1. As one goes down the five-level memory hierarchy discussed in the text, the access time increases. Make a reasonable guess about the ratio of the access time of optical disk to that of registry memory. Assume the disk is already on-line.
2. Sociologists can get three possible answers to a typical survey question such as “Do you believe in the tooth fairy?” –namely, yes, no, and no opinion. With this in mind, the Sociomagnetic Computer Company has decided to build a computer to process survey data. This computer has a trinanry of memory-that is, each byte (tryte?) consists of 8 trits, with a trit holding a 0, 1, or 2. How many trits are needed to hold a 6-bit number? Give an expression for the number or trits needed to hold *n* bits.
3. Compute the data rate of the human ear from the following information. People can hear frequencies up to 22 kHz. To capture all the information in a sound signal at 22 kHz, it is necessary to sample the sound at twice that frequency, that is, at 44 kHz. A 16-bit sample is probably enough to capture most of the auditory information. (i.e., the ear cannot distinguish more than 65,535 intensity levels).
4. Genetic information in all living things is coded as DNA molecules. A DNA molecule is a linear sequence of the four basic nucleotides: A, C, G, and T. The human genome contains approximately 3 x 10^9 nucleotides in the form of about 30,000 genes. What is the total information capacity (in bits) of the human genome? What is the maximum information capacity (in bits) of the average gene?
5. In a Hamming code, some bits are “wasted” in the sense that they are used for checking and not information. What is the percentage of wasted bits for messages whose total length ( data + check bits) is $2^{n}-1$? Evaluate this expression numerically for values of *n* from 3 to 10.
6. A computer has a bus with a 5 nsec cycle time, during which it can read or write a 32-bit word from memory. The computer has an Ultra4-SCSI disk that uses the bus and runs at 160 Mbytes/sec. The CPU normally fetches and executes one 32-bit instruction every 1 nsec. How much does the disk slow down the CPU.
7. How long does it take to read a disk with 10,000 cylinders, each containing four tracks of 2048 sectors? First, all the sectors of track 0 are to be read starting at sector 0, then all the sectors of track 1 starting at sector 0, and so on. The rotation time is 10 msec, and a seek takes 1 msec between adjacent cylinders and 20 msec for the worst case. Switching between tracks of a cylinder can be done instantaneously.
8. To burn a CD-R, the laser must pulse on and off at a high speed. When running at 10x speed in mode 1, what is the pulse length, in nanoseconds?
9. To be able to fit 133 minutes worth of video on a single-sided single-layer DVD, a fair amount of compression is required. Calculate the compression factor required. Assume that 3.5 GB of space is available for the video track, that the image resolution is 720 x 480 pixels with 24-bit color, and images are displayed at 30 frames/sec.
10. In a certain font, a monochrome laser printer can print 50 lines of 80 characters per page. The average character occupies a box 2 mm x 2 mm, about 25% of which is toner. The rest is blank. The toner layer is 25 microns thick. The printer’s toner cartridge measures 25 x 8 x 2 cm. How many pages is one toner cartridge good for?
11. When odd-parity ASCII text is transmitted asynchronously at a rate of 5600 characters/sec over a 56,000 bps modem, what percent of the received bits actually contains data (as opposed to overhead)?
12. The Hi-Fi Modem Company has just designed a new frequency-modulation modem that uses 64 frequencies instead of just 22. Each second is divided into *n* equal time intervals, each of which contains one of 64 possible tones. How many bits per second can this modem transmit, using synchronous transmission?
13. An internet user has subscribed to a 2 Mbps ADSL service. Her neighbor has subscribed to a cable internet service that has a shared bandwidth of 12 MHz. The modulation scheme in use is QAM-64. There are *n* houses on the cables, each with one computer. A fraction *f* of these computers are online at any one time. Under what conditions will the cable use get better service than the ADSL user?
14. A digital camera has a resolution of 3000 x 2000 pixels, with 3 bytes/pixel for RGB color. The manufacturer of the camera wants to be able to write a JPEG image at a 5x compression factor to the flash memory in 2 sec. What data rate is required?