CHAPTER 4 - Memory

Questions 1

Consider the following page reference string: e, c, b, e, a, g, d, c, e, g, d, a

With 4 frames, how many page faults would occur with the following page replacement algorithms? Fill in the tables accordingly.
RS: reference strings; F0: frame 0, F1: frame 1, etc.

Hint: all frames are initially empty, so your first unique pages will all cost one fault each.

1. Optimal

Time	1	2	3	4	5	6	7	8	9	10	11	12
RS	e	c	b	e	a	g	d	c	e	g	d	a
F0												
F1												
F2												
F3												
Page fault?												

Total page fault:

2. LRU

Time	1	2	3	4	5	6	7	8	9	10	11	12
RS	e	c	b	e	a	g	d	c	e	g	d	a
F0												
F1												
F2												
F3												
Page fault?												

Total page fault:

3.Second chance

Time	1	2	3	4	5	6	7	8	9	10	11	12
RS	e	c	b	e	a	g	d	c	e	g	d	a
F0												
F1												
F2												
F3												
Page fault?												

Total page fault:

Questions 2

1. True or False? A program does not need to be stored in memory in its entirety.
2. True or False? A physical address space is at least as large as a virtual address space.
3. When does a page fault occur?
4. True or False? In a pure demand paged system a page is never brought into memory until it is needed.

1. A machine has 48 bit virtual addresses and 32 bit physical addresses. Pages are 8 KB. How many entries are needed for the page table?

2^35 pages

2. For each of the following decimal virtual addresses, compute the virtual page number and offset for a 4-KB page and for an 8 KB page: 20000, 32768, 60000.

    2.1 Page size = 4KB

20000 = page number * 4 * 1024 + offset

Virtual address	Page number	Offset
20000	4	3616
32768		
60000		

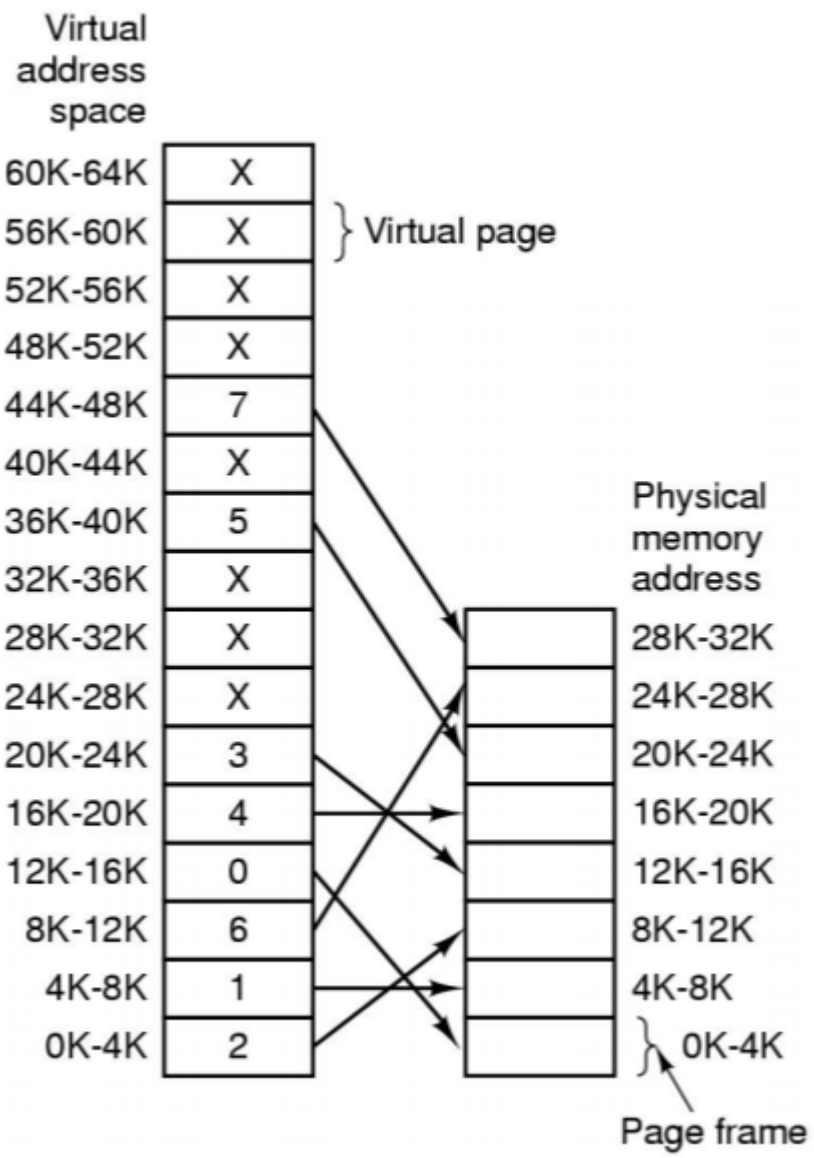
2.2 Page size = 8KB

20000 = page number * 8 * 1024 + offset

Virtual address	Page number	Offset
20000	2	3616
32768		
60000		

3. The figure below shows a virtual address space from 0 to 64K and 32K of physical memory. There are 16 pages and 8 frames and transfers between memory and disk are in pages. Give the physical address corresponding to the following virtual addresses, explain how did you get the answer?:

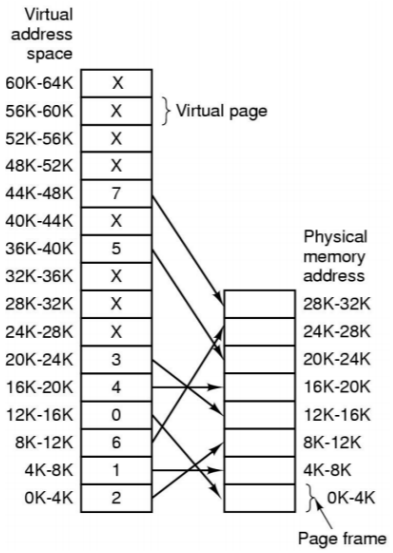
    a) 20 b) 4100 c) 8300



4. A memory free in 3 frames. How many page fault occur after running as the following page 7, 0 , 1, 2 , 0, 3, 0 , 4, 2 , 3 , 0 , 3 , 2 , 1, 2, 0, 1, 0 , 7 using FIFO

	7	**0**	**1**	**2**	**0**	**3**	**0**	**4**	**2**	**3**	**0**	**3**	**2**	**1**	**2**	**0**	**1**	**0**	**7**
F1																			
F2																			
F3																			
PF																			

2. With given page table and 16 bit virtual address, that is split 4 bit page numbers and 12 bit offset. If user references the address 15016, which physical address is in memory?



Answer: ? 2728

3. A memory free in 4 frames. How many page faults do occur after running as the following page 2 3 2 0 1 5 2 4 5 3 2 5 2 using LRU

Answer:

	2	**3**	**2**	**0**	**1**	**5**	**2**	**4**	**5**	**3**	**2**	**5**	**2**
F1													
F2													
F3													
F4													
PF													

4. A memory free in 4 frames. Which state of the memory after the page 4 is accessed when the requested page as 2 3 2 0 1 5 2 4 5 3 2 5 2 using LRU

6. Assume that the Page Table below is in effect. The number of lines per page is 400. The actual memory location for line 1634 is _____34__ .

Page Number	Page Frame Number
0 1 2 3 4	8 10 5 11 0

7. A computer has four page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last ref	R	M
0	226	280	0	0
1	160	265	0	1
2	110	270	1	0
3	120	285	1	1

Which page will LRU replace?

1

8. A computer has four page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last ref.	R	M
0	226	280	0	0
1	160	265	0	1
2	110	270	0	0
3	120	285	1	1

Which page will Second Chance replace? (NRU)

9. A memory free in 3 frames. How many page hits do? Assume that the running as the following page 7, 0 , 1, 2 , 0, 3, 0 , 4, 2 , 3 , 0 , 3 , 2 , 1, 2, 0, 1, 0, 7 using LRU

	7	**0**	**1**	**2**	**0**	**3**	**0**	**4**	**2**	**3**	**0**	**3**	**2**	**1**	**2**	**0**	**1**	**0**	**7**
F1																			
F2																			
F3																			
PF																			

9. A computer provides the user with virtual address space of 2^32 (2 to the power 32) bytes. Pages of size 4096 (4K or 2^12) bytes are used for implementing virtual memory where the total physical memory is equal to 2^18 bytes. If the hexadecimal virtual

address is 23456111, the page number in hexadecimal would be?

10. A computer has four page frames. The time of loading, time of last access, and the R and M bits for each page are as shown below (the times are in clock ticks):

Page	Loaded	Last Ref.	R	M
0	230	285	1	0
1	120	265	0	0
2	140	270	0	1
3	110	280	1	1

(a) Which page will NRU replace? (1)
(b) Which page will FIFO replace? (3)
(c) Which page will LRU replace? (1)
(d) Which page will second chance replace? (1)

11. Consider a logical address space of 64 pages of 2048 words each, mapped unto a physical memory of 32 frames.

a) How many bits are there in logical address?

17

b) How many bits are there in physical address?

16

12. A system with 32 bit virtual address. If the page size is 4 KB and each table entry occupies 4 bytes, what is the size of the page table?

Consider a swapping system in which the memory consists of the following hole sizes: 10K, 4K, 20K, 15K, 9K. Assume worst fit algorithm is used. Which holes are taken for successive segment requests of 8K,

13. If there are 64 pages and the page size is 2048 words, what is the length of logical address?

14. A system with 32 bit virtual address. If the page size is 4 KB and each table entry occupies 4 bytes, what is the size of the page table?

total pages = 2^20

size of page table = 4B * 2 ^ 20 = 4MB

size of virtual memory = 2^ 20 * 4KB = 4GB