The background features a light blue sky with several falling leaves in shades of orange and yellow. On the left, a red brick barn with a yellow bell in a small tower is visible. A yellow school bus is driving on a winding road that curves across a green hillside. The road has a dashed yellow center line. In the foreground, there are several stylized trees with orange and yellow foliage. On the right side, there are several pumpkins of various sizes and colors, including orange and yellow ones with green stems.

Technical English
Unit 45
professional english
Circuits and components

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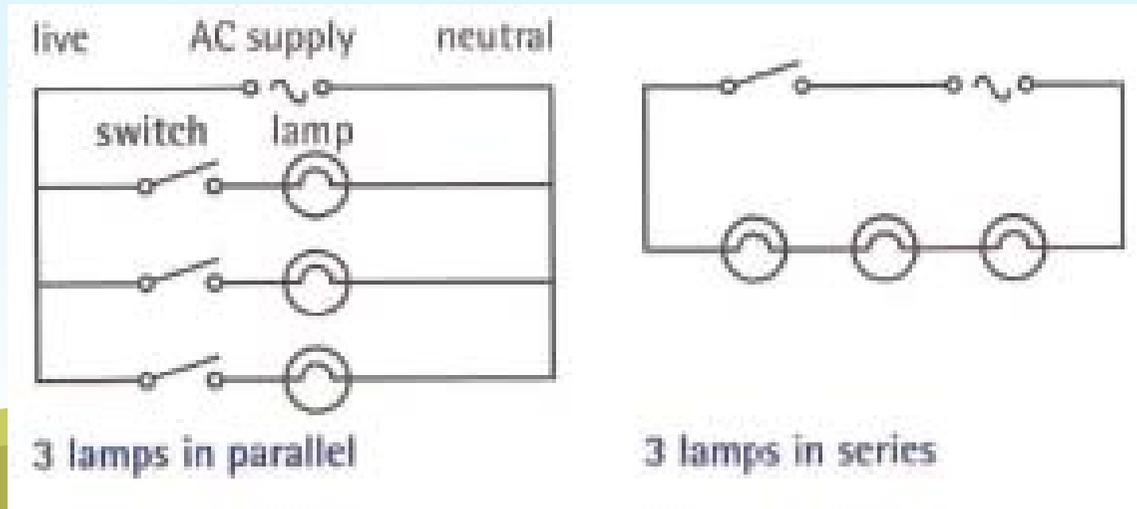


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A. Simple circuit

The circuit diagrams below show lamps connected in a **parallel circuit** and in a **series circuit**. The supply has **live** and **neutral** conductors. On an alternating current (AC) supply, the difference between live and neutral is that conductors on the neutral side of appliances are **earthed**- that is, connected to **earth** (the ground).



BrE: live; AmE: phase
BrE: earth, earthed; AmE: ground, grounded

B. Mains AC circuits and switchboards

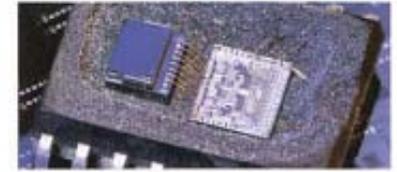
Where an AC supply enters a building, it is connected to a **switchboard**. This has a number of switches to allow different circuits in the building to be **switched on and off**. Circuits include **power circuits**. These supply the **power sockets (or sockets)** for the **plugs** on appliances. Usually, a **circuit-breaker** is fitted to each circuit. This is a safety switch that switches off automatically if there is a problem. This may happen if a person touches a live conductor, or if there is a short circuit. A **short circuit** is when current flows directly from a **live** conductor to a **neutral** conductor -for example, due to damaged insulation. Circuit breakers also allow circuits to be switched off manually, to isolate them (switch them off safely) -for example, before maintenance work.

Note: The equipment in **switchboards** is often called **switchgear**.

C. Printed and integrated circuits



A printed circuit board



An integrated circuit on a microchip

The circuits in electrical appliances are often **printed circuits**, on **printed circuit boards (PCBs)**. These are populated with (fitted with) electrical components. Many appliances also contain small, complex **integrated circuits**- often called **microchips (or chips)**- made from silicon **wafers** (very thin pieces of silicon). They act as **semiconductors**, which can be positively charged at certain points on their surface and negatively charged at other points. This principle is used to make very small circuits.

D. Electrical & electronic components

There are many types of electrical and **electronic** components. These can be used individually or combined with other components to perform different tasks. For example:

- **Sensors or detectors** can sense or detect levels of- or changes in - values such as temperature, pressure and light.
- **Control systems** use **feedback** from sensors to control devices automatically. For example, mechanical devices such as water valves may be moved or adjusted by **servomechanisms** electrically powered mechanisms that are controlled automatically by **signals** ('messages') from sensors.
- **Logic gates** are widely used in control systems. They send signals, in the form of low voltages, to other devices. An output signal from the logic gate is switched on or off, depending on the input signals it receives.

Common components and their functions

Component	Function
amplifier	amplifies an electric current – that is, increases the amplitude (wave height) of the current
antenna	receives or transmits (sends) radio signals
battery	several cells connected together
capacitor	consists of two conductors which are separated by a dielectric (insulating) material – allows a certain amount of electrical charge to be stored
cell	an electrical storage device, containing chemicals, which supplies a direct current
circuit-breaker	a safety device which automatically switches off a circuit
diode	a device with two terminals which allows current to flow in one direction only
fuse	a thin conductor which burns and breaks at a certain amperage, to protect a circuit
inductor	a coil which is used to produce electromagnetic induction
inverter	converts direct current to alternating current
lamp	produce light – often an incandescent lamp, which consists of a filament inside a glass bulb

Component	Symbol
lamp	
microphone	
motor	
ohmmeter	
oscilloscope	
piezoelectric crystal	
transistors	
bipolar NPN (negative, positive, negative) transistor	
bipolar PNP (positive, negative, positive) transistor	
field-effect N-channel (negative channel) transistor	
field-effect P-channel (positive channel) transistor	
MOS (metal oxide semiconductor) field-effect N-channel transistor	
MOS field-effect P-channel transistor	

potentiometer	a variable resistor with three connections
rectifier	converts alternating current to direct current
relay	a switch which is operated electrically (not mechanically)
resistor	produces a precise amount of resistance
rheostat	a variable resistor with two terminals
speaker / loudspeaker	converts electrical energy to sound energy
switch	allows electric current to flow when closed (switched on), and stops current flowing when opened (switched off)
transformer	a step-up transformer increases voltage and reduces amperage, and a step-down transformer reduces voltage and increases amperage
transistor	a device with three terminals which can be used as an amplifier or switch

Component	Symbol
ammeter	
amplifier	
antenna	
battery	

diodes	
Gunn diode	
light-emitting diode (LED)	
PIN diode	
photodiode	

Component	Symbol
Schottky diode	
tunnel diode	
Zener diode	

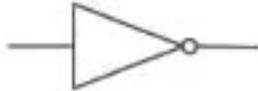
cell	
circuit-breaker	
delay line	

Logic Gates

AND gate 

Input 1	Input 2	Output
0	0	0
0	1	0
1	0	0
1	1	1

The output signal is 1 only if both input signals are 1.

NOT gate, or inverter 

Input 1	Input 2
1	0
0	1

The gate only has one input point. The output signal is the opposite of the input signal.

OR gate 

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	1

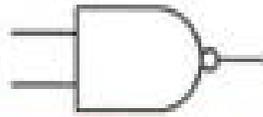
The output signal is 1 if (a) either one of the input signals is 1, or if (b) both input signals are 1.

XOR gate 

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	0

The output signal is 1 if either of the input signals is 1, but is 0 if both input signals are 1.

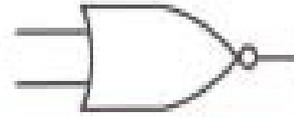
NAND gate



Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

A NAND gate is the opposite of an AND gate, functioning as an AND gate + a NOT gate.

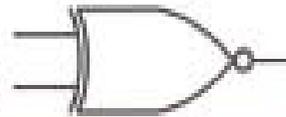
NOR gate



Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

A NOR gate is the opposite of an OR gate, functioning as an OR gate + a NOT gate.

XNOR gate

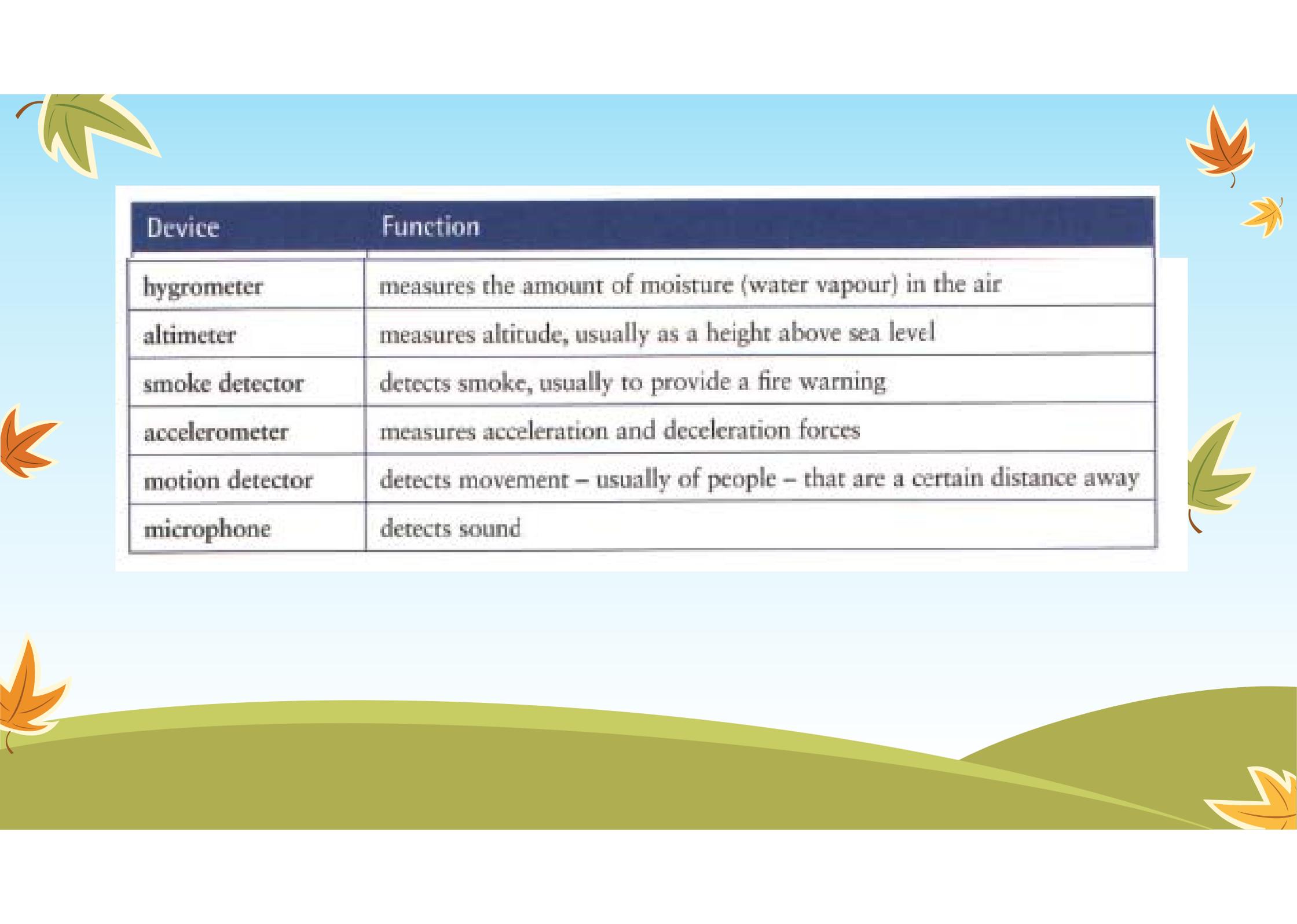


Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	1

An XNOR gate is the opposite of an XOR gate, functioning as an XOR gate + a NOT gate.

Sensing, measuring and regulating devices

Device	Function
voltmeter	detects and measures voltage
ammeter	detects and measures electric current
ohmmeter	detects and measures electrical resistance
thermostat	regulates temperature – switches a heating or cooling system on or off at a set temperature
thermocouple	measures or controls temperature – produces a voltage which varies proportionally as the temperature difference between two points varies
thermistor	measures or controls temperature – produces a resistance which varies proportionally as temperature varies (thermistor is short for 'thermal resistor')
photosensor	a general term for devices that detect and measure light
proximity sensor	measures the distance between itself and nearby objects
piezoelectric sensor	measures movement and strain – produces an electric current when stressed mechanically
flowmeter	measures the rate of flow of a fluid
barometer	measures atmospheric pressure



Device	Function
hygrometer	measures the amount of moisture (water vapour) in the air
altimeter	measures altitude, usually as a height above sea level
smoke detector	detects smoke, usually to provide a fire warning
accelerometer	measures acceleration and deceleration forces
motion detector	detects movement – usually of people – that are a certain distance away
microphone	detects sound

45.1 Make word combination with circuit using words from A and B opposite. Then match the combinations with the description (1-6) below.

1. a circuit containing one or more sockets
2. a simple circuit where all the components are placed one after the other along the same conductor
3. a microchip - a very small, often complex circuit
4. what happens if live and neutral conductors touch while a current is flowing, and there is no component or appliance between them
5. a circuit which allows different components to be controlled independently by separate switches
6. a circuit that can be populated with a large number of components

a
a
a
a
a
an

circuit

45.1 1 power
2 series

3 integrated
4 short

5 parallel
6 printed

45.2 Complete the task from an engineering textbook.

In an experiment, the lights in a room are connected to two types of electronic (1) The first is an occupancy sensor, which will (2) the movement of a person entering the room, and the second is some kind of photosensor, which can determine whether it's daylight or dark. These two devices are connected to an AND gate – a (3) that will produce an output current only if it receives two input currents – in this case, from both the occupancy sensor *and* the photosensor. Therefore, a (4) will be sent to the light switch to (5) the lights only if a person enters the room *and* if it's dark.

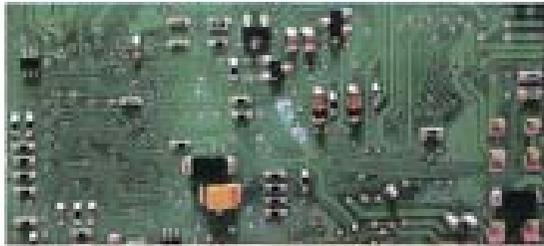
However, for this system to work, we are assuming that the type of photosensor used will be one which is designed to produce a current in the dark, and which will then (6) as soon as daylight appears. But such a sensor may be designed to work in the opposite way – producing a current when it detects daylight and no current in the dark. This would cause an obvious problem. In this case, what type of logic gate could be placed between the photosensor and the AND gate in order to solve the problem?

45.2 1 detector/sensor
2 detect/sense

3 logic gate
4 signal

5 switch on
6 switch off

45.3 Can you answer the question in the text in 45.2? Look at Appendix XIII on page 118 to help you.



A printed circuit board



An integrated circuit on a microchip



Over to you



Think of a device or installation you're familiar with which is automatically controlled, and describe its control systems. What kinds of sensor are used? How does the control system react to different signals from the sensors?

I know it



A printed circuit board

Any Questions