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L08 - Worksheet - Rational Expressions Review

**Factoring Review**

Q1: Factor  $(x^2 + 2x - 15)$   
 $(x-3)(x+5)$   
 $-3 \quad +5$   
 $\square + \square = 2$   
 $\square \times \square = -15$   
 $1, 15$   
 $3, 5$

Q2: Factor  $(x^2 - 2x - 24)$   
 $(x+4)(x-6)$   
 $+4 \quad -6$   
 $\square + \square = -2$   
 $\square \times \square = -24$   
 $1, 24$   
 $2, 12$   
 $3, 8$   
 $4, 6$

Q3: Factor  $(2x^2 + 8x + 6)$   
 $2(x^2 + 4x + 3)$   
 $2(x+1)(x+3)$   
 $+1 \quad +3$   
 $\square + \square = 4$   
 $\square \times \square = 3$   
 $1, 3$

Q4: Factor  $(2x^2 + 2x - 24)$   
 $2(x^2 + x - 12)$   
 $2(x-3)(x+4)$   
 $-3 \quad +4$   
 $\square + \square = 1$   
 $\square \times \square = -12$   
 $1, 12$   
 $2, 6$   
 $3, 4$

Q5: Factor  $(2x^2 - 3x - 9)$   
 $2x^2 + 3x - 6x - 9$   
 $(2x^2 + 3x) + (-6x - 9)$   
 $x(2x+3) - 3(2x+3)$   
 $(2x+3)(x-3)$   
 $+3 \quad -6$   
 $\square + \square = -3$   
 $\square \times \square = -18$   
 $1, 18$   
 $2, 9$   
 $3, 6$

Q6: Factor  $(6x^2 - 7x + 2)$   
 $6x^2 - 3x - 4x + 2$   
 $(6x^2 - 3x) + (-4x + 2)$   
 $3x(2x-1) - 2(2x-1)$   
 $(2x-1)(3x-2)$   
 $-3 \quad -4$   
 $\square + \square = -7$   
 $\square \times \square = 12$   
 $1, 12$   
 $2, 6$   
 $3, 4$

Q7: Factor  $(6x^2 + 14x + 4)$   
 $2(3x^2 + 7x + 2)$   
 $2[3x^2 + 1x + 6x + 2]$   
 $2[(3x^2 + 1x) + (6x + 2)]$   
 $2[x(3x+1) + 2(3x+1)]$   
 $2(3x+1)(x+2)$   
 $+1 \quad +6$   
 $\square + \square = 7$   
 $\square \times \square = 6$   
 $1, 6$   
 $2, 3$

Q8: Factor  $(10x^2 + 5x - 30)$   
 $5(2x^2 + x - 6)$   
 $5[2x^2 - 3x + 4x - 6]$   
 $5[(2x^2 - 3x) + (4x - 6)]$   
 $5[x(2x-3) + 2(2x-3)]$   
 $5(2x-3)(x+2)$   
 $-3 \quad +4$   
 $\square + \square = 1$   
 $\square \times \square = -12$   
 $1, 12$   
 $2, 6$   
 $3, 4$

6.1 - Factoring and Non-Permissible Values

Q9: For the expression  $\frac{2x-10}{2x+6}$ , simplify and state the non-permissible values.

$$\frac{2(x-5)}{2(x+3)} = \frac{x-5}{x+3} \text{ where } x \neq -3$$

$\downarrow$   
 $x \neq -3$

Q10: For the expression  $\frac{x^2-x-6}{x^2+7x+10}$ , simplify and state the non-permissible values.

$$\frac{(x-3)(x+2)}{(x+2)(x+5)} = \frac{x-3}{x+5} \text{ where } x \neq -5, -2$$

$\downarrow$        $\downarrow$   
 $x \neq -2$      $x \neq -5$

Q11: For the expression  $\frac{x^2-2x-15}{x^2-3x+10}$ , simplify and state the non-permissible values.

$$\frac{(x-5)(x+3)}{(x-5)(x+2)} = \frac{x+3}{x+2} \text{ where } x \neq -2, 5$$

$\downarrow$        $\downarrow$   
 $x \neq 5$        $x \neq -2$

Q12: For the expression  $\frac{2x^2+4x-6}{2x^2+12x+18}$ , simplify and state the non-permissible values.

$$\frac{2(x^2+2x-3)}{2(x^2+6x+9)} = \frac{2(x+3)(x-1)}{2(x+3)(x+3)} = \frac{x-1}{x+3} \text{ where } x \neq -3$$

$\downarrow$                        $\downarrow$   
 $x \neq -3$                $x \neq -3$

Q13: For the expression  $\frac{2x^2-5x-12}{2x^2+13x+15}$ , simplify and state the non-permissible values.

$$\frac{(2x+3)(x-4)}{(2x+3)(x+5)} = \frac{x-4}{x+5} \text{ where } x \neq -5, -3/2$$

$\downarrow$                        $\downarrow$   
 $x \neq -3/2$                $x \neq -5$

Q14: For the expression  $\frac{4x^2-9y^2}{2x+3y}$ , simplify and state the non-permissible values.

$$\frac{(2x+3y)(2x-3y)}{(2x+3y)} = 2x-3y \text{ where } x \neq -\frac{3y}{2}$$

$\downarrow$   
 $2x+3y \neq 0$   
 $2x \neq -3y$   
 $x \neq -\frac{3y}{2}$

## 6.2 - Multiplying Rational Expressions

Q15: Simplify the expression  $\left(\frac{5}{8}\right)\left(\frac{4}{3}\right) = \frac{5}{\cancel{(2)}\cancel{(4)}} \cdot \frac{\cancel{(4)}}{3} = \frac{5}{6}$

Q16: Simplify the expression  $\left(\frac{3 \cdot 5}{2 \cdot 2}\right)\left(\frac{2 \cdot 7}{3 \cdot 11}\right) = \frac{\cancel{(3)}\cancel{(7)}}{\cancel{(2)}\cancel{(11)}} = \frac{35}{22}$

Q17: Simplify the expression  $\frac{\cancel{(x+3)}}{(x-1)} * \frac{(x-2)}{\cancel{(x+3)}}$  and identify all non-permissible values.

$\swarrow$   $\searrow$   
 $x \neq 1$        $x \neq -3$

$$= \frac{x-2}{x-1} \text{ where } x \neq -3, 1$$

Q18: Simplify the expression  $\frac{(x+2)\cancel{(x-3)}}{(x-5)(x+6)} * \frac{\cancel{(x+6)}(x-1)}{\cancel{(x-3)}(x+1)}$  and identify all non-permissible values.

$\swarrow$      $\downarrow$      $\downarrow$      $\rightarrow$   
 $x \neq 5$      $x \neq -6$      $x \neq 3$      $x \neq -1$

$$= \frac{(x+2)(x-1)}{(x-5)(x+1)} \text{ where } x \neq -6, -1, 3, 5$$

Q19: Simplify the expression  $\frac{x^2+5x+6}{x^2-x-2} * \frac{x^2-5x-6}{x^2+8x+15}$  and identify all non-permissible values.

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

$\swarrow$      $\downarrow$                        $\downarrow$      $\rightarrow$   
 $x \neq 2$      $x \neq -1$                        $x \neq -3$      $x \neq -5$

$$= \frac{(x+2)(x-6)}{(x-2)(x+5)} \text{ where } x \neq -5, -3, -1, 2$$

Q20 : Simplify the expression  $\frac{2x+1}{x^2-x-2} * \frac{3x^2-4x-4}{2x^2+x}$  and identify all non-permissible values.

$$\frac{\cancel{(2x+1)}}{\cancel{(x-2)}(x+1)} * \frac{(3x+2)\cancel{(x-2)}}{x\cancel{(2x+1)}} = \frac{3x+2}{(x)(x+1)} \text{ where } x \neq -1, -1/2, 0, 2$$

$\downarrow$   $\downarrow$   $\downarrow$   $\downarrow$   
 $x \neq 2$   $x \neq -1$   $x \neq 0$   $x \neq -1/2$

6.2 - Dividing Rational Expressions

Q21: Simplify the expression  $\frac{(2x-5)(x+1)}{(x-3)(x+2)} \div \frac{(2x-5)(x+2)}{(x+1)(x-3)}$  and identify all non-permissible values.

$$\frac{\cancel{(2x-5)}(x+1)}{\cancel{(x-3)}(x+2)} * \frac{(x+1)\cancel{(x-3)}}{\cancel{(2x-5)}(x+2)} = \frac{(x+1)(x+1)}{(x+2)(x+2)} \text{ or } \frac{(x+1)^2}{(x+2)^2} \text{ where } x \neq -2, -1, 5/2, 3$$

$\uparrow$   $\rightarrow$   $x \neq 5/2$   
 $\downarrow$   $\downarrow$   $\downarrow$   $\rightarrow$   $x \neq -2$   
 $x \neq 3$   $x \neq -2$   $x \neq -1$   $x \neq 3$

Q22: Simplify the expression  $\frac{2x(3x+1)}{(x-5)} \div \frac{4x(x+2)^2}{x}$  and identify all non-permissible values.

$$\frac{(2x)(3x+1)}{(x-5)} * \frac{\cancel{x}}{(4x)\cancel{(x+2)}(x+2)} = \frac{(2x)(3x+1)}{(4)(x-5)(x+2)^2} \text{ where } x \neq -2, 0, 5$$

$\uparrow$   $\rightarrow$   $x \neq -2$   
 $\downarrow$   $\downarrow$   
 $x \neq 5$   $x \neq 0$

Q23: Simplify the expression  $\frac{x^2+x-20}{x^2+x-6} \div \frac{x^2-10x+24}{x^2+4x+3}$  and identify all non-permissible values.

$$\frac{(x+5)\cancel{(x-4)}}{(x+3)\cancel{(x-2)}} \div \frac{\cancel{(x-6)}\cancel{(x-4)}}{(x+3)\cancel{(x+1)}} = \frac{(x+5)\cancel{(x-4)}}{\cancel{(x+3)}(x-2)} * \frac{\cancel{(x+3)}(x+1)}{\cancel{(x-6)}\cancel{(x-4)}}$$

$\downarrow$   $\downarrow$   $\downarrow$   $\downarrow$   
 $x \neq -3$   $x \neq 2$   $x \neq -3$   $x \neq -1$

$$= \frac{(x+5)(x+1)}{(x-2)(x-6)} \text{ where } x \neq -3, -1, 2, 4, 6$$

### 6.3 - Adding Rational Expressions

Q24: Simplify the expression  $\frac{1}{5} + \frac{2}{3}$

$$\frac{1}{5} \left( \frac{3}{3} \right) + \frac{2}{3} \left( \frac{5}{5} \right) = \frac{3}{15} + \frac{10}{15} = \frac{13}{15}$$

Q25: Simplify the expression  $\frac{5}{(x+2)} + \frac{3}{(x-3)}$  and identify all non-permissible values.

$$\begin{aligned} & \frac{5}{(x+2)} + \frac{3}{(x-3)} \quad \rightarrow x \neq -2 \quad \rightarrow x \neq 3 \\ & \frac{5}{(x+2)} \left( \frac{x-3}{x-3} \right) + \frac{3}{(x-3)} \left( \frac{x+2}{x+2} \right) = \frac{5x-15}{(x+2)(x-3)} + \frac{3x+6}{(x+2)(x-3)} \\ & = \frac{(5x-15) + (3x+6)}{(x+2)(x-3)} = \frac{8x-9}{(x+2)(x-3)} \quad \text{where } x \neq -2, 3 \end{aligned}$$

Q26: Simplify the expression  $\frac{(x-5)}{(x+6)} + \frac{(x+4)}{(x-1)}$  and identify all non-permissible values.

$$\begin{aligned} & \frac{(x-5)}{(x+6)} + \frac{(x+4)}{(x-1)} \quad \rightarrow x \neq -6 \quad \rightarrow x \neq 1 \\ & \frac{(x-5)}{(x+6)} \left( \frac{x-1}{x-1} \right) + \frac{(x+4)}{(x-1)} \left( \frac{x+6}{x+6} \right) = \frac{x^2-6x+5}{(x+6)(x-1)} + \frac{x^2+10x+24}{(x+6)(x-1)} \\ & = \frac{(x^2-6x+5) + (x^2+10x+24)}{(x+6)(x-1)} = \frac{2x^2+4x+29}{(x+6)(x-1)} \quad \text{where } x \neq -6, 1 \end{aligned}$$

Q27: Simplify the expression  $\frac{x^2+5x+6}{x^2-3x-10} + \frac{x^2-3x-4}{x^2-2x-3}$  and identify all non-permissible values.

$$\begin{aligned} & \frac{(x+2)(x+3)}{(x+2)(x-5)} + \frac{(x-4)(x+1)}{(x-3)(x+1)} \quad \rightarrow x \neq -2 \quad \rightarrow x \neq 5 \quad \rightarrow x \neq 3 \quad \rightarrow x \neq -1 \\ & = \frac{(x+3)}{(x-5)} \left( \frac{x-3}{x-3} \right) + \frac{(x-4)}{(x-3)} \left( \frac{x-5}{x-5} \right) \\ & = \frac{x^2-9}{(x-5)(x-3)} + \frac{x^2-9x+20}{(x-3)(x-5)} = \frac{2x^2-9x+11}{(x-5)(x-3)} \quad \text{where } x \neq -2, -1, 3, 5 \end{aligned}$$

### 6.3 - Subtracting Rational Expressions

**Q28:** Simplify the expression  $\frac{(x+1)}{(x-5)} - \frac{(x+4)}{(x-4)}$  and identify all non-permissible values.

$$\begin{aligned} & \frac{x+1}{x-5} \left( \frac{x-4}{x-4} \right) - \frac{x+4}{x-4} \left( \frac{x-5}{x-5} \right) = \frac{x^2-3x-4}{(x-5)(x-4)} - \frac{x^2-x-20}{(x-4)(x-5)} \\ & = \frac{(x^2-3x-4) - (x^2-x-20)}{(x-4)(x-5)} = \frac{-2x+16}{(x-4)(x-5)} = \frac{-2(x-8)}{(x-4)(x-5)} \text{ where } x \neq 4, 5 \end{aligned}$$

**Q29:** Simplify the expression  $\frac{x^2+5x+6}{x^2-3x-10} - \frac{x^2-3x-4}{x^2-2x-3}$  and identify all non-permissible values.

$$\begin{aligned} & \frac{(x+2)(x+3)}{(x+2)(x-5)} - \frac{(x+1)(x-4)}{(x+1)(x-3)} = \frac{x+3}{x-5} \left( \frac{x-3}{x-3} \right) - \frac{x-4}{x-3} \left( \frac{x-5}{x-5} \right) \\ & = \frac{x^2-9}{(x-3)(x-5)} - \frac{x^2-9x+20}{(x-3)(x-5)} = \frac{(x^2-9) - (x^2-9x+20)}{(x-3)(x-5)} = \frac{9x-29}{(x-3)(x-5)} \text{ where } x \neq -2, -1, 3, 5 \end{aligned}$$

**Q30:** Simplify the expression  $\frac{3-\frac{2}{x}}{x-\frac{2}{x}}$  and identify all non-permissible values.

$$\begin{aligned} & \left( 3 - \frac{2}{x} \right) \div \left( x - \frac{2}{x} \right) = \left[ \frac{3\left(\frac{x}{x}\right) - \frac{2}{x}}{1\left(\frac{x}{x}\right) - \frac{2}{x}} \right] \div \left[ \frac{x\left(\frac{x}{x}\right) - \frac{2}{x}}{1\left(\frac{x}{x}\right) - \frac{2}{x}} \right] \\ & = \left[ \frac{3x-2}{x} \right] \div \left[ \frac{x^2-2}{x} \right] \rightarrow x \neq \pm\sqrt{2} \\ & = \left( \frac{3x-2}{x} \right) \cdot \left( \frac{x}{x^2-2} \right) = \frac{3x-2}{x^2-2} \text{ where } x \neq 0, \pm\sqrt{2} \end{aligned}$$

6.4 - Rational Equations

Q31: Solve the rational equation  $\frac{1}{3x^2} = \frac{x+3}{2x^2} - \frac{1}{6x^2}$  and identify all non-permissible values.

$$\frac{1}{3x^2} \left( \frac{2}{2} \right) = \frac{(x+3)}{2x^2} \left( \frac{3}{3} \right) - \frac{1}{6x^2} \quad \rightarrow x \neq 0$$

$$= \frac{2}{6x^2} = \frac{3x+9}{6x^2} - \frac{1}{6x^2} \quad \text{Look at numerator.}$$

$$2 = (3x+9) - (1)$$

$$2 = 3x + 8$$

$$-6 = 3x$$

$$x = -2$$

Q32: Solve the rational equation  $1 = \frac{3}{m+3} + \frac{3m}{m+3}$  and identify all non-permissible values.

$$\frac{1}{1} \left( \frac{m+3}{m+3} \right) = \frac{3}{m+3} + \frac{3m}{m+3} \quad \rightarrow x \neq -3$$

$$\frac{m+3}{m+3} = \frac{3}{m+3} + \frac{3m}{m+3}$$

Look at numerator.

$$m+3 = (3) + (3m)$$

$$m+3 = 3m+3$$

$$0 = 2m$$

$$m = 0$$

Q33: Solve the rational equation  $\frac{1}{2n} + \frac{1}{4n^2} = \frac{1}{4n}$  and identify all non-permissible values.

$$\frac{1}{2n} \left( \frac{2n}{2n} \right) + \frac{1}{4n^2} = \frac{1}{4n} \left( \frac{n}{n} \right) \quad \rightarrow n \neq 0$$

$$\frac{2n}{4n^2} + \frac{1}{4n^2} = \frac{n}{4n^2} \quad \text{Look at numerators.}$$

$$(2n) + (1) = n$$

$$2n + 1 = n$$

$$n = -1$$

Q34: Solve the rational equation  $\frac{1}{5k^2+2k} - \frac{6}{5k+2} = \frac{6}{5k^2+2k}$  and identify all non-permissible values.

$$\frac{1}{k(5k+2)} - \frac{6}{5k+2} \left( \frac{k}{k} \right) = \frac{6}{k(5k+2)}$$

$$\frac{1}{k(5k+2)} - \frac{6k}{(5k+2)k} = \frac{6}{k(5k+2)} \quad \text{Look at numerator.}$$

$$\rightarrow k \neq 0, -2/5$$

$$(1) - (6k) = 6$$

$$1 - 6k = 6$$

$$-6k = 5$$

$$k = -5/6$$

Word Problems

Q35: Bob can paint a bedroom in 30 minutes. Chad can paint a bedroom in 45 minutes. If Bob and Chad work together, how long does it take the two of them to paint 5 bedrooms?

Bob  
 Paints 1 bedroom in 30 min  
 So paints  $\frac{1}{30}$ th of a bedroom per minute.

CHAD  
 Paints 1 bedroom in 45 min  
 So paints  $\frac{1}{45}$ th of a bedroom per minute.

Let  $n$  = number of minutes.

$$\left(\frac{1}{30} \text{ bedroom per minute}\right)(n \text{ minutes}) + \left(\frac{1}{45} \text{ bedroom per minute}\right)(n \text{ minutes}) = 5 \text{ bedrooms}$$

$$\frac{n}{30} + \frac{n}{45} = 5$$

$$\frac{n}{30} \left(\frac{3}{3}\right) + \frac{n}{45} \left(\frac{2}{2}\right) = \frac{5}{1} \left(\frac{90}{90}\right)$$

$$\frac{3n}{90} + \frac{2n}{90} = \frac{450}{90} \quad \text{Look at numerators.}$$

$$\begin{aligned} (3n) + (2n) &= 450 \\ 5n &= 450 \\ n &= 90 \text{ minutes} \end{aligned}$$

Double check

Bob  
 Paints 1 bedroom in 30 min.  
 Given 90 min should paint 3 rooms.

CHAD  
 Paints 1 bedroom in 45 min.  
 Given 90 min should paint 2 rooms.

Together they paint 5 rooms in 90 min.

KEY

**Q36:** In a hotdog competition, Jack can eat 3 hotdogs per minute. Jill can eat 4 hotdogs per minute. If there are 20 hotdogs, how long does it take them to eat all the hotdogs?

JACK

Eats 3 hotdogs per minute.

JILL

Eats 4 hotdogs per minute.

$$(3 \text{ hotdogs per min})(n \text{ minutes}) + (4 \text{ hotdogs per min})(n \text{ minutes}) = 20 \text{ hotdogs}$$

$$3n + 4n = 20$$

$$7n = 20$$

$$n = \frac{20}{7} \text{ of a minute}$$

$$n \approx 2 \text{ min, } 51 \text{ sec.}$$

**Pg 348 #8:** The sum of two numbers is 25. The sum of their reciprocals is  $\frac{1}{4}$ . Determine the two numbers.

Let  $m$  and  $n$  be our numbers.

$$m + n = 25$$

$$\frac{1}{m} + \frac{1}{n} = \frac{1}{4}$$



$$n = 25 - m$$



$$\frac{1}{m} + \frac{1}{25-m} = \frac{1}{4}$$

Now we can solve.

$$\frac{1}{m} \left( \frac{25-m}{25-m} \right) \left( \frac{4}{4} \right) + \frac{1}{25-m} \left( \frac{4m}{4m} \right) = \frac{1}{4} \left( \frac{m}{m} \right) \left( \frac{25-m}{25-m} \right)$$

$$\frac{100 - 4m}{4m(25-m)} + \frac{4m}{4m(25-m)} = \frac{25m - m^2}{4m(25-m)} \quad \text{Now look at numerator.}$$

$$(100 - 4m) + (4m) = 25m - m^2$$

$$100 = 25m - m^2$$

$$m^2 - 25m + 100 = 0$$

$$(m-5)(m-20) = 0$$

$$m = 5$$

$$m = 20$$

→ If  $m = 5$  (and  $m + n = 25$ ) then  $n = 20$ .

If  $m = 20$  (and  $m + n = 25$ ) then  $n = 5$ .

**Pg 349 #12:** Suppose you are running water into a tub. The tub can be filled in 2min if only the cold tap is used. It fills in 3 min if only the hot tap is turned on. How long will it take to fill the tub if both taps are on simultaneously?

COLD WATER

Fills 1 tub in 2min.  
So fills  $\frac{1}{2}$  tub per min.

HOT WATER

Fills 1 tub in 3min.  
So fills  $\frac{1}{3}$  tub per min.

$$\left(\frac{1}{2} \text{ tub per min}\right)(n \text{ minutes}) + \left(\frac{1}{3} \text{ tub per min}\right)(n \text{ minutes}) = 1 \text{ tub.}$$

$$\left(\frac{1}{2}\right)(n) + \left(\frac{1}{3}\right)(n) = 1$$

$$\frac{n}{2} + \frac{n}{3} = 1$$

$$\frac{n}{2} \left(\frac{3}{3}\right) + \frac{n}{3} \left(\frac{2}{2}\right) = \frac{1}{1} \left(\frac{6}{6}\right)$$

$$\frac{3n + 2n}{6} = \frac{6}{6}$$

Look at numerators

$$5n = 6$$

$$n = \frac{6}{5} \text{ minutes}$$

$$n = 1 \text{ min, } 12 \text{ sec.}$$

**Pg 349 #14:** Two kayakers paddle 18 km downstream with the current in the same time it takes them to go 8 km upstream against the current. The rate of the current is 3 km/h. What is the rate of the kayakers in still water?

Let  $v$  = speed/rate in still water.

DOWNSTREAM

Rate =  $v + 3$  km/h  
(Current speeds it up)

$$\text{DIST} = (\text{RATE})(\text{TIME})$$

$$\text{TIME} = \frac{\text{DIST}}{\text{RATE}}$$

$$\text{TIME} = \frac{18}{v+3}$$

UPSTREAM

Rate =  $v - 3$  km/h  
(Current slows it down)

$$\text{DIST} = (\text{RATE})(\text{TIME})$$

$$\text{TIME} = \frac{\text{DIST}}{\text{RATE}}$$

$$\text{TIME} = \frac{8}{v-3}$$

$$\text{TIME} = \text{TIME}$$

$$\frac{18}{v+3} = \frac{8}{v-3}$$

$$\frac{18}{v+3} \left(\frac{v-3}{v-3}\right) = \frac{8}{v-3} \left(\frac{v+3}{v+3}\right)$$

$$\frac{18v - 54}{(v+3)(v-3)} = \frac{8v + 24}{(v+3)(v-3)}$$

Look at numerators.

$$18v - 54 = 8v + 24$$

$$-8v \quad -8v$$

$$10v - 54 = 24$$

$$+54 \quad +54$$

$$10v = 78$$

$$v = 7.8 \text{ km/h in still water.}$$