Solutions

Each answer shows the steps, then the **result**.

2.1

- primary memory is fast and reached **directly** by the CPU (holds the running program)
- secondary storage is larger, slower, and **keeps data when the power is off**

2.2

- any two of: RAM is volatile / ROM is non-volatile; the CPU can write to RAM / normally not to ROM; RAM holds running programs / ROM holds start-up data

2.3

- benefit e.g. small / cheap / low-power / reliable
- drawback e.g. limited to one task / hard to update / hard to repair

2.4

- **actuator**

3.1

(a) RAM is **volatile** and the CPU can read **and write** it (running programs)

- ROM is **non-volatile** and normally only read

(b) e.g. it stores the **boot/start-up program** (BIOS)

3.2

- SRAM is **faster** and needs no refreshing, so it suits the small, speed-critical cache
- DRAM is **cheaper and denser** per bit, so it suits the large main memory
- even though DRAM must be refreshed

3.3

- **PROM** can be written **once**
- **EPROM** can be erased (by UV light) and rewritten
- **EEPROM** can be erased and rewritten **electrically**, in place

3.4

(a) a **temperature sensor**

(b) the sensor reads the temperature

- the processor compares it with 25 °C and switches a heater/cooler (actuator) on or off
- this changes the temperature, which the sensor reads again — the feedback keeps it near the target

3.5

- **laser printer:** a laser draws the page image as charge on a photosensitive drum
- toner sticks to the charged areas and transfers to the paper
- a fuser melts the toner onto the paper
- *(or a correct layer-by-layer description of a 3D printer)*

3.6

(a) each core can execute instructions, so a quad-core CPU can run up to four tasks (or threads) at the same time

- that means more work per second

(b) the software (or task) must be written to split across cores; a single-threaded program still uses only one core

3.7

- the printer is much slower than the computer; the buffer holds the data waiting to be printed
- the computer (CPU) is freed to do other work instead of waiting for the printer

3.8

(a) a **monitoring** system reads the sensors and reports or records the values — it displays the greenhouse temperature and logs it, but changes nothing

- a **control** system reads the same sensors and **acts** on the result, opening the vent or switching on the irrigation
- so a control system contains a monitoring system plus the output devices that change the conditions

(b) the **ADC** converts the sensor's continuously varying analogue voltage into the binary values the processor can work with

- the **actuator** is the device that carries out the processor's decision — here the motor that drives the vent open

(c) conditions change quickly in a greenhouse, and a plant can be damaged within minutes of overheating

- reading in a continuous loop means the system responds as soon as the threshold is crossed rather than up to an hour later

(d) the design file is sliced into many thin horizontal **layers**

- the printer deposits or solidifies material one layer at a time
- each layer bonds to the one beneath, building the clip from the bottom up

(e) the printer works far more slowly than the computer can send data

- the buffer stores the data waiting to be printed
- without it the computer would have to wait for the printer, unable to do anything else, and data arriving faster than it was consumed would be lost