Round 23

1. MATHEMATICS

Writer: Hanna Yang

Toss Up: Short Answer

Factor (mn)^2 - p^2.

Bonus Answer: (mn - p)(mn + p)

Difference of Squares

Bonus: Short Answer

Factor a^4 + 4b^4.

Bonus Answer: (a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)

Solution:

a^4 + 4b^4 = a^4 + 4a^2b^2 + 4b^4 - 4a^2b^2

(a^2+2b^2)^2 - (2ab)^2 = (a^2 + 2b^2 + 2ab)(a^2 + 2b^2 - 2ab)

Difference of Squares

(This is also the Sophie Germain Identity)

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2. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the common oxidation state of Radium?

Bonus Answer: +2 (don't accept 2)

Bonus: Short Answer

List the following atoms in order of increasing electron affinity: oxygen, boron, and fluorine.

Bonus Answer: (1) BORON, (2) OXYGEN, (3) FLUORINE

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3. BIOLOGY

Writer: Matthew Lee

Toss Up: Multiple Choice

Which of the following types of antibodies is typically used to fight parasitic infections?

W) IgE

X) IgM

Y) IgG

Z) IgA

Toss Up Answer: W

Bonus: Short Answer

The immune response can include complement protein cascades, which form pores in the membrane of the target cell. The cell then swells and lyses do to water and ions rushing in. The type of complex that forms the pore in the membrane is called?

Bonus Answer: membrane attack (accept: membrane attack complex)

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4. CHEMISTRY

Writer: Ivan Zhang

Toss Up: Multiple Choice

Which element breaks the octet rule?

W) Ga

X) Xe

Y) Cu

Z) F

Toss Up Answer: X

Bonus: Short Answer

What is the empirical formula of C6H11?

Bonus Answer: C6H11

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5. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

The trpR gene codes for

W) an inactive repressor

X) an active repressor

Y) catabolite activator protein

Z) a corepressor

Toss Up Answer: W

Bonus: Multiple Choice

Which of the following statements incorrectly characterizes a basic bacterial operon?

W) The gene loci of the operon are continuous.

X) The operator is a component of the promoter region.

Y) The operator does not code for a gene product.

Z) The regulatory gene is always adjacent to the promoter.

Bonus Answer: Z

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6. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Radiation from a mercury lamp source is of energy 2.845 eV. Calculate the wavelength of the radiation.

W) 579 nm

X) 355 nm

Y) 405 nm

Z) 436 nm

Toss Up Answer: Z

Bonus: Multiple Choice

The force constant of the bond in a hydrogen chloride, HCl, molecule is 516 N m-1. Calculate the vibrational potential energy of an HCl molecule with a bond that is extended from its equilibrium length by 0.11 Å.

W) 3.1 × 10^-20 J

X) 6.2 × 10^-20 J

Y) 1.5 × 10^-20 J

Z) 2.6 × 10^-20 J

Bonus Answer: W

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7. MATHEMATICS

Writer: Elias Milborn

Toss Up: Short Answer

What is the probability of, in no particular order, flipping exactly 2 heads and 2 tails when flipping 4 coins?

Bonus Answer: 3/8 (accept .375 or 37.5%)

Bonus: Short Answer

Given a circle centered at 1,2 what is the slope of a tangent line which passes through the point (3,3)

Bonus Answer: -2

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8. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

You have a multicellular organism that reproduces asexually by fission. When you excise a ~10,000 cell portion of its body, both the original organism and the excised portion grow into fully formed, healthy organisms. You take one of the offspring and repeat the procedure for one hundred and twenty-three generations. Each time, the resulting organisms are healthy. What must be true of the nuclei of this species?

W) The cells contain plasmids

X) The cells have multiple forms of DNA polymerase.

Y) The cells have the majority of their genome stored in circular DNA

Z) The cells contain active telomerase.

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following oligonucleotides would have the highest melting point when paired with the proper complementary strand?

W) 5'-AAAAAAAA-3'

X) 5'-ATGCATGC-3'

Y) 5'-CGCGCGCG-3'

Z) 5'-TTTTGGGG-3'

Bonus Answer: Y

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9. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

In the Christmas carol "The 12 Days of Christmas", the singer says that for every day of Christmas, their significant other gives them a quantity of a new gift equal to the current day of Christmas, plus the previous gifts given. For example, on the second day onward, the singer receives 2 turtledoves on each day until the end of Christmas. What is the greatest quantity of a single gift given during the 12 days?

W) 36

X) 40

Y) 42

Z) 48

Toss Up Answer: Y

Bonus: Short Answer

How many total gifts are given in the 12 days of Christmas?

Bonus Answer: 364

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10. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Which of the following is NOT a granulocyte?

W) eosinophil

X) dendritic cell

Y) neutrophil

Z) basophil

Toss Up Answer: X

Bonus: Short Answer

What is another name for granulocytes, based on their oddly shaped nuclei?

Bonus Answer: polymorphonuclear leukocytes

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11. MATHEMATICS

Writer: Jessica Titensky

Toss Up: Short Answer

How many seconds are in a day

Bonus Answer: 86400

Bonus: Multiple Choice

How many days are in a second

W) 1.16*10^-3

X) 1.16*10^-4

Y) 1.16*10^-5

Z) 1.16*10^-6

Bonus Answer: Y

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12. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A hose has a diameter of 2 inches and its nozzle is 0.2 inches in radius. If water flows at 4 m/s in the hose, then how fast will it leave the nozzle?

W) 4 m/s

X) 1 m/s

Y) 100 m/s

Z) 200 m/s

Toss Up Answer: Y

Bonus: Short Answer

To measure moderately low pressures, oil with a density of 8.5 × 10^2 kg/m^3 (READ AS: 8.5 times 10 to the -2 kilogram per cubic meter) is used in place of mercury in a barometer. If the height of the oil column changes by 1.0mm, find the change in the pressure, assuming g = 10 m/s.

Bonus Answer: 8.5 Pa

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13. BIOLOGY

Writer: Janine Goh

Toss Up: Short Answer

What determines the properties of an amino acid?

Bonus Answer: It's variable R group

Bonus: Short Answer

Which 2 of the 20 common amino acids can form disulfide bridges?

Bonus Answer: Methionine and Cysteine

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14. CHEMISTRY

Writer: Janine Goh

Toss Up: Multiple Choice

Who discovered electronegativity?

W) Linus Pauling

X) Ernest Rutherford

Y) Harold Urey

Z) Carl Bosch

Toss Up Answer: W

Bonus: Short Answer

List 2 gases used in the Miller-Urey experiment

Bonus Answer: Hydrogen, Water, Ammonia, Methane

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15. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What was the first object created by people that produces a sonic boom (albeit a very small one)?

W) Bullet

X) Bullwhip

Y) Slingshot

Z) Jet Plane

Toss Up Answer: X

Bonus: Multiple Choice

What kind of semiconductors are essentially all pure semiconductor material?

W) p-type

X) n-type

Y) intrinsic

Z) extrinsic

Bonus Answer: Y

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16. CHEMISTRY

Writer: Seiji Yawata

Toss Up: Multiple Choice

Which of the following compounds can not exist?

W) PF_5

X) P_4O_10

Y) P_4O_6

Z) PH_5

Toss Up Answer: Y

Bonus: Short Answer

Order the following hydrogen halides from the one with the lowest boiling point to one with the highest: HI, HCl, HBr, HF

Bonus Answer: HCl, HBr, HI, HF (2, 3, 1, 4)

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17. MATHEMATICS

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

Which of the following the derivative with the highest degree?

W) X^2 (x squared)

X) 20

Y) 104

Z) 3x

Toss Up Answer: W

Bonus: Short Answer

Find y' = dy/dx for x3 + y3 = 4 . (x cubed + y cubed)

Bonus Answer: -x^2/y^2 (negative x squared over y squared)

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18. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Choose the best choice below to fill in the blanks. When a system reaches equilibrium, the concentrations of the products and reactants are [blank] and the rate of the forward and reverse reactions are [blank].

W) constant, equal

X) equal, constant

Y) unequal, unconstant

Z) constant, unequal

Toss Up Answer: W

Bonus: Short Answer

Which of the following acids are polyprotic: nitrous acid, nitric acid, sulfurous acid, sulfuric acid and hypochlorous acid.

Bonus Answer: 3 and 4 (sulfurous acid and sulfuric acid)

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19. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

If the sound intensity is 10,000 times the threshold of hearing then what is the intensity in decibels?

Bonus Answer: 40dB

Bonus: Short Answer

At what standard frequency would 60 decibels have a loudness of 60 phons?

Bonus Answer: 1000Hz

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20. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

What is the probability of obtaining offspring with the AAbbCCdd genotype from parents with the genotypes AaBbCcDd and AABbCcDd (assume independent assortment of all gene pairs)?

W) 1/64

X) 1/128

Y) 3/128
Z) none of the above

Toss Up Answer: X

Bonus: Multiple Choice

A red pigment is extracted from a marine alga. Which best supports the hypothesis that the pigment is involved in photosynthesis? The red pigment:
W) has an absorption spectrum similar to the photosynthetic action spectrum for that same marine alga
X) contains iron which is a transition element similar to magnesium.
Y) has a molecular structure similar to that of chlorophyll.
Z) is also found in land plants together with a variety of other pigments and specific enzymes that are related to the action spectrum for photosynthesis.

Bonus Answer: W

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21. ENERGY

Writer: Olivia Gallager

Toss Up: Short Answer

Which of the following, by name or number, are not considered to be a greenhouse gas: Nitrous Oxide, Water Vapor, Methane, and Nitrogen gas.

Bonus Answer: Nitrogen Gas, 4

Bonus: Short Answer

What are the two most used fuels for nuclear reactors?

Bonus Answer: Plutonium and Uranium

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22. MATHEMATICS

Writer: Elias Milborn

Toss Up: Multiple Choice

Which of the following is an accurate representation of the inverse of f(x) = x^3 - 5?
W) x^3 - 5
X) (x - 5)^3
Y) (x - 5)^(1/3)
Z) 1/(x-5)^3

Toss Up Answer: Y

Bonus: Short Answer

The three sides of a triangle are 5cm, 6cm, and 8cm. What is the cosine of the smallest angle in reduced fractional form?

Bonus Answer: 25/32

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23. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Suppose all the resistors in the world were only 10,000 Ohm resistors. What is the minimum number of resistors needed to make an equivalent resistance of 600 Ohms.
W) 8
X) 6
Y) 4

Z) 3

Toss Up Answer: Y

Bonus: Short Answer

Two wires of the same material and equal length are joined in parallel. If one of them has half the thickness of the other, and the thinner wire has a resistance of 8 Ohms, what is the resistance of the parallel combination?

Bonus Answer: 1.6 Ohms

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24. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

Who discovered radioactivity in 1896?

W) Wilhelm Rontgen

X) Henri Becquerel

Y) Marie Curie

Z) Albert Einstein

Toss Up Answer: X

Bonus: Multiple Choice

What is made by joining an N-type and P-type semiconductor material?

W) Transistor

X) Diode

Y) Capacitor

Z) Collector

Bonus Answer: X

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25. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

What is the thrust of a rocket ejecting fuel at 200 kg/s and with an exhaust velocity of 1500 m/s?

W) 30000 newtons

X) 60000 newtons

Y) 90000 newtons

Z) 300000 newtons

Toss Up Answer: Z

Bonus: Multiple Choice

A solid disk with a rotational inertia of 5 kg*m^2 (READ AS: kilogram meters squared) and a radius of 0.25 m rotates on a fixed axis perpendicular to the disk and through its center. If a force of 2 N is applied tangentially to the disk, what is the work done by the force after half of a revolution to the nearest tenth?

W) 0.4 J

X) 0.8 J

Y) 1.6 J

Z) 3.1 J

Bonus Answer: Y

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