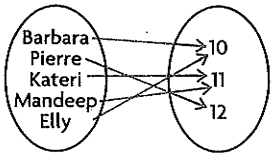
Lesson 1.1, pp. 10–12

1. **a)** Function; each x-value has only one y-value
b) Not a function; for $x = 1$, $y = -3$ and 0
c) Not a Function; for $x = 0$, $y = 4$ and 1
d) Function; each x-value has only one y-value

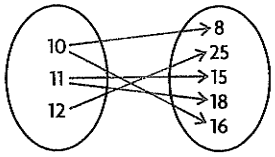
2. **a)** Not a function **c)** Function **e)** Function
b) Not a function **d)** Not a function **f)** Not a function

3. $y = 66$; $y = 2$ or 3; For $y = x^2 - 5x$, each x-value gives a single y-value. For $x = y^2 - 5y$, each x-value gives a quadratic equation in y, which may have two solutions.

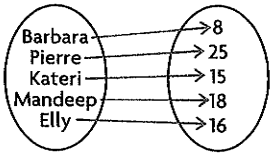
4. **a)** {(Barbara, 10), (Pierre, 12), (Kateri, 11), (Mandeep, 11), (Elly, 10)}



{(10, 8), (12, 25), (11, 15), (11, 18), (10, 16)}



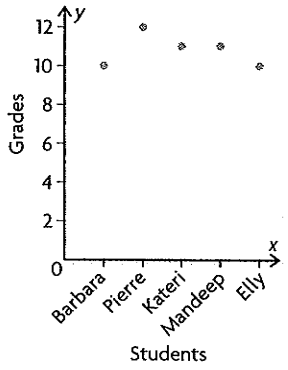
{(Barbara, 8), (Pierre, 25), (Kateri, 15), (Mandeep, 18), (Elly, 16)}



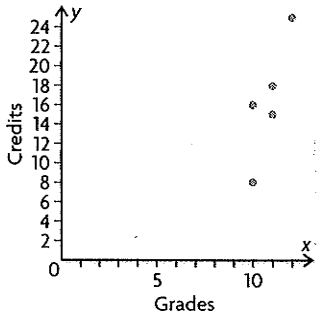
b) students, grades: domain = {Barbara, Pierre, Kateri, Mandeep, Elly}, range = {10, 11, 12} grades, credits: domain = {10, 11, 12}, range = {8, 15, 16, 18, 25} students, credits: domain = {Barbara, Pierre, Kateri, Mandeep, Elly}, range = {8, 15, 16, 18, 25}

c) Only grades-credits relation is not a function; it has repeated range values for single domain values.

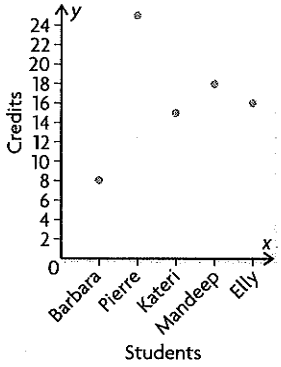
5. students, grades:



grades, credits:

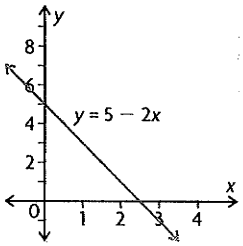


students, credits:

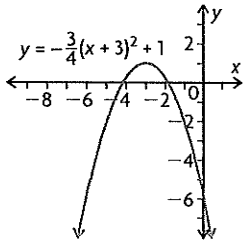


6. $y = 3$: horizontal line; function (passes vertical-line test).
$x = 3$: vertical line; not a function (fails vertical-line test)

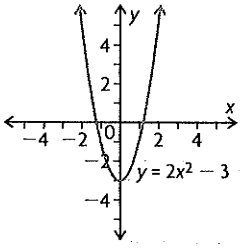
7. **a)** Linear, function



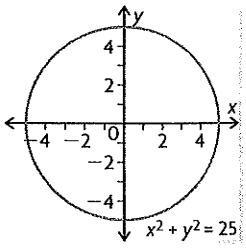
c) Quadratic, function



b) Quadratic, function



d) Circle, not a function



8. a) i) 1.25; 2.75 ii) ± 2; 0 iii) 2; -2 iv) 0; $\pm\sqrt{2}$
b) Functions: (i), (iii)
c) Graph relation and apply vertical-line test, or solve equation for y and check for multiple values

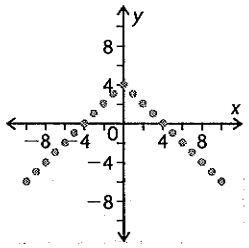
9. Functions: (a), (b), (d)

10. Not a function; for example, when $x = 6$, $y = 2$ or -2; graph fails vertical-line test

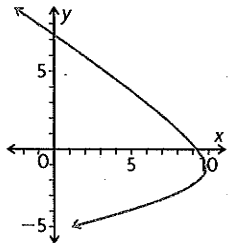
11. Functions: (a), (b)

12. a) domain $= \{x \in \mathbf{R} \mid x \geq 0\}$, range $= \{y \in \mathbf{R} \mid y \geq 44\}$
b) Distance cannot be negative, cost cannot be lower than daily rental charge.
c) Yes, it passes the vertical line test.

13. a) Answers may vary; for example:



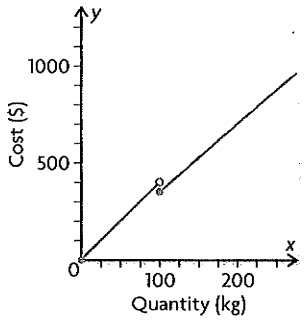
b) Answers may vary; for example:



14. Answers may vary; for example:

Definition: A relation with only one y-value for each x-value	**Characteristics:** A vertical line crosses the graph in at most one place
Function	
Examples: $3x + y = 2$; $y = -2x^2 + 7$	**Non-examples:** $x^2 + y^2 = 16$; $y = \pm\sqrt{x - 7}$

15. a) Each order quantity determines a single cost.
b) domain $= \{x \in \mathbf{R} \mid x \geq 0\}$, range $= \{y \in \mathbf{R} \mid y \geq 0\}$
c)



d) Answers may vary. For example, the company currently charges less for an order of 100 kg ($350) than for an order of 99 kg ($396). A better system would be for the company to charge $50 plus $3.50 per kilogram for orders of 100 kg or more. This would make the prices strictly increasing as the weight of the order increases.

Lesson 1.2, pp. 22–24

1. a) -4 c) 14 e) $2 - 3a$
b) 2 d) $\frac{1}{2}$ f) $2 - 9b$

2. a) 2 b) 4 c) -5 d) -3 or -4

3. a) $f(x) = 1200 - 3x$
b) 840 mL c) 3:10 pm

4. a) 8, 0, -0.75 b) -5, -25, -2.5

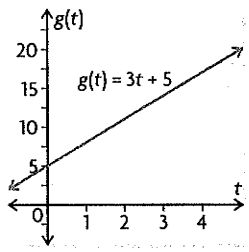
5. a) $-\frac{1}{6}$ b) undefined c) $\frac{1}{3}$ d) $2\frac{2}{3}$

6. a) domain $= \{-2, 2, 3, 5, 7\}$, range $= \{1, 2, 3, 4, 5\}$
b) i) 4 ii) 2 iii) 5 iv) -2

7. a) $2a - 5$ b) $2b - 3$ c) $6c - 7$ d) $-10x - 1$

8. a)

t	$g(t)$
0	5
1	8
2	11
3	14
4	17
5	20



b) i) 5 ii) 14 iii) 3 iv) 3 v) 3 vi) 3

9. a)

s	$f(s)$
0	9
1	4
2	1
3	0

b) i) 9 ii) 4 iii) 1 iv) 0 v) 2 vi) 2
c) They are the same; they represent the second differences, which are constant for a quadratic function.

10. a) 49
b) The y-coordinate of the point on the graph with x-coordinate -2
c) domain $= \{x \in \mathbf{R}\}$, range $= \{y \in \mathbf{R} \mid y \geq -1\}$
d) It passes the vertical-line test.

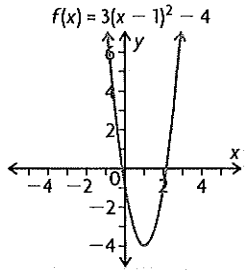
11. a) 2 b) 0.4 c) 0.8 d) $\frac{17}{25}$

12. a) $f(x) = 0.15x + 50$ b) \$120.80 c) 200 km

13. a) $f(x) = (24 - 3x)x$ b) 45, -195, -60 c) 48

14. $f(x) \doteq 0.0036x(281 - x)$

15. a) $f(x) = 3(x - 1)^2 - 4$



b) The y-coordinate of the point on the graph with x-coordinate -1; start from -1 on x-axis, move up to curve, then across to y-axis
c) i) 3 ii) 9 iii) $3x^2 - 4$

16. a) 3, -5 b) 1, -3 c) -1

17. a) $\frac{1}{4}$ b) $\frac{1}{3}$, -1

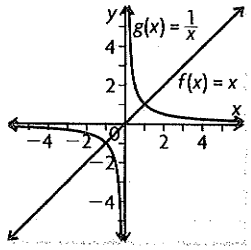
18. Answers may vary; for example: $f(x)$ is defined as equal to an expression involving x, for each x-value in the functions domain; Advantages: function notation connects input with output; we can write expressions involving more than one function; the graph of $f(x)$ is the set of all points $(x, f(x))$ for which x is in the domain. Student examples will vary. Change student examples will vary to: Function notation makes relations clearer, for example, $T(d) = 11 + 0.015d$ helps show that the temperature depends on the depth.

19. a) $f(x) = \frac{2}{3}x + 10$ b) $73\frac{1}{3}, 126\frac{2}{3}, 153\frac{1}{3}, 180$

20. a) 8, 27, 64, 125, 216 b) cube of x or x^3

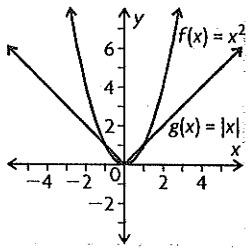
Lesson 1.3, p. 28

1.



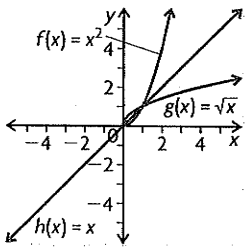
Both graphs lie in quadrants 1 and 3; graph of $g(x)$ is in two curved parts, and does not intersect axes. Vertical asymptote of $g(x)$: $x = 0$; horizontal asymptote of $g(x)$: $g(x) = 0$.

2.



Both graphs lie in quadrants 1 and 2; graph of $f(x)$ curves, but graph of $g(x)$ is formed by two straight half-lines.

3.



Graph of $g(x)$ is reflection of graph of $f(x)$ in graph of $h(x)$.

Lesson 1.4, pp. 35–37

1. a) domain = {1900, 1920, 1940, 1960, 1980, 2000}, range = {47.3, 54.1, 62.9, 69.7, 73.7, 77.0}
b) domain = {−5, −1, 0, 3}, range = {9, 15, 17, 23}
c) domain = {−4, 0, 3, 5}, range = {−1, 0, 3, 5, 7}

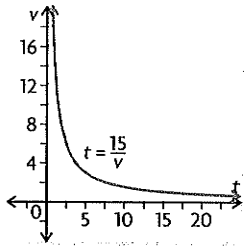
2. a) domain = {0, ±2, ±4, ±6, ±8, ±10}, range = {−8, −7, −6, −5, −4, −2, 0, 4, 8}
b) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R}$}
c) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R} \mid y \geq -8$}
d) domain = {$x \in \mathbf{R} \mid -6 \leq x \leq 6$}, range = {$y \in \mathbf{R} \mid -6 \leq y \leq 6$}
e) domain = {$x \in \mathbf{R} \mid x \leq 6$}, range = {$y \in \mathbf{R} \mid y \geq -2$}
f) domain = {$x \in \mathbf{R} \mid x \geq -10$}, range = {$y \in \mathbf{R} \mid y = -6, -2 \leq y < 2, y \geq 4$}

3. **1.** (a), (b); **2.** (b), (c), (e), (f)

4. domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R} \mid y \geq -3$}

5. a) Even at masses when the price changes, a single price (the lower one) is assigned. It would not make sense to assign two or more prices to the same mass.
b) domain = {$x \in \mathbf{R} \mid 0 < x \leq 500$}, range = {0.52, 0.93, 1.20, 1.86, 2.55}

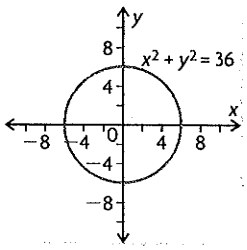
6.



Graph passes vertical line test; domain = {$v \in \mathbf{R} \mid v > 0$}, range = {$t \in \mathbf{R} \mid t > 0$}

Speed (km/h)	Time (h)
1	15.0
2	7.5
3	5.0
4	3.75
5	3.0
6	2.5
8	1.875
10	1.5
15	1.0
20	0.75

7. a)

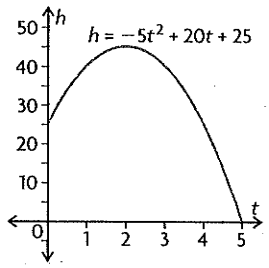


b) domain = {$x \in \mathbf{R} \mid -6 \leq x \leq 6$}, range = {$y \in \mathbf{R} \mid -6 \leq y \leq 6$}
c) No; fails vertical line test

8. $V(t) = t$; domain = {$t \in \mathbf{R} \mid 0 \leq t \leq 2500$}, range = {$V \in \mathbf{R} \mid 0 \leq V \leq 2500$}

9. a) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R}$}
b) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R} \mid y \leq 4$}
c) domain = {$x \in \mathbf{R} \mid x \geq 1$}, range = {$y \in \mathbf{R} \mid y \geq 0$}
d) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R} \mid y \geq -5$}
e) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R}$}
f) domain = {$x \in \mathbf{R} \mid x \leq 5$}, range = {$y \in \mathbf{R} \mid y \geq 0$}

10. a)

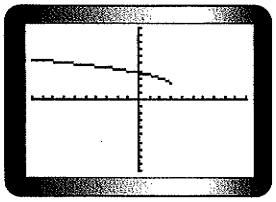


b) domain = {$t \in \mathbf{R} \mid 0 \leq t \leq 5$}, range = {$h \in \mathbf{R} \mid 0 \leq h \leq 45$}
c) $h = -5t^2 + 20t + 25$

11. a) domain = {$x \in \mathbf{R}$}, range = {$y \in \mathbf{R}$}
b) domain = {$x \in \mathbf{R} \mid x \geq 2$}, range = {$y \in \mathbf{R} \mid y \geq 0$}

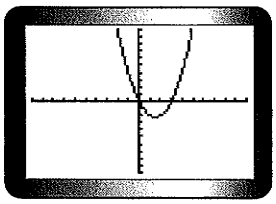
c) domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \geq -4\}$
d) domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \leq -5\}$

12. a)



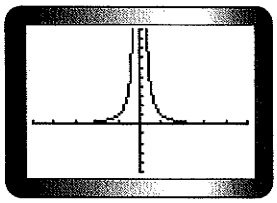
domain = $\{x \in \mathbf{R} \mid x \leq 3\}$, range = $\{y \in \mathbf{R} \mid y \geq 2\}$

b)



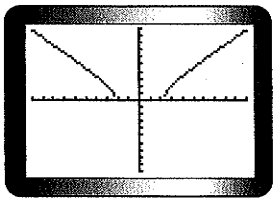
domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \geq -2.25\}$

c)



domain = $\{x \in \mathbf{R} \mid x \neq 0\}$, range = $\{y \in \mathbf{R} \mid y > 0\}$

d)



domain = $\{x \in \mathbf{R} \mid x \leq -\sqrt{5}, x \geq \sqrt{5}\}$,
range = $\{y \in \mathbf{R} \mid y \geq 0\}$

13. a) $A = \left(\frac{450 - 3w}{2}\right)w$

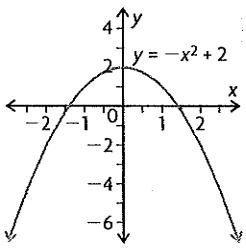
b) domain = $\{w \in \mathbf{R} \mid 0 < w < 150\}$,
range = $\{A \in \mathbf{R} \mid 0 < A \leq 8437.5\}$

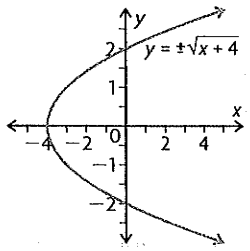
c) $l = 112.5$ m, $w = 75$ m

14. a) $\{-14, -3.5, 4, 7, 13\}$ b) $\{1, 6, 28, 55\}$

15. The domain is the set of x-values for a relation or function; the range is the set of y-values corresponding to these x-values. Domain and range are determined by values in x-column and y-column; x-coordinates and y-coordinates of graph; x-values for which relation or function is defined, and all possible corresponding y-values. Students' examples will vary.

16. a) Answers may vary; for example: b) Answers may vary; for example:





17. a) $A = x^2 + (10 - x)^2$ or $2x^2 - 20x + 100$

b) domain = $\{x \in \mathbf{R} \mid 0 \leq x \leq 10\}$,
range = $\{A \in \mathbf{R} \mid 50 \leq A \leq 100\}$

c) $P = 4\sqrt{x^2 + (10 - x)^2}$ or $\sqrt{2x^2 - 20x + 100}$

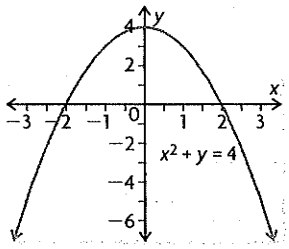
d) domain = $\{x \in \mathbf{R} \mid 0 \leq x \leq 10\}$,
range = $\{P \in \mathbf{R} \mid 5\sqrt{2} \leq P \leq 40\}$

Mid-Chapter Review, p. 40

1. a) Not a function
b) Function; each x-value goes to a single y-value
c) Function; passes vertical line test
d) Not a function
e) Function; each x-value determines a single y-value
f) Function; each x-value determines a single y-value

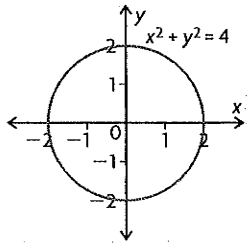
2. $x^2 + y = 4$:

x	y
−3	−5
−2	0
−1	3
0	4
1	3
2	0
3	−5

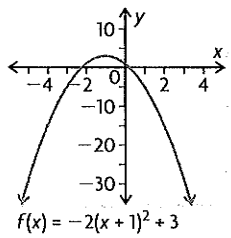


$x^2 + y^2 = 4$:

x	y
−2	0
0	±2
2	0



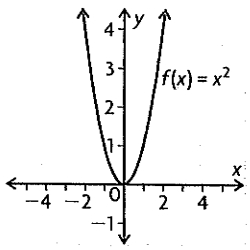
3. a)



b) −5
c) y-coordinate of the point on the graph with x-coordinate −3
d) i) −6 ii) −50 iii) $-2(3 - x)^2 + 3$

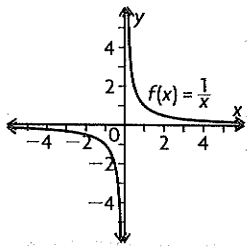
4. a) $f(x) = (20 - 5x)x$ b) 15, −25, −105 c) 20

5. a)



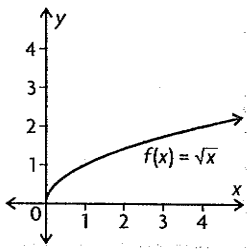
domain = $\{x \in \mathbf{R}\}$,
range = $\{y \in \mathbf{R} \mid y \geq 0\}$

b)



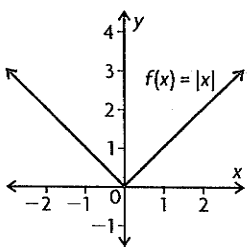
domain = $\{x \in \mathbf{R} \mid x \neq 0\}$,
range = $\{y \in \mathbf{R} \mid y \neq 0\}$

c)



domain = $\{x \in \mathbf{R} \mid x \geq 0\}$,
range = $\{y \in \mathbf{R} \mid y \geq 0\}$

d)



domain = $\{x \in \mathbf{R}\}$,
range = $\{y \in \mathbf{R} \mid y \geq 0\}$

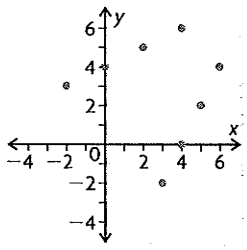
6. a) domain = $\{1, 2, 4\}$, range = $\{2, 3, 4, 5\}$
b) domain = $\{-2, 0, 3, 7\}$, range = $\{-1, 1, 3, 4\}$
c) domain = $\{-4, -3, -2, -1, 0, 1, 2, 3, 4, 5\}$,
range = $\{-4, -3, -2, -1, 0, 1, 2, 3, 4, 5\}$
d) domain = $\{x \in \mathbf{R} \mid x \geq -3\}$, range = $\{y \in \mathbf{R}\}$
e) domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \leq 5\}$
f) domain = $\{x \in \mathbf{R} \mid x \geq 4\}$, range = $\{y \in \mathbf{R} \mid y \geq 0\}$

7. a) $A = \left(\frac{600 - 4w}{2}\right)w$
b) domain = $\{w \in \mathbf{R} \mid 0 < w < 150\}$,
range = $\{A \in \mathbf{R} \mid 0 < A \leq 11\,250\}$
c) $l = 150$ m, $w = 75$ m

8. a) domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \leq 5\}$
b) domain = $\{x \in \mathbf{R}\}$, range = $\{y \in \mathbf{R} \mid y \geq 4\}$
c) domain = $\{x \in \mathbf{R} \mid -7 \leq x \leq 7\}$,
range = $\{y \in \mathbf{R} \mid -7 \leq y \leq 7\}$
d) domain = $\{x \in \mathbf{R} \mid -2 \leq x \leq 6\}$,
range = $\{y \in \mathbf{R} \mid 1 \leq y \leq 9\}$

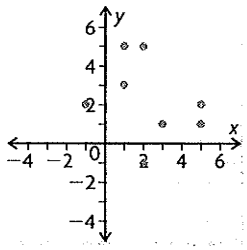
Lesson 1.5, pp. 46–49

1. a) $\{(3, -2), (4, 0), (5, 2), (6, 4)\}$



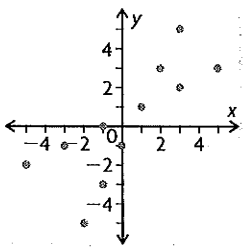
Both relation and inverse relation are functions.

b) $\{(5, 2), (-1, 2), (1, 3), (1, 5)\}$



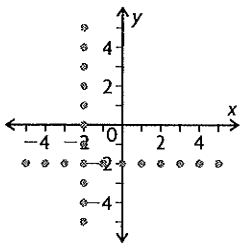
Both relation and inverse relation are not functions.

2. a)



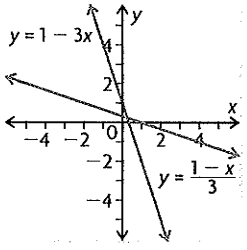
Function, point (1, 1) is common

b)



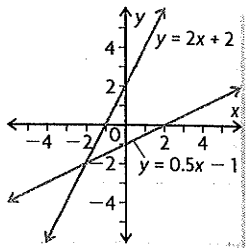
Not a function, point (−2, −2) is common

c)



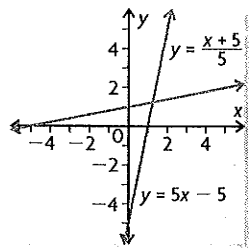
Function, point (0.25, 0.25) is common

d)



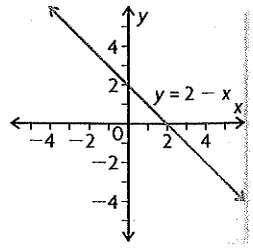
Function, point (−2, −2) is common

e)



Function, point (1.25, 1.25) is common

f)



Function, all points are common. The function and its inverse are the same graph.