PART A

1) State the number of elements (or members) in each set.

a) {blue, green, red, yellow} b) {a,b,c,d,e,f,g} c) {Ontario, Alberta, Manitoba}

d) $\{2,5,6,8,10\}$ e) $\{-9,-8,-7\}$ f) $\{0,1\}$ g) $\{0\}$ h) $\{1,2,3,4,5,...\}$ i) $\{\ \}$

2) Explain why the set $\{7,9,12\}$ is a subset of the set $\{5,6,7,8,9,10,11,12\}$.

3) Explain why the set $\{0,1,4,9,16\}$ is not a subset of the set $\{1,2,3,4,5,...\}$.

4) Match each parent set on the left with its corresponding subset on the right.

a) $\{-8,-7,-6,-5,-4,-3,-2,-1\}$	i) $\{1,3,5,7,9\}$
b) $\{-8,-6,-4,-2,0,2,4,6,8,...\}$	ii) $\{-13\}$
c) $\{1,2,3,4,5...\}$	iii) $\{0,2,4,6,8,...\}$
d) $\{...,-9,-7,-5,-3,-1\}$	iv) $\{-1,-2,-3\}$

5) Express the following sets in braces, { }.
   a) The set of natural numbers less than 10.
   b) The set of odd integers from -5 to 5.
   c) The set of all whole numbers.
   d) The set of all integers.
   e) The set of all even whole numbers greater than or equal to 20.
   f) The set of all integers that are multiples of 5.

PART B

6) List all of the subsets of the set $\{1,2\}$.

7) List all of the subsets of the set $\{-1,0,1\}$.

8) Identify each of the following statements as true or false.
   a) The set of whole numbers is a subset of the set of real numbers.
   b) The set of natural numbers is a subset of the set of integers.
   c) The set of whole numbers is a subset of the set of natural numbers.
   d) The set of rational numbers is a subset of the set of real numbers.
   e) The set of irrational numbers is a subset of the set of rational numbers.
   f) The set of integers is a subset of the set of rational numbers.
   g) $\{2,3,\pi\}$ is a subset of the rational numbers.

9) Jonah stated that subsets always have fewer elements than their parent sets. Is Jonah's claim correct? Explain.

10) Aaliyah claims that the sets $\{3,4,5\}$ and $\{4,5,3\}$ are the same. Is Aaliyah's claim true? Explain.

11) The set of real numbers and its subsets are often represented using the symbols shown on the right. Describe how each of the following pairs of sets are related.

a) $\mathbb{N}$ and $\mathbb{W}$

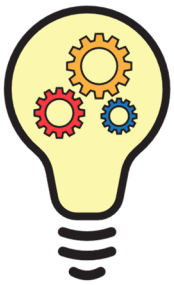
b) $\mathbb{W}$ and $\mathbb{Z}$

c) $\mathbb{Z}$ and $\mathbb{Q}$

d) $\mathbb{Q}$ and $\mathbb{P}$

Set	Symbol
Natural Numbers	$\mathbb{N}$
Whole Numbers	$\mathbb{W}$
Integers	$\mathbb{Z}$
Rational Numbers	$\mathbb{Q}$
Irrational Numbers	$\mathbb{P}$ or $\mathbb{Q}'$ or $\mathbb{R}\setminus\mathbb{Q}$
Real Numbers	$\mathbb{R}$

12) Why do you think the notation $\mathbb{R}\setminus\mathbb{Q}$ is sometimes used to represent the set of irrational numbers?



13) Describe a real-life situation involving numbers where the set of natural numbers may not be adequate, but the set of whole numbers is sufficient.

14) Describe a real-life situation involving numbers where the set of whole numbers may not be adequate, but the set of integers is sufficient.

15) Describe a real-life situation involving numbers where the set of whole numbers may not be adequate, but the set of rational numbers is sufficient.

16) Describe a real-life situation in which you might encounter an irrational number.

17) Create a problem for which the answer involves the irrational number $\sqrt{5}$.

18) If set B is a subset of set A, and set C is a subset of set B, is set C a subset of set A. Explain.

PART C

19) A set that does not contain any elements is called the *empty set*. The symbol $\varnothing$ is used to represent the empty set. Is $\varnothing$ a subset of $\{1,2,3\}$? Explain.

20) Jean-Pierre claims that the empty set is a subset of every set. Is Jean-Pierre's claim correct? Explain.

21) The symbol $\subseteq$ is often used to denote a subset. For example, if set P is a subset of set Q, we would write $P \subseteq Q$. If $A=\{1,2,3,4,5,6,7,8,9\}$, $B=\{2,4,6,8\}$ and $C=\{4,8\}$, indicate whether each of the following statements is true or false.

a) $A \subseteq B$ b) $B \subseteq A$ c) $C \subseteq B$ d) $C \subseteq A$ e) $B \subseteq C$

22) There is a relationship between the number of elements in a set and the number of possible subsets.
a) Determine the total number of possible subsets for the set $\{1, 2, 3\}$.
b) Determine the total number of possible subsets for the set $\{1, 2, 3, 4\}$.
c) Hypothesize a rule for finding the number of subsets for a set containing n elements.
d) Use your hypothesis to predict the number of subsets for a set with 12 elements.

ANSWERS

1) a) 4 b) 7 c) 3 d) 5 e) 3 f) 2 g) 1 h) infinite i) 0

2) All of the elements of the set $\{7,9,12\}$ are contained in the set $\{5,6,7,8,9,10,11,12\}$. Therefore, the set $\{7,9,12\}$ is a subset of the set $\{5,6,7,8,9,10,11,12\}$.

3) Not all of the elements of the set $\{0,1,4,9,16\}$ are contained in the set $\{1,2,3,4,5,...\}$. Specifically, 0 is an member of the first set, but not the second. Therefore, the set $\{0,1,4,9,16\}$ is not a subset of the set $\{1,2,3,4,5,...\}$.

4) a) iv b) iii c) i d) ii

5) a) $\{1,2,3,4,5,6,7,8,9\}$ b) $\{-5,-3,-1,1,3,5\}$ c) $\{0,1,2,3,4,5,...\}$
d) $\{...,-3,-2,-1,0,1,2,3,...\}$ e) $\{20,22,24,26,28,...\}$ f) $\{...,-15,-10,-5,0,5,10,15,...\}$

6) $\{\ \}, \{1\}, \{2\}, \{1,2\}$

7) $\{\ \}, \{-1\}, \{0\}, \{1\}, \{-1,0\}, \{-1,1\}, \{0,1\}, \{-1,0,1\}$

8) a) true b) true c) false d) true e) false f) true g) false

9) Jonah's claim is incorrect. A subset may have the same number of elements as its parent set. For example the parent set $\{1,2,3\}$ and its subset $\{1,2,3\}$ have the same number of members. (Note: A *proper subset* is a subset that is not equal to its parent set. A *proper subset* always has fewer elements than its parent set. No set is a *proper subset* of itself.)

10) Aaliyah's claim is correct. Two sets are considered equal if (and only if) they contain the same elements. The order in which the elements are written does not matter.

11) a) Adding the element 0 to the set of natural numbers ($\mathbb{N}$) gives the set of whole numbers ($\mathbb{W}$). $\mathbb{N}$ is a subset of $\mathbb{W}$.

b) The integers ($\mathbb{Z}$) consist of the set of whole numbers ($\mathbb{W}$) with the negative natural numbers. $\mathbb{W}$ is a subset of $\mathbb{Z}$.

c) The rational numbers ($\mathbb{Q}$) consist of all numbers of the form $\frac{a}{b}$, where *a* and *b* are elements of the integers ($\mathbb{Z}$). $\mathbb{Z}$ is a subset of $\mathbb{Q}$.

d) The rational numbers ($\mathbb{Q}$) consist of all numbers of the form $\frac{a}{b}$, where *a* and *b* are integers, whereas the irrational numbers ($\mathbb{P}$) are all of the real numbers that cannot be expressed in that form. $\mathbb{Q}$ and $\mathbb{P}$ have no elements in common (they are *disjoint sets*).

12) The irrational numbers are all of the real numbers ($\mathbb{R}$) that are not rational numbers ($\mathbb{Q}$). The notation $\mathbb{R} \setminus \mathbb{Q}$ denotes the removal of the rational numbers from the set of real numbers, thus leaving the set of irrational numbers.

13) Answers may vary. For example, describing the number of seconds that have passed since a ball was thrown in the air. The number 0 would be needed to describe the instant the ball was thrown.

14) Answers may vary. For example, describing temperature in degrees Celsius, where negative values are needed for temperatures below freezing.

15) Answers may vary. For example, using an imperial tape measure to make measurements requiring fractions of an inch.

16) Answers may vary. For example, when using the side-length relationship for right triangles (Pythagorean Theorem) to find the length of an unknown side in a right triangle.

17) Answers may vary. For example, determine the side length of a square that has an area of $5\ \text{cm}^2$.

18) Yes. Since *C* is a subset of *B*, all of the elements of *C* are contained in *B*. Since *B* is a subset of *A*, all of the elements of *B* are contained in *A*, and thus all of the elements of *C* are also contained in *A*. Therefore, *C* is a subset of *A*.

19) Yes. A set containing no elements is a possible subset of the set $\{1, 2, 3\}$.

20) Jean-Pierre's claim is correct. A set containing no elements is a possible subset of any set. (Note: A *proper subset* is a subset that is not equal to its parent set. The empty set is not a *proper subset* of itself.)

21) a) false b) true c) true d) true e) false

22) a) 8 b) 16 c) The total number of subsets is equal to 2^n. d) 4096