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1	<b>What is an IoT device ?</b>
	<ul style="list-style-type: none"><li>• IoT refers to Internet of Things.</li><li>• An IoT device is connected to internet (<i>or any network</i>).</li><li>• It has sensors and actuators. So, it can work without human interventions.</li><li>• As it is connected to internet, it can be monitored or controlled remotely.</li><li>• Examples : Digital Door Lock, Smart Traffic Lights, Production line of an industry.</li></ul>
2	<b>What are different elements of an IoT device ?</b>
	<p>An IoT device contains the following elements:</p> <ul style="list-style-type: none"><li>• <b>Sensors</b> – These are collecting data from the environment such as, temperature, humidity, smoke, position, speed, colour, light-intensity, pressure, air quality, pH, etc.</li><li>• <b>Actuators</b> – These are performing actions depending upon the sensor data. Examples: motor, relay-switch, pump, servo-motor, cooling fan, heater, valve, levers, hydraulic systems etc.</li><li>• <b>Microcontroller</b> – This is the core part of a device. It processes the sensor data and gives command to the actuators. It also sends data to the internet and receives data from the internet. Examples: Arduino, Node-MCU, Raspberry-Pi etc.</li><li>• <b>Connectivity</b> – This is used for connecting the device to the internet. Connection can be wired or wireless. Examples: Ethernet connection, Wi-Fi, Bluetooth etc.</li><li>• <b>User Interface</b> – This is the set of input and output elements connected to the device for human interaction. Examples: switches, levers, touch panel, display, indicators, buzzers etc.</li></ul>
3	<b>What are the advantages of IoT ?</b>
	<p>IoT provides the following advantages due to its automation and connectivity.</p> <ul style="list-style-type: none"><li>• Ease of access</li><li>• Effective time management</li><li>• Technical optimisation</li><li>• Improved customer engagement</li></ul>

#### 4 Which are different challenges of IoT ?

IoT devices may suffer from these challenges:

- Security risk on private data
- Network connectivity
- Insufficient test and outdated products
- Lack of knowledge and awareness

#### 5 What are some popular sensors used on IoT devices ?

Some widely used sensors are:

- Temperature sensor – DHT11 / DHT22 (both temperature and humidity)
- Humidity sensor – DHT11 / DHT22
- Soil moisture sensor – YL-69 / FC-28
- Smoke (CO2) sensor – MQ-7
- Gas (LPG / CNG / Alcohol) sensor – MQ-2
- Pressure sensor – BMP180 / BMP280
- Light-intensity sensor – LDR (light dependent resistor) / BH1750
- Colour (RGB) sensor – TCS3200 / TCS34725
- Position sensor – GPS (global positioning system)
- Speed / Velocity sensor – Accelerometer ADXL345
- Vibration sensor – SW-420
- Proximity sensor – Infra-Red (IR) proximity sensor
- Water Flow sensor – YF-S201 / FS300A

Write  
at-least  
**4**  
sensors  
to  
get  
2 marks

#### 6 Which industries can be benefitted from IoT ?

A wide range of industries can be benefitted from IoT, such as:

- Manufacturing
- Agriculture
- Health-care
- Smart-city
- Public-transport
- Education
- Consumer electronics
- Home-automation
- Utilities and Energy
- Environmental benefits

#### 7 What is Arduino ?

- Arduino is a free electronics platform which provides easy-to-use hardware and software.
- It is used in IoT as it has a microcontroller.
- It reads input from the sensors and controls the actuators as per the C program, written in it.
- It can communicate with sensors, actuators, display, GPS, GSM, Wi-Fi, Bluetooth etc.
- It comes with different packages like, Arduino Uno, Arduino Mega, Arduino Nano etc.

## 8 What is Node-MCU ?

- Node-MCU is a low-cost open source IoT platform.
- It runs over ESP-12 / ESP-32 / ESP-8266 CPU and supports C program, like Arduino.
- It is associated with built-in Wi-Fi module, which makes it popular for many applications including WSP (wireless sensor network).

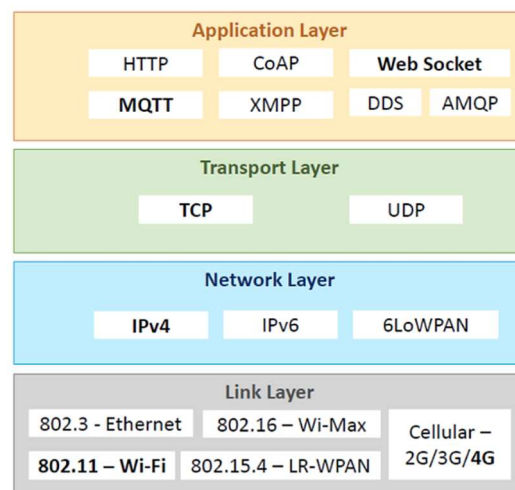
## 9 What is Raspberry Pi ?

- The Raspberry Pi is a small-sized (*a credit card sized*), low-cost computer.
- This can be plugged into a computer monitor or TV with HDMI and used with a standard keyboard and mouse.
- It can do all the operations like a conventional computer, and runs on **Python** programs.
- The recent version of Raspberry Pi **5** has a 64-bit **2.4GHz** quad-core processor and **8GB** RAM.
- It provides additional features such as USB, HDMI, Ethernet, WIFI, Bluetooth and GPIO (*general purpose Input / Output*) pins to communicate with external electronic devices.
- It comes with two more compact versions such as, Raspberry Pi – Zero and Raspberry Pi – Pico.

## 10 What are different layers of IoT protocols ?

The IoT protocol stack contains 4 layers, such as:

- **Application layer** – HTTP / MQTT / Web-Socket / CoAP / XMPP / DDS / AMQP
- **Transport Layer** – TCP / UDP
- **Network Layer** – IPv4 / IPv6 / 6LoWPAN
- **Link Layer** – IEEE 802.3 (Ethernet) / IEEE 802.11 (Wi-Fi) / IEEE 802.15 (Bluetooth) / IEEE 802.15.4 (LR-WPAN) / IEEE 802.16 (Wi-Max) / Cellular 2G/3G/4G (GSM)

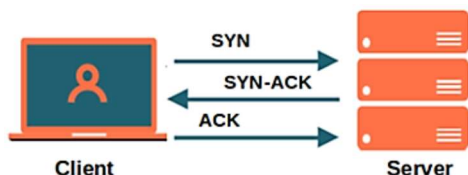


\* You can give one or two examples from each Layer for 2 marks.

## 11 What is difference between TCP and UDP ?

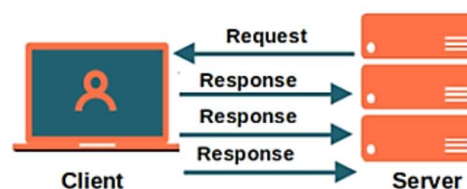
### TCP – Transmission Control Protocol

- It is connected
- It has state memory
- Point to point
- Slower
- Reliable
- Useful for secured data transmission



### UDP – User Datagram Protocol

- It is connectionless
- It is stateless
- Broadcast / multicast
- Faster
- Lossy
- Useful for online gaming / video streaming



## 12 What is difference between HTTP and Web-Socket ?

	HTTP – Hyper-Text Transfer Protocol	Web Socket
<b>Nature</b>	Stateless	Stateful
<b>Communication Pattern</b>	Client-Server	Full-Duplex
<b>Connection Time</b>	Short-lived	Persistent
<b>Usage</b>	Resource Retrieval	Real-time data transfer
<b>Protocol</b>	Text based	Binary and text based
<b>Overhead</b>	High overhead (due to header)	Low (after initial handshake)
<b>Use-Case</b>	Best for traditional web pages, API requests and resource fetching. (where the interaction is <b>request-response</b> based)	Best for real-time applications like chat-apps, live-sports update, online gaming. (where continuous data exchange is necessary)

## 13 What are different communication models in IoT ?

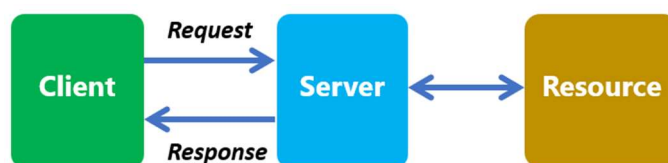
There are 4 commonly used communication models in IoT, such as:

- Request-Response Model
- Publisher-Subscriber Model
- Push-Pull Model
- Exclusive-Pair Model

*The 1<sup>st</sup> and 2<sup>nd</sup> model are mostly used in many IoT architecture*

## 14 What is Request-Response Model ?

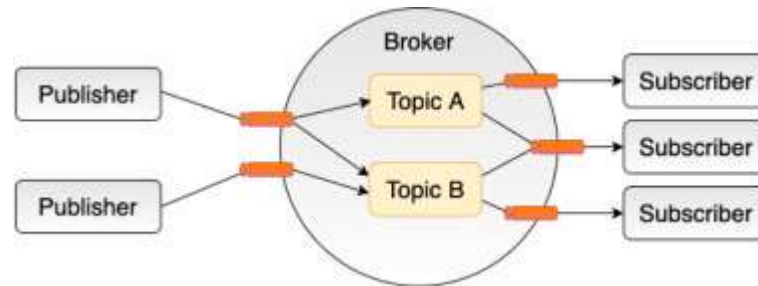
- The Request-Response Model is a communication pattern where a client sends a request to a server, and the server processes the request and sends back a response.
- It is commonly used in network communications and web services.
- The client initiates the request, and the server responds with the requested data or action result.
- It is **synchronous**. The client typically waits for the server's response before continuing its process.
- This model is widely used in HTTP web communications, where browsers (clients) request web pages or data from servers.



## 15 What is Publisher-Subscriber Model ?

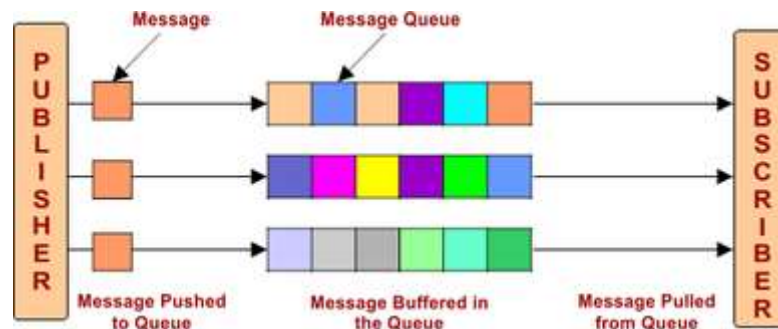
- This model has 3 elements: **Publisher**, **Subscriber** and **Broker**.
- The broker keeps record of all publishers and subscribers.
- The senders are publishers and the interested receivers are subscribers.
- When a publisher sends messages to the broker, then the broker sends that to its subscribers.

- Publishers and subscribers do **not** communicate directly. The publisher sends messages to topics or channels, and subscribers receive messages based on their subscriptions to specific topics.
- It is **asynchronous**. Subscribers receive updates only when a message is published to their subscribed topics, promoting efficiency in distributed systems.
- This model is commonly used in IoT, messaging systems, and event-driven architectures.



## 16 What is Push-Pull Model ?

- The push-pull communication model ensures that data **publishers push** the data into **queues** while **consumers pull** the data from the queues.
- In this model, neither producer nor consumer knows about each other, and it is the responsibility of the queue to decouple the messages between the consumers and the producers.
- Here, queues also act as a buffer if any mismatch is found between the rate at which producers push data and the rate at which consumers receive it.



## 17 What is Exclusive-Pair Model ?

- This is an efficient model for quick communication.
- This is a full-duplex, bidirectional communication model developed for constant/continuous connections between a client and server.
- Once a connection is established, the clients and the servers can send and receive messages.
- As long as a client doesn't send a request to close the connection, the connection remains open and the server takes care of every open connection.



## 18 What is IIoT ?

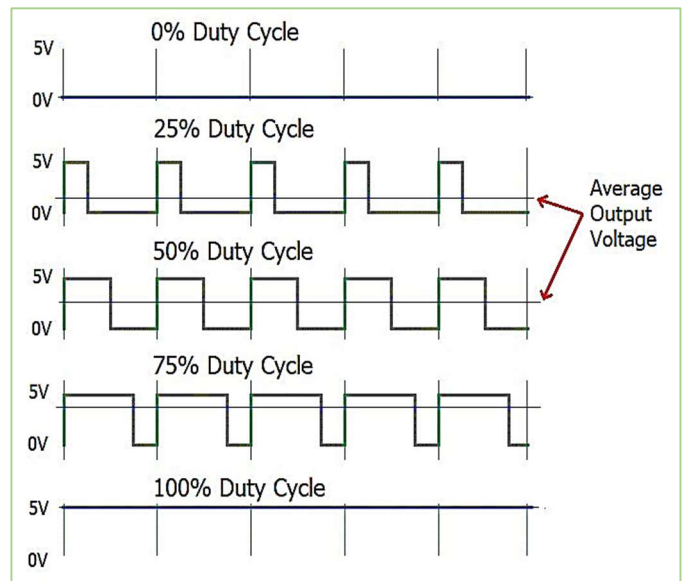
- IIoT stands for **Industrial** Internet of Things.
- This is generally used in industry for manufacturing / production line.
- So, its service model is machine-centric.
- It uses both wired and wireless devices for communication of data.
- The quality and amount of data in IIoT is very high.

## 19 What are the characteristics of IoT ?

- **Dynamic and self-adaptive** – it can dynamically adapt with the changing context. For example, a surveillance camera can switch to HD mode if any motion is detected.
- **Self-configuring** – Setup network and software upgrade with minimal user intervention.
- **Inter-operable communication protocol** – IoT devices should support multiple protocols (TCP / UDP) in order to be adaptive with the system.
- **Unique identity** – Every IoT device should have a unique IP address or URI (*universal resource Identifier*) for end-to-end communication.
- **Integrated into information network** – Every IoT device can be discoverable by other IoT devices in the same network. So, the data can be aggregated and analysed effectively.

## 20 What is PWM and why it is used in IoT ?

- Pulse Width Modulation (PWM) is a technique used to generate an analog-like signal from a digital source by varying the duty cycle of a digital signal.
- Duty cycle refers to the proportion of "on" time to the total time period.
- By adjusting the duty cycle, we can control the power delivered to devices like motors, LEDs etc.
- In IoT, PWM is commonly used for controlling actuators (e.g., motor speed control, dimming LEDs) and sensors in a power-efficient way, making it ideal for low-power IoT applications.



- PWM allows fine control of hardware elements in IoT devices without requiring true analog output.

## 21 What is GPIO ?

- GPIO = General Purpose input / output
- It is a standard interface using which Arduino, Raspberry Pi and other microcontrollers can connect to external electronic components/devices.
- These are basically programmable pins on an integrated circuit or board that allow digital input or output signals to be controlled programmatically.
- The Raspberry Pi has 26 GPIO pins and the Arduino Uno has 20 GPIO pins (6 *analog*, 14 *digital*).

## 22 What is CAN bus ?

- The CAN Bus (**Controller Area Network**) is a robust, standardized communication protocol designed to allow multiple microcontrollers and devices to communicate with each other without the need for a host computer.
- The key features are : Multiple Master and Slaves, Easy Error Detection and Broadcasting.
- CAN Bus is widely used in vehicles for communication between various components like engine control units (ECUs), sensors and actuators.
- It is also used in IoT for reliable and efficient data transmission between devices in harsh environments, such as industrial automation and robotics.
- It has an **ability to operate** in noisy environments, which make it ideal for these applications.

## 23 What is I2C ?

- I2C = I<sup>2</sup>C = IIC = Inter-Integrated Circuit
- It is a serial communication protocol used to connect multiple peripherals to a microcontroller
- It is a 2 wire system for synchronization.
  - ▶ SDA = Serial data
  - ▶ SLC = Serial Clock
- Multiple master and slave devices can communicate on the same bus, with devices identified by unique addresses.
- It is widely used in IoT for communication with sensors, displays, and other low-speed peripherals due to its simplicity and efficiency.

## 24 What is SPI ?

- SPI = Serial Peripheral Interface.
- This is a high-speed, full-duplex communication protocol used to connect microcontrollers to peripherals such as sensors, memory devices, and displays.
- It has Four-Wire System:
  - ▶ MOSI = Master Out Slave In
  - ▶ MISO = Master In Slave Out
  - ▶ SCLK = Serial Clock
  - ▶ SS/CS = Slave Select or Chip Select
- Data can be sent and received simultaneously between the master and slave (*Full Duplex*).
- SPI supports higher data transfer rates compared to I<sup>2</sup>C.
- SPI is widely used in IoT applications where high-speed, real-time communication is required.

## 25 What is MQTT ?

- MQTT = Message Queuing Telemetry Transport
- It is a lightweight, publisher-subscriber messaging protocol.
- MQTT uses a broker to manage message distribution between publishers (who send data) and subscribers (who receive it).



- It is designed for low-bandwidth networks.
- It minimizes overhead, which makes it ideal for IoT devices with limited resources.
- MQTT is widely used in IoT applications for real-time communication between sensors, actuators and cloud platforms.

## 26 What is LR-WPAN ?

- LR-WPAN = Low-Rate Wireless Personal Area Network.
- It is a wireless communication protocol designed for low-power, low-cost and short-range communications between devices.
- Standard = **IEEE 802.15.4**
- Data rate = up to **250** kbps.
- Carrier Frequency = **2.4** GHz.
- It is designed for communication over short distances, typically within **10**-100 meters.
- It consumes minimal power, which makes it ideal for **battery-powered** IoT devices.
- LR-WPAN is used in applications such as smart homes and indoor sensor networks.

## 27 What is IPv4 ?

- IPv4 = Internet Protocol version 4.
- This is used to identify devices on a network using a unique 32-bit address.
- Its format : Four numbers (with 8 bits each), separated by dots (e.g., 104.21.82.220).
- As the IPv4 uses 32-bit addresses, it allows for about 4.3 billion unique IP addresses
- It provides a system for routing data packets between devices across different networks.

## 28 What is RTOS ?

- RTOS = Real-Time Operating System.
- These operating systems are designed to process data and execute tasks within a strict time constraint for timely responses.
- It is commonly used in embedded systems, such as IoT devices, robotics, and automotive systems, where real-time performance is essential.
- Examples: FreeRTOS, VxWorks, RTEMS, QNX, TI-RTOS

## 29 Which OS are used on Raspberry Pi ?

- Raspberry Pi OS (formerly Raspbian)
- Linux Ubuntu
- Kali Linux
- Arc Linux ARM
- Windows 10 IoT Core
- PiCore
- Fedora
- RetroPie
- OpenMediaVault

Except **Windows 10 IoT Core**,  
all are Open Source



### 30 What is Salesforce IoT Cloud ?

- The Salesforce IoT Cloud is an online platform for storing and processing IoT information.
- It is a **collection of** various application development elements, which are called **lightning**.
- This program gathers information from websites, devices, customers and partners. It then triggers actions for period responses.

### 31 List out Some popular companies which are working on IoT.

Popular companies working on IoT are:

- Philips
- LG
- Samsung
- Google
- Apple
- Amazon

### 32 Mention suitable databases for IoT.

The following databases are suitable for IoT applications

- Apache Cassandra
- MongoDB
- SQLite
- influxDB
- RethinkDB

### 33 What is M2M ?

- M2M = Machine-to-Machine communication.
- It refers to direct communication between devices or machines without human intervention.
- It is widely used in smart meters, industrial automation and connected vehicles, which allows seamless communication between devices.

### 34 What is Thingful ?

- Thingful is a search engine for the Internet of Things.
- This allows users to search for real-time IoT data generated by devices, such as environmental sensors, weather stations, and smart cities.

### 35 What is ThingSpeak ?

- ThingSpeak is an open-source IoT platform which allows users to collect, store, analyze, and visualize sensor data in real time.
- It uses HTTP or MQTT protocols.
- It operates as a cloud service for remote monitoring and control of IoT devices.

### 36 Which clouds are used for IoT projects ?

Some of the popular clouds for IoT are:

- Amazon Web Service – AWS
- Google Cloud IoT
- Microsoft Azure IoT
- IBM Watson IoT
- Oracle IoT
- ThingSpeak
- Samsung Artik
- Bosch IoT
- Siemens MindSphere
- Kaa IoT

### 37 What is 6LoWPAN ?

- 6LoWPAN = IPv6 over Low-Power Wireless Personal Area Networks
- It is a communication protocol which allows IPv6 packets to be transmitted over low-power, low-bandwidth wireless networks.
- Operating Frequency = 2.4 GHz
- Data Rate = 250 kbps (max)
- Addressing = IPv6
- Standard = IEEE 802.15.4
- 6LoWPAN is widely used in IoT applications such as, smart homes, industrial automation and sensor networks, where energy efficiency and scalability are important.

### 38 Mention some examples of MEMS sensor.

- MEMS = Micro Electro Mechanical Systems
- These are used in small smart devices like phones, wristbands etc.
  - [1] Accelerometer – ADXL345
  - [2] Piezoelectric sensor – SPH0645LM4H
  - [3] Gyroscope – MPU6050
  - [4] Magnetometers – HMC5883L

### 39 Name some sensors, which are used to check water quality.

- pH sensor
- Turbidity sensor
- Nitrate Sensor
- Chlorine Sensor
- Temperature sensor
- Dissolved Oxygen sensor
- TDS (Total Dissolved Solids) Sensor
- ORP (Oxidation-Reduction Potential) Sensor

### 40 Name some sensors, which are used to check air quality.

- Smoke sensor – MQ135 / MQ7
- CO2 sensor – MQ2 / MHZ19
- NO2 sensor – MiCS 2714
- Ozone sensor – MQ131

### 41 Name some day-to-day commercial items which use IoT.

- Smart Lighting – (Philips Hue, LIFX)
- Smart Speakers – (Amazon Echo, Google Nest)
- Wearable Fitness Trackers – (Fitbit, Apple Watch)
- Smart Refrigerators – (Samsung Family Hub)
- Smart TVs – (Samsung Smart TV, LG Smart TV)
- Smart Locks – (August Smart Lock, Yale)
- Connected Cars – (Tesla, BMW ConnectedDrive)
- Smart Security Cameras – (Ring, Arlo)

#### 42 What are the various types of antennas designed for IoT devices ?

- Chip Antenna
- PCB Antenna
- Wire Antenna
- Dielectric-resonator antenna

#### 43 What is WSN ?

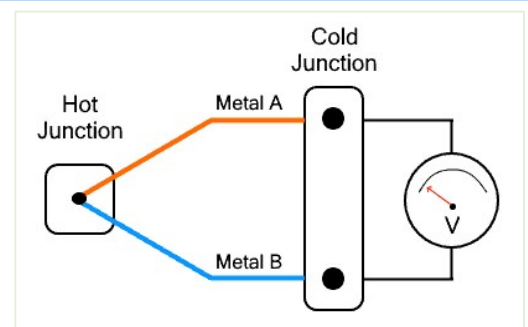
- WSN = Wireless Sensor Network
- This network consists of spatially distributed sensors which communicate wirelessly to monitor and collect data, such as temperature, humidity, pressure or motion.
- It is commonly used environmental monitoring, industrial automation, healthcare and smart cities.
- WSNs is useful for gathering real-time data in remote or hard-to-reach areas.

#### 44 What is LoRa ?

- LoRa = Long Range.
- LoRa is a wireless communication technology designed for long-distance, low-power data transmission, primarily used in IoT networks.
- Operating Frequency = 868 MHz (Europe) / 915 MHz (North America) / 433 MHz (Asia)
- Range = up to 15 km (ideal condition) / up to 5 km (urban area)
- Data Rate = 0.3 kbps to 50 kbps (max)
- It is commonly used in smart cities, agriculture, industrial monitoring and environmental sensing for applications that require low data rates over long distances.

#### 45 What is Thermocouple ?

- Thermocouple is a temperature sensor that consists of two different metal wires joined at one end.
- When the junction of these metals is exposed to heat, it generates a voltage, which is proportional to the temperature difference between the hot junction and the reference point.
- These are widely used in industrial and scientific applications to measure a broad range of temperatures.
- There are different thermocouples like, K-Type, J-Type, T-Type etc. depending upon the materials used, and their temperature ranges.
- Example : K-Type consists of Chromel and Alumel. It's temperature range is  $-200^{\circ}\text{C}$  to  $+1350^{\circ}\text{C}$



#### 46 How does the moisture sensor work ?

- The moisture sensor consists of two metal probes, and inserted into soil.
- It works on the principle of electrical resistance, as water increases electrical conductivity.
- If the soil is **dry**, then electrical **resistance** between the probes is **high** => **low moisture** levels.
- If the soil is wet, the resistance decreases => higher moisture levels.

#### 47 How does the smoke sensor MQ-7 work ?

- The MQ-7 is a carbon monoxide (CO) gas sensor.
- The sensor has a heated layer of tin dioxide (SnO<sub>2</sub>), which has low conductivity in clean air.
- Due to smoke, when the amount of carbon monoxide (CO) increases, then the conductivity of the tin dioxide layer increases.
- It can detect the concentration of CO from 20 ppm to 2000 ppm. *(ppm = parts per million)*

#### 48 What are the features of an IoT based smart city ?

- IoT enabled traffic management system
- Smart parking
- IoT enabled infrastructures (buildings, roads, bridges, etc.) to monitor their condition.
- Weather monitoring system
- Smart electric grids for efficient power distribution
- Emergency response system

#### 49 Can we say “Amazon Echo” is an IoT device ? If yes, explore its components.

Yes, “Amazon Echo” is an IoT device.

It consists of the following components in context to IoT.

- **Sensors:** Microphones, temperature sensors.
- **Actuators:** Speakers, LED indicators.
- **Connectivity:** Wi-Fi, Bluetooth, Zigbee (in some models).
- **Cloud Services:** AWS – Amazon Web Services.
- **User Interface (input):** Volume buttons, Action button, Microphone Mute button
- **User Interface (output):** Speakers (Music, Alarm, Notification)  
LED Ring (Listing, Notifications, Volume Levels)

#### 50 Which types of testing are done for an IoT system?

- **Usability** Testing – *if it is user friendly or not*
- **Compatibility** Testing – *if it can be implemented for different networks / software*
- **Reliability** and **Scalability** Testing – *if it can work for long time / if it can increase the users*
- **Data Integrity** Testing – *if it can handle huge amount of data*
- **Security** Testing – *if the data handled are validated or not*
- **Performance** Testing – *how efficiently does the system work*