CS & IT ENGINEERING

Operating Systems

Memory Management

Lecture No. 3

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- Address Space
- Simple Paging
- Problem Solving

Non-Contiguous Allocation:

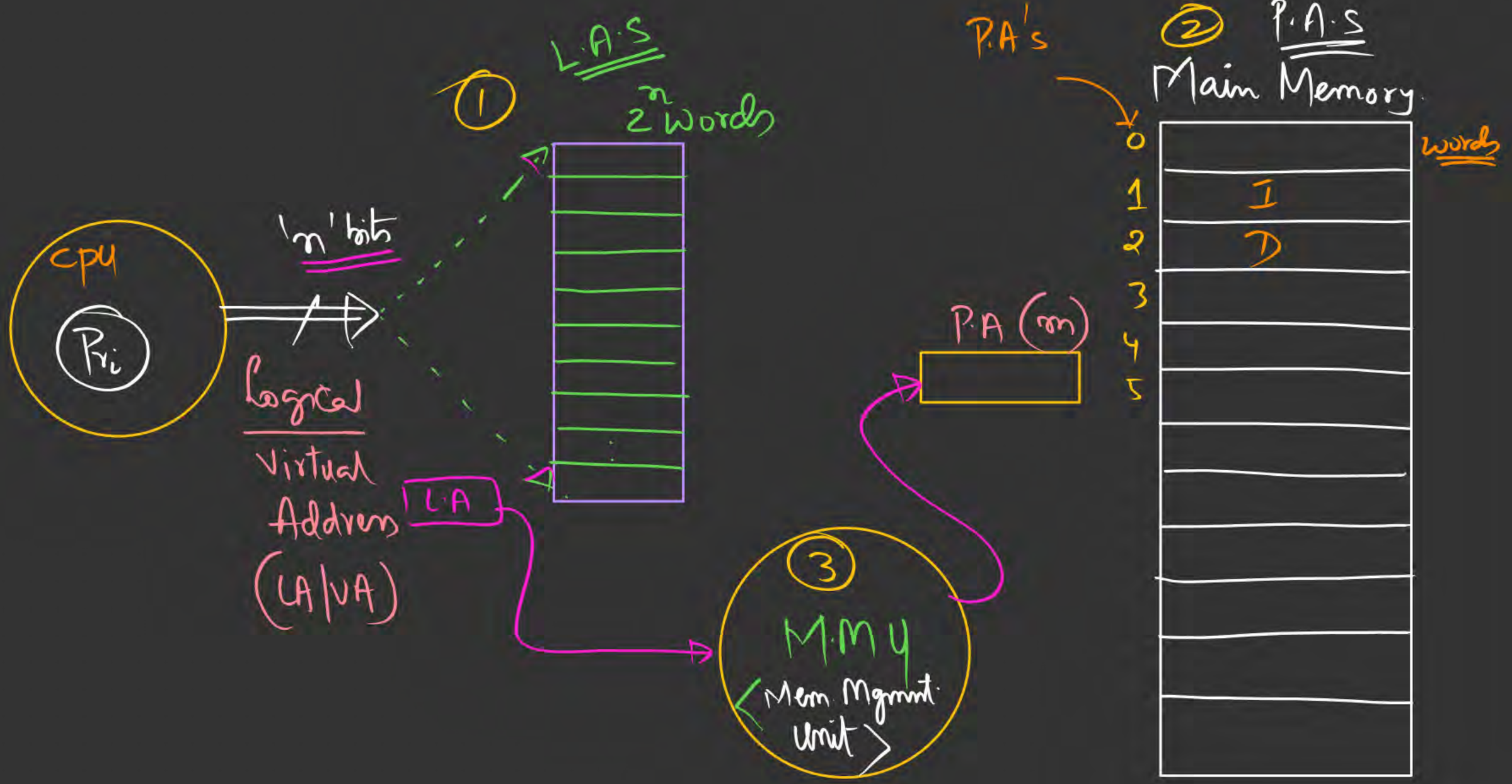
Address Space (AS): { group (space) of words, associated with addresses }

Capacity

$PA \cdot S = 2^{P.A}$, $PA = \log_2 PAS$

$LA \cdot S = 2^{LA}$, $LA = \log_2 LAS$

- Physical Address Space (PAS)
  - ~ Physical Memory
  - Physical Address (PA) bits
- Logical / Virtual Address Space (LAS / VAS)
  - No. of words / Bytes
  - Logical / Virtual Address (LA / VA) bits


L.A.S
1
2^n words
'n' bits
CPU
Pri
Logical
Virtual
Address
(LA/VA)
L.A
3
M.M.U
Mem. Mgmnt.
Unit
P.A's
P.A (m)
2
P.A.S
Main Memory
words
0
1
2
3
4
5
I
D

1. SIMPLE PAGING: <to Eliminate the Problem of Ext. Frag. (MVT)>

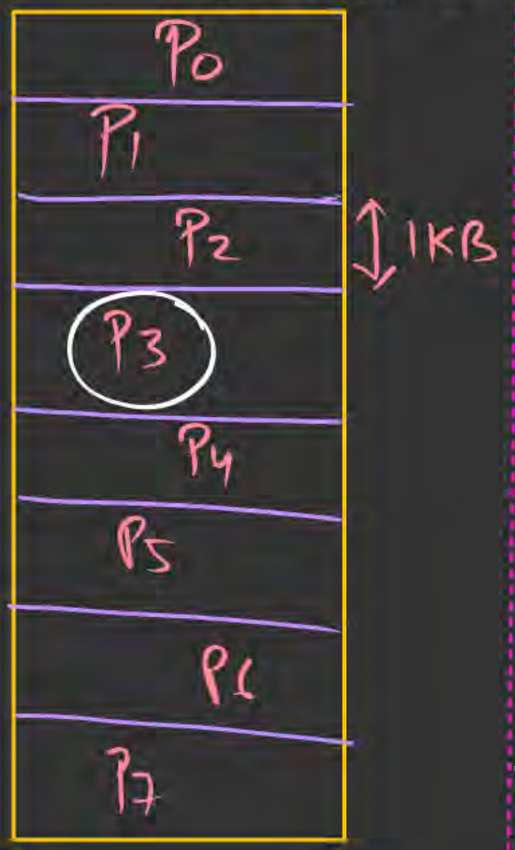
L.A.S = 8KB; P.A.S = 4KB

L.A = 13 bits P.A = 12 bits

1. organization of L.A.S/V.A.S:

→ L.A.S is divided into equal size units known as **Pages**

→ Generally Page Size (P.S) is a power of 2 [2^x Bytes]



Let P.S = 1KB

→ No. of Pages (N) = $\frac{LAS}{PS}$

→ Page No (P) = $\log_2 N$ bits

$N = 2^P$

→ Page offset (d) = $\log_2 PS$ bits

$PS = 2^d$ By

→ L.A format | P | d |

Q1) LA = 23 bits; PA = 20 bits;
PS = 4KB;

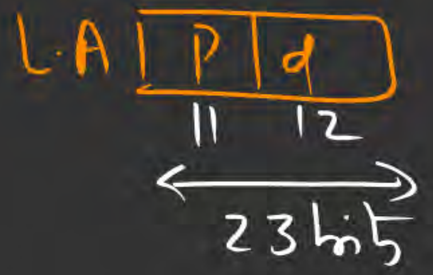
$LAS = 2^{23} = 8MB$

$PAS = 2^{20} = 1MB$

$N = 2^{23}/2^{12} = 2^{11} = 2K$

P = 11 bits

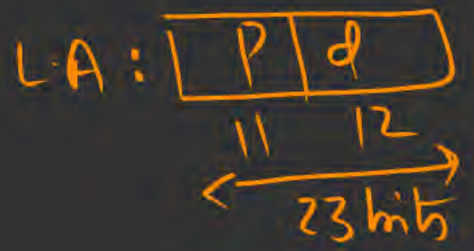
d = 12 bits



Q2) System supports 2K Pages with a Page offset of 12 bits; What is the Size of LAS;

N = 2K ⟹ P = 11 bits

d = 12 bits



∴ $LAS = 2^{23} = 8MB$

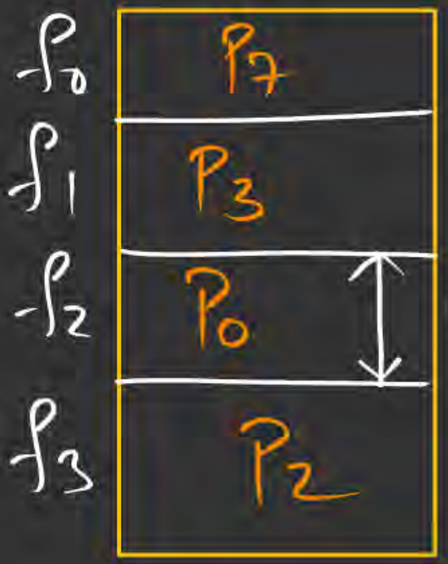
2) LAS = N * PS
= 2K * 4KB = 8MB ✓

11. Organization of P.A.S :

P.A.S = 4KB , PA = 12

P.S = 1KB

F.S = 1KB



→ The P.A.S is divided into equal size units, known as **frames** (Page-frames)

one frame can exactly hold one Page

→ frame size = Page size

→ No. of frames (M) = $\frac{P.A.S}{FS(Ps)}$

→ frame No (f) = $\log_2 M$ bits

$M = 2^f$

→ frame offset = Page offset = d

→ P.A format | f | d |

→ Any Page can be stored in Any frame

Q3) L.A.S = 8MB

P.A.S = 64KB

P.S = 4KB

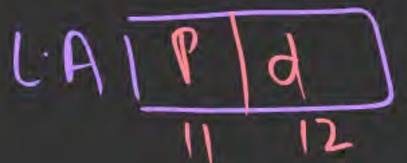
$N = 2^{23}/2^{12} = 2^{11} = 2K$ pages

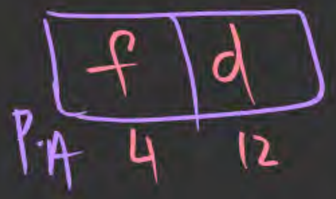
P = 11 bits

$M = 2^{16}/2^{12} = 2^{4} = 16$ frames

f = 4 bits

d = 12 bits

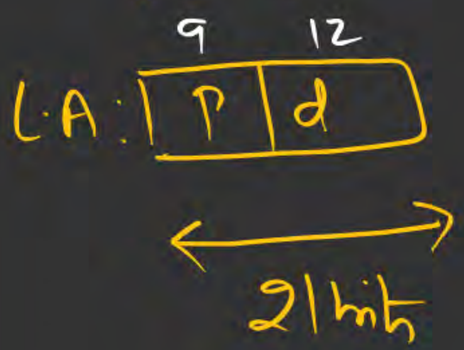


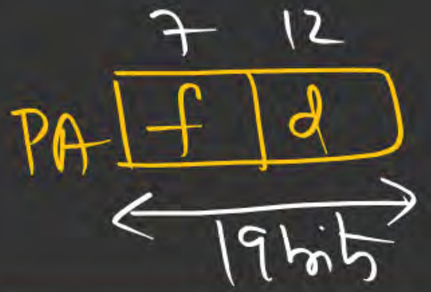


Q4) A System supports 512 Pages and 128 frames; If the length of L.A is 21 bits, then Calculate the Size of P.A.S.

N = 512; M = 128

P = 9 f = 7





$\therefore P.A.S = 2^{19} = 512KB$

(II) Organization of M.M.U (Mem. Mgmnt. unit)

→ The M.M.U is known as Page Table (Page Map Table) (PT)

→ Each Process will have its own P.T

→ P.T's are stored in Memory;

→ P.T's are organized as a set of entries known as P.T entries (PTE)

→ **No. of entries in P.T (P.T.E's) = No. of Pages**

→ P.T.E's contain the frame No (f) in which the referred Page is Present;

→ P.T.E generally is measured in Bytes ($e \geq 1$ Byt)

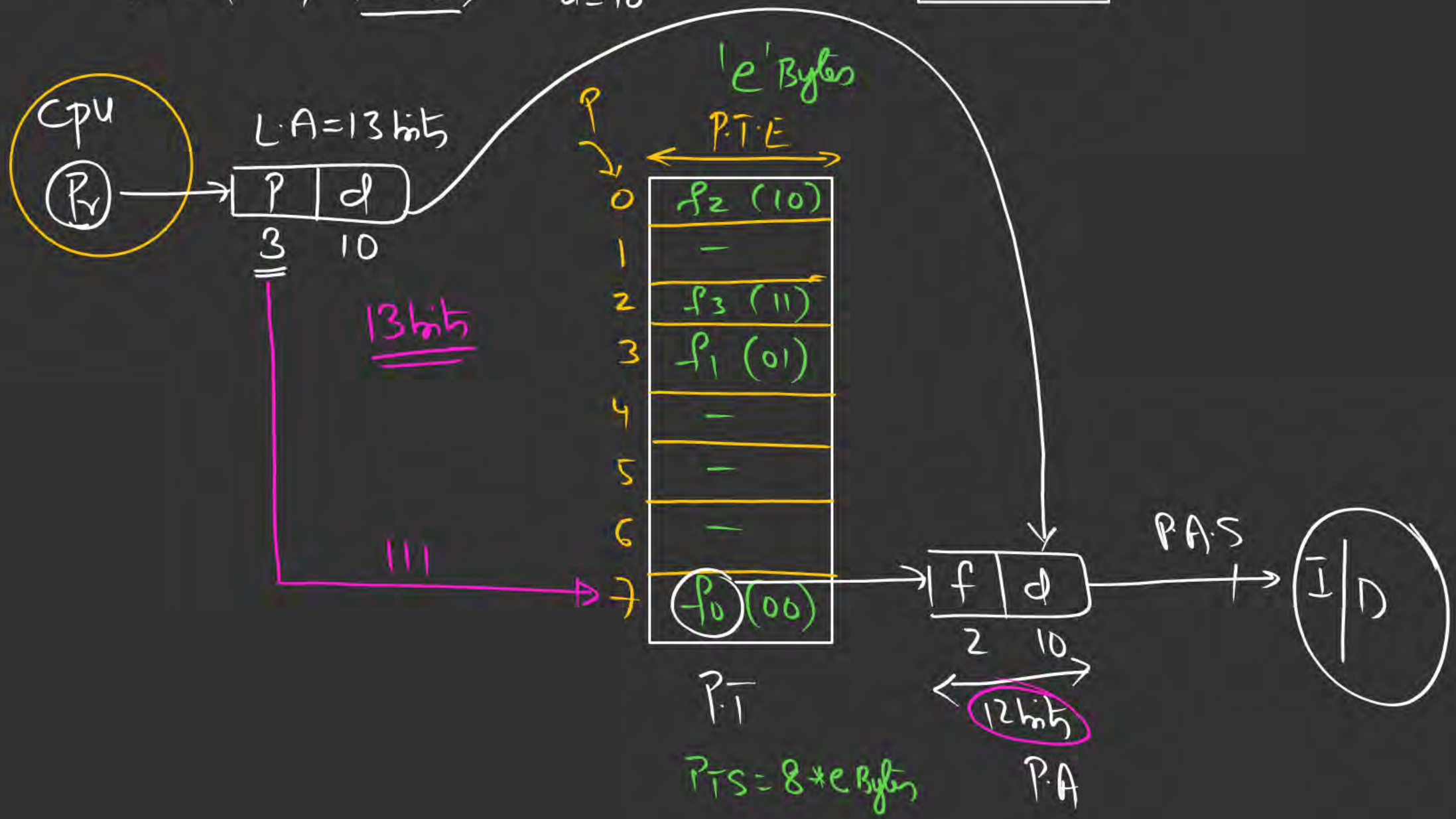
→ **Page Table Size (PTS) = $N * e$ Bytes**

P.T.S $\propto$ N

P.A.S = 4KB; LAS = 8KB; P.S = 1KB

m = 4 ; n = 8 ; d = 10

e ~ p



Q1) L.A = 29 bits ; P.A.S = 64 MB

d = 14 bits ; e = (32 bits) = 4B

Calculate

$L.A.S = 2^{29} = 512MB$

P.A = 26 bits (64 MB)

$N = 2^{29}/2^{14} = 2^{15} = 32K$

$M = 2^{26}/2^{14} = 2^{12} = 4K$

P = 15 bits

f = 12 bits

P.S = 16 KB

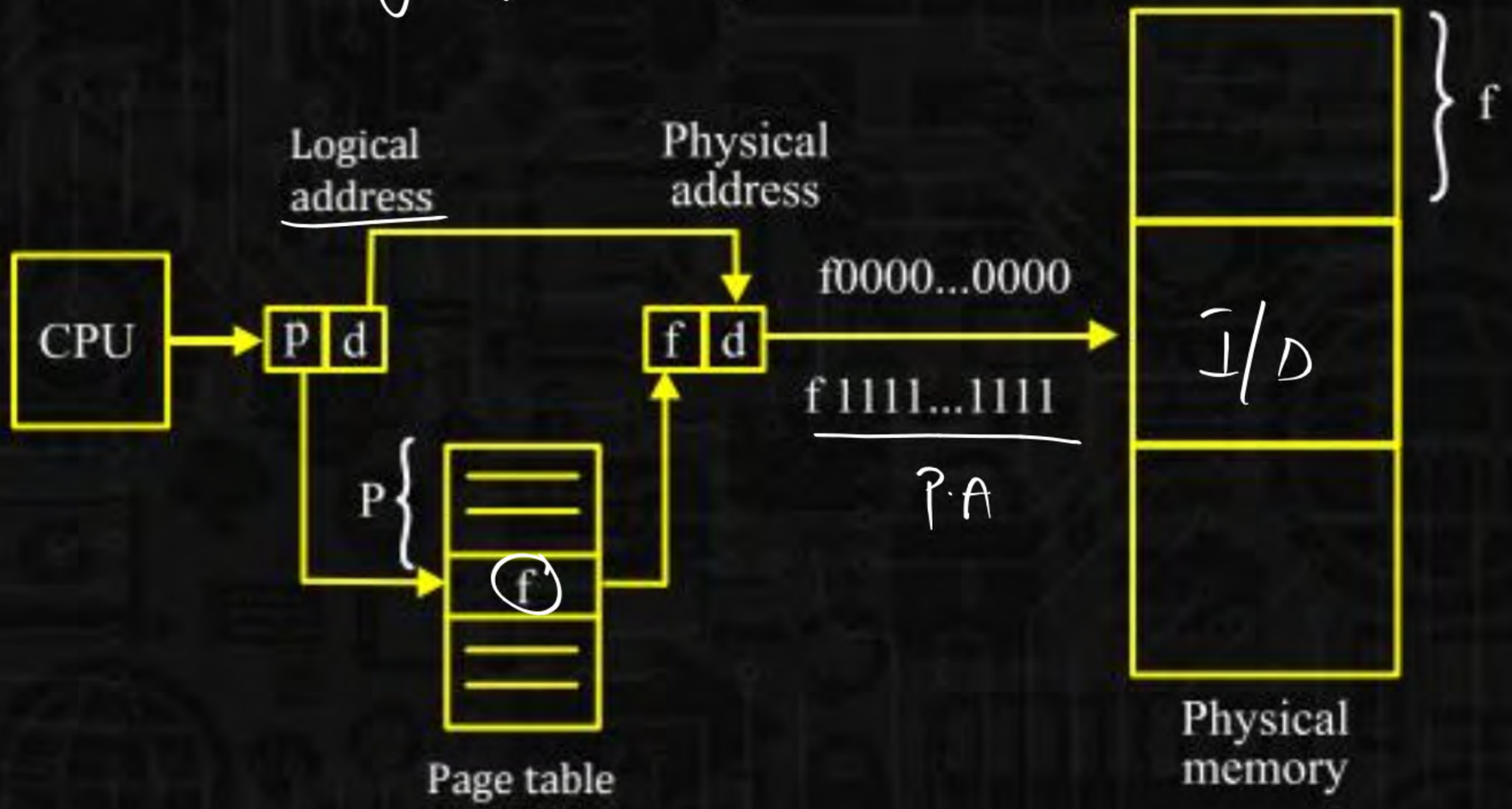
d = 14 bits

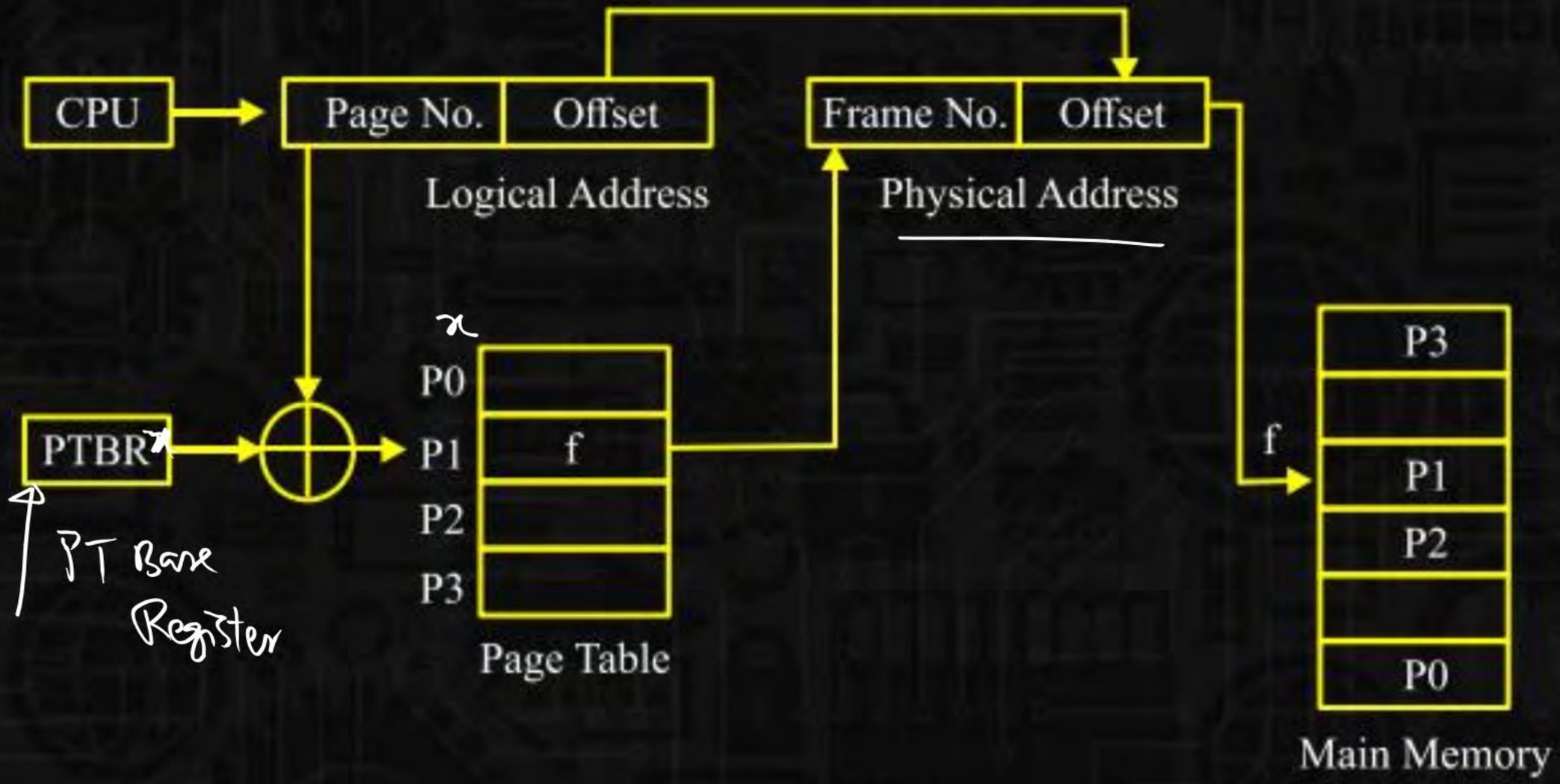
$P.T.S_{Bytes} = N * e(Bytes)$

$= 32K * 4B$

$= 128KB$

Algo - 9 Paging

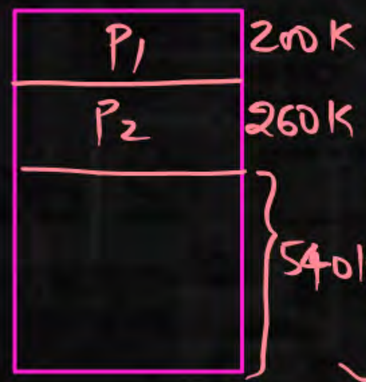



CPU
Page No.
Offset
Logical Address
Frame No.
Offset
Physical Address
PTBR
PT Base Register
P0
P1
P2
P3
f
Page Table
f
P3
P1
P2
P0
Main Memory

Q. 3

Consider a System with Memory of size 1000KBytes. It uses Variable Partitions with no Compaction. Presently there are 2 partitions of sizes 200K & 260K respectively.

(i) What is the allocation request of the Process which would always be denied?



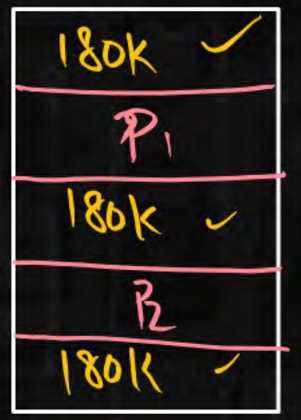
A. 131 K

B. 151 K

C. 181 K

D. 541 K

(ii) The smallest Allocation Request which could be denied is:



A. 131 K

B. 151 K

C. 181 K

D. 541 K

Q. 4

Consider a System having Memory of size 2^{46} Bytes, uses Fixed Partitioning. It is divided into fixed size Partitions each of size 2^{24} Bytes. The OS maintains a Process Table with one entry per Process. Each entry has, two fields: First, is a pointer pointing to Partition in which the Process is loaded and Second, Field is Process ID(PID). The Size of PID is 4Bytes.

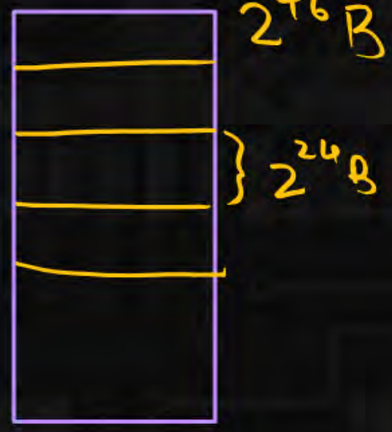
Calculate

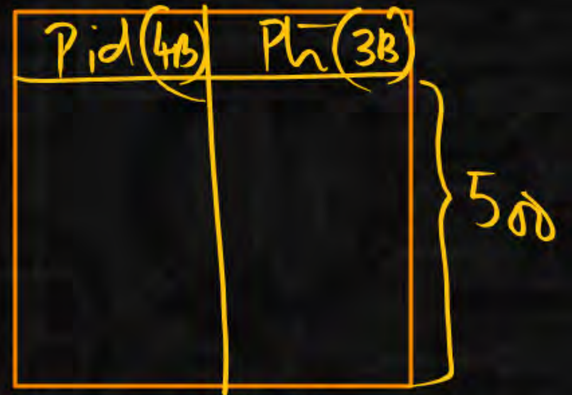
(a) The Size of Pointer to the nearest Byte.

(b) Size of Process Table in Bytes if the System has 500 Processes.

$N_{part's} = \frac{2^{46}}{2^{24}} = 2^{22}$

$n_{bits} = 22 \text{ bits} \sim 3B$





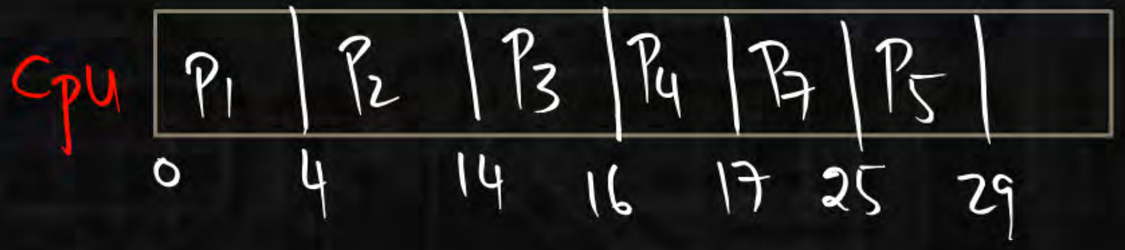
PTS = 500 × 7B = 3500B

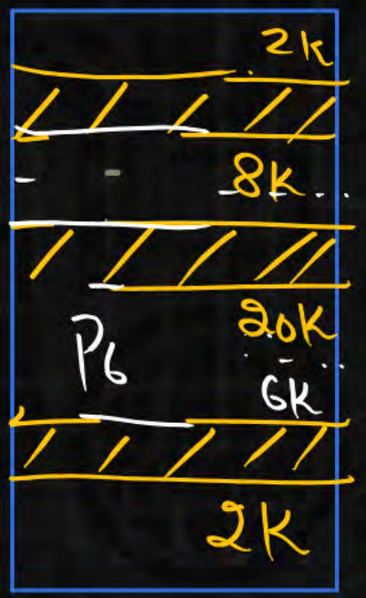
Q. 5

Consider a System Using Variable Partition with no Compaction

Free holes	4K; 8K; 20K; 2K
Program size	2K; 14K; 3K; 6K; 10K; 20K; 2K
Time for Execution	4; 10; 2; 1; 4; 1; 8

Using Best Fit Allocation Policy and FCFS CPU Scheduling Technique, Find the Time of Loading & Time of Completion of each program. The Burst Times are in Seconds.





Q. 6

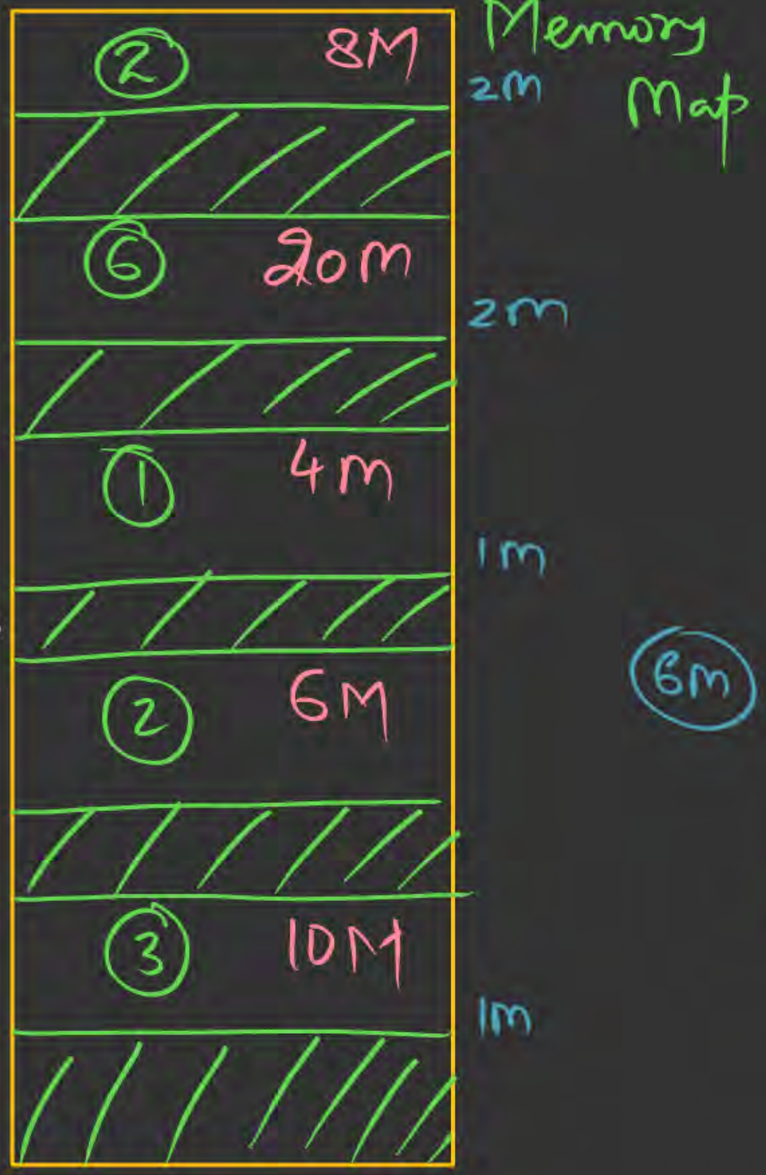
Consider allocation of memory to a new process. Assume that none of the existing holes in the memory will exactly fit the process's memory requirement. Hence, a new hole of smaller size will be created if allocation is made in any of the existing holes. Which one of the following statements is TRUE?

A. The hole created by next fit is never larger than the hole created by best fit

B. The hole created by worst fit is always larger than the hole created by first fit

C. The hole created by first fit is always larger than the hole created by next fit

D. The hole created by best fit is never larger than the hole created by first fit



Consider a Process Request of Size '3M'.

I

a) F.F – 8M
b) B.F – 4M
c) W.F – 20M
d) N.F – 6M

Assume MVT + No Compaction

II:

* What is the Max. # of Consecutive req's of Size 3M that Could be Satisfied?

6m

14 +2

Q. 7

A Computer System using Paging Technique implements an 8KB Page with a Page Table of Size 24MB. The Page Table Entry is 24 bits. What is the length of Virtual Address in this System?

H/W

Q. 8

Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one-level page table per process and each page table entry requires 48 bits, then the size of the per process page table is megabytes.

H/W

Q. 9

A Computer System using Paging technique has a Virtual Address of length 'I'. The Number of Pages in the Address Space are 'Z'. There are 'H' Frames in PAS. Calculate the number of bits in Page Offset and the size of PAS

H/W

Q. 10

Consider a System using Simple Paging Technique with Logical Address (LA) of 32 bits. Page Table Entry (PTE) of 32 bits. What must be the Page Size in bytes, such that the Page Table of the Process Exactly fits in one Frame of Memory (PAS)?

H/W

Q. 18

Consider a computer system with 40-bit virtual addressing and page size of sixteen kilobytes. If the computer system has a one-level page table per process and each page table entry requires 48 bits, then the size of the per process page table in megabytes.

H/W


THANK YOU GW
SOLDIERS !