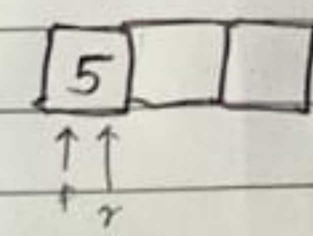
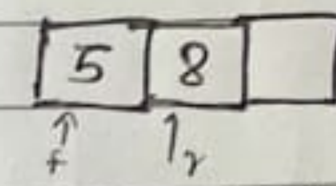
i) Queue is empty

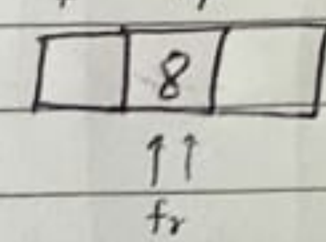
ii) ·5 is added.



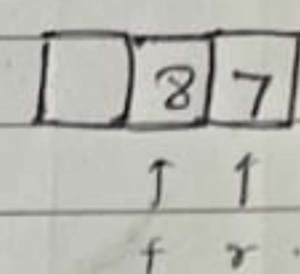
iii) 8 is added



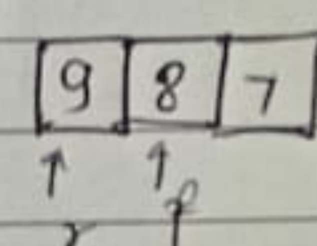
iv) deleted : 5



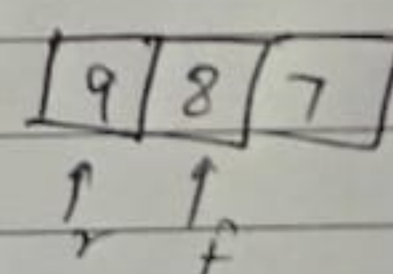
v) enqueue (7)
: 7 is added



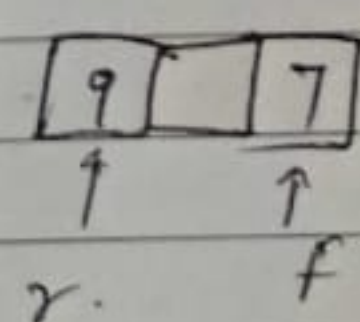
vi) enqueue : 9
9 is added



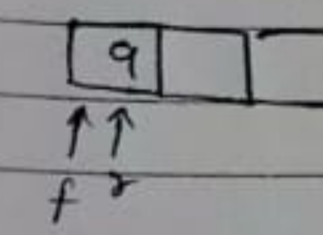
vii) ·enqueue : 9
queue is full



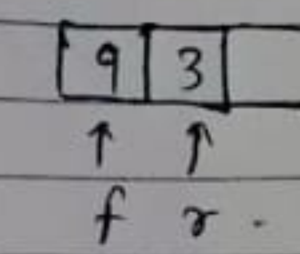
viii) dequeue ()
~~queue~~ deleted : 8



ix) dequeue ()



x) enqueue (3)



Here

$$O(n^{\log_2 4 - \epsilon}) = O(n^{2-\epsilon})$$

Consider $\epsilon = 1$

$$f(n) = O(n^{2-\epsilon})$$
$$n = O(n^1)$$
$$n = O(n)$$

$$\therefore T(n) = \Theta(n^{\log_b a})$$
$$T(n) = \Theta(n^2)$$ #

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(2) $f(n) = \log_2 n \qquad g(n) = \sqrt{n}$

$$\lim_{n\to\infty} \frac{f(n)}{g(n)} \Rightarrow \lim_{n\to\infty} \left(\frac{\log_2 n}{\sqrt{n}}\right)$$

$$\Rightarrow \lim_{n\to\infty} \left(\frac{\log_e n / \log_e 2}{\sqrt{n}}\right)$$

$$\Rightarrow \lim_{n\to\infty} \frac{(1/\log_e 2)(\log_e n)}{\sqrt{n}}$$

$$\Rightarrow \lim_{n\to\infty} \frac{(\log_2 e)(\log_e n)}{\sqrt{n}}$$

$$(\log_2 e) \lim_{n\to\infty} \left(\frac{\log_e n}{\sqrt{n}}\right) \rightarrow \text{Gives } \frac{0}{0}$$

so need to use
L-Hospital rule

$$\therefore \lim_{n\to\infty} \frac{\log_e n}{\sqrt{n}} = \lim_{n\to\infty} \frac{f'(n)}{g'(n)}$$

$$\frac{d}{dx}(\log_e n) = \frac{1}{n}$$

$$\frac{d}{dx}(\sqrt{n}) = \frac{1}{2} n^{-1/2}$$

$$= \frac{1}{2\sqrt{n}}$$

$$\cancel{\lim_{n\to\infty} \frac{1/n}{1/2\sqrt{n}}}$$

$$\log_2 e \lim_{n\to\infty} \left(\frac{1/n}{2\sqrt{n}}\right)$$

$$\log_2 e \lim_{n\to\infty} \frac{2\sqrt{n}}{n}$$

$$= 2\log_2 e \lim_{n\to\infty} \frac{\sqrt{n}}{n} = 0$$

$$\log_2 n \in O(\sqrt{n})$$

(3) $f(n) = n!$ & $g(n) = 2^n$

Sterling rule of $n! = \sqrt{2\pi n} \left(\frac{n}{e}\right)^n$

$$\lim_{n\to\infty} \frac{f(n)}{g(n)}$$

$$= \lim_{n\to\infty} \frac{\sqrt{2\pi n}\,(n/e)^n}{2^n}$$

$$= \lim_{n\to\infty} \sqrt{2\pi n}\, \frac{(n/e)^n}{2^n}$$

Master Theorem

$T(n) = aT(n/b) + f(n)$

where $a \geq 1$, $b > 1$ and $f(n) > 0$

(1) If $f(n) = O(n^{\log_b a - \epsilon})$, then $T(n) = \Theta(n^{\log_b a})$

(2) If $f(n) = \Theta(n^{\log_b a})$ then $T(n) = \Theta(n^{\log_b a} \log n)$

(3) If $f(n) = \Omega(n^{\log_b a + \epsilon})$ then $T(n) = \Theta(f(n))$

Q) $T(n) = 4T(n/2) + n$

$a = 4 \quad b = 2 \quad f(n) = n$

$\log_b a = \log_2 4 = 2$

Now

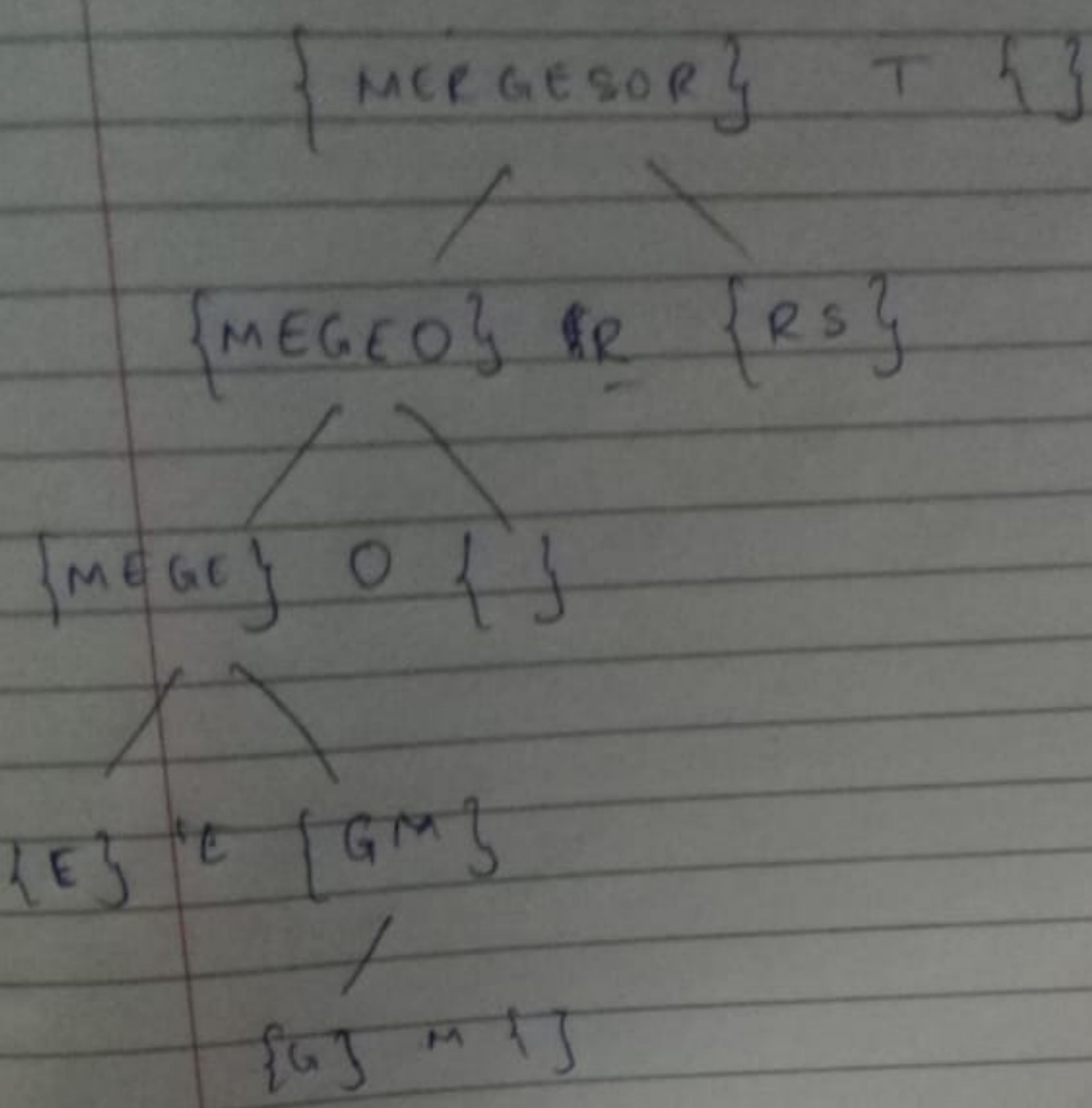
$f(n) = n$

Case 1: If $f(n) = O(n^{\log_b a - \epsilon})$ for some $\epsilon > 0$

$$= \lim_{n \to \infty} \sqrt{2\pi n} \left[\frac{n}{2e}\right]^n = \infty$$

$$n! \in \Omega(2^n)$$

M E R G E S O R T



Sorted Array = {E, E, G, M, O, R, R, S, T}

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```
void insert(struct node* ptr){

    if(head == NULL){
        head= ptr;
        return;
    }

    struct node * temp = head;

    while(temp->next != NULL &&
        temp->next->data < ptr->data)
        temp = temp->next;

    ptr->next = temp->next;
    temp->next = ptr;

}
```