

Round 4

1. PHYSICS

Toss Up: Short Answer

If the acceleration is always perpendicular to an object's velocity, what can be deduced about the object's motion?

Bonus Answer: It is circular motion.

Bonus: Short Answer

If the acceleration of an object is opposite its velocity, what can be said about the object's velocity over time? Assume that the direction of the velocity is positive.

Bonus Answer: It is decreasing.

2. PHYSICS

Toss Up: Short Answer

A car with a mass of one ton collides with a truck with a mass of ten tons. Which applies the greatest force on the other, in Newtons?

Bonus Answer: They both apply an equal force.

Bonus: Short Answer

Which experiences greater acceleration in the collision from a car with a mass of one ton colliding with a truck with a mass of ten tons, and by how many times greater.

Bonus Answer: The car, it will accelerate ten times as much.

3. PHYSICS

Toss Up: Short Answer

A car accelerates from rest at 4 (m/s)^2 . What is the distance traveled by the car in 3 seconds?

Bonus Answer: 18 meters (m)

Bonus: Multiple Choice

A motor scooter travels east at a speed of 13 m/s. The driver then reverses direction and heads west at 17 m/s. What was the change in velocity of the scooter?

W) 13 m/s

X) 17 m/s

Y) 30 m/s

Z) 4 m/s

Bonus Answer: Y

4. PHYSICS

Toss Up: Short Answer

If a rocket has a specific impulse of 800 seconds, what is its exhaust velocity, in m/s? Assume standard gravity to be 10 m/s^2 .

Bonus Answer: Answer: 8000 m/s (also acceptable: 8 km/s). Exhaust velocity is the product of specific impulse as a unit of time and standard gravity.

Bonus: Short Answer

If an engine has a specific impulse of 500 seconds and a thrust of 10 kN, how long will it take the engine to burn 50 kg of fuel? Assume standard gravity to be 10 m/s^2 .

Bonus Answer: Answer: 25 seconds.

Since $F_{\text{thrust}} = G_{\text{standard}} \times I_{\text{sp}} \times R$, where

F_{thrust} = instantaneous thrust of the engine (in newtons)

Gstandard = standard gravity (usually 9.81 m/s^2 , but for simplicity we round to 10)

Isp = specific impulse of the engine in seconds

R = mass flow rate in kg/s

$10000 = 10 \times 500 \times R$, so $R = 2 \text{ kg/s}$

$50 \text{ kg} / 2 \text{ kg/s} = 25 \text{ s}$

5. PHYSICS

Toss Up: Short Answer

A military cannon fires a boy into the air at an angle of 45° above the horizontal, reaching a max height y above his original launch height. The cannon is now aimed so that it fires straight up into the air at an angle of 90° to the horizontal. What is the maximum height reached by the same boy now? (let y represent height)

Bonus Answer: $2y$

Bonus: Short Answer

a

Bonus Answer: a

6. MATHEMATICS

Toss Up: Multiple Choice

The sum $(1+3+3^2+\dots+3^n)$ is equal to which of the following?

W) $2 \cdot 3^n$

X) $4 \cdot 3^n$

Y) $(3^{(n+1)}+1)/2$

Z) $(3^{(n+1)}-1)/2$

Toss Up Answer: Z

Bonus: Short Answer

In space, what is the graph of the equation $x^2 = y$?

Bonus Answer: A parabolic cylinder

7. MATHEMATICS

Toss Up: Short Answer

What is the solution for square root of the quantity $x+5$ equals $x+3$

Bonus Answer: -1 *(do not except: [-1 and -4] or [-3])

Bonus: Short Answer

In a certain language of a certain people of a certain world, to frack a number is to find the average of the number and its square. For example, the frack of 2 is 3 since it is the average of 2 and 2 squared. what is the frack of 100?

Bonus Answer: 2020

8. MATHEMATICS

Toss Up: Multiple Choice

Which of the following is true?

W) -1 is congruent to 1 modulo 5

X) -1 is congruent to 2 modulo 5

Y) -1 is congruent to 3 modulo 5

Z) -1 is congruent to 4 modulo 5

Toss Up Answer: Z

Bonus: Short Answer

Which is larger, 8^{10} or 3^{30}

Bonus Answer: 3^{30}

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9. MATHEMATICS

Toss Up: Short Answer

What is the slope of a line parallel to $45x=9y+5$?

Bonus Answer: 5

Bonus: Multiple Choice

How many vertical asymptotes does $f(x)=(x^2+2x+1)/(x^3-x)$ have?

W) 0

X) 1

Y) 2

Z) 3

Bonus Answer: Y

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10. BIOLOGY

Toss Up: Short Answer

What are the 5 senses?

Bonus Answer: Taste smell sight hearing touch

Bonus: Short Answer

What is an important component to "taste"?

Bonus Answer: Smell!

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11. BIOLOGY

Toss Up: Short Answer

What is the powerhouse of the cell?

Bonus Answer: Mitochondria!!!

Bonus: Short Answer

What do you use to see?

Bonus Answer: Eyes

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12. BIOLOGY

Toss Up: Short Answer

What type of immune cell is involved in humoral immunity?

Bonus Answer: B cells

Bonus: Short Answer

What is the most common type of immunoglobulin?

Bonus Answer: Immunoglobulin G

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13. BIOLOGY

Toss Up: Multiple Choice

Which of the following hormones does not promote, directly or indirectly, spermatogenesis?

W) prostaglandins

- X) luteinizing hormone
- Y) follicle stimulating hormone
- Z) gonadotropin releasing hormone

Toss Up Answer: W

Bonus: Multiple Choice

Which hormone is synthesized in the hypothalamus and released via the anterior pituitary gland?

- W) prolactin
- X) thyroid-stimulating hormone
- Y) adrenocorticotrophic hormone
- Z) oxytocin

Bonus Answer: Z

14. BIOLOGY

Toss Up: Multiple Choice

Which of the following statements concerning photosynthetic light reactions is false?

- W) Photosystem I contains the P700 reaction center.
- X) The electron transport chain following photosystem I drives chemiosmosis.
- Y) NADPH is the final electron acceptor.
- Z) Electrons are replenished in photosystem II by the splitting of water.

Toss Up Answer: X

Bonus: Multiple Choice

Which of the following molecules is not present in the electron transport chain immediately following photosystem II?

- W) cytochrome complex
- X) plastoquinone
- Y) ferredoxin
- Z) plastocyanin

Bonus Answer: Y

15. BIOLOGY

Toss Up: Multiple Choice

Which of the following is a storage protein?

- W) aquaporin
- X) actin
- Y) ovalbumin
- Z) AP2

Toss Up Answer: Y

Bonus: Short Answer

Which of the following amino acids has a sulfhydryl group in its side chain?

Bonus Answer: cysteine

16. BIOLOGY

Toss Up: Multiple Choice

Introns are hydrolyzed and removed from pre-mRNA by

- W) exons
- X) spliceosomes
- Y) small nuclear ribonucleoproteins
- Z) nucleotide-pair substitution

Toss Up Answer: X

Bonus: Short Answer

Okazaki fragments on the lagging strand of DNA are joined by which protein?

Bonus Answer: DNA ligase (ACCEPT: ligase)

17. CHEMISTRY

Toss Up: Multiple Choice

Which of the following is a nonpolar molecule?

- W) Carbon dioxide
- X) Water
- Y) Ammonia
- Z) Hydrochloric acid

Toss Up Answer: W

Bonus: Short Answer

Which of the following forms of radioactive decay has (or have) no electrical charges? 1) Alpha Decay 2) Beta Decay 3) Gamma Decay

Bonus Answer: 3 only

18. CHEMISTRY

Toss Up: Multiple Choice

Which would be the easiest way to burn an iron nail?

- W) Hold an iron nail with crucible tongs, and heat strongly in the flame of a bunsen burner.
- X) Use the above method with an oxyacetylene torch to reach highest temperatures.
- Y) Grind the nail into very small, dust-sized particles and spray them into a flame.
- Z) Dissolve the nail in acid to make the oxide.

Toss Up Answer: Y

Bonus: Multiple Choice

What is a reasonable and safe substitute for zinc in reduction reactions in aqueous solutions?

- W) S
- X) F₂
- Y) K
- Z) Cd

Bonus Answer: Z

19. CHEMISTRY

Toss Up: Short Answer

An ideal gas in a closed inflexible container has a pressure of 6 atmospheres and a temperature of 27°C. What will be the new pressure of the gas if the temperature is decreased to -73°C?

Bonus Answer: 4 atmospheres

Bonus: Multiple Choice

When CO₂ is bubbled through distilled water at 25°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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20. CHEMISTRY

Toss Up: Multiple Choice

Which of the following is not commonly produced by eletrolysis?

- W) NaOCl
- X) Al
- Y) Fe
- Z) NaOH

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following pairs of constants are not mathematically related to eachother?

- W) Equilibrium constant and Gibbs Free Energy
- X) Rate Constant and Activation Energy
- Y) Standard Cell Voltage and Equilibrium Constant
- Z) Standard Cell Voltage and Rate Constant

Bonus Answer: Z

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21. CHEMISTRY

Toss Up: Multiple Choice

What kind of process is the loss of electrons?

- W) electrolysis
- X) thermodynamically favored
- Y) reduction
- Z) oxidation

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following metals does not react with water to produce hydrogen?

- W) Zn
- X) Li
- Y) Ca
- Z) Na

Bonus Answer: W

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22. CHEMISTRY

Toss Up: Short Answer

In 12.4 hours, a 100 gram sample of an element decays so that its mass is 25 grams. What is the approximate half-life of this radioactive substance?

Bonus Answer: 6.2 hours

Bonus: Multiple Choice

Which of the following will raise the boiling point of a sample of water?

- W) Heat the water
- X) Mix gasoline into the water
- Y) Bring the water to a higher altitude
- Z) Dissolve table sugar in the water

Bonus Answer: Z

23. EARTH and SPACE

Toss Up: Short Answer

What is the average temperature of the universe today to the nearest Kelvin?

Bonus Answer: 3K

Bonus: Short Answer

What is the most common star in the Milky Way Galaxy?

Bonus Answer: Red Dwarf

24. EARTH and SPACE

Toss Up: Multiple Choice

Which of the following statements is FALSE regarding the volcano in each statement?

- W) Shield volcanoes can stretch up to 3 or 4 miles in diameter
- X) Cinder cone volcanoes rarely rise past 1,000 feet in elevation
- Y) Stratovolcanoes are some of the smallest volcanoes in the world
- Z) Volcanic domes commonly occur within the craters or on the flanks of large composite volcanoes

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following statements is true regarding stratovolcanoes?

- W) Most commonly occur at subduction zones
- X) They produce basaltic magma
- Y) Their eruptions are infrequent
- Z) They are never dormant

Bonus Answer: W

25. EARTH and SPACE

Toss Up: Short Answer

In terms of mass, what are the four biggest planets in our solar system?

Bonus Answer: Jupiter, Saturn, Neptune, Uranus

Bonus: Multiple Choice

Dark energy makes up about how much of the energy in the universe?

- W) 20%
- X) 40%
- Y) 70%
- Z) 80%

Bonus Answer: Y

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