Round 25

1. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

A heated 8 kg ring with a radius of 4m cools as it rotates, causing it to shrink to a radius of 2m. If it was initially rotating at 6 rad/s, what is it's final angular velocity?

Bonus Answer: 24 rad/s

Bonus: Short Answer

A 120-N child sits on a light swing and is pulled back and held with a horizontal force of 90 N. What is the magnitude of the tension force in each of the two supporting ropes?

Bonus Answer: 75 N

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2. MATHEMATICS

Writer: Benjamin Avrahami

Toss Up: Multiple Choice

What is the smallest positive 'taxicab' number?

W) 87

X) 91

Y) 95

Z) 100

Toss Up Answer: X

Bonus: Short Answer

To what power do you have to raise any number for it to be 0, 1, or -1 in mod 7?

Bonus Answer: 3

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3. CHEMISTRY

Writer: Andrew Chen (Senior)

Toss Up: Multiple Choice

Certain atoms exhibit paramagnetic or diamagnetic bonding. Of the following below which choice is classified as paramagnetic?

W) Zinc (Zn)

X) Krypton (Kr)

Y) Helium (He)

Z) Oxygen (O)

Toss Up Answer: Z

Bonus: Short Answer

Melting point is effected by bond strength. By name or number, order the following compounds in increasing order of melting point:

1. graphite
2. methane
3. lithium
4. sodium chloride

Bonus Answer: Methane, lithium, sodium chloride, graphite (2, 3 , 4, 1)

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4. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

For real numbers x and y on the closed interval from 0 to 1, let a=xy and b=(1-x)(1-y). Find the maximum value over all choices of x and y for the minimum of a and b.

W) 0

X) 1/4

Y) 1/2

Z) 1

Toss Up Answer: X

Bonus: Short Answer

One definition of the Cantor set is the set of all numbers x between 0 and 1 such that x has only the digits 0 and 2 in it's base 3 representation. Which of the following numbers is in the Cantor set.

I. 1/4

II. 1/2

III. 5/26

IV. 7/10

Bonus Answer: 4 only

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5. BIOLOGY

Writer: Calvin Vuong

Toss Up: Short Answer

Amino acids are attached to their respective tRNA molecules by which enzyme?

Bonus Answer: aminoacyl-tRNA synthetase

Bonus: Short Answer

Which high energy molecule is responsible for forming the peptide bonds during translation elongation?

Bonus Answer: GTP (ACCEPT: guanosine triphosphate)

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6. CHEMISTRY

Writer: Prangon Ghose

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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7. BIOLOGY

Writer: Mohammed Jamil

Toss Up: Multiple Choice

Which buffer system prevent large changes in pH in the blood during gas exchange

W) Hemoglobin

X) Phosphate

Y) Protein

Z) Bicarbonate

Toss Up Answer: Z

Bonus: Multiple Choice

How many ml of a 0.4 M HCl solution are required to bring the pH of 10 ml of a 0.4 M NaOH solution to 7.0 (neutral pH)?

W) 4

X) 40

Y) 10

Z) 20

Bonus Answer: Y

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8. CHEMISTRY

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following is the lightest element with no stable isotopes?

W) Tellurium

X) Technetium

Y) Promethium

Z) Radon

Toss Up Answer: X

Bonus: Multiple Choice

Which of the following is the strongest intermolecular force?

W) Hydrogen Bonding

X) Ionic Bonding

Y) London Dispersion Force

Z) Covalent Bonding

Bonus Answer: W

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9. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Acetone has a distinct smell, which many people associate with the smell of nail polish remover. What might the smell of acetone in the urine or on the breath of a patient indicate?

W) The patient might be degrading too many amino acids from muscle proteolysis.

X) The patient's body might be oxidizing too many fatty acids.

Y) The patient might have enteritis and is absorbing endproducts of fermentation.

Z) The patient might have fructose toxicity.

Toss Up Answer: X

Bonus: Multiple Choice

Which description best describes what would happen to the carbon cycle if all
detritivores suddenly went on “strike” and stopped working?

W) Carbon would increase in inorganic mass, while the atmospheric reservoir of carbon would continue to increase and plants would not be jeopardized.

X) Carbon would accumulate in organic mass, the atmospheric reservoir of carbon would decline, and plants would eventually be starved for CO_2 .

Y) Carbon would increase in organic mass, while the atmospheric reservoir of carbon would increase and plant-life would be starved for CO_2.

Z) Carbon would decrease in organic mass, while the atmospheric reservoir of carbon would increase with the result that plant-life would be starved for CO_2.

Bonus Answer: X

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10. MATHEMATICS

Writer: Benjamin Avrahami

Toss Up: Short Answer

In simplest form, express the surface area to volume ratio of a cube with side length s.

Bonus Answer: 6:s

Bonus: Short Answer

Calculate the harmonic mean of the first two perfect numbers and 10.

Bonus Answer: 4 * sqrt(105)

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11. BIOLOGY

Writer: Calvin Vuong

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) NADP+ is the final election 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

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12. ENERGY

Writer: Aaron Gee

Toss Up: Short Answer

Cadmium and boron are used in a nuclear reactor to absorb which
subatomic particle?

Bonus Answer: Neutron

Bonus: Short Answer

The electrical resistance of a semiconducting wire is least likely to be
reduced by a decrease in which of the following four wire characteristics?
Radius, Melting Point, Length, or Temperature?

Bonus Answer: Melting Point

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13. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

Polarity in the developing Drosophila embryo is determined by:
W) a protein gradient of the segmentation protein engrailed
X) a protein gradient of the bicoid protein expressed from maternal mRNA
Y) a protein gradient of the gap protein hunchback
Z) expression of the segmentation protein engrailed throughout the embryo

Toss Up Answer: X

Bonus: Multiple Choice

When a four-cell Xenopus embryo is divided into ventral and dorsal halves,
the half containing the Nieuwkoop center will develop:
W) ventralized features
X) dorsalized features
Y) as a normal embryo
Z) only to the 8-cell stage

Bonus Answer: X

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14. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A cube with 2-m sides and a bulk modulus of 4*10^5 N/m^2 (READ 4 times 10 to the sixth newton meters squared). When it's subjected to a pressure of 2*10^5 Pa, what is the resulting volume of the cube?
W) 0.5m^3
X) 2m^3
Y) 3m^3
Z) 4m^3

Toss Up Answer: Z

Bonus: Multiple Choice

A 4.0-m long steel beam with a cross-sectional area of 1.0 × 10^−2 m^2 and a Young's modulus of 2.0 × 10^11 N/m^2 is wedged horizontally between two vertical walls. In order to wedge the beam, it is compressed by 0.020mm. If the coefficient of static friction between the beam and the walls is 0.70, what is the maximum mass (including its own) it can bear without slipping?
W) 700kg
X) 710kg
Y) 900kg
Z) 910kg

Bonus Answer: X

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15. BIOLOGY

Writer: Calvin Vuong

Toss Up: Multiple Choice

Where do the microtubules of the spindle originate during mitosis in both plant and animal cells?

W) centromere

X) centrosome

Y) centriole

Z) kinetochore

Toss Up Answer: Y

Bonus: Multiple Choice

If cells in the process of dividing are subjected to colchicine, at which stage will mitosis be arrested?

W) anaphase

X) prophase

Y) metaphase

Z) interphase

Bonus Answer: Y

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16. ENERGY

Writer: Elias Milborn

Toss Up: Multiple Choice

Which of the following is measured by total harmonic distortion, a standard for gauging the quality of power provided to customers?

W) How distorted the waveform is from a pure sinusoidal waveform

X) How distorted the waveform is from a triangular waveform

Y) The difference between a sinusoidal waveform and a triangular waveform

Z) the maximum value of a sinusoidal wave form with respect to the reference point of the waveform

Toss Up Answer: W

Bonus: Multiple Choice

Which of the following is NOT an accurate representation of a limitation on the production and use of bioplastics?

W) using crops for plastic diverts plants from the food supply

X) bioplastics are unlikely to disintegrate in a landfill

Y) bioplastics produce a variety of pollutants when burned

Z) Individuals at home would find it more difficult to compost bioplastics

Bonus Answer: Y

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17. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Short Answer

How many sigma and pi bonds does 1,3 butadiene have, respectively?

Bonus Answer: 9 sigma, 2 pi

Bonus: Short Answer

S orbital overlap has what shape?

Bonus Answer: spherical, sphere

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18. PHYSICS

Writer: Jessica Titensky

Toss Up: Multiple Choice

Which has the same units as joules?

W) Newton / meter

X) Pascal * meter^2

Y) Coulomb * volt

Z) Kilogram * meter / second^2

Toss Up Answer: Y

Bonus: Short Answer

What is the derived unit for Newton / meter^2?

Bonus Answer: Pascal

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19. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Multiple Choice

Which of the following is a strong nucleophile?

W) ethanol

X) butanol

Y) Bromide

Z) t-butoxide

Toss Up Answer: Y

Bonus: Multiple Choice

What causes Coordination compounds to be different colors

W) ∆E

X) s orbital overlap

Y) VESPR

Z) p orbital overlap

Bonus Answer: W

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20. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

Which of the 6 quarks is the lightest?

Bonus Answer: Up

Bonus: Multiple Choice

What is the "formal" SI unit of elementary particle spin?

W) joule-second

X) spin-h (planck constant)

Y) joule-plancktime

Z) spinor-second

Bonus Answer: W

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21. BIOLOGY

Writer: Josh Tish

Toss Up: Multiple Choice

In plant cells grown in the presence of a metabolic poison that
specifically inhibits mitochondrial F1 ATP synthase, one would expect:
W) the pH difference across the cristae to be greater than normal.
X) the pH difference across the cristae to be less than normal.
Y) the electron transport chain to become inoperative.
Z) oxygen consumption to cease.

Toss Up Answer: W

Bonus: Short Answer

With proofreading, what is approximately the error rate of DNA
polymerase?

Bonus Answer: One error in every 10^9 bases.

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22. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What quantity of a magnet determines the torque it will experience in an external magnetic field?
W) Multipole Expansion
X) Dipole Inversion
Y) Magnetic Moment
Z) Hysteresis Loop

Toss Up Answer: Y

Bonus: Multiple Choice

What Dutch physicist, living from 1626-1695, pioneered the use of the pendulum in clocks?
W) Willems Gravesande
X) Hans Christian Oersted
Y) Nicolas Hartsoeker
Z) Christiaan Huygens

Bonus Answer: Z

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23. CHEMISTRY

Writer: Siam Muquit

Toss Up: Short Answer

By name or number, which of the following is associated with inversion of stereochemistry?
1. Sn1
2. Sn2
3. E1
4. E2

Bonus Answer: Sn2 only (2 only)

Bonus: Short Answer

Which rule states that in E1 and E2 reactions, the more substituted double bond is more likely to occur?

Bonus Answer: Saytzeff rule

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24. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A wave's equation is given as y = 0.1 sin(3x+10t) (READ AS: y equals 0.1 times sine of open parentheses 3x plus 10t close parentheses). What is the angular wave number?

W) 0.3

X) 1

Y) 10

Z) 3

Toss Up Answer: Z

Bonus: Short Answer

An EM wave has a magnetic field with an amplitude of 200 Teslas. What is the amplitude of the wave's electric field in N/c (READ AS: newtons per coulomb)?

Bonus Answer: 6 * 10^10 N/c

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25. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

An object is dropped from an altitude of one Earth radius above Earth’s surface. In terms of M, the mass of Earth, and R, Earth's radius, what is the speed of the object just before it hits Earth?

Bonus Answer: sqrt(GM/R) (READ AS: square root of GM over R)

Bonus: Short Answer

Two particles, each of mass m, are a distance d apart. If an external force brings a third particle, with mass 2m, from far away to a resting point midway between the two particles, what is the work done by this force?

Bonus Answer: −8Gm^2/d^2

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