

Radicals and Exponential Functions: practice solutions, Grade 9 – download the PDF

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

1 Perfect squares and roots



Each radicand is a perfect square.

a. $7^2 = 49$, so $\sqrt{49} = 7$.

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

c. $\sqrt{\frac{1}{9}} = \frac{\sqrt{1}}{\sqrt{9}} = \frac{1}{3}$.

d. $0.5^2 = 0.25$, so $\sqrt{0.25} = 0.5$.

2 Simplify the radical



a. $\sqrt{20} = \sqrt{4 \cdot 5} = 2\sqrt{5}$.

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

c. $\sqrt{75} = \sqrt{25 \cdot 3} = 5\sqrt{3}$.

d. $\sqrt{98} = \sqrt{49 \cdot 2} = 7\sqrt{2}$.

3 Add and subtract like radicals



- a. The radicals are alike: $(4 + 9)\sqrt{2} = 13\sqrt{2}$.
- b. $(6 - 2 + 1)\sqrt{7} = 5\sqrt{7}$.
- c. Combine the $\sqrt{3}$ terms only: $5\sqrt{3} + 2\sqrt{5}$. The last two radicals are different, so the answer cannot be shortened further.

4 Multiply radicals



- a. $\sqrt{36} = 6$.
- b. $2 \cdot 3 \cdot \sqrt{5 \cdot 5} = 6 \cdot 5 = 30$.
- c. $\sqrt{60} = \sqrt{4 \cdot 15} = 2\sqrt{15}$.

5 Growth or decay?



Compare b with 1.

- a. $a = 5, b = 1.3 > 1$: growth (30% per step).
- b. $a = 200, b = 0.9 < 1$: decay (10% per step).
- c. $a = 0.5, b = 4 > 1$: growth.
- d. $a = 7, b = 0.75 < 1$: decay (25% per step).

6 Reading a graph



- a. $f(0) = 3, f(1) = 6, f(2) = 12, f(3) = 24$.
- b. $\frac{6}{3} = \frac{12}{6} = \frac{24}{12} = 2$, so the growth factor is $b = 2$.
- c. The initial value is 3, so $f(x) = 3 \cdot 2^x$.
- d. $f(4) = 3 \cdot 2^4 = 3 \cdot 16 = 48$.

7 Next terms



The ratio is $r = \frac{10}{2} = 5$ (check: $\frac{250}{50} = 5$). The next terms are $250 \cdot 5 = 1,250$ and $1,250 \cdot 5 = 6,250$.

8 Rationalize the denominator



a. $\frac{10\sqrt{5}}{5} = 2\sqrt{5}$.

b. $\frac{9\sqrt{3}}{2 \cdot 3} = \frac{9\sqrt{3}}{6} = \frac{3\sqrt{3}}{2}$.

c. $\frac{7\sqrt{14}}{14} = \frac{\sqrt{14}}{2}$.

9 A radical rectangle



$$\sqrt{72} = 6\sqrt{2} \text{ and } \sqrt{18} = 3\sqrt{2}.$$

$$\text{Perimeter: } 2(6\sqrt{2} + 3\sqrt{2}) = 18\sqrt{2} \approx 25.46 \text{ feet.}$$

$$\text{Area: } 6\sqrt{2} \cdot 3\sqrt{2} = 18 \cdot 2 = 36 \text{ square feet.}$$

10 Expand with radicals



$$\text{FOIL: } \sqrt{2} \cdot \sqrt{2} + 5\sqrt{2} + 3\sqrt{2} + 15 = 2 + 8\sqrt{2} + 15 = 17 + 8\sqrt{2}.$$

11 A phone loses value



The decay factor is $b = 1 - 0.20 = 0.8$, so $V(t) = 800 \cdot 0.8^t$.

$$V(3) = 800 \cdot 0.512 = \text{\textcolor{red}{\$409.60}}. \text{ The phone is worth } \text{\textcolor{blue}{\$409.60}} \text{ after 3 years.}$$

12 Savings account



$A = 3500 \cdot 1.04^5$. Since $1.04^5 \approx 1.2166529$, $A \approx \$4,258.29$.

After 5 years the account holds about \$4,258.29.

13 Linear or exponential?



Table A: the ratios $\frac{10}{5} = \frac{20}{10} = \frac{40}{20} = 2$ are constant, so it is exponential: $y = 5 \cdot 2^x$.

Table B: the differences $11 - 7 = 15 - 11 = 19 - 15 = 4$ are constant, so it is linear: $y = 4x + 7$.

14 Find a term and its position



a. $a_n = 6 \cdot 3^{n-1}$.

b. $a_5 = 6 \cdot 3^4 = 6 \cdot 81 = 486$.

c. Solve $6 \cdot 3^{n-1} = 1458$: $3^{n-1} = 243 = 3^5$, so $n - 1 = 5$ and $n = 6$. The sixth term is 1,458.

15 True or false?



a. False: the left side is $3 + 4 = 7$ and the right side is 5.

b. True: $\sqrt{2} \cdot \sqrt{8} = \sqrt{16} = 4$.

c. False: the radicals are not alike, so they cannot be added. Numerically, $3\sqrt{2} + 2\sqrt{3} \approx 7.71$ while $5\sqrt{5} \approx 11.18$.

16 Conjugates

★★★

a. Multiply by the conjugate $\sqrt{7} + 1$: $\frac{6(\sqrt{7} + 1)}{7 - 1} = \frac{6(\sqrt{7} + 1)}{6} = \sqrt{7} + 1$.

b. Multiply by $\sqrt{5} - \sqrt{3}$: $\frac{2(\sqrt{5} - \sqrt{3})}{5 - 3} = \sqrt{5} - \sqrt{3}$.

17 Squares and conjugate products

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a. $9 - 12\sqrt{5} + 4 \cdot 5 = 29 - 12\sqrt{5}$.

b. The cross terms cancel: $16 - 3 = 13$.

18 A growing culture

★★★

a. $N(12) = 40 \cdot 2^4 = 40 \cdot 16 = 640$ cells.

b. Solve $40 \cdot 2^{t/3} = 2560$: $2^{t/3} = 64 = 2^6$, so $\frac{t}{3} = 6$ and $t = 18$. There are 2,560 cells after 18 hours.

19 Medicine in the body

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a. After 12 hours, three half-lives have passed: $480 \cdot \left(\frac{1}{2}\right)^3 = 60$ mg.

b. Amounts at each check: 240, 120, 60, 30, 15, 7.5 mg. At 20 hours it is 15 mg, still above 10 mg; at 24 hours it is 7.5 mg. The first check below 10 mg is at **24 hours**.

20 When does exponential win?



$t = 10$: $A = \$1,800$, $B = 1000 \cdot 1.06^{10} \approx \$1,790.85$, so A is ahead.

$t = 11$: $A = \$1,880$, $B \approx \$1,898.30$, so B is ahead.

$t = 12$: $A = \$1,960$, $B \approx \$2,012.20$.

B first exceeds A in year 11, and the gap keeps growing because B is exponential.

21 Compounding frequency



Annually: $5000 \cdot 1.06^3 = \$5,955.08$.

Monthly ($n = 12$, $nt = 36$): $5000 \left(1 + \frac{0.06}{12}\right)^{36} = 5000 \cdot 1.005^{36} \approx \$5,983.40$.

Difference: $5983.40 - 5955.08 = \$28.32$ more with monthly compounding.

22 A bouncing ball



a. The heights 6, 3.6, 2.16, ... form a geometric sequence with ratio 0.6, so

$$h_n = 10 \cdot 0.6^n.$$

b. $h_5 = 10 \cdot 0.6^5 = 0.7776$ foot, about 9.3 inches.

c. $h_4 = 10 \cdot 0.6^4 = 1.296$ feet (still above 1 foot) and $h_5 = 0.7776$ foot. So the 5th bounce is the first one under 1 foot.

23 Missing terms



From $a_5 = a_2 \cdot r^3$: $324 = 12 \cdot r^3$, so $r^3 = 27$ and $r = 3$.

Then $a_1 = \frac{a_2}{r} = \frac{12}{3} = 4$.

Finally $a_7 = 4 \cdot 3^6 = 4 \cdot 729 = 2,916$.



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