Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

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

2.1

checks needed: $10^8/16 = 6.25 \times 10^6$ a second

cycles: $6.25 \times 10^6 \times 400 = 2.5 \times 10^9$ a second

that is 250% of a 1 GHz processor: impossible, so use DMA

2.2

keyboard: interrupts, because key presses are rare and polling would waste cycles

fast sensor: polling (or DMA), because an interrupt costs more than the 10 ns between events

2.3

it gives the DMA controller the memory address, the byte count and the direction

then it does other work until one interrupt says the block is done

2.4

rotation $0.5 \times 60/7200 = 4.17$ ms

transfer $1/100$ s $= 10$ ms

total $4 + 4.17 + 10 \approx \mathbf{18.2}$ ms

3.1

(a) disk $1/0.009 \approx \mathbf{111}$; SSD $1/0.0001 = \mathbf{10\,000}$

(b) $5000/111 \approx 45$, so **46** disks

(c) disk $10\,000/200 = \mathbf{50}$ s; SSD $10\,000/3000 \approx \mathbf{3.3}$ s

(d) sequential reads need no seeks, so the disk's slow moving parts matter much less

3.2

(a) 1 Gbit/s = 125 MB/s; $125 \times 10^6/1500 \approx \mathbf{83\,333}$ packets a second; $83\,333 \times 2000 \approx 1.67 \times 10^8$ cycles; $\div 3 \times 10^9 \approx \mathbf{5.6}\%$

(b) $83\,333/64 \approx 1302$ interrupts; $1302 \times 2000/(3 \times 10^9) \approx \mathbf{0.087}\%$

3.3

(a) $3840 \times 2160 \times 3 = 24.9$ MB per frame; $\times 30 \approx \mathbf{746\ MB/s}$

(b) no: 746 MB/s is about 1.5 times the 500 MB/s the link can carry

(c) $746/10 \approx \mathbf{75\ MB/s}$, which fits easily

(d) lossy $10:1$ compression throws detail away, so use lossless compression (often about $2:1$, giving about 370 MB/s) or a faster link such as Thunderbolt; record to fast SSDs, since 746 MB/s is about 2.7 TB an hour

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