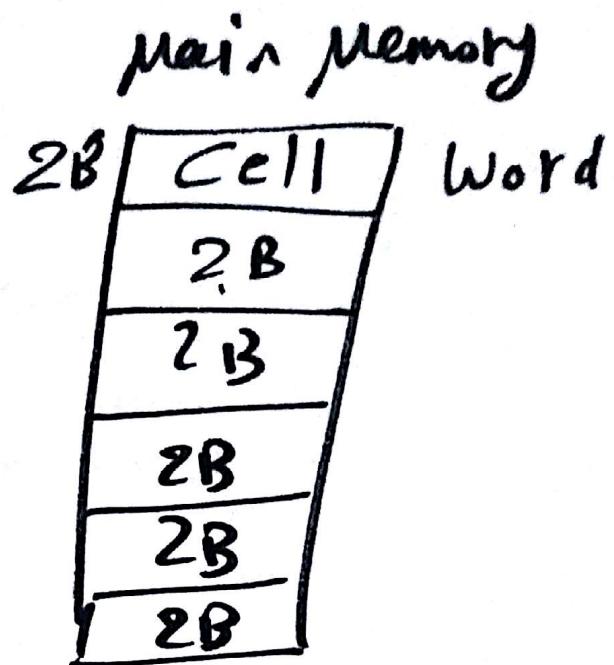


## \* Memory Capacity:

6 Cell X 2 B



Memory Capacity =  
no. of cells X cell size

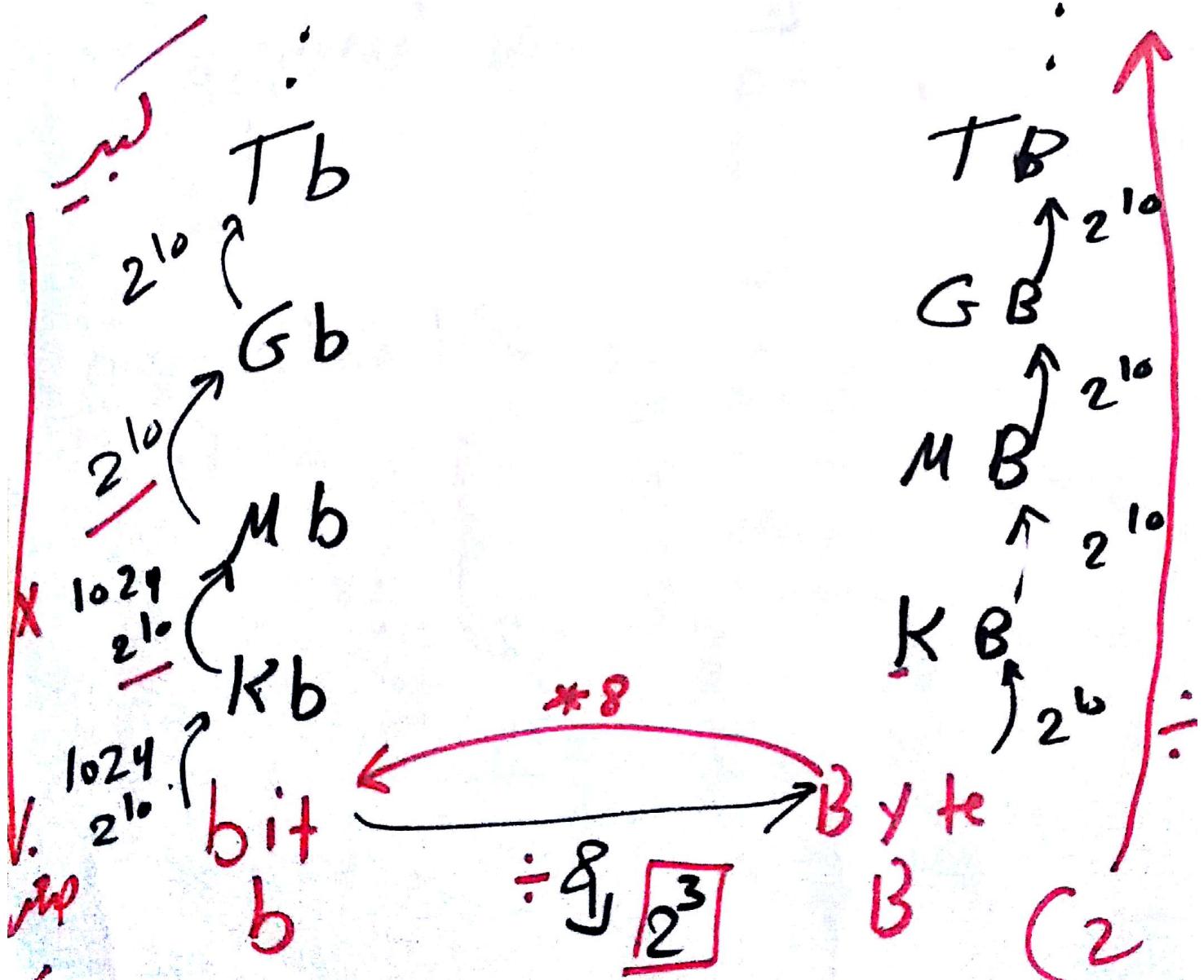
Ex:

Memory Capacity =  
2K words with 16 bits  
each.

b ← bit  $\square \rightarrow 2^0$

B ← Byte  $\square \rightarrow 2^3$   
8 bits = 1 B

$$\begin{array}{l} cm \\ \underline{3m} = 3 * 100 = 300 \text{ cm} \end{array}$$



Ex:

if memory capacity =

2K words with 16 bits each  
cells

find the memory capacity.  
in bits & Bytes

Ans

memory capacity =

No. of cells  $\times$  cell size

$$2^k \times 16 \text{ bits}$$

$$2^k \times 2^4 \text{ bits}$$

25 K bits

$$2^5 \times 2^{10} = 2^{15} \text{ bits}$$

$$\frac{2^{15}}{2^3} = 2^{12} \text{ Bytes}$$

③

\* If memory capacity =  
7M words with 8 bits  
each.

Find memory capacity in  
K bits & Bytes.  
=

Ans

Memory Capacity =  
no. of cells  $\times$  Cell size  
7M  $\times$  8 bits

$$56 \boxed{MB} = 56 \times \frac{2^{10}}{1024}$$

$$\text{Memory Capacity} = \boxed{57344} \text{ kb}$$

$$\begin{aligned}\text{Memory Capacity} &= \frac{57344 \times \frac{2^{10}}{1024}}{8} \\ &= 7340032 \text{ Byte}\end{aligned}$$

(5)

## \* Memory Addressing

Address



(n) Address line

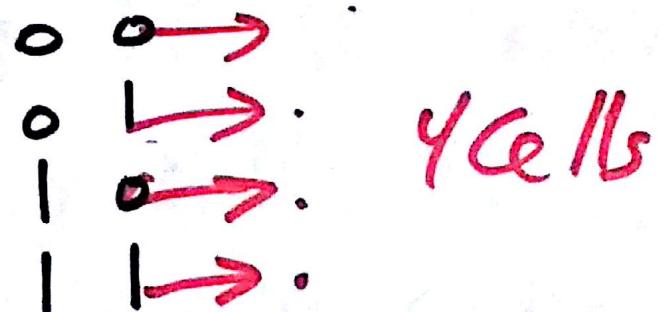
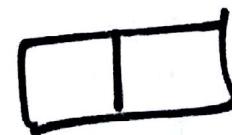
= Address line  
1  
2



2 Address line

$$= n=2$$

$2^2$



$$2 = m \cdot \# \text{cells.}$$

G

$\times$  Memory Capacity =

No. of cells  $\times$  cell size.

Address line  $\rightarrow 2^n \times$  cell size

$2^n \times 1B$  (as default)  
Byte

Ex

$\Rightarrow$  What is the total no. of memory cells that CPU can access using  $2^{20}$  address lines?

Ans.  
 $\frac{\text{No. of cell}}{n} = 2^n = 2^{20}$  cells

$\Rightarrow$  What is the total memory capacity in MB if the capacity of each memory cell is:

$2^8 \leftarrow 16$  bits.

Memory Capacity = No. of cell  $\times$  cell size  
 $2^{20} \times 2^4$  bits  
 $= \frac{2^{24} \text{ bits}}{2^3 \times 2^{20}} = 2 \text{ MB}$

(6)

~~Cell size~~  
 $\frac{16 \text{ bits}}{8} = 2 \text{ B}$

memory capacity = no. of cell  $\times$

$$2^{20} \times 2^1 \text{ B}$$

$$\frac{2^{21} \text{ B}}{2^{10} \times 2^{10} \text{ MB}} = 2^1 \text{ MB}$$



→ What is the number of Address lines if the total memory capacity is 4 GB and the capacity of each memory cell is

32 bits → 4B  
8

ANS.

memory Capacity = no. of cell × cell size.

$$4 \text{ GB} \times 2^{30} \text{ B} = 2^n \times 4 \text{ B}$$

$$2^n = \frac{4 \text{ GB}}{4 \text{ B}} = 1 \text{ GB}$$

$$2^n = 1 \times 2^{10} \times 2^{10} \times 2^{10}$$

~~KB MB = B~~

$$n = 30$$

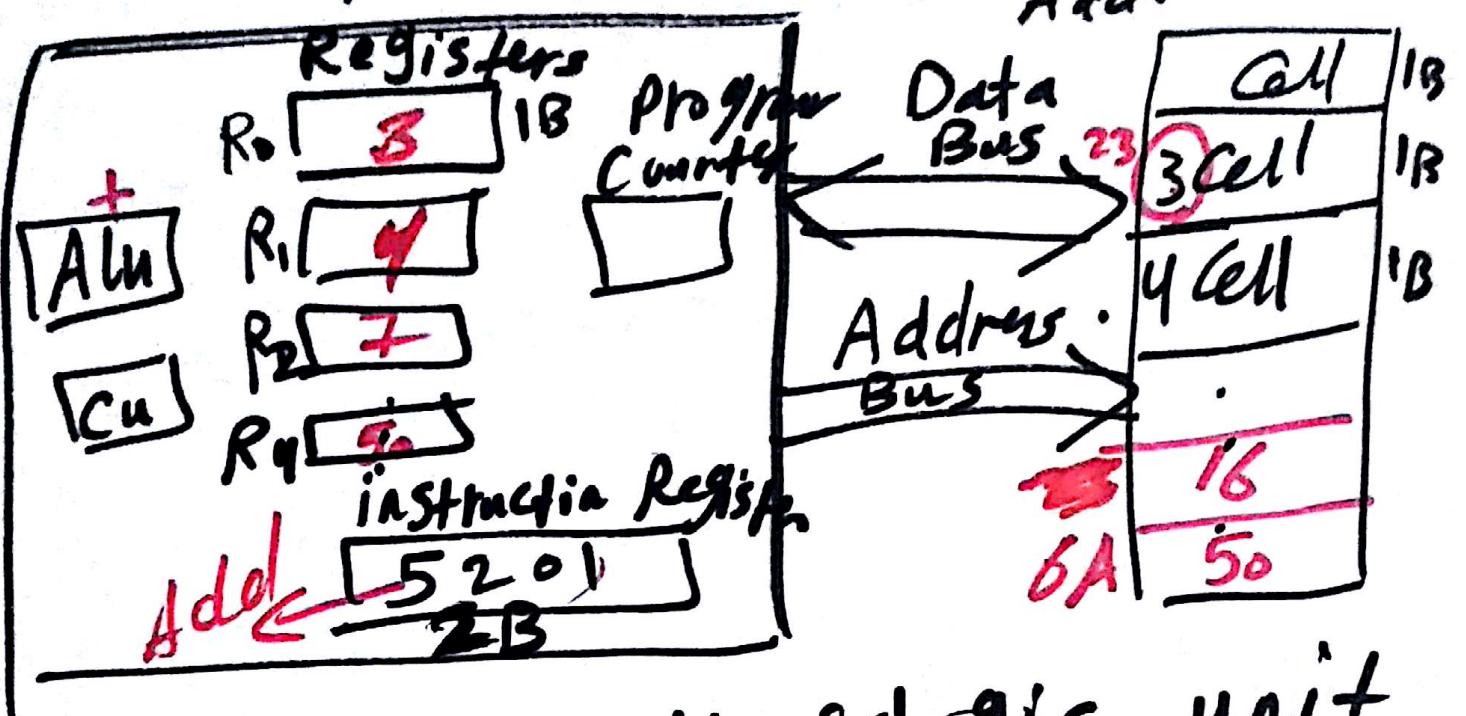
⇒ What is the capacity of  
memory cell in bits if  
the number of address lines is  
24 & the total memory  
Capacity is 64 MB?

ANS.

$$\begin{aligned}\text{Memory Capacity} &= \text{no. of cells} \times \text{Cell size} \\ &= 2^n \times \text{Cell size} \\ 64 \text{ MB} &= 2^{24} \times ? \\ (2^6) &\Rightarrow \frac{64 \text{ MB}}{2^{24}} = ? \text{ bits} \\ \text{Cell size} &= \frac{2^6 \times 2^{10} \times 2^{10} \times 2^3}{2^{24}} \\ &= \frac{2^{29}}{2^{24}} = 2^5 \text{ bits.}\end{aligned}$$

# \* Machine Manipulating \*

Central Processing unit  
CPU



Alu → Arithmetic & logic unit  
Cu → Control Unit

+      AND, OR, XOR

# instruction Register (2B)

16 bits



~~op~~  
OP-Code  
Operation Code

Load  $\leftarrow 1023$  Operands  
register no.  
23  $\rightarrow$  memory Address  
load  $R_0 \leftarrow M[23]$

Load  $\leftarrow 14\overline{6A}$   
 $R_4 \leftarrow M[6A]$

(ii)

$\equiv$

register  
23 41 Value

→ load  $R_3 \leftarrow (41)_{16}$

27 4F

→ load  $R_7 \leftarrow (4F)_{16}$

Operation  
2 → load for Value  
1 → load for a Value  
in memory Address

Diagram illustrating a memory store operation:

- Stack pointer:  $\underline{\text{StOK}}$
- Memory location  $R_2$  contains  $30$ .
- The value  $30$  is being stored into memory location  $M[IA]$ , replacing the previous value  $A$ .

The diagram illustrates a memory move operation. On the left, there is a stack pointer (SP) with the value 4. Below it, the memory locations at addresses 4, 3, and 2 contain the values X, 3, and 2 respectively. A red arrow labeled "MOVE" points from the value 2 at address 2 to the right. On the right, two registers are shown: R<sub>3</sub> containing the value 20, and R<sub>2</sub> containing the value 10. Another red arrow labeled "MOVE" points from R<sub>3</sub> to R<sub>2</sub>, indicating the move operation.

$$\begin{array}{c}
 \text{Add.} \\
 \text{R}_1 \quad \text{R}_2 \quad \text{R}_3 \\
 5 \quad 3 \quad 21 \\
 \downarrow \\
 \text{Add} \quad R_3 \leftarrow R_2 + R_1
 \end{array}$$

CO CO  
Ghalt / stop.



\*EX.

Step 1

146A

Step 2

136C

Step 3

5034

Step 4

306E

Step 5

C000

a) Write the above program in symbolic form

b) Write each instruction in a bit pattern

a)

Step 1

146A → load  $R_4 \leftarrow M[6A]$

Step 2

136C → load  $R_3 \leftarrow M[6C]$

Step 3

5034 → Add  $R_0 \leftarrow R_3 + R_4$

Step 4

306E → Store  $R_0 \rightarrow M[6E]$

Step 5

Stop / halt

Step1  $(1 \cup 6 \cup A)_{16}$   
 $(0001010001101010)$

bit Pattern



Step2

:

:

y

Ex:



Content
210B

Address  
210B 0.0  
01

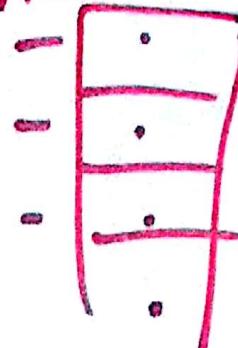
1404 02  
03

C000 04  
05

1B

1B

Add:



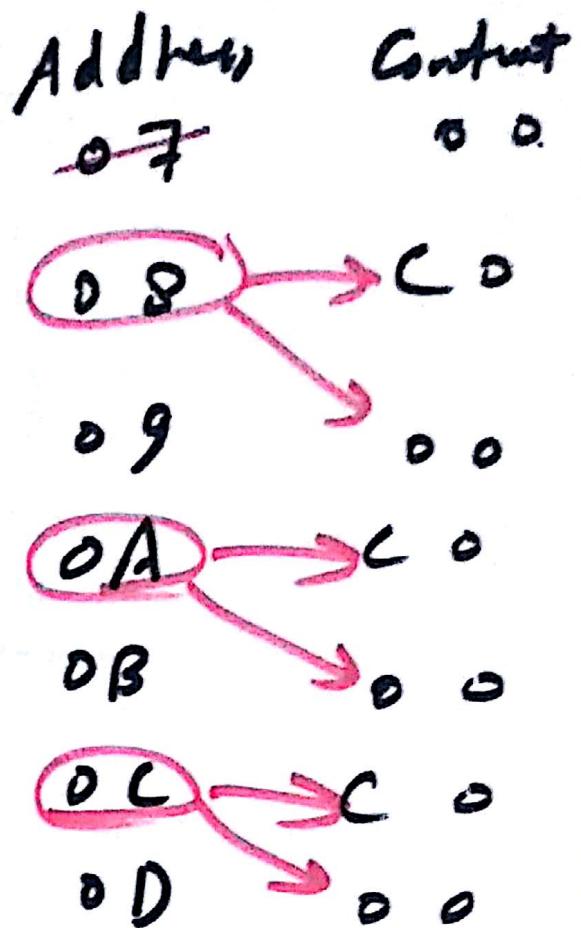
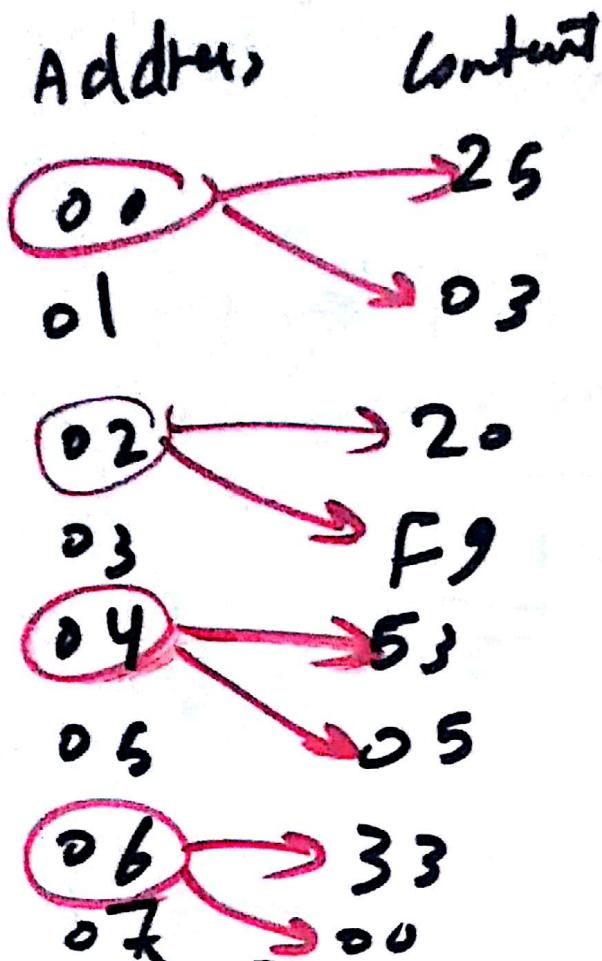
a) What bit pattern will be in Register 4 When the machine halts?  $(C0)_{16} \rightarrow (1100\ 0000)$

b) What bit pattern will be in Register 1 When the machine halts?  $(C0B) \rightarrow (0000\ 1010)$

# \* instruction Table

Start Add	instruction	Description
00	21 0B	load R1 $\leftarrow$ 0B
02	04 04	load R4 $\leftarrow$ M[04]
04	C0 00	halt. R1 0B R4 C0

Ex:



### instruction Table

Address	instruction	Description
00	2503	load R5 $\leftarrow$ 03
02	20F9	load R0 $\leftarrow$ F9
04	5305	Add R3 $\leftarrow$ R0 + R5
06	3300	Store R3 $\rightarrow$ M[00]
08	C000	halt
0A	C000	
0C	C000	

$$R_3 \leftarrow R_o + R_S$$

$$Fg + o3$$

$$\begin{array}{r} | \\ Fg \rightarrow 11111001 \\ o3 \rightarrow 000000011 \\ \hline \end{array}$$

$$R_3 \leftarrow \underbrace{F}_{\text{F}} \underbrace{C}_{\text{C}}$$

Ans

$$R_o = Fg$$

$$R_S = \underline{\underline{o3}}$$

$$R_3 = FC$$

$$M[G_o o3] = R_3 = FC$$

(2)

a) What bit pattern will be in  $R_S$ ?  $R_S = 03$   
 $= 00000011$

b) What bit pattern will be in  $R_O$ ?  $R_O = FG = 11111001$

c) What bit pattern will be in  $R_3$ ?  $R_3 = FC = 11111100$

d) What bit pattern will be at a memory address location 00?

$$M[00] = FC = 111111000 \quad \textcircled{21}$$