# Boolean Logic – Isaac Student Booster

## Handout 1 – Student Activities ANSWERS

### Starter – Writing Boolean expressions

Ava wants to go to a party. Her Dad says, “you can go to the party if you don’t get any detentions this week and don’t make a mess of your room”.

Write a Boolean expression for this situation.

**NOT(detentions) AND NOT(mess)**

***which is equivalent to…***

**NOT(detentions OR mess)**

party =

### Door Open with solid fillActivity 1: Identify the gates

Either on Isaac at [bit.ly/ialogicgates](https://bit.ly/ialogicgates) or below, answer these questions:

Match the gates to their truth tables:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | |  |  |  | | --- | --- | --- | | **A** | **B** | **Q** | | **0** | **0** | **1** | | **0** | **1** | **1** | | **1** | **0** | **1** | | **1** | **1** | **0** | | |  |  |  | | --- | --- | --- | | **A** | **B** | **Q** | | **0** | **0** | **0** | | **0** | **1** | **0** | | **1** | **0** | **0** | | **1** | **1** | **1** | |
|  |  | |  |  |  | | --- | --- | --- | | **A** | **B** | **Q** | | **0** | **0** | **0** | | **0** | **1** | **1** | | **1** | **0** | **1** | | **1** | **1** | **0** | | |  |  |  | | --- | --- | --- | | **A** | **B** | **Q** | | **0** | **0** | **0** | | **0** | **1** | **1** | | **1** | **0** | **1** | | **1** | **1** | **1** | |

### Bonfire outlineActivity 2 – Circuit from a scenario

A fire and intruder alarm will sound:

if motion is detected **and** it is between 20:00 and 06:00 hours, **or…**

…if the temperature exceeds 30 degrees C, whatever time it is.

Inputs are labelled T, M and C

* T will be set to 1 if temperature exceeds 30C, else 0
* M will be 1 if motion is detected, else 0
* C will be 1 if time between 20:00 and 06:00, else 0

There is one output A:

* Alarm A will sound if it receives a 1.

**Question: draw the logic circuit for this scenario below.**

Solution: plug the variables into the question, and identify the operations (and/or/not):

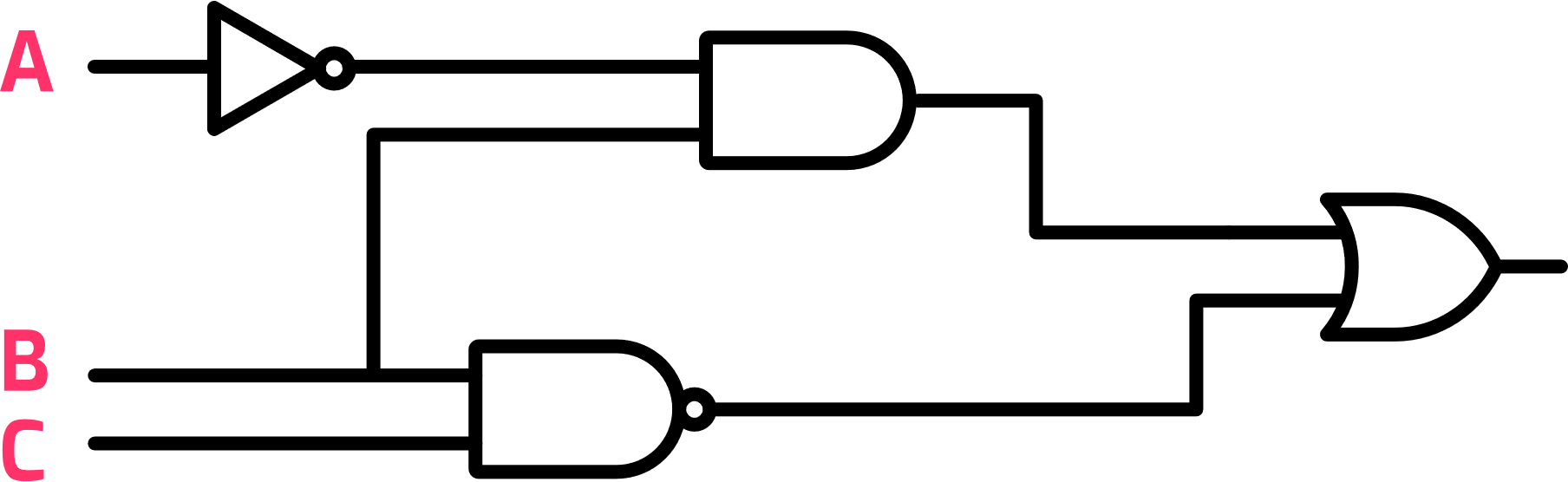
if motion is detected **(M)** and it is between 20:00 and 06:00 hours **(C),** or…

…if the temperature exceeds 30 degrees C, whatever time it is **(T)**A black and white logo

Description automatically generated

### Activity 3: Expression from a circuit

Attempt the Isaac question here: [**bit.ly/ialogic4**](https://bit.ly/ialogic4)or use the diagram below:



Write the boolean expression for this circuit.

**¬A∧B∨¬(B∧C) (OCR)**

**Ā·B+(B·C) (AQA)**

### Activity 4: Half adder

**1  
+ 1 1 0**

Complete the half-adder circuit diagram:

A diagram of a circuit

Description automatically generated

|  |  |  |  |
| --- | --- | --- | --- |
| **INPUTS** | | **OUTPUTS** | |
| **A** | **B** | **C** | **S** |
| **0** | **0** | **0** | **0** |
| **0** | **1** | **0** | **1** |
| **1** | **0** | **0** | **1** |
| **1** | **1** | **1** | **0** |

### Clipboard with solid fillActivity 5: simplifying a Boolean expression:

Simplify this expression: **(A ∧ ¬B) ∨ B (OCR) (A⋅B)+B(AQA)**

OCR

**=B∨(A∧¬B)** < commutative

**=(B∨A)∧(B∨¬B)** < distributive

**=(B∨A)∧1** < identity A∨¬A = 1

**=(B∨A)** < identity A∧1 = A

AQA

**=B+(A⋅B)** < commutative

**=(B+A)⋅(B+B)** < distributive

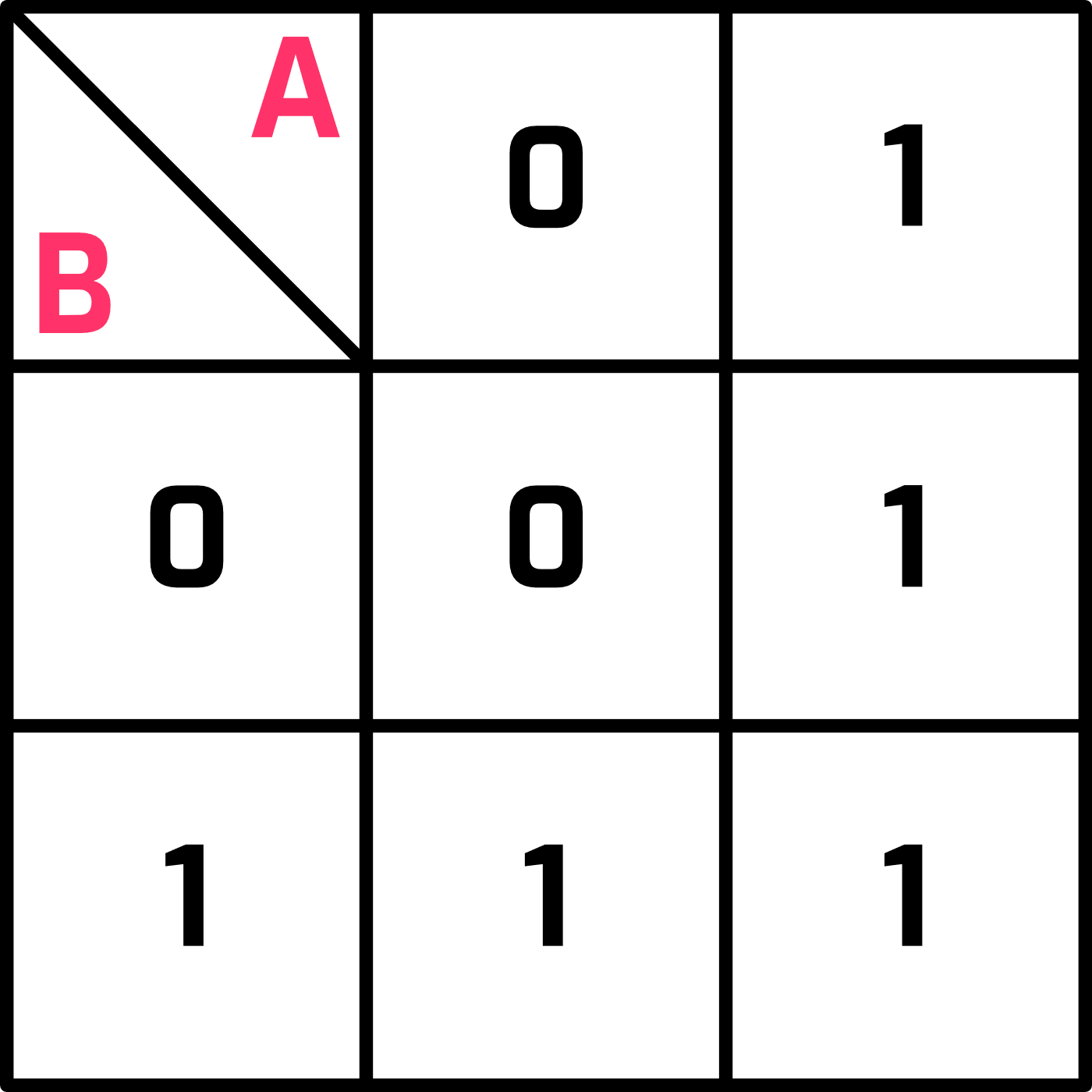
**=(B+A)⋅1** < identity A+Ā = 1

**=(B+A)** < identity A⋅1 = A

For help and more worked examples see [**bit.ly/iabooleanalgebra**](https://bit.ly/iabooleanalgebra)

### Venn diagram with solid fillActivity 6: Simplifying Karnaugh maps

This Karnaugh map represents a boolean logic expression.   
Use it to find the simplest expression that satisfies the map.



In this red group, A = 1 (A is true)

In this blue group, B = 1 (B is true)

So output is 1 when A is 1 or B is 1:

**A∨B (OCR)**

**A+B (AQA)**

For more on this topic and the full A-level course see [IsaacComputerScience.org](https://IsaacComputerScience.org)

***End of document.***