# Answers

1. (i) Rational    (ii) Rational    (iii) Irrational    (iv) Irrational    (v) Irrational
     (vi) Irrational    (vii) Irrational    (viii) Irrational    (ix) Rational    (x) Irrational

2. (i) 
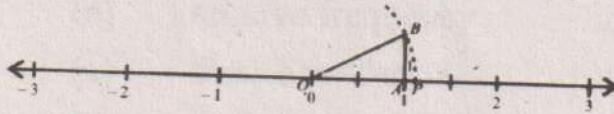
   (ii) 
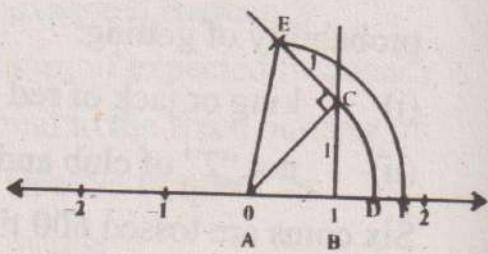
   (iii) 
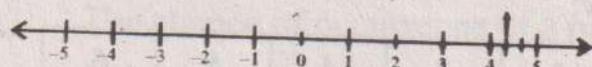
   (iv) 
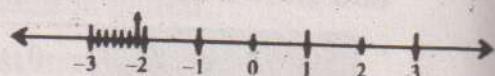
   (v) 
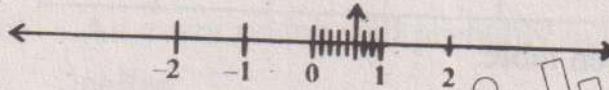
   (vi) 
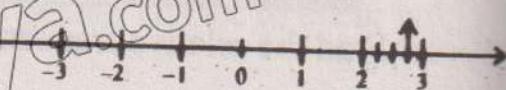
3. (i) $\dfrac{4}{9}$    (ii) $\dfrac{37}{99}$    (iii) $\dfrac{21}{99}$

4. (i) Associative property over addition    (ii) Commutative property over addition
   (iii) Additive inverse    (iv) Left distributive property
   (v) Additive identity    (vi) Multiplicative identity
   (vii) Associative property under multiplication    (viii) Commutative property under multipliction

5. (i) Additive property    (ii) Reciprocal property    (iii) Additive property
   (iv) Multiplicative property    (v) Multiplicative property    (vi) Trichotomy property

## EXERCISE 1.2

1. (i) $4-\sqrt{3}$    (ii) $\dfrac{\sqrt{6}+\sqrt{15}}{3}$    (iii) $\dfrac{\sqrt{10}-\sqrt{5}}{5}$    (iv) $17-12\sqrt{2}$    (v) $5-2\sqrt{6}$

   (vi) $2\sqrt{3}(\sqrt{7}-\sqrt{5})$    2. (i) $\dfrac{8}{27}$    (ii) 12    (iii) $\dfrac{10}{3}$    (iv) $x^2yz^4$    (v) $\dfrac{1}{6}$

   (vi) $\dfrac{9}{2}$    (vii) $\dfrac{27}{16}$    (viii) 243    (ix) 19    3. (i) 6    (ii) $2\sqrt{8}$    (iii) 34

   (iv) $12\sqrt{8}$    (v) 1154    (vi) 32    4. $P=-25, q=18$    5. (i) $\dfrac{3375}{512}$    (ii) $\dfrac{2}{3}$

   (iii) $\dfrac{6}{5}$    (iv) $a+b^2$

## EXERCISE 1.3

1.  13, 14, 15    2.  $\overline{AB} = 4\sqrt{3} - 2\sqrt{5}$    3.  $(11\sqrt{2} - 2)m^2$    4.  45, 23

5.  118.4   6. 20 years   7.  1.33%    8.  Rs.6225    9.  Rs.52500

## REVIEW EXERCISE 1

1.  (i) c   (ii) d   (iii) d   (iv) d   (v) a   (vi) b   (vii) b   (viii) a   (ix) d   (x) d

7.  (i) $\dfrac{x^4 y}{z^4}$    (ii) $3^{2x}$    (iii) 27    8.  15, 17, 19    9.  34, 62    10. 540750

## EXERCISE 2.1

1.  (i) $2 \times 10^6$    (ii) $4.89 \times 10^4$    (iii) $4.2 \times 10^{-3}$    (iv) $9 \times 10^{-7}$    (v) $7.3 \times 10^4$

(vi) $6.5 \times 10^1$   2.  (i) 804    (ii) 300000    (iii) 0.015    (iv) 17700000

(v) 0.0000055    (vi) 0.00004    3.  300,000,000 m/sec    4.  $4.0075 \times 10^7$ m

5.  6779 km    6.  12756 km

## EXERCISE 2.2

1.  (i) $\log_{10} 1000 = 3$    (ii) $\log_2 256 = 8$    (iii) $\log_3 \dfrac{1}{27} = -3$    (iv) $\log_{20} 400 = 2$

(v) $\log_{16} \dfrac{1}{2} = -\dfrac{1}{4}$    (vi) $\log_{11} 121 = 2$    (vii) $\log_q p = r$    (viii) $\log_5 \dfrac{1}{2} = -\dfrac{1}{5}$

2.  (i) $5^3 = 125$    (ii) $2^4 = 16$    (iii) $23^0 = 1$    (iv) $5^1 = 5$

(v) $2^{-3} = \dfrac{1}{8}$    (vi) $9^{\frac{1}{2}} = 3$    (vii) $10^5 = 100000$    (viii) $4^{-2} = \dfrac{1}{16}$

3.  (i) $x = 4$    (ii) $x = 0$    (iii) $x = 8$    (iv) $x = \dfrac{1}{1000}$    (v) $x = 8$    (vi) $x = 10$

## EXERCISE 2.3

1.  (i) 3    (ii) 1    (iii) −2    (iv) 2    (v) −5    (vi) 5

2.  (i) 1.6335   (ii) 2.7627   (iii) 0.2971   (iv) −1.0575    (v) −1.3279    (vi) −3.4510

3.  (i) 3.5019   (ii) 1.5019   (iii) −1.4981    4.  (i) $x = 1.015$    (ii) $x = 15.56$

(iii) $x = 0.0003681$    (iv) $x = 0.02675$    (v) $x = 2270$    (vi) $x = 0.009585$

## EXERCISE 2.4

1.  (i) 1    (ii) 7    (iii) −2    (iv) 2    (v) 5    (vi) 1

2.  (i) $\log 45$    (ii) $\log 27$    (iii) $6 \log_a b$    (iv) $\log_3 x^2 y$    (v) $\log_5 \dfrac{x^4 z}{y}$    (vi) $\ln \dfrac{a^2 b^3}{c^4}$

3.  (i) $\log 11 - \log 5$    (ii) $\dfrac{3}{2} \log_5 2 + 3 \log_5 a$    (iii) $2 \ln a + \ln b - \ln c$    (iv) $\dfrac{1}{9}[\log x + \log y - \log z]$

(v) $\dfrac{4}{3} \ln 2 + \ln x$    (vi) $5[\log_2 (1-a) - \log_2 b]$    4.  (i) $x = 5$    (ii) $x = 4$    (iii) $x = -10$

(iv) $x = 5$    (v) $x = 22$    (vi) $x = 5\dfrac{2}{3}$    5. (i) 2.960   (ii) 23.62   (iii) 1.339

(iv) 14.21    6. M = 3      7. 14 years    8. 17.17 °C

## REVIEW EXERCISE 2

1. (i) c   (ii) b   (iii) b   (iv) d   (v) a   (vi) c   (vii) d   (viii) c   (ix) d   (x) c

2. (i) $5.67 \times 10^{-4}$   (ii) $7.34 \times 10^{2}$   (iii) $3.3 \times 10^{2}$   3. (i) 2600    (ii) 0.0008794

   (iii) 0.000006   4.   (i) $\log_{3} 2187 = 7$    (ii) $\log_{a} c = b$    (iii) $\log_{12} 144 = 2$

5. (i) $4^{x} = 8$   (ii) $9^{3} = 729$   (iii) $4^{5} = 1024$

6. (i) $x = 3$   (ii) $x = -\dfrac{1}{2}$   (iii) $x = -\dfrac{3}{5}$   7. (i) $\log \dfrac{x^{7}}{y^{6}}$   (ii) $\log 2$   (iii) $\log_{5} 2$

8. (i) $\log x + \log y + 6 \log z$   (ii) $\dfrac{1}{6}\left[ 5\log_{3} m + 3 \log_{3} n \right]$ (iii) $\dfrac{3}{2}\left[ \log 2 + \log x \right]$

9. (i) 4.086   (ii) 1133     (iii) 24.01   10. 2035

## EXERCISE 3.1

1. (i)   $\{x \mid x = n^{2}, n \in N \wedge 1 \le x \le 500\}$     (ii)   $\{x \mid x = 2^{n}, n \in N \wedge 1 \le x \le 256\}$

   (iii)   $\{x \mid x \in Z \wedge -1000 \le x \le 1000\}$     (iv)   $\{x \mid x = 6n, n \in N \wedge 1 \le n \le 20\}$

   (v)   $\{x \mid x = 100 + 2n, n \in W \wedge 0 \le n \le 150\}$     (vi)   $\{x \mid x = 3^{n}, n \in W\}$

   (vii)   $\{x \mid x \text{ is a divisor of } 100\}$     (viii)   $\{x \mid x = 5n, n \in N \wedge 1 \le n \le 20\}$

   (ix) $\{x \mid x \in Z \wedge -100 < x\ 1000\}$    2. (i) $\{3, 6, 9, \ldots, 35\}$    (ii) $\left\{ -\dfrac{1}{2} \right\}$

   (iii) $\{2, 3, 5, 7, 11\}$    (iv) $\{1, 2, 4, 8, 16, 32, 64, 128\}$    (v) $\{2, 4, 8, 16, 32, 64, 128\}$

   (vi) { }    (vii) $\{1, 2, 3, 4, 5, \ldots\}$     (viii) { }

4. yes, { } or ∅    5.   $\{a, b\}$ is a set containing two elements $a$ and $b$ while $\{\{a, b\}\}$ is a set containing one element $\{a, b\}$

6. (i) 1    (ii) 4    (iii) 128    (iv) 256    (v) 4    (vi) 9

7. (i) $\{\emptyset, \{9\}, \{11\}, \{9, 11\}\}$

   (ii) $\{\emptyset, \{+\}, \{-\}, \{\times\}, \{\div\}, \{+, -\}, \{+, \times\}, \{+, \div\}, \{-, \times\}, \{-, \div\}, \{\times, \div\}, \{+, -, \times\}, \{+, -, \div\}, \{+, \times, \div\}, \{-, \times, \div\}, \{+, -, \times, \div\}\}$

   (iii) $\{\emptyset, \{\emptyset\}\}$    (iv) $\{\emptyset, \{a\}, \{\{b, c\}\}, \{a, \{b, c\}\}\}$

## EXERCISE 3.2

1. (i) $A = \{6, 12, 18, 24, 30\}$, $B = \{8, 16, 24\}$     (ii) $A \cap B = \{24\}$    (iii)
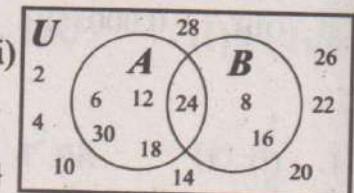
2. (i) $G = \{1, 2, 4, 8, 16, 32, 64, 128\}$,

   $H = \{1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144\}$

   (ii) $G \cup H = \{1, 2, 4, 8, 9, 16, 25, 32, 36, 49, 64, 81, 100, 121, 128, 144\}$

   (iii) $G \cap H = \{1, 4, 16, 64\}$

3. (i) $P \cap Q = \{2, 3, 5, 7\}$   (ii) $P \cup Q = \{1, 2, 3, 5, 6, 7, 10, 11, 13, 14, 15, 17, 19\}$

7. 9    8. 130    9. 9    10. 18    11. (a) $\{1, 2, \ldots, 49, 90, 91, \ldots, 100\}$ (b) 40
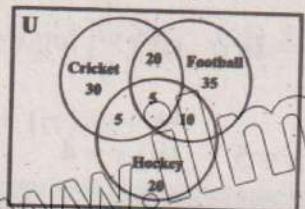
12. (a) 5 (b)

13. (a) 85 (b) 45 (c) 27 (d)
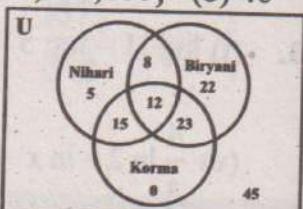
## EXERCISE 3.3

**1.** (i)    $\{(1, 1), (2, 2), (3, 3), (4, 4)\}$

Domain of (i) = $\{1, 2, 3, 4\}$

Range of (i) = $\{1, 2, 3, 4\}$
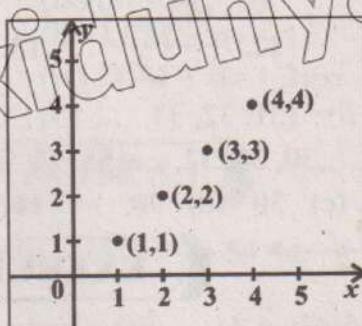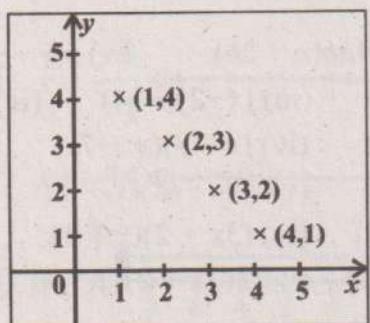


(ii)    $\{(1, 4), (2, 3), (3, 2), (4, 1)\}$

Domain of (ii) = $\{1, 2, 3, 4\}$

Range of (ii) = $\{1, 2, 3, 4\}$

(iii)    $\{(1, 1), (1, 2), (1, 3), (2, 1), (2, 2), (3, 1)\}$

Domain of (iii) = $\{1, 2, 3\}$

Range of (iii) = $\{1, 2, 3\}$
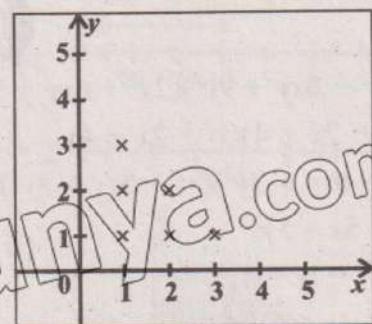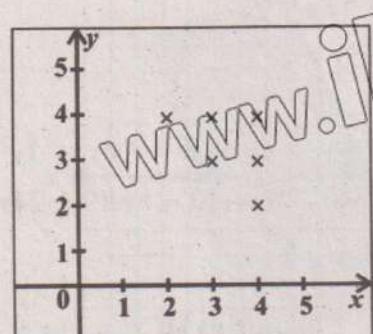
(iv)    $\{(2, 4), (3, 3), (3, 4), (4, 2), (4, 3), (4, 4)\}$

Domain of (iv) = $\{2, 3, 4\}$

Range of (iv) = $\{2, 3, 4\}$

**2.** Fig (1) does not represent a function.    Fig (2) represents a function, which is a bijective function.

Fig (3) represents a function, which is a bijective function.

Fig (4) represents a function, which is an into function.

**3.** (i) 2    (ii) $-7$    (iii) 4    (iv) 2    (v) 17    (vi) $\dfrac{5}{4}$    **4.** $a = 2, b = 1$    **5.** $a = \dfrac{10}{3}, b = -\dfrac{5}{3}$

**6.** $x = 6$    **7.** $c = \dfrac{4}{3}, d = \dfrac{14}{3}$

## REVIEW EXERCISE 3

**1.** (i) b    (ii) c    (iii) a    (iv) d    (v) d    (vi) b    (vii) b    (viii) d    (ix) a    (x) b

**2.** (i) $\{2, 4, 6, 8, 10, \ldots\}$    (ii) $\{3, 5, 7, 9, 11, \ldots\}$    (iii) $\{0, 11, 22, 33, 44, 55, 66, 77, 88, 99, 110\}$

(iv) $\emptyset$    (v) $\emptyset$    (vi) $\emptyset$    (vii) $\{0\}$    (viii) $\emptyset$    **3.** (i) $\{1, 3, 5, 7, 9\}$

(ii) $\{6, 7, 8, 9, 10\}$    (iii) $\{1, 2, 3, 4, 5, 6, 8, 10\}$    (iv) $\{6, 8, 10\}$    (v) $\emptyset$

(vi) $\{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$    (vii) $\{1, 3, 5, 7, 9\}$    (viii) $\emptyset$

8. $\{10, 20, 30, 40, 50, \ldots\}$   10. (i) $-2$ (ii) $-9$ (iii) $-\dfrac{41}{3}$ (iv) $50$ (v) $645$ (vi) $95$

11. $a = \dfrac{7}{6}, b = \dfrac{16}{3}$   12. $\dfrac{103}{16}$   13. $m = \dfrac{45}{16}, n = 5$

14. $A = \{1, 2, 3, \ldots, 30\}, B = \{31, 32, 33, \ldots, 55\}, C = \{76, 77, 78, \ldots, 100\}$.

$A \cup B \cup C = \{1, 2, 3, \ldots, 30, 31, 32, \ldots, 55, 76, 77, \ldots, 100\}$

15. (a) $150$   (b) $30$   (c) $30$   (d) $90$   16. (a) $160$   (b) $160$   (c) $140$   (d) $50$

## EXERCISE 4.1

1. (i) $6(x + 2)$   (ii) $5y(3y + 4)$   (iii) $-3x(4x + 1)$   (iv) $4ab(a + 2b)$   (v) $x(y - 3x + 2)$
   (vi) $3ab(a - 3b + 5)$   2. (i) $5(x+3)$   (ii) $(x+1)(x+3)$   (iii) $(x+2)(x+4)$   (iv) $(x+2)^2$

3. (i) $(x + 4)(x - 3)$   (ii) $(x + 5)(x + 2)$   (iii) $(x - 4)(x - 2)$   (iv) $(x - 8)(x + 7)$
   (v) $(x - 12)(x + 2)$   (vi) $(y + 6)(y - 2)$   (vii) $(y + 9)(y + 4)$   (viii) $(x - 2)(x + 1)$

4. (i) $(2x + 1)(x + 3)$   (ii) $(2x + 5)(x + 3)$   (iii) $(4x + 1)(x + 3)$   (iv) $(3x + 2)(x + 1)$
   (v) $(3y - 2)(y - 3)$   (vi) $(2y - 1)(y - 2)$   (vii) $(4z - 3)(z - 2)$   (viii) $(3x + 2)(3 - x)$

## EXERCISE 4.2

1. (i) $(2x^2 - 6xy + 9y^2)(2x^2 + 6xy + 9y^2)$   (ii) $(a^2 - 4ab + 8b^2)(a^2 + 4ab + 8b^2)$
   (iii) $(x^2 - 2x + 4)(x^2 + 2x + 4)$   (iv) $(x^2 - 4x + 1)(x^2 + 4x + 1)$
   (v) $(x^2 - 6xy + 3y^2)(x^2 + 6xy + 3y^2)$   (vi) $(x^2 - 3xy + y^2)(x^2 + 3xy + y^2)$

2. (i) $(x^2 + 5x + 5)^2$   (ii) $(x^2 - 5x + 3)(x^2 - 5x - 13)$
   (iii) $(2x^2 + 7x + 4)^2$   (iv) $(3x^2 + 5x + 6)(3x^2 + 5x + 2)$
   (v) $(x^2 + 4x + 6)(x^2 + 8x + 6)$   (vi) $(x^2 - 5x + 2)(x^2 + 5x + 2)$

3. (i) $(2x + 1)^3$   (ii) $(3a - 4b)^3$   (iii) $(x + 6y)^3$   (iv) $(2x - 5y)^3$

4. (i) $(5a - 1)(25a^2 + 5a + 1)$   (ii) $(4x + 5)(16x^2 - 20x + 25)$   (iii) $(x^2 - 3)(x^4 + 3x^2 + 9)$
   (iv) $(10a + 1)(100a^2 - 10a + 1)$   (v) $(7x + 6)(49x^2 - 42x + 36)$   (vi) $(3 - 8y)(9 + 24y + 64y^2)$

## EXERCISE 4.3

1. (i) $HCF = 7xy$   (ii) $HCF = 2x - 3y$   (iii) $HCF = x^2 + x + 1$   (iv) $HCF = a(a + 3)$
   (v) $HCF = t + 1$   (vi) $HCF = x + 8$   2. (i) $HCF = 3x - 2$   (ii) $HCF = x^2 - 4x + 3$
   (iii) $HCF = 2(x^2 + 1)$   (iv) $HCF = x(x - 2)$   3. (i) $LCM = 12a^2b^2$   (ii) $LCM = x^2(x + 1)$
   (iii) $LCM = a(a - 2)^2$   (iv) $LCM = x(x^4 - 16)$   (v) $LCM = 4(4 - x^2)(x + 3)$   4. $y^2 - 12y + 35$

5. $q(x) = 9x^3(x^3 - a^2)$   6. $12x^2(x - a)(x + a)^3$

## EXERCISE 4.4

1. (i) $\pm(x - 4)$   (ii) $\pm(3x \pm 2)$   (iii) $\pm(6a + 7)$   (iv) $\pm(8y - 2)$
   (v) $\pm\sqrt{2}(10t - 3)$   (vi) $\pm\sqrt{10}(2x + 3)$

2. (i) $\pm(2x^2 - 7x - 3)$   (ii) $\pm(11x^2 - 9x - 12)$   (iii) $\pm(x^2 - 5xy + y^2)$   (iv) $\pm(2x^2 + 3x + 7)$

3. $x = 2$ or $x = 4$   4. $x = 5$   5. $x = 0, x = 1$ or $x = 2$   6. $x = 1$ or $x = 3$

## REVIEW EXERCISE 4

1. (i) a   (ii) b   (iii) b   (iv) c   (v) c   (vi) a   (vii) c   (viii) a   (ix) c   (x) a

**2.** (i) $2x(2x^2+9x-6)$    (ii) $(x+4y)(x^2-4xy+16y^2)$    (iii) $(xy-2)(x^2y^2+2xy+4)$
    (iv) $-(x+3)(x+20)$   (v) $(2x+1)(x+3)$    (vi) $(x^2+4x+8)(x^2-4x+8)$     (vii) $(x^2+2x+3)(x^2-2x+3)$
    (viii) $x(x+9)(x^2+9x+38)$                 (ix) $(x^2+6x-3)^2$

**3.** (i) LCM $= 8x^2(x+2)(x+3)$, HCF $= 4x$     (ii) LCM $= x(x-1)(x-3)(x+4)$, HCF $= x-1$
    (iii) LCM $= (x-4)(x+4)^2$, HCF $= x+4$     (iv) LCM $= x(x+2)(x^2-9)$, HCF $= x-3$

**4.** $\pm(4x^2+1)$   **5.** 3 years or 5 years

## EXERCISE 5.1
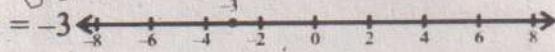
**1.** (i) $x=-3$     (ii) $x=-54$ 
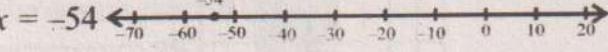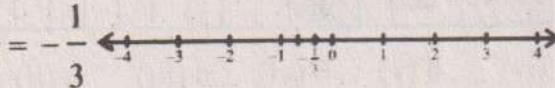
    (iii) $x=-\dfrac{1}{3}$     (iv) $x=-1$ 
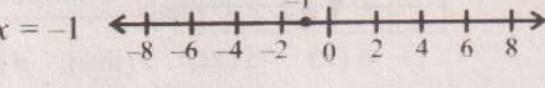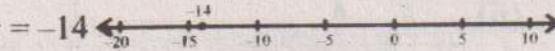
    (v) $x=-14$     (vi) $x=6$ 
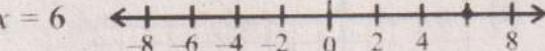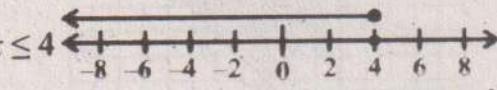
**2.** (i) $x\le 4$     (ii) $x<7$ 

    (iii) $x\ge 0$     (iv) $x\le -10$ 

    (v) $x<\dfrac{2}{5}$     (vi) $x\ge 2$ 

**3.**
(i) 

(ii) 

(iii) 

(iv)

(v)



(vi)



2. (i)



(ii)



(iii)



(iv)



(v)



(vi)
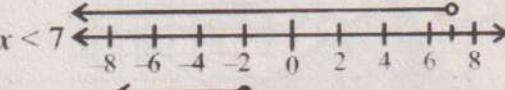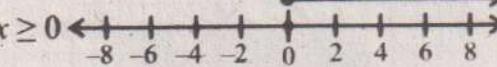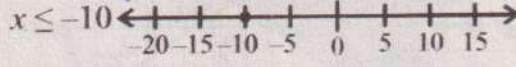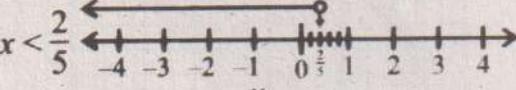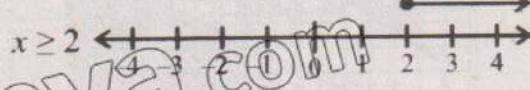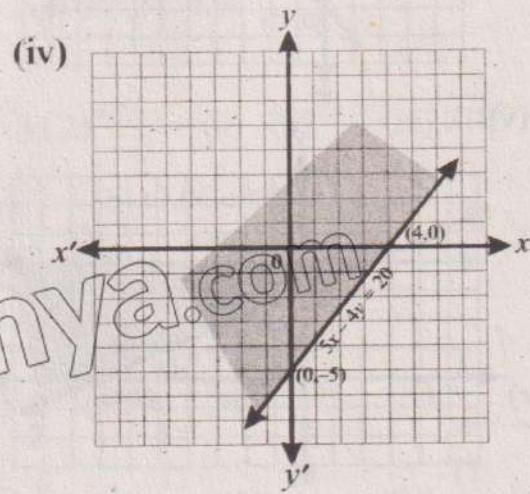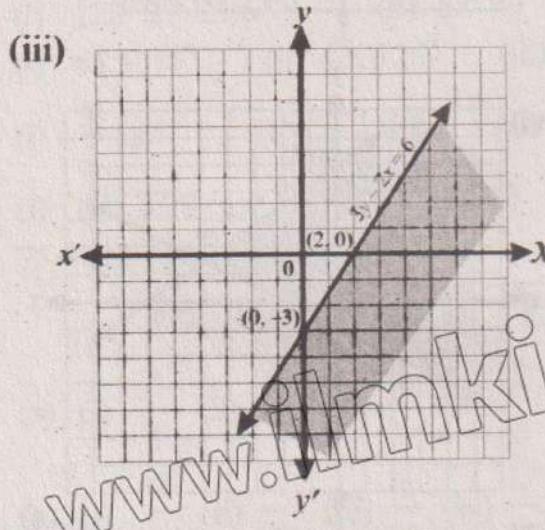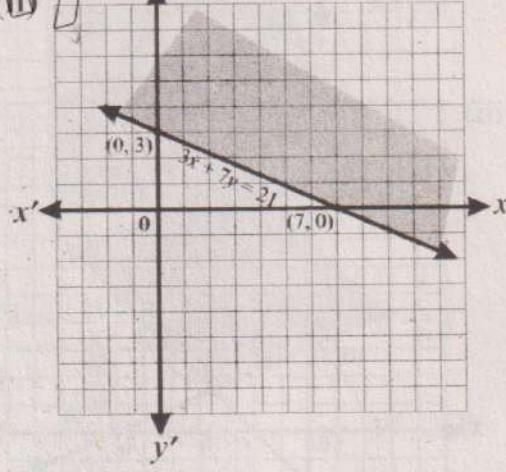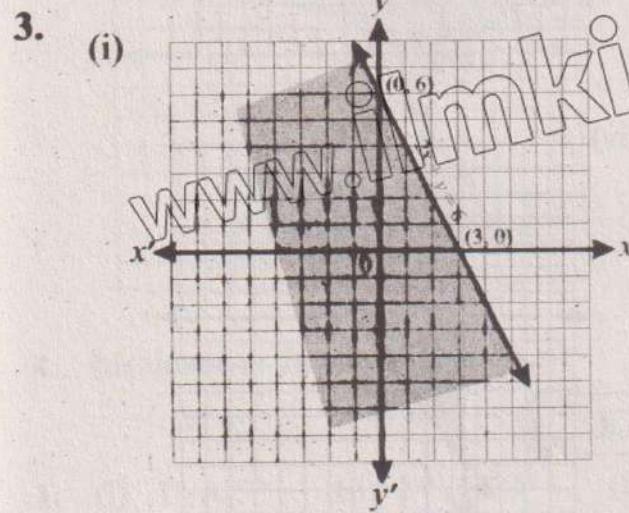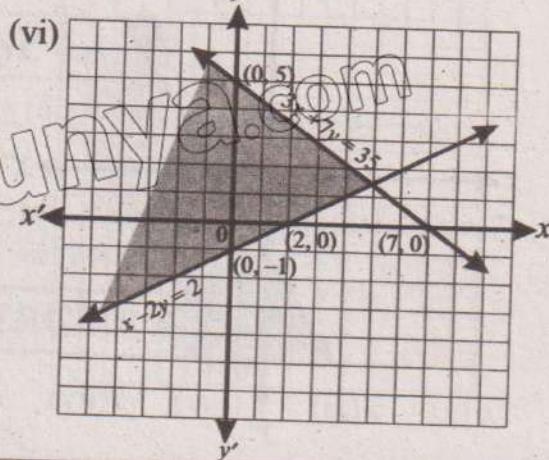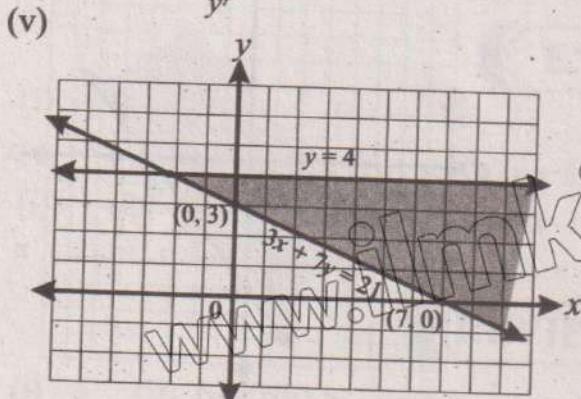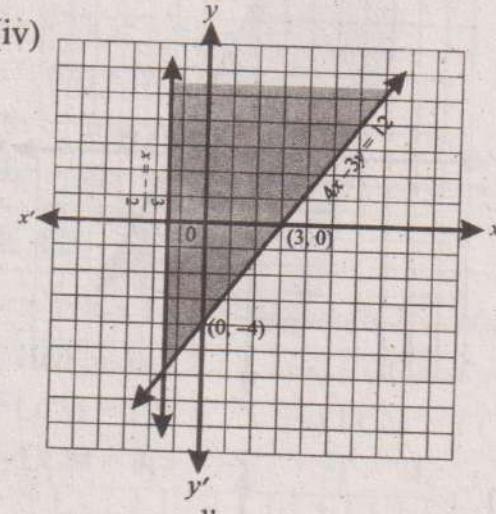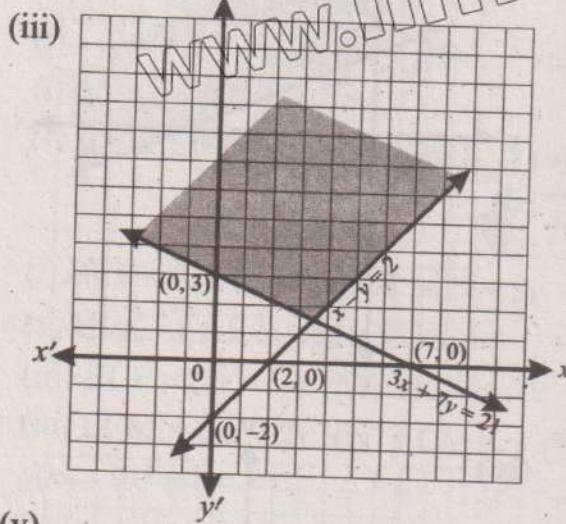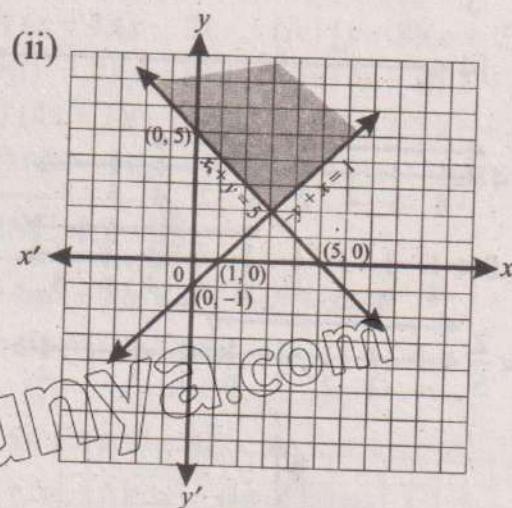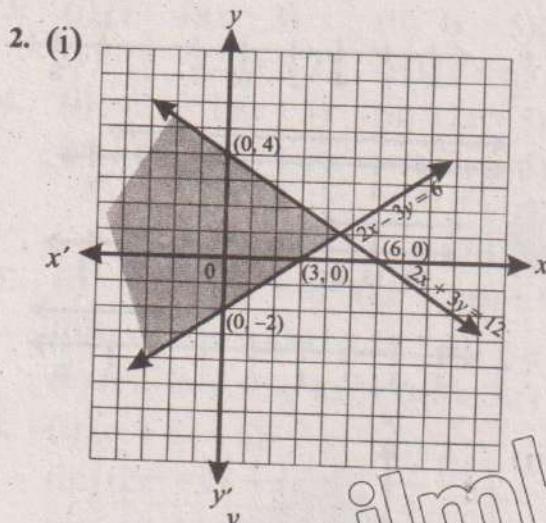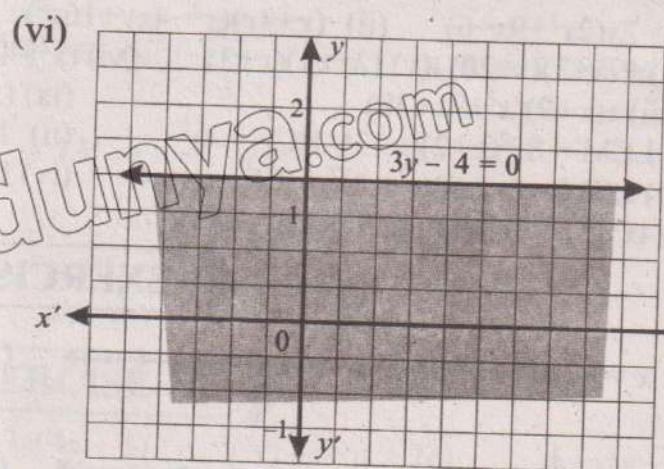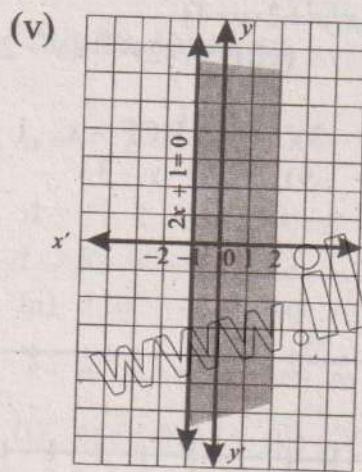
## EXERCISE 5.2

1. Maximum at the corner point (16, 12)
2. Maximum at the corner point (0, 5)
3. Maximum at the corner point (0, 4)
4. Minimum at the corner point (0, 3)
5. Maximum at the corner point (2, 6)
6. Maximum at the corner point (9, 0) and minimum at the corner point (0, 3)

## REVIEW EXERCISE 5

1. (i) c   (ii) c   (iii) c   (iv) d   (v) b   (vi) b   (vii) b   (viii) c   (ix) b   (x) b

2. (i) $x = -\dfrac{1}{2}$      (ii) $x = \dfrac{1}{2}$ 

    (iii) $x < 3$      (iv) $x \leq -1$ 

3. (i)      (ii) 
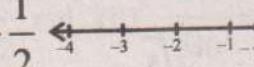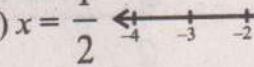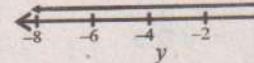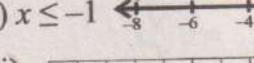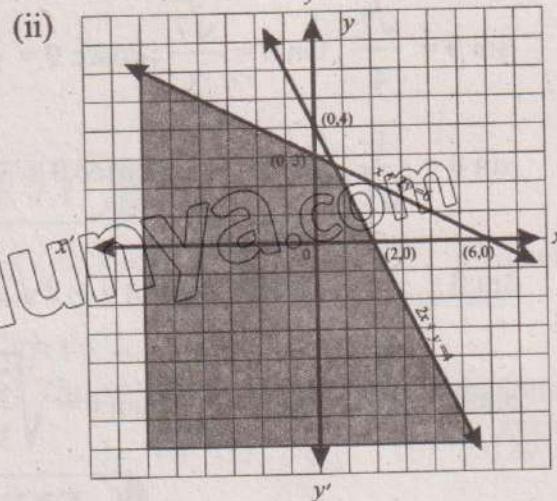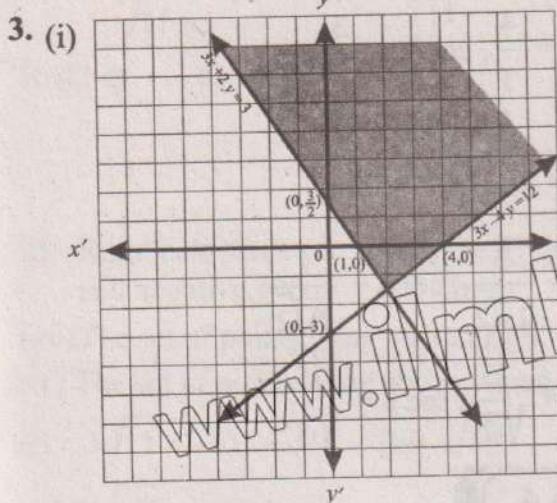
4. Maximum at the corner point (0, 4).     5. Minimum at the corner point $\left(\dfrac{3}{2}, \dfrac{1}{2}\right)$.

## EXERCISE 6.1

1. (i) 1$^{st}$, 425°    (ii) 2$^{nd}$, −225°    (iii) 4$^{th}$, 320°    (iv) 3$^{rd}$, −150°    (v) 3$^{rd}$, 210°

2. (i) 123° 27′ 21.6″     (ii) 58° 47′ 20.76″     (iii) 90° 34′ 4.08″

3. (i) 65.5375°    (ii) 42.3125°    (iii) 78.76°

4. (i) $\dfrac{\pi}{5}$ rad    (ii) $\dfrac{\pi}{8}$    (iii) $\dfrac{3\pi}{8}$ rad    5. (i) 11.25°    (ii) 396°    (iii) 210°

6. (i) (a) 6.28 cm    (b) 18.84 cm$^2$    (ii) (a) 4 cm    (b) 3.06 cm$^2$

7. 75.4 cm$^2$, 16.67%    8. 6.25%      9. 12 cm, 5 cm

## EXERCISE 6.2

1. (a) (i) $\dfrac{4}{5}$   (ii) $\dfrac{3}{5}$   (iii) $\dfrac{4}{3}$   (iv) $\dfrac{5}{3}$   (v) $\dfrac{5}{4}$   (vi) $\dfrac{4}{3}$   (vii) $\dfrac{3}{4}$   (viii) $\dfrac{5}{3}$   (ix) $\dfrac{5}{4}$   (x) $\dfrac{4}{5}$

   (b) (i) $\dfrac{8}{17}$   (ii) $\dfrac{15}{17}$   (iii) $\dfrac{8}{15}$   (iv) $\dfrac{17}{15}$   (v) $\dfrac{17}{8}$   (vi) $\dfrac{8}{15}$   (vii) $\dfrac{15}{8}$   (viii) $\dfrac{17}{15}$   (ix) $\dfrac{17}{8}$   (x) $\dfrac{8}{17}$

(c) (i) $\dfrac{5}{13}$ (ii) $\dfrac{12}{13}$ (iii) $\dfrac{5}{12}$ (iv) $\dfrac{13}{5}$ (v) $\dfrac{13}{12}$ (vi) $\dfrac{5}{12}$ (vii) $\dfrac{12}{5}$ (viii) (ix) $\dfrac{13}{5}$ (x) $\dfrac{5}{13}$

2. (i) $\dfrac{c}{b}$ (ii) $\dfrac{a}{b}$ (iii) $\dfrac{c}{a}$ (iv) $\dfrac{a}{b}$ (v) $\dfrac{c}{b}$ (vi) $\dfrac{a}{c}$

4. (i) cos 60° (ii) sin 60° (iii) cot 60° (iv) cot 30° (v) cos 30° (vi) sin 30° (vii) cos 45°

(viii) cot 45° (ix) sin 45° 5. (i) $\dfrac{a}{b}$ (ii) $\dfrac{a}{b}$ (iii) $\dfrac{c}{a}$ (iv) $\dfrac{b}{c}$ (v) $\dfrac{a}{c}$

(vi) $\dfrac{a}{b}$ (vii) $\dfrac{c}{b}$ (viii) $\dfrac{a}{c}$ (ix) $\dfrac{b}{c}$ (x) $\dfrac{c}{a}$

## EXERCISE 6.3

1. (i) $\cos\theta = \dfrac{\sqrt{5}}{3}$, $\tan\theta = \dfrac{2}{\sqrt{5}}$, $\operatorname{cosec}\theta = \dfrac{3}{2}$, $\sec\theta = \dfrac{3}{\sqrt{5}}$, $\cot\theta = \dfrac{\sqrt{5}}{2}$

(ii) $\sin\theta = \dfrac{\sqrt{7}}{4}$, $\tan\theta = \dfrac{\sqrt{7}}{3}$, $\operatorname{cosec}\theta = \dfrac{4}{\sqrt{7}}$, $\sec\theta = \dfrac{4}{3}$, $\cot\theta = \dfrac{3}{\sqrt{7}}$

(iii) $\sin\theta = \dfrac{1}{\sqrt{5}}$, $\cos\theta = \dfrac{2}{\sqrt{5}}$, $\operatorname{cosec}\theta = \sqrt{5}$, $\sec\theta = \dfrac{\sqrt{5}}{2}$, $\cot\theta = 2$

(iv) $\sin\theta = \dfrac{2\sqrt{2}}{3}$, $\cos\theta = \dfrac{1}{3}$, $\tan\theta = 2\sqrt{2}$, $\operatorname{cosec}\theta = \dfrac{3}{2\sqrt{2}}$, $\cot\theta = \dfrac{1}{2\sqrt{2}}$

(v) $\sin\theta = \sqrt{\dfrac{2}{5}}$, $\cos\theta = \sqrt{\dfrac{3}{5}}$, $\tan\theta = \sqrt{\dfrac{2}{3}}$, $\operatorname{cosec}\theta = \sqrt{\dfrac{5}{2}}$, $\sec\theta = \sqrt{\dfrac{5}{3}}$

## EXERCISE 6.4

1. (i) $\dfrac{1}{2}$ (ii) $\dfrac{\sqrt{3}}{2}$ (iii) $\dfrac{\sqrt{3}}{3}$ (iv) $\sqrt{3}$ (v) 2 (vi) $\dfrac{1}{2}$ (vii) $\dfrac{\sqrt{3}}{3}$ (viii) $\dfrac{\sqrt{3}}{2}$

(ix) $\dfrac{2\sqrt{3}}{3}$ (x) 2 (xi) $\dfrac{\sqrt{2}}{2}$ (xii) $\dfrac{\sqrt{2}}{2}$

2. (i) $\dfrac{\sqrt{3}}{2}$ (ii) $\dfrac{\sqrt{3}}{2}$ (iii) $2\sqrt{2}$ (iv) 1 (v) 0 (vi) $\dfrac{1}{2}$ (vii) $\dfrac{\sqrt{3}}{2}$ (viii) 2

3. (i) 0 (ii) $\dfrac{7}{\sqrt{2}}$ (iii) $\sqrt{2}$

## EXERCISE 6.5

1. (i) $x = \dfrac{4}{\sqrt{3}}$ cm, $z = \dfrac{8}{\sqrt{3}}$ cm (ii) $x = \sqrt{3}$ cm, $z = \sqrt{6}$ cm (iii) $x = 1$ cm, $y = \sqrt{3}$ cm (iv) $x = 4$ cm, $z = 4\sqrt{2}$ cm

2. (i) $b = 4$ cm, $m\angle A = 25.64°$, $m\angle C = 64.36°$ (ii) $b = 4\sqrt{2}$ cm, $m\angle A = m\angle C = 45°$ 3. $60\sqrt{2}$ m

4. (i) $a = 3$ cm, $b = 6$ cm, $m\angle A = 30°$ (ii) $b = 8\sqrt{2}$ cm, $c = 8$ cm, $m\angle A = 45°$

(iii)  $b = 6\sqrt{5}$ cm, $m\angle A = 63.4°$, $m\angle C = 26.6°$   (iv)  $b = 8$ cm, $a = 4\sqrt{3}$ cm, $m\angle C = 30°$

(v)  $a = \dfrac{4}{\sqrt{3}}$ cm , $b = \dfrac{8}{\sqrt{3}}$ cm, $m\angle C = 60°$        (vi)  $c = 8$ cm, $m\angle A = 36.9°$, $m\angle C = 53.1°$

5.  12 m, 1.18 rad     6.  $5\sqrt{5}$ cm     7.  7.75 m     8.  8 m     9.  16 cm, 5 cm

## EXERCISE 6.6

1.  69.28 m     2.  2.89 cm     3. 35.7°     4. 11.55 $m$     5. 86.6 m     6. 49.98°     7. 33.69°

8.  87.4 m     9.  142.5 m, 109.2 m          10.  91.92 m

## REVIEW EXERCISE 6

1.  (i)  d     (ii)  a     (iii) a     (iv) b     (v)  c     (vi) b     (vii) d     (viii) a     (ix) d     (x) a

2.  (a) (i)  $\dfrac{17\pi}{12}$ rad  (ii)  $\dfrac{101\pi}{240}$ rad  (iii)  $\dfrac{19\pi}{24}$ rad     (b) (i)  127° 30′  (ii) 105° (iii) 123°45′

4.  $\sin\theta = \dfrac{3}{\sqrt{11}}$ ,     $\cos\theta = \sqrt{\dfrac{2}{11}}$ ,     $\csc\theta = \dfrac{\sqrt{11}}{3}$ ,     $\sec\theta = \sqrt{\dfrac{11}{2}}$ ,     $\cot\theta = \dfrac{\sqrt{2}}{3}$

5.  56.42 m     6.  9.06 m

## EXERCISE 7.1

1.  (i)  Right half plane     (ii) The 1$^{st}$ quadrant     (iii) $y$-axis   (iv) x-axis   (v)  4$^{th}$ quadrant
    and negative $y$-axis     (vi) Origin     (vii) It is a line bisecting 1$^{st}$ and 3$^{rd}$ quadrant.

    (vii) The set of points lying on and right side of the line $x = 3$.

    (ix) The set of points lying above $x$-axis.          (x) The set of points in 2$^{nd}$ and 4$^{th}$ quadrants.

2.  (i)  $3\sqrt{13}$   (ii) $4\sqrt{5}$   (iii) $\sqrt{53}$   (iv) $\sqrt{113}$     3.  (i)  (a)  $5\sqrt{2}$   (b) $2\sqrt{29}$

    (c)  $\dfrac{2\sqrt{109}}{3}$   (ii) (a) $\left(\dfrac{1}{2}, \dfrac{-3}{2}\right)$   (b)  (−3, 1)  (c)  $\left(-2\sqrt{5}, \dfrac{7}{3}\right)$   4.  (i) $\left(\sqrt{176}, 7\right)$ is at distance

    of 15 units from the origin.     (ii) (10, −10) is not a distance of 15 units from the origin.

    (iii) (1, 15) is not a distance from the origin.     6.    h = 0

7.  h = 1     8.  C(0, −3) ; radius = $\sqrt{26}$     9.  h = −10 or h = 6

## Exercise 7.2

1.  (i)  m = 1, α = 45°     (ii)  m = −9, α = 96° 20′     (iii)  m = ∞, α = 90°     3.  (i)  $k = -11$

    (ii)  $k = \dfrac{23}{2}$          5.  (a)  lines are neither parallel nor perpendicular.

    (b)  lines are neither parallel nor perpendicular.          6.  (a)  $y + 9 = 0$     (b)  $x + 5 = 0$

    (c) $7x - y + 47 = 0$     (d)  $y + 3 = 0$     (e) $x + 8 = 0$     (f)  $x - 7y - 16 = 0$

    (g)  $5x + y + 7 = 0$     (h)  $4x - 3y + 12 = 0$     (i)  $4x + y + 36 = 0$

7.  $4x + 2y - 37 = 0$     8.  $2x - 3y - 10 = 0$          9.  $24x + y - 259 = 0$

10. (a) (i)  $y = \dfrac{1}{2}x + \dfrac{11}{4}$     (ii)  $\dfrac{x}{\dfrac{-11}{2}} + \dfrac{y}{\dfrac{11}{4}} = 1$     (iii) $x\cos(116.57°) + y\sin(116.57°) = \dfrac{11}{2\sqrt{5}}$

(b) (i) $y = \dfrac{-4}{7}x + \dfrac{2}{7}$ (ii) $\dfrac{x}{\frac{1}{2}} + \dfrac{y}{\frac{2}{7}} = 1$ (iii) $x \cos(60.26°) + y \sin(60.26°) = \dfrac{2}{\sqrt{65}}$

(c) (i) $y = \dfrac{8}{15}x - \dfrac{1}{5}$ (ii) $\dfrac{x}{\frac{3}{8}} + \dfrac{y}{-\frac{1}{5}} = 1$ (iii) $x\cos(298.07°) + y\sin(298.07°) = \dfrac{3}{17}$

11. (a) Parallel (b) Perpendicular (c) neither parallel nor perpendicular.

12. $2x - 7y + 57 = 0$ 13. $x + y + 3 = 0$

## Exercise 7.3

1. $\sqrt{85} \approx 9.22$ km   2. $(10, 5)$ 3. $\sqrt{61} \approx 7.81$ m   4. $\sqrt{89} \approx 9.43$ km

5. $(6, 11)$   6. $(5, 7)$   7. $4\sqrt{29} \approx 21.5$ units   8. $26$ units   9. $10\sqrt{5} \approx 22.4$ units

10. Perimeter $= 20$ units   11. $16$ units

## REVIEW EXERCISE 7

1. (i) c (ii) a (iii) b (iv) a (v) b (vi) a (vii) b (viii) a (ix) c (x) d

2. $5\sqrt{2}$   3. $\left(-1, \dfrac{1}{2}\right)$   4. $\dfrac{4}{3}$   5. $y = 2x + 1$   6. $\dfrac{2}{3}$   7. $\sqrt{97} \approx 9.85$ units

8. $(6, 5)$   9. $\dfrac{3}{2}, 4\sqrt{13} \approx 14.4$ units   10. (a) $y = -3x + 2$ (b) $y - 2 = -3(x-1)$

(c) $\dfrac{y-2}{-7-2} = \dfrac{x-1}{4-1}$ (d) $\dfrac{y}{2} + \dfrac{x}{\frac{2}{3}} = 1$ (e) $\dfrac{y}{\sqrt{10}} + \dfrac{3x}{\sqrt{10}} = \dfrac{2}{\sqrt{10}}$ (f) $x\cos(-71.56°) + y\sin(-71.56°) = \dfrac{2}{\sqrt{10}}$

## EXERCISE 8

1. (i) a (ii) d (iii) c (iv) a (v) b (vi) a (vii) c (viii) b (ix) c (x) b

## EXERCISE 9.1

1. Similar   3. $m\overline{DF} = 10$cm, $m\overline{EF} = 8$ cm   4. (i) $x = 3$ cm (ii) $x = 2.25$ cm (iii) $x = 2.19$ cm

5. $10$ cm   6. $7.11$m   7. $x = 10\dfrac{2}{3}$ cm, $y = 8$ cm, $z = 13\dfrac{1}{3}$ cm   8. $m\overline{CE} = 1.5$ cm   9. $\dfrac{18\sqrt{2}}{5}$

## EXERCISE 9.2

1. (i) $1:9$ (ii) $9:16$ (iii) $4:49$ (iv) $64:81$ (v) $36:25$   2. (i) $86.4$ cm$^2$

(ii) $106.67$cm$^2$ (iii) $7.03125$ cm$^2$ (iv) $150$ cm$^2$ (v) $12.6$ cm   3. (a) $100$ cm$^2$

(b) $64$ cm$^2$   4. $5\dfrac{5}{9}$ cm$^2$   5. $1024$ cm$^2$   6. $\dfrac{4}{5}$   7. $22.5$ cm$^2$   8. $289$ cm$^2$

## EXERCISE 9.3

1. $\dfrac{27}{64}$   2. $\dfrac{2}{3}$   3. (i) $\dfrac{4}{5}$ (ii) $\dfrac{16}{25}$   4. (i) $648$ cm$^3$ (ii) $4$ cm$^3$ (iii) $2744$ cm$^3$ (iv) $8$ cm   5. (i) $42.67$ m$^2$

(ii) $810$ cm$^3$   6. (i) $90$ m$^2$ (ii) $1250$ m$^3$

## EXERCISE 9.4

1. (i) $1440°$ (ii) $120°$ (iii) $72°$ (iv) $9$ sides   2. $42.42$ cm$^2$   3. $m\angle ABC = 110°$

$m\angle BCD = 70°$, $m\angle CDA = 110°$    **4.** The shape can tessellate, with interior angles summing to 360°.

**5.** 600 reflections needed to cover the square.        **6.** 1623.8 cm$^2$ ,190 cm        **7.** 180 tiles

**8.** 35 gallons                **9.** 6 litres            **10.** 4.5 m$^2$

## REVIEW EXERCISE 9

**1.** (i)  a      (ii) b      (iii) b      (iv) d      (v) c      (vi) d      (vii) c      (viii) a      (ix) b      (x) d

**3.** 4:1, 8:1      **4.** (a) 1:100      (b) 1:1000      (c) 1:10      (d) 1:1      **5.** 1.69 litres, 4 litres

**6.** 125 millilitres, 216 millilitres        **7.** (a) 1:50 (b) 1:125000      (c) 3 cm      (d) 7500 cm$^2$

**8.** (a) 12:13      (b) 1728:2197        **10.** 6.69 m$^2$

## EXERCISE 10.1

**1.** (i)                    $y = 3x - 5$
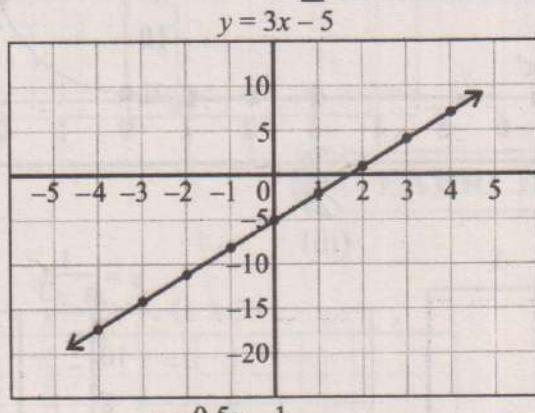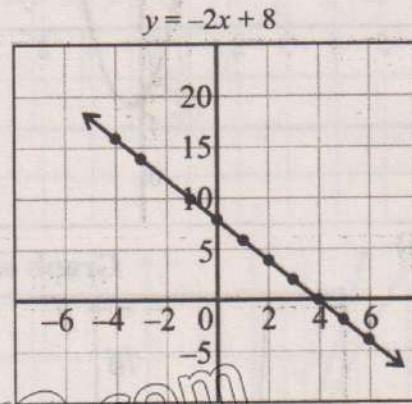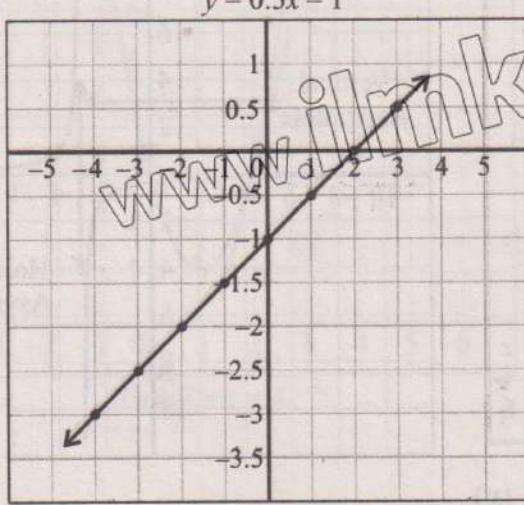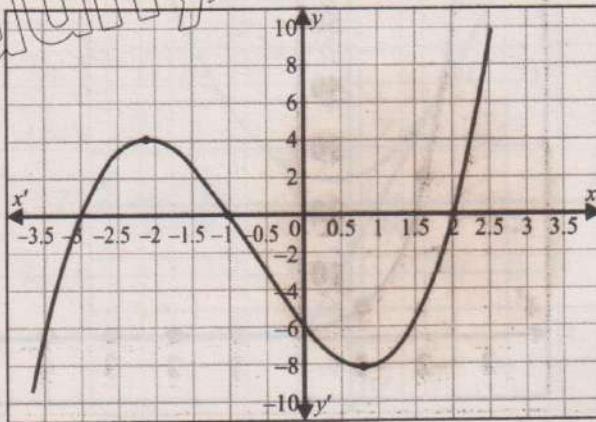


(ii)                    $y = -2x + 8$



(iii)                    $y = 0.5x - 1$



**2.** (i)                    $y = x^3 + 2x^2 - 5x - 6$



(ii)                    $y = x^2 + x - 2$



(iii)                    $y = x^3 + 3x^2 + 2x$

(iv)  $y = 5x^2 - 2x - 3$



3. (i)

**Graph of $y = 4^x$**



(ii)

**Graph of $y = 5^{-x}$**



(iii)  $y = \dfrac{1}{x - 3}$



(iv)  $y = \dfrac{2}{x} + 3$



(v)  $y = x^{\frac{1}{2}}$

(vi)

$y = 3x^{\frac{1}{3}}$



(vii)
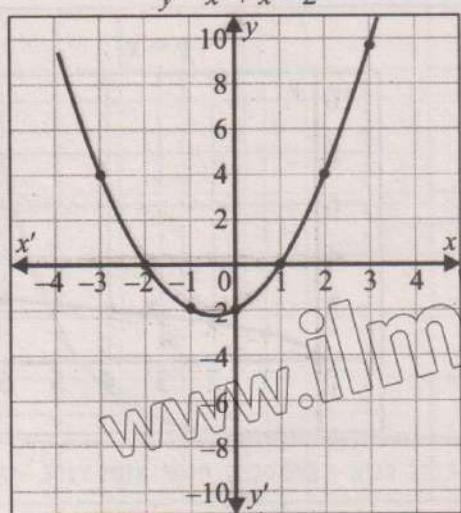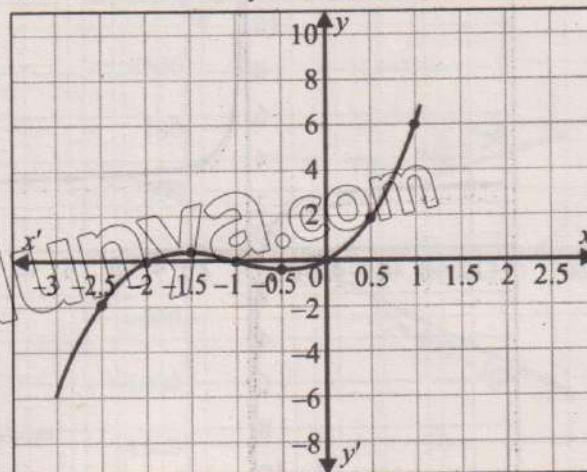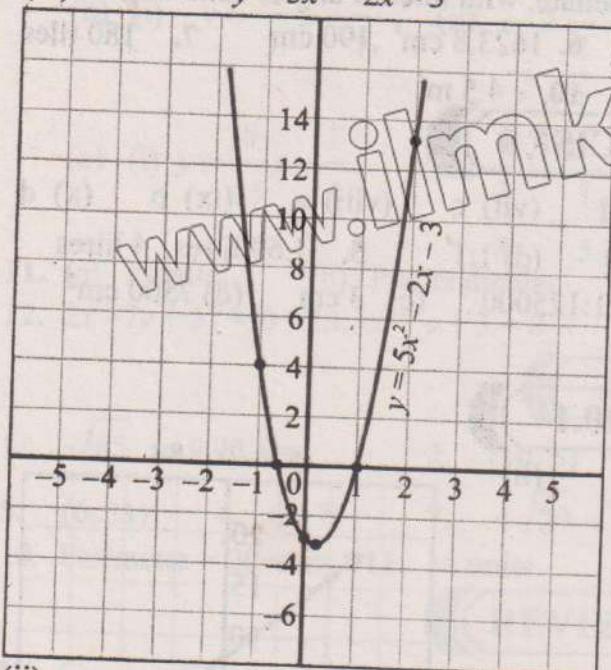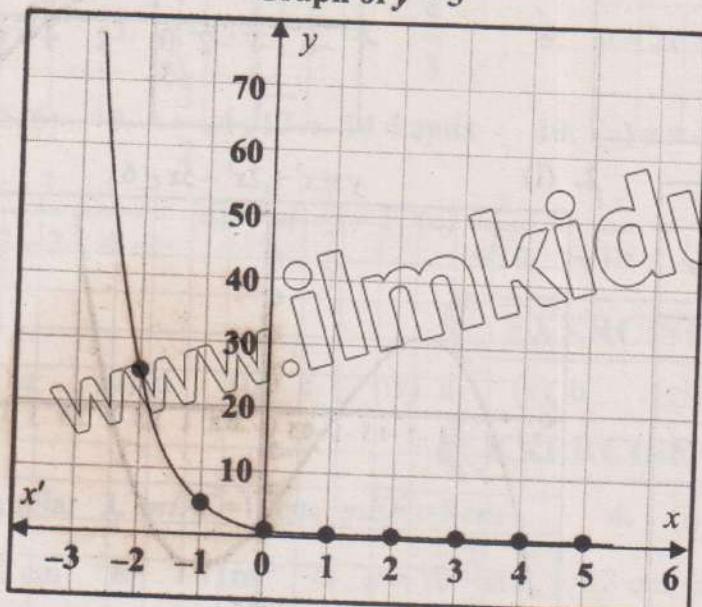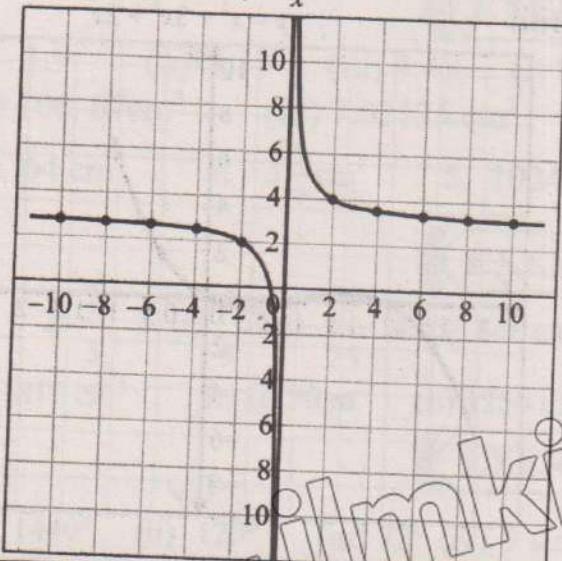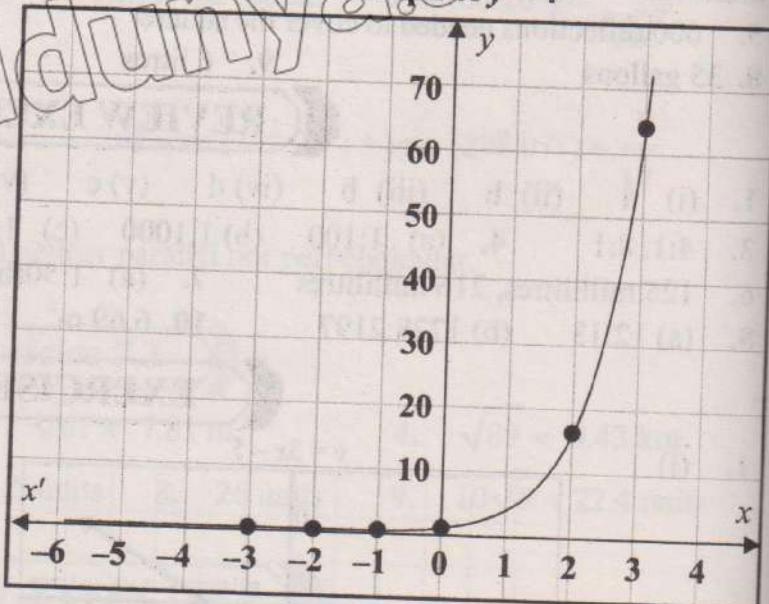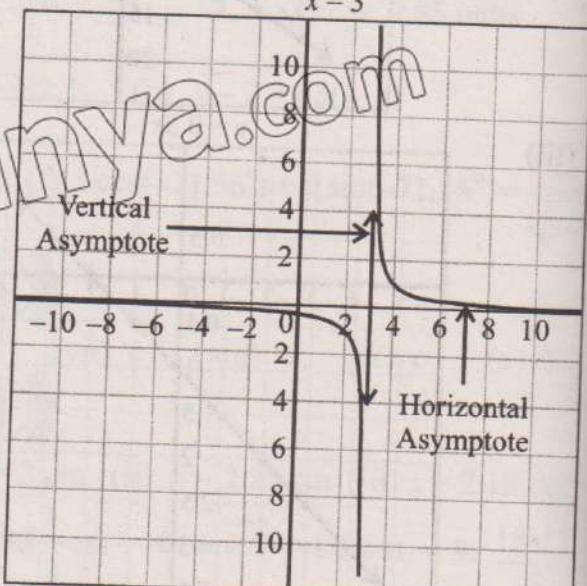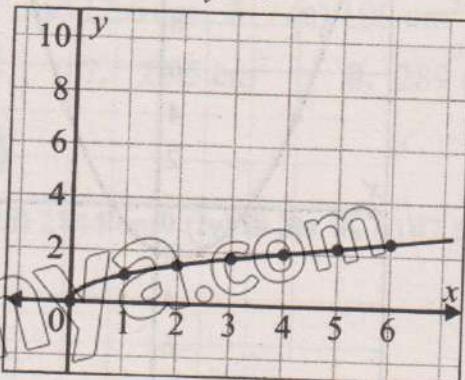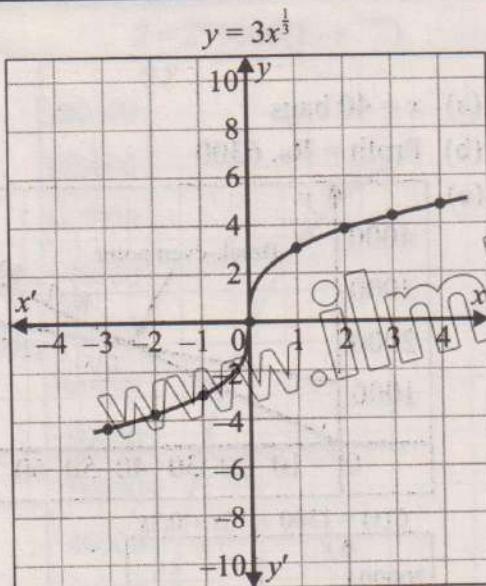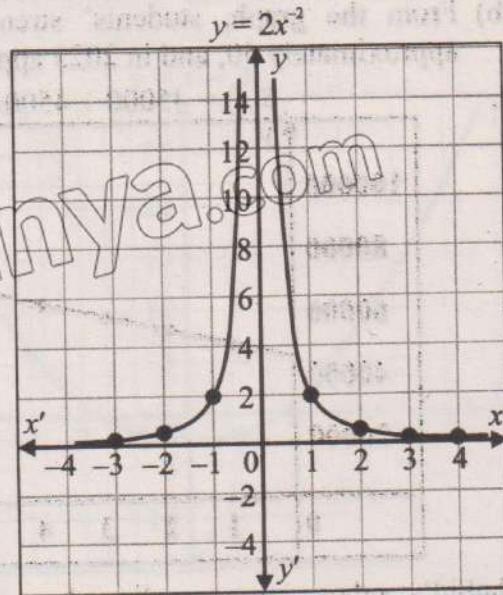
$y = 2x^{-2}$



### EXERCISE 10.2

1.

$y = 2x^2 - 4x + 3$



Gradient = 4

2.

$y = 3x^2 + x + 1$

(1, 5)



Gradient = 7

3.

$y = 1000e^{-t}$



4.

$P_s = 3Q + 24$
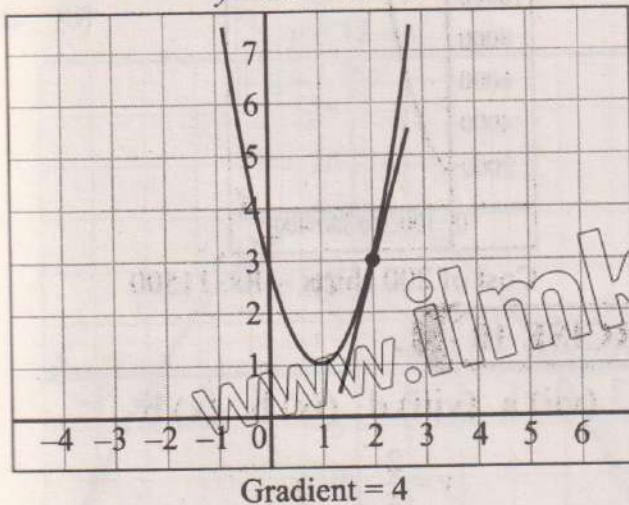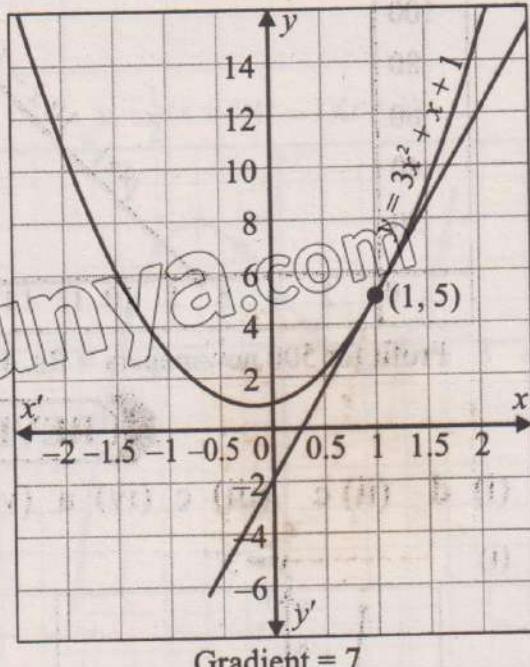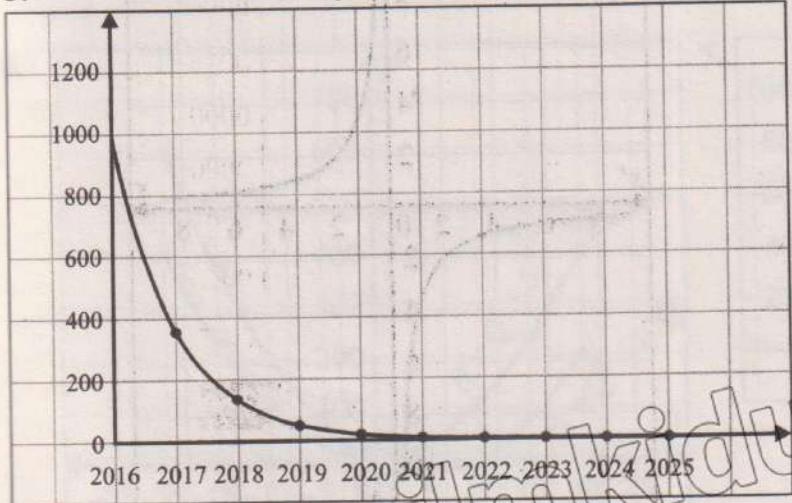
$P_d = 400 - 5Q$
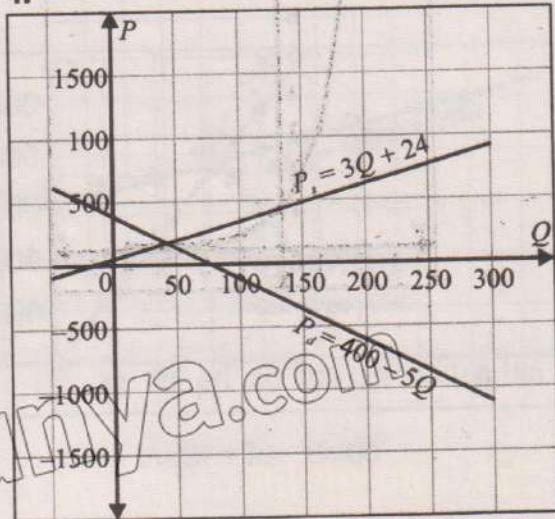
(b) From the graph, students' strength in 2019 is approximately 50, and in 2023 approximately 1.

**5.** $S(x) = 45000 + 4500x$
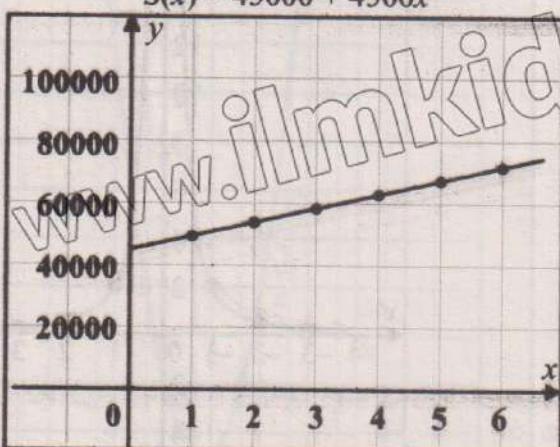


Shahid's salary increases linearly with years of service and rises by Rs. 4500 for every year.

**6.** (a) $x = 40$ bags

(b) Profit = Rs. 6300

(c)



**7.**
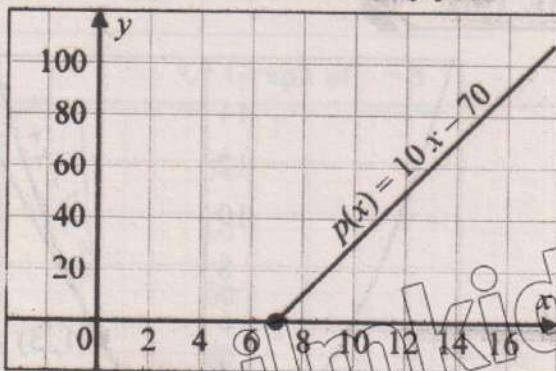


Profit for 500 newspapers = Rs. 4930

**8.** $C(x) = 1500 + 10x + 0.2x^2$
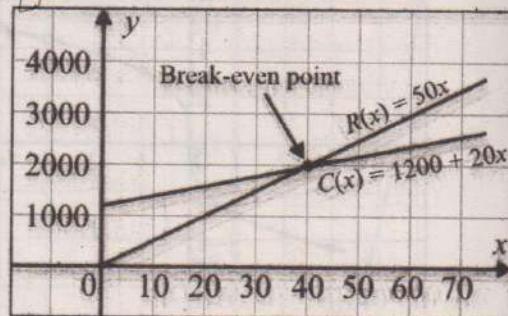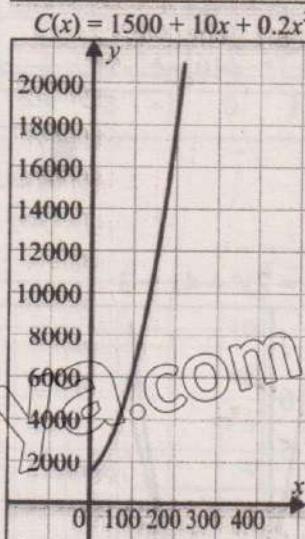


Cost of 200 shirts = Rs. 11500

### REVIEW EXERCISE 10

**1.** (i) d  (ii) c  (iii) c  (iv) a  (v) a  (vi) b  (vii) a  (viii) d  (ix) b  (x) b

**2.** (i) $y = 3^{-x}$



(ii) $y = \dfrac{2}{x}$

3. (a)
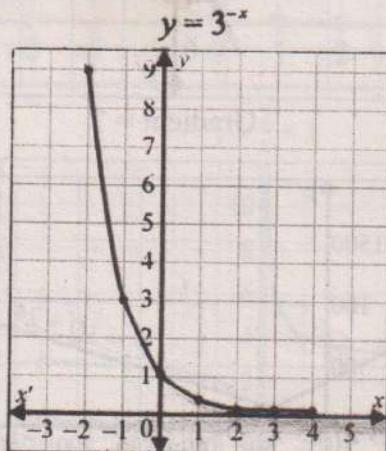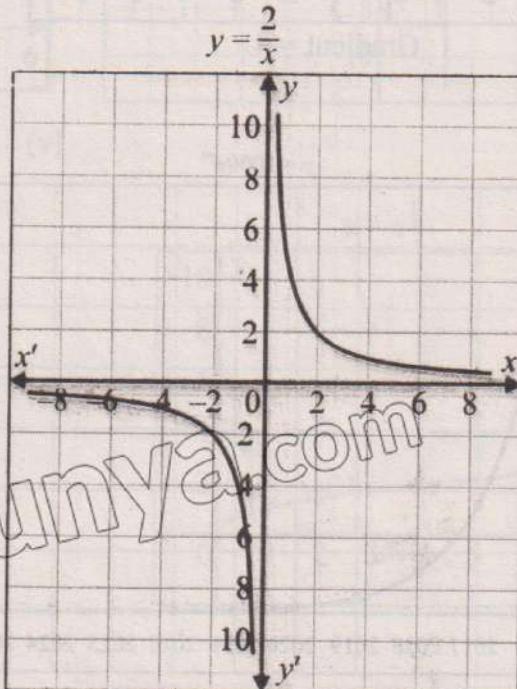
$$S = 200000(1-e^{-0.05t})$$
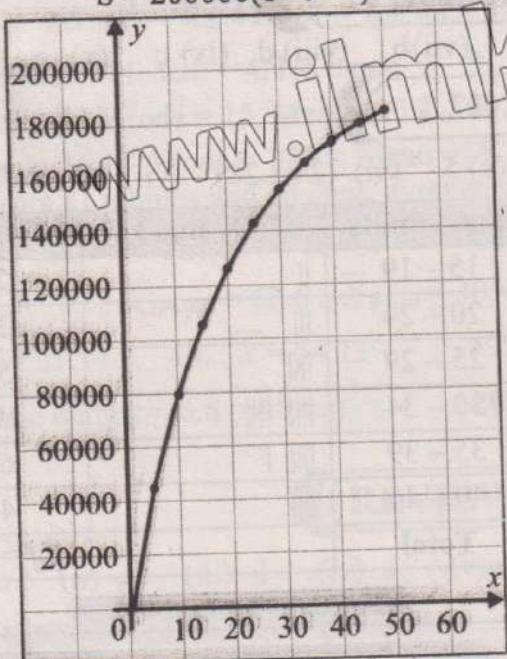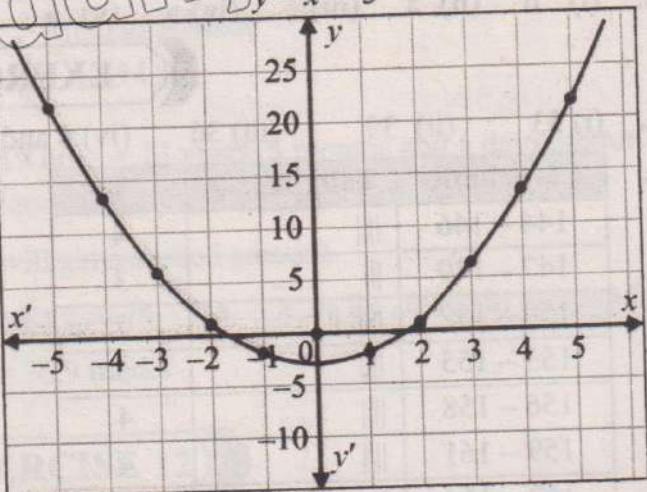


(b) For t = 5, S = 44239.84 and for t = 35,
S = 165245.2

4. (a)

$$y = x^2 - 3$$



4. (b)

$$y = 15 - x^2$$



5. (a)

$$x = \frac{1}{2}(x+4)(x-1)(x-3)$$



6.



7.



$R(x) = 1200x$

$C(x) = 60000 + 250x$

(63, 75790)
**Break-even point**
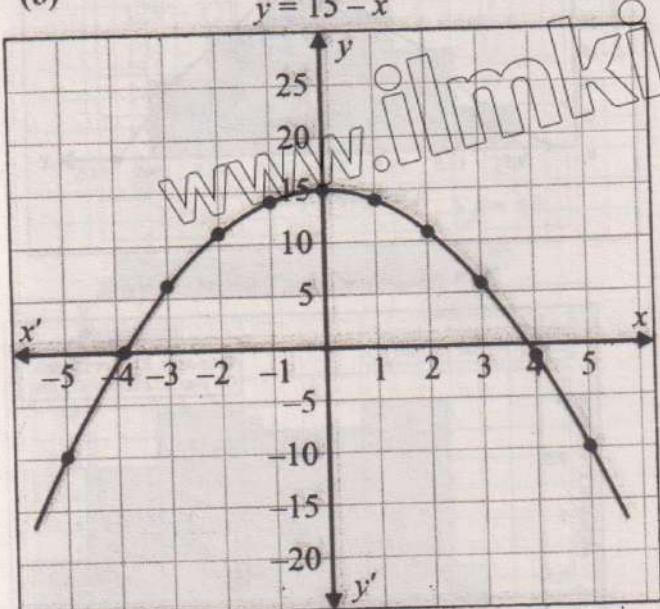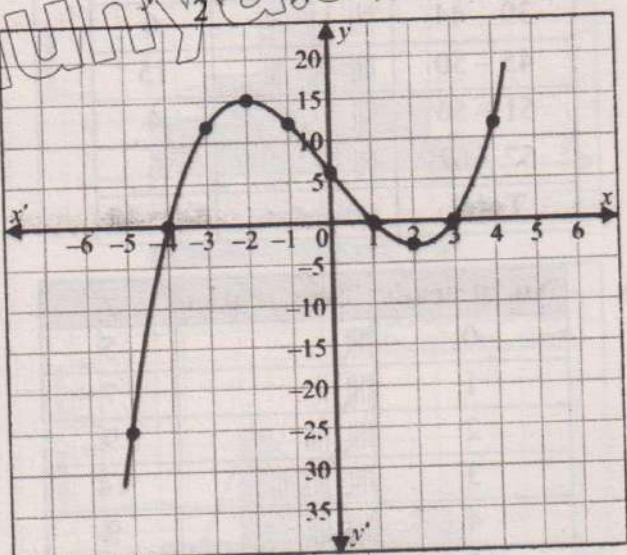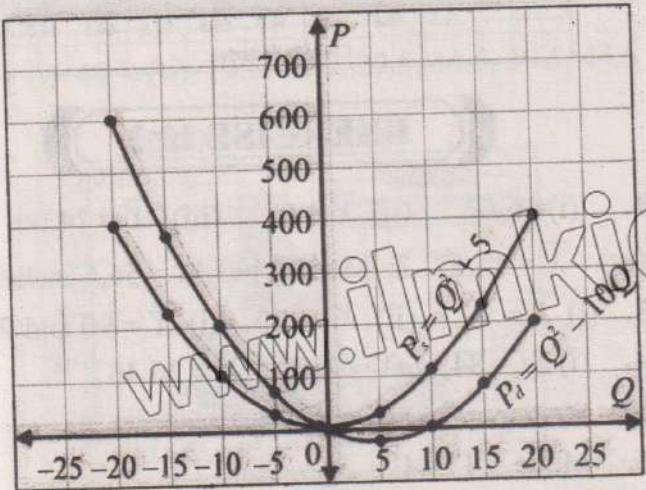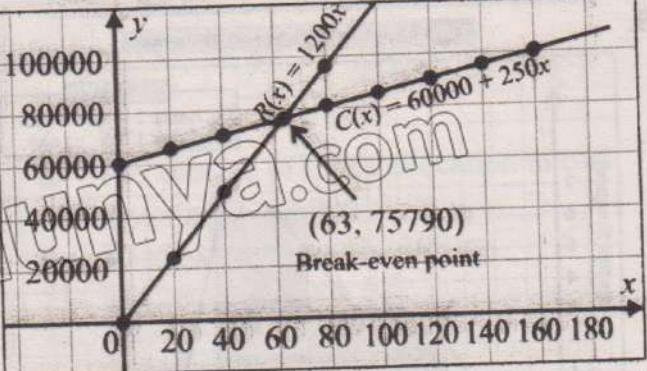
Profit = Rs. 35000

## REVIEW EXERCISE 11

1. (i) b  (ii) a  (iii) c  (iv) a  (v) a  (vi) a  (vii) b  (viii) d  (ix) c  (x) c

## EXERCISE 12.1

1. (i) 53  (ii) 39  (iii) 36  (iv) 6 and 15  (v) 5  (vi) (24 – 28)  (vii) 44  (viii) 44

2.

| Class limits | Tally marks | $f$ |
|---|---|---|
| 144 – 146 | IIII | 4 |
| 147 – 149 | III | 3 |
| 150 – 152 | ℕ II | 7 |
| 153 – 155 | ℕ | 5 |
| 156 – 158 | IIII | 4 |
| 159 – 161 | IIII | 4 |
| 162 – 164 | I | 1 |
| 165 – 167 | II | 2 |
| Total | | $\Sigma f = 30$ |

3.

| Class limits | Tally marks | $f$ |
|---|---|---|
| 15 – 19 | II | 2 |
| 20 – 24 | III | 3 |
| 25 – 29 | ℕ | 5 |
| 30 – 34 | ℕ ℕ | 10 |
| 35 – 39 | ℕ I | 6 |
| 40 – 44 | IIII | 4 |
| Total | | $\Sigma f = 30$ |

4.

| Class limits | Tally marks | $f$ |
|---|---|---|
| 33 – 38 | I | 1 |
| 39 – 44 | ℕ I | 6 |
| 45 – 50 | ℕ ℕ ℕ | 15 |
| 51 – 56 | IIII | 4 |
| 57 – 62 | ℕ I | 6 |
| Total | | $\Sigma f = 30$ |

5.



Title Frequency polygon on histogram

Scale
On x-axis: 2 boxes=5 units
On y-axis: 1 box = 5 units

6.

| No. of heads | Tally marks | $f$ |
|---|---|---|
| 0 | ℕ | 5 |
| 1 | ℕ II | 7 |
| 2 | ℕ IIII | 9 |
| 3 | ℕ ℕ IIII | 14 |
| 4 | ℕ IIII | 9 |
| 5 | ℕ I | 6 |
| Total | | $\Sigma f = 50$ |
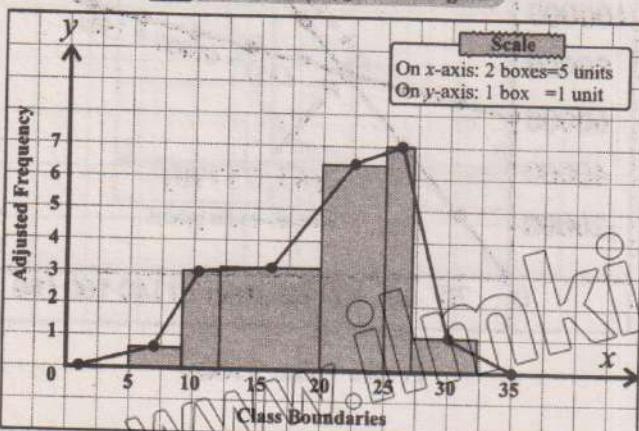
7.



Title Histogram of marks obtained by students

Scale
On x-axis: 2 boxes=5 units
On y-axis: 2 boxes=0.5 unit

8.



Title Frequency polygon on histogram

Scale
On x-axis: 2 boxes=5 units
On y-axis: 1 box = 1 unit
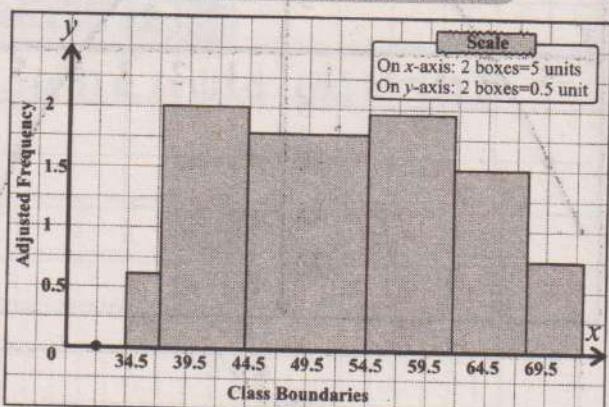
## EXERCISE 12.2

1. (i) 16.67  (ii) $\overline{X} = 0$  (iii) $\overline{X} = 14.04$
(iv) $\overline{X} = 14.57$  2. Median height = 56.5 inches
3. (i) $\overline{X} = 92.1$  (ii) $X = 90$  (iii) $\hat{X} = 90$ and 95
4. (i) $\Sigma f = 84$, $\Sigma fX = 2223$, $\overline{X} = 26.46$
(ii) Median = 26.64,  $c.f. = 9, 27, 62, 79, 84$
5. Mode = 17.44

6. $\overline{X}$ = Rs. 437, $\widetilde{X}$ = Rs. 437, $\hat{X}$ = Rs. 425, Rs. 435, Rs. 450    7. $\Sigma x$ = 3600

8. Mean = 4.20, Median = 4, No mode    9. Mode > Median > Mode

10. Median = 15, Mode = 15, Mean =15.2   160 > 156.5 > 154.33

11. Median = 16.11, Mode = 17.25, Mean =15.70

12. 266 years,11 months and 10 days, average age of 19 boys = 13 years, 3 months and 4 days approx.

13. (i) $\overline{X}$ = 190     (ii) $\overline{X}$ = 710     (iii) $\overline{X}$ = 40     (iv) $\overline{X}$ = 123

14. $\overline{X}_{(Haris)}$ = 70 , $\overline{X}_{(Maham)}$ = 58.6 , $\overline{X}_{(Minal)}$ = 40, Haris will get awarded amount.

15. (i) $\overline{X}$ = 21.17    16. $\overline{X}$ = 54.13    17. $\overline{X}_w$ = Rs 120.74   18. $\overline{X}_w$ = Rs 20.25 (in thousands

19. Average budget = 6.6 (million)    20. $\overline{X}_w$ = 76.9 marks

## ◀ REVIEW EXERCISE 12 ▶

1. (i) b   (ii) a   (iii) d   (iv) a   (v) d   (vi) c   (vii) c   (viii) d   (ix) b   (x) a

3. (a)

| Class limits | Tally marks | $f$ |
|---|---|---|
| 119 – 128 | IIII | 4 |
| 129 – 138 | IIII II | 7 |
| 139 – 148 | IIII IIII III | 13 |
| 149 – 158 | IIII IIII | 9 |
| 159 – 168 | IIII | 5 |
| 169 – 178 | II | 2 |
| **Total** | | $\Sigma f$ = 40 |

(b)

Title: Histogram of weight of 40 students

(c)

Title: Frequency polygon of weight of 40 students

4.

Title: Frequency polygon on histogram
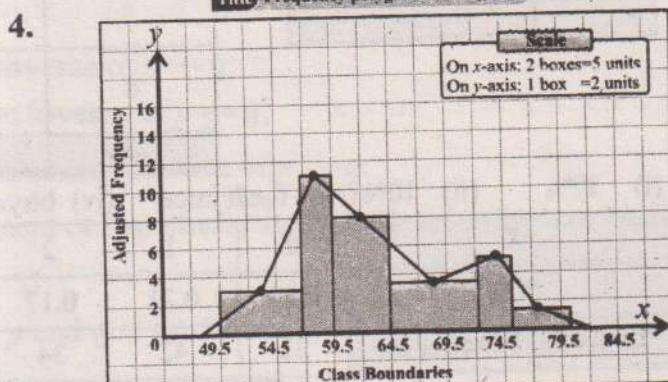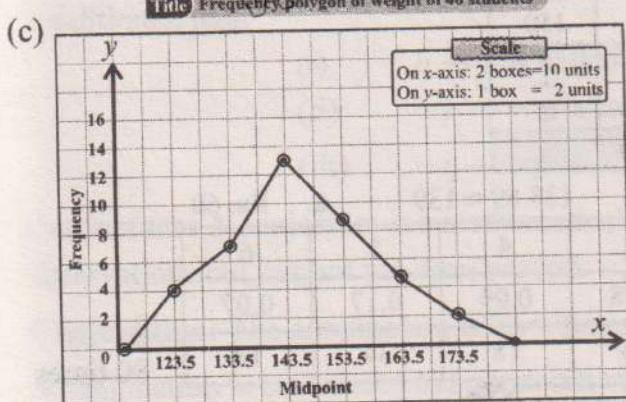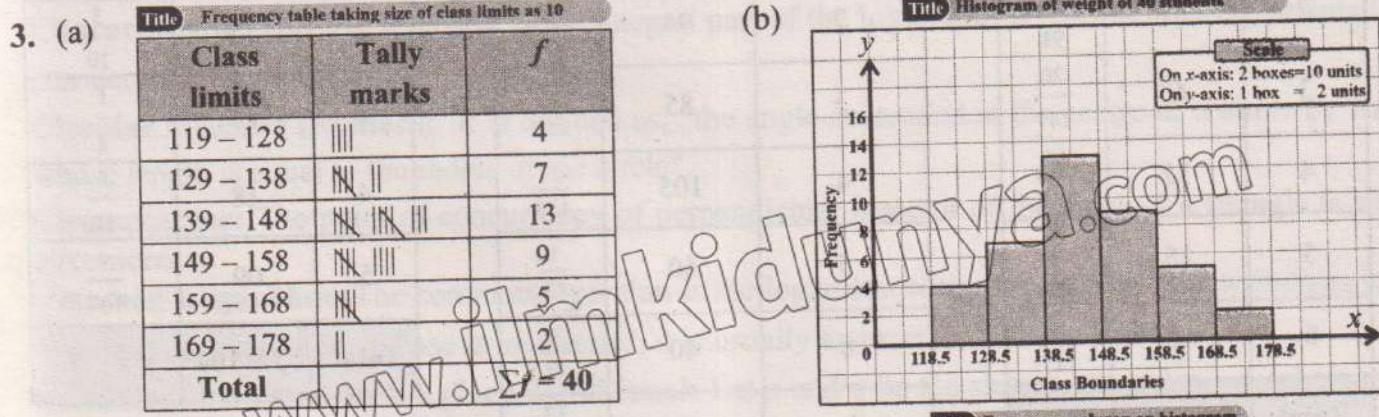
5. (i) 44   (ii) 19.5, 24.5, 29.5, 34.5, 39.5, 44.5   (iii) 22, 27, 32, 37, 42, 47  (iv) 5

6.

Title: Frequency polygon on histogram
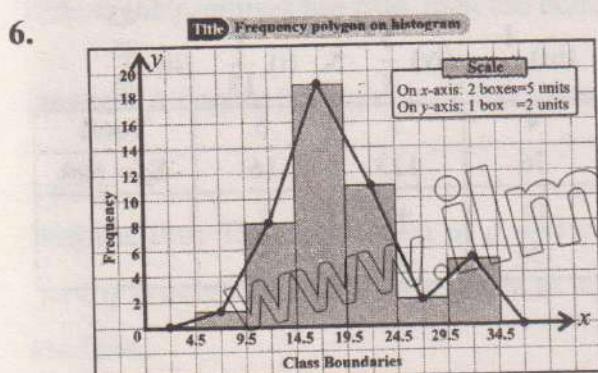
7. Rs. 473.81

8. The average of funds allocation in each sector is Rs. 10,000

9. 80 marks    10. 108 kg

11. Median = 6, Mode = 6

12. Mean = 918.09, Median = 940.46, Mode = 958.33

## EXERCISE 13.1

1. $\frac{2}{3}$  2. (i) $\frac{11}{12}$ (ii) $\frac{11}{36}$ (iii) $\frac{1}{9}$ (iv) $\frac{1}{6}$  3. (i) $\frac{4}{11}$ (ii) $\frac{7}{11}$ (iii) $\frac{1}{11}$ (iv) $\frac{2}{11}$ (v) $\frac{9}{11}$ (vi) $\frac{9}{11}$

4. $P$(getting 3 or 4) $= \frac{1}{3}$, $P$(not getting 3 or 4) $= \frac{2}{3}$  5. (i) $\frac{1}{30}$ (ii) $\frac{1}{5}$ (iii) $\frac{11}{30}$ (iv) $\frac{14}{15}$ (v) $\frac{13}{15}$

6. 0.15  7. (i) $\frac{1}{4}$ (ii) $\frac{1}{6}$ (iii) $\frac{1}{6}$ (iv) $\frac{11}{12}$ (v) $\frac{5}{6}$  8. (i) $\frac{1}{13}$ (ii) $\frac{11}{13}$  9. (i) $\frac{1}{13}$ (ii) $\frac{3}{4}$

## EXERCISE 13.2

1.

| No. of death | $f$ | r.f. |
|---|---|---|
| 0 | 60 | $\frac{30}{147}$ |
| 1 | 50 | $\frac{25}{147}$ |
| 2 | 87 | $\frac{29}{98}$ |
| 3 | 40 | $\frac{20}{147}$ |
| 4 | 32 | $\frac{16}{147}$ |
| 5 | 15 | $\frac{5}{98}$ |
| 6 | 10 | $\frac{5}{147}$ |
| Total | $\Sigma f = 294$ | |

2.

| No. of defective per sample | $f$ | r.f. |
|---|---|---|
| 0 | 120 | $\frac{4}{25}$ |
| 1 | 140 | $\frac{14}{75}$ |
| 2 | 94 | $\frac{47}{375}$ |
| 3 | 85 | $\frac{17}{150}$ |
| 4 | 105 | $\frac{21}{150}$ |
| 5 | 50 | $\frac{1}{15}$ |
| 6 | 40 | $\frac{4}{75}$ |
| 7 | 66 | $\frac{33}{150}$ |
| 8 | 50 | $\frac{1}{15}$ |
| Total | $\Sigma f = 750$ | |

3.

| $X$ | $f$ | r.f. |
|---|---|---|
| 0 | 10 | $\frac{1}{10}$ |
| 1 | 23 | $\frac{23}{100}$ |
| 2 | 15 | $\frac{3}{20}$ |
| 3 | 25 | $\frac{1}{4}$ |
| 4 | 18 | $\frac{9}{50}$ |
| 5 | 09 | $\frac{9}{100}$ |
| Total | $\Sigma f = 100$ | |

4. (i) 37% (ii) 20% (iii) fresh juice (iv) biryani  5. $138.89 \approx 139$  6. Rs. 60

7.

| $X$ | 0 | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|
| $P(X)$ | 0.11 | 0.21 | 0.17 | 0.18 | 0.09 | 0.17 | 0.07 |
| Expected Frequency | 22 | 42 | 34 | 36 | 18 | 34 | 14 |

8. 80 times

## REVIEW EXERCISE 13

1. (i) c (ii) b (iii) c (iv) a (v) a (vi) c (vii) b (viii) c (ix) d (x) b  3. (i) $\frac{5}{23}$

(ii) $\frac{10}{23}$ (iii) $\frac{8}{23}$ (iv) $\frac{13}{23}$ (v) $\frac{18}{23}$  4. (i) $\frac{1}{8}$ (ii) $\frac{1}{2}$ (iii) $\frac{1}{2}$ (iv) $\frac{5}{8}$  5. (i) $\frac{1}{13}$ (ii) $\frac{25}{26}$

6.

| No. of tails | 0 | 1 | 2 | 3 | 4 | 5 | 6 | Total |
|---|---|---|---|---|---|---|---|---|
| $f$ | 110 | 90 | 105 | 80 | 76 | 123 | 16 | $\Sigma f = 600$ |
| Relative Frequency | $\frac{11}{60}$ | $\frac{3}{20}$ | $\frac{7}{40}$ | $\frac{2}{15}$ | $\frac{19}{150}$ | $\frac{41}{200}$ | $\frac{2}{75}$ | |

7. Relative frequency $= \frac{17}{25} = 0.68$

Expected frequency of non-defective items $= 17$

# Glossary

**Antilogarithm:** An antilogarithm is the inverse operation of a logarithm.

**Axiom:** An axiom is a mathematical statement that we believe to be true without any evidence or requiring any proof.

**Biconditional $p \leftrightarrow q$:** The statement $p \to q \land q \to p$ is shortly written as $p \leftrightarrow q$ and is called the biconditional or equivalence.

**Binary Relation:** Any subset of $A \times B$ is called a binary relation, or simply a relation, from $A$ to $B$..

**Centroid:** The point of concurrency of the medians of a triangle is called centroid of the triangle.

**Characteristic:** The characteristic is the integral part of the logarithm. It tells us how big or small the number is.

**Circular Measure (Radian):** It is defined as, "the angle subtended at the centre of a circle by an arc whose length is equal to the radius of the circle".

**Circumcenter:** The point of concurrency of perpendicular bisector of the sides of a triangle is called circumcenter.

**Common Logarithm:** The common logarithm is the logarithm with a base of 10. It is written as $\log_{10}$ or simply as $\log$ (when no base is mentioned, it is usually assumed to be base 10).

**Conditionals related with a given conditional:** Let $p$ and $q$ be the statements and $p \to q$ be a given conditional, then

    (i)      $q \to p$ is called the **converse** of $p \to q$;

    (ii)     $\sim p \to \sim q$ is called the **inverse** of $p \to q$;

    (iii)    $\sim q \to \sim p$ is called the **contrapositive** of $p \to q$.

**Conjecture:** A conjecture is a mathematical statement or hypothesis that is believed to be true based on observations but has not yet been proved.

**Conjunction:** The conjunction of two statements $p$ and $q$ is symbolically written as $p \land q$ ($p$ and $q$). A conjunction is considered to be true only if both statements are true.

**Deductive Proof:** Deductive reasoning is a way of drawing conclusions from premises believed to be true. If the premises are true, then the conclusion must also be true.

**Degree:** A degree (°) is a unit of measurement of angles. It represents $\left(\dfrac{1}{360}\right)^{th}$ of a full rotation around a point.

**Disjunction:** The disjunction of $p$ and $q$ is symbolically written as $p \lor q$ ($p$ or $q$). The disjunction $p \lor q$ is considered to be true when at least one of the statements is true. It is false when both of them are false.

**Domain:** The set of the first elements of the ordered pairs forming a relation is called its domain.

**Event:** The set of results of an experiment is called an event

**Expected Frequency:** Expected frequency is a measure that estimate how often an event should be occurred depended on probability.

**Experiment:** The process which generates results e.g., tossing a coin, rolling a dice, etc. is called an experiment.

**Favourable Outcome:** An outcome which represents how many times we expect the things to be happened.

**Feasible region:** A region which is restricted to the first quadrant is referred to as a feasible region for the set of given constraints.

**Feasible solution:** Each point of the feasible region is called a feasible solution of the system of linear inequalities (or for the set of a given constraints).

**Frequency Polygon:** A frequency polygon is a closed geometrical figure used to display a frequency distribution graphically.

**Implication or conditional:** A compound statement of the form if $p$ then $q$ also written as $p$ implies $q$ is called a conditional or an implication. $p$ is called the **antecedent** or **hypothesis** and $q$ is called the **consequent** or the **conclusion.**

**Incentre:** The point of concurrency of the angle bisectors of a triangle is called incentre of the triangle.

**Linear Equation:** An equation of the form $ax + b = 0$ where '$a$' and '$b$' are constants, $a \neq 0$ and '$x$' is a variable, is called a linear equation in one variable.

**Linear Functions:** A linear function is a polynomial function of degree 1.

**Loci:** A locus (plural loci) is a set of points that follow a given rule. In geometry, loci are often used to define the positions of points relative to one another or to other geometric figures.

**Logarithm of a Real Number:** The logarithm of $x$ to the base $b$ is $y$, means that when b is raised to the power $y$, it equals $x$. The relationship between logarithmic form and exponential form is given as $\log_b(x) = y \Leftrightarrow b^y = x$ where $b > 0$, $x > 0$ and $b \neq 1$..

**Logic:** Logic is a systematic method of reasoning that enables one to interpret the meanings of statements, examine their truth, and deduce new information from existing.

**Mantissa:** The mantissa is the decimal part of the logarithm. It represents the "fractional" component and is always positive.

**Measures of Location (Central Tendency):** The measure that gives the centre of the data is called measure of central tendency.

**Natural Logarithm:** The natural logarithm is the logarithm with base $e$, where $e$ is a mathematical constant approximately equal to 2.71828.

**Negation:** If $p$ is any statement, its negation is denoted by $\sim p$, read 'not $p$'. It follows from this definition that if $p$ is true, $\sim p$ is false, and if $p$ is false, $\sim p$ is true.

**Non-negative constraints:** The variables used in the system of linear inequalities relating to the problems of everyday life are non-negative and are called non-negative constraints.

**Non-Terminating and Recurring Decimal Numbers:** The decimal numbers with repeating a pattern of digits after the decimal point are called non-terminating and recurring decimal numbers.

**Objective function:** A function which is to be maximized or minimized is called an objective function.

**Optimal solution:** The feasible solution which maximizes or minimizes the objective function is called the optimal solution.

**Orthocentre:** The point of concurrency of the altitudes of the triangle is called orthocentre of the triangle.

**Outcomes:** The results of an experiment are called outcomes e.g., the possible outcomes of tossing a coin are head or tail.

**Point of concurrency:** A point of concurrency is the single point where three or more lines, rays or line segments intersect or meet in a geometric figure.

**Problem constraints:** The system of linear inequalities involved in the problem concerned is called problem constraints.

**Range:** The set of the second elements of the ordered pairs forming a relation is called its range

**Relative Frequency:** Relative frequency is an estimated probability of an event occurring when an experiment is repeated a fixed number of times.

**Sample Space:** The set of all possible outcomes of an experiment is called sample space.

**Scientific Notation:** A number in scientific notation is written as: $a \times 10^n$, where $1 \leq a < 10$ and $n \in Z$. Here "$a$" is called the coefficient or base number.

**Similar Solids:** Two solids are said to be similar if they have same shape but possibly different sizes. Two solids are similar if lengths of the corresponding sides are proportional.

**Similarity of Polygons:** Similar figures have same shape but not necessarily of same size.

**Slope or Gradient of a Line:** The measure of steepness (ratio of rise to the run) is termed as slope or gradient of the inclined path.

**Square Root of an Algebraic Expression:** The square root of an algebraic expression refers to a value that, when multiplied by itself, gives the original expression.

**Statement:** A sentence or mathematical expression which may be true or false but not both is called a statement.

**Terminating Decimal Numbers:** A decimal number with a finite number of digits after the decimal point is called a terminating decimal number.

**Tessellation:** A tessellation is a pattern of shapes that fit together perfectly, without any gaps or overlaps, covering a plane.

**Theorem:** A theorem is a mathematical statement that has been proved true based on previously known facts.

**Triangle Inequality Theorem:** The sum of the measure of any two sides of a triangle is always greater than the measure of the third side.

# Symbols / Notations

| Symbols | Stands for |
|---------|-----------|
| $=$ | is equal to |
| $\neq$ | is not equal to |
| $\in$ | belongs to/element of |
| $\notin$ | not belongs to/not element of |
| $\wedge$ | logical and |
| $\vee$ | logical or |
| $\cup$ | union |
| $\cap$ | intersection |
| $>$ | is greater than |
| $<$ | is less than |
| $\leq$ | is less than or equal to |
| $\geq$ | is greater than or equal to |
| $\ngtr$ | is not greater than |
| $\nless$ | is not less than |
| $\mid$ | such that |
| $\subseteq$ | subset |
| $\not\subseteq$ | not a subset |
| $\subset$ | proper subset |
| $\supseteq$ | superset |
| $\not\supseteq$ | not a superset |
| $\emptyset$ or $\{\}$ | empty set |
| $\therefore$ | therefore/so |
| $\because$ | since |
| $\approx$ | is approximately equal to |
| $\sim$ | is similar to |
| $\Rightarrow$ | implies that |
| $\Leftrightarrow$ | if and only if |
| $\lvert x \rvert$ | absolute value of $x$ |
| $\sqrt{\phantom{x}}$ | square root |

| Symbols | Stands for |
|---------|-----------|
| $\forall$ | for all |
| $\pi$ | pi |
| $e$ | euler constant |
| $^\circ C$ | degree celsius |
| $^\circ F$ | degree fahrenheit |
| $\log$ | logarithm |
| $\ln$ | natural logarithm |
| $\overline{AB}$ | line segment $AB$ |
| $m\,\overline{AB}$ | measure of line segment $AB$ |
| $\overrightarrow{AB}$ | ray $AB$ |
| $\overleftrightarrow{AB}$ | line $AB$ |
| $\angle ABC$ | angle $ABC$ |
| $m\angle ABC$ | measure of angle $ABC$ |
| $\Delta ABC$ | triangle $ABC$ |
| $\lvert \overline{AB} \rvert$ | length of $\overline{AB}$ |
| $\overset{\frown}{AB}$ | arc $AB$ |
| $\parallel$ | is parallel to |
| $\nparallel$ | is not parallel to |
| $\perp$ | is perpendicular to |
| $\rightarrow$ | if . . . then or implies |
| $\theta$ | theta |
| $\phi$ | phi |
| $\alpha$ | alpha |
| $\circ$ | degree |
| $/$ | telly mark |
| $\bar{X}$ | arithmetic mean |
| $\bar{X}_w$ | weighted mean |
| $\tilde{X}$ | median |
| $\hat{X}$ | mode |

# Logarithms

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | | | | Mean Difference | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| **10** | 0000 | 0043 | 0086 | 0128 | 0170 | | | | | | 4 | 9 | 13 | 17 | 21 | 26 | 30 | 34 | 38 |
| | | | | | | 0212 | 0253 | 0294 | 0334 | 0374 | 4 | 8 | 12 | 16 | 20 | 24 | 28 | 32 | 37 |
| **11** | 0414 | 0453 | 0492 | 0531 | 0569 | | | | | | 4 | 8 | 12 | 15 | 19 | 23 | 27 | 31 | 35 |
| | | | | | | 0607 | 0645 | 0682 | 0719 | 0755 | 4 | 7 | 11 | 15 | 19 | 22 | 26 | 30 | 33 |
| **12** | 0792 | 0828 | 0864 | 0899 | 0934 | 0969 | | | | | 3 | 7 | 11 | 14 | 18 | 21 | 25 | 28 | 32 |
| | | | | | | | 1004 | 1038 | 1072 | 1106 | 3 | 7 | 10 | 14 | 17 | 20 | 24 | 27 | 31 |
| **13** | 1139 | 1173 | 1206 | 1239 | 1271 | | | | | | 3 | 7 | 10 | 13 | 16 | 20 | 23 | 26 | 30 |
| | | | | | | 1303 | 1335 | 1367 | 1399 | 1430 | 3 | 7 | 10 | 12 | 16 | 19 | 22 | 25 | 29 |
| **14** | 1461 | 1492 | 1523 | 1553 | | | | | | | 3 | 6 | 9 | 12 | 15 | 18 | 21 | 24 | 28 |
| | | | | | 1584 | 1614 | 1644 | 1673 | 1703 | 1732 | 3 | 6 | 9 | 12 | 15 | 17 | 20 | 23 | 26 |
| **15** | 1761 | 1790 | 1818 | 1847 | 1875 | 1903 | | | | | 3 | 6 | 9 | 11 | 14 | 17 | 20 | 23 | 26 |
| | | | | | | | 1931 | 1959 | 1987 | 2014 | 3 | 5 | 8 | 11 | 14 | 16 | 19 | 22 | 25 |
| **16** | 2041 | 2068 | 2095 | 2122 | 2148 | | | | | | 3 | 5 | 8 | 11 | 14 | 16 | 19 | 22 | 24 |
| | | | | | | 2175 | 2201 | 2227 | 2253 | 2279 | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 21 | 23 |
| **17** | 2304 | 2330 | 2355 | 2380 | 2405 | 2430 | | | | | 3 | 5 | 8 | 10 | 13 | 15 | 18 | 20 | 23 |
| | | | | | | | 2455 | 2480 | 2504 | 2529 | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 19 | 22 |
| **18** | 2553 | 2577 | 2601 | 2625 | 2648 | | | | | | 2 | 5 | 7 | 9 | 12 | 14 | 16 | 19 | 21 |
| | | | | | | 2672 | 2695 | 2718 | 2742 | 2765 | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 18 | 21 |
| **19** | 2788 | 2810 | 2833 | 2856 | 2878 | | | | | | 2 | 4 | 7 | 9 | 11 | 13 | 16 | 18 | 20 |
| | | | | | | 2900 | 2923 | 2945 | 2967 | 2989 | 2 | 4 | 6 | 8 | 11 | 13 | 15 | 17 | 19 |
| **20** | 3010 | 3032 | 3054 | 3075 | 3096 | 3118 | 3139 | 3160 | 3181 | 3201 | 2 | 4 | 6 | 8 | 11 | 13 | 15 | 17 | 19 |
| **21** | 3222 | 3243 | 3263 | 3284 | 3304 | 3324 | 3345 | 3365 | 3385 | 3404 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| **22** | 3424 | 3444 | 3464 | 3483 | 3502 | 3522 | 3541 | 3560 | 3579 | 3598 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 15 | 17 |
| **23** | 3617 | 3636 | 3655 | 3674 | 3692 | 3711 | 3729 | 3747 | 3766 | 3784 | 2 | 4 | 6 | 7 | 9 | 11 | 13 | 15 | 17 |
| **24** | 3802 | 3820 | 3838 | 3856 | 3874 | 3892 | 3909 | 3927 | 3945 | 3962 | 2 | 4 | 5 | 7 | 9 | 11 | 12 | 14 | 16 |
| **25** | 3979 | 3997 | 4014 | 4031 | 4048 | 4065 | 4082 | 4099 | 4116 | 4133 | 2 | 3 | 5 | 7 | 9 | 10 | 12 | 14 | 15 |
| **26** | 4150 | 4166 | 4183 | 4200 | 4216 | 4232 | 4249 | 4265 | 4281 | 4298 | 2 | 3 | 5 | 7 | 8 | 10 | 11 | 13 | 15 |
| **27** | 4314 | 4330 | 4346 | 4362 | 4378 | 4393 | 4409 | 4425 | 4440 | 4456 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 13 | 14 |
| **28** | 4472 | 4487 | 4502 | 4518 | 4533 | 4548 | 4564 | 4579 | 4594 | 4609 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 |
| **29** | 4624 | 4639 | 4654 | 4669 | 4683 | 4698 | 4713 | 4728 | 4742 | 4757 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 |
| **30** | 4771 | 4786 | 4800 | 4814 | 4829 | 4843 | 4857 | 4871 | 4886 | 4900 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 13 |
| **31** | 4914 | 4928 | 4942 | 4955 | 4969 | 4983 | 4997 | 5011 | 5024 | 5038 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 12 |
| **32** | 5051 | 5065 | 5079 | 5092 | 5105 | 5119 | 5132 | 5145 | 5159 | 5172 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 |
| **33** | 5185 | 5198 | 5211 | 5224 | 5237 | 5250 | 5263 | 5276 | 5289 | 5302 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 12 |
| **34** | 5315 | 5328 | 5340 | 5353 | 5366 | 5378 | 5391 | 5403 | 5416 | 5428 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 |
| **35** | 5441 | 5453 | 5465 | 5478 | 5490 | 5502 | 5514 | 5527 | 5539 | 5551 | 1 | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 |
| **36** | 5563 | 5575 | 5587 | 5599 | 5611 | 5623 | 5635 | 5647 | 5658 | 5670 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 |
| **37** | 5682 | 5694 | 5705 | 5717 | 5729 | 5740 | 5752 | 5763 | 5775 | 5786 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 |
| **38** | 5798 | 5809 | 5821 | 5832 | 5843 | 5855 | 5866 | 5877 | 5888 | 5899 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 |
| **39** | 5911 | 5922 | 5933 | 5944 | 5955 | 5966 | 5977 | 5988 | 5999 | 6010 | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 |
| **40** | 6021 | 6031 | 6042 | 6053 | 6064 | 6075 | 6085 | 6096 | 6107 | 6117 | 1 | 2 | 3 | 4 | 5 | 6 | 8 | 9 | 10 |
| **41** | 6128 | 6138 | 6149 | 6160 | 6170 | 6180 | 6191 | 6201 | 6212 | 6222 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **42** | 6232 | 6243 | 6253 | 6263 | 6274 | 6284 | 6294 | 6304 | 6314 | 6325 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **43** | 6335 | 6345 | 6355 | 6365 | 6375 | 6385 | 6395 | 6405 | 6415 | 6425 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **44** | 6435 | 6444 | 6454 | 6464 | 6474 | 6484 | 6493 | 6503 | 6513 | 6522 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **45** | 6532 | 6542 | 6551 | 6561 | 6571 | 6580 | 6590 | 6599 | 6609 | 6618 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| **46** | 6628 | 6637 | 6646 | 6656 | 6665 | 6675 | 6684 | 6693 | 6702 | 6712 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 7 | 8 |
| **47** | 6721 | 6730 | 6739 | 6749 | 6758 | 6767 | 6776 | 6785 | 6794 | 6803 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 |
| **48** | 6812 | 6821 | 6830 | 6839 | 6848 | 6857 | 6866 | 6875 | 6884 | 6893 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 |
| **49** | 6902 | 6911 | 6920 | 6928 | 6937 | 6946 | 6955 | 6964 | 6972 | 6981 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 |

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Mean Difference | | | | | | | | |
|----|------|------|------|------|------|------|------|------|------|------|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 50 | 6990 | 6998 | 7007 | 7016 | 7024 | 7033 | 7042 | 7050 | 7059 | 7067 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 |
| 51 | 7076 | 7084 | 7093 | 7101 | 7110 | 7118 | 7126 | 7135 | 7143 | 7152 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 |
| 52 | 7160 | 7168 | 7177 | 7185 | 7193 | 7202 | 7210 | 7218 | 7226 | 7235 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 7 |
| 53 | 7243 | 7251 | 7259 | 7267 | 7275 | 7284 | 7292 | 7300 | 7308 | 7316 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 |
| 54 | 7324 | 7332 | 7340 | 7348 | 7356 | 7364 | 7372 | 7380 | 7388 | 7396 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 |
| 55 | 7404 | 7412 | 7419 | 7427 | 7435 | 7443 | 7451 | 7459 | 7466 | 7474 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| 56 | 7482 | 7490 | 7497 | 7505 | 7513 | 7520 | 7528 | 7536 | 7543 | 7551 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| 57 | 7559 | 7566 | 7574 | 7582 | 7589 | 7597 | 7604 | 7612 | 7619 | 7627 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| 58 | 7634 | 7642 | 7649 | 7657 | 7664 | 7672 | 7679 | 7686 | 7694 | 7701 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| 59 | 7709 | 7716 | 7723 | 7731 | 7738 | 7745 | 7752 | 7760 | 7767 | 7774 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 |
| 60 | 7782 | 7789 | 7796 | 7803 | 7810 | 7818 | 7825 | 7832 | 7839 | 7846 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 |
| 61 | 7853 | 7860 | 7868 | 7875 | 7882 | 7889 | 7896 | 7903 | 7910 | 7917 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 |
| 62 | 7924 | 7931 | 7938 | 7945 | 7952 | 7959 | 7966 | 7973 | 7980 | 7987 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 |
| 63 | 7993 | 8000 | 8007 | 8014 | 8021 | 8028 | 8035 | 8041 | 8048 | 8055 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 5 | 6 |
| 64 | 8062 | 8069 | 8075 | 8082 | 8089 | 8096 | 8102 | 8109 | 8116 | 8122 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| 65 | 8129 | 8136 | 8142 | 8149 | 8156 | 8162 | 8169 | 8176 | 8182 | 8189 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| 66 | 8195 | 8202 | 8209 | 8215 | 8222 | 8228 | 8235 | 8241 | 8248 | 8254 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| 67 | 8261 | 8267 | 8274 | 8280 | 8287 | 8293 | 8299 | 8306 | 8312 | 8319 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| 68 | 8325 | 8331 | 8338 | 8344 | 8351 | 8357 | 8363 | 8370 | 8376 | 8382 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 69 | 8388 | 8395 | 8401 | 8407 | 8414 | 8420 | 8426 | 8432 | 8439 | 8445 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| 70 | 8451 | 8457 | 8463 | 8470 | 8476 | 8482 | 8488 | 8494 | 8500 | 8506 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 |
| 71 | 8513 | 8519 | 8525 | 8531 | 8537 | 8543 | 8549 | 8555 | 8561 | 8567 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 |
| 72 | 8573 | 8579 | 8585 | 8591 | 8597 | 8603 | 8609 | 8615 | 8621 | 8627 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 |
| 73 | 8633 | 8639 | 8645 | 8651 | 8657 | 8663 | 8669 | 8675 | 8681 | 8686 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 |
| 74 | 8692 | 8698 | 8704 | 8710 | 8716 | 8722 | 8727 | 8733 | 8739 | 8745 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 |
| 75 | 8751 | 8756 | 8762 | 8768 | 8774 | 8779 | 8785 | 8791 | 8797 | 8802 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 |
| 76 | 8808 | 8814 | 8820 | 8825 | 8831 | 8837 | 8842 | 8848 | 8854 | 8859 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 |
| 77 | 8865 | 8871 | 8876 | 8882 | 8887 | 8893 | 8899 | 8904 | 8910 | 8915 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 78 | 8921 | 8927 | 8932 | 8938 | 8943 | 8949 | 8954 | 8960 | 8965 | 8971 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 79 | 8976 | 8982 | 8987 | 8993 | 8998 | 9004 | 9009 | 9015 | 9020 | 9025 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 80 | 9031 | 9036 | 9042 | 9047 | 9053 | 9058 | 9063 | 9069 | 9074 | 9079 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 81 | 9085 | 9090 | 9096 | 9101 | 9106 | 9112 | 9117 | 9122 | 9128 | 9133 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 82 | 9138 | 9143 | 9149 | 9154 | 9159 | 9165 | 9170 | 9175 | 9180 | 9186 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 83 | 9191 | 9196 | 9201 | 9206 | 9212 | 9217 | 9222 | 9227 | 9232 | 9238 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 84 | 9243 | 9248 | 9253 | 9258 | 9263 | 9269 | 9274 | 9279 | 9284 | 9289 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 85 | 9294 | 9299 | 9304 | 9309 | 9315 | 9320 | 9325 | 9330 | 9335 | 9340 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 86 | 9345 | 9350 | 9355 | 9360 | 9365 | 9370 | 9375 | 9380 | 9385 | 9390 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| 87 | 9395 | 9400 | 9405 | 9410 | 9415 | 9420 | 9425 | 9430 | 9435 | 9440 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 88 | 9445 | 9450 | 9455 | 9460 | 9465 | 9469 | 9474 | 9479 | 9484 | 9489 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 89 | 9494 | 9499 | 9504 | 9509 | 9513 | 9518 | 9523 | 9528 | 9533 | 9538 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 90 | 9542 | 9547 | 9552 | 9557 | 9562 | 9566 | 9571 | 9576 | 9581 | 9586 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 91 | 9590 | 9595 | 9600 | 9605 | 9609 | 9614 | 9619 | 9624 | 9628 | 9633 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 92 | 9638 | 9643 | 9647 | 9652 | 9657 | 9661 | 9666 | 9671 | 9675 | 9680 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 93 | 9685 | 9689 | 9694 | 9699 | 9703 | 9708 | 9713 | 9717 | 9722 | 9727 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 94 | 9731 | 9736 | 9741 | 9745 | 9750 | 9754 | 9759 | 9763 | 9768 | 9773 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 95 | 9777 | 9782 | 9786 | 9791 | 9795 | 9800 | 9805 | 9809 | 9814 | 9818 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 96 | 9823 | 9827 | 9832 | 9836 | 9841 | 9845 | 9850 | 9854 | 9859 | 9863 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 97 | 9868 | 9872 | 9877 | 9881 | 9886 | 9890 | 9894 | 9899 | 9903 | 9908 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 98 | 9912 | 9917 | 9921 | 9926 | 9930 | 9934 | 9939 | 9943 | 9948 | 9952 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| 99 | 9956 | 9961 | 9965 | 9969 | 9974 | 9978 | 9983 | 9987 | 9991 | 9996 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 |

# Antilogarithms

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Mean Difference | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .00 | 1000 | 1002 | 1005 | 1007 | 1009 | 1012 | 1014 | 1016 | 1019 | 1021 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| .01 | 1023 | 1026 | 1028 | 1030 | 1033 | 1035 | 1038 | 1040 | 1042 | 1045 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| .02 | 1047 | 1050 | 1052 | 1054 | 1057 | 1059 | 1062 | 1064 | 1067 | 1069 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| .03 | 1072 | 1074 | 1076 | 1079 | 1081 | 1084 | 1086 | 1089 | 1091 | 1094 | 0 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 |
| .04 | 1096 | 1099 | 1102 | 1104 | 1107 | 1109 | 1112 | 1114 | 1117 | 1119 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| .05 | 1122 | 1125 | 1127 | 1130 | 1132 | 1135 | 1138 | 1140 | 1143 | 1146 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| .06 | 1148 | 1151 | 1153 | 1156 | 1159 | 1161 | 1164 | 1167 | 1169 | 1172 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 2 |
| .07 | 1175 | 1178 | 1180 | 1183 | 1186 | 1189 | 1191 | 1194 | 1197 | 1199 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| .08 | 1202 | 1205 | 1208 | 1211 | 1213 | 1216 | 1219 | 1222 | 1225 | 1227 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| .09 | 1230 | 1233 | 1236 | 1239 | 1242 | 1245 | 1247 | 1250 | 1253 | 1256 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| .10 | 1259 | 1262 | 1265 | 1268 | 1271 | 1274 | 1276 | 1279 | 1282 | 1285 | 0 | 1 | 1 | 1 | 1 | 2 | 2 | 2 | 3 |
| .11 | 1288 | 1291 | 1294 | 1297 | 1300 | 1303 | 1306 | 1309 | 1312 | 1315 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 2 | 3 |
| .12 | 1318 | 1321 | 1324 | 1327 | 1330 | 1334 | 1337 | 1340 | 1343 | 1346 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .13 | 1349 | 1352 | 1355 | 1358 | 1361 | 1365 | 1368 | 1371 | 1374 | 1377 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .14 | 1380 | 1384 | 1387 | 1390 | 1393 | 1396 | 1400 | 1403 | 1406 | 1409 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .15 | 1413 | 1416 | 1419 | 1422 | 1426 | 1429 | 1432 | 1435 | 1439 | 1442 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .16 | 1445 | 1449 | 1452 | 1455 | 1459 | 1462 | 1466 | 1469 | 1472 | 1476 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .17 | 1479 | 1483 | 1486 | 1489 | 1493 | 1496 | 1500 | 1503 | 1507 | 1510 | 0 | 1 | 1 | 1 | 2 | 2 | 2 | 3 | 3 |
| .18 | 1514 | 1517 | 1521 | 1524 | 1528 | 1531 | 1535 | 1538 | 1542 | 1545 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |
| .19 | 1549 | 1552 | 1556 | 1560 | 1563 | 1567 | 1570 | 1574 | 1578 | 1581 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |
| .20 | 1585 | 1589 | 1592 | 1596 | 1600 | 1603 | 1607 | 1611 | 1614 | 1618 | 0 | 1 | 1 | 1 | 2 | 2 | 3 | 3 | 3 |
| .21 | 1622 | 1626 | 1629 | 1633 | 1637 | 1641 | 1644 | 1648 | 1652 | 1656 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| .22 | 1660 | 1663 | 1667 | 1671 | 1675 | 1679 | 1683 | 1687 | 1690 | 1694 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 3 |
| .23 | 1698 | 1702 | 1706 | 1710 | 1714 | 1718 | 1722 | 1726 | 1730 | 1734 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 |
| .24 | 1738 | 1742 | 1746 | 1750 | 1754 | 1758 | 1762 | 1766 | 1770 | 1774 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 |
| .25 | 1778 | 1782 | 1786 | 1791 | 1795 | 1799 | 1803 | 1807 | 1811 | 1816 | 0 | 1 | 1 | 2 | 2 | 2 | 3 | 3 | 4 |
| .26 | 1820 | 1824 | 1828 | 1832 | 1837 | 1841 | 1845 | 1849 | 1854 | 1858 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 |
| .27 | 1862 | 1866 | 1871 | 1875 | 1879 | 1884 | 1888 | 1892 | 1897 | 1901 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 3 | 4 |
| .28 | 1905 | 1910 | 1914 | 1919 | 1923 | 1928 | 1932 | 1936 | 1941 | 1945 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| .29 | 1950 | 1954 | 1959 | 1963 | 1968 | 1972 | 1977 | 1982 | 1986 | 1991 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| .30 | 1995 | 2000 | 2004 | 2009 | 2014 | 2018 | 2023 | 2028 | 2032 | 2037 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| .31 | 2042 | 2046 | 2051 | 2056 | 2061 | 2065 | 2070 | 2075 | 2080 | 2084 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| .32 | 2089 | 2094 | 2099 | 2104 | 2109 | 2113 | 2118 | 2123 | 2128 | 2133 | 0 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 |
| .33 | 2138 | 2143 | 2148 | 2153 | 2158 | 2163 | 2168 | 2173 | 2178 | 2183 | 0 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 |
| .34 | 2188 | 2193 | 2198 | 2203 | 2208 | 2213 | 2218 | 2223 | 2228 | 2234 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| .35 | 2239 | 2244 | 2249 | 2254 | 2259 | 2265 | 2270 | 2275 | 2280 | 2286 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| .36 | 2291 | 2296 | 2301 | 2307 | 2312 | 2317 | 2323 | 2328 | 2333 | 2339 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| .37 | 2344 | 2350 | 2355 | 2360 | 2366 | 2371 | 2377 | 2382 | 2388 | 2393 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 4 | 5 |
| .38 | 2399 | 2404 | 2410 | 2415 | 2421 | 2427 | 2432 | 2438 | 2443 | 2449 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 |
| .39 | 2455 | 2460 | 2466 | 2472 | 2477 | 2483 | 2489 | 2495 | 2500 | 2506 | 1 | 1 | 2 | 2 | 3 | 3 | 4 | 5 | 5 |
| .40 | 2512 | 2518 | 2523 | 2529 | 2535 | 2541 | 2547 | 2553 | 2559 | 2564 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 5 |
| .41 | 2570 | 2576 | 2582 | 2588 | 2594 | 2600 | 2606 | 2612 | 2618 | 2624 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 |
| .42 | 2630 | 2636 | 2642 | 2649 | 2655 | 2661 | 2667 | 2673 | 2679 | 2685 | 1 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 |
| .43 | 2692 | 2698 | 2704 | 2710 | 2716 | 2723 | 2729 | 2735 | 2742 | 2748 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| .44 | 2754 | 2761 | 2767 | 2773 | 2780 | 2786 | 2793 | 2799 | 2805 | 2812 | 1 | 1 | 2 | 3 | 3 | 4 | 4 | 5 | 6 |
| .45 | 2818 | 2825 | 2831 | 2838 | 2844 | 2851 | 2858 | 2864 | 2871 | 2877 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| .46 | 2884 | 2891 | 2897 | 2904 | 2911 | 2917 | 2924 | 2931 | 2938 | 2944 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 5 | 6 |
| .47 | 2951 | 2958 | 2965 | 2972 | 2979 | 2985 | 2992 | 2999 | 3006 | 3013 | 1 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 6 |
| .48 | 3020 | 3027 | 3034 | 3041 | 3048 | 3055 | 3062 | 3069 | 3076 | 3083 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 |
| .49 | 3090 | 3097 | 3105 | 3112 | 3119 | 3126 | 3133 | 3141 | 3148 | 3155 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 6 |

| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Mean Difference 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| .50 | 3162 | 3170 | 3177 | 3184 | 3192 | 3199 | 3206 | 3214 | 3221 | 3228 | 1 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 |
| .51 | 3236 | 3243 | 3251 | 3258 | 3266 | 3273 | 3281 | 3289 | 3296 | 3304 | 1 | 2 | 2 | 3 | 4 | 4 | 5 | 6 | 7 |
| .52 | 3311 | 3319 | 3327 | 3334 | 3342 | 3350 | 3357 | 3365 | 3373 | 3381 | 1 | 2 | 2 | 3 | 4 | 5 | 5 | 6 | 7 |
| .53 | 3388 | 3396 | 3404 | 3412 | 3420 | 3428 | 3436 | 3443 | 3451 | 3459 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 |
| .54 | 3467 | 3475 | 3483 | 3491 | 3499 | 3508 | 3516 | 3524 | 3532 | 3540 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 6 | 7 |
| .55 | 3548 | 3556 | 3565 | 3573 | 3581 | 3589 | 3597 | 3606 | 3614 | 3622 | 1 | 2 | 2 | 3 | 4 | 5 | 6 | 7 | 7 |
| .56 | 3631 | 3639 | 3648 | 3656 | 3664 | 3673 | 3681 | 3690 | 3698 | 3707 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 |
| .57 | 3715 | 3724 | 3733 | 3741 | 3750 | 3758 | 3767 | 3776 | 3784 | 3793 | 1 | 2 | 3 | 3 | 4 | 5 | 6 | 7 | 8 |
| .58 | 3802 | 3811 | 3819 | 3828 | 3837 | 3846 | 3855 | 3864 | 3873 | 3882 | 1 | 2 | 3 | 4 | 4 | 5 | 6 | 7 | 8 |
| .59 | 3890 | 3899 | 3908 | 3917 | 3926 | 3936 | 3945 | 3954 | 3963 | 3972 | 1 | 2 | 3 | 4 | 5 | 5 | 6 | 7 | 8 |
| .60 | 3981 | 3990 | 3999 | 4009 | 4018 | 4027 | 4036 | 4046 | 4055 | 4064 | 1 | 2 | 3 | 4 | 5 | 6 | 6 | 7 | 8 |
| .61 | 4074 | 4083 | 4093 | 4102 | 4111 | 4121 | 4130 | 4140 | 4150 | 4159 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .62 | 4169 | 4178 | 4188 | 4198 | 4207 | 4217 | 4227 | 4236 | 4246 | 4256 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .63 | 4266 | 4276 | 4285 | 4295 | 4305 | 4315 | 4325 | 4335 | 4345 | 4355 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .64 | 4365 | 4375 | 4385 | 4395 | 4406 | 4416 | 4426 | 4436 | 4446 | 4457 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .65 | 4467 | 4477 | 4487 | 4498 | 4508 | 4519 | 4529 | 4539 | 4550 | 4560 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| .66 | 4571 | 4581 | 4592 | 4603 | 4613 | 4624 | 4634 | 4645 | 4656 | 4667 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 10 |
| .67 | 4677 | 4688 | 4699 | 4710 | 4721 | 4732 | 4742 | 4753 | 4764 | 4775 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 9 | 10 |
| .68 | 4786 | 4797 | 4808 | 4819 | 4831 | 4842 | 4853 | 4864 | 4875 | 4887 | 1 | 2 | 3 | 4 | 5 | 7 | 8 | 9 | 10 |
| .69 | 4898 | 4909 | 4920 | 4932 | 4943 | 4955 | 4966 | 4977 | 4989 | 5000 | 1 | 2 | 3 | 5 | 6 | 7 | 8 | 9 | 10 |
| .70 | 5012 | 5023 | 5035 | 5047 | 5058 | 5070 | 5082 | 5093 | 5105 | 5117 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 9 | 11 |
| .71 | 5129 | 5140 | 5152 | 5164 | 5176 | 5188 | 5200 | 5212 | 5224 | 5236 | 1 | 2 | 4 | 5 | 6 | 7 | 8 | 10 | 11 |
| .72 | 5248 | 5260 | 5272 | 5284 | 5297 | 5309 | 5321 | 5333 | 5346 | 5358 | 1 | 2 | 4 | 5 | 6 | 7 | 9 | 10 | 11 |
| .73 | 5370 | 5383 | 5395 | 5408 | 5420 | 5433 | 5445 | 5458 | 5470 | 5483 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 11 |
| .74 | 5495 | 5508 | 5521 | 5534 | 5546 | 5559 | 5572 | 5585 | 5598 | 5610 | 1 | 3 | 4 | 5 | 6 | 8 | 9 | 10 | 12 |
| .75 | 5623 | 5636 | 5649 | 5662 | 5675 | 5689 | 5702 | 5715 | 5728 | 5741 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 10 | 12 |
| .76 | 5754 | 5768 | 5781 | 5794 | 5808 | 5821 | 5834 | 5848 | 5861 | 5875 | 1 | 3 | 4 | 5 | 7 | 8 | 9 | 11 | 12 |
| .77 | 5888 | 5902 | 5916 | 5929 | 5943 | 5957 | 5970 | 5984 | 5998 | 6012 | 1 | 3 | 4 | 5 | 7 | 8 | 10 | 11 | 12 |
| .78 | 6026 | 6039 | 6053 | 6067 | 6081 | 6095 | 6109 | 6124 | 6138 | 6152 | 1 | 3 | 4 | 6 | 7 | 8 | 10 | 11 | 13 |
| .79 | 6166 | 6180 | 6194 | 6209 | 6223 | 6237 | 6252 | 6266 | 6281 | 6295 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 11 | 13 |
| .80 | 6310 | 6324 | 6339 | 6353 | 6368 | 6383 | 6397 | 6412 | 6427 | 6442 | 1 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 |
| .81 | 6457 | 6471 | 6486 | 6501 | 6516 | 6531 | 6546 | 6561 | 6577 | 6592 | 2 | 3 | 4 | 6 | 7 | 9 | 10 | 12 | 13 |
| .82 | 6607 | 6622 | 6637 | 6653 | 6668 | 6683 | 6699 | 6714 | 6730 | 6745 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 |
| .83 | 6761 | 6776 | 6792 | 6808 | 6823 | 6839 | 6855 | 6871 | 6887 | 6902 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 12 | 14 |
| .84 | 6918 | 6934 | 6950 | 6966 | 6982 | 6998 | 7015 | 7031 | 7047 | 7063 | 2 | 3 | 5 | 6 | 8 | 9 | 11 | 13 | 14 |
| .85 | 7079 | 7096 | 7112 | 7129 | 7145 | 7161 | 7178 | 7194 | 7211 | 7228 | 2 | 3 | 5 | 6 | 8 | 10 | 11 | 13 | 15 |
| .86 | 7244 | 7261 | 7278 | 7295 | 7311 | 7328 | 7345 | 7362 | 7379 | 7396 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 |
| .87 | 7413 | 7430 | 7447 | 7464 | 7482 | 7499 | 7516 | 7534 | 7551 | 7568 | 2 | 3 | 5 | 7 | 8 | 10 | 12 | 13 | 15 |
| .88 | 7586 | 7603 | 7621 | 7638 | 7656 | 7674 | 7691 | 7709 | 7727 | 7745 | 2 | 3 | 5 | 7 | 9 | 10 | 12 | 14 | 16 |
| .89 | 7762 | 7780 | 7798 | 7816 | 7834 | 7852 | 7870 | 7889 | 7907 | 7925 | 2 | 4 | 5 | 7 | 9 | 11 | 12 | 14 | 16 |
| .90 | 7943 | 7962 | 7980 | 7998 | 8017 | 8035 | 8054 | 8072 | 8091 | 8110 | 2 | 4 | 5 | 7 | 9 | 11 | 13 | 14 | 16 |
| .91 | 8128 | 8147 | 8166 | 8185 | 8204 | 8222 | 8241 | 8260 | 8279 | 8299 | 2 | 4 | 6 | 7 | 9 | 11 | 13 | 15 | 17 |
| .92 | 8318 | 8337 | 8356 | 8375 | 8395 | 8414 | 8433 | 8453 | 8472 | 8492 | 2 | 4 | 6 | 8 | 9 | 11 | 13 | 15 | 17 |
| .93 | 8511 | 8531 | 8551 | 8570 | 8590 | 8610 | 8630 | 8650 | 8670 | 8690 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 15 | 17 |
| .94 | 8710 | 8730 | 8750 | 8770 | 8790 | 8810 | 8831 | 8851 | 8872 | 8892 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| .95 | 8913 | 8933 | 8954 | 8974 | 8995 | 9016 | 9036 | 9057 | 9078 | 9099 | 2 | 4 | 6 | 8 | 10 | 12 | 14 | 16 | 18 |
| .96 | 9120 | 9141 | 9162 | 9183 | 9204 | 9226 | 9247 | 9268 | 9290 | 9311 | 2 | 4 | 6 | 8 | 10 | 12 | 15 | 17 | 19 |
| .97 | 9333 | 9354 | 9376 | 9397 | 9419 | 9441 | 9462 | 9484 | 9506 | 9528 | 2 | 4 | 6 | 8 | 11 | 13 | 15 | 17 | 19 |
| .98 | 9550 | 9572 | 9594 | 9616 | 9638 | 9661 | 9683 | 9705 | 9727 | 9750 | 2 | 4 | 7 | 9 | 11 | 13 | 15 | 17 | 20 |
| .99 | 9772 | 9795 | 9817 | 9840 | 9863 | 9886 | 9908 | 9931 | 9954 | 9977 | 2 | 5 | 7 | 9 | 11 | 13 | 16 | 18 | 20 |
| | | | | | | | | | | | 2 | 5 | 7 | 9 | 11 | 14 | 16 | 18 | 20 |