Candidate Name	Centre Number	Candidate Number
		2

GCE AS/A level

382/01

ELECTRONICS
ET2

A.M. FRIDAY, 16 May 2008

1½ hours

For Examiner's use only.	
1	
2	
3	
4	
5	
6	
7	
8	
9	
Total	

ADDITIONAL MATERIALS

In addition to this examination paper, you will need a calculator.

INSTRUCTIONS TO CANDIDATES

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 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.

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.

RC networks

$V_C = V_O (1 - e^{-t/RC})$ for a charging capacitor

$V_C = V_O e^{-t/RC}$ for a discharging capacitor

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

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

Alternating Voltages

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

Silicon Diode

$V_F \approx 0{\cdot}7\,V$

Bipolar Transistor

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

$V_{BE} \approx 0{\cdot}7\,V$ in the on state

MOSFETs

$I_D = g_M V_{GS}$

Operational amplifier

$G = -\frac{R_F}{R_{IN}}$ Inverting amplifier

$G = 1 + \frac{R_F}{R_1}$ Non-inverting amplifier

$V_{OUT} = -R_F\left(\frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}\right)$ Summing amplifier

$\text{Slew Rate} = \frac{\Delta V_{OUT}}{\Delta t}$ Slew rate

555 Monostable

$T = 1{\cdot}1\,RC$

555 Astable

$t_H = 0{\cdot}7\,(R_A + R_B)C$

$t_L = 0{\cdot}7\,R_B C$

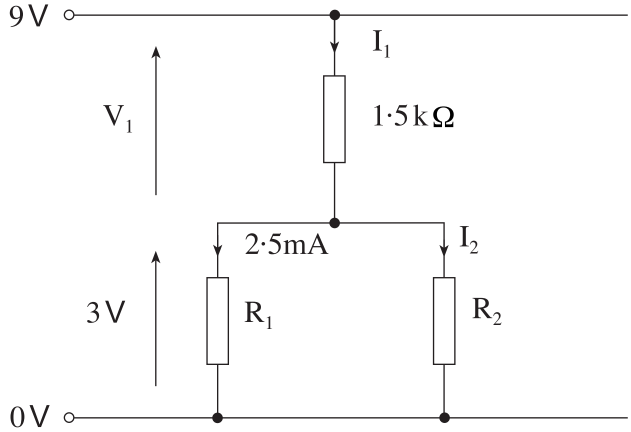
$f = \frac{1{\cdot}44}{(R_A + 2R_B)C}$

Schmitt Astable

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

Examiner only

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



(a) V_1 ....

....

(b) I_1 ....

....

(c) R_1 ....

....

(d) I_2 ....

....

(e) R_2 ....

....

(f) Calculate the effective resistance of the parallel combination R_1 and R_2.

....

....

[7]

Turn over.

2. Electronic systems may contain monostable and astable sub-systems.

(a) Draw sketches to illustrate the output waveform produced by each sub-system. Your sketches should show clearly how the waveforms differ.

[2]

(b) Give one application for each sub-system.

(i) Monostable

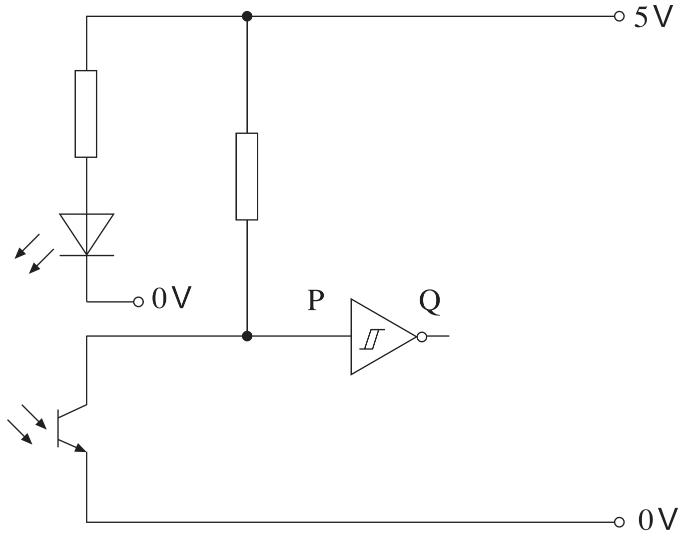
(ii) Astable

[2]

(c) Draw the circuit diagram for an astable sub-system.

[3]

3. A driverless vehicle in a warehouse is designed to follow a white line painted on a black background.
Part of the electronic system that checks if the vehicle is on the white line makes use of a LED and phototransistor.



(a) State whether the voltage levels at P and Q are high or low when the LED and phototransistor are:

(i) Over the white line

P = ... Q = ... [1]

(ii) Over the black background

P = ... Q = ... [1]

(b) Explain why it is desirable to include a **Schmitt** inverter rather than use a NOT gate in this circuit:

....

.... [1]

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

(i) Calculate the value of resistance required to limit the current through the LED to not more than 35 mA.

....

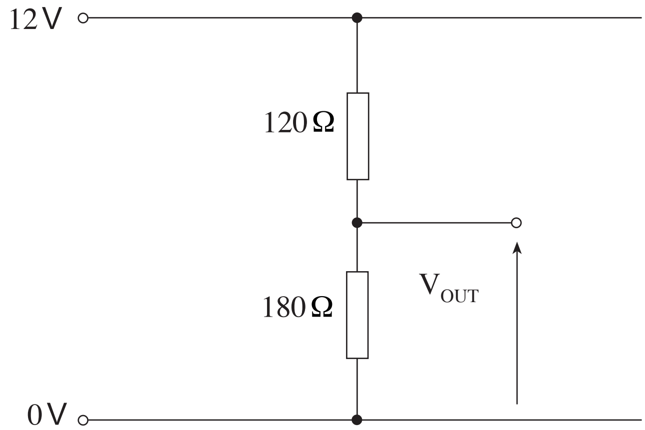
.... [2]

(ii) Select the preferred value of resistor that you would use from the E24 series.

.... [1]

Examiner only

4. 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}.

....

....

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

....

....

(iii) Calculate the equivalent resistance R_O.

....

....

[3]

Examiner only

(b) (i) Draw the equivalent circuit with a load resistance of 200 Ω connected across the output terminals.

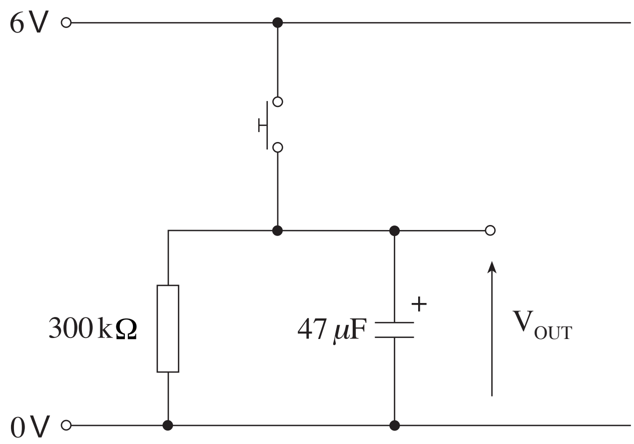
(ii) Use the equivalent circuit to calculate the voltage drop across the output terminals.

....

....

[2]

5. The following diagram shows a timing system.



(a) Calculate the time constant of the timing system.

[2]

(b) The switch is **momentarily** closed at time t = 0, and the capacitor is initially uncharged.

(i) Estimate the time taken for the capacitor to fully charge.

[1]

(ii) Determine the time taken for V_{OUT} to fall to 3 V.

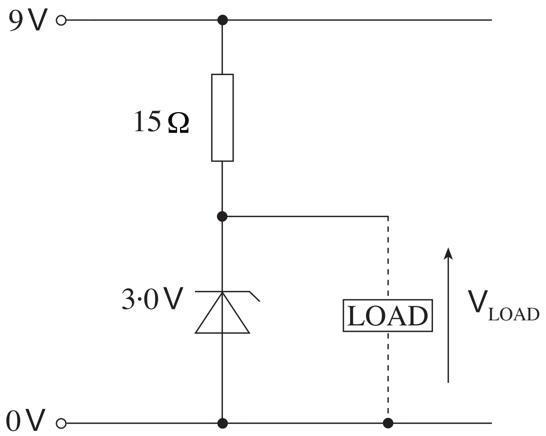
[2]

(iii) Calculate the value of V_{OUT} at time t = 3 s.

[2]

Examiner only

6. The following diagram shows a simple power supply based on a zener diode.



The table gives information from a data sheet for the zener diode

Type	BZX85 series
Zener voltage	3·0V
Power rating	1·3W
Minimum zener current	6 mA

(a) Calculate the value of the current through the zener diode when there is no load connected?

....

....

....

[2]

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

....

....

[1]

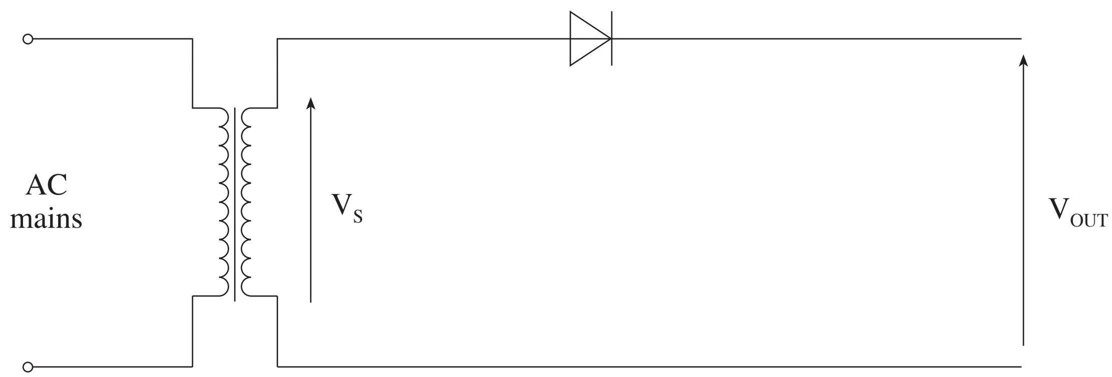
(c) Show by calculation whether the power rating of the zener is sufficient when there is no load connected.

....

....

[2]

7. The following diagram shows part of a half-wave rectified power supply without a smoothing capacitor or a load resistor.



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

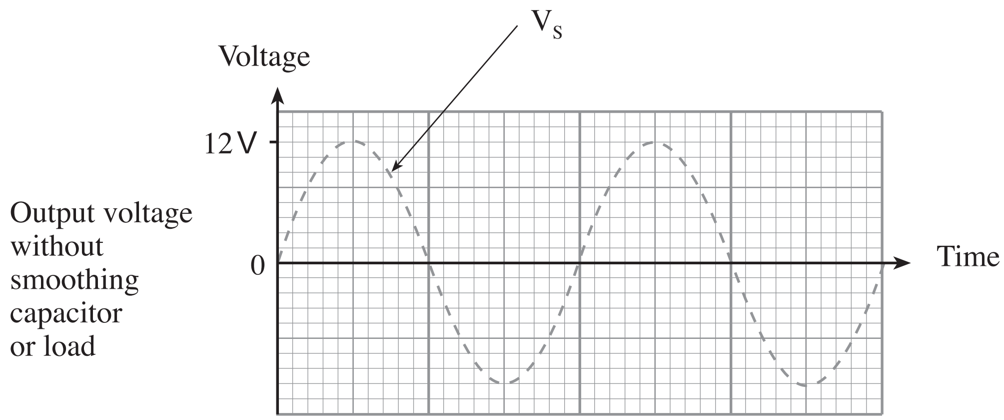
....

[1]

(b) On the axes provided below, sketch a graph to show the voltage V_{OUT}.

Label the axes with any relevant voltages.

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

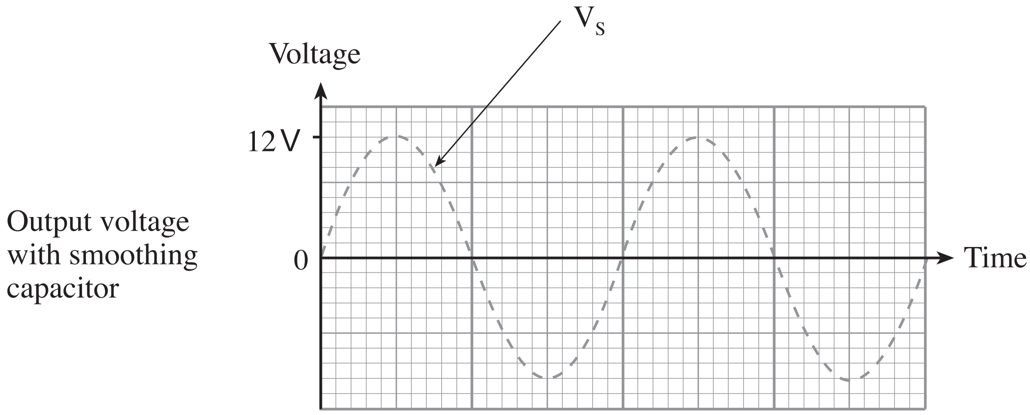


[2]

Examiner only

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

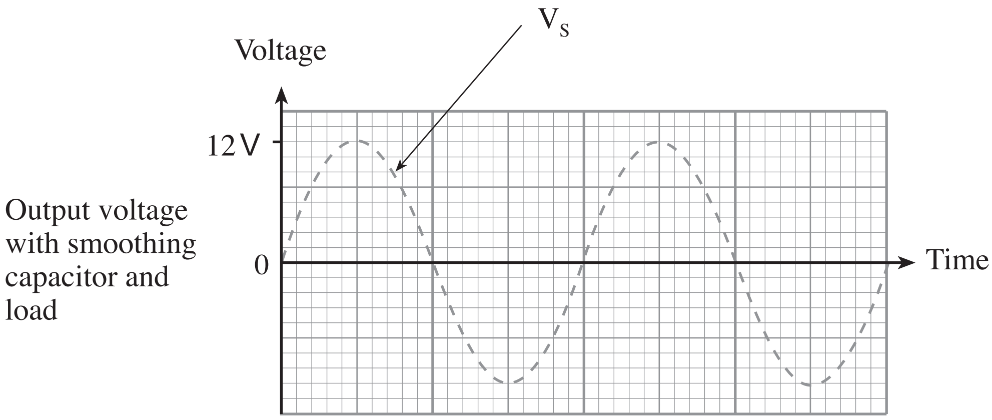
(ii) Show the effect of the smoothing capacitor on the output voltage. Use the next set of axes to sketch V_{OUT} for this modified circuit.



[2]

(d) (i) Add a load resistor to the circuit diagram.

(ii) Show the effect of the load resistor on the output voltage. Use the next set of axes to sketch V_{OUT} for this modified circuit.



[2]

(e) The half-wave rectifier is replaced with a full-wave rectifier.

(i) What effect will this have on the amplitude of the ripple voltage?

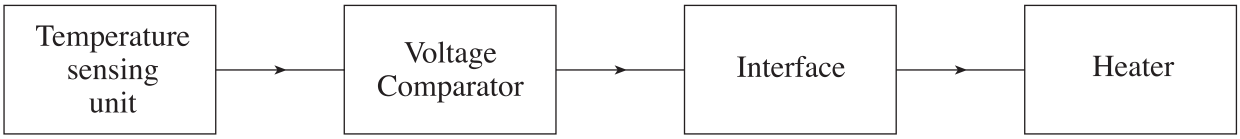
....

(ii) If the mains frequency is 50 Hz, what will be the frequency of the ripple voltage?

....

[2]

8. The system shown below is used to control the temperature in a greenhouse.



The heater which is rated at 12 V, 9A comes on when the temperature drops below a predetermined value.

(a) You are asked to choose between an npn transistor and a MOSFET for the interface circuit.

The data sheets for the two options are given below

MOSFET

V_{GS}/V (max)	I_D/A (max)	g_M/S	P_{TOT}/W
15	10	0·95	50

Transistor

h_{FE} (min)	I_C/A (max)	P_{TOT}/W
48	10	50

When connected to the 12 V power supply the maximum output current and voltage available from the comparator are 170 mA and 11 V respectively. The heater current should be 9 A.

(i) What collector current would be produced by the npn transistor when the comparator outputs 170 mA?

....

(ii) What input voltage is needed by the MOSFET to produce an output current of 9 A?

....

(iii) Use these results to decide whether the npn transistor or the MOSFET is more suitable for use as the interface device. Explain how you arrive at your decision.

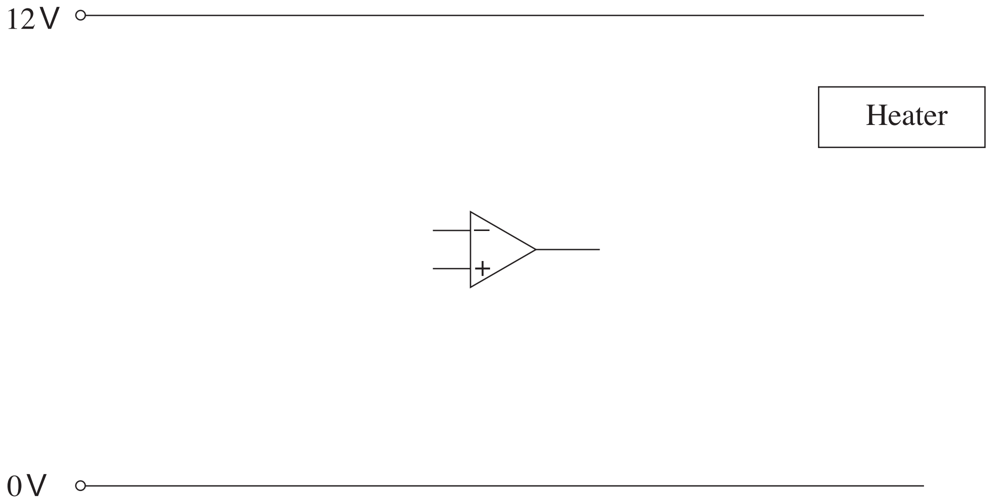
....

....

[3]

Examiner only

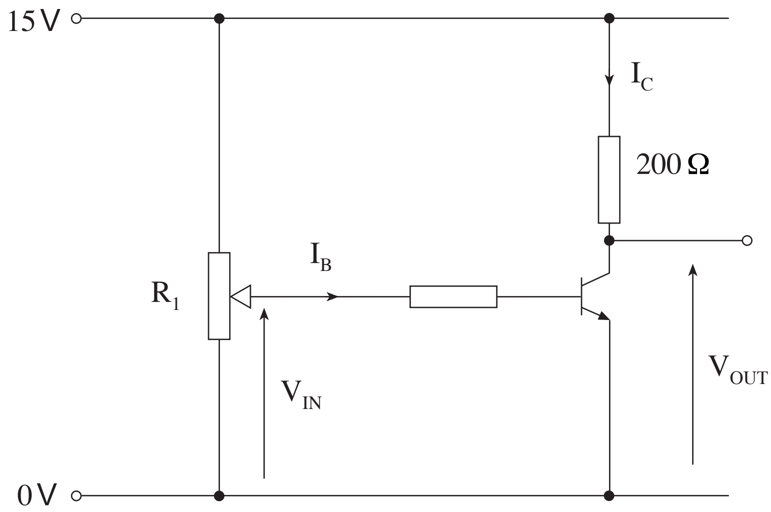
(b) Complete the circuit diagram for your design. The temperature at which the heater comes on should be adjustable.



[5]

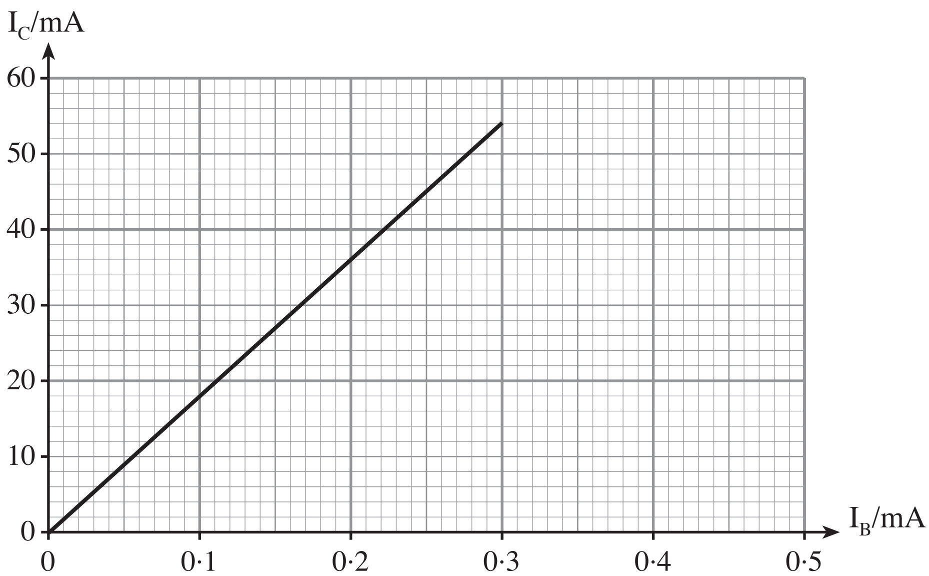
Examiner only

9. The following circuit is set up to investigate a transistor switching circuit.



Potentiometer R_1 is varied and readings of V_{IN}, V_{OUT}, I_B and I_C are taken.

(a) A graph is drawn to show how I_C changes as I_B is varied.



Determine the current gain (h_{FE}) of the transistor.

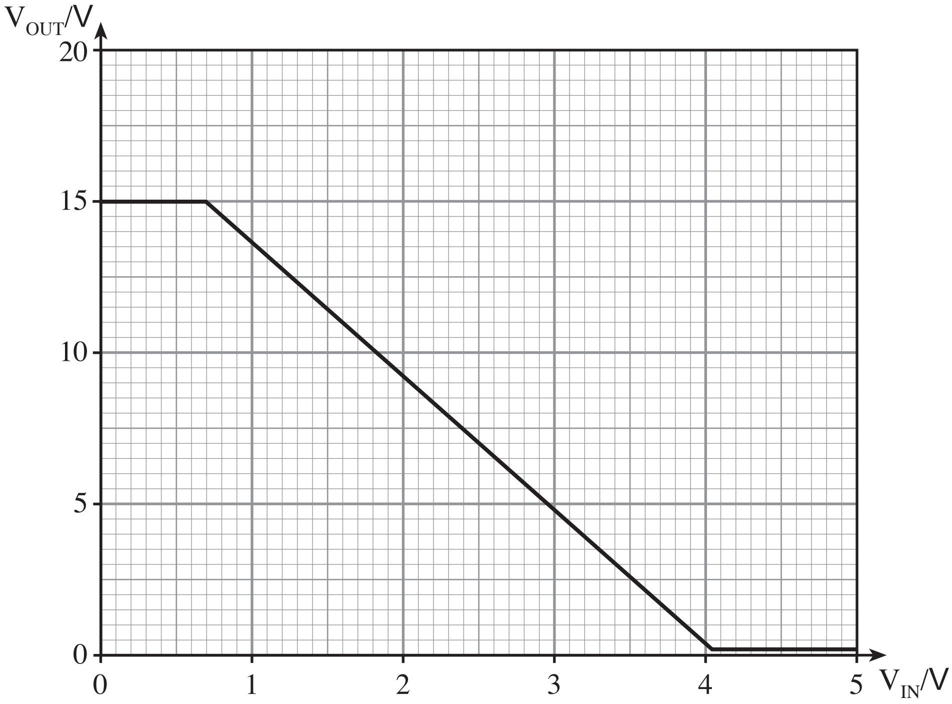
....

....

[1]

Examiner only

(b) A second graph is drawn to show how V_{OUT} changed as V_{IN} was increased.



Use the graph to determine

(i) the minimum value of V_{IN} required to saturate the transistor.

....

[1]

(ii) the value of V_{OUT} when V_{IN} = 2.5 V and the load resistor = 200 Ω.

....

[1]

(c) V_{IN} = 2.5 V and the load resistance is 200 Ω.

Calculate the collector current and the power dissipated in the transistor.

....

....

....

....

....

[3]