Exercises 1. Vectors

Question 1a

```
H <- (1:20)
H
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
```

Question 1b

```
X <- (20:1)
X
```

```
##  [1] 20 19 18 17 16 15 14 13 12 11 10  9  8  7  6  5  4  3  2  1
```

Question 1c

```
F <- c(1:20,19:1)
F
```

```
##  [1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20 19 18 17
## [24] 16 15 14 13 12 11 10  9  8  7  6  5  4  3  2  1
```

Question 1d

```
P <- c(4,6,3)
```

Question 1e

```
rep(c(4,6,3) , times = 4)
```

```
##  [1] 4 6 3 4 6 3 4 6 3 4 6 3
```

Question 1f

```
rep(c(4,6,3),times = c(10,1,1))
```

```
##  [1] 4 4 4 4 4 4 4 4 4 4 6 3
```

Question 1g

```
rep(c(4,6,3), times = c(11,10,10))
```

```
##  [1] 4 4 4 4 4 4 4 4 4 4 4 6 6 6 6 6 6 6 6 6 6 3 3 3 3 3 3 3 3 3 3
```

Question 1h

```
rep(c(4,6,3), times = c(10,20,30))
```

```
##  [1] 4 4 4 4 4 4 4 4 4 4 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 6 3 3 3 3 3
## [36] 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3 3
```

Question 2

```
x <- seq(3 ,6, 0.1)
x
```

```
##  [1] 3.0 3.1 3.2 3.3 3.4 3.5 3.6 3.7 3.8 3.9 4.0 4.1 4.2 4.3 4.4 4.5 4.6
## [18] 4.7 4.8 4.9 5.0 5.1 5.2 5.3 5.4 5.5 5.6 5.7 5.8 5.9 6.0
```

```
exp(x)*cos(x)
```

```
##  [1] -19.884531 -22.178753 -24.490697 -26.773182 -28.969238 -31.011186
##  [7] -32.819775 -34.303360 -35.357194 -35.862834 -35.687732 -34.685042
## [13] -32.693695 -29.538816 -25.032529 -18.975233 -11.157417  -1.362099
## [19]  10.632038  25.046705  42.099201  61.996630  84.929067 111.061586
## [25] 140.525075 173.405776 209.733494 249.468441 292.486707 338.564378
## [31] 387.360340
```

Question 3a

```
x <- seq(3,36 ,by =3)
y <- seq(1,34 ,by =3)
z <- rep(0.1, times = 12)
h <- rep(0.2, times = 12)
g <- z^x*h^y
g
```

```
##  [1] 2.000000e-04 1.600000e-09 1.280000e-14 1.024000e-19 8.192000e-25
##  [6] 6.553600e-30 5.242880e-35 4.194304e-40 3.355443e-45 2.684355e-50
## [11] 2.147484e-55 1.717987e-60
```

Question 3b

```
x <- seq(2,25)
y <- 2
z <- c(y,y^x/x)
z
```

```
##  [1] 2.000000e+00 2.000000e+00 2.666667e+00 4.000000e+00 6.400000e+00
##  [6] 1.066667e+01 1.828571e+01 3.200000e+01 5.688889e+01 1.024000e+02
## [11] 1.861818e+02 3.413333e+02 6.301538e+02 1.170286e+03 2.184533e+03
## [16] 4.096000e+03 7.710118e+03 1.456356e+04 2.759411e+04 5.242880e+04
## [21] 9.986438e+04 1.906502e+05 3.647221e+05 6.990507e+05 1.342177e+06
```

Question 4a

```
H =c(10:100)
sum(H + 4^2)
```

```
## [1] 6461
```

Question 4b

```
H <- c(1:25)
sum(2^H/H + 3^H/H^2)
```

```
## [1] 2129170437
```

Question 5a

```
x <- paste("label",1:30)
x
```

```
##  [1] "label 1"  "label 2"  "label 3"  "label 4"  "label 5"  "label 6"
##  [7] "label 7"  "label 8"  "label 9"  "label 10" "label 11" "label 12"
## [13] "label 13" "label 14" "label 15" "label 16" "label 17" "label 18"
## [19] "label 19" "label 20" "label 21" "label 22" "label 23" "label 24"
## [25] "label 25" "label 26" "label 27" "label 28" "label 29" "label 30"
```

Question 5b

```r
x <- paste0("fn",1:30)
x
```

```
##  [1] "fn1"  "fn2"  "fn3"  "fn4"  "fn5"  "fn6"  "fn7"  "fn8"  "fn9"  "fn10"
## [11] "fn11" "fn12" "fn13" "fn14" "fn15" "fn16" "fn17" "fn18" "fn19" "fn20"
## [21] "fn21" "fn22" "fn23" "fn24" "fn25" "fn26" "fn27" "fn28" "fn29" "fn30"
```

Question 6a

```r
set.seed(50)
xVec <- sample(0:999, 250, replace=T)
yVec <- sample(0:999, 250, replace=T)
z <- yVec[seq(2:250)]-xVec[seq(1:249)]
z
```

```
##   [1]    1  434  115 -250  108  886 -262  302  115  676  488  202   31   14
##  [15]  138  184 -562  404  507  213 -569  154 -481 -838  -30 -239  121  717
##  [29]  230  -89 -142  447  376  158   -4   94  417 -369 -342    2  169   81
##  [43]  707    2  650 -452 -707  426 -396   37 -902 -477 -596  276  329 -251
##  [57] -502  432  444  520  360 -227  733 -484  201  603 -109  927  364 -659
##  [71] -479 -114 -555  255 -569  266 -115 -386  229   41 -322  471 -222 -170
##  [85]  -60  804  427  111 -404 -595 -445 -616 -308 -117  731  399  776 -511
##  [99]  130 -115  310 -212 -167   10  742 -775  625 -357  153   15   41   44
## [113]   31  573  391 -171  421 -154  169 -326 -314  401  263 -126  228 -178
## [127]  702    2  254 -237  384  426 -318  158   95  529  405  436  428 -284
## [141] -132  640  512  -41  127  178 -523 -109 -243  456  686  -29 -175 -288
## [155] -519 -447  733  648  264  555  556   56  -17 -111 -458 -147  519  505
## [169] -508 -265 -600   82  622  478  313  898   97   35 -258 -284 -229  564
## [183] -102 -436 -246 -519 -106   46  361  618 -339  412  -45 -563 -559  202
## [197]  385 -193 -747 -405   15 -133  324  199  148  637 -555   -2 -444 -158
## [211]  383 -602  766  956 -520 -298  385 -233  627 -146 -331  306  -79  447
## [225]   20  696  -69   40 -213  636  471  437 -313  122 -456 -575  565 -180
## [239]  528  175  758  177  152 -125  432  308  615 -415  430
```

Question 6b

```r
sinyVec <- sin(yVec)
CosxVec <- cos(xVec)
R <- sinyVec/CosxVec
R
```

```
##   [1]   2.02224118   0.73968009   1.52945836   1.08735281   1.42036850
##   [6]   0.08847263 -71.75899159  -1.75965837   0.19887866  -0.68867562
##  [11]  -1.10346427  -0.61666901  -1.52167866  -3.42170793   0.35537857
##  [16]   0.84243010   0.39758743   1.08970839   1.12635241  10.14928967
##  [21]   0.12746796  -4.79219922   0.32996237  -0.75787347   1.30991968
##  [26]  -0.54757257   1.08425361   0.12947238  -0.96401439  -0.62382798
##  [31]   0.70309169   0.50942082  -0.65595693   0.04247691   1.90448080
##  [36]  -4.00639404  14.56327813   0.92876667   0.61186365   1.24070688
##  [41]  -6.03040679  -0.35832744 -32.11768687   2.15248877  43.33854286
##  [46]  -0.22017777   1.84394289  -1.19716653  -0.29933282  -2.92966766
##  [51]   0.24688637 -38.55875997   2.69212918   0.10364309   0.85473844
##  [56]   1.47871163  -2.07165736  -0.98805976   0.09360676  -1.10967079
##  [61]   0.97397918  30.67068598  -0.14607958   0.57387175   0.13493108
##  [66]   0.12024696  -4.99875777  -3.87259442   0.76364893  15.93204208
##  [71]  -0.75457827  -1.54187008  -2.41949323   4.44066360   1.01515599
##  [76]   0.67661739  -1.08593420  -1.69908732   8.19023718  -1.55646283
```

```
##  [81]  -1.00707220   3.15805397  -0.72018468   0.84193590  -0.22103754
##  [86]  -0.09823146   1.25262125  -4.08478811  -0.88893147   0.46652380
##  [91]   0.82608346  -0.25383317  -5.27407661   0.88653353   0.17921727
##  [96]   3.72439497   0.08889620  -0.68826374  -0.92361424  -0.19900142
## [101]   1.38794248   1.02746487  -0.05161370   5.16142318  -1.22943275
## [106]  -2.28926258  -0.46222186   3.17876321  -0.69141192  -1.00979278
## [111] -13.27270954  -0.24467433   3.93126785   0.90991087   1.03397865
## [116]  15.26050437  -0.07996892  -0.43288100   0.74421774   0.29289038
## [121]  -2.21727311  -1.39332814  -0.91450986   1.43510474   1.02488134
## [126]  -2.80890859  -0.80841107  -0.04425644  -0.16059274  -3.76663351
## [131]   1.52980298  -0.78042342   0.95756502   6.72751593 -17.63864391
## [136]   1.22093897   0.78392512   0.28676946   0.72901085  -1.12883797
## [141]   0.69986489  -0.91630052   1.01225144  -2.47731549   1.25149056
## [146]   0.72411963  -0.98646483  -0.71357003   1.50029807   4.94640133
## [151]   0.49443189  -0.37565996   0.13253965   0.83721068   4.76667873
## [156]  -1.44296451  -1.03780715   1.47839784   0.37645012   0.72209540
## [161]   2.87696138   0.66384767   0.76144921  38.54157545   3.18437146
## [166] -12.54976486  -2.35133916   0.50460855  -0.29910650  -1.07783748
## [171]  -0.55051589   8.22889069  -0.33574968  -1.84806391  -0.70931651
## [176]  -3.26677853  -1.69009620  -0.76221705  -1.10310314  -0.91533184
## [181]   3.95398337  -1.18003547   0.53525009  -0.48387737   0.04788876
## [186]  26.48066032   2.77855928  -3.33178453   2.15339808   0.50268724
## [191]   2.98975610   0.83754480  -0.51028283   0.13378488   0.43154465
## [196]   1.05521895   1.00309162  -0.42595063  -6.84587078   0.00000000
## [201]   0.52133101  -1.70311929   3.92988906  -0.83154363   1.38401860
## [206] -10.40226625  -1.00116743   2.83651590  -0.05456952   4.65763832
## [211]  11.15798675   0.86648198   8.63571342   4.99641348   0.96268119
## [216]  -0.54822504   1.15437050  11.00904435  -1.81212089  -1.11094305
## [221]   1.33916876  -1.16810067   4.34655509   0.79059444   1.27497233
## [226]   2.44458539  -0.54176617   1.29585328   1.17561576   0.89236686
## [231]   3.83037757  -0.70295997   0.30553050  -3.43646161   3.19670009
## [236]   0.31239096  -0.42854781   2.27786529  -0.98357751  -2.76018329
## [241]  -0.36919280   1.45298083   0.75537730  -0.41916040  -1.00171748
## [246]  15.06322256  -0.30501941  -0.56373684   1.26567417   1.31370513
```

Question 6c

```
y <- xVec[1:248]
m <- xVec[2:249]
w <- xVec[3:250]
ZY <- y + 2 * m - w
ZY
```

```
##   [1] 1382   70 1221 1749  -98  796 1949  623 -134  618  288 1472  517  -45
##  [15]  794 1982 1489  344 -206 1207  292  771 2085  810 1032 1547  767  537
##  [29]  702  676  737  664 1451  435 1355  168 1150  989  926  348 1757 1299
##  [43]  409 -497  501 2150 1157 1081 1323 2030 1887 1744  879  590  493 1330
##  [57] 1254 1281  465  767 1691  464 1238  805 -519 1425  710 -611 1517  963
##  [71] 1836 2243 -158 1860  606  506 1917 1304 2021 2025  238  226  733 1538
##  [85]  581 -659  824 1109 1136 1339 1239 1584 2300  562  567 -375 1372  761
##  [99] 1142  714 1801 2220  624 -806 1738  268  398 1941  668 2037  829  345
## [113]  337  -45  635 -285 1225  691 1792 2216  123  538 1130 1124 1172  944
## [127]  271  -62  229  785  -70 1346 1622  381  104 1036 1015  199  589 1399
## [141]  601  506  560 -145  171 1204 1427 1278 1128  615  269   37 1521 2172
## [155] 1602  464   74 1575  599   88 -267 1185 1655 1564 1420  880  229 1651
```

```
## [169]  959 1306 2008 1243  267 1110  556 -791 1300  844 1578 2427  708 1554
## [183] 1439 1150 1269 2274 1419 1067  187 2071  781 -148 1767 1851 1019 -196
## [197]  554 2223 1710  -90  788 1209  876 1322  275 1191  323 1570 1234  768
## [211] 1715  903 -768 1546 1452  -47 1125 -330  871 2463  894  133  975  201
## [225] -137 1553  299  865  746  184  267  839  -63  863 2411  133 1739 1145
## [239] 1015   47  209 1468  846   10 1146   31 1405 1058
```

Question 6d

```
x <- xVec[-length(xVec)]+10
y <- exp(-xVec[-1])
z <- sum(y/x)
z
```

```
## [1] 0.01269872
```

Question 7a

```
X <- sort(yVec[1:600])
X
```

```
##   [1]   0   4  10  13  14  18  19  28  31  43  44  47  49  50  63  67  72
##  [18]  72  78  83  87  91  94  95  99 101 106 116 117 117 127 133 133 151
##  [35] 157 167 174 175 184 187 193 194 195 211 213 216 216 218 220 221 222
##  [52] 224 225 229 246 247 248 257 268 273 273 277 279 279 280 282 284 285
##  [69] 287 288 290 293 295 296 299 309 310 315 317 320 325 329 330 330 332
##  [86] 345 347 358 368 381 398 398 400 409 411 414 415 419 421 421 424 426
## [103] 428 428 428 437 441 460 465 469 471 473 482 484 488 488 489 498 500
## [120] 503 509 512 516 517 520 521 529 532 538 542 553 554 557 570 575 580
## [137] 581 589 593 593 598 604 609 611 613 615 615 615 621 632 632 635 635
## [154] 641 643 645 660 665 668 671 675 681 681 686 687 689 693 693 695 698
## [171] 705 709 712 717 721 738 743 743 752 760 766 768 772 776 777 779 783
## [188] 783 786 791 791 791 792 798 800 800 803 813 813 815 823 824 827 828
## [205] 835 840 841 845 846 850 853 855 860 863 866 871 872 876 878 881 881
## [222] 881 884 884 890 902 915 917 919 921 924 930 930 938 941 942 947 948
## [239] 948 952 955 957 961 965 970 974 985 988 993 997
```

Question 7b

```
x <- which(yVec >600)
x
```

```
##   [1]   1   2   5   6   8  10  11  13  16  18  27  28  32  33  34  36  42
##  [18]  43  45  48  50  55  58  59  60  61  63  66  67  68  72  79  80  86
##  [35]  88  94  95  96  97 101 102 105 107 109 111 114 118 119 120 123 125
##  [52] 127 131 132 134 136 137 138 139 142 143 150 151 154 157 158 159 161
##  [69] 163 164 167 168 172 173 174 175 176 178 180 181 182 183 187 189 190
##  [86] 203 204 205 206 211 213 214 219 220 224 226 227 230 232 237 238 239
## [103] 241 243 245 246 247 249 250
```

Question 7c

```
x <- which(xVec > 600)
y <- which(yVec > 600)
x <- append(x,y,after = length(x))
h <- sort(x)
h
```

```
##   [1]   1   1   2   4   5   6   7   8   8  10  11  13  13  16  16  17  18
##  [18]  21  23  24  26  27  28  32  33  34  34  36  36  38  42  42  43  45
```

```
##  [35]  46  47  48  49  50  50  51  52  53  55  57  58  59  60  61  62  63
##  [52]  66  67  67  68  70  72  72  73  75  77  78  79  79  80  80  86  88
##  [69]  88  90  91  92  93  94  94  95  96  97  98 100 101 102 102 103 105
##  [86] 106 107 108 109 109 111 111 114 118 118 119 120 120 121 123 125 127
## [103] 131 132 133 134 136 137 138 139 142 143 147 148 150 151 154 154 155
## [120] 157 158 159 159 161 163 163 164 164 165 167 168 169 171 172 172 173
## [137] 174 175 176 178 178 180 180 181 181 182 183 183 184 185 186 187 187
## [154] 189 190 191 194 198 199 202 203 204 205 206 207 209 211 212 213 214
## [171] 215 219 220 220 221 224 226 227 227 230 232 235 236 237 238 238 239
## [188] 241 243 243 245 246 247 248 249 250
```

```
h[duplicated(h)]
```

```
##  [1]   1   8  13  16  34  36  42  50  67  72  79  80  88  94 102 109 111
## [18] 118 120 154 159 163 164 172 178 180 181 183 187 220 227 238 243
```

Question 7d

```
G <- abs(xVec - mean(xVec))
sqrt(G)
```

```
##   [1] 16.0044994  3.8543482 15.8699716 17.7522956  7.8194629 20.1954450
##   [7] 15.7208142 13.9335566 20.2449006 18.5702989  7.8648585 13.5224258
##  [13] 13.7165593 19.3611983 13.2233127 14.9714395 19.5740645  9.3731532
##  [19] 19.4385185 16.8480266 12.8118695 16.0890025 16.0668603 19.7520632
##  [25] 11.9522383 14.0763632 11.1867779 13.9590831 11.3073427  9.1572922
##  [31]  9.6879306  6.6223863  3.8543482 12.8896858 15.1610026 13.2341981
##  [37] 18.1894475 15.7842960  8.8800901  2.4787093  9.4263461 19.5995918
##  [43] 13.1854465 18.9434949 19.9212449 15.7525871 22.4085698  2.4787093
##  [49] 16.1599505 18.7388367 23.3268943 17.6958752 13.6800585 12.3634947
##  [55]  9.6879306  5.1822775 16.2217138  8.5524266  7.6905136 13.6329014
##  [61] 11.2313846 14.2528594 15.9642100 11.5388041 17.9681941 20.3434510
##  [67] 16.4967876 19.7700784 17.7723381 22.1843188  7.4259006 23.3054500
##  [73] 14.4618118 19.4385185 22.6967839 17.4314658 14.3228489 22.4531512
##  [79] 14.1472259 22.4531512  9.5469367 20.8532012 10.6233705  4.1405314
##  [85]  9.5991666 20.8051917 21.2333700 15.1044364  9.2273506 13.8976257
##  [91] 15.4642814 15.3669776 19.3944322 17.5540309 20.0961688 12.5640758
##  [97] 19.5667064 18.8452647 11.8682770 14.7018366  7.2899931 22.6305988
## [103] 13.4217734 21.0678903 20.6846803 20.2520122 21.0203711 12.7335777
## [109] 19.7013705  9.9426355 20.6432556 19.4898948 16.0890025 18.4080417
## [115] 19.2316406 11.3954377 18.9962101 18.3614814  2.8028557 23.1115556
## [121] 13.1203658 20.8292103  9.2273506 10.1066315  7.9463199  2.8537694
## [127] 13.7424889 20.2449006 19.3870060 13.9948562  9.6361818 16.2128344
## [133] 18.8452647  2.2680388 18.7844617 13.3362663  9.5469367 11.3073427
## [139] 16.6089133  5.0143793  9.4416100 17.0837935 13.8512093 16.6690132
## [145] 20.0961688  6.0709143 15.9732276 13.1584194  8.8399095  6.6974622
## [151] 15.3576040 15.0948998  7.5402918 22.9160206 19.3944322  3.0239048
## [157] 17.4314658 12.6038089 14.4271965 20.3434510 17.7441821 15.0948998
## [163] 20.0035997 17.0629423 15.2034207  9.6511139  9.9426355  8.9919964
## [169] 20.3505282  0.3794733 18.9510950 17.7804387 10.6233705 15.7751704
## [175]  5.1131204 20.0712730 20.7811453 20.6916408  5.3050919 23.3268943
## [181] 21.0272205  9.7394045 21.1694119 12.2940636 14.6677878 18.3069386
## [187] 22.8066657  2.2680388  3.8915293 11.3073427 21.8207241 18.5163711
## [193]  9.3196566 23.1331796 10.9610219 13.1093860 18.4080417 15.8159413
## [199] 22.6084940  6.8451443 19.7194320 13.0055373  8.0711833  2.4199174
## [205]  9.0079964 16.1819653 13.6434600 13.2987217 20.3259440  4.1056059
```

```
## [211]  7.0102782 14.7358067 18.1067943 20.9250090 21.6366356 11.9939985
## [217] 19.1795725  8.4346903 21.1389688 20.2766861 20.2025741 18.2169152
## [223] 15.6797959  7.2702132 20.5634627 13.9948562 15.0380850 19.8205953
## [229]  6.7189285 16.2436449 18.0237621 13.9232180  8.7095350 16.7587589
## [235] 18.1423262 20.4485696 18.4893483 22.4754088 12.9172753  8.3579902
## [241] 20.4415264  6.9897067 13.3844686 15.9642100 16.5183534  9.6511139
## [247] 18.1343872 17.5540309 14.6238162 16.5485951
```

Question 7e

```
R <- sum( yVec>max(yVec)-200 )
R
```

```
## [1] 57
```

Question 7f

```
xVec[which(xVec %% 2 == 0)]
```

```
##   [1] 708 200  44 646  42 390 640 676 364  74 168 616 710 842 650 324 368
##  [18] 358 408 618 222 458 836 278 700 954 458 996 358 266 578  38 724 136
##  [35] 944  74 148 956 652 956 544 680 688 828 760  48 294 668 964 632   8
##  [52]  24 862  10 614 840 878  72  82 322 444 986 624  18 554 460  42  76
##  [69] 256 274 324 176 160 260 174  48 530 216 224 828 148 660  38 224 852
##  [86] 866 452 768 478  20 880 480 996 894 900 972 324 928 572 280 702 446
## [103] 190 638 124  14 920 308  84 860 120 206 256 678 188 258 376 870 110
## [120] 382  34 760 238 178
```

Question 7g

```
sort(order(xVec)[yVec])
```

```
##  [1]   7  15  18  24  25  29  34  42  46  50  53  63  66  69  72  73  74
## [18]  76  89  91  95 105 106 107 109 110 115 120 127 138 145 155 156 156
## [35] 157 158 160 166 170 171 171 182 186 194 200 200 207 212 213 221 223
## [52] 236 242 247 249 249
```

Question 7h

```
yVec[seq(1,250, by=3)]
```

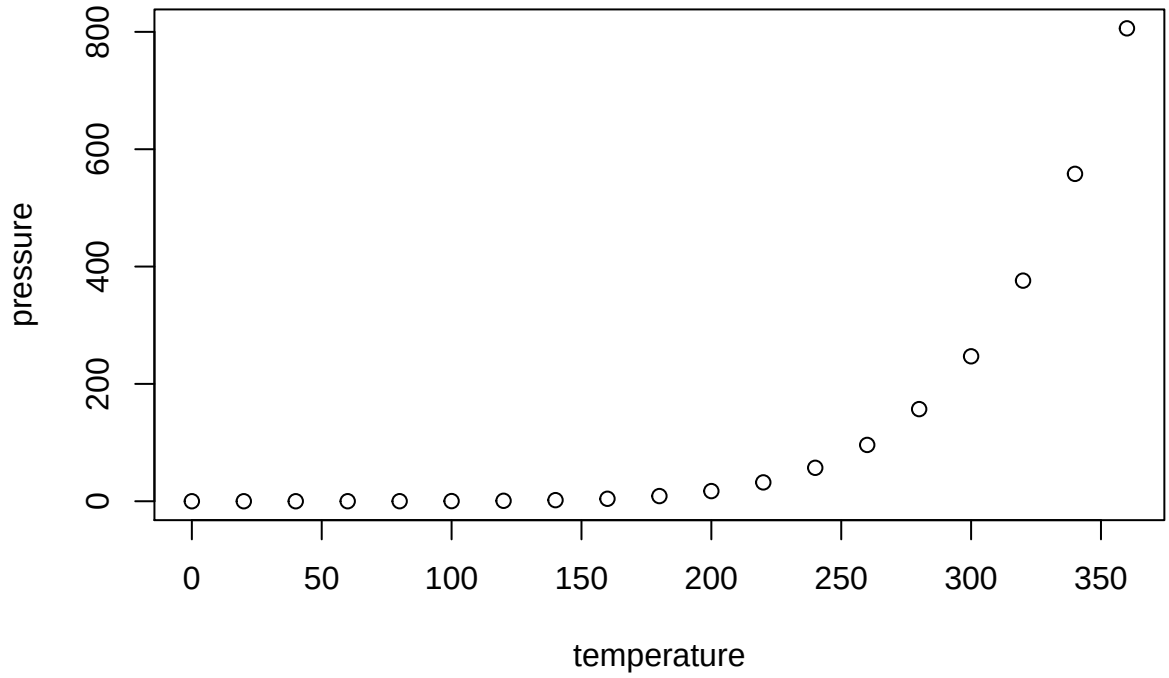
```
##  [1] 709 517 437 783 671 860 581 347 279 974 216 776 538 460 985 248 317
## [18] 288 687 957 938 101 615 285 106 414 881 488 484 791 246 643 845 553
## [35] 465  87 993 116 473 635 310 428 965  19 489 803 604 800 175 516 902
## [52] 689 881 593 835 398 358 850 791 915 665 167 866 942 320 482 216 488
## [69] 681 273 884 970 469 717 127 952 284 695 325 777 792  72 738 791
```

Question 8

```
d <- seq(2,38,by=2)
e <- seq(3,39,by=2)
T <- sum(cumprod(d/e))
1 + T
```

```
## [1] 6.976346
```

You can also embed plots, for example:



Note that the `echo = FALSE` parameter was added to the code chunk to prevent printing of the R code that generated the plot.