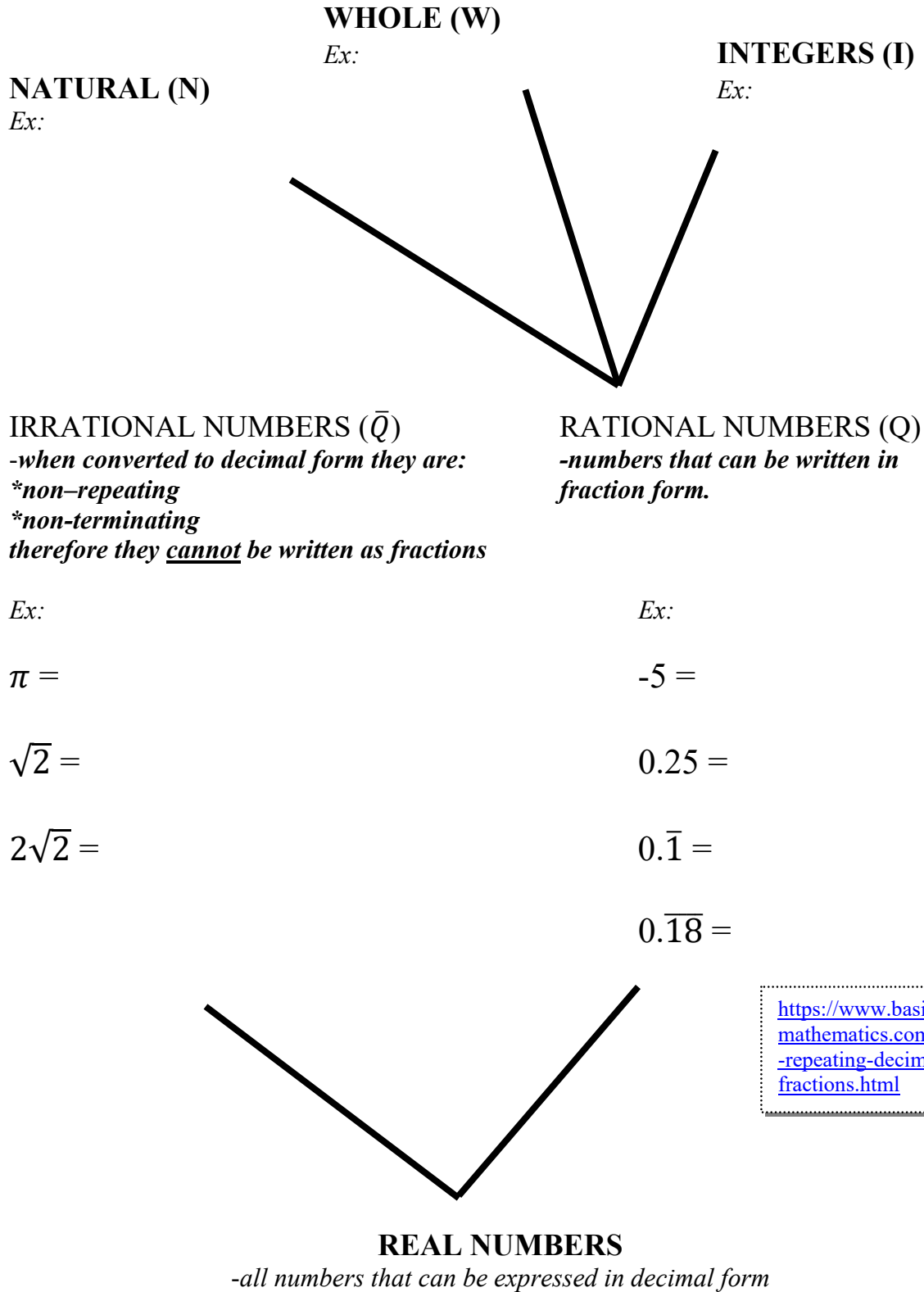
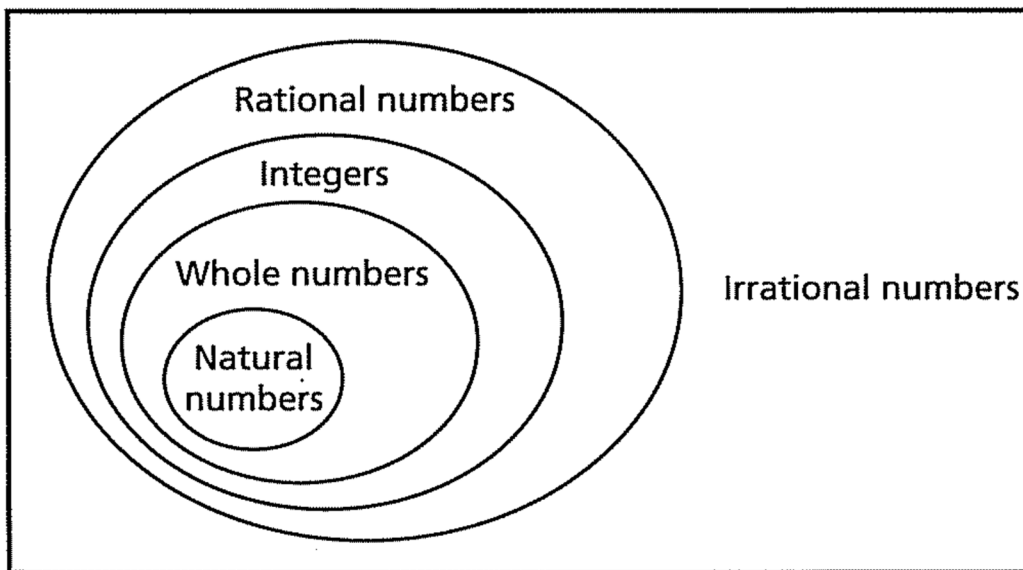


### 3.1 – Classifying Numbers



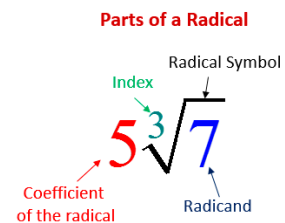
**Summary Chart:**

Real Numbers



**Example #1:** Use a number line to order these numbers from least to greatest.

$$\sqrt[3]{13} \quad \sqrt{18} \quad 2\sqrt{9} \quad \sqrt[4]{27} \quad \sqrt[3]{-5}$$



### 3.2 – Exponent Laws

	Example	Expanded	Simplified	Exponent Rule
Multiplication	$a^3 \cdot a^5$			$a^m \cdot a^n = a^{m+n}$
Division	$\frac{a^6}{a^2}$			$\frac{a^m}{a^n} = a^{m-n}$
Power Law	$(a^2)^4$			$(a^m)^n = a^{m \times n}$
Power of a Product	$(a^2b)^3$			$(a^x b^y)^m = a^{xm} b^{ym}$
Power of a Quotient	$\left(\frac{a}{b^3}\right)^5$			$\left(\frac{a^x}{b^y}\right)^m = \frac{a^{xm}}{b^{ym}}$

**Example 1:** Simplify:

a)  $0.3^{-3} \cdot 0.3^5$

b)  $\left[\left(-\frac{3}{2}\right)^{-4}\right]^2 \cdot \left[\left(-\frac{3}{2}\right)^2\right]^3$

c)  $\frac{(1.4^3)(1.4^4)}{1.4^{-2}}$

d)  $(x^3y^2)(x^2y^{-4})$

e)  $\frac{10a^5b^3}{2a^2b^{-2}}$

f)  $\frac{6x^4y^{-3}}{14xy^2}$

To SIMPLIFY _____ _____ _____.
--------------------------------------

**Example 2:** Simplify:

a)  $(25a^4b^2)^{\frac{3}{2}}$

b)  $\left(\frac{3x^3y}{4}\right)^2$

**Example 3:** Simplify:

a)  $\left(\frac{6x^5y^3}{2y^4}\right)^{-2}$

b)  $\left(\frac{100a}{25a^2b^{-\frac{1}{2}}}\right)^{\frac{1}{2}}$

## 3.2 WS

**Simplify. Your answer should contain only positive exponents.**

1)  $7n^2 \cdot 6n^2$

2)  $x^2y^3 \cdot 5x^3y^3 \cdot 6xy^2$

3)  $\frac{x^0y^2}{6x^2y^3}$

4)  $\frac{4yx^3}{3x^2y^2}$

5)  $\frac{n}{6n^2}$

6)  $(2x)^2$

7)  $(xy)^0$

8)  $(3x^3y^2)^2$

9)  $(-5m^{-1}n^3)^2$

10)  $(6mn^{-2})^{-3}$

11)  $(-2x^3y^2)^{-3}$

12)  $\frac{3n^{-1}}{5m^0n^2}$

13)  $-\frac{a^{-1}b^0}{b^2}$

14)  $\frac{3y^3}{-2y}$



### 3.3 – Fractional Exponents

A. Use a calculator to complete the tables.

$x$	$x^{\frac{1}{2}}$
1	
4	
9	
16	
25	

$x$	$x^{\frac{1}{3}}$
1	
8	
27	
64	
125	

Notice the pattern:

$\sqrt{x}$  the \_\_\_\_\_ in exponential form is \_\_\_\_\_

$\sqrt[3]{x}$  the \_\_\_\_\_ in exponential form is \_\_\_\_\_

$\sqrt[5]{x}$  the \_\_\_\_\_ in exponential form is \_\_\_\_\_

IN GENERAL,  $x^{\frac{1}{n}}$  as a radical becomes  $\sqrt[n]{x}$ . And vice versa,  $\sqrt[n]{x}$  equals  $x^{\frac{1}{n}}$ .

**Ex #1:** Write as a radical and then evaluate.

a)  $1000^{\frac{1}{3}}$

b)  $0.25^{\frac{1}{2}}$

c)  $\left(\frac{16}{81}\right)^{\frac{1}{4}}$

In a fractional exponent,

$\begin{array}{l} \frac{m}{x^n} \leftarrow \text{Exponent of the root or radicand} \\ \frac{m}{x^n} \leftarrow \text{Index of the root (little \#)} \end{array}$	$\text{so } x^{\frac{m}{n}} = \sqrt[n]{x^m} \text{ or } (\sqrt[n]{x})^m$
--	--

**Ex#2:** Write  $32^{\frac{2}{5}}$  in radical form two ways.

a)

b)

To help remember: \_\_\_\_\_

\_\_\_\_\_

**Ex#3:** Write in exponent form.

a)  $\sqrt{3^5}$

b)  $(\sqrt[3]{25})^2$

**Ex#4:** Write in radical form and then evaluate.

a)  $8^{\frac{2}{3}}$

b)  $81^{\frac{3}{4}}$

c)  $(-27)^{\frac{4}{3}}$

d)  $(-32)^{0.4}$



**3.4 - Negative Exponents**

***Warm Up:***

1. Evaluate each power.

a)  $7^2 =$       b)  $-7^2 =$       c)  $(-7)^2 =$       d)  $-(7)^2 =$       e)  $-(-7)^2 =$

Brackets influence the solution by \_\_\_\_\_

2. Write the reciprocal.

a)  $2 =$       b)  $6 =$       c)  $\frac{1}{2} =$       d)  $\frac{1}{100} =$

**NEGATIVE EXPONENT LAW**

$\frac{2^2}{2^5} =$       OR       $\frac{2^2}{2^5} =$

Algebra:  $x^{-n} = \frac{1}{x^n}$  where  $x$  can be any number but 0.

\_\_\_\_\_

\_\_\_\_\_

Foundations and Precalculus 10

Ex #1 : Evaluate:

a)  $3^{-2}$

b)  $(-3)^{-2}$

c)  $0.3^{-4}$

Algebra:  $\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^{+n}$  where  $a, b$  can be any number but 0.

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Ex #2 – Evaluate:

a)  $\left(\frac{5}{4}\right)^{-2}$

b)  $\left(-\frac{3}{4}\right)^{-3}$

c)  $\left(\frac{10}{3}\right)^{-3}$

Ex #3 – Evaluate without using a calculator. \*\*Remember  $x^{\frac{m}{n}} = \sqrt[n]{x^m}$

a)  $8^{-\frac{2}{3}}$

b)  $\left(\frac{9}{16}\right)^{-\frac{3}{2}}$

c)  $(-0.027)^{-\frac{2}{3}}$



\_\_\_ 12. Determine which of these numbers is the least.

$$\sqrt{14}, \sqrt[3]{30}, \sqrt[4]{100}, \sqrt[3]{75}, \sqrt{17}$$

- a.  $\sqrt[4]{100}$                       b.  $\sqrt[3]{30}$                       c.  $\sqrt{14}$                       d.  $\sqrt[3]{75}$

\_\_\_ 13. Between which two consecutive integers on a number line would you locate  $\sqrt[3]{-18}$ ?

- a. -2 and -3                      b. -3 and -4                      c. 2 and 3                      d. -1 and -2

\_\_\_ 14. Which of these numbers is an integer, but not a whole number?

$$-9, 0, 1, \sqrt{5}$$

- a. 0                      b. -9                      c.  $\sqrt{5}$                       d. 1

\_\_\_ 15. Which of these numbers is a natural number?

$$9, 0, -1, 1.\bar{8}$$

- a. 9                      b. 0                      c.  $1.\bar{8}$                       d. -1

\_\_\_ 16. Which of these numbers is a whole number, but not a natural number?

$$0, -3, 1, 8.1$$

- a. 8.1                      b. 1                      c. 0                      d. -3

\_\_\_ 17. To which set(s) of numbers does  $-\sqrt{25}$  belong?

I	Natural
II	Integer
III	Rational
IV	Irrational

- a. II and III only                      b. III only                      c. I, II and III only                      d. IV only

\_\_\_ 23. Order these numbers from greatest to least:  $2\sqrt{30}, 3\sqrt{3}, 2\sqrt{7}, 5\sqrt{5}, 2\sqrt{13}$

- a.  $2\sqrt{13}, 2\sqrt{7}, 3\sqrt{3}, 5\sqrt{5}, 2\sqrt{30}$                       c.  $5\sqrt{5}, 2\sqrt{30}, 3\sqrt{3}, 2\sqrt{13}, 2\sqrt{7}$   
b.  $5\sqrt{5}, 2\sqrt{30}, 2\sqrt{13}, 2\sqrt{7}, 3\sqrt{3}$                       d.  $3\sqrt{3}, 5\sqrt{5}, 2\sqrt{30}, 2\sqrt{13}, 2\sqrt{7}$

\_\_\_ 24. Evaluate  $64^{\frac{1}{3}}$  without using a calculator.

- a. 8                      b. 4                      c. -4                      d.  $21\frac{1}{3}$

\_\_\_ 25. Evaluate  $0.25^{\frac{1}{2}}$  without using a calculator.

- a. 0.05                      b. 0.125                      c. 0.5                      d. 0.29

\_\_\_ 26. Evaluate  $(-27)^{\frac{1}{3}}$  without using a calculator.

- a. -3                      b. 3                      c. -9                      d. does not exist

\_\_\_ 27. Evaluate  $\left(\frac{256}{625}\right)^{\frac{1}{4}}$  without using a calculator.

- a.  $\frac{64}{625}$                       b.  $\frac{4}{25}$                       c.  $\frac{4}{5}$                       d.  $\frac{16}{25}$

\_\_\_ 28. Write  $42^{\frac{5}{4}}$  as a radical.

a.  $\sqrt[5]{42^4}$       b.  $(\sqrt[4]{42})^5$       c.  $\sqrt[125]{42}$       d.  $(\sqrt[5]{42})^4$

\_\_\_ 29. Write  $\sqrt{\left(\frac{3}{4}\right)^9}$  as a power.

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

\_\_\_ 30. Evaluate  $0.16^{\frac{5}{2}}$ .

a. 0.4804      b. 0.1012      c. 0.0256      d. 0.010 24

\_\_\_ 31. Evaluate  $(-243)^{0.6}$

a. -27      c. 27  
b. does not exist      d. 9462.5994...

\_\_\_ 32. Evaluate  $4^{2.5}$

a. 18      c. 1.741 101...  
b. 32      d. 40

\_\_\_ 33. Evaluate  $\left(\frac{125}{8}\right)^{\frac{4}{3}}$

a.  $\frac{625}{4}$       c.  $\frac{625}{16}$   
b. 7.858 958...      d.  $\frac{625}{8}$

\_\_\_ 34. Evaluate  $3^{-2}$  without using a calculator.

a.  $\sqrt{3}$       b.  $\frac{1}{6}$       c.  $\frac{1}{9}$       d. 9

\_\_\_ 35. Evaluate  $\left(\frac{2}{3}\right)^{-3}$ .

a.  $-\frac{27}{8}$       b.  $-\frac{8}{27}$       c.  $\frac{27}{8}$       d.  $-\frac{1}{6}$

\_\_\_ 36. Evaluate  $64^{-\frac{4}{3}}$  without using a calculator.

a.  $\frac{1}{256}$

b.  $\frac{3}{256}$

c.  $-\frac{1}{256}$

d.  $-256$

\_\_\_ 37. Evaluate  $(0.81)^{-\frac{3}{2}}$  without using a calculator.

a.  $\frac{81}{100}$

b.  $\frac{729}{1000}$

c.  $\frac{100}{81}$

d.  $\frac{1000}{729}$

\_\_\_ 38. Evaluate  $49^{-0.5}$  without using a calculator.

a.  $\frac{2}{49}$

b.  $\frac{1}{49}$

c.  $\frac{1}{7}$

d.  $7$

\_\_\_ 39. Which power with a negative exponent is equivalent to  $\frac{1}{125}$ ?

a.  $5^{-3}$

b.  $-5^{-3}$

c.  $3^{-5}$

d.  $(-5)^3$

\_\_\_ 40. Given that  $6^{10} = 60\,466\,176$ , what is  $6^{-10}$ ?

a.  $-6$

b.  $-\frac{1}{6}$

c.  $-\frac{1}{60\,466\,176}$

d.  $\frac{1}{60\,466\,176}$

Simplify.

44.  $\left(\frac{x}{2}\right)^3$

45.  $\left(\frac{a}{b}\right)^4$

46.  $\left(\frac{x^2}{y^3}\right)^5$

47.  $\left(\frac{x}{3}\right)^{-1}$

48.  $\left(\frac{m^{-3}}{n}\right)^0$

49.  $\left(\frac{a^{-2}}{b^{-3}}\right)^{-2}$

Simplify.

50.  $5m^4 \times 3m^2$

51.  $(4ab^4)(-5a^3b^2)$

52.  $5a(-2ab^2)(-3b^3)$

53.  $(-6m^3n^2)(-4mn^5)$

54.  $(7x^2)(6x^{-2})$

55.  $(3x^{-2}y^2)(-2x^2y^{-3})$

56.  $(-6a^{-1}b^2)(-a^{-3}b^{-4})$

57.  $(-10x^4) \div (-2x)$

58.  $\frac{45a^2b^4}{9ab^2}$

59.  $\frac{(4m^2n^4)(7m^3n)}{14mn^5}$

60.  $\frac{3ab^3 \times 10a^4b^2}{15a^2b^6}$

61.  $\frac{4a^4b^3}{a^5b^6} \times \frac{-a^3}{-(b^2)}$

62.  $(35x^5) \div (5x^{-3})$

63.  $(-6m^{-4}n^2) \div (2m^{-1}n^{-6})$

64.  $\frac{-54a^5b^{-7}}{-6a^{-2}b^{-3}}$

65.  $\frac{(-2x^{-3}y)(-12x^{-4}y^{-2})}{6xy^{-3}}$

Simplify.

66.  $(2m^3)^2$

67.  $(-4x^2)^3$

68.  $(-3m^3n^2)^2$

69.  $(5c^{-3}d^3)^{-2}$

70.  $(2a^{-3}b^{-2})^{-3}$

71.  $(-3x^3y^{-2})^{-4}$

72.  $\left(\frac{4x}{3y}\right)^2$

73.  $\left(\frac{-2a^2}{3y^3}\right)^3$

74.  $\left(\frac{3a}{-b^4}\right)^4$

75.  $\left(\frac{2m^2}{n^3}\right)^{-2}$

76.  $\left(\frac{6ab^3}{2ab}\right)^3$

77.  $\left(\frac{4x^{-3}y^4}{8x^2y^{-2}}\right)^{-2}$

Write each of the following with positive exponents. Then simplify as much as possible.

No Calculator

25.  $3^{-2}$

26.  $(-5)^{-2}$

27.  $(-2)^{-5}$

28.  $2^{-5}$

29.  $(-3)^{-2}$

30.  $(-7)^{-2}$

31.  $\left(\frac{3}{4}\right)^{-2}$

32.  $\left(\frac{3}{5}\right)^{-2}$

33.  $\left(\frac{1}{3}\right)^{-2} + \left(\frac{1}{2}\right)^{-3}$

34.  $\left(\frac{1}{2}\right)^{-2} + \left(\frac{1}{3}\right)^{-3}$

35.  $\left(\frac{2}{3}\right)^{-2} - \left(\frac{2}{5}\right)^{-2}$

36.  $\left(\frac{3}{2}\right)^{-2} - \left(\frac{3}{4}\right)^{-2}$

Solutions - Page 1

43.  $x^{-6}y^{-9}$  44.  $\frac{x^3}{8}$  45.  $\frac{a^4}{b^4}$  46.  $\frac{x^{10}}{y^{15}}$  47.  $\frac{3}{x}$  48. 1  
 49.  $\frac{a^4}{b^6}$  50.  $15m^6$  51.  $-20a^4b^6$  52.  $30a^2b^5$  53.  $24m^4n^7$   
 54. 42 55.  $-6y^{-1}$  56.  $6a^{-4}b^{-2}$  57.  $5x^3$  58.  $5ab^2$  59.  $2m^4$   
 60.  $2a^3b^{-1}$  61.  $\frac{4a^2}{b^3}$  62.  $7x^8$  63.  $-3m^{-3}n^8$  64.  $9a^7b^{-4}$   
 65.  $4x^{-8}y^{-2}$  66.  $4m^6$  67.  $-64x^6$  68.  $9m^6n^4$  69.  $\frac{c^6}{25d^6}$   
 70.  $\frac{a^9b^6}{8}$  71.  $\frac{y^8}{81x^{12}}$  72.  $\frac{16x^2}{9y^2}$  73.  $-\frac{8a^6}{27y^9}$   
 74.  $\frac{81a^4}{b^{16}}$  75.  $\frac{n^6}{4m^4}$  76.  $27b^6$  77.  $\frac{4x^{10}}{y^{12}}$  78. 3 79.  $\frac{3}{8}$

Solutions - Page 2

25.  $\frac{1}{9}$  26.  $\frac{1}{25}$   
 27.  $-\frac{1}{32}$  28.  $\frac{1}{32}$   
 29.  $\frac{1}{9}$  30.  $\frac{1}{49}$   
 31.  $\frac{16}{9}$  32.  $\frac{25}{9}$   
 33. 17 34. 31  
 35. -4 36.  $-\frac{4}{3}$