Round 24

1. MATHEMATICS

Writer: Aaron Gee

Toss Up: Multiple Choice

If an arc of 60° on circle 1 has the same length as an arc of 45° on
circle 2, what is the ratio of the area of circle 1 to the area of circle 2?

W) 9:16

X) 9:15

Y) 4:3

Z) 2:5

Toss Up Answer: W

Bonus: Short Answer

What is the reciprocal of the complex number 2 + i?

Bonus Answer: (2/5) – (1/5)i

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2. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the empirical formula of glucose?

Bonus Answer: CH2O

Bonus: Short Answer

What is the shape of an Acetylene (C2H2) molecule?

Bonus Answer: Linear

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3. MATHEMATICS

Writer: Andrew Chen (Senior)

Toss Up: Short Answer

A square is inscribed within a circle with a radius of 2.5 cm. To the nearest tenths place what is the area of the square?

Bonus Answer: 12.5 cm^2

Bonus: Multiple Choice

Given the parabola y=4x^2+2x-10 what is the equation of the line tangent to it at the point (0,-10)?

W) y=2x+10

X) y=2x-5

Y) y=5x-8

Z) y=2x-10

Bonus Answer: Z

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4. CHEMISTRY

Writer: Prangon Ghose

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

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5. BIOLOGY

Writer: Olivia Gallager

Toss Up: Short Answer

Out of the following, by name or number, which are considered gram positive: Influenza, Bacillus Anthracis, Escherischia Coli, and Bordetella Pertussis

Bonus Answer: 2, Bacillus Anthracis

Bonus: Short Answer

What is the main immunoglobulin found in mucous secretions?

Bonus Answer: igA, immunoglobulin A

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6. MATHEMATICS

Writer: Justin Lam

Toss Up: Short Answer

What is the volume of a sphere if the radius is 7 inches? (use 22 / 7 for pi) You may either use fractions or decimals rounded to the nearest hundredth as your answer.

Bonus Answer: V = 4312 / 3 cubic inches

or V = 1437. 33 cubic inches

(they must include the correct units)

Bonus: Short Answer

Find the surface area of a rectangular prism if the length is 2 inches, the width is 3 inches, and the height is 2 inches.

Bonus Answer: V = 32 square inches

(they must include the correct units)

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7. CHEMISTRY

Writer: Hanna Yang

Toss Up: Short Answer

What characteristic of water causes its temperature to change slowly in response to the environment?

Bonus Answer: High Specific Heat

Bonus: Short Answer

What is the most abundant molecule in the human body?

Bonus Answer: Water

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8. MATHEMATICS

Writer: Hussain Waris

Toss Up: Multiple Choice

A set is countable:
W) If and only if it is finite.
X) If and only if a surjection can be made between the set ant he natural numbers.
Y) If it has the same cardinality as some subset of the natural numbers.
Z) If it has the same cardinality as some subset of the real numbers.
Toss Up Answer: Y

Bonus: Short Answer
Who was the famous German mathematician that invented Set Theory and effectively proved the unaccountableness of the reals?
Bonus Answer: Georg Cantor (accept Cantor)

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9. PHYSICS

Writer: Shantanu Jha
Toss Up: Short Answer
In planetary motion the line from the star to the planet sweeps out equal areas in equal times. This is a direct consequence of which law?
Bonus Answer: law of conservation of angular momentum (DO NOT ACCEPT: Kepler's Second Law)

Bonus: Multiple Choice
In modern theoretical physics, what effect plays an important role in the chiral bag model of the nucleon?
W) Anderson
X) Sabinsky
Y) Lamoreaux
Z) Casimir

Bonus Answer: Z

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10. CHEMISTRY

Writer: Siam Muquit
Toss Up: Multiple Choice
Which of the following is an example of a strong nucleophile but a weak base?
W) CH3OH
X) OH-
Y) I-
Z) F-
Toss Up Answer: Y

Bonus: Short Answer
By name or number, which of the following are second order reactions?
1. Sn1
2. Sn2
3. E1
4. E2
Bonus Answer: Sn2 and E2 only (accept 2, 4 only)

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11. ENERGY

Writer: George Papastefanou
Toss Up: Multiple Choice
Which material takes the least energy and C02 to produce?

W) Wood
X) Aluminum
Y) Glass
Z) HDPE (High Density Polyethylene Plastic)
Toss Up Answer: W

Bonus: Short Answer
What electrophysical process is behind wireless charging?
Bonus Answer: Induction

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12. BIOLOGY

Writer: Josh Tish
Toss Up: Multiple Choice
If a gene is fixed in a population:
W) the gene cannot undergo mutation
X) one allele exhibits complete dominance over the other allele of that gene
Y) only one allele appears for that gene in the population
Z) the gene is incapable of recombination

Toss Up Answer: Y

Bonus: Multiple Choice
The Species-Area Relationship suggests that 10% of a given area supports:
W) 90% of species
X) 70% of species
Y) 50% of species
Z) 30% of species

Bonus Answer: Y

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13. ENERGY

Writer: Aaron Gee
Toss Up: Short Answer
What is the most common sulfur compound that occurs naturally in
natural gas?
Bonus Answer: HYDROGEN SULFIDE

Bonus: Short Answer
Earth's core is kept hot by the radioactive decay of several radioactive substances, including Uranium-235 and 238; name the other two heat-producing isotopes which are also significant contributors to the radioactive heat production of the Earth.
Bonus Answer: POTASSIUM-40 AND THORIUM-232 (Question is very hard?)

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14. BIOLOGY

Writer: Matthew Lee
Toss Up: Multiple Choice
Which one of the following is hexaploid?
W) apple
X) wheat
Y) strawberry

Z) banana

Toss Up Answer: X

Bonus: Short Answer

What is the only animal known to reproduce asexually?

Bonus Answer: Bdelloid rotifer

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15. PHYSICS

Writer: Aaron Gee

Toss Up: Short Answer

A 10 volt battery connected to a capacitor delivers a charge of 0.5 coulombs. The capacitance of the capacitor is

Bonus Answer: 5 times 10^(-2) Farads

Bonus: Short Answer

To convert a galvanometer to a voltmeter, you should add what to a series?

Bonus Answer: high resistance

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16. BIOLOGY

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following cells come from megakaryocytes?

W) Erythrocytes

X) Leukocytes

Y) Blood Thrombocytes

Z) Osteocytes

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following diseases is caused by a point mutation?

W) Huntington's Disease

X) Hemophilia B

Y) Cystic Fibrosis

Z) Tay-Sachs Disease

Bonus Answer: X

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17. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Multiple Choice

cis 1,2 chloro-ethene and trans 1,2 chloro-ethene differ in which of the following?

W) electron geometry

X) enthalpy

Y) entropy

Z) boiling point

Toss Up Answer: Z

Bonus: Short Answer

In an acid/base reaction, which (acid or base) is the electrophile?

Bonus Answer: acid

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18. BIOLOGY

Writer: Aaron Gee

Toss Up: Multiple Choice

Which of the following most closely approximates the number of protein-coding genes in the human genome?

W) 10,000

X) 20,000

Y) 50,000

Z) 100,000

Toss Up Answer: X

Bonus: Short Answer

Arrange the following to depict the conduction pathway in the vertebrate heart: 1) atrioventricular node, 2) right and left bundle branches, 3) sinoatrial node, 4) Bundle of His, 5) Purkinje fibers.

Bonus Answer: 3) SINOATRIAL NODE
1) ATRIOVENTRICULAR NODE
4) BUNDLE OF HIS
2)RIGHT AND LEFT BUNDLE BRANCHES
5) PURKINJE FIBERS

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19. PHYSICS

Writer: Mohammed Jamil

Toss Up: Short Answer

Given that the specific heat capacity of water is 11 times that of copper, calculate the mass of copper at a temperature of 100 °C required to raise the temperature of 200 g of water from 20.0 °C to 24.0 °C, assuming no energy is lost to the surroundings.

Bonus Answer: 0.116 kg

Bonus: Short Answer

1 kg of water at a temperature of 45 °C is mixed with 1.5 kg of alcohol at 20 °C. Find the final temperature of the mixture.

Take the specific heat capacity of water to be 4200 J kg –1 K –1 and the specific heat capacity of alcohol to be 2400 J kg –1 K –1 . Assume no other exchange of heat occurs.

Bonus Answer: 33°C

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20. CHEMISTRY

Writer: Olivia Gallager

Toss Up: Multiple Choice

Which of the following describes the reaction that involves a hydrocarbon chain and H2 gas yielding two shorter hydrocarbon chains?

W) Synthesis

X) Cracking

Y) Hydrocracking

Z) Substitution

Toss Up Answer: Y

Bonus: Short Answer

What electron geometry does ammonia(NH3) have?

Bonus Answer: tetrahedral, tetrahedron also accepted

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21. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

The circuit breaker in a typical household light circuit is rated for how many amps?

W) 2

X) 20

Y) 200

Z) 2000

Toss Up Answer: X

Bonus: Short Answer

Most power lines carry high voltages. Before the electricity is fed into your home, it must be put through what device that lowers the voltage to 110 volts?

Bonus Answer: Transformer

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22. CHEMISTRY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The H–C–O bond angle in H2C=O (formaldehyde) is approximately:

W) 90

X) 109

Y) 120

Z) 180

Toss Up Answer: Y

Bonus: Short Answer

In which compound does carbon have the highest oxidation state?

1. CH4
2. HCN
3. H2CO
4. CH2Cl2

Bonus Answer: 2. HCN

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23. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

Diffraction plays an important role in which of the following phenomena?

W) The sun appearing as a disk to the naked eye

X) Light being bent through a glass prism

Y) Shouting through a megaphone

Z) A thin soap film displaying colors when light is incident on it

Toss Up Answer: Y

Bonus: Multiple Choice

A beam of light passes though one polarizing filter and through another filter rotated at 45 degrees compared to the

first one. If the original intensity of the light was 100 W, what is the new intensity of the polarized light?
W) 50
X) 75
Y) 100
Z) 150

Bonus Answer: W

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24. PHYSICS

Writer: George Papastefanou

Toss Up: Multiple Choice

What is the fundamental frequency, in Hz, for a string with a Tension of 250 N, a mass per length of .25 grams per meter, and a length of 50 cm?
W) 1200
X) 5000
Y) 1000
Z) 250

Toss Up Answer: Y

Bonus: Short Answer

Will a projectile fired at a 30 degree angle at 55 m/s clear a 25-meter fence located 50 meters away?

Bonus Answer: No (height at that point is ~23.5 m)

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25. PHYSICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

You decide to set off on a voyage to another star. To stop your muscles from atrophying, you want to generate artificial gravity by having your ship constantly accelerate at 1 g from your reference frame. Ignoring fuel requirements, is there a problem with generating artificial gravity this way over very long time frames?
W) Yes, this setup would not work to generate artificial gravity
X) Yes, 1 g isn't enough to prevent your muscles from atrophying
Y) No, this can be used indefinitely to generate artificial gravity
Z) Yes, eventually the ship would need to go faster than the speed of light, which is impossible

Toss Up Answer: Y

Bonus: Short Answer

A box of mass 3 kg is placed on the edge of a merry-go-round of radius 4 m. The coefficient of static friction between the box and the merry-go-round is 0.4. What is the square of the merry-go-round's speed at the moment the box slides off?

Bonus Answer: 12 (m/s)^2

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