OCR GCSE (J277)

Module Q: Boolean logic

Workbooklet · 6 parts · 123 marks

Q2 is IGCSE (Cambridge) only and not on J277.

Contents

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	Total	**123**

MODULE Q BOOLEAN LOGIC · Q1

Logic gates: AND, OR and NOT

Original practice questions · 20 marks · ~25 minutes · OCR J277 spec 2.4.1

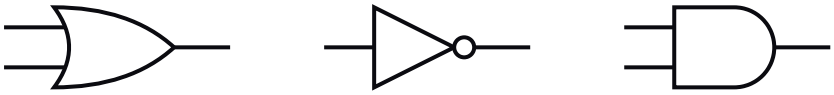
Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **20 marks**. In this worksheet 1 means true/on and 0 means false/off. Use the standard logic gate symbols when you draw. All scenarios are made up.

1

Total: 4 marks

Three logic gate symbols are shown, labelled X, Y and Z.



X Y Z

(a) Identify the logic gate shown by each symbol. **[3]**

X

Y

Z

(b) The AND operator is also called conjunction. State the Boolean operator that is also called **disjunction**. **[1]**

2

Total: 3 marks

(a) Tick (✓) **one** box in each row to show which logic gate each statement describes. **[3]**

Statement	AND	OR	NOT
The gate has only one input.			
The output is 1 when either input is 1 or both inputs are 1.			
The output is 0 if any of its inputs is 0.			

3 **Total: 4 marks**

(a) Complete the table to show the output P (0 or 1) of each expression for the input values given. **[4]**

Expression	Input values	Output P
`P = A AND B`	A = 1, B = 0	
`P = A OR B`	A = 0, B = 1	
`P = NOT A`	A = 1	
`P = A OR B`	A = 0, B = 0	

4 **Total: 3 marks**

A room heater is controlled by a temperature sensor, input **T**. T is 1 when the room is warm enough and 0 when it is not. The heater, output **H**, is on (H = 1) only when the room is **not** warm enough.

(a) Draw the logic diagram for the heater. Connect input T to output H. **[2]**



(b) Write a Boolean expression for H. **[1]**

H =

5 **Total: 6 marks**

A charging locker for electric bikes switches the charger on only when the locker door is closed **and** a bike is plugged in. The output is **P**: P = 1 means the charger is on.

Input	Input of 1 means	Input of 0 means
D	the locker door is closed	the locker door is open
B	a bike is plugged in	no bike is plugged in

(a) Identify the logic gate needed for this locker. **[1]**

(b) Draw the logic diagram for the locker. Connect inputs D and B to output P. **[2]**



(c) A technician suggests using an OR gate instead. Explain why an OR gate would **not** work for this locker. Use one combination of input values in your answer. **[3]**

Total for this worksheet: 20 marks

MODULE Q BOOLEAN LOGIC · Q3

Truth tables for single gates

Original practice questions · 21 marks · ~25 minutes · OCR J277 specification 2.4.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Write truth table values as 1 and 0 (T and F are also accepted). The total for this worksheet is **21 marks**.

1

Total: 3 marks

(a) State what a truth table shows. **[1]**

(b) A logic gate has **two** inputs, A and B. State how many rows (not counting the heading row) its truth table needs, and explain why. **[2]**

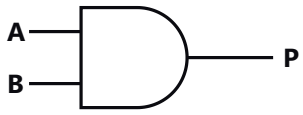
2

Total: 5 marks

Three logic gate symbols are shown. Each gate has output P.

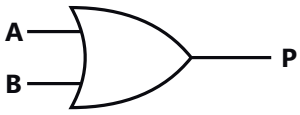
(a) Complete the truth table for **each** gate. **[5]**

Gate 1



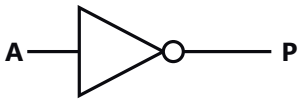
A	B	P
0	0	
0	1	
1	0	
1	1	

Gate 2



A	B	P
0	0	
0	1	
1	0	
1	1	

Gate 3



A	P
0	
1	

3 **Total: 3 marks**

A technician has tested three logic gates, J, K and L, and recorded the results using T for true and F for false. Gates J and K have two inputs. Gate L has one input.

A	B	Output of gate J	Output of gate K
F	F	F	F
F	T	T	F
T	F	T	F
T	T	T	T

A	Output of gate L
F	T
T	F

(a) Identify the logic gate used for J, K and L. **[3]**

Gate J .....

Gate K .....

Gate L .....

4 **Total: 4 marks**

A paint workshop has an extractor fan. The fan is controlled by **one** logic gate with two inputs and one output.

Input / output	1 means	0 means
H (heat sensor)	the room is too hot	the room is not too hot
F (fume sensor)	fumes are detected	no fumes are detected
E (fan)	the fan is on	the fan is off

The fan is on if the room is too hot, or fumes are detected, or both.

(a) Identify the logic gate needed. **[1]**

.....

(b) Complete the truth table for the fan. **[2]**

H	F	E
0	0	
0	1	
1	0	
1	1	

(c) Use your truth table to state the values of H and F when the fan is off. **[1]**

.....

5 Total: 4 marks

A technician has written this truth table for an AND gate. It contains **two** errors.

Row	A	B	P = A AND B
1	0	0	0
2	0	1	0
3	0	1	0
4	1	1	0

(a) Identify each error and state the correction needed. **[4]**

Error 1

Error 2

6 Total: 2 marks

(a) An AND gate and an OR gate are both given the inputs A = 1 and B = 0. Explain why the two gates give different outputs. **[2]**

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q4

Reading logic circuits with more than one gate

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.4.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. In every circuit, 1 means on / True and 0 means off / False. Draw logic gates in pencil using the standard symbols. The total for this worksheet is **21 marks**.

1

Total: 4 marks

Fig. 1 shows a logic circuit. The output of gate 1 is labelled X.

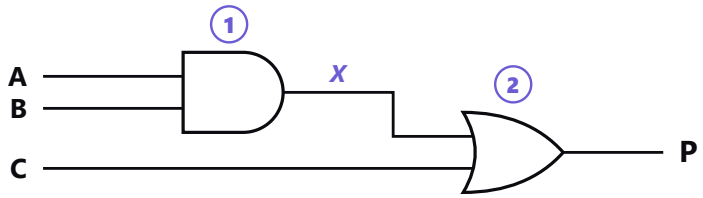


Fig. 1

(a) Identify the logic gate labelled **1** and the logic gate labelled **2** in Fig. 1. **[2]**

Gate 1	
Gate 2	

(b) The inputs are A = 1, B = 0 and C = 1. State the value of X and the value of P. **[2]**

X = ... **P =** .....

2

Total: 4 marks

Fig. 2 shows a logic circuit with three inputs. D, E and F are the outputs of the first three gates. P is the final output.

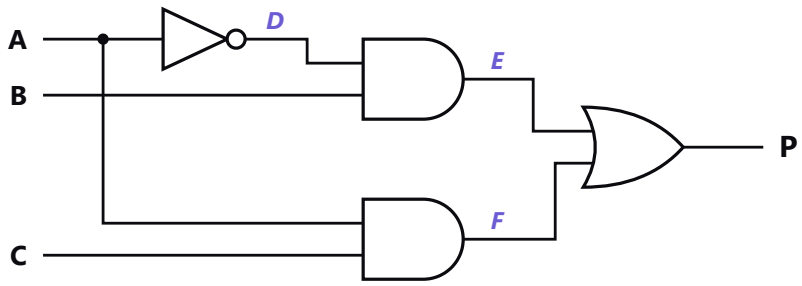


Fig. 2

(a) Complete the table to show the values of D, E, F and P for each set of inputs. **[4]**

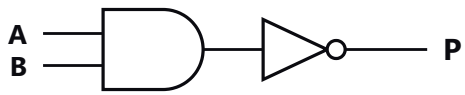
A	B	C	D	E	F	P
0	1	0				
1	1	0				
1	0	1				
0	0	1				

3

Total: 2 marks

Fig. 3 shows two different logic circuits. Each circuit uses one AND gate and one NOT gate.

Circuit 1



Circuit 2

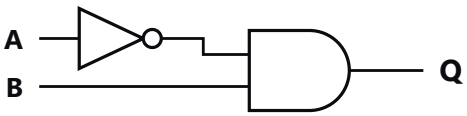


Fig. 3

(a) The inputs to both circuits are A = 1 and B = 0. State the output P of circuit 1 and the output Q of circuit 2. **[2]**

P = ... **Q =** .....

4 **Total: 4 marks**

The heater in a bakery oven is controlled by the logic circuit in Fig. 4. The inputs and output are:

Input / output	Meaning
D (door sensor)	1 = door closed, 0 = door open
T (timer)	1 = timer running, 0 = timer finished
K (temperature sensor)	1 = oven too hot, 0 = oven not too hot
H (output)	1 = heater on, 0 = heater off

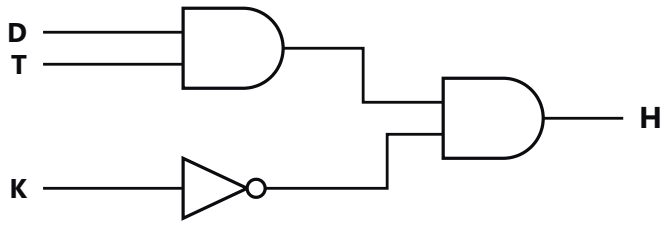


Fig. 4

(a) The door is closed, the timer is running and the oven is too hot. State the value of H. **[1]**

(b) Describe the conditions that make the heater switch on. **[3]**

5 **Total: 4 marks**

A garden watering system has a pump (P = 1 means the pump runs). The pump must run when the soil is dry and it is not raining, **or** when the manual button is pressed.

Input / output	Meaning
S (soil sensor)	1 = soil dry, 0 = soil wet
R (rain sensor)	1 = raining, 0 = not raining
M (manual button)	1 = pressed, 0 = not pressed

Fig. 5 shows the logic diagram for the pump. One gate is missing from the dashed box.

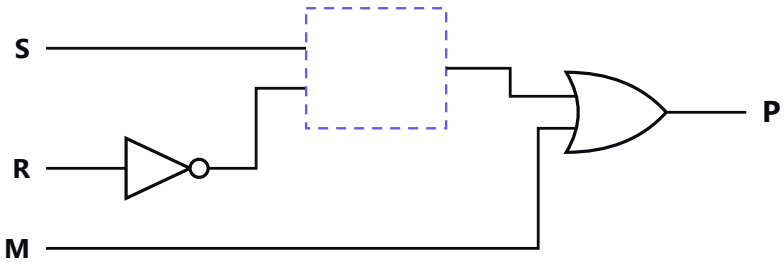


Fig. 5

(a) Complete the logic diagram in Fig. 5 by drawing the missing gate in the dashed box. **[1]**

(b) The owner changes the rule. The pump must now run only when it is **not** raining **and** either the soil is dry or the manual button is pressed. **[3]**

Draw the logic diagram for the new rule. Use the inputs S, R and M and the output P.

6 **Total: 3 marks**

Fig. 6 shows another logic circuit.

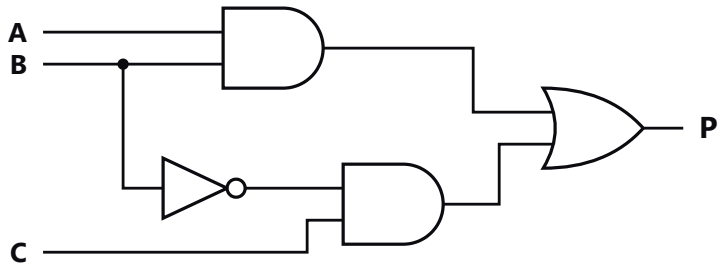


Fig. 6

A technician says: "Whenever input C is 1, the output P is 1."

(a) Explain, using the circuit in Fig. 6, whether the technician is correct. **[3]**

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q5

Completing a truth table for a logic circuit

Original practice questions · 21 marks · ~25 minutes · OCR J277 specification 2.4.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. Use 1 for true / on and 0 for false / off. Shaded cells have been filled in for you. Blank columns between the inputs and the output are for your working. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**.

1

Total: 2 marks

(a) State the number of rows needed in a truth table for a logic diagram with **three** inputs. Do not count the heading row. **[1]**

(b) The truth table below is for a logic diagram with inputs A, B and C. Complete column C so that the inputs count up in binary from 000 to 111. **[1]**

A	B	C
0	0	
0	0	
0	1	
0	1	
1	0	
1	0	
1	1	
1	1	

2 Total: 4 marks

A sensor unit on a lift door uses the logic diagram in Fig. 1. It has two inputs, A and B, and one output, Q.

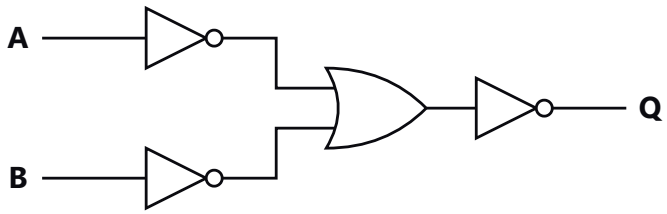


Fig. 1

(a) Complete the truth table for the logic diagram in Fig. 1. **[3]**

A	B	NOT A	NOT B	(NOT A) OR (NOT B)	Q
0	0				
0	1				
1	0				
1	1				

(b) Look at your completed Q column. Identify the **single** logic gate that would give the same output as the whole of Fig. 1. **[1]**

3 Total: 4 marks

In the logic diagram in Fig. 2, D and E label the outputs of the first two gates.

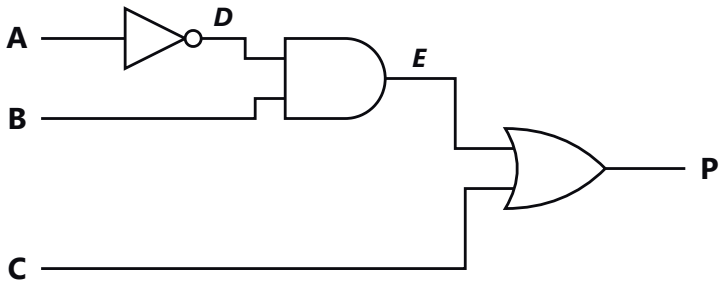


Fig. 2

Complete the truth table for Fig. 2. Columns D and E are for working. **[4]**

A	B	C	D	E	P
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

4 **Total: 4 marks**

A warehouse has an automatic loading-bay door. The door opens (O = 1) when a lorry is detected at the door **and** the bay is **not** full, **or** when the manager presses the override button.

Input	Meaning when 1	Meaning when 0
L	Lorry detected	No lorry detected
F	Bay is full	Bay is not full
M	Override button pressed	Override button not pressed

Complete the truth table to show when the door opens. Use the blank column for any working. **[4]**

L	F	M		O
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

5 Total: 3 marks

An engineer completed the truth table for the logic diagram in Fig. 3. **Three** of the values in column P are wrong.

Circle the **three** incorrect values in column P. **[3]**

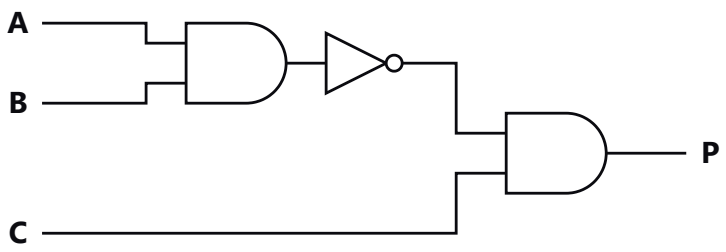


Fig. 3

A	B	C	P
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	0
1	0	1	1
1	1	0	1
1	1	1	1

6 Total: 4 marks

A logic system uses this expression:

```
P = (A AND C) OR (NOT B)
```

Complete the truth table for this expression. You may use the two blank columns for working, and write your own headings for them. **[4]**

A	B	C			P
0	0	0			
0	0	1			
0	1	0			
0	1	1			
1	0	0			
1	0	1			
1	1	0			
1	1	1			

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q6

Logic expressions: writing them and drawing them

Original practice questions · 21 marks · ~25 minutes · OCR J277 spec 2.4.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. The total for this worksheet is **21 marks**. Logic expressions use AND, OR and NOT. Draw logic diagrams in pencil with the standard gate symbols. All scenarios are made up.

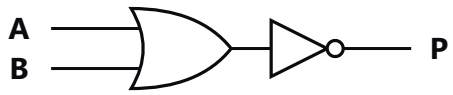
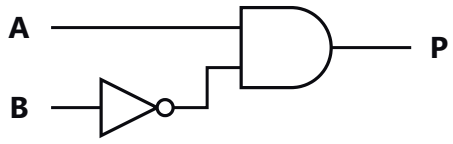
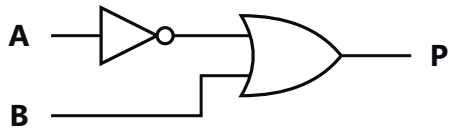
1

Total: 3 marks

Here are four logic expressions.

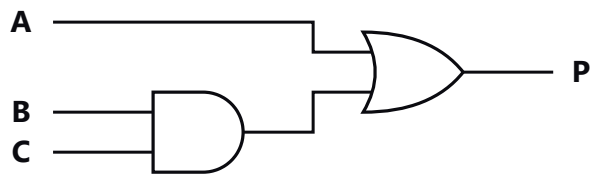
Number	Logic expression
1	`P = A AND (NOT B)`
2	`P = (NOT A) OR B`
3	`P = NOT (A OR B)`
4	`P = A OR (NOT B)`

(a) Write the number of the matching logic expression next to each circuit. One expression is not used. **[3]**

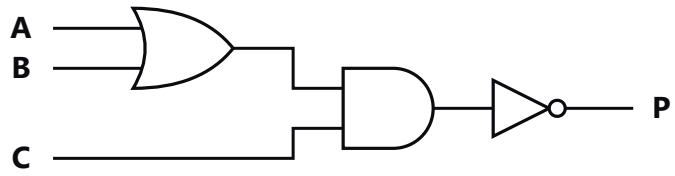
	Circuit	Expression number
(i)		
(ii)		
(iii)		

2 **Total: 5 marks**

A control unit in a car park barrier contains the logic circuits below.



(a) Write the logic expression for this circuit. Start with `P =` **[2]**



(b) Write the logic expression for this circuit. Use brackets to show which part the NOT applies to. **[3]**

3 **Total: 3 marks**

A lighting panel uses this logic expression:

```
P = (A AND (NOT B)) OR C
```

(a) Draw the logic diagram for this expression. Use the correct symbol for each gate. **[3]**



4 **Total: 6 marks**

Two logic expressions use the same inputs and the same gates, but the NOT is in a different place.

```
P = NOT (A AND B)
Q = (NOT A) AND B
```

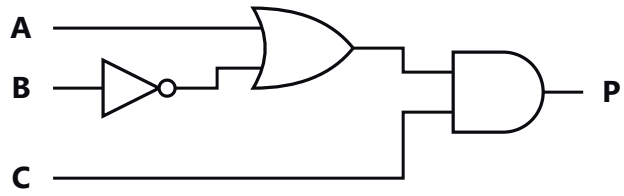
(a) Complete the truth table for **both** expressions. **[4]**

A	B	P	Q
0	0		
0	1		
1	0		
1	1		

(b) Explain why P and Q do not always give the same output. Refer to **one** row of your truth table in your answer. **[2]**

5 **Total: 4 marks**

A technician looks at this circuit from a greenhouse heater controller.



The technician writes this logic expression for the circuit:

```
P = A OR NOT (B AND C)
```

(a) Describe **two** mistakes in the technician's expression. **[2]**

(b) Write the correct logic expression for the circuit. **[2]**

Total for this worksheet: 21 marks

MODULE Q BOOLEAN LOGIC · Q7

From problem statement to logic circuit

Original practice questions · 19 marks · ~25 minutes · OCR J277 spec 2.4.1

Name _____ Date _____

Instructions. Answer all questions in the spaces provided. The marks for each part are shown in brackets [ ]. Use only AND, OR and NOT gates, drawn with the standard symbols. The total for this worksheet is **19 marks**.

1

Total: 4 marks

Each statement describes a system with one output. Tick (✓) **one** box in each row to show the single logic gate needed for that system. **[4]**

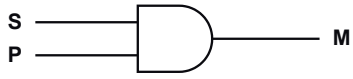
Statement	AND	OR	NOT
A paper shredder runs only when the waste bin is in place and there is paper in the slot.			
A doorbell sounds when the front button or the side button is pressed.			
A freezer door sensor gives 1 when the door is closed. A warning light is on when the door is not closed.			
A lift alarm sounds when the alarm button is pressed or the lift has stopped between floors.			

2

Total: 4 marks

A motor closes an automatic pool cover (M = 1) when the close switch is on (S = 1) **and** nobody is detected in the pool. A sensor gives P = 1 when a person is detected in the pool, and P = 0 when nobody is detected.

A technician drew this logic diagram for the pool cover.



(a) Give **one** set of input values for which the technician's diagram gives the wrong output. State the output the diagram gives and the output it should give. **[2]**

S	P	Output the diagram gives	Output it should give

(b) Draw a correct logic diagram for the pool cover. **[2]**



3 **Total: 6 marks**

A pottery studio has an electric kiln. Its heater is on only when the start switch is on, the lid is locked, **and** the kiln has **not** yet reached its target temperature. A temperature sensor gives T = 1 when the kiln has reached its target temperature.

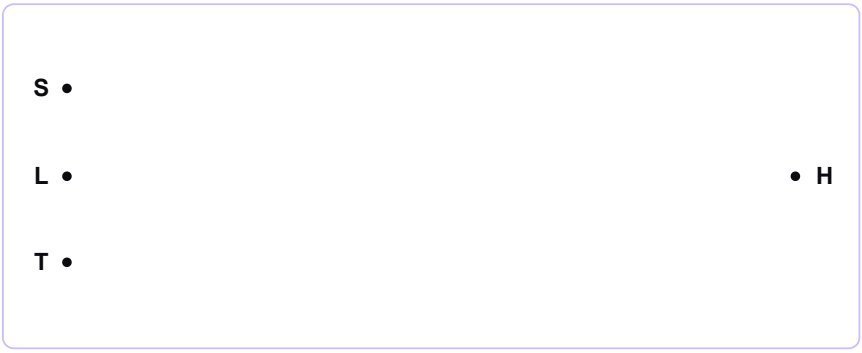
(a) Complete the table to show what 1 and 0 mean for output H. **[1]**

	Letter	1 means	0 means
Input	S	the start switch is on	the start switch is off
Input	L	the lid is locked	the lid is not locked
Input	T	the kiln has reached its target temperature	the kiln has not reached its target temperature
Output	H		

(b) Write the logic expression for H, using S, L and T. **[2]**

H =

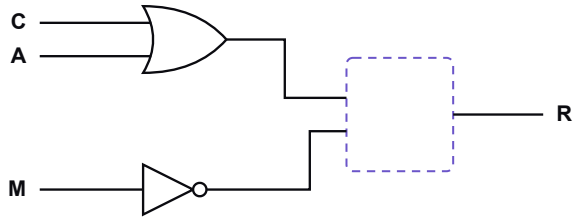
(c) Draw the logic diagram for the kiln heater. **[3]**



4 **Total: 5 marks**

A bike-share dock releases a bike (R = 1) when a member taps a valid card (C = 1) **or** enters an accepted app code (A = 1). A bike is never released while the dock is in maintenance mode (M = 1).

An engineer has started the logic diagram for the dock. One gate is missing.



(a) Draw the missing gate in the dashed box. **[1]**

(b) Complete the truth table for the dock. **[4]**

C	A	M	R
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Total for this worksheet: 19 marks