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Question: 1

Which of these demonstrates the relationship between the sets of prime numbers, real numbers, natural numbers, complex numbers, rational numbers, and integers?
$\mathbb{P}$ – Prime; $\mathbb{R}$ – Real; $\mathbb{N}$ – Natural; $\mathbb{C}$ – Complex; $\mathbb{Q}$ – Rational; $\mathbb{Z}$ – Integer

A. $\mathbb{P} \subseteq \mathbb{Q} \subseteq \mathbb{R} \subseteq \mathbb{Z} \subseteq \mathbb{C} \subseteq \mathbb{N}$
B. $\mathbb{P} \subseteq \mathbb{N} \subseteq \mathbb{Z} \subseteq \mathbb{Q} \subseteq \mathbb{R} \subseteq \mathbb{C}$
C. $\mathbb{C} \subseteq \mathbb{R} \subseteq \mathbb{Q} \subseteq \mathbb{Z} \subseteq \mathbb{N} \subseteq \mathbb{P}$
D. None of these

Answer: B

Explanation:
The notation $\mathbb{P} \subseteq \mathbb{N} \subseteq \mathbb{Z} \subseteq \mathbb{Q} \subseteq \mathbb{R} \subseteq \mathbb{C}$ means that the set of prime numbers is a subset of the set natural numbers, which is a subset of the set of integers, which is a subset of the set of rational numbers, which is a subset of the set real numbers, which is a subset of the set of complex numbers.

Question: 2

To which of the following sets of numbers does-4 NOT belong?

A. The set of whole numbers
B. The set of rational numbers
C. The set of integers
D. The set of real numbers

Answer: A

Explanation:
A: The set of whole numbers, {0, 1, 2, 3,….} does not contain the number —4. Since —4 is an integer, it is also a rational number and a real number.

Question: 3

Which of these forms a group?

A. The set of prime numbers under addition
B. The set of negative integers under multiplication
C. The set of negative integers under addition
D. The set of non-zero rational numbers under multiplication

Answer: D

Explanation:
In order for a set to be a group under operation
1. The set must be closed under that operation. In other words, when the operation is performed on any two members of the set, the result must also be a member of that set.
2. The set must demonstrate associatively under the operation: a * (b c) = (a * b) * c
3. There must exist an identity element e in the group: a * e = e * a = a
4. For every element in the group, there must exist an inverse element in the group: a * b = Note: the group need not be commutative for every pair of elements in the group. If the group demonstrates commutatively, it is called an abelian group.
The set of prime numbers under addition is not closed. For example, 3+5=8, and 8 is not a member of the set of prime numbers. Similarly, the set of negative integers under multiplication is not closed since the product of two negative integers is a positive integer. Though the set of negative integers under addition is closed and is associative, there exists no identity element (the number zero in this case) in the group. The set of positive rational numbers under multiplication is closed and associative; the multiplicative identity I is a member of the group, and for each element in the group, there is a multiplicative inverse (reciprocal).

Question: 4

Simplify $\frac{2+3i}{4-2i}$.

A. $\frac{1}{10}+\frac{4}{5}i$
B. $\frac{1}{10}$
C. $\frac{7}{6}+\frac{2}{3}i$
D. $\frac{1}{10}+\frac{3}{10}i$

Answer: A

Explanation:
First multiply the numerator and denominator by the denominator's conjugate, 4 + 21. Then, simplify the result and write the answer in the form a + bj.

$$\frac{2+3i}{4-2i}\cdot\frac{4+2i}{4+2i}=\frac{8+4i+12i+6i^2}{16-4i^2}=\frac{8+16i-6}{16+4}=\frac{2+16i}{20}=\frac{1}{10}+\frac{4}{5}i$$

Question: 5

Simplify $|(2-3i)^2-(1-4i)|$.

A. $\sqrt{61}$

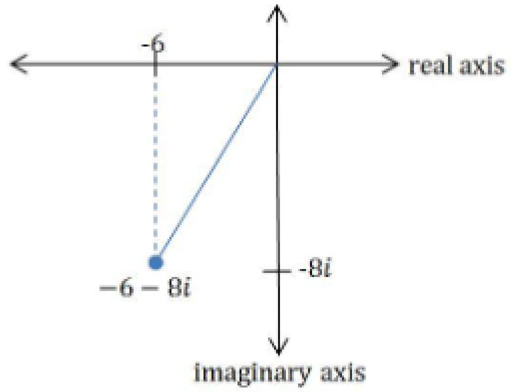
B. -6 -8i
C. 6 + 8i
D. 10

Answer: D

Explanation:
First, simplify the expression within the absolute value symbol.

$$|(2-3i)^2-(1-4i)|$$
$$|4-12i+9i^2-1+4i|$$
$$|4-12i-9-1+4i|$$
$$|-6-8i|$$

The absolute value of a complex number is its distance from 0 on the complex plane. Use the Pythagorean Theorem (or the 3-4-5 Pythagorean triple and similarity) to find the distance of —6 — 8t from the origin.



Since the distance from the origin to the point $-6-8i$ is 10, $|-6-8i|$=10.

Question: 6

Which of these sets forms a group under multiplication?

A. {-i, 0, i}
B. {-1, 1, i, -i}
C. {i, 1}
D. {i, -i, 1}

Answer: B

Explanation:
In order for a set to be a group under operation
1. The set must be closed under that operation. In other words, when the operation is performed on any two members of the set, the result must also be a member of that set.
2. The set must demonstrate associatively under the operation: a * (b c) = (a * b) * c
3. There must exist an identity element e in the group: a e = e a = a

4. For every element in the group, there must exist an inverse element in the group: a * b = b * a = e
Choice A can easily be eliminated as the correct answer because the set {-i,0, i} does not contain the multiplicative identity 1. Though choices C and D contain the element 1, neither is closed: for example, since i . i = —1, —1 must be an element of the group. Choice B is closed contains the multiplicative identity 1, and the inverse of each element is included in the set as well. Of course, multiplication is an associative operation, so the set {—1, 1, i, —i} forms a group under multiplication

×	-1	1	i	$-i$
-1	1	-1	$-i$	i
1	-1	1	i	$-i$
i	$-i$	i	-1	1
$-i$	i	$-i$	1	-1

Question: 7

The set {a, b , c, d) forms a group under operation #. Which of these statements is (are) true about the group?

#	a	b	c	d
a	c	d	b	a
b	d	c	a	b
c	b	a	d	c
d	a	b	c	d

I. The identity element of the group is d.
II. The inverse of cis c.
III. The operation # is commutative.

A. I
B. III
C. I, III
D. I, II, III

Answer: D

Explanation:
The identity element is d since d # a = a # d = a, d #b = b # d = b, d # c = c # d = c, and d # d = d. The inverse of element c is c since c # c = d, the identity element. The operation # is commutative because a # b = b # a, a # c = c # a, etc. Rather than check that the operation is commutative for each pair of elements, note that elements in the table display symmetry about the diagonal elements; this indicates that the operation is indeed commutative.

#	a	b	c	d
a	c	d	b	a
b	d	c	a	b
c	b	a	d	c
d	a	b	c	d

Question: 8

If the square of twice the sum of x and three is equal to the product of twenty-four and x, which of these is a possible value of x?

A. $6 + 3\sqrt{2}$
B. $\frac{3}{2}$
C. -3i
D. -3

Answer: C

Explanation:

"The square of twice the sum of x and three is equal to the product of twenty-four and x" is represented by the equation $[2(x+3)]^2 = 24x$. Solve for x.

$$[2(x+3)]^2 = 24x$$

$$[2x+6]^2 = 24x$$

$$4x^2 + 24x + 36 = 24x$$

$$4x^2 = -36$$

$$x^2 = -9$$

$$x = \pm\sqrt{-9}$$

$$x = \pm 3i$$

So, $-3i$ is a possible value of x.

Question: 9

Given that x is a prime number and that the greatest common factor of x and y is greater than 1, compare the two quantities.

Quantity A	Quantity B
y	the least common multiple of x and y

A. Quantity A is greater.
B. Quantity B is greater.
C. The two quantities are the same.
D. The relationship cannot be determined from the given information.

Answer: C

Explanation:

If x is a prime number and that the greatest common factor of x and y is greater than 1, the greatest common factor of x and y must be x. The least common multiple of two numbers is equal to the product of those numbers divided by their greatest common factor. So, the least common multiple of x and y is $\frac{xy}{x} = y$. Therefore, the values in the two columns are the same.

Question: 10

If a, b, and c are even integers and $3a^2 + 9b^3 = c$, which of these is the largest number which must be factor of c?

A. 2
B. 3
C. 6
D. 12

Answer: D

Explanation:
Since a and b are even integers, each can be expressed as the product of 2 and an integer. So, if we write $a = 2x$ and $b = 2y$, $3(2x)^2 + 9(2y)^3 = c$.

$$3(4x^2) + 9(8y^3) = c$$

$$12x^2 + 72y^3 = c$$

$$12(x^2 + 6y^3) = c$$

Since c is the product of 12 and some other integer, 12 must be a factor of c. Incidentally, the numbers 2, 3, and 6 must also be factors of c since each is also a factor of 12.