

Surname	Centre Number	Candidate Number
Other Names		2



GCE AS/A level

1142/01

**ELECTRONICS
ET2**

P.M. FRIDAY, 18 May 2012

1¼ hours

For Examiner's Use Only		
Question	Maximum Mark	Mark Awarded
1.	6	
2.	5	
3.	7	
4.	6	
5.	9	
6.	7	
7.	5	
8.	8	
9.	7	
Total	60	

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 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 IN ET2

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

$$V_o = V_{\text{rms}}\sqrt{2}$$

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

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

$$t_L = 0.7R_B C$$

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

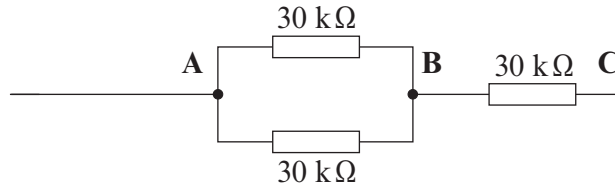
Schmitt Astable

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

1. (a) For the circuit below, calculate the effective resistance between:

(i) points A and B

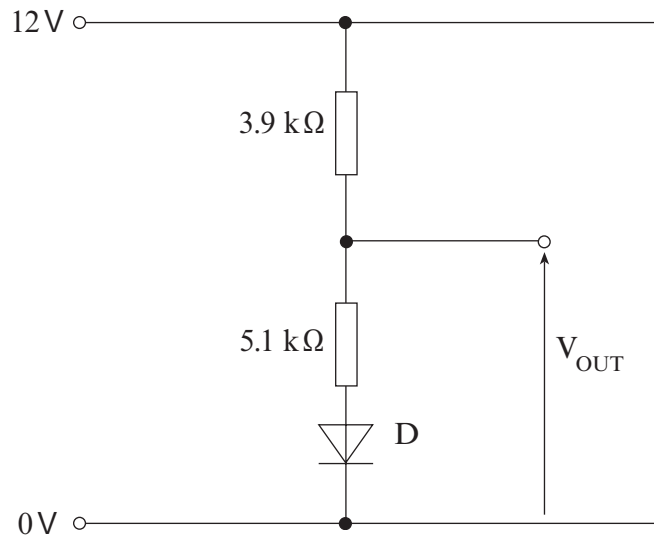
(ii) points A and C



[2]

(b) In the following circuit, D is a silicon diode.

(i) Calculate the voltage V_{OUT} .



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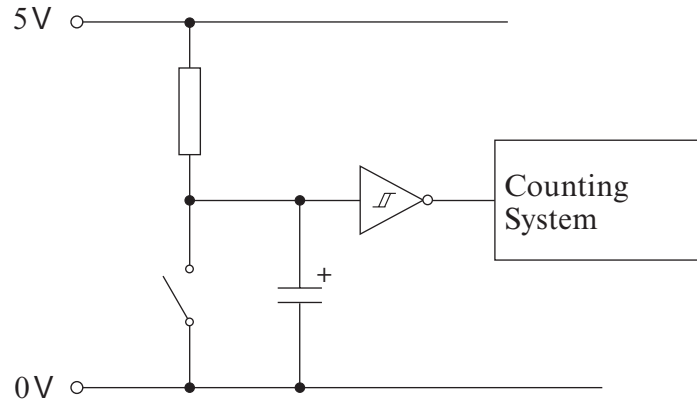
[3]

(ii) Diode D is reversed. What is the new value of V_{OUT} ?

[1]

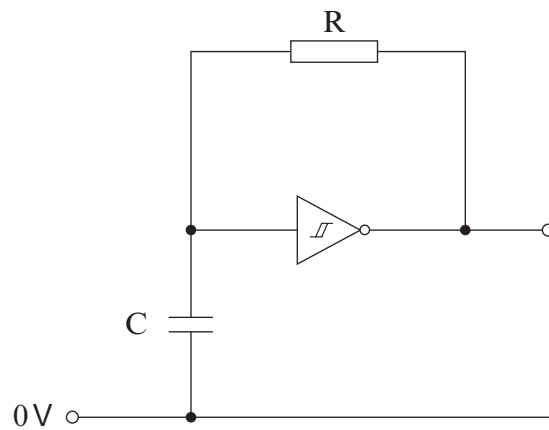
2. Schmitt inverters have many uses in electronics.

- (a) (i) What is the combined effect of the capacitor and Schmitt inverter on the signal from the switch?



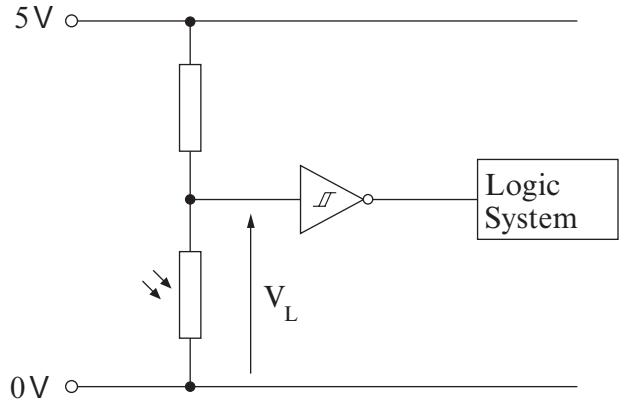
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 [1]

- (ii) What is the name for the sub-system shown in the circuit diagram?



Name: [1]

(b) Here is a Schmitt inverter being used to condition the signal produced by a light sensor.

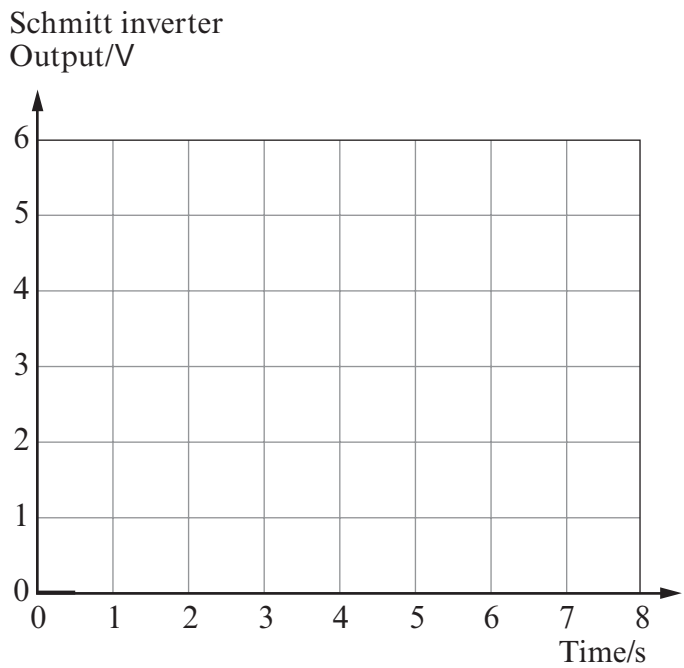
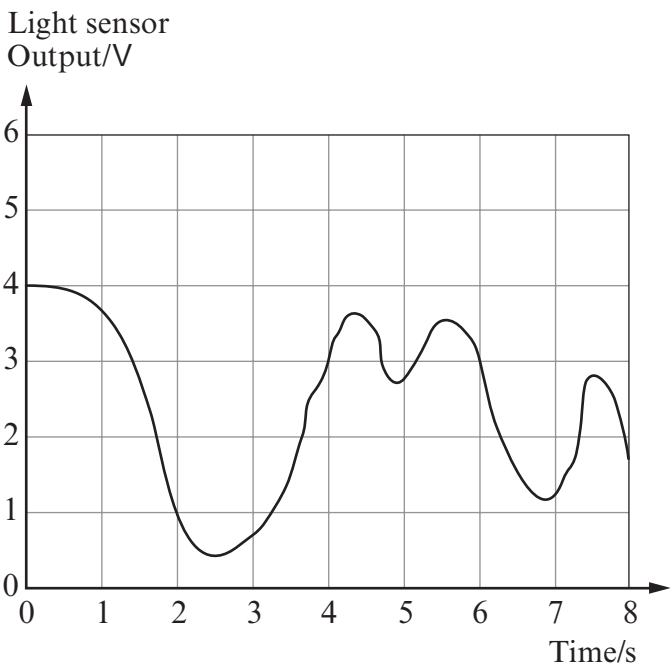


When connected to a 5V supply, the Schmitt inverter has the following properties

- logic 0 = 0V
- logic 1 = 5V
- the output changes from logic 1 to logic 0 when a **rising** input voltage reaches 3V
- the output changes from logic 0 to logic 1 when a **falling** input voltage reaches 1V

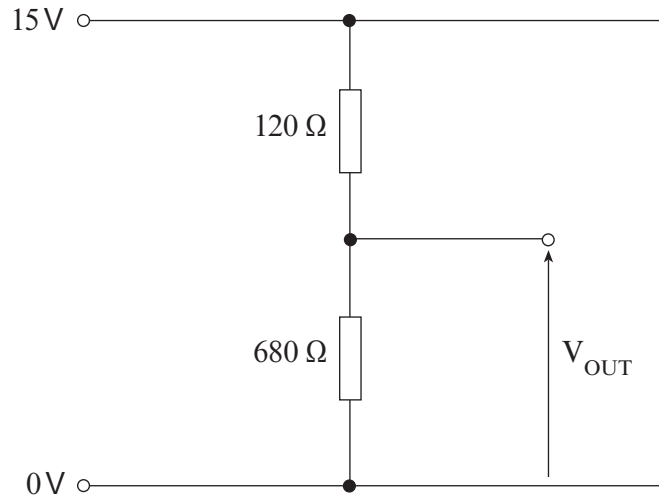
The first graph below shows the light sensor output, V_L .

Complete the second graph to show the signal obtained at the output of the Schmitt inverter.



[3]

3. 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} .

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

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- (iii) Calculate the equivalent resistance R_O .

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[3]

(b) (i) Draw the equivalent circuit with a load resistance connected across the output terminals.

(ii) The voltage across the load must not drop below 10V. Use the equivalent circuit to calculate the minimum load resistance in this situation.

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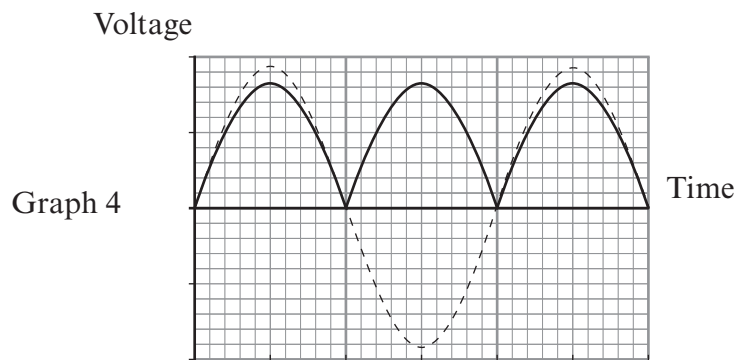
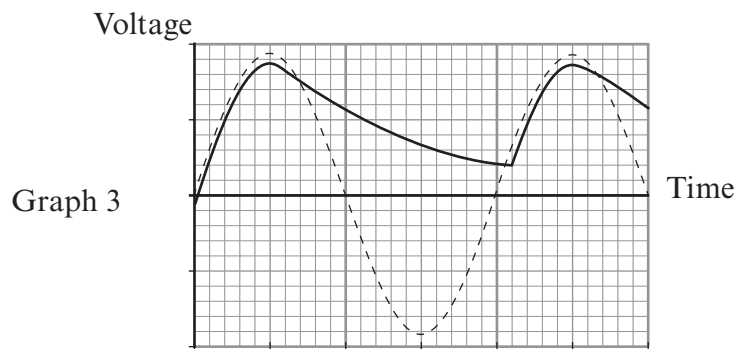
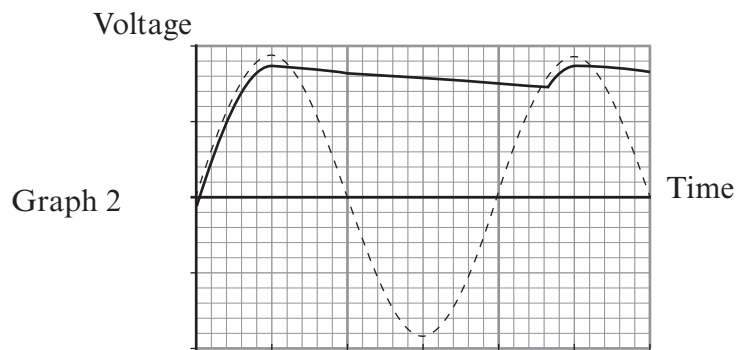
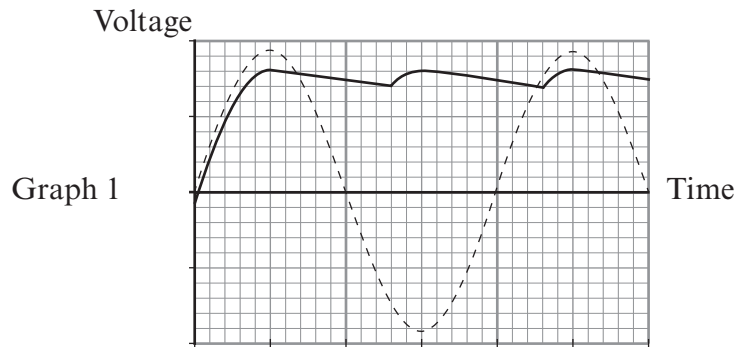
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[4]

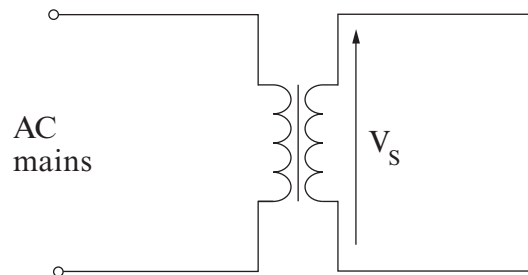
4. Here are four waveforms produced by diode rectifiers. All four graphs have the same scales on the voltage and time axes.
The voltage across the secondary windings of the transformer is shown as a dotted waveform.



(a) Complete the following statements using the appropriate graph number.

- (i) The smoothed output of a half-wave rectifier with a large ripple voltage is shown in graph
- (ii) The smoothed output of a full-wave rectifier with a small ripple voltage is shown in graph
- (iii) The unsmoothed output of a full-wave rectifier is shown in graph [3]

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

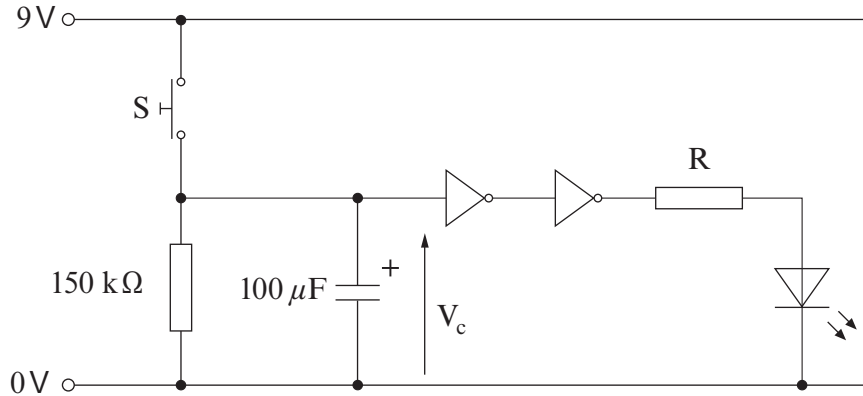


Complete the circuit by adding:

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

[3]

5. Here is the circuit diagram for a monostable.



The CMOS inverting buffers (NOT gates) have the following parameters:

<i>Parameter</i>	<i>Value</i>
Input switching threshold	Half supply voltage
Input impedance	Infinite
Output current capability	30 mA
Output voltage	Supply voltage

(a) Initially the capacitor is discharged. State whether the LED is on or off. Explain your answer.

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[1]

(b) Switch S is momentarily closed.

(i) What is the voltage, V_c , across the capacitor at this instant?

(ii) Determine the time taken for V_c to fall to half the supply voltage.

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[3]

(iii) State clearly what happens to the LED over a period of 20 s.

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[2]

(c) The LED is lit and the forward voltage drop across the LED is 2V.

(i) Calculate the voltage drop across resistor R.

(ii) Calculate the value of resistance required to limit the current through the LED to a maximum of 25 mA.

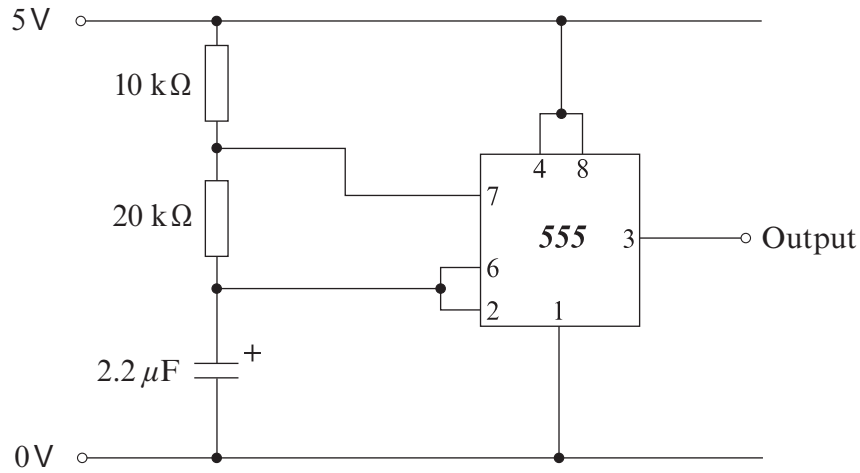
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(iii) Select the preferred value of resistor that you would use from the E24 series. Give a reason for your choice.

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[3]

6. The diagram shows an astable circuit.



(a) Calculate the value of the *mark* and *space* for the astable.

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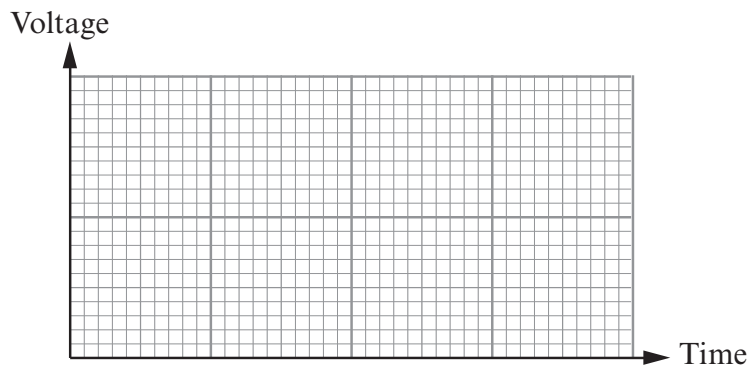
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[3]

(b) Draw a sketch to illustrate the shape of one complete cycle of the output waveform. Label the *mark* T_1 , the *space* T_2 and include suitable scales on both axes.



[2]

(c) Calculate the frequency of the output waveform.

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[2]

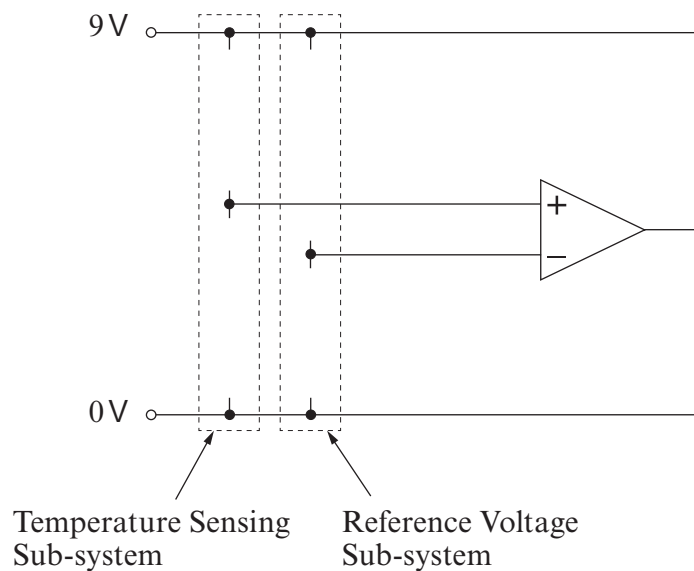
7. An electric fan is used to prevent overheating in a computer.

The specification for the system is:

- the system requires a 9 V power supply
- the temperature at which the fan comes on should be adjustable
- the fan motor is capable of being driven directly from the comparator output.

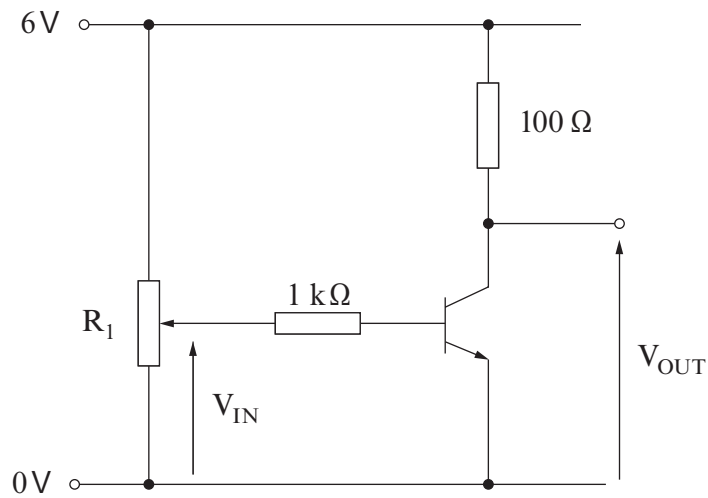
Complete the circuit diagram for a system by adding:

- the reference voltage sub-system to provide a reference voltage of 6 V
- the component values used in the reference voltage sub-system
- the sensing sub-system
- the output sub-system



[5]

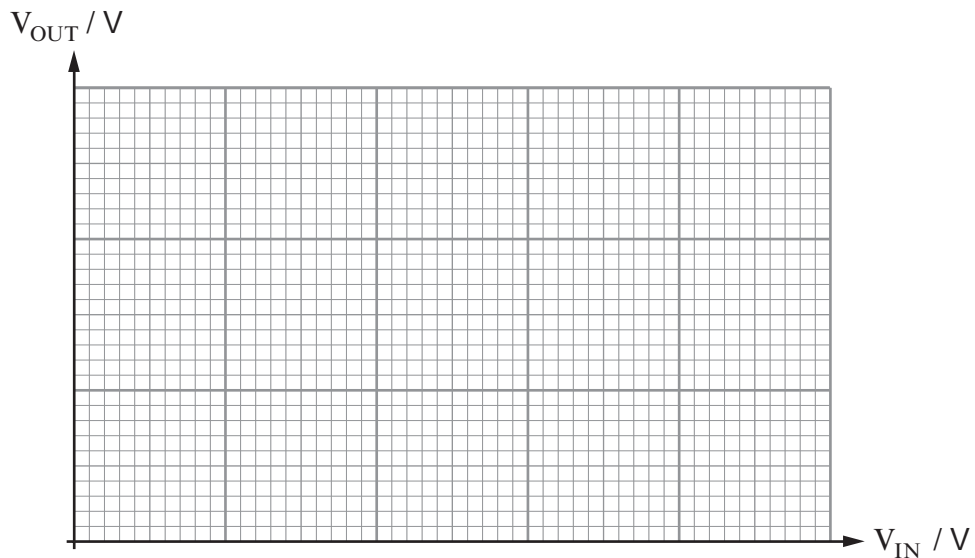
8. The following circuit is used to investigate a transistor switching circuit.



(a) The table shows the results obtained for values of base voltage (V_{IN}) and collector emitter voltage (V_{OUT}) as the base voltage is gradually increased from 0 to 2.25 V.

V_{IN} / V	V_{OUT} / V
0.25	6.00
0.50	6.00
0.75	5.45
1.00	3.27
1.25	0.65
1.50	0.32
1.75	0.21
2.00	0.21
2.25	0.21

(i) Plot a graph of V_{OUT} against V_{IN} on the axes below. Label both axes with your chosen scales.



- (ii) Use the graph to determine the minimum value of V_{IN} that will cause the transistor to saturate.

..... [1]

- (iii) Use this value of V_{IN} to calculate the base current.

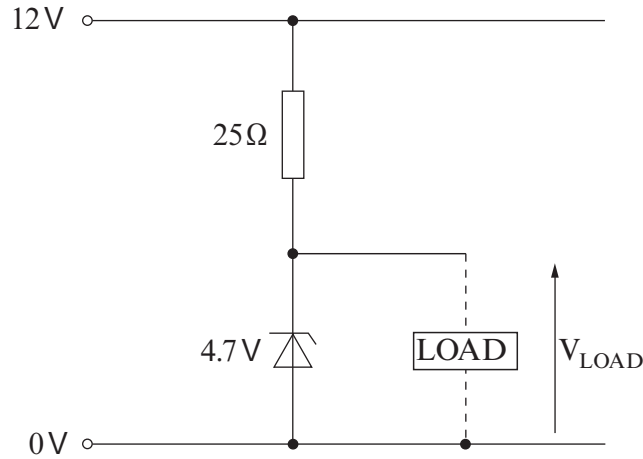
..... [2]
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- (b) Calculate the collector current when the transistor is just saturated and hence determine the current gain (h_{FE}) of the transistor.

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TURN OVER FOR QUESTION 9

9. The following diagram shows a simple regulated power supply. The zener diode requires a **minimum** current of 7 mA to maintain the zener voltage.



- (a) Calculate the current through the 25 Ω resistor when there is no load connected.

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[2]

- (b) Calculate the minimum power rating required for the 25 Ω resistor.

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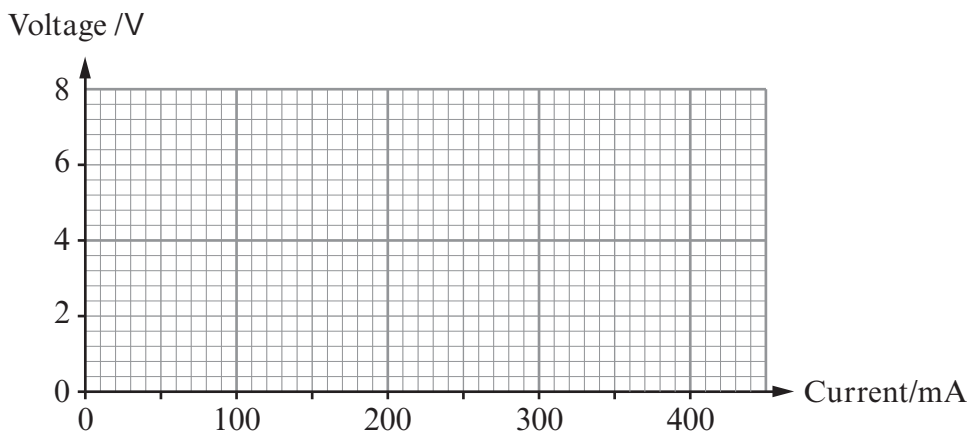
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[2]

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

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- (d) Sketch a graph to show how V_{LOAD} changes as the load current is increased gradually from 0 to 400 mA.



[2]

THERE ARE NO MORE QUESTIONS IN THE EXAMINATION