Solutions

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

2.1

- program instructions and data are stored together in the same memory
- the instructions are fetched from memory and executed one at a time, in order

2.2

- the contents of the memory location whose address is held in the MAR
- are copied into the MDR

2.3

- **Status Register:** holds flags, such as carry, zero, negative and overflow, set by the result of an operation
- **Index Register:** holds a value that is added to an address, to step through memory locations

2.4

- n lines give 2^n addresses
- $2^{24} =$ **16 777 216** locations

2.5

(a) **USB**

(b) **HDMI**

(c) **VGA**

2.6

- hardware, any two of: a key is pressed; a printer runs out of paper; the mouse is moved; a timer signal
- software, one of: division by zero; an attempt to use a memory location that is not allowed; a request for an operating system service

3.1

- step 2: `PC ← [PC] + 1`
- step 3: `MDR ← [[MAR]]`
- step 4: `CIR ← [MDR]`

3.2

(a) a **hardware** interrupt, because the signal comes from a device, the printer

(b) any **five** of:

- the printer sends an interrupt signal to the processor
- the processor checks for interrupts at the end of each fetch-execute cycle

- it compares the priority of the interrupt with the priority of the current task
- the contents of the PC and the other registers are saved on the stack
- the address of the Interrupt Service Routine is loaded into the PC
- the ISR runs, for example to show a message asking for more paper
- the saved contents are restored, and the report program carries on

(c) the registers hold the state of the interrupted program, including the address of its next instruction in the PC

- restoring them lets the program carry on exactly where it stopped, with nothing lost

3.3

- **cores:** more cores execute more instructions at the same time, and video editing software can divide its work between them, so B gains
- **clock speed:** A's faster clock completes more fetch-execute cycles per second on each core
- **cache:** B's larger cache holds more of the instructions and data in use, so fewer slow fetches from main memory are needed
- choose **computer B**: for video editing, eight cores and more cache outweigh A's faster clock

3.4

(a) $2^{20} =$ **1 048 576**

(b) twice as many bits are carried in each transfer

- so more data is moved per second, and larger values can be moved in one step

(c) any two of: memory read; memory write; clock signal; interrupt request; bus request

3.5

(a) monitor: **HDMI**; keyboard: **USB**; external hard disk: **USB**

(b) VGA carries an **analogue** signal, so the digital picture must be converted, and it can pick up noise and lose detail

- HDMI carries a **digital**, high definition signal, and it carries sound as well