MODULE J · CAMBRIDGE 0478 3.2, 6.1, 6.2, 6.3 · NOT ON OCR J277

Hardware and emerging tech

Input and output devices, **sensors**, **automated systems**, **robotics**, **AI**, **expert systems** and **machine learning**. **Every card is IGCSE only: OCR J277 students can skip this module.** There is no J2. Spec versions as checked in November 2026.

01 Input and output (J1) IGCSE only

Input Enters data or instructions for processing. Keyboard, optical mouse, microphone, digital camera, barcode and QR code scanners, 2D and 3D scanners, touch screen.

Touch Resistive: top layer pressed onto layer below (gloves OK). Capacitive: finger changes the charge (no gloves). Infra-red: beams broken (gloves OK).

Output Presents results, or makes a physical action. LED and LCD screens, LCD and DLP projectors, speaker, actuator.

Printers Inkjet: ink droplets, quality colour photos. Laser: toner fused, fast for lots of text. 3D: builds an object layer by layer.

Exam Say why the device is needed in this system.

03 Sensors (J3) IGCSE only

Sensor Input device that measures a physical property and sends the data to a computer or microprocessor. Monitors automatically and continuously.

The 14 **Acoustic** sound · **accelerometer** acceleration, tilt · **flow** liquid or gas in a pipe · **gas** e.g. CO_2 · **humidity** water vapour in air · **infra-red** IR, broken beams · **level** height of liquid · **light** intensity · **magnetic field** changes, e.g. a car over it · **moisture** water in soil · **pH** acid or alkali · **pressure** force · **proximity** how near · **temperature**.

Exam No "motion sensor". Humidity = air; moisture = soil.

04 Automated systems (J4) IGCSE only

Sensor Takes readings continuously; sends them to the microprocessor.

Micro Compares each reading with stored values; decides if action is needed.

Actuator Gets a signal; makes a physical change (motor, valve, pump). Loop repeats.

Example Vent opens above 28 °C, closes below 22 °C. 25 °C: no action; 30 °C: open; 21 °C: close.

+ / - 24/7, fast, consistent, safer in hazards, fewer staff. Costly to set up and maintain, can fail or be hacked, job losses, can't handle the unexpected.

05 Robotics (J5) IGCSE only

Robotics Branch of computer science: design, construction and operation of robots.

Robot 1 mechanical structure or framework; 2 electrical components (sensors, microprocessors, actuators); 3 programmable. Need not look human.

Areas Industry, transport, agriculture, medicine, domestic settings, entertainment. E.g. factory arms, robot vacuums, drones.

+ / - 24/7, consistent, precise, dangerous places. Expensive, job losses, can't handle unfamiliar situations.

06 Artificial intelligence (J6) IGCSE only

AI Branch of computer science dealing with the simulation of intelligent behaviours by computers.

Traits A collection of data and the rules for using that data; the ability to reason; can include the ability to learn and adapt.

Limited to Expert systems and machine learning.

Exam An AI system does not have to learn to be AI.

07 Expert systems (J7) IGCSE only

Knowledge base Facts about the specialist area, from human experts.

Rule base IF ... THEN rules used to reason with the facts.

Inference engine Applies the rules to the facts and the user's answers; picks the next question; reaches a conclusion.

Interface User enters answers; shows questions and the conclusion.

Operation Question, answer, rules applied; not enough data, ask again; rule met, output the result.

08 Machine learning (J8) IGCSE only

Meaning When a program has the ability to automatically adapt its own processes and/or data.

How Learns from data and experience; finds patterns; improves without being reprogrammed. Shows the ability to learn and adapt.

Example Spam filter: users mark spam, it finds patterns, adapts its own rules.

Data Poor or biased data gives poor or biased results.

09 Expert vs ML (J7, J8) IGCSE only

Rules from Expert system: people, from human experts. Machine learning: patterns it finds in data.

Changes itself? Expert system: no, people update it. Machine learning: yes, automatically.

Both Have data and rules, and the ability to reason.

01
The **sensor reads**, the **microprocessor decides**, the **actuator acts**. A sensor never switches anything on.

02
Name sensors from the **list of 14**. Gloves: **resistive** or **infra-red** touch screen, not capacitive.

03
Knowledge base = facts; **rule base = rules**; the **inference engine** decides.

04
Advantages and disadvantages: **expand** each point in the scenario. "Faster" alone scores 0.