

## Lesson 7.3 Exercises, pages 553–559

**A**

3. Simplify.

$$\begin{aligned} \text{a) } \frac{5}{a} + \frac{3}{a} \\ = \frac{8}{a}, a \neq 0 \end{aligned}$$

$$\begin{aligned} \text{b) } \frac{1}{9x} + \frac{4}{9x} \\ = \frac{5}{9x}, x \neq 0 \end{aligned}$$

$$\begin{aligned} \text{c) } \frac{7e}{e+2} - \frac{3e}{e+2} \\ = \frac{4e}{e+2}, e \neq -2 \end{aligned}$$

$$\begin{aligned} \text{d) } \frac{3h}{h^2+3h+4} - \frac{8h}{h^2+3h+4} \\ = \frac{-5h}{h^2+3h+4} \end{aligned}$$

4. a) Determine the least common multiple of the expressions in each pair.

i)  $4d, 5d$

$$4d = 2 \cdot 2 \cdot d$$

$$5d = 5 \cdot d$$

Least common multiple:

$$2 \cdot 2 \cdot 5 \cdot d = 20d$$

ii)  $6e^2, 7e$

$$6e^2 = 2 \cdot 3 \cdot e \cdot e$$

$$7e = 7 \cdot e$$

Least common multiple:

$$2 \cdot 3 \cdot 7 \cdot e \cdot e = 42e^2$$

b) Use your results from part a to write each pair of expressions with a common denominator.

i)  $\frac{3}{4d}, \frac{-2}{5d}$

Common denominator:  $20d$

$$\frac{3}{4d} \cdot \frac{5}{5} = \frac{15}{20d}$$

$$\frac{-2}{5d} \cdot \frac{4}{4} = \frac{-8}{20d}$$

ii)  $\frac{5}{6e^2}, \frac{6}{7e}$

Common denominator:  $42e^2$

$$\frac{5}{6e^2} \cdot \frac{7}{7} = \frac{35}{42e^2}$$

$$\frac{6}{7e} \cdot \frac{6e}{6e} = \frac{36e}{42e^2}$$

c) Simplify.

i)  $\frac{3}{4d} + \frac{-2}{5d}$

Non-permissible value:  $d = 0$

$$= \frac{15}{20d} + \frac{-8}{20d}$$

$$= \frac{7}{20d}, d \neq 0$$

ii)  $\frac{5}{6e^2} - \frac{6}{7e}$

Non-permissible value:  $e = 0$

$$= \frac{35}{42e^2} - \frac{36e}{42e^2}$$

$$= \frac{35 - 36e}{42e^2}, e \neq 0$$

## B

5. Simplify.

a)  $\frac{4}{a} - \frac{2}{3}$

Non-permissible value:  $a = 0$

Common denominator:  $3a$

$$= \frac{4}{a} \cdot \frac{3}{3} - \frac{2}{3} \cdot \frac{a}{a}$$

$$= \frac{12}{3a} - \frac{2a}{3a}$$

$$= \frac{12 - 2a}{3a}, a \neq 0$$

b)  $\frac{4}{3x} + \frac{1}{5x}$

Non-permissible value:  $x = 0$

Common denominator:  $15x$

$$= \frac{4}{3x} \cdot \frac{5}{5} + \frac{1}{5x} \cdot \frac{3}{3}$$

$$= \frac{20}{15x} + \frac{3}{15x}$$

$$= \frac{23}{15x}, x \neq 0$$

6. Simplify.

a)  $\frac{1}{3a} + \frac{2a}{5a^2}$

Non-permissible value:  $a = 0$

Common denominator:  $15a^2$

$$= \frac{1}{3a} \cdot \frac{5a}{5a} + \frac{2a}{5a^2} \cdot \frac{3}{3}$$

$$= \frac{5a}{15a^2} + \frac{6a}{15a^2}$$

$$= \frac{11a}{15a^2}$$

$$= \frac{11}{15a}, a \neq 0$$

b)  $4 - \frac{1}{x}$

Non-permissible value:  $x = 0$

Common denominator:  $x$

$$= \frac{4}{1} \cdot \frac{x}{x} - \frac{1}{x}$$

$$= \frac{4x}{x} - \frac{1}{x}$$

$$= \frac{4x - 1}{x}, x \neq 0$$

7. Simplify.

a)  $\frac{2}{xz^2} - \frac{5}{x^2z}$

Non-permissible values:

$x = 0, z = 0$

Common denominator:  $x^2z^2$

$$= \frac{2}{xz^2} \cdot \frac{x}{x} - \frac{5}{x^2z} \cdot \frac{z}{z}$$

$$= \frac{2x}{x^2z^2} - \frac{5z}{x^2z^2}$$

$$= \frac{2x - 5z}{x^2z^2}, x \neq 0, z \neq 0$$

b)  $\frac{3}{r^2s^2} + \frac{2}{rs^3}$

Non-permissible values:

$r = 0, s = 0$

Common denominator:  $r^2s^3$

$$= \frac{3}{r^2s^2} \cdot \frac{s}{s} + \frac{2}{rs^3} \cdot \frac{r}{r}$$

$$= \frac{3s}{r^2s^3} + \frac{2r}{r^2s^3}$$

$$= \frac{3s + 2r}{r^2s^3}, r \neq 0, s \neq 0$$

c)  $\frac{1}{x} + \frac{7}{6y}$

Non-permissible values:

$x = 0, y = 0$

Common denominator:  $6xy$

$$= \frac{1}{x} \cdot \frac{6y}{6y} + \frac{7}{6y} \cdot \frac{x}{x}$$

$$= \frac{6y}{6xy} + \frac{7x}{6xy}$$

$$= \frac{6y + 7x}{6xy}, x \neq 0, y \neq 0$$

d)  $\frac{2}{3e^5f^2} + \frac{3}{5ef^3}$

Non-permissible values:

$e = 0, f = 0$

Common denominator:  $15e^5f^3$

$$= \frac{2}{3e^5f^2} \cdot \frac{5f}{5f} + \frac{3}{5ef^3} \cdot \frac{3e^4}{3e^4}$$

$$= \frac{10f}{15e^5f^3} + \frac{9e^4}{15e^5f^3}$$

$$= \frac{10f + 9e^4}{15e^5f^3}, e \neq 0, f \neq 0$$

8. Simplify.

a)  $\frac{2x - 3}{x} + \frac{x - 1}{3x}$

Non-permissible value:  $x = 0$

Common denominator:  $3x$

$$= \frac{2x - 3}{x} \cdot \frac{3}{3} + \frac{x - 1}{3x}$$

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

$$= \frac{6x - 9 + x - 1}{3x}$$

$$= \frac{7x - 10}{3x}, x \neq 0$$

b)  $\frac{2p + 4}{2p} + \frac{3p + 1}{3p^2}$

Non-permissible value:  $p = 0$

Common denominator:  $6p^2$

$$= \frac{2p + 4}{2p} \cdot \frac{3p}{3p} + \frac{3p + 1}{3p^2} \cdot \frac{2}{2}$$

$$= \frac{3p(2p + 4)}{6p^2} + \frac{2(3p + 1)}{6p^2}$$

$$= \frac{6p^2 + 12p + 6p + 2}{6p^2}$$

$$= \frac{6p^2 + 18p + 2}{6p^2}$$

$$= \frac{2(3p^2 + 9p + 1)}{6p^2}$$

$$= \frac{3p^2 + 9p + 1}{3p^2}, p \neq 0$$

$$\text{c) } \frac{3t - 4}{t} - \frac{2t - 7}{8}$$

Non-permissible value:  $t = 0$

Common denominator:  $8t$

$$= \frac{3t - 4}{t} \cdot \frac{8}{8} - \frac{2t - 7}{8} \cdot \frac{t}{t}$$

$$= \frac{8(3t - 4)}{8t} - \frac{t(2t - 7)}{8t}$$

$$= \frac{24t - 32 - 2t^2 + 7t}{8t}$$

$$= \frac{-2t^2 + 31t - 32}{8t}, t \neq 0$$

$$\text{d) } \frac{2q - 3}{5q^2} - \frac{1 - q}{4q^3}$$

Non-permissible value:  $q = 0$

Common denominator:  $20q^3$

$$= \frac{2q - 3}{5q^2} \cdot \frac{4q}{4q} - \frac{1 - q}{4q^3} \cdot \frac{5}{5}$$

$$= \frac{4q(2q - 3)}{20q^3} - \frac{5(1 - q)}{20q^3}$$

$$= \frac{8q^2 - 12q - 5 + 5q}{20q^3}$$

$$= \frac{8q^2 - 7q - 5}{20q^3}, q \neq 0$$

9. Simplify.

$$\text{a) } \frac{a + b}{5a} - \frac{b - a}{15b}$$

Non-permissible values:

$$a = 0, b = 0$$

Common denominator:  $15ab$

$$= \frac{a + b}{5a} \cdot \frac{3b}{3b} - \frac{b - a}{15b} \cdot \frac{a}{a}$$

$$= \frac{3b(a + b)}{15ab} - \frac{a(b - a)}{15ab}$$

$$= \frac{3ab + 3b^2 - ab + a^2}{15ab}$$

$$= \frac{3b^2 + 2ab + a^2}{15ab}, a \neq 0, b \neq 0$$

$$\text{b) } \frac{2x - y}{x^2y} + \frac{x + y}{xy^2}$$

Non-permissible values:

$$x = 0, y = 0$$

Common denominator:  $x^2y^2$

$$= \frac{2x - y}{x^2y} \cdot \frac{y}{y} + \frac{x + y}{xy^2} \cdot \frac{x}{x}$$

$$= \frac{y(2x - y)}{x^2y^2} + \frac{x(x + y)}{x^2y^2}$$

$$= \frac{2xy - y^2 + x^2 + xy}{x^2y^2}$$

$$= \frac{x^2 + 3xy - y^2}{x^2y^2}, x \neq 0, y \neq 0$$

$$\text{c) } \frac{11j - 7}{6j^2} - \frac{k + 2}{7k}$$

Non-permissible values:

$$j = 0, k = 0$$

Common denominator:  $42j^2k$

$$= \frac{11j - 7}{6j^2} \cdot \frac{7k}{7k} - \frac{k + 2}{7k} \cdot \frac{6j^2}{6j^2}$$

$$= \frac{7k(11j - 7)}{42j^2k} - \frac{6j^2(k + 2)}{42j^2k}$$

$$= \frac{77jk - 49k - 6j^2k - 12j^2}{42j^2k},$$

$$j \neq 0, k \neq 0$$

$$\text{d) } \frac{b + 1}{7bc} - \frac{b^2 - 1}{8b^3}$$

Non-permissible values:

$$b = 0, c = 0$$

Common denominator:  $56b^3c$

$$= \frac{b + 1}{7bc} \cdot \frac{8b^2}{8b^2} - \frac{b^2 - 1}{8b^3} \cdot \frac{7c}{7c}$$

$$= \frac{8b^2(b + 1)}{56b^3c} - \frac{7c(b^2 - 1)}{56b^3c}$$

$$= \frac{8b^3 + 8b^2 - 7b^2c + 7c}{56b^3c},$$

$$b \neq 0, c \neq 0$$

10. Here is a student's solution for subtracting rational expressions.

Identify the error in the solution. Write a correct solution.

$$\begin{aligned}\frac{3x+6}{2x^2} - \frac{x-4}{3x} &= \frac{3x+6}{2x^2} \cdot \frac{3}{3} - \frac{x-4}{3x} \cdot \frac{2x}{2x} \\ &= \frac{3(3x+6)}{6x^2} - \frac{2x(x-4)}{6x^2} \\ &= \frac{9x+18-2x^2-8x}{6x^2} \\ &= \frac{-2x^2+x+18}{6x^2}, x \neq 0\end{aligned}$$

There is an error in line 3:  $-2x(-4)$  should be  $8x$ , not  $-8x$ .

Correct solution:

$$\begin{aligned}\frac{3x+6}{2x^2} - \frac{x-4}{3x} &= \frac{3x+6}{2x^2} \cdot \frac{3}{3} - \frac{x-4}{3x} \cdot \frac{2x}{2x} \\ &= \frac{3(3x+6)}{6x^2} - \frac{2x(x-4)}{6x^2} \\ &= \frac{9x+18-2x^2+8x}{6x^2} \\ &= \frac{-2x^2+17x+18}{6x^2}, x \neq 0\end{aligned}$$

11. Simplify.

a)  $\frac{6}{3x} - \frac{2}{4x} + \frac{3}{6x}$

Non-permissible value:  $x = 0$

Common denominator:  $12x$

$$\begin{aligned}&= \frac{6}{3x} \cdot \frac{4}{4} - \frac{2}{4x} \cdot \frac{3}{3} + \frac{3}{6x} \cdot \frac{2}{2} \\ &= \frac{24}{12x} - \frac{6}{12x} + \frac{6}{12x} \\ &= \frac{24}{12x} \\ &= \frac{2}{x}, x \neq 0\end{aligned}$$

b)  $\frac{2}{u} - \frac{3}{u^2} + \frac{1}{2u}$

Non-permissible value:  $u = 0$

Common denominator:  $2u^2$

$$\begin{aligned}&= \frac{2}{u} \cdot \frac{2u}{2u} - \frac{3}{u^2} \cdot \frac{2}{2} + \frac{1}{2u} \cdot \frac{u}{u} \\ &= \frac{4u}{2u^2} - \frac{6}{2u^2} + \frac{u}{2u^2} \\ &= \frac{4u-6+u}{2u^2} \\ &= \frac{5u-6}{2u^2}, u \neq 0\end{aligned}$$

c)  $\frac{-10}{4n} + \frac{5}{3} - \frac{6}{m}$

Non-permissible values:

$n = 0$  and  $m = 0$

Common denominator:  $12nm$

$$\begin{aligned}&= \frac{-10}{4n} \cdot \frac{3m}{3m} + \frac{5}{3} \cdot \frac{4mn}{4mn} - \frac{6}{m} \cdot \frac{12n}{12n} \\ &= \frac{-30m}{12mn} + \frac{20mn}{12mn} - \frac{72n}{12mn} \\ &= \frac{2(-15m+10mn-36n)}{12mn} \\ &= \frac{-15m+10mn-36n}{6mn}, \\ & m \neq 0, n \neq 0\end{aligned}$$

d)  $\frac{4j-5}{3j} + \frac{2j+1}{5j^2} - \frac{7-3j}{2}$

Non-permissible value:  $j = 0$

Common denominator:  $30j^2$

$$\begin{aligned}&= \frac{(4j-5)}{3j} \cdot \frac{10j}{10j} + \frac{(2j+1)}{5j^2} \cdot \frac{6}{6} - \frac{(7-3j)}{2} \cdot \frac{15j^2}{15j^2} \\ &= \frac{10j(4j-5)}{30j^2} + \frac{6(2j+1)}{30j^2} - \frac{15j^2(7-3j)}{30j^2} \\ &= \frac{40j^2-50j+12j+6-105j^2+45j^3}{30j^2} \\ &= \frac{45j^3-65j^2-38j+6}{30j^2}, j \neq 0\end{aligned}$$

12. Simplify.

a)  $\frac{x^2 - 3}{2x} + x - 2$

Non-permissible value:  $x = 0$

Common denominator:  $2x$

$$= \frac{x^2 - 3}{2x} + \frac{x}{1} \cdot \frac{2x}{2x} - \frac{2}{1} \cdot \frac{2x}{2x}$$

$$= \frac{x^2 - 3}{2x} + \frac{2x^2}{2x} - \frac{4x}{2x}$$

$$= \frac{3x^2 - 4x - 3}{2x}, x \neq 0$$

b)  $4w + \frac{1}{v} - \frac{2w - 3}{w^2}$

Non-permissible values:  $v = 0, w = 0$

Common denominator:  $vw^2$

$$= \frac{4w}{1} \cdot \frac{vw^2}{vw^2} + \frac{1}{v} \cdot \frac{w^2}{w^2} - \frac{(2w - 3)}{w^2} \cdot \frac{v}{v}$$

$$= \frac{4vw^3}{vw^2} + \frac{w^2}{vw^2} - \frac{v(2w - 3)}{vw^2}$$

$$= \frac{4vw^3 + w^2 - 2vw + 3v}{vw^2}, v \neq 0, w \neq 0$$

c)  $\frac{x + y}{y} + \frac{x - y}{x} - 4xy$

Non-permissible values:

$x = 0$  and  $y = 0$

Common denominator:  $xy$

$$= \frac{(x + y)}{y} \cdot \frac{x}{x}$$

$$+ \frac{(x - y)}{x} \cdot \frac{y}{y} - \frac{4xy}{1} \cdot \frac{xy}{xy}$$

$$= \frac{x(x + y)}{xy} + \frac{y(x - y)}{xy} - \frac{4x^2y^2}{xy}$$

$$= \frac{x^2 + xy + xy - y^2 - 4x^2y^2}{xy}$$

$$= \frac{x^2 + 2xy - y^2 - 4x^2y^2}{xy},$$

$x \neq 0, y \neq 0$

d)  $\frac{-2 + t}{6t} + 3 - \frac{2t + 3}{5}$

Non-permissible value:

$t = 0$

Common denominator:  $30t$

$$= \frac{(-2 + t)}{6t} \cdot \frac{5}{5} + \frac{3}{1} \cdot \frac{30t}{30t} - \frac{(2t + 3)}{5} \cdot \frac{6t}{6t}$$

$$= \frac{5(-2 + t) + 90t - 6t(2t + 3)}{30t}$$

$$= \frac{-10 + 5t + 90t - 12t^2 - 18t}{30t}$$

$$= \frac{-12t^2 + 77t - 10}{30t}, t \neq 0$$

13. Simplify.

a)  $\frac{3}{2a} + \frac{5a^3}{3ab^3} \cdot \frac{12b^2}{10a^2}$

Non-permissible values:

$a = 0, b = 0$

$$= \frac{3}{2a} + \frac{5 \cancel{a^3}}{3 \cancel{a} b^3} \cdot \frac{2 \cancel{12} \cancel{b^2}}{\cancel{10} \cancel{a^2}}$$

$$= \frac{3}{2a} + \frac{2}{b}$$

Common denominator:  $2ab$

$$= \frac{3}{2a} \cdot \frac{b}{b} + \frac{2}{b} \cdot \frac{2a}{2a}$$

$$= \frac{3b + 4a}{2ab}, a \neq 0, b \neq 0$$

b)  $\frac{6x}{2(x + 3)} \div \frac{4x^2}{5(x + 3)} - \frac{x}{2}$

Non-permissible values:

$x = -3, x = 0$

$$= \frac{3 \cancel{6} x}{\cancel{2} (x + 3)} \cdot \frac{5 \cdot \cancel{(x + 3)}}{4x^2} - \frac{x}{2}$$

$$= \frac{15}{4x} - \frac{x}{2}$$

Common denominator:  $4x$

$$= \frac{15}{4x} - \frac{x}{2} \cdot \frac{2x}{2x}$$

$$= \frac{15 - 2x^2}{4x}, x \neq -3, 0$$

**C**

14. Is the statement  $\frac{a}{x} + \frac{b}{y} = \frac{ay + bx}{xy}$ , for  $x, y \neq 0$ , sometimes true, always true, or never true? Justify your answer.

**Non-permissible values:**  $x = 0, y = 0$

$$\begin{aligned}\frac{a}{x} + \frac{b}{y} &= \frac{a}{x} \cdot \frac{y}{y} + \frac{b}{y} \cdot \frac{x}{x} \\ &= \frac{ay}{xy} + \frac{bx}{xy} \\ &= \frac{ay + bx}{xy}, x \neq 0, y \neq 0\end{aligned}$$

Always true

15. Determine the sum of the first 6 terms of each series.

a)  $\frac{1}{x} + \frac{1}{2x} + \frac{1}{3x} + \frac{1}{4x} + \dots$

$$\frac{1}{x} + \frac{1}{2x} + \frac{1}{3x} + \frac{1}{4x} + \frac{1}{5x} + \frac{1}{6x}$$

A common denominator is  $120x$ .

A non-permissible value is  $x = 0$ .

$$\begin{aligned}&= \frac{1}{x} \cdot \frac{120}{120} + \frac{1}{2x} \cdot \frac{60}{60} + \frac{1}{3x} \cdot \frac{40}{40} + \frac{1}{4x} \cdot \frac{30}{30} + \frac{1}{5x} \cdot \frac{24}{24} + \frac{1}{6x} \cdot \frac{20}{20} \\ &= \frac{120 + 60 + 40 + 30 + 24 + 20}{120x} \\ &= \frac{294}{120x}, \text{ or } \frac{147}{60x}, x \neq 0\end{aligned}$$

b)  $\frac{1}{x} + \frac{1}{x^2} + \frac{1}{x^3} + \frac{1}{x^4} + \dots$

$$\frac{1}{x} + \frac{1}{x^2} + \frac{1}{x^3} + \frac{1}{x^4} + \frac{1}{x^5} + \frac{1}{x^6}$$

A common denominator is  $x^6$ .

A non-permissible value is  $x = 0$ .

$$\begin{aligned}&= \frac{1}{x} \cdot \frac{x^5}{x^5} + \frac{1}{x^2} \cdot \frac{x^4}{x^4} + \frac{1}{x^3} \cdot \frac{x^3}{x^3} + \frac{1}{x^4} \cdot \frac{x^2}{x^2} + \frac{1}{x^5} \cdot \frac{x}{x} + \frac{1}{x^6} \\ &= \frac{x^5 + x^4 + x^3 + x^2 + x + 1}{x^6}, x \neq 0\end{aligned}$$