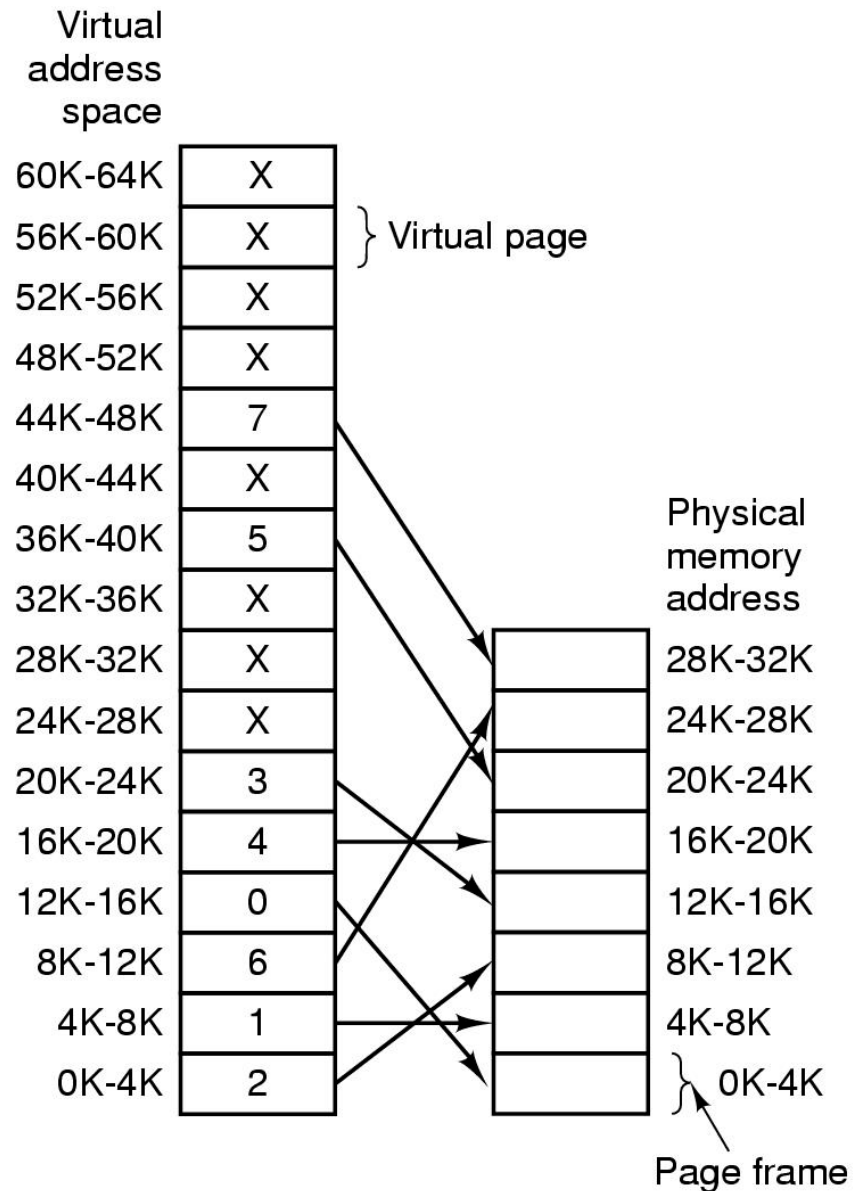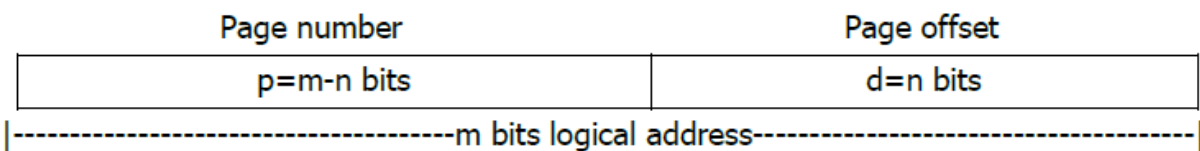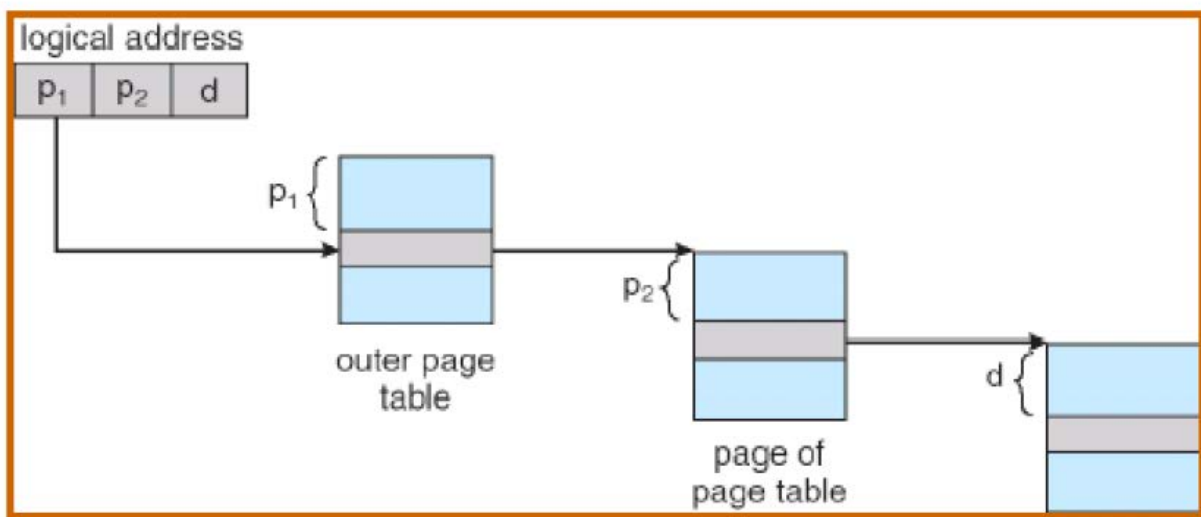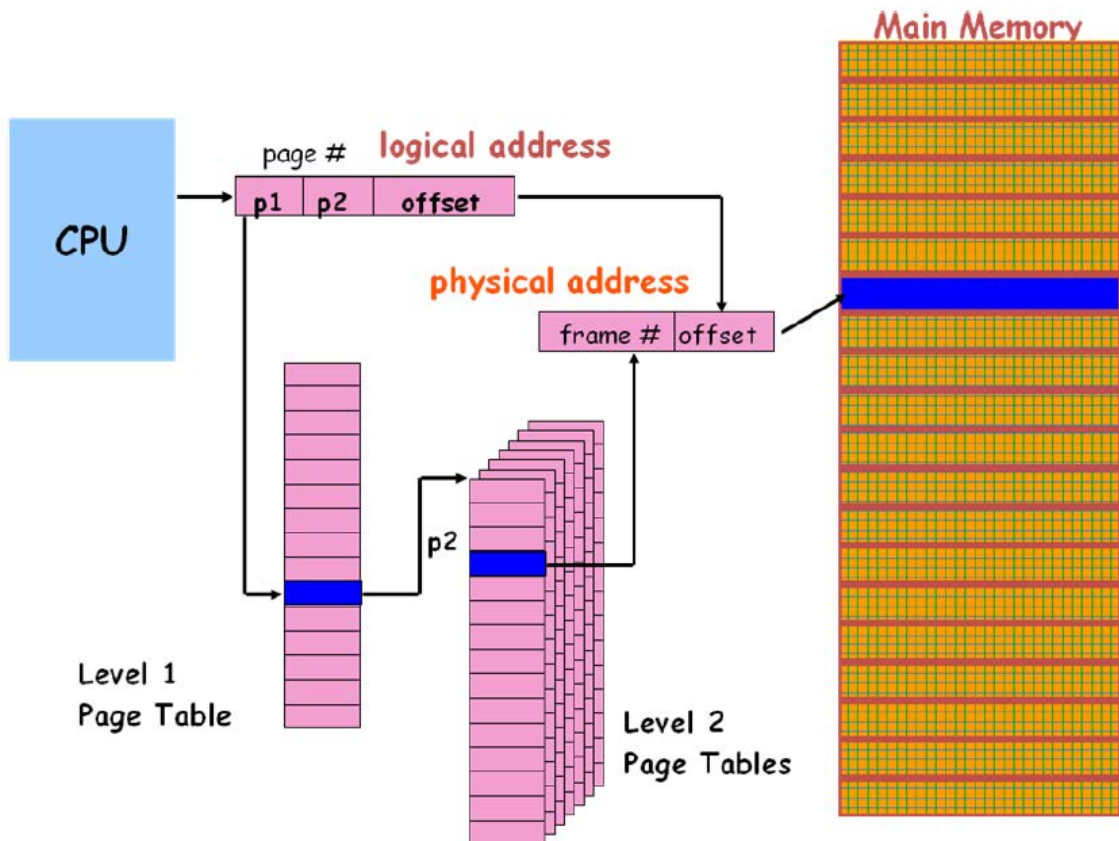# Assignment 6

Introduction

Most virtual memory systems use a technique called **paging**, which we will now describe. On any computer, programs reference a set of memory addresses.

Virtual address space

60K-64K	X
56K-60K	X
52K-56K	X
48K-52K	X
44K-48K	7
40K-44K	X
36K-40K	5
32K-36K	X
28K-32K	X
24K-28K	X
20K-24K	3
16K-20K	4
12K-16K	0
8K-12K	6
4K-8K	1
0K-4K	2

Virtual page

Physical memory address

28K-32K
24K-28K
20K-24K
16K-20K
12K-16K
8K-12K
4K-8K
0K-4K

Page frame

logical address

CPU

page # logical address

p1 | p2 | offset

physical address

frame # | offset

Main Memory

Level 1
Page Table

p2

Level 2
Page Tables

logical address

p₁ | p₂ | d

p_1

outer page
table

p_2

page of
page table

d

Page number	Page offset
p=m-n bits	d=n bits

|---m bits logical address--|

4 KB page size

32 bit logical addresses

$4KB = 2^2 * 2^{10} B = 2^{12} B \rightarrow d=12$

p=32-12=20 bits	d=12 bits

|---------------------------------------32 bits logical address--------------------------------------|
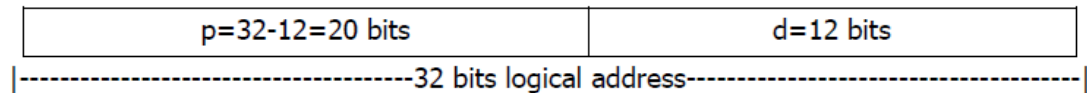
Guideline

Page number = 2^d

1   One level Paging

A computer with an Intel Pentium processor (i.e. 32bit, 4K page size, 2 layer paging) runs a memory-based operating system based on paging. The dynamic memory space (heap segment) of a process occupies all addresses from 0x08800000 to 0x08dfffff (size 6MBytes). How many memory pages does the page table occupy to represent the above segment? Which Page Directory Entries are used?

2   Two Level Paging

We have an Intel Pentium processor (i.e. 32bit, 4K page size, 2 layer paging) and the operating system uses paging. The process has 16MB. How much space do the page tables of the process take up in memory in the best and worst case?

3   Singly Linked List (Optional)

A computer system has a 36-bit virtual address space with a page size of 8K and the page frame address in each Page Table Entry (PTE) is 32 bits.

 - How many pages are in the virtual address space?

 - What is the maximum size of addressable physical memory in this system?

 - If the average process size is 8GB, would you use a one-level, two-level, or three-level page table? Why?