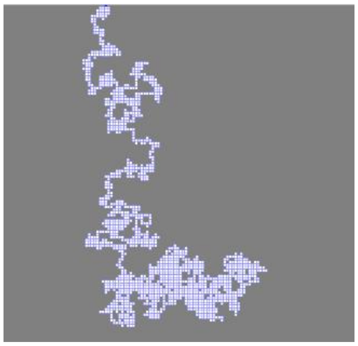
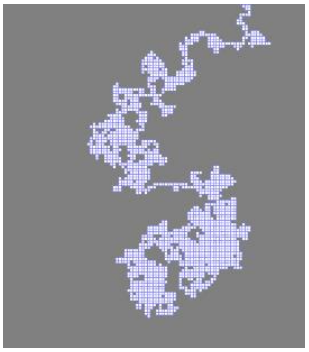
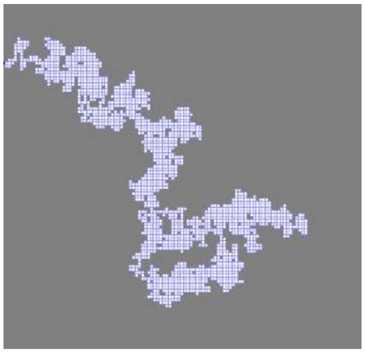
1. Use and adapt the code PowersOfTwo.java, to print the first 50 powers of 2^N. Include your code as well as the output result.

```
public class PowersOfTwo {
    public static void main(String[] args) {

               Scanner in = new Scanner(System.in);
               System.out.print("Number of powers of 2^N : ");

               String powers = in.next();
               in.close();

        // read in one command-line argument
        int N = Integer.parseInt(powers);
        int i = 0;                // count from 0 to N
        int powerOfTwo = 1;       // the ith power of two

        // repeat until i equals N
        while (i <= N) {
            System.out.println(i + " " + powerOfTwo);   // print out the power of two
            powerOfTwo = 2 * powerOfTwo;                // double to get the next one
            i = i + 1;
        }

    }
}
```

25. Use the code for RandomWalk.java to create 3 pictures that you like, using the number 100 as argument. To compile, you are required to previously compile StdDraw.java. You will produce 3 plots to be copied into your Activity log document.







26. Use the code Factors.java that prints the prime factors of a number. Follow the examples in the code headings comments and you are required to measure the computation time for the next 6 cases: 3, 6, 9, 12, 15, and 18 digit primes

- java Factors 997
- java Factors 999983
- java Factors 999999937
- java Factors 999999999989
- java Factors 999999999999989

- java Factors 999999999999999989

You are free to modify the source code to include a timing function. Here is an example you can review at stackoverflow.com. Include source code and output in your working document.

```
public class Factors {

    public static void main(String[] args) {
              Scanner in = new Scanner(System.in);
              System.out.print("Number of Factors : ");

              String factors = in.next();
              in.close();
        long n = Long.parseLong(factors);

        System.out.print("The prime factorization of " + n + " is: ");
        long startTime = System.currentTimeMillis();

        // for each potential factor i
        for (long i = 2; i*i <= n; i++) {

            // if i is a factor of N, repeatedly divide it out
            while (n % i == 0) {
                System.out.print(i + " ");
                n = n / i;
            }
        }

        // if biggest factor occurs only once, n > 1
        if (n > 1) System.out.println(n);
        else       System.out.println();

        long stopTime = System.currentTimeMillis();
        System.out.println("Total Execution Time: "+(stopTime - startTime) +" miliseconds");
    }
}
```

4. Use the program FunctionGrowth.java that prints a table of the values of *log N*, *N*, *N log N*, N^2, N^3, and 2^N for *N* = 16, 32, 64, ..., 2048. What are the limits of this code? Suppose we want to stop not at N=2048. but at N=1073741824. Modify your code to do this. Add the modified code to your document and include generated output.

```
    public class FunctionGrowth {

public static void main(String[] args) {
       Scanner in = new Scanner(System.in);
       System.out.print("log N limit number : ");

       String logN = in.next();
       in.close();
    long n = Long.parseLong(logN);

   System.out.println("log N \tN \tN log N\tN^2 \tN^3");
   for (long i = 2; i <= n; i *= 2) {
      System.out.print((int) Math.log(i));
      System.out.print('\t');             // tab character
```

```
            System.out.print(i);
            System.out.print('\t');
            System.out.print((int) (i * Math.log(i)));
            System.out.print('\t');
            System.out.print(i * i);
            System.out.print('\t');
            System.out.print(i * i * i);
            System.out.println();
        }
    }
}
```

```
log N limit number : 1073741824
log N  N      N log N       N^2    N^3
0      2      1      4      8
1      4      5      16     64
2      8      16     64     512
2      16     44     256    4096
3      32     110    1024   32768
4      64     266    4096   262144
4      128    621    16384  2097152
5      256    1419   65536  16777216
6      512    3194   262144 134217728
6      1024   7097   1048576       1073741824
7      2048   15615  4194304       8589934592
8      4096   34069  16777216      68719476736
9      8192   73817  67108864      549755813888
9      16384  158991 268435456     4398046511104
10     32768  340695 1073741824    35184372088832
11     65536  726817 4294967296    281474976710656
11     131072 1544487       17179869184   2251799813685248
12     262144 3270678       68719476736   18014398509481984
13     524288 6904766       274877906944  144115188075855872
13     1048576       14536349      10995116277761152921504606846976
14     2097152       30526334      4398046511104-9223372036854775808
15     4194304       63959939      17592186044416       0
15     8388608       133734419     70368744177664       0
16     16777216      279097919     281474976710656      0
17     33554432      581453998     1125899906842624     0
18     67108864      1209424316    4503599627370496     0
18     134217728     2147483647    18014398509481984    0
19     268435456     2147483647    72057594037927936    0
20     536870912     2147483647    288230376151711744   0

20    1073741824     2147483647    1152921504606846976 0
```

5. Modify the code Binary.java that converts any number to binary form, to convert any number to its hexadecimal form. Print the first 256 numbers in hex. Include code and output in your working document.

```
public class Binary {
    public static void main(String[] args) {
          Scanner in = new Scanner(System.in);
          System.out.print("Number to Binary : ");

          String number = in.next();
          in.close();
       long n = Long.parseLong(number);

       System.out.println("HEX VALUE: "+Long.toHexString(n));

        // set v to the largest power of two that is <= n
        int v = 1;
        while (v <= n/2) {
            v = v * 2;
        }

        System.out.print("BIN VALUE: ");
        // check for presence of powers of 2 in n, from largest to smallest
        while (v > 0) {

            // v is not present in n
            if (n < v) {
                System.out.print(0);
            }

            // v is present in n, so remove v from n
            else {
                System.out.print(1);
                n = n - v;
            }

            // next smallest power of 2
            v = v / 2;
        }

        System.out.println();
        System.out.println("HEXADECIMAL FIRST 256 NUMBERS: ");
        for(int i=0; i<256; i++){
              System.out.println("INT: "+i+" - HEX: "+Integer.toHexString(i));
        }
    }
}
```

OUTPUT:

```
Number to Binary : 10
HEX VALUE: a
BIN VALUE: 1010
HEXADECIMAL FIRST 256 NUMBERS:
INT: 0 - HEX: 0
INT: 1 - HEX: 1
INT: 2 - HEX: 2
INT: 3 - HEX: 3
INT: 4 - HEX: 4
INT: 5 - HEX: 5
INT: 6 - HEX: 6
INT: 7 - HEX: 7
INT: 8 - HEX: 8
INT: 9 - HEX: 9
```

```
INT: 10 - HEX: a
INT: 11 - HEX: b
INT: 12 - HEX: c
INT: 13 - HEX: d
INT: 14 - HEX: e
INT: 15 - HEX: f
INT: 16 - HEX: 10
INT: 17 - HEX: 11
INT: 18 - HEX: 12
INT: 19 - HEX: 13
INT: 20 - HEX: 14
INT: 21 - HEX: 15
INT: 22 - HEX: 16
INT: 23 - HEX: 17
INT: 24 - HEX: 18
INT: 25 - HEX: 19
INT: 26 - HEX: 1a
INT: 27 - HEX: 1b
INT: 28 - HEX: 1c
INT: 29 - HEX: 1d
INT: 30 - HEX: 1e
INT: 31 - HEX: 1f
INT: 32 - HEX: 20
INT: 33 - HEX: 21
INT: 34 - HEX: 22
INT: 35 - HEX: 23
INT: 36 - HEX: 24
INT: 37 - HEX: 25
INT: 38 - HEX: 26
INT: 39 - HEX: 27
INT: 40 - HEX: 28
INT: 41 - HEX: 29
INT: 42 - HEX: 2a
INT: 43 - HEX: 2b
INT: 44 - HEX: 2c
INT: 45 - HEX: 2d
INT: 46 - HEX: 2e
INT: 47 - HEX: 2f
INT: 48 - HEX: 30
INT: 49 - HEX: 31
INT: 50 - HEX: 32
INT: 51 - HEX: 33
INT: 52 - HEX: 34
INT: 53 - HEX: 35
INT: 54 - HEX: 36
INT: 55 - HEX: 37
INT: 56 - HEX: 38
INT: 57 - HEX: 39
INT: 58 - HEX: 3a
INT: 59 - HEX: 3b
INT: 60 - HEX: 3c
INT: 61 - HEX: 3d
INT: 62 - HEX: 3e
INT: 63 - HEX: 3f
INT: 64 - HEX: 40
```

```
INT: 65 - HEX: 41
INT: 66 - HEX: 42
INT: 67 - HEX: 43
INT: 68 - HEX: 44
INT: 69 - HEX: 45
INT: 70 - HEX: 46
INT: 71 - HEX: 47
INT: 72 - HEX: 48
INT: 73 - HEX: 49
INT: 74 - HEX: 4a
INT: 75 - HEX: 4b
INT: 76 - HEX: 4c
INT: 77 - HEX: 4d
INT: 78 - HEX: 4e
INT: 79 - HEX: 4f
INT: 80 - HEX: 50
INT: 81 - HEX: 51
INT: 82 - HEX: 52
INT: 83 - HEX: 53
INT: 84 - HEX: 54
INT: 85 - HEX: 55
INT: 86 - HEX: 56
INT: 87 - HEX: 57
INT: 88 - HEX: 58
INT: 89 - HEX: 59
INT: 90 - HEX: 5a
INT: 91 - HEX: 5b
INT: 92 - HEX: 5c
INT: 93 - HEX: 5d
INT: 94 - HEX: 5e
INT: 95 - HEX: 5f
INT: 96 - HEX: 60
INT: 97 - HEX: 61
INT: 98 - HEX: 62
INT: 99 - HEX: 63
INT: 100 - HEX: 64
INT: 101 - HEX: 65
INT: 102 - HEX: 66
INT: 103 - HEX: 67
INT: 104 - HEX: 68
INT: 105 - HEX: 69
INT: 106 - HEX: 6a
INT: 107 - HEX: 6b
INT: 108 - HEX: 6c
INT: 109 - HEX: 6d
INT: 110 - HEX: 6e
INT: 111 - HEX: 6f
INT: 112 - HEX: 70
INT: 113 - HEX: 71
INT: 114 - HEX: 72
INT: 115 - HEX: 73
INT: 116 - HEX: 74
INT: 117 - HEX: 75
INT: 118 - HEX: 76
INT: 119 - HEX: 77
```

```
INT: 120 - HEX: 78
INT: 121 - HEX: 79
INT: 122 - HEX: 7a
INT: 123 - HEX: 7b
INT: 124 - HEX: 7c
INT: 125 - HEX: 7d
INT: 126 - HEX: 7e
INT: 127 - HEX: 7f
INT: 128 - HEX: 80
INT: 129 - HEX: 81
INT: 130 - HEX: 82
INT: 131 - HEX: 83
INT: 132 - HEX: 84
INT: 133 - HEX: 85
INT: 134 - HEX: 86
INT: 135 - HEX: 87
INT: 136 - HEX: 88
INT: 137 - HEX: 89
INT: 138 - HEX: 8a
INT: 139 - HEX: 8b
INT: 140 - HEX: 8c
INT: 141 - HEX: 8d
INT: 142 - HEX: 8e
INT: 143 - HEX: 8f
INT: 144 - HEX: 90
INT: 145 - HEX: 91
INT: 146 - HEX: 92
INT: 147 - HEX: 93
INT: 148 - HEX: 94
INT: 149 - HEX: 95
INT: 150 - HEX: 96
INT: 151 - HEX: 97
INT: 152 - HEX: 98
INT: 153 - HEX: 99
INT: 154 - HEX: 9a
INT: 155 - HEX: 9b
INT: 156 - HEX: 9c
INT: 157 - HEX: 9d
INT: 158 - HEX: 9e
INT: 159 - HEX: 9f
INT: 160 - HEX: a0
INT: 161 - HEX: a1
INT: 162 - HEX: a2
INT: 163 - HEX: a3
INT: 164 - HEX: a4
INT: 165 - HEX: a5
INT: 166 - HEX: a6
INT: 167 - HEX: a7
INT: 168 - HEX: a8
INT: 169 - HEX: a9
INT: 170 - HEX: aa
INT: 171 - HEX: ab
INT: 172 - HEX: ac
INT: 173 - HEX: ad
INT: 174 - HEX: ae
```

```
INT: 175 - HEX: af
INT: 176 - HEX: b0
INT: 177 - HEX: b1
INT: 178 - HEX: b2
INT: 179 - HEX: b3
INT: 180 - HEX: b4
INT: 181 - HEX: b5
INT: 182 - HEX: b6
INT: 183 - HEX: b7
INT: 184 - HEX: b8
INT: 185 - HEX: b9
INT: 186 - HEX: ba
INT: 187 - HEX: bb
INT: 188 - HEX: bc
INT: 189 - HEX: bd
INT: 190 - HEX: be
INT: 191 - HEX: bf
INT: 192 - HEX: c0
INT: 193 - HEX: c1
INT: 194 - HEX: c2
INT: 195 - HEX: c3
INT: 196 - HEX: c4
INT: 197 - HEX: c5
INT: 198 - HEX: c6
INT: 199 - HEX: c7
INT: 200 - HEX: c8
INT: 201 - HEX: c9
INT: 202 - HEX: ca
INT: 203 - HEX: cb
INT: 204 - HEX: cc
INT: 205 - HEX: cd
INT: 206 - HEX: ce
INT: 207 - HEX: cf
INT: 208 - HEX: d0
INT: 209 - HEX: d1
INT: 210 - HEX: d2
INT: 211 - HEX: d3
INT: 212 - HEX: d4
INT: 213 - HEX: d5
INT: 214 - HEX: d6
INT: 215 - HEX: d7
INT: 216 - HEX: d8
INT: 217 - HEX: d9
INT: 218 - HEX: da
INT: 219 - HEX: db
INT: 220 - HEX: dc
INT: 221 - HEX: dd
INT: 222 - HEX: de
INT: 223 - HEX: df
INT: 224 - HEX: e0
INT: 225 - HEX: e1
INT: 226 - HEX: e2
INT: 227 - HEX: e3
INT: 228 - HEX: e4
INT: 229 - HEX: e5
```

```
INT: 230 - HEX: e6
INT: 231 - HEX: e7
INT: 232 - HEX: e8
INT: 233 - HEX: e9
INT: 234 - HEX: ea
INT: 235 - HEX: eb
INT: 236 - HEX: ec
INT: 237 - HEX: ed
INT: 238 - HEX: ee
INT: 239 - HEX: ef
INT: 240 - HEX: f0
INT: 241 - HEX: f1
INT: 242 - HEX: f2
INT: 243 - HEX: f3
INT: 244 - HEX: f4
INT: 245 - HEX: f5
INT: 246 - HEX: f6
INT: 247 - HEX: f7
INT: 248 - HEX: f8
INT: 249 - HEX: f9
INT: 250 - HEX: fa
INT: 251 - HEX: fb
INT: 252 - HEX: fc
INT: 253 - HEX: fd
INT: 254 - HEX: fe
INT: 255 - HEX: ff
```

6. Modify the code DayOfWeek.java to print the Day of the Week (Sunday, Monday, ...).

```java
Calendar c = Calendar.getInstance();
c.set(Calendar.MONTH, m-1);
c.set(Calendar.DAY_OF_MONTH, d);
c.set(Calendar.YEAR, y);
System.out.println(c.getDisplayName(Calendar.MONTH, Calendar.LONG, Locale.US));
```

12. Let's play cards. Use the code Deal.java to play 21 or BlackJack for 2 users. You are always the first deal of cards, the house the second. Modify the code to ask for an additional card (Hit=1) or none (Stay=0) for the user. In 20 trials, how many times did you beat the house?. Add the modified code to your working document and describe your experience.

```java
public class Deal {
  public static void main(String[] args) {
     Scanner in = new Scanner(System.in);
     System.out.print("Number of Players : ");

     String players = in.next();
    int PLAYERS  = Integer.parseInt(players);

    int CARDS_PER_PLAYER = 5;

```

```java
        String[] suit = { "Clubs", "Diamonds", "Hearts", "Spades" };
        String[] rank = { "2", "3", "4", "5", "6", "7", "8", "9", "10", "Jack", "Queen", "King", "Ace" };

        // avoid hardwired constants
        int SUITS = suit.length;
        int RANKS = rank.length;
        int CARDS = SUITS * RANKS;

        if (CARDS_PER_PLAYER * PLAYERS > CARDS) throw new RuntimeException("Too many players");

        // initialize deck
        String[] deck = new String[CARDS];
        for (int i = 0; i < RANKS; i++) {
            for (int j = 0; j < SUITS; j++) {
                deck[SUITS*i + j] = rank[i] + " of " + suit[j];
            }
        }

        // shuffle
        for (int i = 0; i < CARDS; i++) {
            int r = i + (int) (Math.random() * (CARDS-i));
            String t = deck[r];
            deck[r] = deck[i];
            deck[i] = t;
        }

        String [] player = new String[5];
        int index = 0;

        // print shuffled deck
        for (int i = 0; i < PLAYERS * CARDS_PER_PLAYER; i++) {
            System.out.println(deck[i]);
            player[index++] = deck[i];
            if (i % CARDS_PER_PLAYER == CARDS_PER_PLAYER - 1){

               System.out.println("\nTHIS IS YOUR PREVIOUS DECK, Do you want to change a card (1=YES 0=NO) :  ");
               String extra = in.next();
               int EXTRACARD  = Integer.parseInt(extra);

               if(EXTRACARD == 1){
                      int randomCard = (int)(Math.random()*5 + 1);
                      player[randomCard] = deck[deck.length - i];
                      System.out.println("YOUR NEW DECK:  ");
                } else if (EXTRACARD == 0){
                  System.out.print("ACCEPT YOUR ORIGINAL DECK:  ");
                } else {
                  System.out.print("NOT VALID OPTION; ACCEPT YOUR ORIGINAL DECK:  ");
                }

                      for(int l=0; l<player.length; l++){
                             System.out.println(player[l]);
                      }
               System.out.println();
               System.out.println("----------------------------");
               player = new String[5];
               index = 0;

            }
        }

       in.close();
    }
```

I won several times (12/20) and I just need to identify in where part of the program needs to do the program modification (we can do it in different places.)

85. Use the code Birthday.java, to run at least 20 experiments and compute the average number of people needed to show up in a room in order that 2 people share the same birthday.

11, 29, 19, 23, 55, 2, 25, 58, 17, 15, 14, 48, 11, 16, 22, 36, 25, 27, 35, 14 = 25.1

86. Use the code to build the Pascal triangle, Pascal.java. Produce a Pascal Triangle to level 10

```
1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1
1 6 15 20 15 6 1
1 7 21 35 35 21 7 1
1 8 28 56 70 56 28 8 1
1 9 36 84 126 126 84 36 9 1
```

87. You are required to run the code that generates a Sierpinski triangle: Sierpinski.java. This code requires compiling beforehand DrawingPanel.java. Can you guess an algorithm that counts how many solid black inverted triangles and how many upright white triangles per level N. Justify your answer.

Level	**0**	**1**	**2**	**3**	**4**
Inverted triangles:	**0**	**1**	**4 (8/2)**	**13 (26/2)**	**40 (80/2)**
Upright triangles:	**1**	**3**	**9**	**27**	**81**

With all this data test we can define (where level = n):

Inverted triangles: 3^n- 1 / 2

Upright triangles: 3^n