

Radicals and Rational Exponents: practice solutions, Grade 11 – download the PDF

Written solutions to the chapter problems. Check each step, then correct yourself.

1 Evaluating roots



a) $12^2 = 144$, so $\sqrt{144} = 12$.

b) $5^3 = 125$, so $\sqrt[3]{125} = 5$.

c) $3^4 = 81$, so $\sqrt[4]{81} = 3$.

d) $(-4)^3 = -64$, so $\sqrt[3]{-64} = -4$.

e) $\sqrt{\frac{49}{25}} = \frac{\sqrt{49}}{\sqrt{25}} = \frac{7}{5}$.

2 Radical form to exponent form



a) $7^{1/2} = \sqrt{7}$.

b) $5^{2/3} = \sqrt[3]{5^2} = \sqrt[3]{25}$.

c) $x^{3/4} = \sqrt[4]{x^3}$.

d) $(2y)^{1/5} = \sqrt[5]{2y}$.

3 Exponent form from radicals



- a) $\sqrt{11} = 11^{1/2}$.
- b) $\sqrt[3]{a^5} = a^{5/3}$.
- c) $\sqrt[5]{b^2} = b^{2/5}$.
- d) $\frac{1}{\sqrt{z}} = \frac{1}{z^{1/2}} = z^{-1/2}$.

4 Evaluating rational exponents



- a) $9^{3/2} = (\sqrt{9})^3 = 3^3 = 27$.
- b) $8^{4/3} = (\sqrt[3]{8})^4 = 2^4 = 16$.
- c) $32^{2/5} = (\sqrt[5]{32})^2 = 2^2 = 4$.
- d) $100^{-1/2} = \frac{1}{\sqrt{100}} = \frac{1}{10}$.

5 Pulling out perfect squares



- a) $\sqrt{50} = \sqrt{25 \cdot 2} = 5\sqrt{2}$.
- b) $\sqrt{48} = \sqrt{16 \cdot 3} = 4\sqrt{3}$.
- c) $\sqrt{200} = \sqrt{100 \cdot 2} = 10\sqrt{2}$.
- d) $\sqrt{75} = \sqrt{25 \cdot 3} = 5\sqrt{3}$.

6 True or false?



- a) **False.** For $x = -3$, $\sqrt{9} = 3$, not -3 . In general $\sqrt{x^2} = |x|$.
- b) **True.** $(-2)^3 = -8$.
- c) **False.** The left side is $3 + 4 = 7$ and the right side is 5 .
- d) **False.** $16^{1/2} = \sqrt{16} = 4$; the exponent $\frac{1}{2}$ means a square root, not half.

7 Where is it defined?



- a) We need $x - 5 \geq 0$, so $x \geq 5$.
- b) We need $7 - 2x \geq 0$, so $x \leq \frac{7}{2}$.
- c) The index is odd, so every real number works.
- d) We need $3x + 9 \geq 0$, so $x \geq -3$.

8 How far is the horizon?



- a) $d = 1.22\sqrt{36} = 1.22 \times 6 = 7.32$ miles.
- b) $d = 1.22\sqrt{144} = 1.22 \times 12 = 14.64$ miles.
- c) $1.22\sqrt{h} = 12.2$, so $\sqrt{h} = 10$ and $h = 100$ ft (about 30 m).

9 Simplifying with variables



- a) $\sqrt{18x^5} = \sqrt{9 \cdot 2 \cdot x^4 \cdot x} = 3x^2\sqrt{2x}$.
- b) $\sqrt[3]{40a^4} = \sqrt[3]{8 \cdot 5 \cdot a^3 \cdot a} = 2a\sqrt[3]{5a}$.
- c) $\sqrt{12} \cdot \sqrt{27} = \sqrt{324} = 18$.
- d) $\sqrt{5} \cdot \sqrt{20} = \sqrt{100} = 10$.

10 Rationalizing denominators



- a) $\sqrt{8} = 2\sqrt{2}$, so $\frac{6}{2\sqrt{2}} = \frac{3}{\sqrt{2}} = \frac{3\sqrt{2}}{2}$.
- b) Multiply by the conjugate: $\frac{4(\sqrt{7} + \sqrt{3})}{7 - 3} = \sqrt{7} + \sqrt{3}$.
- c) Multiply top and bottom by $\sqrt[3]{4}$, since $\sqrt[3]{2} \cdot \sqrt[3]{4} = \sqrt[3]{8} = 2$: $\frac{3\sqrt[3]{4}}{2}$.

11 Exponent rules



a) $\frac{2}{3} + \frac{5}{6} = \frac{4}{6} + \frac{5}{6} = \frac{9}{6} = \frac{3}{2}$, so the result is $x^{3/2}$.

b) Multiply each exponent by 6: $x^3 y^{-2} = \frac{x^3}{y^2}$.

c) $\frac{3}{4} - \frac{1}{4} = \frac{1}{2}$, so $x^{1/2}$.

d) $\left(-\frac{2}{3}\right)\left(-\frac{3}{2}\right) = 1$, so the result is x .

12 Negative rational exponents



a) $\left(\frac{27}{8}\right)^{-2/3} = \left(\frac{8}{27}\right)^{2/3} = \left(\frac{2}{3}\right)^2 = \frac{4}{9}$.

b) $81^{-3/4} = \frac{1}{(\sqrt[4]{81})^3} = \frac{1}{27}$.

c) $64^{5/6} = (\sqrt[6]{64})^5 = 2^5 = 32$.

13 A square root equation



Square both sides: $3x - 5 = 16$, so $3x = 21$ and $x = 7$.

Check: $\sqrt{3 \cdot 7 - 5} = \sqrt{16} = 4$. The solution is $x = 7$.

14 A cube root equation



Cube both sides: $x + 4 = -8$, so $x = -12$.

Check: $\sqrt[3]{-12 + 4} = \sqrt[3]{-8} = -2$. The solution is $x = -12$.

15 Isolate first



Isolate the radical: $\sqrt{x-3} = 4$. Square: $x-3 = 16$, so $x = 19$.

Check: $\sqrt{16} + 5 = 9$. The solution is $x = 19$.

16 Domain, range and table



a) We need $x+2 \geq 0$, so the domain is $x \geq -2$. Since $\sqrt{x+2} \geq 0$, the range is $y \geq -3$.

b) $f(-2) = 0 - 3 = -3$; $f(-1) = 1 - 3 = -2$; $f(2) = 2 - 3 = -1$; $f(7) = 3 - 3 = 0$.

c) Shift the parent graph 2 units left and 3 units down. The starting point moves from $(0, 0)$ to $(-2, -3)$.

17 An extraneous solution



Square both sides: $2x + 15 = x^2$, so $x^2 - 2x - 15 = 0$, i.e. $(x-5)(x+3) = 0$.

Candidates: $x = 5$ and $x = -3$.

Check $x = 5$: $\sqrt{25} = 5$. True.

Check $x = -3$: $\sqrt{9} = 3 \neq -3$. False, so -3 is extraneous.

The only solution is $x = 5$.

18 Both candidates survive



Square: $5x + 1 = x^2 + 2x + 1$, so $x^2 - 3x = 0$, i.e. $x(x-3) = 0$. Candidates: 0 and 3 .

$x = 0$: $\sqrt{1} = 1$ and $0 + 1 = 1$. True.

$x = 3$: $\sqrt{16} = 4$ and $3 + 1 = 4$. True.

Both are solutions: there is no extraneous solution here, which is why the check is needed to know for sure.

19 Two radicals



Isolate one radical: $\sqrt{x+6} = 1 + \sqrt{x-1}$.

Square both sides: $x+6 = 1 + 2\sqrt{x-1} + (x-1) = x + 2\sqrt{x-1}$.

So $6 = 2\sqrt{x-1}$, then $\sqrt{x-1} = 3$ and $x-1 = 9$, giving $x = 10$.

Check: $\sqrt{16} - \sqrt{9} = 4 - 3 = 1$. The solution is $x = 10$.

20 Equations with rational exponents



a) Raise both sides to the power $\frac{3}{2}$: $|x| = 25^{3/2} = 125$. So $x = 125$ or $x = -125$. Check: $(\sqrt[3]{-125})^2 = (-5)^2 = 25$. Both work.

b) Raise both sides to the power $\frac{2}{3}$: $x+2 = 64^{2/3} = 16$, so $x = 14$. Check: $16^{3/2} = 4^3 = 64$.

21 Find the equation from the graph



a) The curve starts at $P(-4, -3)$, so $h = -4$ and $k = -3$. Then $R(0, -1)$ gives $a\sqrt{4} - 3 = -1$, so $2a = 2$ and $a = 1$. Thus $f(x) = \sqrt{x+4} - 3$. Check with Q : $\sqrt{1} - 3 = -2$; with S : $\sqrt{9} - 3 = 0$.

b) Domain $x \geq -4$; range $y \geq -3$.

c) $\sqrt{x+4} - 3 = 1$, so $\sqrt{x+4} = 4$, $x+4 = 16$ and $x = 12$.

22 The storage cube



a) $s^3 = 2744$, so $s = \sqrt[3]{2744} = 14$ cm (because $14^3 = 2744$), about 5.5 in.

b) The surface area is $6s^2 = 6 \times 196 = 1,176$ cm².

c) $s = \sqrt[3]{V} = V^{1/3}$.

23 A growing colony



a) $N(1) = 200 \cdot 4^{1/2} = 400$; $N(3) = 200 \cdot 4^{3/2} = 200 \cdot 8 = 1,600$;
 $N(5) = 200 \cdot 4^{5/2} = 200 \cdot 32 = 6,400$.

b) $200 \cdot 4^{t/2} = 3200$, so $4^{t/2} = 16 = 4^2$. Then $\frac{t}{2} = 2$, so $t = 4$ hours.

c) Each extra hour multiplies the count by $4^{1/2} = \sqrt{4} = 2$.

24 Find the student's error



The algebra is right, but the student never checked the candidates.

$x = 3$: the left side is $\sqrt{1} = 1$ while the right side is $3 - 4 = -1$. False, so **3** is extraneous.

$x = 6$: the left side is $\sqrt{4} = 2$ and the right side is $6 - 4 = 2$. True.

The only solution is $x = 6$.



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