Surname	Centre Number	Candidate Number
Other Names		0

GCSE

4161/01

S17-4161-01

ELECTRONICS

UNIT E1: Paper replacement test

TUESDAY, 13 JUNE 2017 – AFTERNOON

1 hour

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**6**	
2.	**4**	
3.	**4**	
4.	**2**	
5.	**3**	
6.	**3**	
7.	**2**	
8.	**4**	
9.	**5**	
10.	**2**	
11.	**3**	
12.	**2**	
13.	**3**	
14.	**2**	
15.	**3**	
16.	**3**	
17.	**5**	
18.	**4**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this paper you may require a calculator and a ruler.

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 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.

INFORMATION SHEET FOR UNIT E1

This information may be of use in answering the questions.

1. Resistor Colour Codes

BLACK	**0**	**GREEN**	**5**
BROWN	**1**	**BLUE**	**6**
RED	**2**	**VIOLET**	**7**
ORANGE	**3**	**GREY**	**8**
YELLOW	**4**	**WHITE**	**9**

The fourth band colour gives the tolerance as follows:

GOLD ± 5%

SILVER ± 10%

2. Preferred Values for Resistors – E24 series

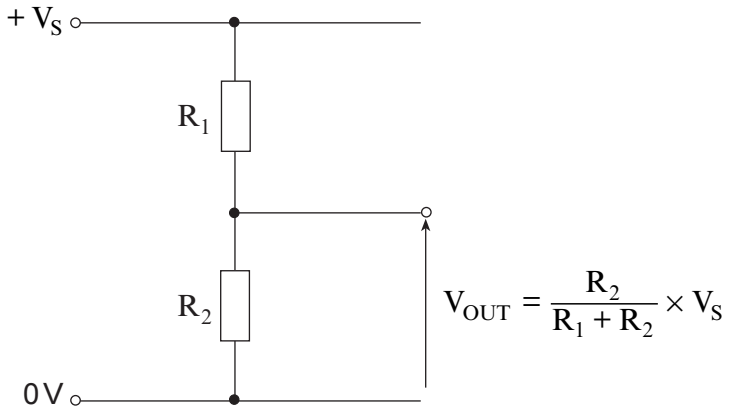
10, 11, 12, 13, 15, 16, 18, 20, 22, 24, 27, 30, 33, 36, 39, 43, 47, 51, 56, 62, 68, 75, 82, 91.

3. Resistance = $\frac{\text{voltage}}{\text{current}}$; $R = \frac{V}{I}$.

4. Effective resistance, R, of two resistors R_1 and R_2 in series is given by $R = R_1 + R_2$.

5. Effective resistance, R, of two resistors R_1 and R_2 in parallel is given by $R = \frac{R_1 R_2}{R_1 + R_2}$.

6. Voltage Divider



7. Power = voltage × current; $P = VI = I^2R = \frac{V^2}{R}$.

8. LED The forward voltage drop across a LED is 2 V.

9. NPN Transistors (i) Current gain = $\frac{\text{Collector current}}{\text{Base current}}$; $h_{FE} = \frac{I_C}{I_B}$.

(ii) The forward voltage drop across the base emitter junction is 0.7 V.

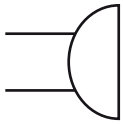
Answer **all** *questions.*

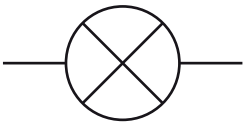
1. *(a)* Here is a list of electronic components.

Resistor Lamp Push-to-make switch Thyristor

Push-to-break switch LED Buzzer

Complete each box with the correct name for **each** component. [3]





(b) The following is a list of different electronic sub-systems.

NOT gate Latch unit Sound sensing unit Delay unit Pulse generator

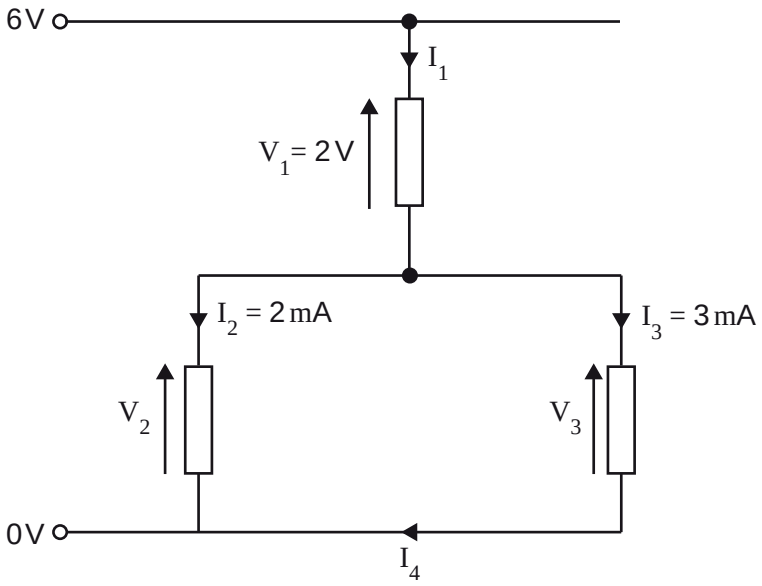
Magnetic switch unit Motor unit Lamp unit Comparator

Write each sub-system into the correct column in the table below. [3]

Input sub-system	Processing sub-system	Output sub-system

Examiner only

2. Study the following circuit.



Select the correct answers to the following questions.

0	1	2	3	4	5	6	7	8	9	10	11	12	13

(a) What is the value of V_2? ..... V [1]

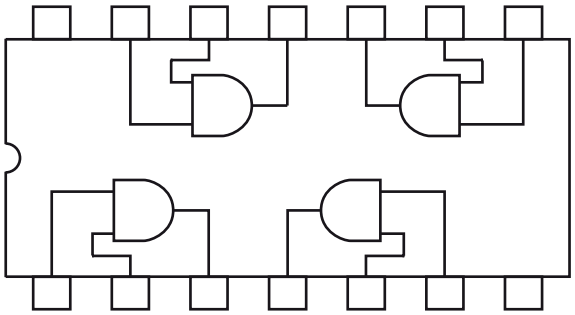
(b) What is the value of I_1? ..... mA [1]

(c) What is the value of V_3? ..... V [1]

(d) What is the value of I_4? ..... mA [1]

Examiner only

3. Here is the pinout for a logic gate IC.



On the diagram write:

(a) the letter 'Q' on all output pins; [1]

(b) the symbol '+' on the positive supply pin; [1]

(c) the number '9' on pin 9. [1]

(d) What type of logic gate is shown in the diagram? ..... [1]

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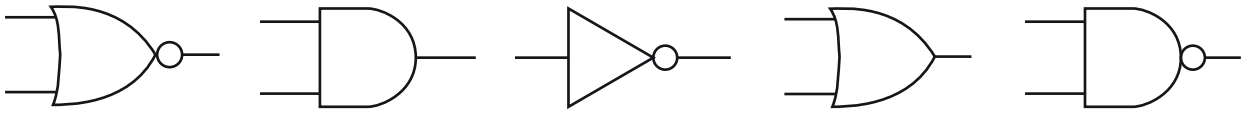
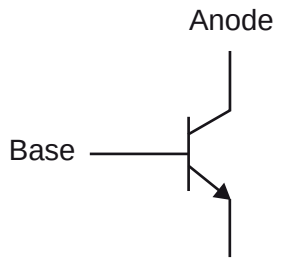
4. Draw the correct logic gate to match the name in the table below. [2]



Logic gate name	Symbol
NOR gate	
NOT gate	

Examiner only

5. *(a)* The following diagram shows the circuit symbol for a transistor.
(Tick (✓) the correctly labelled symbol.) [1]



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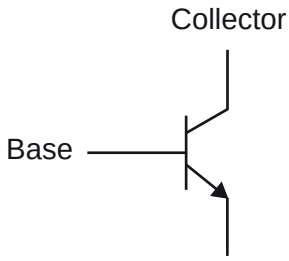

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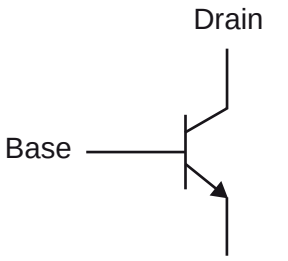

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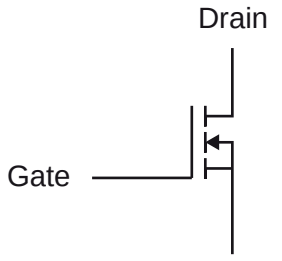
(b) The following diagram shows the circuit symbol for a MOSFET.
(Tick (✓) the correctly labelled symbol.) [1]



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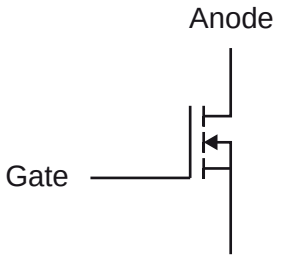

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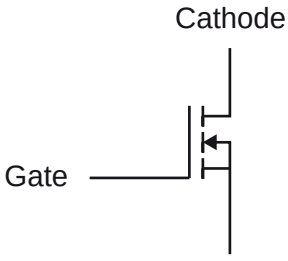

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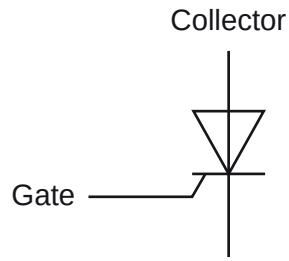
(c) The following diagram shows the circuit symbol for a thyristor.
(Tick (✓) the correctly labelled symbol.) [1]



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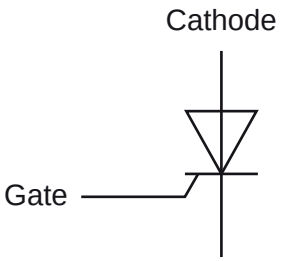

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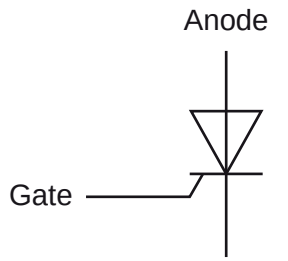

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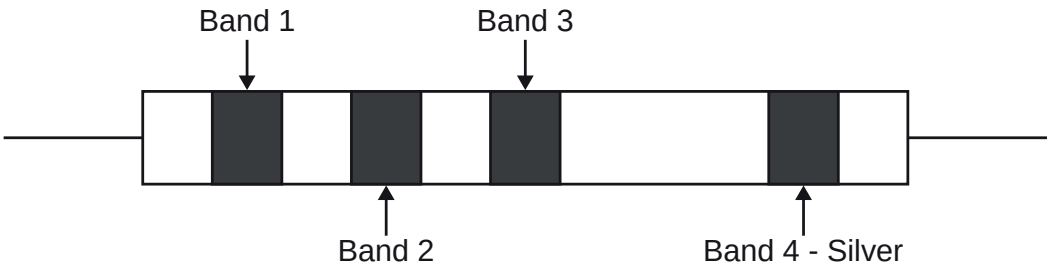
Examiner only

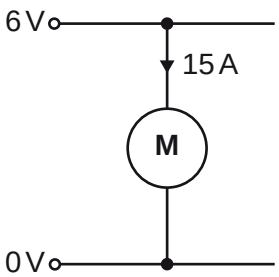
6. The diagram shows a 56 Ω ± 10% resistor.



Write down the correct colour of bands 1, 2 and 3 present on this resistor. [3]

Band 1 ..... Band 2 ..... Band 3 .....

7. The diagram shows a motor.



(a) Select the correct equation to calculate the power used in the motor in watts (W). (Tick (✓) the correct answer.) [1]

☐ $P = \frac{6}{15}$ ☐ $P = \frac{15}{6}$ ☐ $P = 6 \times 1500$

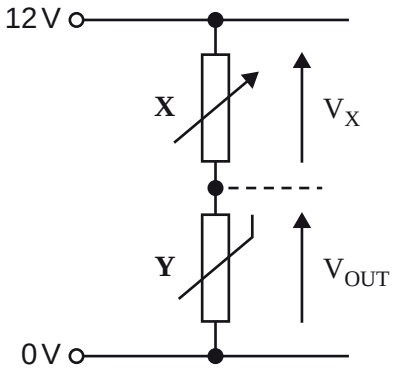
☐ $P = 6 \times 15$ ☐ $P = \frac{6}{1.5}$ ☐ $P = \frac{15000}{6}$

(b) Calculate the power used in the motor. [1]

..... W

Examiner only

8. Here is an analogue sensing circuit at room temperature.



(a) Circle the name of the component labelled **X**. [1]

LDR Resistor Thermistor Variable resistor

(b) V_{OUT} = 3 V. Circle the correct voltage across the component X. [1]

0 V 1 V 2 V 3 V 4 V 5 V 6 V 7 V 8 V 9 V 10 V 11 V 12 V

(c) (i) What would happen to the resistance of component Y if an ice cube was placed on top of it? (Tick (✓) the correct answer.) [1]

☐ The resistance of component Y would increase

☐ The resistance of component Y would stay the same

☐ The resistance of component Y would decrease

☐ The resistance of component Y will halve

(ii) What effect would this have on the output voltage V_{OUT}?
(Tick (✓) the correct answer.) [1]

☐ V_{OUT} would increase

☐ V_{OUT} would decrease

☐ V_{OUT} would stay the same

☐ V_{OUT} would become 0 V

Examiner only

9. A luxury car has heated front seats for both the driver and front passenger.

The driver's seat heater will only operate if:

- the driver is sitting on the driver's seat
- the engine ignition is switched on
- the outside temperature is below a set temperature.

The passenger's seat heater will only operate if:

- there is someone sitting in the driver's seat
- the engine ignition is switched on
- the outside temperature is below a set temperature
- there is someone sitting in the passenger seat.

A number of sensing sub-systems are available for use, with the following specifications:

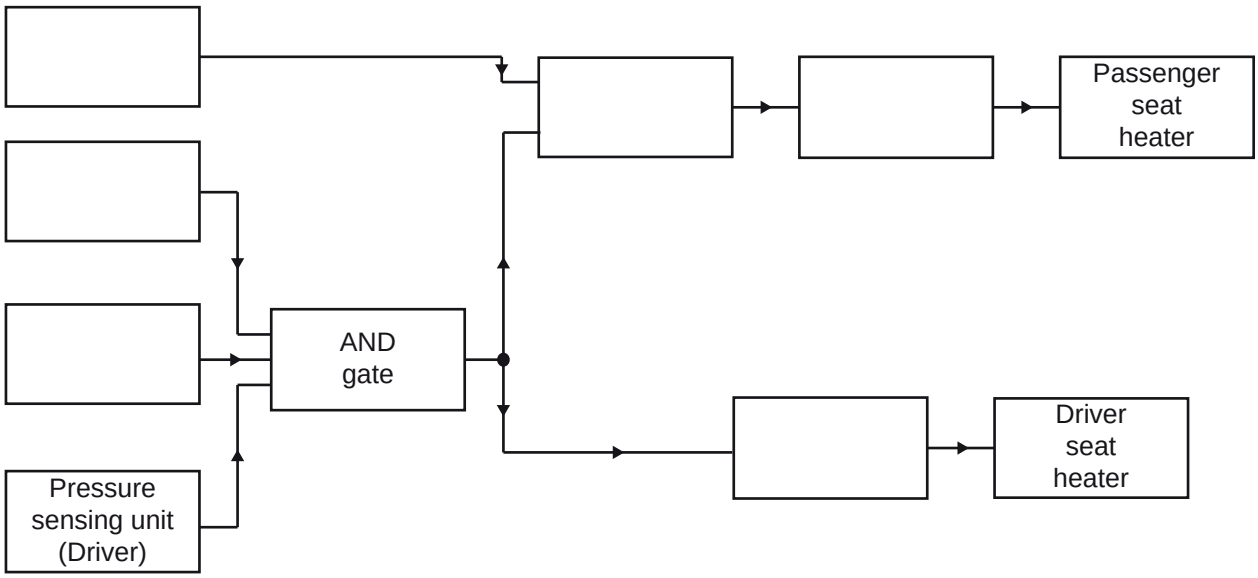
- a light sensor that outputs a Logic 1 when in daylight and Logic 0 when it is dark
- a temperature sensor that outputs a Logic 1 when it is cold and Logic 0 when it is warm
- a pressure sensor that outputs Logic 0 when it is not under pressure and Logic 1 when it is under pressure
- a moisture sensor that outputs a Logic 0 when wet and Logic 1 when dry.

Complete the block diagram for the car seat heating system using the information about each type of sensor above and the other sub-systems in the list below: [5]

Thyristor **OR gate** **Inverter** **Pressure sensing unit**

Temperature sensing unit **Moisture sensing unit** **Switch unit**

Transducer driver **NOT gate** **Light sensing unit** **AND gate**



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Turn over.

Examiner only

10. *(a)* Circle the logic gate that has the following truth table. [1]

Inputs		Output
A	**B**	**Q**
0	0	0
0	1	1
1	0	1
1	1	1

AND gate NAND gate NOR gate NOT gate OR gate

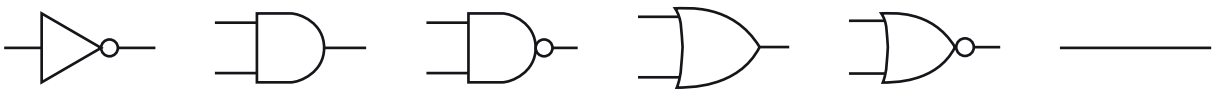
(b) Circle the logic gate that outputs a logic 1 signal **only** when both inputs are at logic 1. [1]

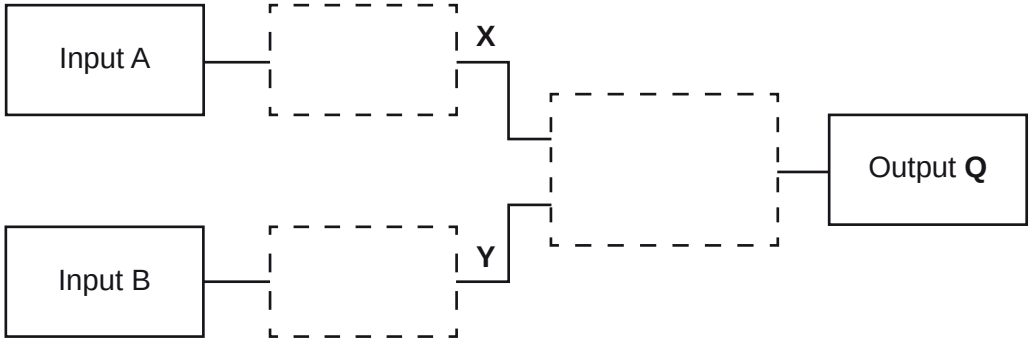
AND gate NAND gate NOR gate NOT gate OR gate

11. A logic system has the following truth table.

Inputs		Outputs		
A	**B**	**X**	**Y**	**Q**
0	0	0	1	1
0	1	0	0	0
1	0	1	1	1
1	1	1	0	1

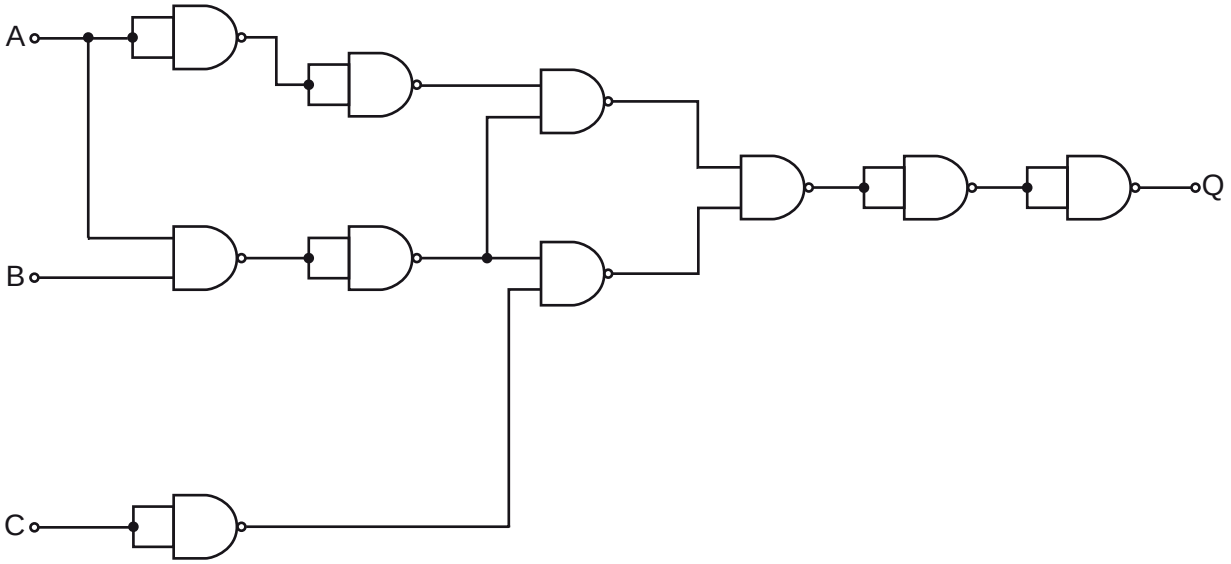
Draw the correct logic gates / connections to the following circuit to produce the truth table given above. [3]





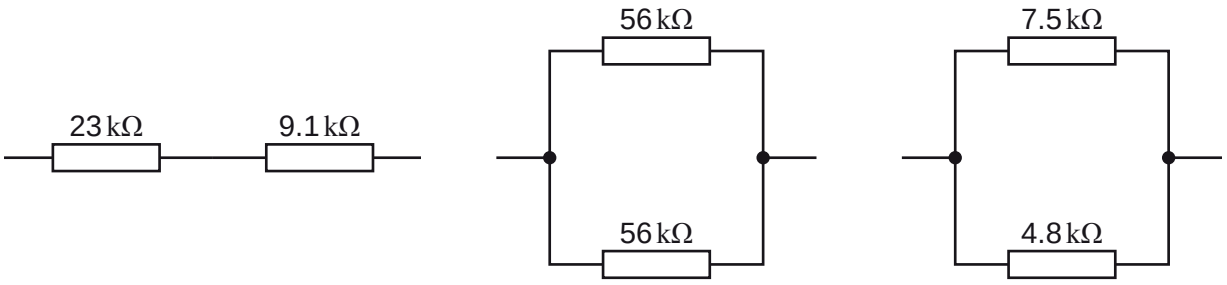
Examiner only

12. The logic circuit below contains some NAND gates that are redundant.
Circle all the redundant NAND gates. [2]



13. The diagrams below show three different combinations of resistors.

Calculate the effective resistance of each combination in kΩ. [3]



..... kΩ ..... kΩ ..... kΩ

Examiner only

14. Select the correct truth table that represents the function described by each Boolean equation. (Tick (✓) the correct answer.)

(a) **$Q = A.\bar{B}$** [1]

Inputs		Output
A	**B**	**Q**
0	0	0
0	1	0
1	0	0
1	1	1

☐

Inputs		Output
A	**B**	**Q**
0	0	1
0	1	0
1	0	1
1	1	0

☐

Inputs		Output
A	**B**	**Q**
0	0	1
0	1	0
1	0	0
1	1	1

☐

Inputs		Output
A	**B**	**Q**
0	0	0
0	1	0
1	0	1
1	1	0

☐

(b) **$Q = \bar{A} + B$** [1]

Inputs		Output
A	**B**	**Q**
0	0	0
0	1	1
1	0	0
1	1	1

☐

Inputs		Output
A	**B**	**Q**
0	0	1
0	1	1
1	0	1
1	1	0

☐

Inputs		Output
A	**B**	**Q**
0	0	1
0	1	1
1	0	0
1	1	1

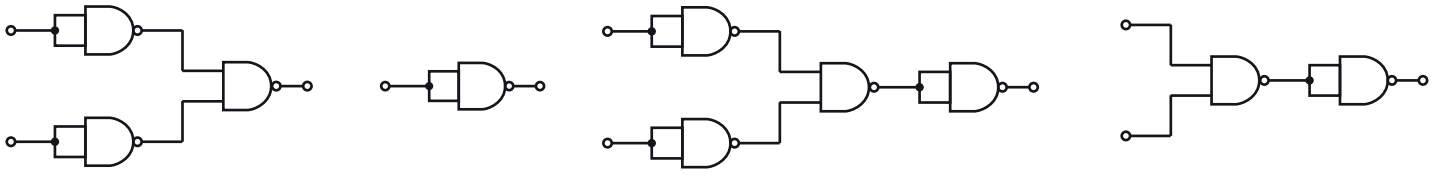
☐

Inputs		Output
A	**B**	**Q**
0	0	1
0	1	0
1	0	1
1	1	0

☐

Examiner only

15. The following show the NAND equivalent circuits for a number of standard gates.



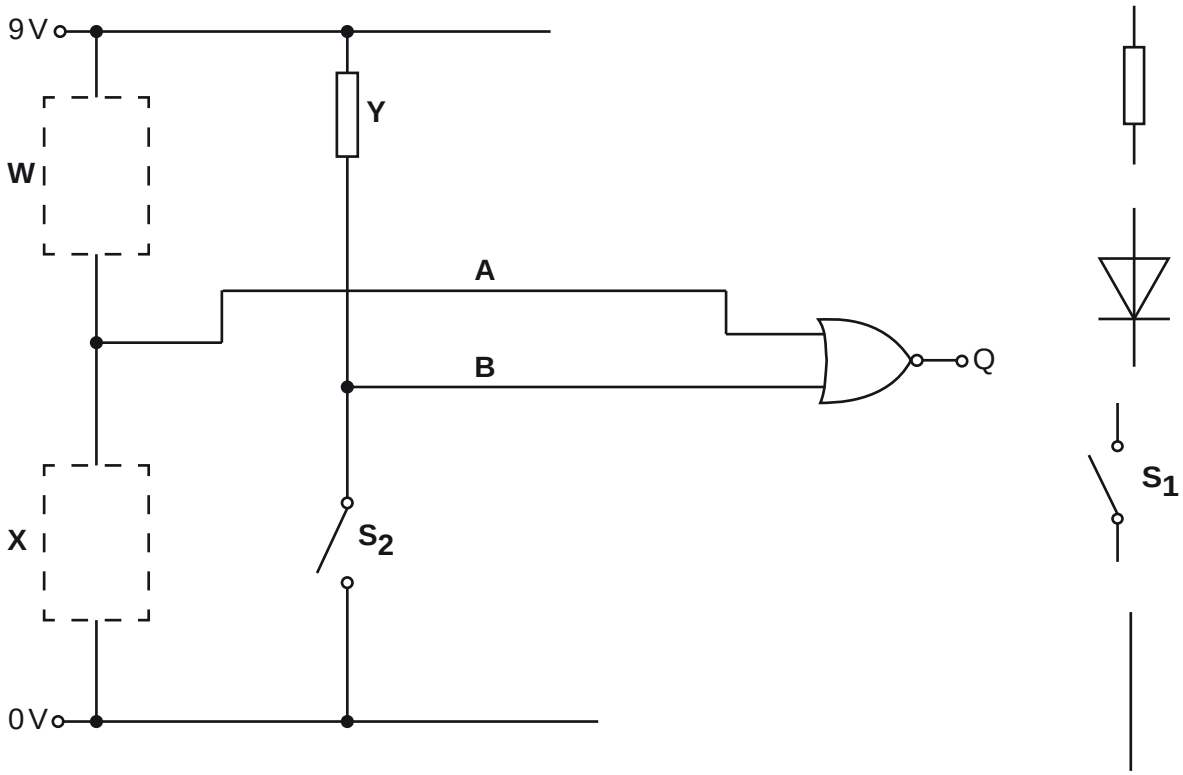
Draw the NAND equivalent circuit to match the standard gate given below. [3]

Standard gate	**NAND equivalent circuit**
NOR gate	
AND gate	
NOT gate	

Examiner only

16. The following circuit is **part of** a larger electronic system.

(a) Input A of the logic system needs to be at logic 1 when switch S_1 is pressed. Draw the correct components in boxes W and X. [1]



(b) What is the purpose of the component labelled 'Y' in the circuit above? [1]

.....

.....

.....

(c) What combination(s) of switch settings produce a logic 1 output Q from the circuit. (Tick (✓) all that apply.) [1]

☐ S_1 open & S_2 open

☐ S_1 closed & S_2 open

☐ S_1 open & S_2 closed

☐ S_1 closed & S_2 closed

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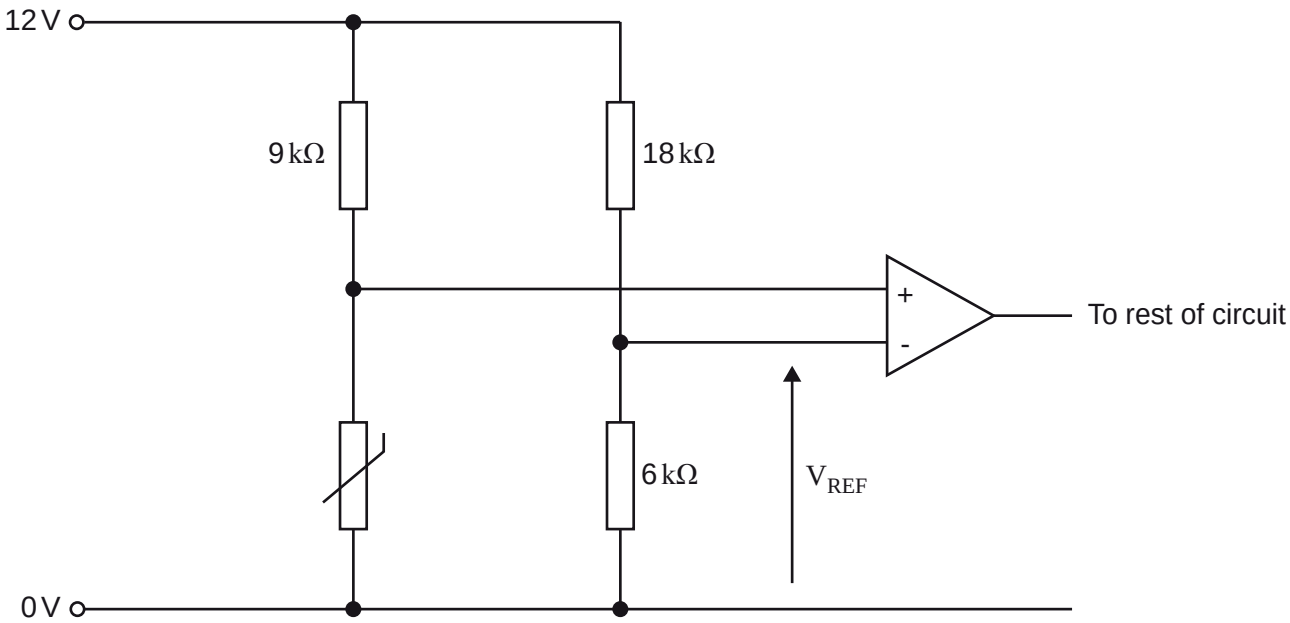
Examiner only

17. The following **incomplete** circuit diagram shows a comparator used to switch on a greenhouse heater when the temperature gets too cold.



(a) Select the correct equation to calculate the voltage V_{REF}.
(Tick (✓) the correct answer.) [1]

☐ $V_{REF} = \frac{9}{18+6} \times 12$ ☐ $V_{REF} = \frac{6}{18+9} \times 12$

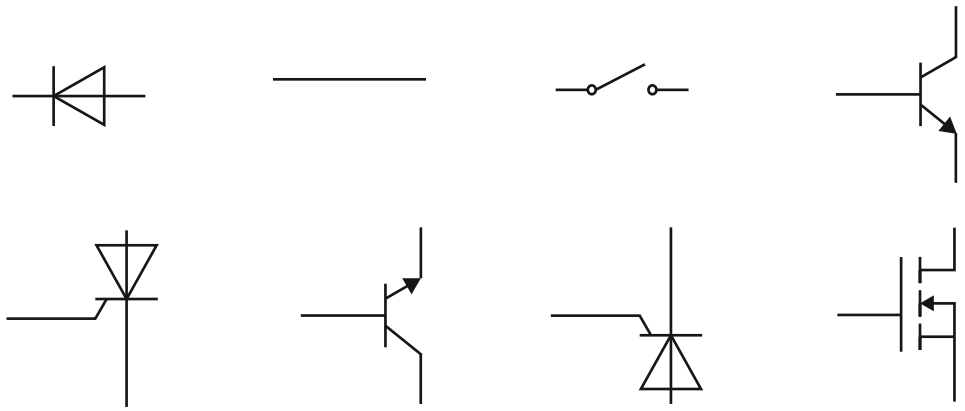
☐ $V_{REF} = \frac{6}{6+18} \times 12$ ☐ $V_{REF} = \frac{18}{6+18} \times 12$

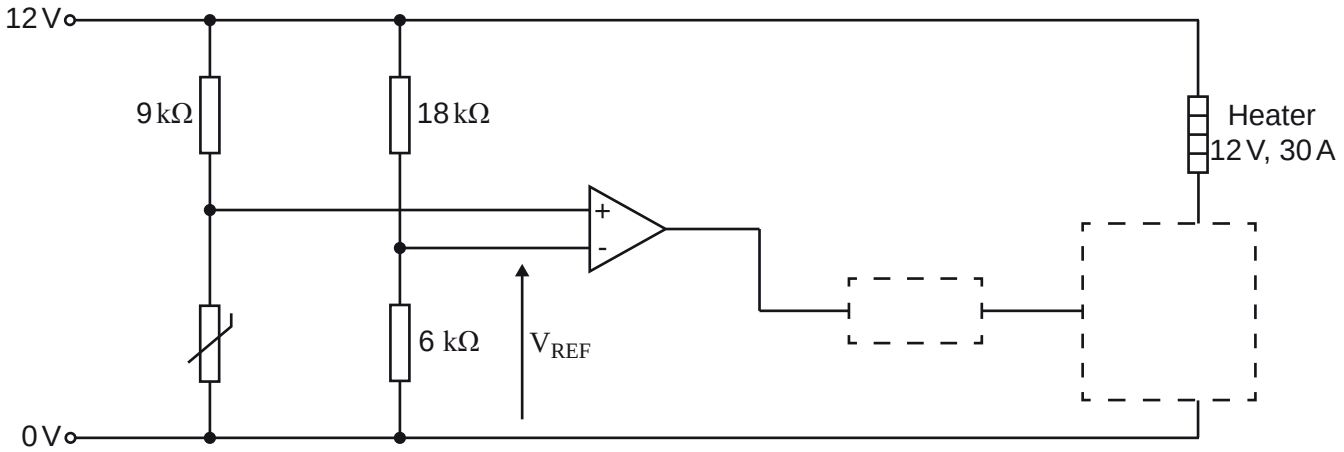
(b) Calculate the voltage V_{REF} at the inverting input. [1]

..... V

Examiner only

(c) Complete the circuit diagram below to make a non-latching output circuit for the comparator using the components shown below. [2]





(d) What modification could be made to the circuit so that the temperature that the heater switches on could be changed? [1]

.....

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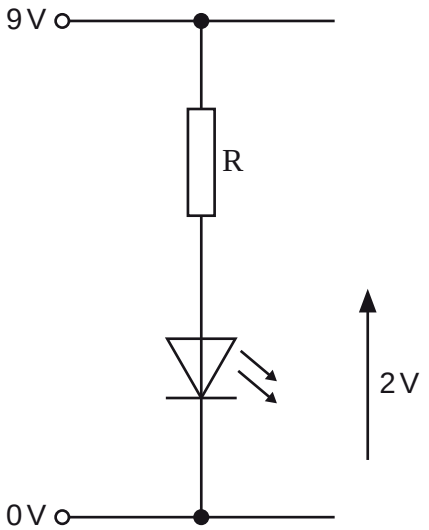
Examiner only

18. A high power LED is to be used as a power on indicator as shown below.



(a) What is the voltage drop across the resistor R? [1]

..... V

(b) Select the correct equation to calculate the ideal resistance of resistor R (in kΩ) to provide a current of 25 mA through the LED.
(Tick (✓) the correct answer.) [1]

☐	$R = 9 \times 25$	☐	$R = \frac{2}{25}$
☐	$R = \frac{7}{25}$	☐	$R = 7 \times 25$
☐	$R = 9 \times 2$	☐	$R = \frac{9}{25}$
☐	$R = \frac{9}{2}$	☐	$R = 9 \times 23$

(c) What is the ideal resistance of resistor R? ..... kΩ [1]

(d) Use the E24 resistor series on the information sheet to select the preferred value for resistor R **in ohms** to ensure that the current through the LED is just **less** than 25 mA. [1]

..... Ω

END OF PAPER

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