Computer Organization and Design (4th)
by Hennessy, Patterson
Chapter 6.11, Problem 1E

Step 1

Yes, the CPU does relinquish control of memory when DMA is active. The CPU initiates the data transfer then starts the data transfer, the device and memory communicate directly with no intervention from the CPU.

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Step 1

a. Yes. If the CPU is processing the graphical data that is to be displayed, allowing the graphics card to access that data without going through the CPU can prevent substantial delays.

Step 2

b. Yes. If the CPU is processing sound data that is to be output by the sound card in real time, allowing the sound card to access data without going through the CPU can have extensive benefit.

DMA is useful when individual transactions with the CPU may involve large amounts of data. A frame handled by a graphics card may be huge, but is treated as one display action. Conversely, input from a mouse is small.

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Step 1

Virtual memory swaps memory pages in and out of physical memory based on locations being addressed. If a page is not in memory when an address associated with it is accessed, the page must be loaded, potentially displacing another page. Virtual memory works because of the principle of locality. Specifically, when memory is accessed, the chance of the next access being nearby is high. Thus, pulling a page from disk to memory due to a memory access not only retrieves the memory be accessed, but likely the next memory element being access. Any of the devices listed in the table could cause potential problems if it causes virtual memory to thrash, continuously swapping in and out pages from physical memory. This would happen if the locality principle is violated by the device. Careful design and sufficient physical memory will almost always solve this problem.