

Working with Exponents, Roots and Fractional Powers

Grade 9 – Algebra 1 math · Worksheet Answer Key · Standards: N-RN.A.1, N-RN.A.2

Each answer key shows the rule used at every step. Exact radical answers come first, followed by decimal approximations, so you can compare both forms with your own work.

Standards: N-RN.A.1, N-RN.A.2 · **Level:** Grade 9 Algebra 1

Problem 1 Product of powers

Same base, so add the exponents: $3 + 5 = 8$.

$$x^8$$

Problem 2 Quotient of powers

Subtract the exponents: $9 - 4 = 5$.

$$x^5$$

Problem 3 Power of a power

Multiply the exponents: $2 \times 6 = 12$.

$$x^{12}$$

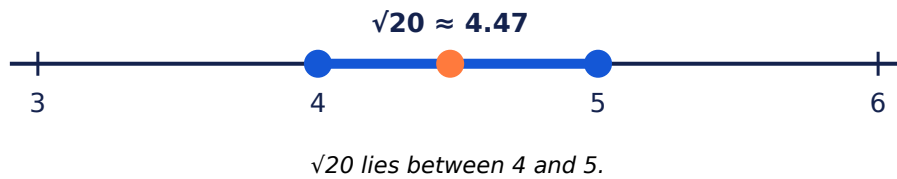
Problem 4 Negative exponent

A negative exponent means a reciprocal: $3^{-2} = 1 \div 3^2 = 1 \div 9$.

$$\frac{1}{9}$$

Problem 5 Between two integers

$4^2 = 16$ and $5^2 = 25$, and $16 < 20 < 25$, so $\sqrt{20}$ lies between 4 and 5. A calculator gives about 4.47.



Between 4 and 5

Problem 6 Multiply monomials

Multiply the coefficients: $3 \times 4 = 12$. Add exponents of x : $2 + 5 = 7$. Add exponents of y : $3 + 1 = 4$.

$$12x^7y^4$$

Problem 7 Divide monomials

$18 \div 6 = 3$. $a: 7 - 3 = 4$. $b: 2 - 5 = -3$.

So $3a^4b^{-3} = 3a^4 \div b^3$.

$$3a^4/b^3$$

Problem 8 Power of a product

$$(2x^3)^4 = 2^4 \cdot x^{12} = 16x^{12}.$$

$$(-3x^2)^3 = (-3)^3 \cdot x^6 = -27x^6.$$

$$16x^{12} \text{ and } -27x^6$$

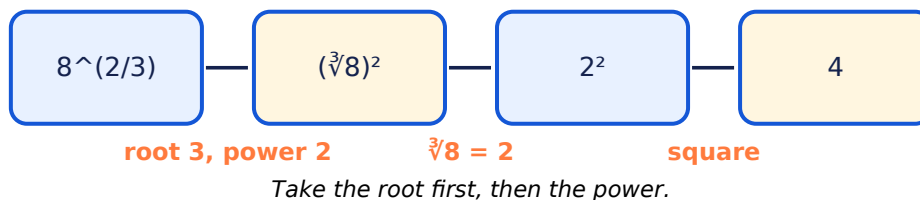
Problem 9 Positive exponents only

x^{-3} moves to the denominator as x^3 , and z^{-4} moves to the numerator as z^4 .

$$y^2z^4/x^3$$

Problem 10 Rational exponent evaluation

$$8^{2/3} = (\sqrt[3]{8})^2 = 2^2 = 4. \quad 16^{3/4} = (\sqrt[4]{16})^3 = 2^3 = 8.$$



4 and 8

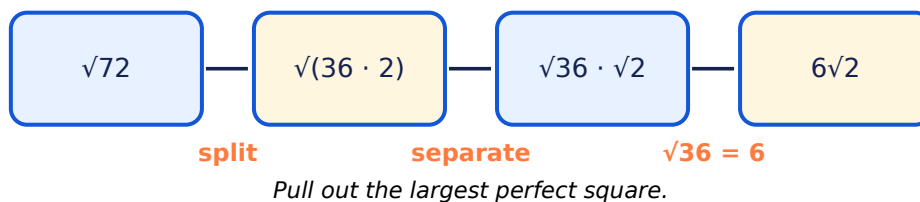
Problem 11 Radical and exponent forms

(a) $\sqrt[3]{x^5} = x^{5/3}$. (b) $\sqrt{x} = x^{1/2}$. (c) $y^{3/2} = \sqrt{y^3} = (\sqrt{y})^3$.

(a) $x^{5/3}$ (b) $x^{1/2}$ (c) $\sqrt{y^3}$

Problem 12 Simplify a square root

The largest perfect square factor of 72 is 36: $\sqrt{72} = \sqrt{36 \cdot 2} = 6\sqrt{2}$.



Check: $6(1.4142) \approx 8.485$ and $\sqrt{72} \approx 8.485$.

$6\sqrt{2}$

Problem 13 Square side length

Side = $\sqrt{48} = \sqrt{16 \cdot 3} = 4\sqrt{3}$.

$4 \times 1.732 \approx 6.93$.

$4\sqrt{3} \approx 6.93$ inches

Problem 14 Radical with a variable

$\sqrt{18x^6} = \sqrt{9 \cdot 2 \cdot (x^3)^2} = 3 \cdot x^3 \cdot \sqrt{2}$.

$3x^3\sqrt{2}$

Problem 15 Rectangle with radical sides

$$\sqrt{8} = 2\sqrt{2} \text{ and } \sqrt{18} = 3\sqrt{2}.$$

$$\text{Area} = \sqrt{8} \cdot \sqrt{18} = \sqrt{144} = 12 \text{ ft}^2.$$

$$\text{Perimeter} = 2(2\sqrt{2} + 3\sqrt{2}) = 10\sqrt{2} \approx 14.14 \text{ ft.}$$

Area 12 ft²; perimeter 10√2 ft

Problem 16 File sizes

$$\text{Total: } 2^{13} \cdot 2^7 = 2^{20} = 1,048,576 \text{ bytes.}$$

$$\text{Per drive: } 2^{20} \div 2^5 = 2^{15} = 32,768 \text{ bytes.}$$

2²⁰ = 1,048,576 bytes; 2¹⁵ = 32,768 bytes per drive

Problem 17 Square garden fence

$$\text{Side} = \sqrt{200} = \sqrt{(100 \cdot 2)} = 10\sqrt{2} \approx 14.14 \text{ ft.}$$

$$\text{Fence} = 4 \cdot 10\sqrt{2} = 40\sqrt{2} \approx 56.57 \text{ ft.}$$

Side 10√2 ft; fence 40√2 ≈ 56.57 ft

Problem 18 Half-life

$$t = 18: (1/2)^3 = 1/8, \text{ so } A = 64/8 = 8 \text{ g.}$$

$$t = 9: (1/2)^{9/6} = (1/2)^{3/2} = 1/(2\sqrt{2}) = \sqrt{2}/4, \text{ so } A = 64 \cdot \sqrt{2}/4 = 16\sqrt{2} \approx 22.63 \text{ g.}$$

8 g and 16√2 ≈ 22.63 g

Problem 19 Falling object

$$d = 72: t = \sqrt{(72/16)} = \sqrt{72} \div 4 = 6\sqrt{2} \div 4 = 3\sqrt{2}/2 \approx 2.12 \text{ s.}$$

$$d = 100: t = \sqrt{(100/16)} = 10/4 = 2.5 \text{ s.}$$

3√2/2 ≈ 2.12 s; 2.5 s

Problem 20 Ladder against a wall

$$c^2 = 6^2 + 12^2 = 36 + 144 = 180, \text{ so } c = \sqrt{180} = \sqrt{(36 \cdot 5)} = 6\sqrt{5}.$$

$$c^2 = 6^2 + 12^2 = 36 + 144 = 180$$

$$c = \sqrt{180} = \sqrt{(36 \cdot 5)} = 6\sqrt{5}$$

$$6\sqrt{5} \approx 13.42 \text{ feet}$$

Hypotenuse of the triangle.

$$\mathbf{6\sqrt{5} \approx 13.42 \text{ feet}}$$