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Date:

Class:

Beyond Binary Worksheet Answer Key

Objective: To understand and select the appropriate logic gate based on a given scenario; build the gate; and combine it with others in your group to achieve the required functionality.

1. What is your given scenario? **Industry: Mechanical Press; Security; Agricultural: Smart Greenhouse Ventilation; Pet Door; Automotive Headlights; Industry: Chemical**
2. What is your role? **Answers vary; see charts below.**
3. What is your first input? **Answers vary; see charts below.**
4. What is your second input? **Answers vary; see charts below.**
5. Complete the table below: **See charts below.**

Industry: Mechanical Press

Authorizing users through badges or master keys (OR Gate)

Input A: Badge scan status	Input B: Master key status	Output C: Authorized user signal
Badge is scanned successfully; signal HIGH	Master key engaged; signal HIGH	Both badge and key signals received; signal HIGH
Badge is scanned successfully; signal HIGH	Master key missing; signal LOW	At least one input present; signal HIGH
Badge is not scanned; signal LOW	Master key engaged; signal HIGH	At least one input present; signal HIGH
Badge is not scanned; signal LOW	Master key missing; signal LOW	Both badge and key signals are missing; signal LOW

Users and safety shield verification (AND Gate)

Input C: Authorized user signal	Input D: Safety shield location	Output E: User and shield status
At least one form of ID is present; signal HIGH	Safety shield down; signal HIGH	User and shield are good to run; signal HIGH
At least one form of ID is present; signal HIGH	Safety shield up; signal LOW	User or shield status is not acceptable; signal LOW
Missing authorization for use; signal LOW	Safety shield down; signal HIGH	User or shield status is not acceptable; signal LOW
Missing authorization for use; signal LOW	Safety shield up; signal LOW	User or shield status is not acceptable; signal LOW

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Emergency Stop Button System (NOT)

Input F: Emergency stop button status	Output G: Emergency stop system signal*
Emergency button is pressed; signal HIGH	System needs to stop ASAP; signal LOW
Emergency button is NOT pressed; signal LOW	System is not facing an emergency and should continue working; signal HIGH

*Note: Output G is inverted to integrate with AND logic for final system operability.

Emergency Stop Button System (AND Gate)

Input G: Emergency stop system signal	Input E: User and shield status	Output H: System operability
System is not facing an emergency and should continue working; signal HIGH	User and shield are good to run; signal HIGH	System is cleared to run; signal HIGH
System is not facing an emergency and should continue working; signal HIGH	User or shield status is not acceptable; signal LOW	System fault is present; signal LOW
System needs to stop ASAP; signal LOW	User and shield are good to run; signal HIGH	System fault is present; signal LOW
System needs to stop ASAP; signal LOW	User or shield status is not acceptable; signal LOW	System fault is present; signal LOW

Security System

Exterior Breach sensor (OR Gate)

Input A: Door status	Input B: window status	Output C: Security breach detected signal
Door is breached; signal HIGH	Window is breached; signal HIGH	Exterior breach trigger; signal HIGH
Door is breached; signal HIGH	Window is not breached; signal LOW	Exterior breach trigger; signal HIGH
Door is NOT breached; signal LOW	Window is breached; signal HIGH	Exterior breach trigger; signal HIGH
Door is NOT breached; signal LOW	Window is not breached; signal LOW	No exterior breach indicated; signal LOW

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Class:

Accidental triggering during business hours prevention (AND Gate)

Input C: Security breach detected signal	Input D: Timing system signal	Output E: Security breach validated by time of day
Exterior breach detected; signal HIGH	Outside of business hours; signal HIGH	Suspected unauthorized presence; signal HIGH
Exterior breach; signal HIGH	Inside of business hours; signal LOW	No suspected unauthorized presence; signal LOW
No exterior breach indicated; signal LOW	Outside of business hours; signal HIGH	No suspected unauthorized presence; signal LOW
No exterior breach indicated; signal LOW	Inside of business hours; signal LOW	No suspected unauthorized presence; signal LOW

Disarming System/ Manual override code entered (NOT Gate)

Input F: Manual disarming code use	Output G: Manual override code status
Manual disarming code correctly entered; signal HIGH	System override engaged; signal LOW
Manual disarming code not entered; signal LOW	No manual override; signal HIGH

Security Alarm Activation and Sound (2nd AND Gate)

Input E: Security breach validated by time of day	Input G: Manual override signal	Output H: Security alarm activates
Suspected unauthorized presence; signal HIGH	System override engaged; signal LOW	System doesn't activate or sound; signal LOW
No suspected unauthorized presence; signal LOW	System override engaged; signal LOW	System doesn't activate or sound; signal LOW
Suspected unauthorized presence; signal HIGH	No manual override; signal HIGH	System activates or sounds; signal HIGH
No suspected unauthorized presence; signal LOW	No manual override; signal HIGH	System doesn't activate or sound; signal LOW

Smart Greenhouse Ventilation System Humidity and Temperature Sensor (OR Gate)

Input A: Interior humidity sensor	Input B: Temperature sensor in greenhouse	Output C: Signal for temp/humidity sensors
High humidity in the greenhouse; signal HIGH	Excessive temperature in the greenhouse; signal HIGH	Humidity/temperature sensor; signal HIGH

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Date:

Class:

Input A: Interior humidity sensor	Input B: Temperature sensor in greenhouse	Output C: Signal for temp/humidity sensors
Low humidity in the greenhouse; signal LOW	Excessive temperature in the greenhouse; signal HIGH	Humidity/temperature sensor; signal HIGH
High humidity in the greenhouse; signal HIGH	Acceptable temperature in the greenhouse; signal LOW	Humidity/temperature sensor; signal HIGH
Low humidity in the greenhouse; signal LOW	Acceptable temperature in the greenhouse; signal LOW	Humidity/temperature; signal LOW

Outdoor Climate Sensor (NOT gate)

Input D: Raining outside	Output E: Signal regarding rain
Rain detected; signal HIGH	Ventilation blocked by rain; signal LOW
No rain detected; signal LOW	Ventilation not limited by rain; signal HIGH

System Integration Specialist (AND)

Input C: Signal for humidity/temperature sensor	Input E: Signal regarding rain	Output F: Ventilation status
Humidity/temperature sensor; signal HIGH	Ventilation not limited by rain; signal HIGH	Ventilation on; signal HIGH
Humidity/temperature sensor; signal HIGH	Ventilation blocked by rain; signal LOW	Ventilation off; signal LOW
Humidity/temperature sensor; signal LOW	Ventilation not limited by rain; signal HIGH	Ventilation off; signal LOW
Humidity/temperature sensor; signal LOW	Ventilation blocked by rain; signal LOW	Ventilation off; signal LOW

Smart Pet Door System

Pet verification system (OR Gate)

Input A: Interior proximity sensor	Input B: Exterior proximity sensor	Output C: Pet presence signal
Interior sensor triggered; signal HIGH	Exterior sensor triggered; signal HIGH	Pet presence detected; signal HIGH
Interior sensor triggered; signal HIGH	Exterior sensor not triggered ; signal LOW	Pet presence detected; signal HIGH

Name:

Date:

Class:

Input A: Interior proximity sensor	Input B: Exterior proximity sensor	Output C: Pet presence signal
Interior sensor not triggered; signal LOW	Exterior sensor triggered; signal HIGH	Pet presence detected; signal HIGH
Interior sensor not triggered ; signal LOW	Exterior sensor not triggered ; signal LOW	Pet presence not detected; signal LOW

Door Swing Safety Control (AND Gate)

Input D: Door swing clearance	Input C: Pet presence signal	Output E: Sensor signal for presence and swing clearance
Door clearance is confirmed; signal HIGH	Pet presence verified; signal HIGH	Sensor signal for presence and swing clearance; signal HIGH
Door clearance is confirmed; signal HIGH	Pet presence not indicated; signal LOW	No sensor signal for presence and swing clearance; signal LOW
Door is blocked; signal LOW	Pet presence verified; signal HIGH	No sensor signal for presence and swing clearance; signal LOW
Door is blocked; signal LOW	Pet presence not indicated; signal LOW	No sensor signal for presence and swing clearance; signal LOW

Security Mode for house alarm Sensor (NOT gate)

Input F: Security Mode for house alarm	Output G: signal regarding security mode
Security mode engaged; signal HIGH	Signal for security mode override off; signal LOW
Security mode off; signal LOW	Signal for security mode override on; signal HIGH

Reasons for opening door and security mode status (2nd AND Gate)

Input E: Sensor signal for approving door opening	Input G: Signal regarding security mode	Output H: Pet door swings open
Door opening is approved; signal HIGH	Signal for security mode override on; signal HIGH	Signal is sent for door to open; signal HIGH
Door opening is approved; signal HIGH	Signal for security mode override off; signal LOW	Signal is not sent for door to open; signal LOW

Name:

Date:

Class:

Input E: Sensor signal for approving door opening	Input G: Signal regarding security mode	Output H: Pet door swings open
Door opening is not approved; signal LOW	Signal for security mode override on; signal HIGH	Signal is not sent for door to open; signal LOW
Door opening is not approved; signal LOW	Signal for security mode override; signal off LOW	Signal is not sent for door to open; signal LOW

Smart Automatic Headlight Control System

Low light and rain sensors (OR Gate)

Input A: Photocell reading	Input B: Windshield wiper status	Output C: Signal for wipers/photocell
Photocell reads low light; signal HIGH	Windshield wipers on; signal HIGH	Signal for wipers /photocell; signal HIGH
Photocell reads low light; signal HIGH	Windshield wipers off; signal LOW	Signal for wipers /photocell; signal HIGH
Photocell does NOT read low light; signal LOW	Windshield wipers on; signal HIGH	Signal for wipers /photocell; signal HIGH
Photocell does NOT read low light; signal LOW	Windshield wipers off; signal LOW	Signal for wipers /photocell; signal LOW

Ignition and power connection (AND Gate)

Input D: Engine Status	Input C: Signal for wipers/photocell	Output E: Signal for engine; lights; and wipers
Engine is on; signal HIGH	Signal for wipers/photocell is on; signal HIGH	Engine is on and wipers/photocell signal is on; signal HIGH
Engine is on; signal HIGH	Signal for wipers/photocell is off; signal LOW	Engine is on and wipers/photocell signal is off; signal LOW
Engine is off; signal LOW	Signal for wipers/photocell is on; signal HIGH	Engine is off and wipers/photocell signal is on; signal LOW
Engine is off; signal LOW	Signal for wipers/photocell is off; signal LOW	Engine off and wipers/photocell signal is off; signal LOW

Manual override control (NOT Gate)

Input F: Manual override status	Output G: Override signal
Manual override is on HIGH	Automatic control is blocked LOW

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Input F: Manual override status	Output G: Override signal
Manual Override is off LOW	Automatic control is on HIGH

Ignition and power connection (AND Gate)

Input E Signal for engine; lights; and wipers	Input G Override signal	Output H Automatic headlight status
Signal for engine; lights; and wipers HIGH	Automatic control is on HIGH	Headlights on automatically HIGH
Signal for engine; lights; and wipers HIGH	Automatic control is blocked LOW	Headlights are not on automatically LOW
Engine; wipers/ photocell signal is LOW	Signal for wipers /photocell HIGH	Headlights are not on automatically LOW
Engine; wipers/ photocell signal is off LOW	Automatic control is on HIGH	Headlights are not on automatically LOW

Smart Chemical Manufacturing System

Pressure and temperature sensors (AND Gate)

Input A: Pressure limit sensor	Input B: Temperature limit sensor	Output C: Pressure/temperature out-of-range signal
Pressure too high; signal HIGH	Temperature too high; signal HIGH	Both pressure and temperature are out-of-range; signal HIGH
Pressure too high; signal HIGH	Temperature normal; signal LOW	Pressure out of range but temperature within range; signal LOW
Pressure normal; signal LOW	Temperature too high; signal HIGH	Pressure within range but temperature out of range; signal LOW
Pressure normal; signal LOW	Temperature normal; signal LOW	Both pressure and temperature are within range; signal LOW

Gas leak or Pressure/temperature detection (OR Gate)

Input D: Gas leak detection	Input C: Pressure/temperature out-of-range signal	Output E: Gas leak and pressure/temperature signal
Gas leak detected; signal HIGH	Pressure/temperature signal in range; signal LOW	Gas leak but pressure/temperature signal is within range; signal HIGH

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Input D: Gas leak detection	Input C: Pressure/temperature out-of-range signal	Output E: Gas leak and pressure/temperature signal
Gas leak detected; signal HIGH	Pressure/temperature signal out of range; signal HIGH	Gas leak and pressure/temperature signal is out of range; signal HIGH
Gas leak not detected; signal LOW	Pressure/temperature signal in range; signal LOW	No gas leak and pressure/temperature signal is within range; signal LOW
Gas leak not detected; signal LOW	Pressure/temperature signal out of range; signal HIGH	No gas leak but pressure/temperature signal is out of range; signal HIGH

Shutdown initiation (NOT Gate)

Input E: Signal for gas leak; pressure/temperature	Output F: System shutdown initiation
Gas, temperature or pressure warning signal is activated; signal HIGH	Machines shut down for safety; signal LOW
Gas, temperature or pressure warning signal not activated; signal LOW	Machines continue as normal; signal HIGH

- Describe another scenario using your gate; detailing the inputs and outputs.
Answers will vary.
- Create a diagram using logic gate symbols to show how you combined your gates to solve your problem.
See the logic equations; diagrams and truth tables in the slides.
- Create truth tables for each gate to indicate how they work together to solve the problem.
See the appropriate section above and the logic equations; diagrams and truth tables in the slides.
- How did this experience impact your understanding of how multiple inputs can be used to solve problems? Why is it important?
Answers vary but should include some reference to how most decisions are based on more than one factor and the way answers are determined depends on how the factors are related; can also reference levels of abstraction used to understand computers.