

1. Answer:

- a) A frame has the same size as a page, 2^{10} bytes.
- b) There is one entry for each page in the logical address space. Therefore, there are 2^{16} entries.
- c) The number of bytes in the logical address space is $(2^{16} \text{ pages}) \times (2^{10} \text{ bytes/page}) = 2^{26}$ bytes.
- d) The number of frames needed to store the largest page table is $(2^{16} \text{ entries}) \times (2^2 \text{ bytes/entry}) / 2^{10} \text{ bytes/frame} = 2^8$ frames.

2. Answer:

- a) $660 + 198 = 858$
- b) $222 + 156 = 378$
- c) Invalid address because the length of segment 1 is $422 < 530$.

3. Answer:

- a)
 - Relative address is $5499 = 5 \times 1024 + 379$, i.e., virtual address is 5, 379
 - Virtual address in binary is 0000 0001 0101 0111 1011
 - Map to frame number 2
 - The physical address is 0000 1001 0111 1011
- b)
 - Relative address is $2221 = 2 \times 1024 + 173$, i.e., virtual address is 2, 173
 - Virtual address in binary is 0000 0000 10 00 1010 1101
 - The page has not been loaded into memory yet, resulting in a page fault

4. Answer:

a) OPT:

7	0	1	2	0	3	0	4	2	3	0	3	2
7	7	7	2	2	2	2	2	2	2	2	2	2
	0	0	0	0	0	0	4	4	4	0	0	0
		1	1	1	3	3	3	3	3	3	3	3
F	F	F	F		F		F			F		

Number of page faults=7

b) FIFO:

7	0	1	2	0	3	0	4	2	3	0	3	2
7	7	7	2	2	2	2	4	4	4	0	0	0
	0	0	0	0	3	3	3	2	2	2	2	2
		1	1	1	1	0	0	0	3	3	3	3
F	F	F	F		F	F	F	F	F	F		

Number of page faults=10

c) LRU:

7	0	1	2	0	3	0	4	2	3	0	3	2
7	7	7	2	2	2	2	4	4	4	0	0	0
	0	0	0	0	0	0	0	0	3	3	3	3
		1	1	1	3	3	3	2	2	2	2	2
F	F	F	F		F		F	F	F	F		

Number of page faults=9

d) Clock:

7	0	1	2	0	3	0	4	2	3	0	3	2
7*	7*	→7*	2*	2*	→2*	→2*	4*	4*	4*	→4	3*	3*
→	0*	0*	→0	→0*	0	0*	→0	2*	2*	2	→2	→2*
	→	1*	1	1	3*	3*	3	→3	→3*	0*	0*	0*
F	F	F	F		F		F	F		F	F	

Number of page faults=9

Self-test

1. B
2. C
3. C
4. B
5. A
6. C