**Bharatiya Vidya Bhavan's**

# Sardar Patel Institute of Technology

Bhavan's Campus, Munshi Nagar, Andheri (West), Mumbai-400058-India

(Autonomous College Affiliated to University of Mumbai)

| | |
|---|---|
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| **Class** | COMPS A (B batch) |
| **Experiment No.** | 01 A |

**Aim:** To implement the various functions e.g., linear, non-linear, quadratic, exponential etc.

## Algorithm:

**1)** $f(n) = n$

Algorithm:
F(n): Return n

***2)*** $f(n) = log(n)$

Algorithm:
F(n): Return log2(n)

***3)*** $f(n) = log\ (log\ n)$

Algorithm:
F(n) : Return log2(log2(n))

***4)*** *f(n) = n log n*

Algorithm:
F(n) :
if n = 0
    Error
else return n * log2(n)

***5)*** $f(n) = (\log n)^{\log(n)}$

Algorithm:
F(n):
If n = 0 Error Else Return pow(log (n), log (n))

***6)*** $f(n) = \sqrt{log2(n)}$

Algorithm:
F(n): If n = 0 Error else Return sqrt(log2(n))

***7)*** $f(n) = 2^{\log(n)}$

Algorithm:
F(n): If n = 0 Error else Return pow(2, log2(n))

***8)*** *f(n) = (log n)!*

LogFactorial(n):
    If n <= 0
        Error // as log of 0 does not exist
Else

fact = 1
for i from 1 to ceil(log n) do
    fact = fact * i
Return fact

***9)*** $f(n) = (\sqrt{2})^{\log n}$

Algorithm:
F(n): If n = 0 Error else Return pow(sqrt(2), log n)

***10)*** $f(n) = n^3$

Algorithm:
F(n): Return n * n * n

Code:

```c
#include <math.h>
#include <stdio.h>

int fn_01(int n) {
    return n;
}

double fn_02(int n) {
    if (n <= 0) return -1.0;
    return log2(n);
}

double fn_03(int n) {
    if (n <= 0) return -1.0;
    if (log2(n) == 0) return -1.0;
    return log2(log2(n));
}

double fn_04(int n) {
    if (n <= 0) return -1.0;
    return n * log2(n);
}
```

```c
double fn_05(int n) {
    if (n <= 0) return -1.0;
    return pow(log2(n), log2(n));
}

double fn_06(int n) {
    if (n <= 0) return -1.0;
    return sqrt(log2(n));
}

double fn_07(int n) {
    if (n <= 0) return -1.0;
    return pow(2, log2(n));
}

// (lg n)!
double fn_08(int n) {
    if (n <= 0) return -1.0;
    double fact = 1;
    for (int i = 1; i <= ceil(log2(n)); i++) {
        fact *= i;
    }
    return fact;
}

double fn_09(int n) {
    if (n <= 0) return -1.0;

    return pow(sqrt(2), log2(n));
}

double fn_10(int n) {
    return n * n * n;
}

double fact(int n) {
    if (n == 0) return 1;
    double f = 1.0;
    for (int i = 1; i <= n; i++) {
        f = f * i;
    }
    return f;
}

int main() {
    FILE *fptr;
    // fptr = fopen("D://Tejas//College//sem4//daa//data.csv", "w");
    fptr = fopen("../csv/functions.csv", "w");
```

```
    fprintf(fptr, "i,n,lg n,lg(lg n),n*lg n,(lg n)^(lg n),sqrt(lg n),2^lg n,(lg
n)!,sqrt(2)^lg n,n^3,n!\n");
    printf("\n  i |   n   lg n  lg(lg n)  n*lg n  (lg n)^(lg n)  sqrt(lg n)
 2^lg n  (lg n)!  sqrt(2)^lg n   n^3\n\n");

    for (int i = 0; i <= 100; i++) {
        printf("%3d | %3d  %5.2f  %8.2f  %8.2f  %10.2f  %10.2f  %6.0f  %7.0f
 %8.2f  %10.0f\n", i, fn_01(i), fn_02(i), fn_03(i), fn_04(i), fn_05(i),
fn_06(i), fn_07(i), fn_08(i), fn_09(i), fn_10(i));

        fprintf(fptr, "%d,%d,%f,%f,%f,%f,%f,%.0f,%.0f,%f,%.0f", i, fn_01(i),
fn_02(i), fn_03(i), fn_04(i), fn_05(i), fn_06(i), fn_07(i), fn_08(i), fn_09(i),
fn_10(i));

        if (i <= 20) {
            fprintf(fptr, ",%0.f\n", fact(i));
        } else {
            fprintf(fptr, ",-\n");
        }
    }
    fclose(fptr);
    printf("\n\nFactorials: \n");
    for (int i = 0; i <= 20; i++) {
        printf("%2d! = %.0f\n", i, fact(i));
    }
    return 0;
}
```

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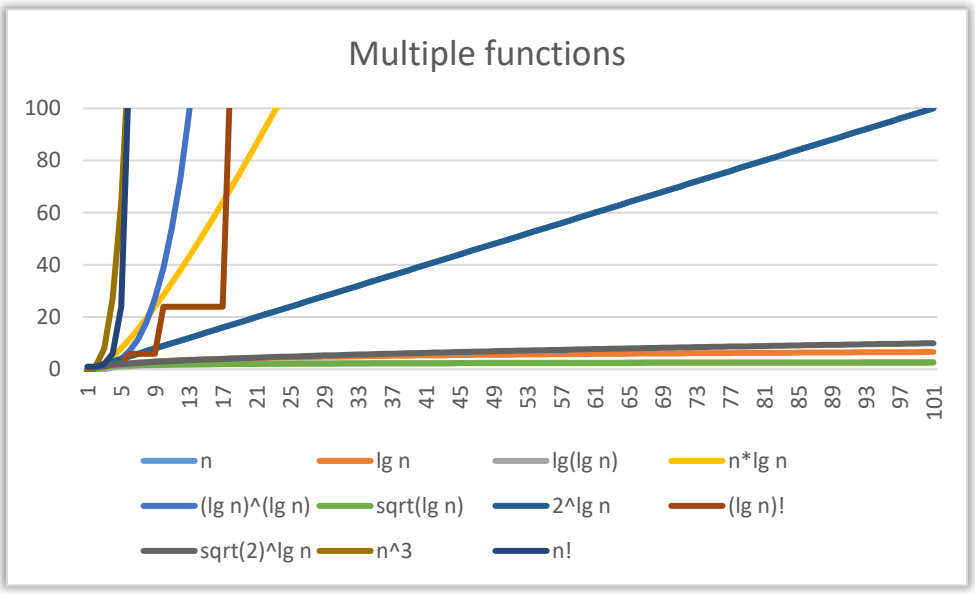
## Output:

| i | n | lg n | lg(lg n) | n*lg n | (lg n)^(lg n) | sqrt(lg n) | 2^lg n | (lg n)! | sqrt(2)^lg n | n^3 |
|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 0 | -1.00 | -1.00 | -1.00 | -1.00 | -1.00 | -1 | -1 | -1.00 | 0 |
| 1 | 1 | 0.00 | -1.00 | 0.00 | 1.00 | 0.00 | 1 | 1 | 1.00 | 1 |
| 2 | 2 | 1.00 | 0.00 | 2.00 | 1.00 | 1.00 | 2 | 1 | 1.41 | 8 |
| 3 | 3 | 1.58 | 0.66 | 4.75 | 2.08 | 1.26 | 3 | 2 | 1.73 | 27 |
| 4 | 4 | 2.00 | 1.00 | 8.00 | 4.00 | 1.41 | 4 | 2 | 2.00 | 64 |
| 5 | 5 | 2.32 | 1.22 | 11.61 | 7.07 | 1.52 | 5 | 6 | 2.24 | 125 |
| 6 | 6 | 2.58 | 1.37 | 15.51 | 11.65 | 1.61 | 6 | 6 | 2.45 | 216 |
| 7 | 7 | 2.81 | 1.49 | 19.65 | 18.14 | 1.68 | 7 | 6 | 2.65 | 343 |
| 8 | 8 | 3.00 | 1.58 | 24.00 | 27.00 | 1.73 | 8 | 6 | 2.83 | 512 |
| 9 | 9 | 3.17 | 1.66 | 28.53 | 38.75 | 1.78 | 9 | 24 | 3.00 | 729 |
| 10 | 10 | 3.32 | 1.73 | 33.22 | 53.95 | 1.82 | 10 | 24 | 3.16 | 1000 |
| 11 | 11 | 3.46 | 1.79 | 38.05 | 73.22 | 1.86 | 11 | 24 | 3.32 | 1331 |
| 12 | 12 | 3.58 | 1.84 | 43.02 | 97.23 | 1.89 | 12 | 24 | 3.46 | 1728 |
| 13 | 13 | 3.70 | 1.89 | 48.11 | 126.70 | 1.92 | 13 | 24 | 3.61 | 2197 |
| 14 | 14 | 3.81 | 1.93 | 53.30 | 162.42 | 1.95 | 14 | 24 | 3.74 | 2744 |
| 15 | 15 | 3.91 | 1.97 | 58.60 | 205.22 | 1.98 | 15 | 24 | 3.87 | 3375 |
| 16 | 16 | 4.00 | 2.00 | 64.00 | 256.00 | 2.00 | 16 | 24 | 4.00 | 4096 |
| 17 | 17 | 4.09 | 2.03 | 69.49 | 315.71 | 2.02 | 17 | 120 | 4.12 | 4913 |
| 18 | 18 | 4.17 | 2.06 | 75.06 | 385.38 | 2.04 | 18 | 120 | 4.24 | 5832 |
| 19 | 19 | 4.25 | 2.09 | 80.71 | 466.07 | 2.06 | 19 | 120 | 4.36 | 6859 |
| 20 | 20 | 4.32 | 2.11 | 86.44 | 558.92 | 2.08 | 20 | 120 | 4.47 | 8000 |
| 21 | 21 | 4.39 | 2.13 | 92.24 | 665.14 | 2.10 | 21 | 120 | 4.58 | 9261 |
| 22 | 22 | 4.46 | 2.16 | 98.11 | 785.99 | 2.11 | 22 | 120 | 4.69 | 10648 |
| 23 | 23 | 4.52 | 2.18 | 104.04 | 922.80 | 2.13 | 23 | 120 | 4.80 | 12167 |
| 24 | 24 | 4.58 | 2.20 | 110.04 | 1076.96 | 2.14 | 24 | 120 | 4.90 | 13824 |
| 25 | 25 | 4.64 | 2.22 | 116.10 | 1249.94 | 2.15 | 25 | 120 | 5.00 | 15625 |
| 26 | 26 | 4.70 | 2.23 | 122.21 | 1443.27 | 2.17 | 26 | 120 | 5.10 | 17576 |
| 27 | 27 | 4.75 | 2.25 | 128.38 | 1658.54 | 2.18 | 27 | 120 | 5.20 | 19683 |
| 28 | 28 | 4.81 | 2.27 | 134.61 | 1897.43 | 2.19 | 28 | 120 | 5.29 | 21952 |
| 29 | 29 | 4.86 | 2.28 | 140.88 | 2161.67 | 2.20 | 29 | 120 | 5.39 | 24389 |
| 30 | 30 | 4.91 | 2.29 | 147.21 | 2453.08 | 2.22 | 30 | 120 | 5.48 | 27000 |
| 31 | 31 | 4.95 | 2.31 | 153.58 | 2773.54 | 2.23 | 31 | 120 | 5.57 | 29791 |
| 32 | 32 | 5.00 | 2.32 | 160.00 | 3125.00 | 2.24 | 32 | 120 | 5.66 | 32768 |
| 33 | 33 | 5.04 | 2.33 | 166.47 | 3509.50 | 2.25 | 33 | 720 | 5.74 | 35937 |
| 34 | 34 | 5.09 | 2.35 | 172.97 | 3929.15 | 2.26 | 34 | 720 | 5.83 | 39304 |
| 35 | 35 | 5.13 | 2.36 | 179.52 | 4386.13 | 2.26 | 35 | 720 | 5.92 | 42875 |
| 36 | 36 | 5.17 | 2.37 | 186.12 | 4882.70 | 2.27 | 36 | 720 | 6.00 | 46656 |
| 37 | 37 | 5.21 | 2.38 | 192.75 | 5421.20 | 2.28 | 37 | 720 | 6.08 | 50653 |
| 38 | 38 | 5.25 | 2.39 | 199.42 | 6004.04 | 2.29 | 38 | 720 | 6.16 | 54872 |
| 39 | 39 | 5.29 | 2.40 | 206.13 | 6633.74 | 2.30 | 39 | 720 | 6.24 | 59319 |
| 40 | 40 | 5.32 | 2.41 | 212.88 | 7312.86 | 2.31 | 40 | 720 | 6.32 | 64000 |
| 41 | 41 | 5.36 | 2.42 | 219.66 | 8044.06 | 2.31 | 41 | 720 | 6.40 | 68921 |
| 42 | 42 | 5.39 | 2.43 | 226.48 | 8830.10 | 2.32 | 42 | 720 | 6.48 | 74088 |
| 43 | 43 | 5.43 | 2.44 | 233.33 | 9673.79 | 2.33 | 43 | 720 | 6.56 | 79507 |
| 44 | 44 | 5.46 | 2.45 | 240.21 | 10578.06 | 2.34 | 44 | 720 | 6.63 | 85184 |
| 45 | 45 | 5.49 | 2.46 | 247.13 | 11545.89 | 2.34 | 45 | 720 | 6.71 | 91125 |
| 46 | 46 | 5.52 | 2.47 | 254.08 | 12580.38 | 2.35 | 46 | 720 | 6.78 | 97336 |
| 47 | 47 | 5.55 | 2.47 | 261.07 | 13684.70 | 2.36 | 47 | 720 | 6.86 | 103823 |
| 48 | 48 | 5.58 | 2.48 | 268.08 | 14862.10 | 2.36 | 48 | 720 | 6.93 | 110592 |
| 49 | 49 | 5.61 | 2.49 | 275.12 | 16115.93 | 2.37 | 49 | 720 | 7.00 | 117649 |
| 50 | 50 | 5.64 | 2.50 | 282.19 | 17449.64 | 2.38 | 50 | 720 | 7.07 | 125000 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| 51 | 51 | 5.67 | 2.50 | 289.29 | 18866.75 | 2.38 | 51 | 720 | 7.14 | 132651 |
| 52 | 52 | 5.70 | 2.51 | 296.42 | 20370.89 | 2.39 | 52 | 720 | 7.21 | 140608 |
| 53 | 53 | 5.73 | 2.52 | 303.58 | 21965.77 | 2.39 | 53 | 720 | 7.28 | 148877 |
| 54 | 54 | 5.75 | 2.52 | 310.76 | 23655.19 | 2.40 | 54 | 720 | 7.35 | 157464 |
| 55 | 55 | 5.78 | 2.53 | 317.97 | 25443.07 | 2.40 | 55 | 720 | 7.42 | 166375 |
| 56 | 56 | 5.81 | 2.54 | 325.21 | 27333.39 | 2.41 | 56 | 720 | 7.48 | 175616 |
| 57 | 57 | 5.83 | 2.54 | 332.47 | 29330.26 | 2.42 | 57 | 720 | 7.55 | 185193 |
| 58 | 58 | 5.86 | 2.55 | 339.76 | 31437.86 | 2.42 | 58 | 720 | 7.62 | 195112 |
| 59 | 59 | 5.88 | 2.56 | 347.08 | 33660.48 | 2.43 | 59 | 720 | 7.68 | 205379 |
| 60 | 60 | 5.91 | 2.56 | 354.41 | 36002.51 | 2.43 | 60 | 720 | 7.75 | 216000 |
| 61 | 61 | 5.93 | 2.57 | 361.77 | 38468.44 | 2.44 | 61 | 720 | 7.81 | 226981 |
| 62 | 62 | 5.95 | 2.57 | 369.16 | 41062.85 | 2.44 | 62 | 720 | 7.87 | 238328 |
| 63 | 63 | 5.98 | 2.58 | 376.57 | 43790.44 | 2.44 | 63 | 720 | 7.94 | 250047 |
| 64 | 64 | 6.00 | 2.58 | 384.00 | 46656.00 | 2.45 | 64 | 720 | 8.00 | 262144 |
| 65 | 65 | 6.02 | 2.59 | 391.45 | 49664.42 | 2.45 | 65 | 5040 | 8.06 | 274625 |
| 66 | 66 | 6.04 | 2.60 | 398.93 | 52820.70 | 2.46 | 66 | 5040 | 8.12 | 287496 |
| 67 | 67 | 6.07 | 2.60 | 406.43 | 56129.94 | 2.46 | 67 | 5040 | 8.19 | 300763 |
| 68 | 68 | 6.09 | 2.61 | 413.95 | 59597.35 | 2.47 | 68 | 5040 | 8.25 | 314432 |
| 69 | 69 | 6.11 | 2.61 | 421.49 | 63228.26 | 2.47 | 69 | 5040 | 8.31 | 328509 |
| 70 | 70 | 6.13 | 2.62 | 429.05 | 67028.08 | 2.48 | 70 | 5040 | 8.37 | 343000 |
| 71 | 71 | 6.15 | 2.62 | 436.63 | 71002.34 | 2.48 | 71 | 5040 | 8.43 | 357911 |
| 72 | 72 | 6.17 | 2.63 | 444.23 | 75156.69 | 2.48 | 72 | 5040 | 8.49 | 373248 |
| 73 | 73 | 6.19 | 2.63 | 451.86 | 79496.87 | 2.49 | 73 | 5040 | 8.54 | 389017 |
| 74 | 74 | 6.21 | 2.63 | 459.50 | 84028.75 | 2.49 | 74 | 5040 | 8.60 | 405224 |
| 75 | 75 | 6.23 | 2.64 | 467.16 | 88758.31 | 2.50 | 75 | 5040 | 8.66 | 421875 |
| 76 | 76 | 6.25 | 2.64 | 474.84 | 93691.62 | 2.50 | 76 | 5040 | 8.72 | 438976 |
| 77 | 77 | 6.27 | 2.65 | 482.54 | 98834.89 | 2.50 | 77 | 5040 | 8.77 | 456533 |
| 78 | 78 | 6.29 | 2.65 | 490.26 | 104194.42 | 2.51 | 78 | 5040 | 8.83 | 474552 |
| 79 | 79 | 6.30 | 2.66 | 498.00 | 109776.66 | 2.51 | 79 | 5040 | 8.89 | 493039 |
| 80 | 80 | 6.32 | 2.66 | 505.75 | 115588.14 | 2.51 | 80 | 5040 | 8.94 | 512000 |
| 81 | 81 | 6.34 | 2.66 | 513.53 | 121635.53 | 2.52 | 81 | 5040 | 9.00 | 531441 |
| 82 | 82 | 6.36 | 2.67 | 521.32 | 127925.60 | 2.52 | 82 | 5040 | 9.06 | 551368 |
| 83 | 83 | 6.38 | 2.67 | 529.13 | 134465.25 | 2.52 | 83 | 5040 | 9.11 | 571787 |
| 84 | 84 | 6.39 | 2.68 | 536.95 | 141261.49 | 2.53 | 84 | 5040 | 9.17 | 592704 |
| 85 | 85 | 6.41 | 2.68 | 544.80 | 148321.48 | 2.53 | 85 | 5040 | 9.22 | 614125 |
| 86 | 86 | 6.43 | 2.68 | 552.66 | 155652.45 | 2.54 | 86 | 5040 | 9.27 | 636056 |
| 87 | 87 | 6.44 | 2.69 | 560.54 | 163261.80 | 2.54 | 87 | 5040 | 9.33 | 658503 |
| 88 | 88 | 6.46 | 2.69 | 568.43 | 171157.02 | 2.54 | 88 | 5040 | 9.38 | 681472 |
| 89 | 89 | 6.48 | 2.70 | 576.34 | 179345.74 | 2.54 | 89 | 5040 | 9.43 | 704969 |
| 90 | 90 | 6.49 | 2.70 | 584.27 | 187835.71 | 2.55 | 90 | 5040 | 9.49 | 729000 |
| 91 | 91 | 6.51 | 2.70 | 592.21 | 196634.80 | 2.55 | 91 | 5040 | 9.54 | 753571 |
| 92 | 92 | 6.52 | 2.71 | 600.17 | 205751.02 | 2.55 | 92 | 5040 | 9.59 | 778688 |
| 93 | 93 | 6.54 | 2.71 | 608.14 | 215192.49 | 2.56 | 93 | 5040 | 9.64 | 804357 |
| 94 | 94 | 6.55 | 2.71 | 616.13 | 224967.48 | 2.56 | 94 | 5040 | 9.70 | 830584 |
| 95 | 95 | 6.57 | 2.72 | 624.14 | 235084.35 | 2.56 | 95 | 5040 | 9.75 | 857375 |
| 96 | 96 | 6.58 | 2.72 | 632.16 | 245551.63 | 2.57 | 96 | 5040 | 9.80 | 884736 |
| 97 | 97 | 6.60 | 2.72 | 640.19 | 256377.96 | 2.57 | 97 | 5040 | 9.85 | 912673 |
| 98 | 98 | 6.61 | 2.73 | 648.24 | 267572.12 | 2.57 | 98 | 5040 | 9.90 | 941192 |
| 99 | 99 | 6.63 | 2.73 | 656.31 | 279143.00 | 2.57 | 99 | 5040 | 9.95 | 970299 |
| 100 | 100 | 6.64 | 2.73 | 664.39 | 291099.66 | 2.58 | 100 | 5040 | 10.00 | 1000000 |

```
Factorials:
 0! = 1
 1! = 1
 2! = 2
 3! = 6
 4! = 24
 5! = 120
 6! = 720
 7! = 5040
 8! = 40320
 9! = 362880
10! = 3628800
11! = 39916800
12! = 479001600
13! = 6227020800
14! = 87178291200
15! = 1307674368000
16! = 20922789888000
17! = 355687428096000
18! = 6402373705728000
19! = 121645100408832000
20! = 2432902008176640000
```

**Chart:**



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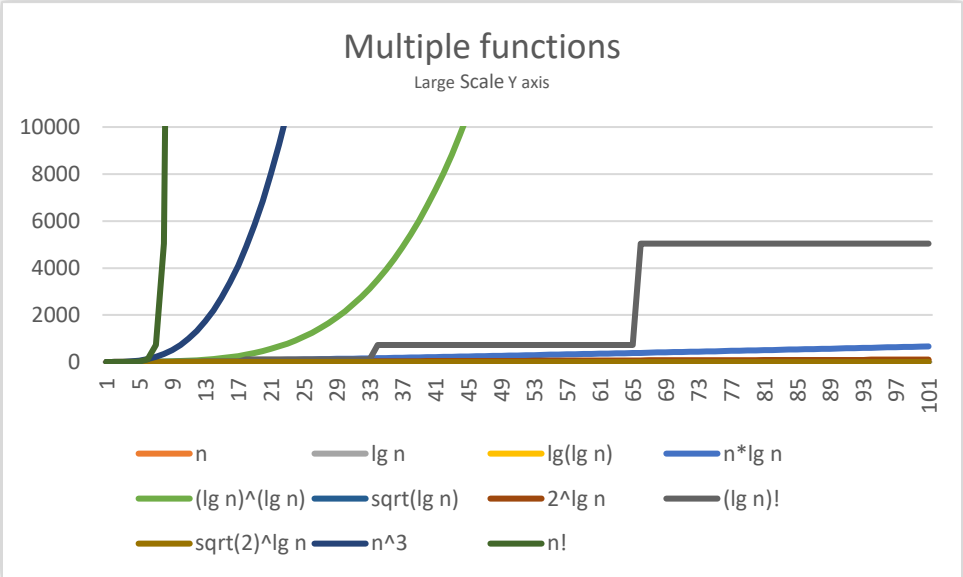


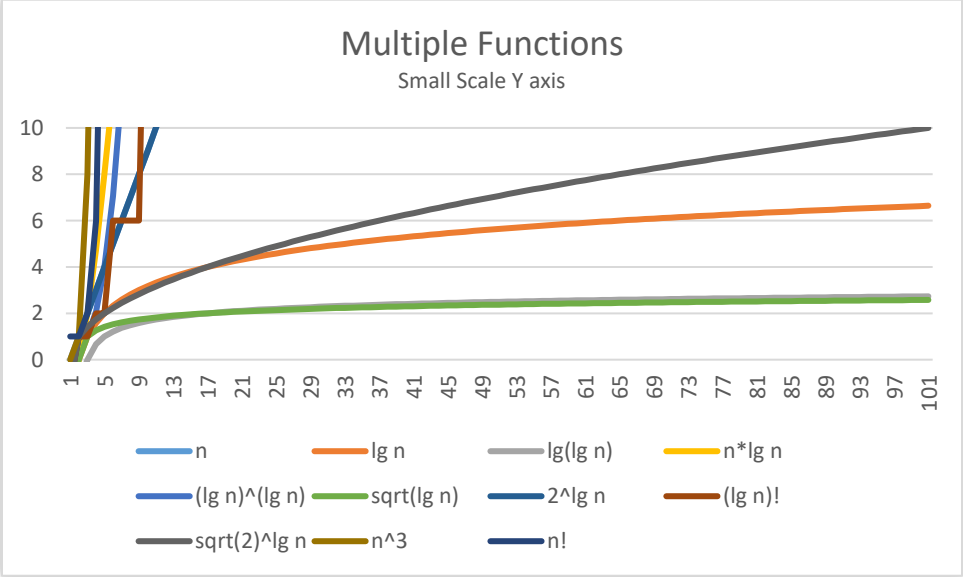

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## Observations:

| Sr | Function *f(n)* | Observation |
|---|---|---|
| 1 | *n* | 1) Linear graph<br>2) Value increases equally with the input *n*<br>3) Slope of the graph is 1<br>4) Steady increase in value |
| 2 | $log(n)$ | 1) Logarithmic graph<br>2) Value increases but slowly<br>3) Slope of graph is $\frac{1}{x \log(2)}$ meaning, for greater value of n the slope becomes smaller and smaller<br>4) The function is undefined for 0 |
| 3 | *log (log n)* | 1) Logarithmic graph<br>2) Value increases even slower compared to *log n*<br>3) Slope is $\frac{1}{x^2 (log\ n)^2}$ meaning, for greater values of n, the slope even smaller compared to *log n*.<br>4) The function is undefined for n=0 and n=1 |
| 4 | *n log n* | 1) Not exactly linear but not exponential<br>2) Value keeps on increasing faster compared to *n*<br>3) Slope is *log n* + 1, implying that it keeps on increasing<br>4) Undefined at n = 0 |
| 5 | $(log\ n)^{log(n)}$ | 1) Exponential graph<br>2) Initially, the rate of increase is low as compared to *n log n*, but eventually, it becomes larger and the function completely explodes<br>3) The slope keeps on increasing<br>4) Undefined at n = 0 |
| 6 | $\sqrt{\log(n)}$ | 1) Logarithmic graph<br>2) As slow as *log (log n)*<br>3) Slope becomes smaller and smaller with increasing values of n<br>4) Undefined at n = 0 |

| | | |
|---|---|---|
| 7 | $2^{log(n)}$ | 1) From the property of logarithms, $2^{\log(n)} = n$<br>2) Hence this function is essentially the same as $f(n) = n$<br>3) Therefore, we see a linear graph with slope 1<br>4) Completely coincides with $f(n) = n$ |
| 8 | $(log\ n)!$ | 1) Factorial can only be taken of whole numbers, hence only the ceil of log n is considered<br>2) We get the same ceil value for a range of log n values. Therefore, we observe a step like behavior in graph<br>3) The slope is 0 for sometime, then suddenly when ceil(log n) jumps to its next value, the slope becomes infinite and graph jumps on the next level |
| 9 | $(\sqrt{2})^{log\ n}$ | 1) Its growth is slightly greater than log n<br>2) Grows really slowly for an exponential function<br>3) Slope slowly keeps on increasing<br>4) Not defined on n = 0 |
| 10 | $n^3$ | 1) Cubic graph<br>2) Grows extremely fast<br>3) Slope is $3n^2$ |
| 11 | $n!$ | 1) Grows the fastest among the above 10 functions<br>2) Goes out of bounds immediately<br>3) Slope grows extremely fast |

**Conclusion:**

Through this experiment, I have understood how different functions grow with growing input. I have observed their graph and comparatively studied it. I have understood how the composition of function affects the overall output and how functions compare to each other.