```
> punif(10, 0, 20)
[1] 0.5
> punif(10, 0, 20) - punif(5, 0, 20)
[1] 0.25

> plot(c(-5, 25), c(0, 1/20), main = "P.D.F. of Uniform(0, 20)", xlab
= expression(x), ylab = expression(f(x)), type = "n")
> points(seq(-5, -0.001, len = 1001), dunif(seq(-5, -0.001, len =
1001), 0, 20), type = "l", col = "green")
> points(seq(0, 20, len = 1001), dunif(seq(0, 20, len = 1001), 0, 20),
type = "l", col = "green")
> points(seq(20.001, 25, len = 1001), dunif(seq(20.001, 25, len =
1001), 0, 20), type = "l", col = "green")
> points(seq(0, 10, len = 1001), dunif(seq(0, 10, len = 1001), 0, 20),
type = "h", col = "green")

> 1 - pexp(1000, 1/2000)
[1] 0.6065307
> pexp(2000, 1/2000) - pexp(1000, 1/2000)
[1] 0.2386512

> plot(c(-2000, 10000), c(0, 1/2000), main = "P.D.F. of
Exponential(2000)", xlab = expression(x), ylab = expression(f(x)),
type = "n")
> points(seq(-2000, -1, len = 1001), dexp(seq(-2000, -1, len = 1001),
1/2000), type = "l", col = "green")
> points(seq(0, 10000, len = 1001), dexp(seq(0, 10000, len = 1001),
1/2000), type = "l", col = "green")
> points(seq(1000, 10000, len = 1001), dexp(seq(1000, 10000, len =
1001), 1/2000), type = "h", col = "green")

> pexp(1000, 1/2000)
[1] 0.3934693
> 1 - pexp(2000, 1/2000)
[1] 0.3678794
> pexp(2000, 1/2000) - pexp(1000, 1/2000)
[1] 0.2386512
```

```
> plot(seq(-2000, 10000, len = 1001), pexp(seq(-2000, 10000, len =
1001), 1/2000), main = "C.D.F. of Exponential(2000)", xlab =
expression(x), ylab = expression(F(x)), type = "l", col = "green")
> lines(c(0, 2000), c(0, 1), col = "red")

> xl <- runif(100, 0, 20)
> x2 <- runif(10000, 0, 20)
> x3 <- runif(1000000, 0, 20)
> c(mean(xl), mean(x2), mean(x3))
[1] 9.109439 9.945257 9.994837
> c(sd(xl), sd(x2), sd(x3))
[1] 5.276749 5.757900 5.770938
> c(var(xl), var(x2), var(x3))
[1] 27.84408 33.15341 33.30373

> xl <- rexp(100, 1/2000)
> x2 <- rexp(10000, 1/2000)
> x3 <- rexp(1000000, 1/2000)
> c(mean(xl), mean(x2), mean(x3))
[1] 1832.325 2001.375 2000.807
> c(sd(xl), sd(x2), sd(x3))
[1] 1659.768 1989.676 1997.450
> c(var(xl), var(x2), var(x3))
[1] 2754828 3958812 3989807

> plot(seq(-7, 19, len = 1001), dnorm(seq(-7, 19, len = 1001), 5, 1),
main = "P.D.F.s of N(5, 1), N(15, 1), and N(5, 9)", xlab =
expression(x), ylab = expression(f(x)), type = "l", col = "green")
> points(seq(-7, 19, len = 1001), dnorm(seq(-7, 19, len = 1001), 15,
1), type = "l", col = "red")
> points(seq(-7, 19, len = 1001), dnorm(seq(-7, 19, len = 1001), 5,
3), type = "l", col = "blue")
```

```
> xl <- rnorm(100)
> x2 <- rnorm(10000)
> x3 <- rnorm(1000000)
> c(mean(xl), mean(x2), mean(x3))
[1] 0.0561830506 0.0062967826 0.0001334927
> c(sd(xl), sd(x2), sd(x3))
[1] 1.0974188 0.9998079 1.0006614
> c(var(xl), var(x2), var(x3))
[1] 1.2043280 0.9996158 1.0013233

> 1 - pnorm(13, 10, 2)
[1] 0.0668072

> plot(seq(2, 18, len = 1001), dnorm(seq(2, 18, len = 1001), 10, 2),
main = "P.D.F. of N(10, 4)", xlab = expression(x), ylab =
expression(f(x)), type = "l", col = "green")
> points(seq(13, 18, len = 1001), dnorm(seq(13, 18, len = 1001), 10,
2), type = "h", col = "green")

> c(pnorm(1) - pnorm(-1), pnorm(2) - pnorm(-2), pnorm(3) -
pnorm(-3))
[1] 0.6826895 0.9544997 0.9973002

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-1, 1, len = 1001), dnorm(seq(-1, 1, len = 1001)), type =
"h", col = "green")
> points(c(seq(-2, -1, len = 1001), seq(1, 2, len = 1001)),
dnorm(c(seq(-2, -1, 0.001), seq(1, 2, 0.001))), type = "h", col =
"red")
> points(c(seq(-3, -2, len = 1001), seq(2, 3, len = 1001)),
dnorm(c(seq(-3, -2, len = 1001), seq (2, 3, len = 1001))), type = "h",
col = "blue")
```

```
> c(pnorm(0.00), pnorm(0.01), pnorm(0.02), pnorm(0.03))
[1] 0.5000000 0.5039894 0.5079783 0.5119665
> c(pnorm(1.50), pnorm(1.51), pnorm(1.52), pnorm(1.53))
[1] 0.9331928 0.9344 783 0.9357445 0.9369916

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-4, 1.5, len = 1001), dnorm(seq(-4, 1.5, len = 1001)),
type = "h", col = "green")

> 1 - pnorm(1.26)
[1] 0.1038347

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(1.26, 4, len = 1001), dnorm(seq(1.26, 4, len = 1001)),
type = "h", col = "green")
> points(seq(-4, 1.26, len = 1001), dnorm(seq(-4, 1.26, len = 1001)),
type = "h", col = "red")

> pnorm(-0.86)
[1] 0.1948945

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-4, -0.86, len = 1001), dnorm(seq(-4, -0.86, len =
1001)), type = "h", col = "green")

> c(1 - pnorm(-1.37), pnorm(1.37))
[1] 0.9146565 0.9146565
```

```
> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-1.37, 1.37, len = 1001), dnorm(seq(-1.37, 1.37, len =
1001)), type = "h", col = "green")
> points(seq(1.37, 4, len = 1001), dnorm(seq(1.37, 4, len = 1001)),
type = "h", col = "red")
> points(seq(-4, -1.37, len = 1001), dnorm(seq(-4, -1.37, len =
1001)), type = "h", col = "blue")

> c(pnorm(0.37) - pnorm(-1.25), pnorm(0.37), pnorm(-1.25))
[1] 0.5386590 0.6443088 0.1056498

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-1.25, 0.37, len = 1001), dnorm(seq(-1.25, 0.37, len =
1001)), type = "h", col = "green")
> points(seq(-4, -1.25, len = 1001), dnorm(seq(-4, -1.25, len =
1001)), type = "h", col = "red")

> c(pnorm(-4.6), pnorm(-3.99))
[1] 2.112455e-06 3.303665e-05

> plot(seq(-5, 5, len = 1001), dnorm(seq(-5, 5, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-5, -4.6, len = 1001), dnorm(seq(-5, -4.6, len = 1001)),
type = "h", col = "red")
> points(seq(-4.6, -3.99, len = 1001), dnorm(seq(-4.6, -3.99, len =
1001)), type = "h", col = "blue")

> qnorm(1 - 0.05)
[1] 1.644854
```

```
> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-4, qnorm(1 - 0.05), len = 1001), dnorm(seq(-4,
qnorm(1 - 0.05), len = 1001)), type = "h", col = "green")

> c(qnorm(0.005), qnorm(1 - 0.005))
[1] -2.575829  2.575829

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(qnorm(0.005), qnorm(1 - 0.005), len = 1001),
dnorm(seq(qnorm(0.005), qnorm(1 - 0.005), len = 1001)), type =
"h", col = "green")

> c(1 - pnorm(13, 10, 2), 1 - pnorm((13 - 10)/2))
[1] 0.0668072 0.0668072

> plot(seq(2, 18, len = 1001), dnorm(seq(2, 18, len = 1001), 10, 2),
main = "P.D.F. of N(10, 4)", xlab = expression(x), ylab =
expression(f(x)), type = "l", col = "green")
> points(seq(13, 18, len = 1001), dnorm(seq(13, 18, len = 1001), 10,
2), type = "h", col = "green")

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(1.5, 4, len = 1001), dnorm(seq(1.5, 4, len = 1001)), type
= "h", col = "green")

> pnorm((11 - 10)/2) - pnorm((9 - 10)/2)
[1] 0.3829249
> c(qnorm(0.98), 10 + 2*qnorm(0.98))
[1]    2.053749 14.107498
```

```
> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(-4, qnorm(0.98), len = 1001), dnorm(seq(-4,
qnorm(0.98), len = 1001)), type = "h", col = "green")

> plot(seq(10 - 2*4, 10 + 2*4, len = 1001), dnorm(seq(10 - 2*4, 10 +
2*4, len = 1001), 10, 2), main = "P.D.F. of N(10, 4)", xlab =
expression(x), ylab = expression(f(x)), type = "l", col = "green")
> points(seq(10 - 2*4, 10 + 2*qnorm(0.98), len = 1001),
dnorm(seq(10 - 2*4, 10 + 2*qnorm(0.98), len = 1001), 10, 2), type =
"h", col = "green")

> 1 - pnorm(0.9/0.45)
[1] 0.02275013
> c(qnorm(1 - (1 - 0.99)/2), 0.45*qnorm(1 - (1 - 0.99)/2))
[1] 2.575829 1.159123
> pnorm((0.9 - 1.8)/0.45)
[1] 0.02275013

> plot(seq(-4, 4, len = 1001), dnorm(seq(-4, 4, len = 1001)), main =
"P.D.F. of N(0, 1)", xlab = expression(x), ylab = expression(phi(x)),
type = "l", col = "green")
> points(seq(qnorm((1 - 0.99)/2), qnorm(1 - (1 - 0.99)/2), len =
1001), dnorm(seq(qnorm((1 - 0.99)/2), qnorm(1 - (1 - 0.99)/2), len =
1001)), type = "h", col = "green")

> plot(seq(-0.45*4, 0.45*4, len = 1001), dnorm(seq(-0.45*4, 0.45*4,
len = 1001), 0, 0.45), main = "P.D.F. of N(0, 0.45^2)", xlab =
expression(x), ylab = expression(f(x)), type = "l", col = "green")
> points(seq(0.45*qnorm((1 - 0.99)/2), 0.45*qnorm(1 - (1 - 0.99)/2),
len = 1001), dnorm(seq(0.45*qnorm((1 - 0.99)/2), 0.45*qnorm(1 - (1
- 0.99)/2), len = 1001), 0, 0.45), type = "h", col = "green")
```

```
> pnorm((0.2515 - 0.2508)/0.0005) - pnorm((0.2500 - 0.0015 -
0.2508)/0.0005)
[1] 0.9192412
> pnorm((0.2515 - 0.2500)/0.0005) - pnorm((0.2500 - 0.0015 -
0.2500)/0.0005)
[1] 0.9973002

> plot(seq(0.2508 - 0.0005*4, 0.2508 + 0.0005*4, len = 1001 ),
dnorm(seq(0.2508 - 0.0005*4, 0.2508 + 0.0005*4, len = 1001),
0.2508, 0.0005), main= "P.D.F. of N(0.2508, 0.0005^2)", xlab =
expression(x), ylab = expression(f(x)), type = "l", col = "green")
> points(seq(0.2500 - 0.0015, 0.2500 + 0.0015, len = 1001),
dnorm(seq(0.2500 - 0.0015, 0.2500 + 0.0015, len = 1001), 0.2508,
0.0005), type = "h", col = "green")

> plot(seq(-1, 6, len = 1001), dlnorm(seq(-1, 6, len = 1001), 0, 0.5),
main = "P.D.F.s of LogN(0, 0.25), LogN(0, 1), and LogN(0, 2.25)",
xlab = expression(x), ylab = expression(f(x)), type = "l", col =
"green")
> points(seq(-1, 6, len = 1001), dlnorm(seq(-1, 6, len = 1001)), type
= "l", col = "red")
> points(seq(-1, 6, len = 1001), dlnorm(seq(-1, 6, len = 1001), 0,
1.5), type = "l", col = "blue")

> 1 - plnorm(10000, 10, 1.5)
[1] 0.7007086
> qlnorm(1 - 0.99, 10, 1.5)
[1] 672.1478
```

```
> xl <- rlnorm(100, 10, 1.5)
> x2 <- rlnorm(10000, 10, 1.5)
> x3 <- rlnorm(1000000, 10, 1.5)
> c(mean(xl), mean(x2), mean(x3))
[1] 67687.86 70256.99 67842.72
> c(sd(xl), sd(x2), sd(x3))
[1] 127449.6 195232.0 200527.4
> c(var(xl), var(x2), var(x3))
[1] 16243403106 38115525117 40211246065

> c(gamma(1), gamma(2), gamma(3), gamma(4), gamma(5),
gamma(6), gamma(7))
[1]   1   1   2   6  24 120 720
> gamma(1/2)
[1] 1.772454

> plot(c(-1, 12), c(0, 1), main = "P.D.F.s of Ga(1, 1), Ga(8.3, 1/2),
and Ga(7.5, 1/3.75)", xlab = expression(x), ylab = expression(f(x)),
type = "n")
> points(seq(-1, -0.001, len = 1001), dgamma(seq(-1, -0.001, len =
1001), 1, 1), type = "l", col = "green")
> points(seq(0, 12, len = 1001), dgamma(seq(0, 12, len = 1001), 1,
1), type = "l", col = "green")
> points(seq(-1, 12, len = 1001), dgamma(seq(-1, 12, len = 1001),
8.3, 2), type = "l", col = "red")
> points(seq(-1, 12, len = 1001), dgamma(seq(-1, 12, len = 1001),
7.5, 3.75), type = "l", col = "blue")
```

```
> plot(c(-1, 15), c(0, 1), main = "P.D.F.s of Gamma(k/2, 2) for k = 1,
2, 3, 4, 5", xlab = expression(x), ylab = expression(f(x)), type = "n")
> points(seq(-1, -0.001, len = 1001), dgamma(seq(-1, -0.001 , len =
1001), 1/2, 1/2), type = "l", col = "green")
> points(seq(0.001, 15, len = 1001), dgamma(seq(0.001, 15, len =
1001), 1/2, 1/2), type = "l", col = "green")
> points(seq(-1, -0.001, len = 1001), dgamma(seq(-1, -0.001 , len =
1001), 1, 1/2), type = "l", col = "red")
> points(seq(0, 15, len = 1001), dgamma(seq(0, 15, len = 1001), 1,
1/2), type = "l", col = "red")
> points(seq(-1, 15, len = 1001), dgamma(seq(-1, 15, len = 1001),
3/2, 1/2), type = "l", col = "blue")
> points(seq(-1, 15, len = 1001), dgamma(seq(-1, 15, len = 1001), 2,
1/2), type = "l", col = "purple")
> points(seq(-1, 15, len = 1001), dgamma(seq(-1, 15, len = 1001),
5/2, 1/2), type = "l")

> plot(c(-1, 80), c(0, 0.1), main = "P.D.F.s of Gamma(k/2, 2) for k =
10, 20, 30, 40, 50", xlab = expression(x), ylab = expression(f(x)),
type = "n")
> points(seq(-1, 80, len = 1001), dgamma(seq(-1, 80, len = 1001), 5,
1/2), type = "l", col = "green")
> points(seq(-1, 80, len = 1001), dgamma(seq(-1, 80, len = 1001),
10, 1/2), type = "l", col = "red")
> points(seq(-1, 80, len = 1001), dgamma(seq(-1, 80, len = 1001),
15, 1/2), type = "l", col = "blue")
> points(seq(-1, 80, len = 1001), dgamma(seq(-1, 80, len = 1001),
20, 1/2), type = "l", col = "purple")
> points(seq(-1, 80, len = 1001), dgamma(seq(-1, 80, len = 1001),
25, 1/2), type = "l")
```

```
> plot(c(-1, 8), c(0, 1), main = "P.D.F.s of Wei(1, 1), Wei(2, 3.4),
and Wei(6.5, 4.5)", xlab = expression(x), ylab = expression(f(x)),
type = "n")
> points(seq(-1, -0.001, len = 1001), dweibull(seq(-1, -0.001, len =
1001), 1, 1), type = "l", col = "green")
> points(seq(0, 8, len = 1001), dweibull(seq(0, 8, len = 1001), 1, 1),
type = "l", col = "green")
> points(seq(-1, 8, len = 1001), dweibull(seq(-1, 8, len = 1001), 2,
3.4), type = "l", col = "red")
> points(seq(-1, 8, len = 1001), dweibull(seq(-1, 8, len = 1001), 6.5,
4.5), type = "l", col = "blue")

> 1 - pweibull(6000, 1/2, 5000)
[1] 0.3343907

> xl <- rweibull(100, 1/2, 5000)
> x2 <- rweibull(10000, 1/2, 5000)
> x3 <- rweibull(1000000, 1/2, 5000)
> c(mean(xl), mean(x2), mean(x3))
[1]    9070.494    9926.869 10006.306
> c(sd(xl), sd(x2), sd(x3))
[1] 21929.32 22613.13 22361.01
> c(var(xl), var(x2), var(x3))
[1] 480895149 511353751 500014834
```

```
> plot(c(0, 1), c(0, 5), main = "P.D.F.s of B(0.5, 0.5), B(5, 1), B(1,
3), B(2, 2) and B(2, 5)", xlab = expression(x), ylab =
expression(f(x)), type = "n")
> points(seq(0.001, 0.999, len = 1001), dbeta(seq(0.001, 0.999, len =
1001), 0.5, 0.5), type = "l", col = "green")
> points(seq(0, 1, len = 1001), dbeta(seq(0, 1, len = 1001), 5, 1),
type = "l", col = "red")
> points(seq(0, 1, len = 1001), dbeta(seq(0, 1, len = 1001), 1, 3),
type = "l", col = "blue")
> points(seq(0, 1, len = 1001), dbeta(seq(0, 1, len = 1001), 2, 2),
type = "l", col = "purple")
> points(seq(0, 1, len = 1001), dbeta(seq(0, 1, len = 1001), 2, 5),
type = "l")

> 1 - pbeta(0.7, 2.5, 1)
[1] 0.5900366

> c(2.5/(2.5 + 1), 2.5/(3.5^2*4.5))
[1] 0.71428571 0.04535147

> xl <- rbeta(100, 2.5, 1)
> x2 <- rbeta(10000, 2.5, 1)
> x3 <- rbeta(1000000, 2.5, 1)
> c(mean(xl), mean(x2), mean(x3))
[1] 0.7380543 0.7120905 0.7142915
> c(sd(xl), sd(x2), sd(x3))
[1] 0.1940278 0.2140382 0.2129866
> c(var(xl), var(x2), var(x3))
[1] 0.03764678 0.04581233 0.04536331

> Battery <- c(176, 191, 214, 220, 205, 192, 201, 190, 183, 185)
> sort(Battery)
 [1] 176 183 185 190 191 192 201 205 214 220
> qnorm((1:10 - 1/2)/10)
 [1] -1.6448536 -1.0364334 -0.6744898 -0.3853205 -0.1256613
0.1256613
 [7]  0.3853205  0.6744898  1.0364334  1.6448536
```

```
> qqnorm(Battery, main = "Normal Q-Q Plot of Battery")

> shapiro.test(Battery)

        Shapiro-Wilk normality test

data:  Battery
W = 0.95412, p-value = 0.7173

> AluminumAlloy <- c(81, 249, 117, 227, 134, 98, 135, 149, 225,
59, 291, 223, 127, 185, 181, 101, 205, 115, 240, 151, 98, 80, 198,
161, 240, 118, 117, 342, 197, 146, 158, 82, 83, 98, 104, 197, 64, 34,
65, 100, 139, 137, 342, 144, 215, 249, 149, 185, 151, 200)

> qqnorm(AluminumAlloy, main = "Normal Q-Q Plot of Aluminum
Alloy")

> shapiro.test(AluminumAlloy)

        Shapiro-Wilk normality test

data:  AluminumAlloy
W = 0.95749, p-value = 0.0698

> qqnorm(log(AluminumAlloy), main = "Lognormal Q-Q Plot of
Aluminum Alloy", ylab = "Sample Log(Quantiles)")

> shapiro.test(log(AluminumAlloy))

        Shapiro-Wilk normality test

data:  log(AluminumAlloy)
W = 0.97634, p-value = 0.41

> qqplot(log(-log(1 - (1:50 - 1/2)/50)), log(AluminumAlloy), main =
"Weibull Q-Q Plot of Aluminum Alloy", xlab = "Theoretical
Quantiles", ylab = "Sample Log(Quantiles)")
```