Exercise 1

1.

t = 0.9 ns
F = 1/(0.9ns) = 1,11 MHz

2.
AMAT = t_hit + p_miss * t_miss
AMAT = 0,9 ns + (1-0,94) * 70 ns = 5,1 ns

3.
We need to take into account how many times the processor executes a load/store instruction. Therefore, we multiply by the percentage.

CPI = CPI_ideal + percentage_of_load/store * (miss_rate * miss penalty)
miss_penalty (in clock cycles) = miss_time * clk freq
miss_penalty = 70 ns * 1,11 MHz = 77,7
CPI = 1 + 0,36 * ((1-0,94) * 77,7) = 2.68

4.
AMAT = t_hit_L1 + p_miss_L1 * t_miss_L1

p_miss_L2 = miss rate to main memory = 0,1

Calculate the miss time for L1 cache, so when looking into L2, finding the data or looking into L2 and not finding the data.
t_miss_L1 = t_hit_L2 + p_miss_L2 * t_miss_L2
t_miss_L1 = 6 ns + 0,1 * 70 ns = 13 ns

AMAT = 0,9 ns + 0,06 * 13 ns = 1,68 ns

5.
CPI = CPI_ideal + p_miss_L1 * (hit_time_L2 + p_miss_L2 * hit_time_main_memory) * F_clk
CPI = 1 + 0,06 * (6 ns + 0,1 * 70 ns) * 1,11 MHz
CPI = 1.87

6.
Yes, CPI is 2,68 / 1,87 = 1,43 times lower. AMAT is 5,1 / 1,68 = 3,04 times lower. So everything has decreased in time, making it faster.

Exercise 2

1.
VA = 48 bits
Page size = 8Kb

VA size = Virtual page number size + page offset size
Page offset size = log2(page size) = log2(8KB) = 13 bits
Virtual page number size = VA – page offset = 48 – 13 = 35 bits
Number of virtual pages = 2^(35) = 34,36e9 pages

2.
Physical address size = physical page number size + page offset size
PTE size = Physical page number size + reserved bits size
PTE size = 4 Bytes = 32 bits
Physical page number size = 32 bits - 12 bits = 20 bits

Physical address size = 20 + 13 = 33 bits

Physical addressable space = 2^33 = 8,59e9 pages

3.
Total storage needed in bits = number of PTEs in bits + PTE size in bits
PTE size = 4 bytes = 32 bits = 2^5 bits
(Slide 24 of lecture 10 uses PTE size in bytes, but that is incorrect due to different units right?)
Total storage needed in bits = 35 bits + 32 bits = 67 bits

4.
20 bits are reserved for the physical addresses.
Each page is 8KB

This means that there are 2^20 * 8KB = 8,4 GB of physical space