A1

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Qusetion 1

```
# a
seq(8.7, 29.7, 3)
```

```
## [1]  8.7 11.7 14.7 17.7 20.7 23.7 26.7 29.7
```

```
# b
(cumsum(factorial(0:5) * 0:5) + 0.8)[6:1]
```

```
## [1] 719.8 119.8  23.8   5.8   1.8   0.8
```

```
# c
rep(2.5, 7) + cumsum(2:8) - 2
```

```
## [1]  2.5  5.5  9.5 14.5 20.5 27.5 35.5
```

```
# d
x <- cumsum(1:8)
ifelse(x > 20, 20, x)
```

```
## [1]  1  3  6 10 15 20 20 20
```

```
# e
x <- 1:4
rep(ifelse(x == 4, 0, x), 3)
```

```
##  [1] 1 2 3 0 1 2 3 0 1 2 3 0
```

```
# f
seq(10, 10.9, 0.3)
```

```
## [1] 10.0 10.3 10.6 10.9
```

```r
# g
rep(seq(0.4, 0.9, 0.1), rep(3:1, 2))
```

```
##  [1] 0.4 0.4 0.4 0.5 0.5 0.6 0.7 0.7 0.7 0.8 0.8 0.9
```

```r
# h
x <- numeric(14)
{x[5] <- 1; x[9] <- 2; x[12] <- 3; x[14] <- 4; x}
```

```
##  [1] 0 0 0 0 1 0 0 0 2 0 0 3 0 4
```

```r
# i
paste(rep('x', 10), rep(-1:-4, 4:1), sep = '-^')
```

```
##  [1] "x-^-1" "x-^-1" "x-^-1" "x-^-1" "x-^-2" "x-^-2" "x-^-2" "x-^-3" "x-^-3"
## [10] "x-^-4"
```

```r
# j
1 + sum(cumprod(seq(3, 30, 3)) / cumprod(seq(2, 47, 5)))
```

```
## [1] 6.677615
```

Question 2:

```r
name <- function(x, n=1000000) {
  if (x == 0){
    return (1)
  }
  sums=1
  for (elt in n:1){
    sums = 1+x*sums/elt # use the formula for approximation e^x = 1 + (x/1)(1+x/2)(1+x/3)(...)
  }
  sums
}
q2 <- function(x) {
  sapply(x, name)
}
print(q2(709), digits = 20) # if the input greater than 709, output would be Inf
```

```
## [1] 8.2184074615549514285e+307
```

```r
print(exp(709), digits = 20)
```

```
## [1] 8.2184074615549723848e+307
```

```r
q2(0)
```

```
## [1] 1
```

```r
exp(0)
```

```
## [1] 1
```

```r
sample_test <- sample(1:708, 10);sample_test
```

```
##  [1] 680 490 116 119 653 404  56 460 650 480
```

```r
q2(sample_test)
```

```
##  [1] 2.090488e+295 6.372299e+212  2.388691e+50  4.797813e+51 3.929133e+283
##  [6] 2.850826e+175  2.091659e+24 5.962957e+199 1.956200e+282 2.893019e+208
```

```r
exp(sample_test)
```

```
##  [1] 2.090488e+295 6.372299e+212  2.388691e+50  4.797813e+51 3.929133e+283
##  [6] 2.850826e+175  2.091659e+24 5.962957e+199 1.956200e+282 2.893019e+208
```

Question 3a:

```r
ML <-  c(31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31)
dates <- function(x, year = 2021) {
  if (x <= 31){ # if input less than 31, it must be in Jan
    paste(x, 1, year, sep = '/')}
  else {
    tr_fl = ifelse(x %% cumsum(ML) == x, FALSE, TRUE)
    valid_date = x %% cumsum(ML)[tr_fl]
    num <- length(valid_date)
    x = if (valid_date[num] == 0) valid_date[num - 1] else valid_date[num]
    y = if (valid_date[num] == 0) num else num + 1
    paste(x, y, year, sep = '/')}
}
date <- function(x) {
  sapply(x, dates)
}
date(1)
```

```
## [1] "1/1/2021"
```

```r
date(365)
```

```
## [1] "31/12/2021"
```

```r
sample_test <- sample(2:364, 10);sample_test
```

```
##  [1]   2 147 187 141 171 237 362 333 220  84
```

```r
date(sample_test)
```

```
##  [1] "2/1/2021"   "27/5/2021"  "6/7/2021"   "21/5/2021"  "20/6/2021"
##  [6] "25/8/2021"  "28/12/2021" "29/11/2021" "8/8/2021"   "25/3/2021"
```

Question 3b:

```r
ML <-  c(31, 28, 31, 30, 31, 30, 31, 31, 30, 31, 30, 31)
cumML <- cumsum(ML)
week <- c('Monday', 'Tuesday', 'Wednesday', 'Thursday', 'Friday', 'Saturday', 'Sunday')
day.of.weeks <- function(x) {
  if (nchar(x) == 8) { # eg: 1/1/2021
    day = as.numeric(substring(x, 1, 1))
    month = as.numeric(substring(x, 3, 3))
  }
  if (nchar(x) == 10) {# eg: 31/12/2021
    day = as.numeric(substring(x, 1, 2))
    month = as.numeric(substring(x, 4, 5))
  }
  if (nchar(x) == 9) { # eg: 10/1/2021 or 1/10/2021
    day = as.numeric(ifelse(substring(x, 2, 2) == '/', substring(x, 1, 1), substring(x, 1, 2)))
    month = as.numeric(ifelse(substring(x, 3, 3) == '/', substring(x, 4, 4), substring(x, 3, 4)))
  }
  date <- ifelse(month != 1, (cumML[month-1] + day - 3) %% 7, (day - 3) %% 7)
  week[ifelse(date == 0, 7, date)]
}
day.of.week <- function(x) {
  unlist(lapply(x, day.of.weeks))
}
day.of.week('14/8/2021')
```

```
## [1] "Saturday"
```

```r
day.of.week('31/12/2021')
```

```
## [1] "Friday"
```

```r
c(day.of.week('16/8/2021'), day.of.week('17/8/2021'))
```

```
## [1] "Monday"  "Tuesday"
```

```r
day.of.week('1/1/2021')
```

```
## [1] "Friday"
```

```r
day.of.week(c('16/8/2021', '17/8/2021'))
```

```
## [1] "Monday"  "Tuesday"
```

```r
day.of.week(c('24/12/2021', '25/12/2021'))
```

```
## [1] "Friday"   "Saturday"
```

Question 4

```r
name <- function(z, n) {
  num = z %/% 1 # j has to be integer
  zero <- ifelse(num <= 0 | num == Inf, numeric(1), numeric(num + 1))
  if (0 <= z & z <= n){
      j = 0:num
      zero[seq(along = j)] = (-1)^j*choose(n, j)*(z-j)^(n-1)/factorial(n-1)
      return (sum(zero))
  }
  return (zero)
}
f <- function(z, n) {
  sapply(z, name, n)
}

sample_test_x <- sample(seq(-100, 100, .25), 5);sample_test_x
```

```
## [1] 53.50  5.25  4.75 69.75 -5.00
```

```r
sample_test_n <- sample(0:100, 1); sample_test_n
```

```
## [1] 89
```

```r
f(sample_test_x, sample_test_n)
```

```
## [1]  1.740404e+07  1.275602e-71  1.908685e-75 -7.540787e+19  0.000000e+00
```

```r
f(3, 6)
```

```
## [1] 0.55
```

```r
f(-Inf, 3)
```

```
## [1] 0
```

```r
f(Inf, 6)
```

```
## [1] 0
```

```r
f(seq(-1, 3, by = 0.4), 6)
```

```
##  [1] 0.000000e+00 0.000000e+00 0.000000e+00 2.666667e-06 6.480000e-04
##  [6] 8.333333e-03 4.430667e-02 1.410800e-01 3.050933e-01 4.755467e-01
## [11] 5.500000e-01
```