hz AC mains.

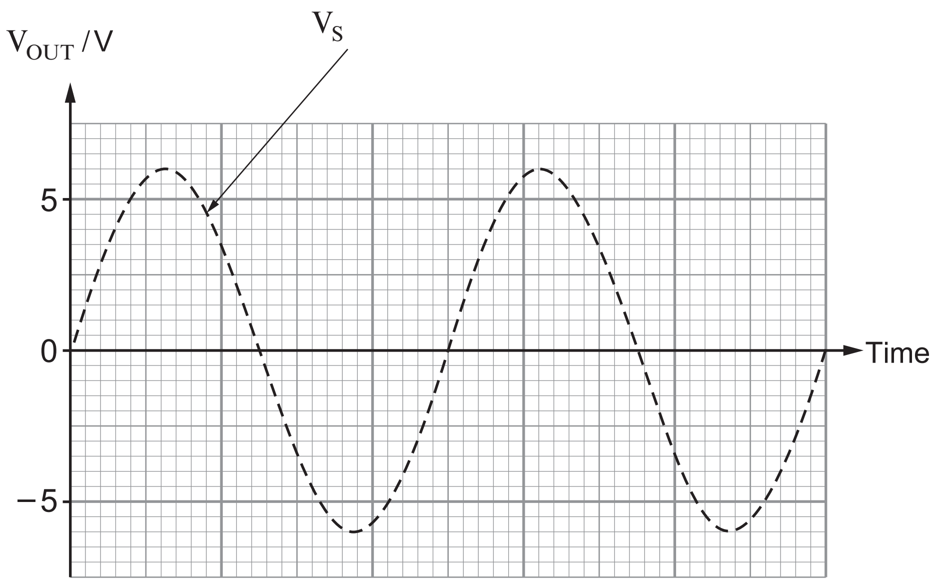


(a) In the graph below the voltage across the secondary windings of the transformer (V_S) is shown as a dotted waveform and has a peak voltage of 6 V.

(i) What is the **peak** value of the voltage V_{OUT}? [1]

....

(ii) On the axes provided below sketch the graph to show the output voltage V_{OUT} when a small current flows through the load resistor, R. [2]



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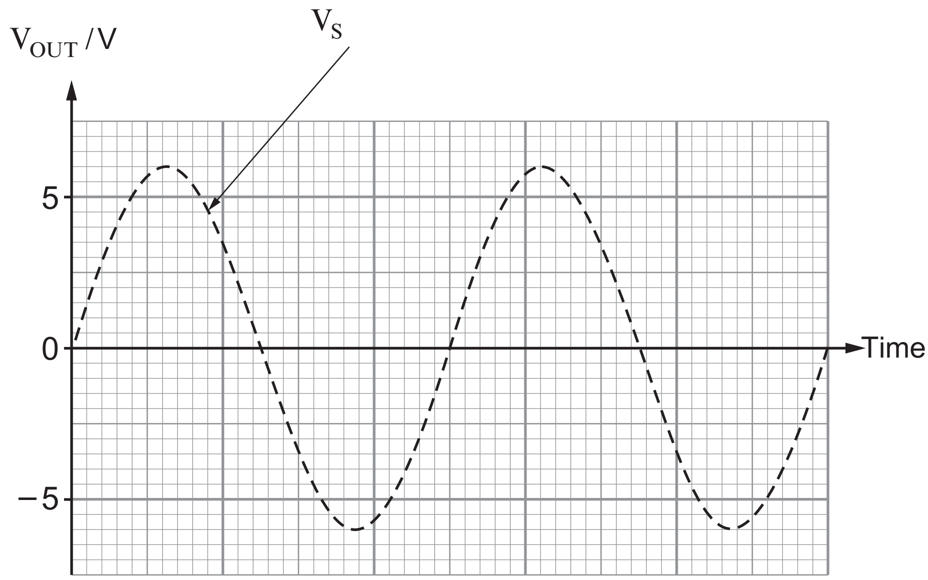
(b) R is adjusted to allow a large load current to flow. Use the axes below to sketch the resulting voltage V_{OUT}. [1]



(c) The 1000 μF capacitor is replaced with a 2200 μF capacitor. [2]

(i) What happens to the amplitude of the ripple voltage?

....

(ii) What is the frequency of the ripple voltage?

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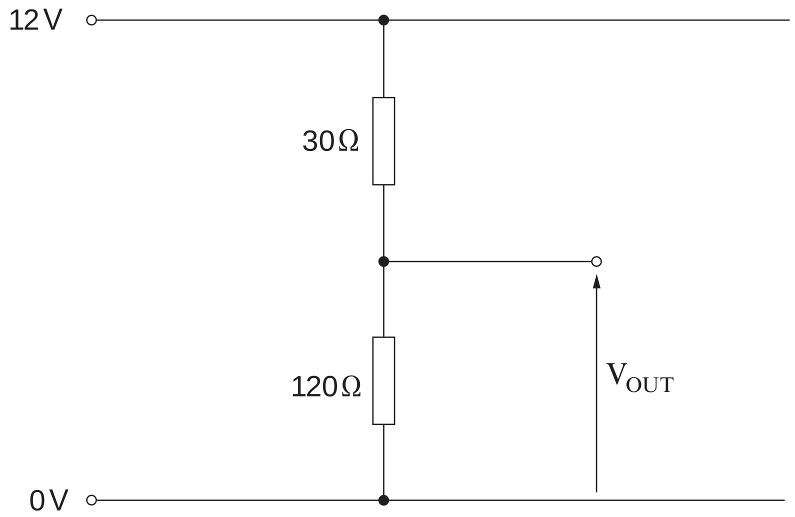
5. The following circuit is used as a voltage source.



(a) Thevenin's theorem is used to produce an equivalent circuit.

(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) This voltage source is used to drive two output devices each having a resistance of 72 Ω.

(i) Draw the equivalent circuit with the two 72 Ω output devices connected ***in parallel*** across the output. [1]

(ii) Use the equivalent circuit to calculate the power dissipated in **one** of the output devices. [3]

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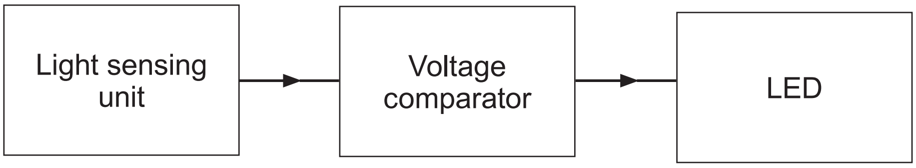
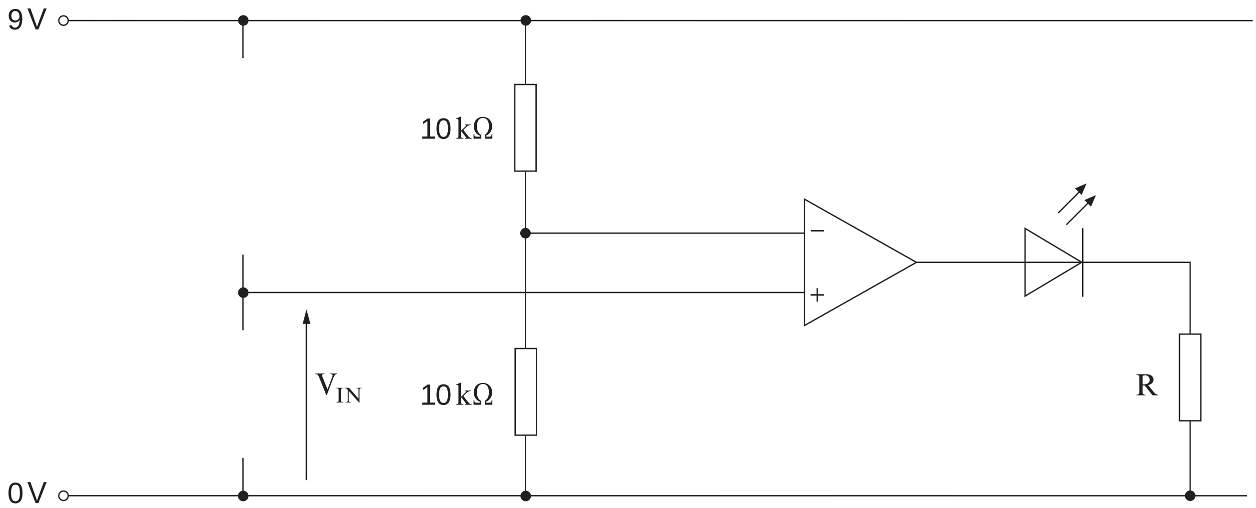
6. The block diagram for a simple light meter is shown below.



The incomplete circuit diagram for the system is shown below.



(a) The LED must come on when the light level drops below a certain value.

(i) **Complete the circuit diagram** by adding an LDR and another component. The input voltage that activates the LED should be adjustable. [3]

(ii) Determine the minimum value of V_{IN} at which the LED will come on. [1]

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(b) The following data sheet gives some properties for high intensity LEDs.

Colour	**Lum. int. (mcd) @ I_F = 30 mA**	**I_F max. (mA)**	**V_F typ. (V)**
White	30 000	50	3.6
Green	30 000	50	3.3
Red	20 000	50	2.1

(i) A high intensity green LED is chosen. The output voltage of the comparator is 9 V. Calculate the value of R, required to limit the current through the LED to a maximum of 40 mA. [2]

....

....

(ii) Select the preferred value for R from the E24 series. [1]

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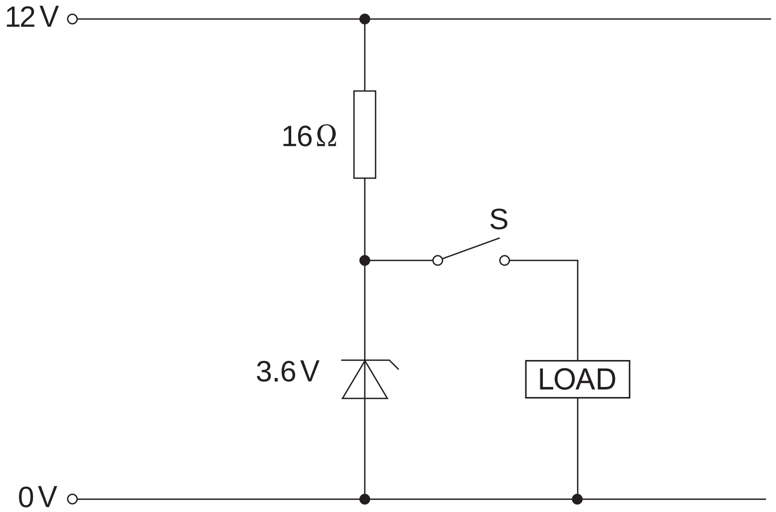
7. The following diagram shows a simple regulated power supply.



The zener diode requires a **minimum** current of 5 mA to maintain the zener voltage.

(a) Switch S is initially open.

(i) Calculate the current through the zener diode. [2]

....

....

....

(ii) Calculate the minimum power rating required for the zener diode. [2]

....

....

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

....

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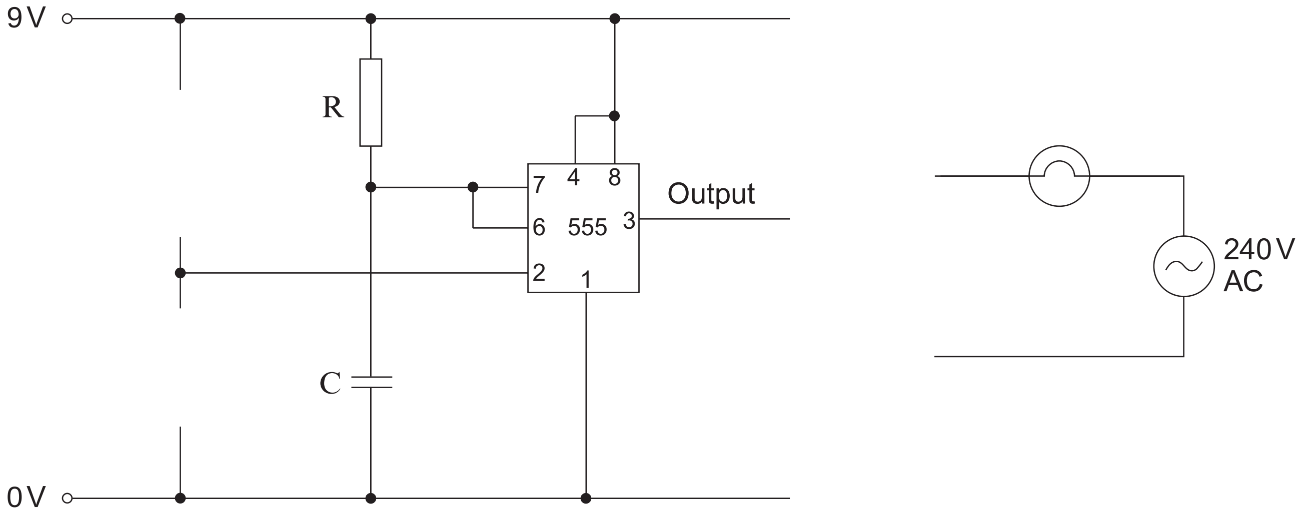
8. A 240 V AC mains lamp is used to light up a corridor.
The lamp comes on for a predetermined time when a switch is pressed.

The following diagram shows an incomplete circuit for a 555 monostable timer used to control the lamp.



(a) **Add** a switch and any other necessary component to the diagram to complete the trigger sub-system of the monostable. The 555 timer is *falling-edge-triggered*. [2]

(b) **Add** a relay and any connections to the circuit diagram to show how the 555 timer monostable output is interfaced to the mains lamp. [2]

(c) Capacitor C is a 470 μF capacitor. Calculate the ideal value of resistor R, so that the lamp will come on for 1 minute when the trigger switch is momentarily pressed. [3]

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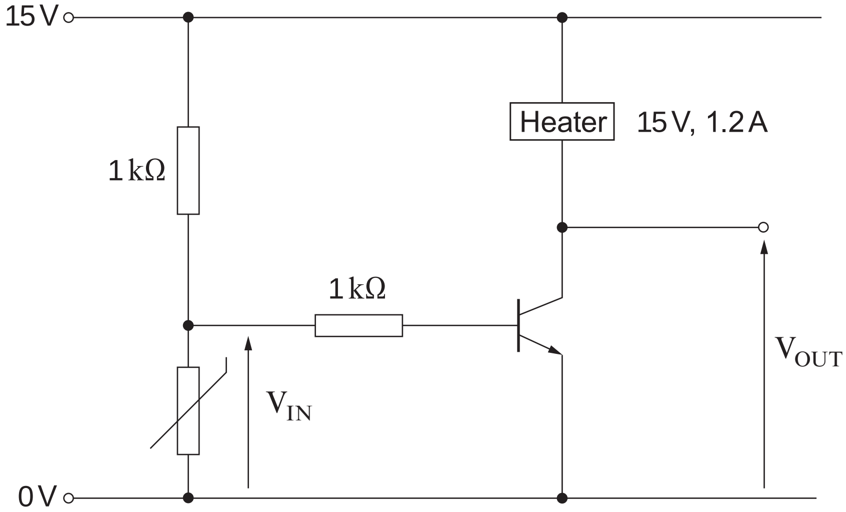
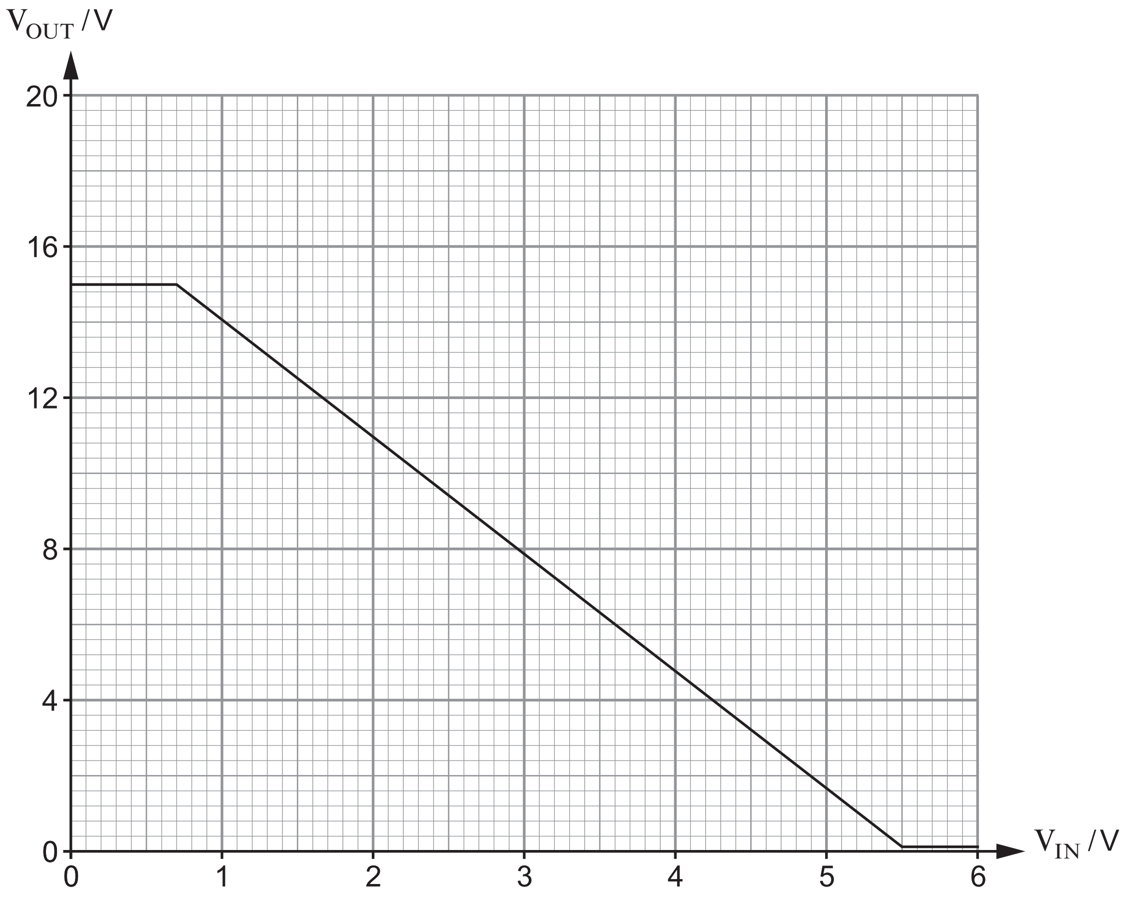
9. The following switching circuit is used to operate a heater when the temperature in a seed propagator decreases below a predetermined value.



(a) The relationship between V_{IN} and V_{OUT} as the temperature inside the propagator changes is shown below.



Use the graph to determine the minimum value of V_{IN} required to saturate the transistor. [1]

....

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(b) For this value of V_{IN} calculate:

(i) the base current; [2]

....

....

(ii) the transistor current gain (h_{FE}). [1]

....

....

(c) The thermistor has a resistance of 250 Ω at a certain temperature.

(i) Calculate the value of V_{IN}. [2]
(Assume that the base current is small enough to be ignored in this calculation.)

....

....

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

....

(iii) Describe the effect this would have on the transistor and why this problem would be overcome if the transistor were replaced with a MOSFET. [2]

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