Exponents and Radicals Lesson #5:
Applications of Radicals

Application - Ordering a Set of Irrational Numbers

Class Ex. #1

Without using a calculator, arrange the following mixed radicals in order from greatest to least.

i) $3\sqrt{5}$ ii) $5\sqrt{3}$ iii) $\sqrt{15}$ iv) $2\sqrt{8}$ v) $8\sqrt{2}$

rounded down — closest perfect square — rounded up

$3\sqrt{4}$ $5\sqrt{4}$ $\sqrt{16}$ $2\sqrt{9}$ $8\sqrt{1}$

estimation: $3(2)$ $5(2)$ ≈ 4 $2(3)$ ≈ 8

≈ 6 (under estimate) ≈ 10 ≈ 6 (over estimate)

$5\sqrt{3}, 8\sqrt{2}, 3\sqrt{5}, 2\sqrt{8}, \sqrt{15}$

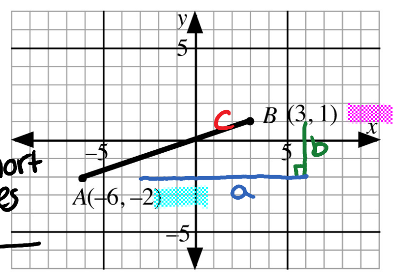
Complete Assignment Questions #1 - #3

Application - Pythagorean Theorem

Class Ex. #2

Consider line segment *AB* shown on the grid.

Determine the exact length of the line segment in simplest mixed radical form using



a) the Pythagorean Theorem $c^2 = a^2 + b^2$ ← right angled Δ's (longest side; 2 short sides)

a: x-value left → right: $-6 \to 3$ $= 9$

b: y-value top → bottom: $1 \to -2$ $= 3$

$c^2 = 9^2 + 3^2 = 81 + 9$ → $\sqrt{c^2} = \sqrt{90}$, $c = \sqrt{90} = 3\sqrt{10}$ or $\sqrt{9}\sqrt{10}$

looking for short side: $c^2 - b^2 = a^2$ — long side & 1 short side

b) the Distance Formula $d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$

$(x_1, y_1) \to (-6, -2)$

$(x_2, y_2) \to (3, 1)$

$d = \sqrt{(3-(-6))^2 + (1-(-2))^2}$

$= \sqrt{9^2 + 3^2}$

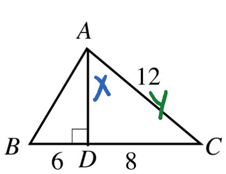
$= \sqrt{81+9} = \sqrt{90} = 3\sqrt{10}$

Class Ex. #3

Use the Pythagorean Theorem to determine the exact length of *AB*. Express the answer as

a) an exact value in simplest mixed radical form

b) as a decimal to the nearest hundredth



*solve for y → long side and short side given, use $c^2 - b^2 = a^2$

$12^2 - 8^2 = y^2$

$144 - 64 = y^2$

$80 = y^2$

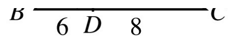
solve for x using two short sides

$x^2 = 6^2 + \sqrt{80}^2$

$\sqrt{116}$ → 2, 58 → 2, 29

*want mixed simple radical

a) $2\sqrt{29}$



144 − 64 = y²
80 = y²
y = √80

sides
$x^2 = 6^2 + \sqrt{80}^2$
$= 36 + 80$
$x^2 = 116$
$x = \sqrt{116}$

2.24

a) $2\sqrt{29}$
b) 10.7703...
hundredth = 2 decimal places
b) 10.77

Complete Assignment Questions #4 - #7

#1, 2, 4, 5, 6ac, 7ac

Other Applications

Given that $\sqrt{5}$ is approximately equal to 2.24, and $\sqrt{50}$ is approximately equal to 7.07, then find the approximate value of

a) $\sqrt{500}$ **b)** $\sqrt{5\,000}$ **c)** $\sqrt{20}$ **d)** $\sqrt{0.05}$ **e)** $\sqrt{0.5}$

Complete Assignment Questions #8 - #12

Assignment

1. Without using a calculator, arrange the following radicals in order from greatest to least.
$3\sqrt{7},\ 5\sqrt{3},\ \sqrt{60},\ 2\sqrt{11},\ \frac{1}{2}\sqrt{200}$

2. Without using a calculator, arrange the following radicals in order from least to greatest.
$7\sqrt[6]{1},\ -3\sqrt[3]{-27},\ \frac{5}{2}\sqrt[4]{16},\ 3\sqrt{\sqrt[3]{64}}$

3. Consider the following radicals: $2\sqrt[3]{11},\ 3\sqrt[3]{3},\ 4\sqrt[3]{2},\ 2\sqrt[3]{6}$.

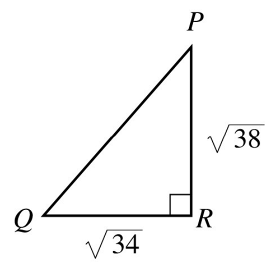
a) **Explain** how to arrange the radicals in order from least to greatest without using a calculator.

b) Arrange the radicals in order from least to greatest.

4. Consider $\triangle PQR$ as shown. Students are trying to determine the length of PQ using the Pythagorean Formula.

Louis expresses each side to the nearest hundredth and calculates the length of PQ to the nearest hundredth.

Asia uses the entire radical form for each side and expresses her answer to the nearest hundredth.



a) Complete each student's work.

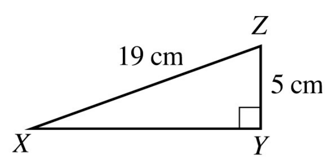
Louis's Work	Asia's Work
$(PQ)^2 = (QR)^2 + (PR)^2$	$(PQ)^2 = (QR)^2 + (PR)^2$
$= 5.83^2 +$	$= \left(\sqrt{34}\right)^2 +$
$=$	

b) Which student's answer is more accurate? Explain.

c) State the **exact** answer as a mixed radical.

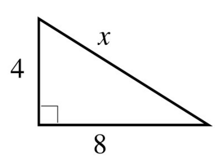
5. Use the Pythagorean formula, $c^2 = a^2 + b^2$, in the given triangle to calculate the length of XY. Express the answer as

i) an entire radical
ii) a mixed radical
iii) a decimal to the nearest hundredth

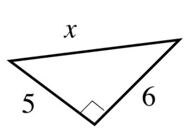


6. Find the lengths of the missing sides.
Express the answers in simplest mixed radical form.

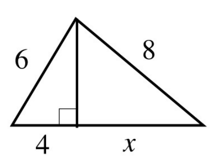
a)



b)



c)



7. Determine the exact distance between the following pairs of points.
Answer as a mixed radical in simplest form.

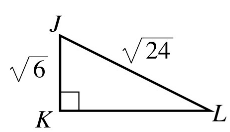
a) (−3, 8) and (−1, 4) **b)** (3, 2) and (−3, −4) **c)** (15, 8) and (9, 20)

8. Given that $\sqrt{6}$ is approximately equal to 2.45, and $\sqrt{60}$ is approximately equal to 7.75, then, without using a calculator, find the approximate value of

a) $\sqrt{600}$ **b)** $\sqrt{6\,000}$ **c)** $\sqrt{600\,000}$ **d)** $\sqrt{0.06}$

Multiple Choice **9.** The length of KL can be represented by which of the following?

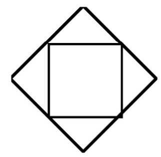
A. $\sqrt{540}$
B. $3\sqrt{2}$
C. $\sqrt{30}$
D. $9\sqrt{2}$



Numerical Response **10.** The volume of an ice cube is 32 000 mm^3. The exact length of each edge of the ice cube can be written in simplest mixed radical form as $p\sqrt[3]{q}$ where p and q are whole numbers.

The value of $p - q$ is ______.
(Record your answer in the numerical response box from left to right.)

11. The smaller square has side length 8 cm. The side length of the larger square can be written in simplest form as $p\sqrt{q}$, where $p, q \in N$. The value of pq is _____.



(Record your answer in the numerical response box from left to right)

Use the following information to answer question #12.

In Ancient Greece, a formula was developed which could be used to calculate the area of a triangle. The formula, known as Heron's Formula, is shown below.

$$A = \sqrt{s(s-a)(s-b)(s-c)}$$

where a, b, and c are the lengths of the sides of a triangle,

and $s = \dfrac{a+b+c}{2}$

12. The area of a triangle whose sides measure 14, 15, and 25 can be written in simplest form as $p\sqrt{26}$, where $a \in N$. The value of p is _____.

(Record your answer in the numerical response box from left to right)

Answer Key

1. $5\sqrt{3}$, $3\sqrt{7}$, $\sqrt{60}$, $\frac{1}{2}\sqrt{200}$, $2\sqrt{11}$ **2.** $\frac{5}{2}\sqrt[4]{16}$, $3\sqrt{\sqrt[3]{64}}$, $7\sqrt[6]{1}$, $-3\sqrt[3]{-27}$

3. **a)** Convert the mixed radicals to entire form and compare the radicands. **b)** $2\sqrt[3]{6}$, $3\sqrt[3]{3}$, $2\sqrt[3]{11}$, $4\sqrt[3]{2}$

4. **a)** Louis 8.48, Asia 8.49

b) Asia because she used exact values rather than rounded values in her calculation.   **c)** $6\sqrt{2}$

4. a) Louis 8.48, Asia 8.49

b) Asia because she used exact values rather than rounded values in her calculation. **c)** $6\sqrt{2}$

5. i) $\sqrt{336}$ cm **ii)** $4\sqrt{21}$ cm **iii)** 18.33 cm

6. a) $4\sqrt{5}$ **b)** $\sqrt{61}$ **c)** $2\sqrt{11}$

7. a) $2\sqrt{5}$ **b)** $6\sqrt{2}$ **c)** $6\sqrt{5}$

8. a) 24.5 **b)** 77.5 **c)** 775 **d)** 0.245

9. B

10.

1	6		

11.

1	6		

12.

1	8		

Exponents and Radicals Lesson #6:
Rational Exponents - Part One

Review of the Exponent Laws

The exponent laws with integral exponents and numerical and variable bases were covered in previous math courses.

Complete the table as a review of the exponent laws.

Numerical Bases	Variable Bases	Exponent Laws
$8^3 \times 8^2 = (8 \cdot 8 \cdot 8)(8 \cdot 8)$ $= 8^5$ or 8^{3+2}	$a^3 \times a^2 = (a \cdot a \cdot a)(a \cdot a)$ $= a^5$ or a^{3+2}	**Product Law** $(a^m)(a^n) = a^{m+n}$
$8^3 \div 8^2 = \frac{8 \cdot 8 \cdot 8}{8 \cdot 8}$ $= 8^1$ or 8^{3-2}	$a^3 \div a^2 = \frac{a \cdot a \cdot a}{a \cdot a}$ $= a^1$ or a^{3-2}	**Quotient Law** $a^m \div a^n = \frac{a^m}{a^n} = a^{m-n}$ $(a \neq 0)$
$(8 \cdot 7)^3 = (8 \cdot 7)(8 \cdot 7)(8 \cdot 7)$ $= (8 \cdot 8 \cdot 8)(7 \cdot 7 \cdot 7)$ $= 8^3 \cdot 7^3$	$(a \cdot b)^3 = (a \cdot b)(a \cdot b)(a \cdot b)$ $= (a \cdot a \cdot a)(b \cdot b \cdot b)$ $= a^3 b^3$	**Power of a Product Law** $(ab)^m = a^m b^m$
$\left(\frac{8}{7}\right)^3 = \left(\frac{8}{7}\right)\left(\frac{8}{7}\right)\left(\frac{8}{7}\right)$ $= \frac{8^3}{7^3}$	$\left(\frac{a}{b}\right)^3 = \left(\frac{a}{b}\right)\left(\frac{a}{b}\right)\left(\frac{a}{b}\right)$ $= \frac{a^3}{b^3}$	**Power of a Quotient Law** $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$ $(b \neq 0)$
$(8^3)^2 = (8^3)(8^3)$ $= (8 \cdot 8 \cdot 8)(8 \cdot 8 \cdot 8)$ $= 8^6$ or $8^{3 \times 2}$	$(a^3)^2 = (a^3)(a^3)$ $= (a \cdot a \cdot a)(a \cdot a \cdot a)$ $= a^6$ or $a^{3 \times 2}$	**Power of a Power Law** $(a^m)^n = a^{mn}$

Investigating the Meaning of $a^{\frac{1}{n}}$

a) Complete and evaluate the following.

i) $\sqrt{5} \cdot \sqrt{5} = \sqrt{}$ 25 5 **ii)** $5^{\frac{1}{2}} \cdot 5^{\frac{1}{2}} = 5^{\square + \square} = 5^{\square} =$ 1 5

$x^n \cdot x^m = x^{n+m}$

Deduce a meaning for $5^{\frac{1}{2}}$ in radical form. $= \sqrt{5}$

b) Complete and evaluate the following.

i) $\sqrt[3]{2} \cdot \sqrt[3]{2} \cdot \sqrt[3]{2} = \sqrt[3]{}$ $= 8$ 2 **ii)** $2^{\frac{1}{3}} \cdot 2^{\frac{1}{3}} \cdot 2^{\frac{1}{3}} = 2^{\square + \square + \square} = 2^{\square}$ 1 $= 2$

Deduce a meaning for $2^{\frac{1}{3}}$. $= \sqrt[3]{2}$

c) Write the following in radical form and evaluate manually. Verify with a calculator.

i) $25^{\frac{1}{2}} =$ $\sqrt{25} = 5$ **ii)** $64^{\frac{1}{3}} =$ $\sqrt[3]{64} = 4$ **iii)** $81^{\frac{1}{4}} =$ $\sqrt[4]{81} = 3$

25 ^ (1÷2) 25 x^y (1÷2)

d) Write the following in radical form.

i) $x^{\frac{1}{2}} =$ $\sqrt{x}$ **ii)** $b^{\frac{1}{3}} =$ $\sqrt[3]{b}$ **iii)** $p^{\frac{1}{10}} =$ $\sqrt[10]{p}$ **iv)** $a^{\frac{1}{n}} =$ $\sqrt[n]{a}$

Investigating the Meaning of $a^{\frac{m}{n}}$

1. a) Complete and evaluate the following.

i) $\sqrt{5^3} \cdot \sqrt{5^3} =$ 5^3 125 **ii)** $5^{\frac{3}{2}} \cdot 5^{\frac{3}{2}} = 5^{\square + \square} = 5^{\square} =$ $\frac{6}{2}$ $5^3 = 125$

$\sqrt{5^3 \cdot 5^3} = \sqrt{(5^3)^2}$

Deduce a meaning for $5^{\frac{3}{2}}$ in radical form. $\sqrt{5^3}$

b) Complete and evaluate the following.

i) $\sqrt[3]{2^2} \cdot \sqrt[3]{2^2} \cdot \sqrt[3]{2^2} = \qquad =$ **ii)** $2^{\frac{2}{3}} \cdot 2^{\frac{2}{3}} \cdot 2^{\frac{2}{3}} = 2^{\square + \square + \square} = 2^{\square}$

Deduce a meaning for $2^{\frac{2}{3}}$.

c) Write the following in radical form.

i) $x^{\frac{5}{3}} =$ $\sqrt[3]{x^5}$ (← exponent, ← index) **ii)** $b^{\frac{4}{5}} =$ $\sqrt[5]{b^4}$ **iii)** $p^{\frac{5}{2}} =$ $\sqrt[2]{p^5} = \sqrt{p^5}$ **iv)** $a^{\frac{m}{n}} =$ $\sqrt[n]{a^m}$

2. a) Evaluate **i)** $8^{\frac{2}{3}} = (8^{\frac{1}{3}})^2 = \left(\sqrt[3]{8}\right)^2 =$ $2^2 = 4$ **ii)** $8^{\frac{2}{3}} = (8^2)^{\frac{1}{3}} = \sqrt[3]{(8^2)} =$ $\sqrt[3]{64} = 4$

2. a) Evaluate i) $8^{\frac{2}{3}} = (8^{\frac{1}{3}})^2 = \left(\sqrt[3]{8}\right)^2 =$ ii) $8^{\frac{2}{3}} = (8^2)^{\frac{1}{3}} = \sqrt[3]{(8^2)} =$

b) Which of the calculations above is the easier method for evaluating $8^{\frac{2}{3}}$?

c) Write the following in radical form and evaluate manually. Verify with a calculator.

i) $64^{\frac{3}{2}} =$ **ii)** $4^{\frac{5}{2}}$ **iii)** $81^{\frac{3}{4}}$

3. a) Use exponent laws to simplify $8^{\frac{2}{3}} \times 8^{-\frac{2}{3}}$.

b) Use the result in a) to write $8^{-\frac{2}{3}}$ in a form with a positive exponent.
Evaluate $8^{-\frac{2}{3}}$ without using a calculator.

Rational Exponents

$a^{\frac{m}{n}} = \left(\sqrt[n]{a}\right)^m$ or $a^{\frac{m}{n}} = \sqrt[n]{a^m}$, $m \in I$, $n \in N$, $a \neq 0$ when m is 0.
Note that if n is even, then a must be non-negative.

$a^{-\frac{m}{n}} = \dfrac{1}{\left(\sqrt[n]{a}\right)^m}$ or $a^{-\frac{m}{n}} = \dfrac{1}{\sqrt[n]{a^m}}$, $m \in I$, $n \in N$, $a \neq 0$ when m is 0.
Note that if n is even, then a must be positive.

Write the following in radical form and evaluate without using a calculator.
Verify with a calculator.

a) $25^{\frac{3}{2}}$ **b)** $1000^{\frac{4}{3}}$ **c)** $27^{-\frac{2}{3}}$ **d)** $16^{-\frac{3}{4}}$

e) $(-8)^{\frac{2}{3}}$ **f)** $-8^{\frac{2}{3}}$ **g)** $(3^2 + 4^2)^{\frac{1}{2}}$

Write the following in radical form and evaluate without using a calculator.
Verify with a calculator.

a) $\left(\frac{9}{4}\right)^{\frac{3}{2}}$ **b)** $\left(\frac{9}{4}\right)^{-\frac{3}{2}}$

Complete Assignment Questions #1 - #5

Class Ex. #3

Write an equivalent expression using radicals.

a) $r^{\frac{1}{3}} =$ **b)** $s^{\frac{4}{7}} =$ **c)** $t^{-\frac{1}{6}}$ **d)** $v^{-\frac{3}{2}} =$

Class Ex. #4

Consider the following powers.

A. $64^{\frac{2}{3}}$ **B.** $(-64)^{\frac{2}{3}}$ **C.** $64^{\frac{3}{2}}$ **D.** $(-64)^{\frac{3}{2}}$

Explain why three of the above powers can be calculated but the other has no meaning.

Class Ex. #5

A cube has a volume of 60 m^3.

a) Write a power which represents the edge length of the cube.

b) Write a power which represents the surface area of the cube.

c) Use a calculator to calculate the edge length and surface area to the nearest tenth.

Class Ex. #6

Write the number 10 in the following forms:

a) as a power with an exponent of $\frac{1}{2}$ **b)** as a power with an exponent of $\frac{1}{3}$

Complete Assignment Questions #6 - #13

Assignment

1. Evaluate without the use of a calculator.

a) $4^{\frac{1}{2}}$ **b)** $100^{\frac{1}{2}}$ **c)** $64^{\frac{1}{3}}$ **d)** $9^{\frac{3}{2}}$ **e)** $49^{\frac{3}{2}}$

f) $16^{\frac{3}{4}}$ **g)** $8^{\frac{2}{3}}$ **h)** $125^{\frac{1}{3}}$ **i)** $(6^2 + 8^2)^{\frac{3}{2}}$ **j)** $(0.04)^{0.5}$

2. Determine the exact value without using a calculator.

a) $9^{-\frac{1}{2}}$ **b)** $4^{-\frac{7}{2}}$ **c)** $25^{-\frac{3}{2}}$ **d)** $1000^{-\frac{2}{3}}$ **e)** $64^{-\frac{5}{6}}$

f) $8^{-\frac{4}{3}}$ **g)** $49^{-\frac{1}{2}}$ **h)** $32^{-\frac{2}{5}}$ **i)** $(5^2 - 3^2)^{-\frac{5}{4}}$ **j)** $(0.09)^{-\frac{3}{2}}$

3. Determine the exact value without using a calculator.

a) $\left(\frac{1}{25}\right)^{\frac{1}{2}}$ **b)** $\left(\frac{1}{4}\right)^{-\frac{1}{2}}$ **c)** $\left(\frac{1}{8}\right)^{\frac{4}{3}}$ **d)** $\left(\frac{9}{4}\right)^{-\frac{3}{2}}$ **e)** $\left(\frac{16}{81}\right)^{-\frac{3}{4}}$

4. Determine the exact value without using a calculator.

a) $(-8)^{\frac{1}{3}}$ **b)** $(-27)^{\frac{2}{3}}$ **c)** $-25^{-\frac{1}{2}}$ **d)** $-(-32)^{-\frac{4}{5}}$ **e)** $(-0.008)^{\frac{2}{3}}$

5. Use a calculator to evaluate the following to the nearest hundredth.

a) $4^{\frac{2}{3}}$ **b)** $7^{\frac{3}{4}}$ **c)** $(-5)^{\frac{6}{5}}$ **d)** $6^{-\frac{1}{4}}$ **e)** $-(-0.8)^{\frac{2}{3}}$

6. Write an equivalent expression using radicals.

a) $a^{\frac{1}{4}} =$ **b)** $b^{\frac{1}{2}} =$ **c)** $c^{\frac{1}{5}} =$ **d)** $d^{-\frac{1}{2}} =$

6. Write an equivalent expression using radicals.

a) $a^{\frac{1}{4}} =$ **b)** $b^{\frac{1}{2}} =$ **c)** $c^{\frac{1}{5}} =$ **d)** $d^{-\frac{1}{2}} =$

e) $e^{-\frac{1}{10}} =$ **f)** $f^{\frac{2}{3}} =$ **g)** $g^{\frac{4}{3}} =$ **h)** $h^{\frac{5}{2}} =$

i) $i^{-\frac{3}{2}} =$ **j)** $j^{-\frac{4}{5}} =$ **k)** $k^{-\frac{3}{4}} =$ **l)** $l^{\frac{m}{n}} =$

7. Assuming that x represents a positive integer, state which of the following expressions has no meaning.

a) $(-x)^{\frac{7}{3}}$ **b)** $(-x)^{\frac{3}{2}}$ **c)** $-(-x)^{\frac{1}{9}}$ **d)** $-(-x)^{\frac{5}{6}}$

8. A cube has a volume of 216 cm^3.

a) Write a power which represents the edge length of the cube.

b) Write a power which represents the surface area of the cube.

c) Calculate the exact edge length and surface area of the cube.

9. A cube has a volume of $V \text{ cm}^3$.

a) Write a power and a radical which represents the edge length of the cube.

b) Write a power and a radical for the area of one of the faces of the cube.

10. In each case write the given number as a power with the given exponent.

a) 5 as a power with an exponent of $\frac{1}{2}$ **b)** 8 as a power with an exponent of $\frac{1}{3}$

c) -3 as a power with an exponent of $\frac{1}{3}$ **d)** $\frac{1}{4}$ as a power with an exponent of $-\frac{1}{2}$

e) 6 as a power with an exponent of $-\frac{1}{2}$ **f)** 100 as a power with an exponent of $\frac{2}{3}$

e) 6 as a power with an exponent of $-\frac{1}{2}$ **f)** 100 as a power with an exponent of $\frac{2}{3}$

Multiple Choice

11. $\left(\frac{9}{16}\right)^{-0.5}$ is equal to

A. $\frac{256}{81}$
B. $\frac{4}{3}$
C. $-\frac{4}{3}$
D. $\frac{81}{256}$

12. $\left(-\frac{1}{4}\right)^{-1.5}$ is equal to

A. -8
B. 8
C. 6
D. has no meaning

Numerical Response

13. Evaluate the following and arrange the answers from greatest to least.

Calculation 1. $-(27)^{-\frac{2}{3}}$ **Calculation 2.** $\left(\frac{1}{27}\right)^{\frac{1}{3}}$

Calculation 3. $(-27)^{\frac{2}{3}}$ **Calculation 4.** $\left(-\frac{1}{27}\right)^{-\frac{1}{3}}$

Place the calculation # with the greatest answer in the first box.
Place the calculation # with the second greatest answer in the second box.
Place the calculation # with the third greatest answer in the third box.
Place the calculation # with the smallest answer in the fourth box.
(Record your answer in the numerical response box from left to right)

Answer Key

1.a) 2 **b)** 10 **c)** 4 **d)** 27 **e)** 343 **f)** 8 **g)** 4 **h)** 5 **i)** 1000 **j)** 0.2

2.a) $\frac{1}{3}$ **b)** $\frac{1}{128}$ **c)** $\frac{1}{125}$ **d)** $\frac{1}{100}$ **e)** $\frac{1}{32}$ **f)** $\frac{1}{16}$ **g)** $\frac{1}{7}$ **h)** $\frac{1}{4}$ **i)** $\frac{1}{32}$ **j)** $\frac{1000}{27}$

3.a) $\frac{1}{5}$ **b)** 2 **c)** $\frac{1}{16}$ **d)** $\frac{8}{27}$ **e)** $\frac{27}{8}$

4.a) -2 **b)** 9 **c)** $-\frac{1}{5}$ **d)** $-\frac{1}{16}$ **e)** 0.04 **5.a)** 2.52 **b)** 4.30 **c)** 6.90 **d)** 0.64 **e)** -0.86

6.a) $\sqrt[4]{a}$ **b)** $\sqrt{b}$ **c)** $\sqrt[5]{c}$ **d)** $\frac{1}{\sqrt{d}}$ **e)** $\frac{1}{\sqrt[10]{e}}$ **f)** $\left(\sqrt[3]{f}\right)^2$ **g)** $\left(\sqrt[3]{g}\right)^4$ **h)** $\left(\sqrt{h}\right)^5$

i) $\frac{1}{\left(\sqrt{i}\right)^3}$ **j)** $\frac{1}{\left(\sqrt[5]{j}\right)^4}$ **k)** $\frac{1}{\left(\sqrt[4]{k}\right)^3}$ **l)** $\left(\sqrt[n]{l}\right)^m$

7. **b)** and **d)** have no meaning

8.a) $(216)^{\frac{1}{3}}$ cm **b)** $6(216)^{\frac{2}{3}}$ cm^2 **c)** edge length = 6 cm, surface area = 216 cm^2

9.a) edge length = $V^{\frac{1}{3}}$ cm = $\sqrt[3]{V}$ cm **b)** area = $V^{\frac{2}{3}}$ cm^2 = $\left(\sqrt[3]{V}\right)^2$ cm^2

10.a) $5 = 25^{\frac{1}{2}}$ **b)** $8 = 512^{\frac{1}{3}}$ **c)** $-3 = (-27)^{\frac{1}{3}}$ **d)** $\frac{1}{4} = 16^{-\frac{1}{2}}$ **e)** $6 = \left(\frac{1}{36}\right)^{-\frac{1}{2}}$ **f)** $100 = 1000^{\frac{2}{3}}$

11. B **12.** D **13.**

3	2	1	4