1.4

a. Energy: 1/8. Power: Unchanged.

b. Energy: $\text{Energy}_{\text{new}}/\text{Energy}_{\text{old}} = (\text{Voltage} \times 1/8)^2/\text{Voltage}^2 = 0.156$
Power: $\text{Power}_{\text{new}}/\text{Power}_{\text{old}} = 0.156 \times (\text{Frequency} \times 1/8)/\text{Frequency} = 0.00195$

c. Energy: $\text{Energy}_{\text{new}}/\text{Energy}_{\text{old}} = (\text{Voltage} \times 0.5)^2/\text{Voltage}^2 = 0.25$
Power: $\text{Power}_{\text{new}}/\text{Power}_{\text{old}} = 0.25 \times (\text{Frequency} \times 1/8)/\text{Frequency} = 0.0313$

d. 1 core = 25% of the original power, running for 25% of the time.

$$0.25 \times 0.25 + (0.25 \times 0.2) \times 0.75 = 0.0625 + 0.0375 = 0.1$$

1.5

a. Amdahl's law: $1/(0.8/4 + 0.2) = 1/(0.2 + 0.2) = 1/0.4 = 2.5$

b. 4 cores, each at 1/(2.5) the frequency and voltage
Energy: $\text{Energy}_{\text{quad}}/\text{Energy}_{\text{single}} = 4 \times (\text{Voltage} \times 1/(2.5))^2/\text{Voltage}^2 = 0.64$
Power: $\text{Power}_{\text{new}}/\text{Power}_{\text{old}} = 0.64 \times (\text{Frequency} \times 1/(2.5))/\text{Frequency} = 0.256$

c. 2 cores + 2 ASICs vs. 4 cores

$$(2 + (0.2 \times 2))/4 = (2.4)/4 = 0.6$$

1.8

a. 50%

b. Energy: $\text{Energy}_{\text{new}}/\text{Energy}_{\text{old}} = (\text{Voltage} \times 1/2)^2/\text{Voltage}^2 = 0.25$

1.10

a. $10^9/100 = 10^7$

b. $10^7/10^7 + 24 = 1$

1.13

a. old execution time = 0.5 new + 0.5 × 10 new = 5.5 new

b. In the original code, the unenhanced part is equal in time to the enhanced part (sped up by 10), therefore:
$(1 - x) = x/10$
$10 - 10x = x$
$10 = 11x$
$10/11 = x = 0.91$

1.14

a. $1/(0.8 + 0.20/2) = 1.11$

b. $1/(0.7 + 0.20/2 + 0.10 \times 3/2) = 1.05$

c. fp ops: 0.1/0.95 = 10.5%, cache: 0.15/0.95 = 15.8%

1.15

a. $1/(0.5+0.5/22)=1.91$

b. $1/(0.1+0.90/22)=7.10$

c. $41\% \times 22=9$. A runs on 9 cores. Speedup of A on 9 cores: $1/(0.5+0.5/9)=1.8$ Overall speedup if 9 cores have 1.8 speedup, others none: $1/(0.6+0.4/1.8)=1.22$

d. Calculate values for all processors like in c. Obtain: 1.8, 3, 1.82, 2.5, respectively.

e. $1/(0.41/1.8+0.27/3+0.18/1.82+0.14/2.5)=2.12$

1.16

a. $1/(0.2+0.8/N)$

b. $1/(0.2+8\times 0.005+0.8/8)=2.94$

c. $1/(0.2+3\times 0.005+0.8/8)=3.17$

d. $1/(.2+\log N\times 0.005+0.8/N)$

e. $d/dN\ (1/((1-P)+\log N\times 0.005+P/N)=0)$