

## 1. Mathematics

### Toss Up: Short Answer

What is the imaginary unit "i" when raised to the power 30?

Toss Up Answer: -1

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### Bonus: Short Answer

What is the sum of the first 50 positive integers?

Bonus Answer: 1275

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## 2. Earth and Space Science

### Toss Up: Multiple Choice

The seasons we experience on the Earth are caused by

- W) the change in the Earth's distance from the sun during the year
- X) the precession of the Earth's pole
- Y) the tilt of the Earth's axis with respect to the ecliptic pole
- Z) the change in the Moon's distance from the Earth during the year

Toss Up Answer: Y

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### Bonus: Multiple Choice

If we compare two stars of different temperature, the hotter star

- W) will appear redder
- X) emits more energy from each unit area of surface
- Y) will have a brighter apparent magnitude
- Z) will have a brighter absolute magnitude

Bonus Answer: X

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## 3. Physics

### Toss Up: Short Answer

A toy train moves in a circle of 8 meters radius with a speed of 4 meters per second. What is the magnitude of the acceleration of the train?

Toss Up Answer: 2 meters per second<sup>2</sup>

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### Bonus: Short Answer

A certain machine exerts a force of 200 newtons on a box whose mass is 30 kilograms. The machine moves the box a distance of 20 meters along a horizontal floor. What amount of work does the machine do on the box?

Bonus Answer: 4000 J (joules)

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## 4. Biology

### Toss Up: Short Answer

What part of the brain controls the interaction between the two hemispheres?

Toss Up Answer: corpus callosum

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**Bonus: Short Answer**

Which lobe of the brain is known for spatial reasoning and navigation?

**Bonus Answer: parietal lobes**  
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**5. Earth and Space Science**

**Toss Up: Multiple Choice**

Which of the following has the lowest specific heat?

W) Copper

X) Granite

Y) Marble

Z) Dry air

**Toss Up Answer: W**  
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**Bonus: Short Answer**

Order the following rock particles from the biggest to the smallest: 1. Sand 2. Silt 3. Pebbles 4. Clay

**Bonus Answer: 3, 1, 2, 4**  
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**6. Mathematics**

**Toss Up: Multiple Choice**

What is asymptote of the function:  $f(x) = 1/x$ ?

W)  $y = 0$

X)  $x = 0$

Y)  $x = 0, y = 1$

Z)  $x = 0, y = 0$

**Toss Up Answer: Z**  
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**Bonus: Short Answer**

Plugging the divergent series,  $1 + 2 + 3 + 4 + \dots$ , into the Riemann Zeta Function results in which number?

**Bonus Answer:  $-1/12$**   
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**7. Chemistry**

**Toss Up: Short Answer**

An ideal gas in a closed inflexible container has a pressure of 6 atmospheres and a temperature of  $27^\circ\text{C}$ .

What will be the new pressure of the gas if the temperature is decreased to  $-73^\circ\text{C}$ ?

**Toss Up Answer: 4 atmospheres**  
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**Bonus: Multiple Choice**

When  $\text{CO}_2$  is bubbled through distilled water at  $25^\circ\text{C}$ , which of the following is most likely to occur?

W) Solid carbon will form

X) The pH of the solution will be reduced

Y) The water will boil

Z) Methane gas will be formed

**Bonus Answer: X**  
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**8. Physics**

### Toss Up: Short Answer

A box is initially at rest on a horizontal, frictionless table. If a force of 10 Newtons acts on the box for 3 seconds, what is the momentum of the box at the end of the 3 second interval?

**Toss Up Answer: 30 N (newton) seconds**

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### Bonus: Short Answer

A 10 kilogram body initially moving with a velocity of 10 meters per second makes a head-on collision with a 15 kilogram body initially at rest. The two objects stick together. What is the velocity of the combined system just after the collision?

**Bonus Answer: 4 meters per seconds**

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## 9. Earth and Space Science

### Toss Up: Multiple Choice

What happens as air rises?

W) It gets warmer

X) It gets colder

Y) The temperature fluctuates

Z) Nothing

**Toss Up Answer: X**

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### Bonus: Short Answer

How are winds named?

**Bonus Answer: By the direction they are coming in**

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## 10. Mathematics

### Toss Up: Multiple Choice

Which of the following sets has the greatest cardinality?

W) The set of all real numbers

X) The set of all integers

Y) The set of all rational numbers

Z) They all have the same cardinality

**Toss Up Answer: W**

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### Bonus: Short Answer

If set A has a cardinality of 5, set B has a cardinality of 6, and set A and B are disjoint sets, what is the cardinality of the union of set A and B?

**Bonus Answer: 11**

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## 11. Biology

### Toss Up: Short Answer

Asexual prokaryotic cell division occurs via which process?

**Toss Up Answer: binary fission**

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### Bonus: Multiple Choice

Mitosis in protists differ from other forms of eukaryotic mitosis in which way?

- W) Microtubules attach to the chromosome kinetochores.
- X) Chromosomes are condensed in prophase.
- Y) The nuclear envelope is not disassembled and remains intact throughout the process.
- Z) Sister chromatids cross over.

Bonus Answer: Y

## 12. Physics

Toss Up: Multiple Choice

A vector extends 6 meters in the x direction and  $2\sqrt{3}$  meters in the y direction. The angle this vector makes with the positive x axis is:

- W) 30 degrees
- X) 60 degrees
- Y) 90 degrees
- Z) 180 degrees

Toss Up Answer: W

Bonus: Multiple Choice

A brick slides on a horizontal surface. Which of the following will increase the frictional force on it?

- W) Increasing the surface of contact
- X) Decreasing the surface of contact
- Y) Increasing the mass of the brick
- Z) Decreasing the mass of the brick

Bonus Answer: Y

## 13. Chemistry

Toss Up: Multiple Choice

Given the following ions,  $\text{Na}^+$ ,  $\text{Br}^-$ ,  $\text{Ag}^+$ , and  $\text{Cu}^{2+}$  which ion has the greatest atomic radius?

- W)  $\text{Na}^+$
- X)  $\text{Br}^-$
- Y)  $\text{Ag}^+$
- Z)  $\text{Cu}^{2+}$

Toss Up Answer: Y

Bonus: Short Answer

Name the group of elements with the least electronegativity.

Bonus Answer: Noble gases (Group 18)

## 14. Biology

Toss Up: Multiple Choice

Select the description that most correctly describes the term recessive:

- W) A weak phenotype.
- X) An allele that confers a weak phenotype.
- Y) A phenotype conferred when only one copy of an allele is present.
- Z) A phenotype conferred when two copies of an allele are present.

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

Which of the following interactions is most responsible for the structural stability of soluble globular proteins?

- W) Dipole-dipole interactions.
- X) Electrostatic interactions.
- Y) Hydrogen bonds.
- Z) The Hydrophobic Effect.

**Bonus Answer: Z**

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**15. Physics**

**Toss Up: Short Answer**

Name all of the following that are NOT correct units for work: Joule, Newton\*meter, Watt, ft\*lb, Volt

**Toss Up Answer: Watt, Volt**

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**Bonus: Multiple Choice**

An 80-N crate slides with constant speed a distance of 5.0 m downward along a rough slope that makes an angle of 30 degrees with the horizontal. The work done by the force of gravity is:

- W) -400 J
- X) -200 J
- Y) 200 J
- Z) 400 J

**Bonus Answer: Y**

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**16. Earth and Space Science**

**Toss Up: Multiple Choice**

Given the following choices chose the one that best presents the layers of the earth's atmosphere from lowest to highest altitude.

- W) Thermosphere, Mesosphere, Stratosphere, Troposphere
- X) Mesosphere, Thermosphere, Stratosphere, Troposphere
- Y) Troposphere, Stratosphere, Mesosphere, Thermosphere
- Z) Stratosphere, Troposphere, Thermosphere, Mesosphere

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

There are various different particle sizes when dealing with sediments. What is the approximate particle size range of sand?

- W) 2 - 4 mm
- X) 1/16 - 2 mm
- Y) 1/256 - 1/16 mm
- Z) 4 - 64 mm

Bonus Answer: X

## 17. Chemistry

Toss Up: Multiple Choice

Which of the one of the following salts is insoluble?

W)  $\text{NH}_4\text{Cl}$

X)  $\text{Ca}(\text{NO}_3)_2$

Y)  $\text{BaCO}_3$

Z)  $\text{Na}_2\text{S}$

Toss Up Answer: Y

Bonus: Short Answer

What is the empirical formula for glucose?

Bonus Answer:  $\text{CH}_2\text{O}$

## 18. Mathematics

Toss Up: Short Answer

What is the slope of the tangent line to  $e^{(2x)}$  at  $x=3$

Toss Up Answer:  $2e^6$

Bonus: Short Answer

What is the slope of the tangent line to  $\ln(2x)$  at  $x=3$

Bonus Answer:  $1/3$

## 19. Biology

Toss Up: Multiple Choice

Which of the following would lead to a DECREASE in activity of the Anterior Pituitary gland?

W) A lack of receptors for Cortisol on the Hypothalamus.

X) A lack of receptors for Cortisol on the Anterior Pituitary.

Y) Intravenous injection of a large amount of ACTH.

Z) A tumor of the Hypothalamus causing it to secrete excess Corticotropin- Releasing Hormone

Toss Up Answer: Y

Bonus: Multiple Choice

What would happen if the Adrenal Cortex was artificially stimulated to produce large amounts of Cortisol?

W) Less Corticotropin-Releasing Hormone would be released.

X) More ACTH would be released.

Y) The activity of the Hypothalamus would increase.

Z) The activity of the Anterior Pituitary would increase.

Bonus Answer: W

## 20. Chemistry

Toss Up: Short Answer

In organisms, the bonds in polypeptide chains are formed between which two ends of the amino acid?

**Toss Up Answer:** Carboxyl, amino OR the side with the NH<sub>2</sub> group, the side with the COOH group

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**Bonus: Short Answer**

Fatty acids have three carbon chains attached to what type of molecule?

**Bonus Answer:** glycerol

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## 21. Mathematics

**Toss Up: Multiple Choice**

$3^{12} = 27^x$ . What is the value of x?

W)  $x = 12$

X)  $x = 4$

Y)  $x = 6$

Z)  $x = 3$

**Toss Up Answer:** X

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**Bonus: Short Answer**

$3^{12} + 3^{11} + 3^{10} = b \cdot 3^a$  What is the positive difference between the product and the sum of a and b?

**Bonus Answer:** 107

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## 22. Chemistry

**Toss Up: Multiple Choice**

What suggests that metal, M, is not in Group I of the Periodic Table?

W) M has a bright, silvery appearance and is a good conductor of electricity.

X) M is hard and difficult to cut

Y) M produces an alkaline solution when it reacts with water.

Z) M produces hydrogen gas when it reacts with water.

**Toss Up Answer:** X

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**Bonus: Multiple Choice**

Lactic acid, CH<sub>3</sub>CH(OH)CO<sub>2</sub>H, causes pain when it builds up in muscles.

Which reagent reacts with both of the –OH groups in lactic acid?

W) acidified potassium dichromate(VI)

X) ethanol

Y) sodium

Z) sodium hydroxide

**Bonus Answer:** Y

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## 23. Earth and Space Science

**Toss Up: Multiple Choice**

Glaciers effect the land through glacial erosion. Different geographies are formed but what is the specific name of the long narrow ridges that show where the glacier was once present?

W) Glacial retreat

X) Drumlins

Y) Glacial errotics

Z) Morianes

Toss Up Answer: Z

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Bonus: Short Answer

Ice sheets and glaciers expanded to cover large areas of land during the last major glacial epoch. During which time period did this take place?

Bonus Answer: Quaternary

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## 24. Mathematics

Toss Up: Short Answer

On which point does  $y = 10x + 8$  and  $y = x + 5$  intersect?

Toss Up Answer:  $(-1/3, 14/3)$

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Bonus: Short Answer

How many distinct roots does the cubic equation  $y = x^3 - 4x^2 + 4x$  have?

Bonus Answer: It has 2 roots.

(Explanation: It intersects the x-axis twice, once at  $x = 0$  and once at  $x = 2$ .)

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