**Shell Sort**

A is an ordered integer array with 10 elements from small to large (Assume that this array is 1 2 3 4 5 6 7 8 9 10 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | N (number of elements) | K (next element that will be looking for) |
|---|---|---|---|---|
| **1** 2 3 4 5 **6** 7 8 9 10 | 1 | 0 | 10 | 5 |
| 1 **2** 3 4 5 6 **7** 8 9 10 | 2 | 0 | 10 | 5 |
| 1 2 **3** 4 5 6 7 **8** 9 10 | 3 | 0 | 10 | 5 |
| 1 2 3 **4** 5 6 7 8 **9** 10 | 4 | 0 | 10 | 5 |
| 1 2 3 4 **5** 6 7 8 9 **10** | 5 | 0 | 10 | 5 |
| **1** 2 **3** 4 5 6 7 8 9 10 | 6 | 0 | 10 | 2 |
| 1 **2** 3 **4** 5 6 7 8 9 10 | 7 | 0 | 10 | 2 |
| 1 2 **3** 4 **5** 6 7 8 9 10 | 8 | 0 | 10 | 2 |
| 1 2 3 **4** 5 **6** 7 8 9 10 | 9 | 0 | 10 | 2 |
| 1 2 3 4 **5** 6 **7** 8 9 10 | 10 | 0 | 10 | 2 |
| 1 2 3 4 5 **6** 7 **8** 9 10 | 11 | 0 | 10 | 2 |
| 1 2 3 4 5 6 **7** 8 **9** 10 | 12 | 0 | 10 | 2 |
| 1 2 3 4 5 6 7 **8** 9 **10** | 13 | 0 | 10 | 2 |
| **1 2** 3 4 5 6 7 8 9 10 | 14 | 0 | 10 | 1 |
| 1 **2 3** 4 5 6 7 8 9 10 | 15 | 0 | 10 | 1 |
| 1 2 **3 4** 5 6 7 8 9 10 | 16 | 0 | 10 | 1 |
| 1 2 3 **4 5** 6 7 8 9 10 | 17 | 0 | 10 | 1 |
| 1 2 3 4 **5 6** 7 8 9 10 | 18 | 0 | 10 | 1 |
| 1 2 3 4 5 **6 7** 8 9 10 | 19 | 0 | 10 | 1 |
| 1 2 3 4 5 6 **7 8** 9 10 | 20 | 0 | 10 | 1 |
| 1 2 3 4 5 6 7 **8 9** 10 | 21 | 0 | 10 | 1 |
| 1 2 3 4 5 6 7 8 **9 10** | 22 | 0 | 10 | 1 |

B is an ordered integer array with 10 elements from large to small (Assume that this array is 10 9 8 7 6 5 4 3 2 1 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | N (number of elements) | K (next element that will be looking for) |
|---|---|---|---|---|
| **10** 9 8 7 6 **5** 4 3 2 1 | 1 | 1 | 10 | 5 |
| 5 **9** 8 7 6 10 **4** 3 2 1 | 2 | 2 | 10 | 5 |
| 5 4 **8** 7 6 10 9 **3** 2 1 | 3 | 3 | 10 | 5 |
| 5 4 3 **7** 6 10 9 8 **2** 1 | 4 | 4 | 10 | 5 |
| 5 4 3 2 **6** 10 9 8 7 **1** | 5 | 5 | 10 | 5 |
| **5** 4 **3** 2 1 10 9 8 7 6 | 6 | 6 | 10 | 2 |
| 3 **4** 5 **2** 1 10 9 8 7 6 | 7 | 7 | 10 | 2 |
| 3 2 **5** 4 **1** 10 9 8 7 6 | 8 | 8 | 10 | 2 |
| **3** 2 **1** 4 5 10 9 8 7 6 | 9 | 9 | 10 | 2 |
| 1 2 3 **4** 5 **10** 9 8 7 6 | 10 | 9 | 10 | 2 |
| 1 2 3 4 **5** 10 **9** 8 7 6 | 11 | 9 | 10 | 2 |
| 1 2 3 4 5 **10** 9 **8** 7 6 | 12 | 10 | 10 | 2 |
| 1 2 3 **4** 5 **8** 9 10 7 6 | 13 | 10 | 10 | 2 |
| 1 2 3 4 5 8 **9** 10 **7** 6 | 14 | 11 | 10 | 2 |
| 1 2 3 4 **5** 8 **7** 10 9 6 | 15 | 11 | 10 | 2 |
| 1 2 3 4 5 8 7 **10** 9 **6** | 16 | 12 | 10 | 2 |
| 1 2 3 4 5 **8** 7 **6** 9 10 | 17 | 13 | 10 | 2 |
| 1 2 3 **4** 5 **6** 7 8 9 10 | 18 | 13 | 10 | 2 |
| **1 2** 3 4 5 6 7 8 9 10 | 19 | 13 | 10 | 2 |
| 1 **2 3** 4 5 6 7 8 9 10 | 20 | 13 | 10 | 1 |

| | | | | |
|---|---|---|---|---|
| 1 2 **3 4** 5 6 7 8 9 10 | 21 | 13 | 10 | 1 |
| 1 2 3 **4 5** 6 7 8 9 10 | 22 | 13 | 10 | 1 |
| 1 2 3 4 **5 6** 7 8 9 10 | 23 | 13 | 10 | 1 |
| 1 2 3 4 5 **6 7** 8 9 10 | 24 | 13 | 10 | 1 |
| 1 2 3 4 5 6 **7 8** 9 10 | 25 | 13 | 10 | 1 |
| 1 2 3 4 5 6 7 **8 9** 10 | 26 | 13 | 10 | 1 |
| 1 2 3 4 5 6 7 8 **9 10** | 27 | 13 | 10 | 1 |

C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | N (number of elements) | K (next element that will be looking for) |
|---|---|---|---|---|
| **5** 2 13 9 1 7 **6** 8 1 15 4 11 | 1 | 0 | 12 | 6 |
| 5 **2** 13 9 1 7 6 **8** 1 15 4 11 | 2 | 0 | 12 | 6 |
| 5 2 **13** 9 1 7 6 8 **1** 15 4 11 | 3 | 1 | 12 | 6 |
| 5 2 1 9 **1** 7 6 8 13 **15** 4 11 | 4 | 1 | 12 | 6 |
| 5 2 1 9 1 **7** 6 8 13 15 **4** 11 | 5 | 2 | 12 | 6 |
| 5 2 1 9 1 4 **6** 8 13 15 7 **11** | 6 | 2 | 12 | 6 |
| **5** 2 1 **9** 1 4 6 8 13 15 7 11 | 7 | 2 | 12 | 3 |
| 5 **2** 1 9 **1** 4 6 8 13 15 7 11 | 8 | 3 | 12 | 3 |
| 5 1 **1** 9 2 **4** 6 8 13 15 7 11 | 9 | 3 | 12 | 3 |
| 5 1 1 **9** 2 4 **6** 8 13 15 7 11 | 10 | 4 | 12 | 3 |
| **5** 1 1 **6** 2 4 9 8 13 15 7 11 | 11 | 4 | 12 | 3 |
| 5 1 1 6 **2** 4 9 **8** 13 15 7 11 | 12 | 4 | 12 | 3 |
| 5 1 1 6 2 **4** 9 8 **13** 15 7 11 | 13 | 4 | 12 | 3 |
| 5 1 1 6 2 4 **9** 8 13 **15** 7 11 | 14 | 4 | 12 | 3 |
| 5 1 1 6 2 4 9 **8** 13 15 **7** 11 | 15 | 5 | 12 | 3 |
| 5 1 1 6 **2** 4 9 **7** 13 15 8 11 | 16 | 5 | 12 | 3 |
| 5 1 1 6 2 4 9 7 **13** 15 8 **11** | 17 | 6 | 12 | 3 |
| 5 1 1 6 2 **4** 9 7 **11** 15 8 13 | 18 | 6 | 12 | 3 |
| **5 1** 1 6 2 4 9 7 11 15 8 13 | 19 | 7 | 12 | 1 |
| 1 **5 1** 6 2 4 9 7 11 15 8 13 | 20 | 8 | 12 | 1 |
| **1 1** 5 6 2 4 9 7 11 15 8 13 | 21 | 8 | 12 | 1 |
| 1 1 **5 6** 2 4 9 7 11 15 8 13 | 22 | 8 | 12 | 1 |
| 1 1 5 **6 2** 4 9 7 11 15 8 13 | 23 | 9 | 12 | 1 |
| 1 1 **5 2** 6 4 9 7 11 15 8 13 | 24 | 10 | 12 | 1 |
| 1 **1 2** 5 6 4 9 7 11 15 8 13 | 25 | 10 | 12 | 1 |
| 1 1 2 5 **6 4** 9 7 11 15 8 13 | 26 | 11 | 12 | 1 |
| 1 1 2 **5 4** 6 9 7 11 15 8 13 | 27 | 12 | 12 | 1 |
| 1 1 **2 4** 5 6 9 7 11 15 8 13 | 28 | 12 | 12 | 1 |
| 1 1 2 4 5 **6 9** 7 11 15 8 13 | 29 | 12 | 12 | 1 |
| 1 1 2 4 5 6 **9 7** 11 15 8 13 | 30 | 13 | 12 | 1 |
| 1 1 2 4 5 **6 7** 9 11 15 8 13 | 31 | 13 | 12 | 1 |
| 1 1 2 4 5 6 7 **9 11** 15 8 13 | 32 | 13 | 12 | 1 |
| 1 1 2 4 5 6 7 9 **11 15** 8 13 | 33 | 13 | 12 | 1 |
| 1 1 2 4 5 6 7 9 11 **15 8** 13 | 34 | 14 | 12 | 1 |
| 1 1 2 4 5 6 7 9 **11 8** 15 13 | 35 | 15 | 12 | 1 |
| 1 1 2 4 5 6 7 **9 8** 11 15 13 | 36 | 16 | 12 | 1 |
| 1 1 2 4 5 6 **7 8** 9 11 15 13 | 37 | 16 | 12 | 1 |
| 1 1 2 4 5 6 7 8 9 11 **15 13** | 38 | 17 | 12 | 1 |
| 1 1 2 4 5 6 7 8 9 **11 13** 15 | 39 | 17 | 12 | 1 |

D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | N (number of elements) | K (next element that will be looking for) |
|---|---|---|---|---|

| | | | | |
|---|---|---|---|---|
| **S** B I M H Q **C** L R E P K | 1 | 1 | 12 | 6 |
| C **B** I M H Q S **L** R E P K | 2 | 1 | | |
| C B **I** M H Q S L **R** E P K | 3 | 1 | | |
| C B I **M** H Q S L R **E** P K | 4 | 2 | | |
| C B I E **H** Q S L R M **P** K | 5 | 2 | | |
| C B I E H **Q** S L R M P **K** | 6 | 3 | | |
| **C** B I **E** H K S L R M P Q | 7 | 3 | | 3 |
| C **B** I E **H** K S L R M P Q | 8 | 3 | | |
| C B **I** E H **K** S L R M P Q | 9 | 3 | | |
| C B I **E** H K **S** L R M P Q | 10 | 3 | | |
| C B I E **H** K S **L** R M P Q | 11 | 3 | | |
| C B I E H **K** S L **R** M P Q | 12 | 3 | | |
| C B I E H K **S** L R **M** P Q | 13 | 4 | | |
| C B I **E** H K **M** L R S P Q | 14 | 4 | | |
| C B I E H K M **L** R S **P** Q | 15 | 4 | | |
| C B I E H K M L **R** S P **Q** | 16 | 5 | | |
| C B I E H **K** M L **Q** S P R | 17 | 5 | | |
| **C B** I E H K M L Q S P R | 18 | 6 | | 1 |
| B **C I** E H K M L Q S P R | 19 | 6 | | |
| B C **I E** H K M L Q S P R | 20 | 7 | | |
| B **C E** I H K M L Q S P R | 21 | 7 | | |
| B C E **I H** K M L Q S P R | 22 | 8 | | |
| B C **E H** I K M L Q S P R | 23 | 8 | | |
| B C E H **I K** M L Q S P R | 24 | 8 | | |
| B C E H I **K M** L Q S P R | 25 | 8 | | |
| B C E H I K **M L** Q S P R | 26 | 9 | | |
| B C E H I **K L** M Q S P R | 27 | 9 | | |
| B C E H I K L **M Q** S P R | 28 | 9 | | |
| B C E H I K L M **Q S** P R | 29 | 9 | | |
| B C E H I K L M Q **S P** R | 30 | 10 | | |
| B C E H I K L M **Q P** S R | 31 | 11 | | |
| B C E H I K L **M P** Q S R | 32 | 11 | | |
| B C E H I K L M P Q **S R** | 33 | 12 | | |
| B C E H I K L M P **Q R** S | 34 | 12 | | |

**Merge Sort**

A is an ordered integer array with 10 elements from small to large (Assume that this array is 1 2 3 4 5 6 7 8 9 10 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Arrays |
|---|---|---|---|
| 1 2 3 4 5 6 7 8 9 10 | 0 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 5 – 6 7 8 9 10 | 0 | 0 | 1 2 - 3 4 5 - 6 7 - 8 9 10 |
| 1 2 - 3 4 5 - 6 7 - 8 9 10 | 0 | 0 | 1 2 - 3 - 4 5 - 6 7 - 8 - 9 10 |
| **1** 2 - **3** - 4 5 - 6 7 - 8 - 9 10 | 1 | 0 | 1 2 - 3 - 4 5 - 6 7 - 8 - 9 10 |
| 1 **2** - **3** - 4 5 - 6 7 - 8 - 9 10 | 2 | 0 | 1 2 3 - 4 5 - 6 7 - 8 - 9 10 |
| 1 2 3 - 4 5 - 6 7 - **8** - **9** 10 | 3 | 0 | 1 2 3 - 4 5 - 6 7 - 8 - 9 10 |
| 1 2 3 - 4 5 - 6 7 - **8** - 9 **10** | 4 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| **1** 2 3 - **4** 5 - 6 7 - 8 9 10 | 5 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| 1 **2** 3 - **4** 5 - 6 7 - 8 9 10 | 6 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| 1 2 **3** - **4** 5 - 6 7 - 8 9 10 | 7 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| **1** 2 3 - 4 **5** - 6 7 - 8 9 10 | 8 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| 1 **2** 3 - 4 **5** - 6 7 - 8 9 10 | 9 | 0 | 1 2 3 - 4 5 - 6 7 - 8 9 10 |
| 1 2 **3** - 4 **5** - 6 7 - 8 9 10 | 10 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |
| 1 2 3 4 5 - **6** 7 - **8** 9 10 | 11 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |
| 1 2 3 4 5 - 6 **7** - **8** 9 10 | 12 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |
| 1 2 3 4 5 - **6** 7 - 8 **9** 10 | 13 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |

| | | | |
|---|---|---|---|
| 1 2 3 4 5 - 6 **7** - 8 **9** 10 | 14 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |
| 1 2 3 4 5 - **6** 7 - 8 9 **10** | 15 | 0 | 1 2 3 4 5 - 6 7 - 8 9 10 |
| 1 2 3 4 5 - 6 **7** - 8 9 **10** | 16 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| **1** 2 3 4 5 - **6** 7 8 9 10 | 17 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 **2** 3 4 5 - **6** 7 8 9 10 | 18 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 **3** 4 5 - **6** 7 8 9 10 | 19 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 **4** 5 - **6** 7 8 9 10 | 20 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 **5** - **6** 7 8 9 10 | 21 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| **1** 2 3 4 5 - 6 **7** 8 9 10 | 22 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 **2** 3 4 5 - 6 **7** 8 9 10 | 23 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 **3** 4 5 - 6 **7** 8 9 10 | 24 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 **4** 5 - 6 **7** 8 9 10 | 25 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 **5** - 6 **7** 8 9 10 | 26 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| **1** 2 3 4 5 - 6 7 **8** 9 10 | 27 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 **2** 3 4 5 - 6 7 **8** 9 10 | 28 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 **3** 4 5 - 6 7 **8** 9 10 | 29 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 **4** 5 - 6 7 **8** 9 10 | 30 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 **5** - 6 7 **8** 9 10 | 31 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| **1** 2 3 4 5 - 6 7 8 **9** 10 | 32 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 **2** 3 4 5 - 6 7 8 **9** 10 | 33 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 **3** 4 5 - 6 7 8 **9** 10 | 34 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 **4** 5 - 6 7 8 **9** 10 | 35 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 **5** - 6 7 8 **9** 10 | 36 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| **1** 2 3 4 5 - 6 7 8 9 **10** | 37 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 **2** 3 4 5 - 6 7 8 9 **10** | 38 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 **3** 4 5 - 6 7 8 9 **10** | 39 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 **4** 5 - 6 7 8 9 **10** | 40 | 0 | 1 2 3 4 5 - 6 7 8 9 10 |
| 1 2 3 4 **5** - 6 7 8 9 **10** | 41 | 0 | 1 2 3 4 5 6 7 8 9 10 |

B is an ordered integer array with 10 elements from large to small (Assume that this array is 10 9 8 7 6 5 4 3 2 1 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Arrays |
|---|---|---|---|
| 10 9 8 7 6 5 4 3 2 1 | 0 | 0 | 10 9 8 7 6 - 5 4 3 2 1 |
| 10 9 8 7 6 - 5 4 3 2 1 | 0 | 0 | 10 9 8 - 7 6 - 5 4 3 - 2 1 |
| 10 9 8 - 7 6 - 5 4 3 - 2 1 | 0 | 0 | 10 9 - 8 - 7 6 - 5 4 - 3 - 2 1 |
| 10 - 9 - 8 - 7 - 6 - 5 - 4 - 3 - 2 - 1 | 0 | 0 | 10 - 9 - 8 - 7 - 6 - 5 - 4 - 3 - 2 - 1 |
| **10** - **9** - 8 - 7 - 6 - 5 - 4 - 3 - 2 - 1 | 1 | 1 | 9 10 - 8 - 7 - 6 - 5 - 4 - 3 - 2 - 1 |
| 9 10 - 8 - 7 - 6 - 5 - 4 - 3 - **2** - **1** | 2 | 2 | 9 10 - 8 - 7 - 6 - 5 - 4 - 3 - 1 2 |
| **9** 10 - **8** - 7 - 6 - 5 - 4 - 3 - 1 2 | 3 | 3 | 8 10 - 9 - 7 - 6 - 5 - 4 - 3 - 1 2 |
| 8 **10** - **9** - 7 - 6 - 5 - 4 - 3 - 1 2 | 4 | 4 | 8 9 10 - 7 - 6 - 5 - 4 - 3 - 1 2 |
| 8 9 10 - 7 - 6 - 5 - 4 - **3 - 1 2** | 5 | 5 | 8 9 10 - 7 - 6 - 5 - 4 - 1 2 3 |
| 8 9 10 - **7 - 6** - 5 - 4 - 1 2 3 | 6 | 6 | 8 9 10 - 6 7 - 5 - 4 – 1 2 3 |
| 8 9 10 - 6 7 - **5 - 4** – 1 2 3 | 7 | 7 | 8 9 10 - 6 7 - 4 5 - 1 2 3 |
| **8** 9 10 - **6** 7 - 4 5 - 1 2 3 | 8 | 8 | 6 - 4 5 - 1 2 3 |
| **8** 9 10 - 6 **7** - 4 5 - 1 2 3 | 9 | 9 | 6 7 8 9 10 - 4 5 - 1 2 3 |
| 6 7 8 9 10 - **4** 5 - **1** 2 3 | 10 | 10 | 6 7 8 9 10 - 1 |
| 6 7 8 9 10 - **4** 5 - 1 **2** 3 | 11 | 11 | 6 7 8 9 10 - 1 2 |
| 6 7 8 9 10 - **4** 5 - 1 2 **3** | 12 | 12 | 6 7 8 9 10 - 1 2 3 4 5 |
| **6** 7 8 9 10 - **1** 2 3 4 5 | 13 | 13 | 1 |
| **6** 7 8 9 10 - 1 **2** 3 4 5 | 14 | 14 | 1 2 |
| **6** 7 8 9 10 - 1 2 **3** 4 5 | 15 | 15 | 1 2 3 |
| **6** 7 8 9 10 - 1 2 3 **4** 5 | 16 | 16 | 1 2 3 4 |
| **6** 7 8 9 10 - 1 2 3 4 **5** | 17 | 17 | 1 2 3 4 5 6 7 8 9 10 |

C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Arrays |
|---|---|---|---|
| 5 2 13 9 1 7 6 8 1 15 4 11 | 0 | 0 | 5 2 13 9 1 7 - 6 8 1 15 4 11 |
| 5 2 13 9 1 7 - 6 8 1 15 4 11 | 0 | 0 | 5 2 13 - 9 1 7 - 6 8 1 - 15 4 11 |
| 5 2 13 - 9 1 7 - 6 8 1 - 15 4 11 | 0 | 0 | 5 - 2 13 - 9 1 - 7 - 6 8 - 1 - 15 4 - 11 |
| 5 - 2 13 - 9 1 - 7 - 6 8 - 1 - 15 4 - 11 | 0 | 0 | 5 - 2 13 - 9 - 1 - 7 - 6 8 - 1 - 15 - 4 - 11 |
| **5** - **2** 13 - 9 - 1 - 7 - 6 8 - 1 – 15 - 4 - 11 | 1 | 1 | 2 - 9 - 1 - 7 - 6 8 - 1 – 15 - 4 - 11 |
| **5** - 2 **13** - 9 - 1 - 7 - 6 8 - 1 – 15 - 4 - 11 | 1 | 1 | 2 5 13 - 9 - 1 - 7 - 6 8 - 1 - 15 - 4 - 11 |
| 2 5 13 - 9 - 1 - 7 - 6 8 - 1 – **15** - **4** - 11 | 2 | 2 | 2 5 13 - 9 - 1 - 7 - 6 8 - 1 - 4 15 - 11 |
| 2 5 13 - 9 - 1 - 7 - 6 8 - 1 – **4** 15 - **11** | 3 | 2 | 2 5 13 - 9 - 1 - 7 - 6 8 - 1 - 4 |
| 2 5 13 - 9 - 1 - 7 - 6 8 - 1 – 4 **15** - **11** | 4 | 3 | 2 5 13 - 9 - 1 - 7 - 6 8 - 1 - 4 11 15 |
| 2 5 13 - **9** - **1** - 7 - 6 8 - 1 – 4 11 15 | 5 | 4 | 2 5 13 - 1 9 - 7 - 6 8 - 1 - 4 11 15 |
| 2 5 13 - **1** 9 - **7** - 6 8 - 1 - 4 11 15 | 6 | 5 | 2 5 13 - 1- 6 8 - 1 - 4 11 15 |
| 2 5 13 - 1 **9** - **7** - 6 8 - 1 - 4 11 15 | 7 | 6 | 2 5 13 - 1 7 9 - 6 8 - 1 - 4 11 15 |
| 2 5 13 - 1 7 9 - **6** 8 - **1** - 4 11 15 | 8 | 7 | 2 5 13 - 1 7 9 - 1 6 8 - 4 11 15 |
| **2** 5 13 - **1** 7 9 - 1 6 8 - 4 11 15 | 9 | 8 | 1 - 1 6 8 - 4 11 15 |
| **2** 5 13 - 1 **7** 9 - 1 6 8 - 4 11 15 | 10 | 8 | 1 2 - 1 6 8 - 4 11 15 |
| 2 **5** 13 - 1 **7** 9 - 1 6 8 - 4 11 15 | 11 | 8 | 1 2 5 - 1 6 8 - 4 11 15 |
| 2 5 **13** – 1 **7** 9 - 1 6 8 - 4 11 15 | 12 | 9 | 1 2 5 7 - 1 6 8 - 4 11 15 |
| 2 5 **13** – 1 7 **9** - 1 6 8 - 4 11 15 | 13 | 10 | 1 2 5 7 9 13 - 1 6 8 - 4 11 15 |
| 1 2 5 7 9 13 - **1** 6 8 - **4** 11 15 | 14 | 10 | 1 2 5 7 9 13 - 1 |
| 1 2 5 7 9 13 - 1 **6** 8 - **4** 11 15 | 15 | 11 | 1 2 5 7 9 13 - 1 4 |
| 1 2 5 7 9 13 - 1 **6** 8 - 4 **11** 15 | 16 | 11 | 1 2 5 7 9 13 - 1 4 6 |
| 1 2 5 7 9 13 - 1 6 **8** - 4 **11** 15 | 17 | 11 | 1 2 5 7 9 13 – 1 4 6 8 11 15 |
| **1** 2 5 7 9 13 – **1** 4 6 8 11 15 | 18 | 11 | 1 |
| **1** 2 5 7 9 13 – 1 **4** 6 8 11 15 | 19 | 11 | 1 1 |
| 1 **2** 5 7 9 13 – 1 **4** 6 8 11 15 | 20 | 11 | 1 1 2 |
| 1 2 **5** 7 9 13 – 1 **4** 6 8 11 15 | 21 | 12 | 1 1 2 4 |
| 1 2 **5** 7 9 13 – 1 4 **6** 8 11 15 | 22 | 12 | 1 1 2 4 5 |
| 1 2 5 **7** 9 13 – 1 4 **6** 8 11 15 | 23 | 13 | 1 1 2 4 5 6 |
| 1 2 5 **7** 9 13 – 1 4 6 **8** 11 15 | 24 | 13 | 1 1 2 4 5 6 7 |
| 1 2 5 7 **9** 13 – 1 4 6 **8** 11 15 | 25 | 14 | 1 1 2 4 5 6 7 8 |
| 1 2 5 7 **9** 13 – 1 4 6 8 **11** 15 | 26 | 14 | 1 1 2 4 5 6 7 8 9 |
| 1 2 5 7 9 **13** – 1 4 6 8 **11** 15 | 27 | 15 | 1 1 2 4 5 6 7 8 9 11 |
| 1 2 5 7 9 **13** – 1 4 6 8 11 **15** | 28 | 15 | 1 1 2 4 5 6 7 8 9 11 13 15 |

D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Arrays |
|---|---|---|---|
| S B I M H Q C L R E P K | 0 | 0 | S B I M H Q - C L R E P K |
| S B I M H Q - C L R E P K | 0 | 0 | S B I - M H Q - C L R - E P K |
| S B I - M H Q - C L R - E P K | 0 | 0 | S B - I - M - H Q - C - L R - E - P K |
| S B - I - M - H Q - C - L R - E - P K | 0 | 0 | S - B - I - M - H Q - C - L R - E - P - K |
| **S - B** - I - M - H Q - C - L R - E - P - K | 1 | 1 | B S - I - M - H Q - C - L R - E - P - K |
| B S - I - M - H Q - C - L R - E - **P - K** | 2 | 2 | B S - I - M - H Q - C - L R - E - K P |
| **B** S - **I** - M - H Q - C - L R - E - K P | 3 | 2 | B - M - H Q - C - L R - E - K P |
| B **S** - **I** - M - H Q - C - L R - E - K P | 4 | 3 | B I S - M - H Q - C - L R - E - K P |
| B I S - M - H Q - C - L R - **E** - **K** P | 5 | 3 | B I S - M - H Q - C - L R – E K P |
| B I S - **M** - **H** Q - C - L R – E K P | 6 | 4 | B I S - H - C - L R – E K P |
| B I S - **M** - H **Q** - C - L R – E K P | 7 | 4 | B I S - H M Q - C - L R – E K P |
| B I S - H M Q - **C** - **L** R – E K P | 8 | 4 | B I S - H M Q - C L R – E K P |
| **B** I S - **H** M Q - C L R – E K P | 9 | 4 | B - C L R – E K P |

| | | | |
|---|---|---|---|
| B **I** S - **H** M Q - C L R – E K P | 10 | 5 | B H - C L R – E K P |
| B **I** S - H **M** Q - C L R – E K P | 11 | 5 | B H I - C L R – E K P |
| B I **S** - H **M** Q - C L R – E K P | 12 | 6 | B H I M- C L R – E K P |
| B I **S** - H M **Q** - C L R – E K P | 13 | 7 | B H I M Q S - C L R – E K P |
| B H I M Q S - **C** L R – **E** K P | 14 | 7 | B H I M Q S - C |
| B H I M Q S - C **L** R – **E** K P | 15 | 8 | B H I M Q S - C E |
| B H I M Q S - C **L** R – E **K** P | 16 | 9 | B H I M Q S - C E K |
| B H I M Q S - C **L** R – E K **P** | 17 | 9 | B H I M Q S - C E K L |
| B H I M Q S - C L **R** – E K **P** | 18 | 10 | B H I M Q S - C E K L P R |
| **B** H I M Q S - **C** E K L P R | 19 | 10 | B |
| B **H** I M Q S - **C** E K L P R | 20 | 11 | B C |
| B **H** I M Q S - C **E** K L P R | 21 | 11 | B C E |
| B **H** I M Q S - C E **K** L P R | 22 | 12 | B C E H |
| B H **I** M Q S - C E **K** L P R | 23 | 12 | B C E H I |
| B H I **M** Q S - C E **K** L P R | 24 | 12 | B C E H I K |
| B H I **M** Q S - C E K **L** P R | 25 | 13 | B C E H I K L |
| B H I **M** Q S - C E K L **P** R | 26 | 14 | B C E H I K L M |
| B H I M **Q** S - C E K L **P** R | 27 | 14 | B C E H I K L M P |
| B H I M **Q** S - C E K L P **R** | 28 | 15 | B C E H I K L M P Q |
| B H I M Q **S** - C E K L P **R** | 29 | 16 | B C E H I K L M P Q R S |

**Heap Sort**

A is an ordered integer array with 10 elements from small to large (Assume that this array is 1 2 3 4 5 6 7 8 9 10 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Ordered Array | Explanation |
|---|---|---|---|---|
| 1 2 3 4 5 6 7 8 9 10 | 0 | 0 | | Heapify this array(Min-heap) |
| 1 2 3 4 5 6 7 8 9 10 | 0 | 1 | 1 | Switch first and last element and delete last element and add root element another array |
| **10 2 3** 4 5 6 7 8 9 | 1 | 2 | 1 | Check which of the childs are smaller, then switch smaller child which is (2n+1) and (2n+2) then if there is child continue that procedure |
| 2 **10** 3 **4 5** 6 7 8 9 | 2 | 3 | 1 | |
| 2 4 3 **10** 5 6 7 **8 9** | 3 | 4 | 1 | |
| 2 4 3 8 5 6 7 10 9 | 3 | 5 | 1 2 | |
| **9 4 3** 8 5 6 7 10 | 4 | 6 | 1 2 | |
| 3 4 **9** 8 5 **6 7** 10 | 5 | 7 | 1 2 | |
| 3 4 6 8 5 9 7 10 | 5 | 8 | 1 2 3 | |
| **10 4 6** 8 5 9 7 | 6 | 9 | 1 2 3 | |
| 4 **10** 6 **8 5** 9 7 | 7 | 10 | 1 2 3 | |
| 4 5 6 8 10 9 7 | 7 | 11 | 1 2 3 4 | |
| **7 5 6** 8 10 9 | 8 | 12 | 1 2 3 4 | |
| 5 **7** 6 **8 10** 9 | 9 | 14 | 1 2 3 4 5 | |
| **9 7 6** 8 10 | 10 | 15 | 1 2 3 4 5 | |
| 6 7 **9** 8 10 | 11 | 17 | 1 2 3 4 5 6 | |
| **10 7 9** 8 | 12 | 18 | 1 2 3 4 5 6 | |
| 7 **10** 9 8 | 13 | 19 | 1 2 3 4 5 6 7 | |
| **8 10 9** | 14 | 20 | 1 2 3 4 5 6 7 8 | |
| **9** 10 | 15 | 21 | 1 2 3 4 5 6 7 8 9 10 | |

B is an ordered integer array with 10 elements from large to small (Assume that this array is

10 9 8 7 6 5 4 3 2 1 just for being able to show steps)(Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Ordered Array | Explanation |
|---|---|---|---|---|
| 10 9 8 7 6 5 4 3 2 1 | 0 | 0 | | Heapify this array(Min-heap) |
| 10 | 0 | 0 | | |
| 10 9 | 1 | 1 | 9 10 | |
| 9 10 8 | 2 | 2 | 8 9 10 | |
| 8 9 10 7 | 3 | 3 | 8 7 10 9 | |
| 8 7 10 9 | 4 | 4 | 7 8 10 9 | |
| 7 8 10 9 6 | 5 | 5 | 7 6 10 9 8 | |
| 7 6 10 9 8 | 6 | 6 | 6 7 10 9 8 | |
| 6 7 10 9 8 5 | 7 | 7 | 6 7 5 9 8 10 | |
| 6 7 5 9 8 10 | 8 | 8 | 5 7 6 9 8 10 | |
| 5 7 6 9 8 10 4 | 9 | 9 | 5 7 4 9 8 10 6 | |
| 5 7 4 9 8 10 6 | 10 | 10 | 4 7 5 9 8 10 6 | |
| 4 7 5 9 8 10 6 3 | 11 | 11 | 4 7 5 3 8 10 6 9 | |
| 4 7 5 3 8 10 6 9 | 12 | 12 | 4 3 5 7 8 10 6 9 | |
| 4 3 5 7 8 10 6 9 | 13 | 13 | 3 4 5 7 8 10 6 9 | |
| 3 4 5 7 8 10 6 9 2 | 14 | 14 | 3 4 5 2 8 10 6 9 7 | |
| 3 4 5 2 8 10 6 9 7 | 15 | 15 | 3 2 5 4 8 10 6 9 7 | |
| 3 2 5 4 8 10 6 9 7 | 16 | 16 | 2 3 5 4 8 10 6 9 7 | |
| 2 3 5 4 8 10 6 9 7 1 | 17 | 17 | 2 3 5 4 1 10 6 9 7 8 | |
| 2 3 5 4 1 10 6 9 7 8 | 18 | 18 | 2 1 5 4 3 10 6 9 7 8 | |
| 2 1 5 4 3 10 6 9 7 8 | 19 | 19 | 1 2 5 4 3 10 6 9 7 8 | (Heapified) |
| 1 2 5 4 3 10 6 9 7 8 | 19 | 20 | 1 | Switch first and last element and delete last element and add root element another array |
| **8 2 5** 4 3 10 6 9 7 | 20 | 21 | 1 | Check which of the childs are smaller, then switch smaller child which is (2n+1) and (2n+2) then if there is child continue that procedure |
| 2 **8** 5 **4 3** 10 6 9 7 | 21 | 22 | 1 | |
| 2 3 5 4 **8** 10 6 9 7 | 22 | 24 | 1 2 | |
| **7 3 5** 4 8 10 6 9 | 23 | 25 | 1 2 | |
| 3 **7** 5 **4 8** 10 6 9 | 24 | 26 | 1 2 | |
| 3 4 5 **7** 8 10 6 **9** | 25 | 26 | 1 2 | |
| 3 4 5 7 8 10 6 9 | 25 | 27 | 1 2 3 | |
| **9 4 5** 7 8 10 6 | 26 | 28 | 1 2 3 | |
| 4 **9** 5 **7 8** 10 6 | 27 | 28 | 1 2 3 | |
| 6 7 5 9 8 10 | 28 | 28 | 1 2 3 4 | |
| **6 7 5** 9 8 10 | 29 | 30 | 1 2 3 4 | |
| 5 7 **6** 9 8 **10** | 30 | 30 | 1 2 3 4 | |
| 5 7 6 9 8 10 | 30 | 31 | 1 2 3 4 5 | |
| **10 7 6** 9 8 | 31 | 32 | 1 2 3 4 5 | |
| 6 7 10 9 8 | 31 | 33 | 1 2 3 4 5 6 | |
| **8 7 10** 9 | 32 | 34 | 1 2 3 4 5 6 | |
| 7 8 10 9 | 32 | 35 | 1 2 3 4 5 6 7 | |
| **9 8 10** | 33 | 36 | 1 2 3 4 5 6 7 | |
| 8 9 10 | 33 | 37 | 1 2 3 4 5 6 7 8 | |
| 9 10 | 34 | 37 | 1 2 3 4 5 6 7 8 9 | |

| | | | | |
|---|---|---|---|---|
| 10 | 34 | 37 | 1 2 3 4 5 6 7 8 9 10 | |

C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Ordered Array | Explanation |
|---|---|---|---|---|
| 5 2 13 9 1 7 6 8 1 15 4 11 | 0 | 0 | | Heapify this array(Min-heap) |
| 5 | 0 | 0 | 5 | |
| 5 2 | 1 | 1 | 2 5 | |
| 2 5 13 | 2 | 1 | 2 5 13 | |
| 2 5 13 9 | 3 | 1 | 2 5 13 9 | |
| 2 5 13 9 1 | 4 | 2 | 2 1 13 9 5 | |
| 2 1 13 9 5 | 5 | 3 | 1 2 13 9 5 | |
| 1 2 13 9 5 7 | 6 | 4 | 1 2 7 9 5 13 | |
| 1 2 7 9 5 13 | 7 | 4 | 1 2 7 9 5 13 | |
| 1 2 7 9 5 13 6 | 8 | 5 | 1 2 6 9 5 13 7 | |
| 1 2 6 9 5 13 7 | 9 | 5 | 1 2 6 9 5 13 7 | |
| 1 2 6 9 5 13 7 8 | 10 | 6 | 1 2 6 8 5 13 7 9 | |
| 1 2 6 8 5 13 7 9 | 11 | 6 | 1 2 6 8 5 13 7 9 | |
| 1 2 6 8 5 13 7 9 1 | 12 | 7 | 1 2 6 1 5 13 7 9 8 | |
| 1 2 6 1 5 13 7 9 8 | 13 | 8 | 1 1 6 2 5 13 7 9 8 | |
| 1 1 6 2 5 13 7 9 8 | 14 | 8 | 1 1 6 2 5 13 7 9 8 | |
| 1 1 6 2 5 13 7 9 8 15 | 15 | 8 | 1 1 6 2 5 13 7 9 8 15 | |
| 1 1 6 2 5 13 7 9 8 15 4 | 16 | 9 | 1 1 6 2 4 13 7 9 8 15 5 | |
| 1 1 6 2 4 13 7 9 8 15 5 | 17 | 9 | 1 1 6 2 4 13 7 9 8 15 5 | |
| 1 1 6 2 4 13 7 9 8 15 5 11 | 18 | 10 | 1 1 6 2 4 11 7 9 8 15 5 13 | |
| 1 1 6 2 4 11 7 9 8 15 5 13 | 19 | 10 | 1 1 6 2 4 11 7 9 8 15 5 13 | (Heapified) |
| 1 1 6 2 4 11 7 9 8 15 5 13 | 19 | 11 | 1 | Switch first and last element and delete last element and add root element another array |
| **13 1 6** 2 4 11 7 9 8 15 5 | 20 | 12 | 1 | |
| 1 **13** 6 **2 4** 11 7 9 8 15 5 | 21 | 13 | 1 | |
| 1 2 6 **13** 4 11 7 **9 8** 15 5 | 22 | 14 | 1 | |
| 1 2 6 8 4 11 7 9 13 15 5 | 22 | 15 | 1 1 | |
| **5 2 6** 8 4 11 7 9 13 15 | 23 | 16 | 1 1 | |
| 2 **5** 6 **8 4** 11 7 9 13 15 | 24 | 17 | 1 1 | |
| 2 4 6 8 **5** 11 7 9 13 **15** | 25 | 17 | 1 1 | |
| 2 4 6 8 5 11 7 9 13 15 | 25 | 18 | 1 1 2 | |
| **15 4 6** 8 5 11 7 9 13 | 26 | 19 | 1 1 2 | |
| 4 **15** 6 **8 5** 11 7 9 13 | 27 | 20 | 1 1 2 | |
| 4 5 6 8 15 11 7 9 13 | 27 | 21 | 1 1 2 4 | |
| **13 5 6** 8 15 11 7 9 | 28 | 22 | 1 1 2 4 | |
| 5 **13** 6 **8 15** 11 7 9 | 29 | 23 | 1 1 2 4 | |
| 5 8 6 **13** 15 11 7 **9** | 30 | 24 | 1 1 2 4 | |
| 5 8 6 9 15 11 7 13 | 30 | 25 | 1 1 2 4 5 | |
| **13 8 6** 15 11 7 | 31 | 26 | 1 1 2 4 5 | |
| 6 8 **13** 15 11 **7** | 32 | 27 | 1 1 2 4 5 | |
| 6 8 7 15 11 13 | 32 | 28 | 1 1 2 4 5 6 | |
| **13 8 7** 15 11 | 33 | 29 | 1 1 2 4 5 6 | |
| 7 8 13 15 11 | 33 | 30 | 1 1 2 4 5 6 7 | |

| | | | | |
|---|---|---|---|---|
| **11 8 13** 15 | 34 | 31 | 1 1 2 4 5 6 7 | |
| 8 **11** 13 **15** | 35 | 31 | 1 1 2 4 5 6 7 | |
| 8 11 13 15 | 35 | 32 | 1 1 2 4 5 6 7 8 | |
| **15 11 13** | 36 | 33 | 1 1 2 4 5 6 7 8 | |
| 11 15 13 | 36 | 34 | 1 1 2 4 5 6 7 8 11 | |
| **13 15** | 37 | 34 | 1 1 2 4 5 6 7 8 11 | |
| 13 15 | 37 | 35 | 1 1 2 4 5 6 7 8 11 13 | |
| 15 | 37 | 35 | 1 1 2 4 5 6 7 8 11 13 15 | |

D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Ordered Array | Explanation |
|---|---|---|---|---|
| S B I M H Q C L R E P K | 0 | 0 | | Heapify this array(Min-heap) |
| S | 0 | 0 | S | |
| S B | 1 | 1 | B S | |
| B S I | 2 | 1 | B S I | |
| B S I M | 3 | 2 | B M I S | |
| B M I S H | 4 | 3 | B H I S M | |
| B H I S M Q | 5 | 3 | B H I S M Q | |
| B H I S M Q C | 6 | 4 | B H C S M Q I | |
| **B** H **C** S M Q I | 7 | 4 | B H C S M Q I | |
| B H C S M Q I L | 8 | 5 | B H C L M Q I S | |
| B **H** C **L** M Q I S | 9 | 5 | B H C L M Q I S | |
| B H C L M Q I S R | 10 | 5 | B H C L M Q I S R | |
| B H C L M Q I S R E | 11 | 6 | B H C L E Q I S R M | |
| B **H** C L **E** Q I S R M | 12 | 7 | B E C L H Q I S R M | |
| **B E** C L H Q I S R M | 13 | 7 | B E C L H Q I S R M | |
| B E C L H Q I S R M P | 14 | 7 | B E C L H Q I S R M P | |
| B E C L H **Q** I S R M P **K** | 15 | 8 | B E C L H K I S R M P Q | |
| B E **C** L H **K** I S R M P Q | 16 | 8 | B E C L H K I S R M P Q | (Heapified) |
| B E C L H K I S R M P Q | 16 | 9 | B | Switch first and last element and delete last element and add root element another array |
| **Q E C** L H K I S R M P | 17 | 10 | B | |
| C E **Q** L H **K I** S R M P | 18 | 11 | B | |
| C E I L H K Q S R M P | 18 | 12 | B C | |
| **P E I** L H K Q S R M | 19 | 13 | B C | |
| E **P** I **L H** K Q S R M | 20 | 14 | B C | |
| E H I L **P** K Q S R **M** | 21 | 15 | B C | |
| E H I L M K Q S R P | 21 | 16 | B C E | |
| **P H I** L M K Q S R | 22 | 17 | B C E | |
| H **P** I **L M** K Q S R | 23 | 18 | B C E | |
| H L I **P** M K Q **S R** | 24 | 18 | B C E | |
| H L I P M K Q S R | 24 | 19 | B C E H | |
| **R L I** P M K Q S | 25 | 20 | B C E H | |
| I L **R** P M **K Q** S | 26 | 21 | B C E H | |
| I L K P M R Q S | 26 | 22 | B C E H I | |
| **S L K** P M R Q | 27 | 23 | B C E H I | |
| K L **S** P M **R Q** | 28 | 24 | B C E H I | |

| | | | | |
|---|---|---|---|---|
| K L Q P M R S | 28 | 25 | B C E H I K | |
| **S L Q** P M R | 29 | 26 | B C E H I K | |
| L **S** Q **P M** R | 30 | 27 | B C E H I K | |
| L M Q P S R | 30 | 28 | B C E H I K L | |
| **R M Q** P S | 31 | 29 | B C E H I K L | |
| M **R** Q **P S** | 32 | 30 | B C E H I K L | |
| M P Q R S | 32 | 31 | B C E H I K L M | |
| **S P Q** R | 33 | 32 | B C E H I K L M | |
| P **S** Q **R** | 34 | 33 | B C E H I K L M | |
| P R Q S | 34 | 34 | B C E H I K L M P | |
| **S R Q** | 35 | 35 | B C E H I K L M P | |
| Q R S | 35 | 36 | B C E H I K L M P Q | |
| **S R** | 36 | 36 | B C E H I K L M P Q | |
| R S | 36 | 37 | B C E H I K L M P Q R | |
| S | 36 | 37 | B C E H I K L M P Q R S | |

Quick Sort

A is an ordered integer array with 10 elements from small to large (Assume that this array is 1 2 3 4 5 6 7 8 9 10 just for being able to show steps)(Element that are at (i + 1)th position are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Pivot element position | i | j |
|---|---|---|---|---|---|
| **1** 2 3 4 5 6 7 8 9 10 | 1 | 0 | 9 | -1 | 0 |
| 1 **2** 3 4 5 6 7 8 9 10 | 2 | 0 | 9 | 0 | 1 |
| 1 2 **3** 4 5 6 7 8 9 10 | 3 | 0 | 9 | 1 | 2 |
| 1 2 3 **4** 5 6 7 8 9 10 | 4 | 0 | 9 | 2 | 3 |
| 1 2 3 4 **5** 6 7 8 9 10 | 5 | 0 | 9 | 3 | 4 |
| 1 2 3 4 5 **6** 7 8 9 10 | 6 | 0 | 9 | 4 | 5 |
| 1 2 3 4 5 6 **7** 8 9 10 | 7 | 0 | 9 | 5 | 6 |
| 1 2 3 4 5 6 7 **8** 9 10 | 8 | 0 | 9 | 6 | 7 |
| 1 2 3 4 5 6 7 8 **9** 10 | 9 | 0 | 9 | 7 | 8 |
| **1** 2 3 4 5 6 7 8 9 **10** | 10 | 0 | 8 | -1 | 0 |
| 1 **2** 3 4 5 6 7 8 9 **10** | 11 | 0 | 8 | 0 | 1 |
| 1 2 **3** 4 5 6 7 8 9 **10** | 12 | 0 | 8 | 1 | 2 |
| 1 2 3 **4** 5 6 7 8 9 **10** | 13 | 0 | 8 | 2 | 3 |
| 1 2 3 4 **5** 6 7 8 9 **10** | 14 | 0 | 8 | 3 | 4 |
| 1 2 3 4 5 **6** 7 8 9 **10** | 15 | 0 | 8 | 4 | 5 |
| 1 2 3 4 5 6 **7** 8 9 **10** | 16 | 0 | 8 | 5 | 6 |
| 1 2 3 4 5 6 7 **8** 9 **10** | 17 | 0 | 8 | 6 | 7 |
| **1** 2 3 4 5 6 7 8 **9 10** | 18 | 0 | 7 | -1 | 0 |
| 1 **2** 3 4 5 6 7 8 **9 10** | 19 | 0 | 7 | 0 | 1 |
| 1 2 **3** 4 5 6 7 8 **9 10** | 20 | 0 | 7 | 1 | 2 |
| 1 2 3 **4** 5 6 7 8 **9 10** | 21 | 0 | 7 | 2 | 3 |
| 1 2 3 4 **5** 6 7 8 **9 10** | 22 | 0 | 7 | 3 | 4 |
| 1 2 3 4 5 **6** 7 8 **9 10** | 23 | 0 | 7 | 4 | 5 |
| 1 2 3 4 5 6 **7** 8 **9 10** | 24 | 0 | 7 | 5 | 6 |
| **1** 2 3 4 5 6 7 **8 9 10** | 25 | 0 | 6 | -1 | 0 |
| 1 **2** 3 4 5 6 7 **8 9 10** | 26 | 0 | 6 | 0 | 1 |
| 1 2 **3** 4 5 6 7 **8 9 10** | 27 | 0 | 6 | 1 | 2 |
| 1 2 3 **4** 5 6 7 **8 9 10** | 28 | 0 | 6 | 2 | 3 |
| 1 2 3 4 **5** 6 7 **8 9 10** | 29 | 0 | 6 | 3 | 4 |
| 1 2 3 4 5 **6** 7 **8 9 10** | 30 | 0 | 6 | 4 | 5 |
| **1** 2 3 4 5 6 **7 8 9 10** | 31 | 0 | 5 | -1 | 0 |
| 1 **2** 3 4 5 6 **7 8 9 10** | 32 | 0 | 5 | 0 | 1 |
| 1 2 **3** 4 5 6 **7 8 9 10** | 33 | 0 | 5 | 1 | 2 |

| | | | | | |
|---|---|---|---|---|---|
| 1 2 3 **4** 5 6 **7 8 9 10** | 34 | 0 | 5 | 2 | 3 |
| 1 2 3 4 **5** 6 **7 8 9 10** | 35 | 0 | 5 | 3 | 4 |
| **1** 2 3 4 5 **6 7 8 9 10** | 36 | 0 | 4 | -1 | 0 |
| 1 **2** 3 4 5 **6 7 8 9 10** | 37 | 0 | 4 | 0 | 1 |
| 1 2 **3** 4 5 **6 7 8 9 10** | 38 | 0 | 4 | 1 | 2 |
| 1 2 3 **4** 5 **6 7 8 9 10** | 39 | 0 | 4 | 2 | 3 |
| **1** 2 3 4 **5 6 7 8 9 10** | 40 | 0 | 3 | -1 | 0 |
| 1 **2** 3 4 **5 6 7 8 9 10** | 41 | 0 | 3 | 0 | 1 |
| 1 2 **3** 4 **5 6 7 8 9 10** | 42 | 0 | 3 | 1 | 2 |
| **1** 2 3 **4 5 6 7 8 9 10** | 43 | 0 | 2 | -1 | 0 |
| 1 **2** 3 **4 5 6 7 8 9 10** | 44 | 0 | 2 | 0 | 1 |
| **1** 2 3 **4 5 6 7 8 9 10** | 45 | 0 | 1 | -1 | 0 |
| **1 2 3 4 5 6 7 8 9 10** | 46 | 0 | 0 | -1 | 0 |

B is an ordered integer array with 10 elements from large to small (Assume that this array is 10 9 8 7 6 5 4 3 2 1 just for being able to show steps)(Element that are at j th position are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Pivot element position | i | j |
|---|---|---|---|---|---|
| **10** 9 8 7 6 5 4 3 2 1 | 1 | 0 | 9 | -1 | 0 |
| 10 **9** 8 7 6 5 4 3 2 1 | 2 | 0 | 9 | -1 | 1 |
| 10 9 **8** 7 6 5 4 3 2 1 | 3 | 0 | 9 | -1 | 2 |
| 10 9 8 **7** 6 5 4 3 2 1 | 4 | 0 | 9 | -1 | 3 |
| 10 9 8 7 **6** 5 4 3 2 1 | 5 | 0 | 9 | -1 | 4 |
| 10 9 8 7 6 **5** 4 3 2 1 | 6 | 0 | 9 | -1 | 5 |
| 10 9 8 7 6 5 **4** 3 2 1 | 7 | 0 | 9 | -1 | 6 |
| 10 9 8 7 6 5 4 **3** 2 1 | 8 | 0 | 9 | -1 | 7 |
| **1 9** 8 7 6 5 4 3 2 10 | 9 | 1 | 8 | -1 | 0 |
| 1 9 **8** 7 6 5 4 3 2 10 | 10 | 1 | 8 | 0 | 1 |
| 1 9 8 **7** 6 5 4 3 2 10 | 11 | 1 | 8 | 1 | 2 |
| 1 9 8 7 **6** 5 4 3 2 10 | 12 | 1 | 8 | 2 | 3 |
| 1 9 8 7 6 **5** 4 3 2 10 | 13 | 1 | 8 | 3 | 4 |
| 1 9 8 7 6 5 **4** 3 2 10 | 14 | 1 | 8 | 4 | 5 |
| 1 9 8 7 6 5 4 **3** 2 10 | 15 | 1 | 8 | 5 | 6 |
| 1 9 8 7 6 5 4 3 **2** 10 | 16 | 1 | 8 | 6 | 7 |
| **1 2** 8 7 6 5 4 3 9 **10** | 17 | 2 | 7 | -1 | 0 |
| 1 2 **8** 7 6 5 4 3 9 **10** | 18 | 2 | 7 | 0 | 1 |
| 1 2 8 **7** 6 5 4 3 9 **10** | 19 | 2 | 7 | 1 | 2 |
| 1 2 8 7 **6** 5 4 3 9 **10** | 20 | 2 | 7 | 2 | 3 |
| 1 2 8 7 6 **5** 4 3 9 **10** | 21 | 2 | 7 | 3 | 4 |
| 1 2 8 7 6 5 **4** 3 9 **10** | 22 | 2 | 7 | 4 | 5 |
| 1 2 8 7 6 5 4 **3** 9 **10** | 23 | 2 | 7 | 5 | 6 |
| **1 2** 8 7 6 5 4 3 **9 10** | 24 | 2 | 6 | -1 | 0 |
| 1 2 **8** 7 6 5 4 3 **9 10** | 25 | 2 | 6 | 0 | 1 |
| 1 2 8 **7** 6 5 4 3 **9 10** | 26 | 2 | 6 | 0 | 2 |
| 1 2 8 7 **6** 5 4 3 **9 10** | 27 | 2 | 6 | 0 | 3 |
| 1 2 8 7 6 **5** 4 3 **9 10** | 28 | 2 | 6 | 0 | 4 |
| 1 2 8 7 6 5 **4** 3 **9 10** | 29 | 2 | 6 | 0 | 5 |
| **1 2 3** 7 6 5 4 8 **9 10** | 30 | 3 | 4 | -1 | 0 |
| 1 2 3 7 **6** 5 4 8 **9 10** | 31 | 3 | 4 | 0 | 1 |
| 1 2 3 7 6 **5** 4 8 **9 10** | 32 | 3 | 4 | 1 | 2 |
| 1 2 3 7 6 5 **4** 8 **9 10** | 33 | 3 | 4 | 2 | 3 |
| 1 2 3 **7** 6 5 4 **8 9 10** | 34 | 3 | 3 | -1 | 0 |
| 1 2 3 7 **6** 5 4 **8 9 10** | 35 | 3 | 3 | -1 | 1 |
| 1 2 3 7 6 **5** 4 **8 9 10** | 36 | 3 | 3 | -1 | 2 |
| **1 2 3 4 6** 5 7 **8 9 10** | 37 | 4 | 2 | -1 | 0 |

| | | | | | |
|---|---|---|---|---|---|
| 1 2 3 4 6 **5** 7 8 9 10 | 38 | 4 | 2 | 0 | 1 |
| 1 2 3 4 **6** 5 7 8 9 10 | 39 | 4 | 1 | -1 | 0 |
| 1 2 3 4 5 6 7 8 9 10 | 40 | 5 | 0 | -1 | 0 |

C = {5, 2, 13, 9, 1, 7, 6, 8, 1, 15, 4, 11} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Pivot element position | i | j |
|---|---|---|---|---|---|
| **5** 2 13 9 1 7 6 8 1 15 4 11 | 1 | 1 | 11 | -1 | 0 |
| 5 **2** 13 9 1 7 6 8 1 15 4 11 | 2 | 2 | 11 | 0 | 1 |
| 5 2 **13** 9 1 7 6 8 1 15 4 11 | 3 | 2 | 11 | 1 | 2 |
| 5 2 13 **9** 1 7 6 8 1 15 4 11 | 4 | 3 | 11 | 1 | 3 |
| 5 2 9 13 **1** 7 6 8 1 15 4 11 | 5 | 4 | 11 | 2 | 4 |
| 5 2 9 1 13 **7** 6 8 1 15 4 11 | 6 | 5 | 11 | 3 | 5 |
| 5 2 9 1 7 13 **6** 8 1 15 4 11 | 7 | 6 | 11 | 4 | 6 |
| 5 2 9 1 7 6 13 **8** 1 15 4 11 | 8 | 7 | 11 | 5 | 7 |
| 5 2 9 1 7 6 8 13 **1** 15 4 11 | 9 | 8 | 11 | 6 | 8 |
| 5 2 9 1 7 6 8 1 13 **15** 4 11 | 10 | 8 | 11 | 7 | 9 |
| 5 2 9 1 7 6 8 1 13 15 **4** 11 | 11 | 9 | 11 | 7 | 10 |
| 5 2 9 1 7 6 8 1 4 15 13 **11** | 11 | 10 | 11 | 8 | 11 |
| **5** 2 9 1 7 6 8 1 4 11 13 15 | 12 | 10 | 8 | -1 | 0 |
| 5 **2** 9 1 7 6 8 1 4 11 13 15 | 13 | 11 | 8 | -1 | 1 |
| 2 5 **9** 1 7 6 8 1 4 11 13 15 | 14 | 11 | 8 | 0 | 2 |
| 2 5 9 **1** 7 6 8 1 4 11 13 15 | 15 | 12 | 8 | 0 | 3 |
| 2 1 9 5 **7** 6 8 1 4 11 13 15 | 16 | 12 | 8 | 1 | 4 |
| 2 1 9 5 7 **6** 8 1 4 11 13 15 | 17 | 12 | 8 | 1 | 5 |
| 2 1 9 5 7 6 **8** 1 4 11 13 15 | 18 | 12 | 8 | 1 | 6 |
| 2 1 9 5 7 6 8 **1** 4 11 13 15 | 19 | 13 | 8 | 1 | 7 |
| 2 1 1 5 7 6 8 9 **4** 11 13 15 | 19 | 14 | 8 | 2 | 8 |
| **2** 1 1 4 7 6 8 9 5 11 13 15 | 20 | 14 | 2 | -1 | 0 |
| 2 **1** 1 4 7 6 8 9 5 11 13 15 | 21 | 14 | 2 | -1 | 1 |
| 1 1 2 4 **7** 6 8 9 5 11 13 15 | 22 | 14 | 1 | -1 | 0 |
| 1 1 2 4 7 **6** 8 9 5 11 13 15 | 23 | 14 | 4 | -1 | 0 |
| 1 1 2 4 7 6 **8** 9 5 11 13 15 | 24 | 14 | 4 | -1 | 1 |
| 1 1 2 4 7 6 8 **9** 5 11 13 15 | 25 | 14 | 4 | -1 | 2 |
| 1 1 2 4 7 6 8 9 **5** 11 13 15 | 26 | 14 | 4 | -1 | 3 |
| 1 1 2 4 5 **6** 8 9 7 11 13 15 | 27 | 15 | 3 | -1 | 0 |
| 1 1 2 4 5 6 **8** 9 7 11 13 15 | 28 | 16 | 3 | 0 | 1 |
| 1 1 2 4 5 6 8 **9** 7 11 13 15 | 29 | 16 | 3 | 0 | 2 |
| 1 1 2 4 5 **6** 7 9 8 11 13 15 | 29 | 17 | 0 | 0 | 3 |
| 1 1 2 4 5 6 7 **9** 8 11 13 15 | 30 | 17 | 1 | -1 | 0 |
| 1 1 2 4 5 6 7 8 9 11 **13** 15 | 31 | 18 | 1 | -1 | 1 |
| 1 1 2 4 5 6 7 8 9 11 13 15 | 32 | 18 | 1 | -1 | 0 |
| 1 1 2 4 5 6 7 8 9 11 13 15 | | | | | |

D = {'S', 'B', 'I', 'M', 'H', 'Q', 'C', 'L', 'R', 'E', 'P', 'K'} (Element that will be compared are shown as bold)

| Steps | Number of Comparison | Number of Displacement | Pivot element position | i | j |
|---|---|---|---|---|---|
| **S** B I M H Q C L R E P K | 1 | 0 | 11 | -1 | 0 |
| S **B** I M H Q C L R E P K | 2 | 1 | 11 | -1 | 1 |
| B S **I** M H Q C L R E P K | 3 | 2 | 11 | 0 | 2 |
| B I S **M** H Q C L R E P K | 4 | 2 | 11 | 1 | 3 |
| B I S M **H** Q C L R E P K | 5 | 3 | 11 | 1 | 4 |
| B I H M S **Q** C L R E P K | 6 | 3 | 11 | 2 | 5 |
| B I H M S Q **C** L R E P K | 7 | 4 | 11 | 2 | 6 |
| B I H C S Q M **L** R E P K | 8 | 4 | 11 | 3 | 7 |
| B I H C S Q M L **R** E P K | 9 | 4 | 11 | 3 | 8 |

| | | | | | |
|---|---|---|---|---|---|
| B I H C S Q M L R **E** P K | 10 | 5 | 11 | 3 | 9 |
| B I H C E K M L R S **P** Q | 11 | 5 | 11 | 4 | 10 |
| **B** I H C E **K** M L R S P Q | 12 | 5 | 4 | -1 | 0 |
| B **I** H C E **K** M L R S P Q | 13 | 5 | 4 | 0 | 1 |
| B I **H** C E **K** M L R S P Q | 14 | 6 | 4 | 0 | 2 |
| B H I **C** E **K** M L R S P Q | 15 | 6 | 4 | 1 | 3 |
| B H C I E **K** M L R S P Q | 15 | 7 | 4 | 2 | 4 |
| **B** H C **E** I **K** M L R S P Q | 16 | 7 | 2 | -1 | 0 |
| B **H** C **E** I **K** M L R S P Q | 17 | 7 | 2 | 0 | 1 |
| B **C** H **E** I **K** M L R S P Q | 17 | 7 | 0 | -1 | 0 |
| **B C** H **E** I **K** M L R S P Q | 17 | 7 | 0 | -1 | 0 |
| **B C H E** I **K** M L R S P Q | 17 | 7 | 0 | -1 | 0 |
| **B C H E I K M** L R S P Q | 18 | 7 | 5 | -1 | 0 |
| **B C H E I K** M **L** R S P Q | 19 | 7 | 5 | 0 | 1 |
| **B C H E I K** M L **R** S P Q | 20 | 7 | 5 | 1 | 2 |
| **B C H E I K** M L R **S** P Q | 21 | 7 | 5 | 1 | 3 |
| **B C H E I K** M L R S **P** Q | 22 | 7 | 5 | 1 | 4 |
| **B C H E I K** M L P Q R S | 22 | 8 | 5 | 2 | 5 |
| **B C H E I K M** L P **Q** R S | 23 | 8 | 2 | -1 | 0 |
| **B C H E I K** M **L** P **Q** R S | 24 | 8 | 2 | 0 | 1 |
| **B C H E I K M** L **P Q** R S | 25 | 8 | 1 | -1 | 0 |
| **B C H E I K** M L **P Q** R S | 25 | 9 | 1 | -1 | 1 |
| **B C H E I K L M P Q** R S | 25 | 9 | 0 | -1 | 0 |
| **B C H E I K L M P Q** R S | 26 | 9 | 1 | -1 | 0 |
| **B C H E I K L M P Q** R S | 26 | 9 | 1 | 0 | 1 |
| **B C H E I K L M P Q** R **S** | 26 | 9 | 0 | -1 | 0 |
| **B C H E I K L M P Q R S** | | | | | |
| | | | | | |
| | | | | | |
| | | | | | |