Assignment 7:

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Input:

1 ans: 64, 32, 79, 83, 67, 46, 96, 55, 68, 12

(a) Insertion Sort:

original		P=1	P=2	P=3	P=4	P=5	P=6	P=7	P=8	P=9
0	64	32	32	32	32	32	32	32	32	32
1	32	64	64	64	64	46	46	46	46	46
2	79	79	79	79	67	64	64	55	55	55
3	83	83	83	83	79	67	67	64	64	64
4	67	67	67	67	83	79	79	67	67	67
5	46	46	46	46	46	83	83	79	68	68
6	96	96	96	96	96	96	96	83	79	79
7	55	55	55	55	55	55	55	96	83	83
8	68	68	68	68	68	68	68	68	96	96
9	12	12	12	12	12	12	12	12	12	

∴ The sorted result is:

12, 32, 46, 55, 64, 67, 68, 79, 83, 96.

(b) Shell Sort: | case1: h1 = 5 | 5-sorted:

original:						
64		46	46	46	46	46
32		32	32	32	32	32
79		79	79	55	55	55
83		83	83	83	68	68
67		67	67	67	67	12
46		64	64	64	64	64
96		96	96	96	96	96
55		55	55	79	79	79
68		68	68	68	83	83
12		12	12	12	12	67

Case 2: h2 = 3.

5-sorted   3-sorted:

46	46	46	46	46	46	46	46
32	32	12	12	12	12	12	12
55	55	55	55	55	55	55	55
68	68	68	68	68	68	68	67
12	12	32	32	32	32	32	32
64	64	64	64	64	64	64	64
96	96	96	96	96	96	96	68
79	79	79	79	79	79	79	79
83	83	83	83	83	83	83	83
67	67	67	67	67	67	67	96
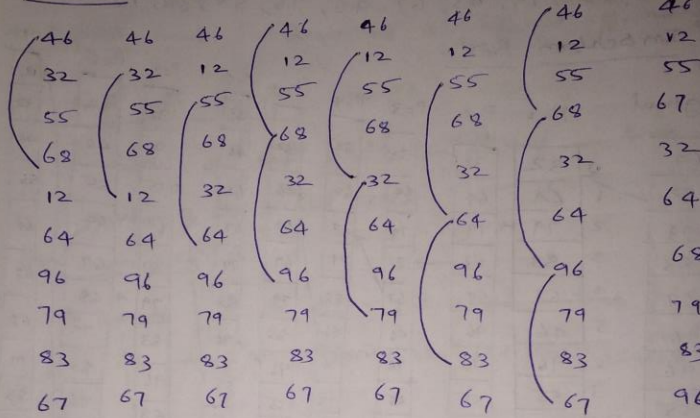
Case 3: h3 = 1.

3-sorted   sorted

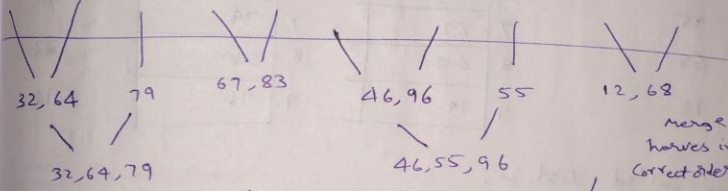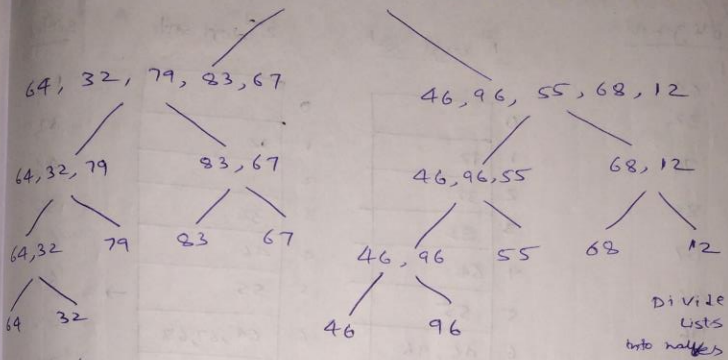| 46	12	12	12	12	12	12	12	12	12
12	46	46	46	32	32	32	32	32	32
55	55	55	55	46	46	46	46	46	46
67	67	67	67	55	55	55	55	55	55
32	32	32	32	67	64	64	64	64	64
64	64	64	64	64	67	67	67	67	67
68	68	68	68	68	67	68	68	68	68
79	79	79	79	79	79	79	79	79	79
83	83	83	83	83	83	83	83	83	83
96	96	96	96	96	96	96	96	96	96

Thus the sorted list is,

12, 32, 46, 55, 64, 67, 68, 79, 83, 96.

(c) **Merge Sort:**

64, 32, 79, 83, 67, 46, 96, 55, 68, 12

64, 32, 79, 83, 67   46, 96, 55, 68, 12

64, 32, 79   83, 67   46, 96, 55   68, 12

64, 32   79   83   67   46, 96   55   68   12

64   32   46   96

32, 64   79   67, 83   46, 96   55   12, 68

32, 64, 79   46, 55, 96

32, 64, 67, 79, 83   12, 46, 55, 68, 96

12, 32, 46, 55, 64, 67, 68, 79, 83, 96

Divide
Lists
into halves

Merge
halves in
Correct order

∴ The sorted List is,

12, 32, 46, 55, 64, 67, 68, 79, 83, 96.

(d) Radix sort:

original:	1st digit sort:		2nd digit sort		sorted
64		0		0	12
32	0				32
79	1	12		1	12	46
83	2	32		2		55
67	3	83		3	32	64
46	4	64		4	46	67
96	5	55		5	55	68
55	6	46, 96		6	64, 67, 68	79
68	7	67		7	79	83
12	8	68		8	83	96
	9	79		9	96	

∴ sorted List is,

12, 32, 46, 55, 64, 67, 68, 79, 83, 96.

2 ans:

Given List,

64	12	68	23	97	38	81	76	55	32	48	29	46
0	1	2	3	4	5	6	7	8	9	10	11	12

Pivot is median-of-three.

Also, if partition size is ≤ 3 then direct sort.

Picking pivot is done by median-of-three
↓
left most, center, Right most

$$center = \frac{0+12}{2} = 6$$

Pivot = median-of-three (list[0], list[6], list[12])

= median (64, 81, 46)

= 64.

Elements should be kept in the correct position.

so

46	12	68	23	97	38	64	76	55	32	48	29	81
0	1	2	3	4	5	6	7	8	9	10	11	12

Pivot

Since values were kept in position.

i will start at 1, and

j will start at 10. (Pivot will be pushed to right end)

Now, swap the values in pivot and right most.

46	12	68	23	97	38	29	76	55	32	48	64	81
0	1	2	3	4	5	6	7	8	9	10	11	12

i ~~Pivot~~ j Pivot

i slides until   list[i] > Pivot &

j slides until   list[j] < Pivot

0	1	2	3	4	5	6	7	8	9	10	11	12
46	12	68	23	97	38	29	76	55	32	48	64	81

i   j   Pivot

swap (68, 48)

0	1	2	3	4	5	6	7	8	9	10	11	12
46	12	48	23	97	38	29	76	55	32	68	64	81

i   j   P

swap (97, 32)

0	1	2	3	4	5	6	7	8	9	10	11	12
46	12	48	23	32	38	29	76	55	97	68	64	81

i j   P

swap (76, 55)

0	1	2	3	4	5	6	7	8	9	10	11	12
46	12	48	23	32	38	29	55	76	97	68	64	81

j i   P

swap pivot and i

0	1	2	3	4	5	6	7	8	9	10	11	12
46	12	48	23	32	38	29	55	64	97	68	76	81

P

Now new lists are,

0	1	2	3	4	5	6	7
46	12	48	23	32	38	29	55

→ case (i)

0	1	2	3
97	68	76	81

→ case (ii)

⊛ Case (i):

For 1st list:

0	1	2	3	4	5	6	7
46	12	48	23	32	38	29	55

↑ Pivot (at index 3)

Center = $\frac{0+7}{2}$ = 3

Pivot =

median - of - three (46, 23, 55)

∴ pivot = 46

Keeping elements in order

0	1	2	3	4	5	6	7
23	12	48	46	32	38	29	55

↑ Pivot (at index 3)

i starts at 1

j starts at 5

swap (pivot, a[6])

0	1	2	3	4	5	6	7
23,	12,	48,	29,	32,	38,	46,	55

i (at 1)   j, P (at 6)

23   12   48   29   32   38   46   55

i   j   P

swap (48, 38)

23   12   38   29   32   48   46   55

j   i   P

swap (a[i], P)

0	1	2	3	4	5	6	7
23	12	38	29	32	46	48	55

New List)

0	1	2	3	4
23	12	38	29	32

↑
Pivot

other new
list

| 48 | 55 | element
≤3 |

sort them

| 48 | 55 |

$$center = \frac{0+4}{2} = 2$$

Pivot = median - q - three (23, 38, 32)

= 32

Keep them in right positions.

0	1	2	3	4
23	12	32	29	38

↑
P

i starts at 1

j starts at 2

swap (pivot, a [3])

23   12   29   32   38
       i   j   ↓
            P

23   12   29   32   38
      i   ij   ↓
           (P)
            i

23	12	29	32	38

↑
P

New list,

23	12	29

Since elements ≤ 3

So normal slot.

12	23	29

other new
list

| 38 |

so no need to
sort.

38

After first merge

| 12 | 23 | 29 | + | 32 | + | 38 |

| 12 | 23 | 29 | 32 | 38 |

After second merge

| 12 | 23 | 29 | 32 | 38 | + | 46 | + | 48 | 55 |

| 12 | 23 | 29 | 32 | 38 | 46 | 48 | 55 |

case (ii)

⊕ Fd 2nd List:

	0	1	2	3
	97	68	76	81

Center $= \dfrac{0+3}{2} = 1$

Pivot $=$ median $(97, 68, 81)$

$= 81$

Keeping them in exact position.

	0	1	2	3
	68	81	76	97

i starts at 1

j starts at 1

swap(pivot, a[2])

	0	1	2	3
	68	76	81	97

j i

    i pivot

68,	76,	81,	97

↑ Pivot
j   i

New lists,

| 68 | 76 | ⇒ | 68 | 76 |

after normal sort [elements ≤3]

| 97 | ⇒ | 97 |

So after merge

| 68 | 76 | 81 | 97 |

After merging,

case (i) + case (ii)

| 12 | 23 | 29 | 32 | 38 | 46 | 48 | 55 | + | 68 | 76 | 81 | 97 |

| 12 | 23 | 29 | 32 | 38 | 46 | 48 | 55 | 68 | 76 | 81 | 97 |
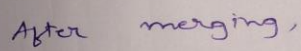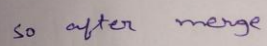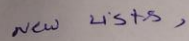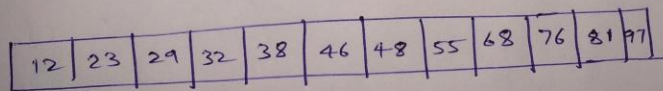
∴ The final sorted list is,

12, 23, 29, 32, 38, 46, 48, 55, 68, 76, 81, 97.

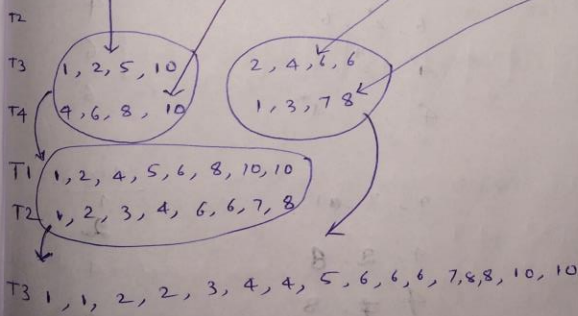**3ans:**

Given   Input,

8, 7, 4, 2, 5, 5, 2, 4, 5, 7, 8

original: Sorted:

original			Sorted
8 ✓	0		2
7 ✓	1		2
4 ✓	2	2	4
2 ✓	3		4
5 ✓	4	2	5
5 ✓	5	3	5
2 ✓	6		5
4 ✓			7
5 ✓	7	2	7
7 ✓	8	2	8
8			8

4ans: Given Input,

T₁ 10, 1, 5, 2, 6, 8, 4, 10, 6, 6, 2, 4, 1, 8, 7, 3

T2

T3   1, 2, 5, 10   2, 4, 6, 6

T4   4, 6, 8, 10   1, 3, 7 8

T1   1, 2, 4, 5, 6, 8, 10, 10

T2   1, 2, 3, 4, 6, 6, 7, 8

T3 1, 1, 2, 2, 3, 4, 4, 5, 6, 6, 6, 7, 8, 8, 10, 10

Thus, sorted list,

1, 1, 2, 2, 3, 4, 4, 5, 6, 6, 6, 7, 8, 8, 10, 10.

5 ans:

Given Input,

10, 1, 5, 2, 6, 8, 4, 10, 6, 6, 2, 4, 1, 8, 7

Input:	Memory (holds 3)	output:
10	10	
1	10, 1	Run 1
5	10, 1, 5	1
2	10, 2, 5	2
6	10, 6, 5	5
8	10, 6, 8	6
4	10, 4, 8	6
10	10, 4*, 10	8
6	6*, 4*, 10	10
6	6*, 4*, 6*	10
2		
4		Run 2:
1	6, 4, 6	
8	6, 2*, 6	4
7	4*, 2*, 6	6
	4*, 2*, 1*	6

		Run 3?
4, 2, 1	1
4, 2, 8	2
4, 7, 8	4
7, 8	7
8	8

6 ans:

No. of items to be compared are 4.

$$\therefore N = 4$$

The No. of leaves in the decision tree

are $N! = 4!$

$$= 4 \times 3 \times 2 \times 1$$

$$= 24.$$

No. of comparision = Depth of tree

$$= \lceil \log (N!) \rceil$$

$$= \lceil \log (24) \rceil$$

$$= \lceil 4.58 \rceil = 5$$

$$= 5$$