Round 1

1. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A body at rest in a system is capable of doing work if:
W) the potential energy of the system is positive
X) it is free to move in such a way as to decrease the potential energy of the system
Y) it is free to move in such a way as to increase the potential energy of the system
Z) it is free to move in such a way as to decrease its kinetic energy

Toss Up Answer: X

Bonus: Short Answer

If the force of a non-linear spring is defined as F(x) = 3x^2+2x+5, what is the work done on the spring if it's stretched to 3 meters from equilibrium?

Bonus Answer: 51 J

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2. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

It is known that 28 g of a certain ideal gas occupy 22.4 liters at standard conditions. The volume occupied by 42 g of this gas at standard conditions is:

Bonus Answer: 33.6 liters

Bonus: Multiple Choice

Use R = 8.2 × 10−5 m3 · atm/mol · K and NA = 6.02 × 10^23 mol−1. The approximate number of air molecules in a 1m3 volume at 300K and atmospheric pressure is:
W) 41
X) 450
Y) 2.5 × 10^25
Z) 5.4 × 10^26

Bonus Answer: Y

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3. PHYSICS

Writer: Joyce Lei

Toss Up: Short Answer

A parallel circuit has two resistors, one with a resistance of 4 ohms, and the other of 8 ohms. What is the equivalent resistance of the circuit? State the answer as a fraction.

Bonus Answer: 8/3 ohms

Bonus: Short Answer

What is the equivalent capacitance of a parallel circuit with capacitors of 8 micro-Farads, 12 micro-Farads, and 15 micro-Farads?

Bonus Answer: 35 micro-Farads

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4. PHYSICS

Writer: William Xiang

Toss Up: Short Answer

In a well-known physical experiment, two small masses were suspended by a thread, each positioned near two much larger stationary masses. A mirror was used to measure the angle through which the thread twists due to the rotation

of the small masses' movement. Which physicist conducted this experiment, and what constant did he/she derive from it?

Bonus Answer: Henry Cavendish (accept "Cavendish") and Universal gravitational constant (accept "big G", don't accept "gravity" or just "g")

Bonus: Short Answer

A skydiver leaps from a plane at a high altitude. Given acceleration due to gravity is equal to 10 meters per second squared and it takes 45 seconds for the skydiver to fall, calculate the height at which the skydiver fell from, rounded to the nearest thousand meters.

Bonus Answer: 20000 [Calculation: x = a * t^2 = (10 m/s^2)(45s)^2 = 20250m -> rounded to 20000]

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5. PHYSICS

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Sound waves can propagate through a plasma because of:

W) high coulomb interactions between particles

X) high density of particles

Y) high energy of particles

Z) high kinetic pressure force

Toss Up Answer: W

Bonus: Short Answer

Which description(s) of plasma is most often used to understand the macroscopic features of plasma: Single particle theory, kinetic theory, fluid description

Bonus Answer: Fluid description

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6. MATHEMATICS

Writer: Calvin Aw

Toss Up: Multiple Choice

If x+(1/x)=2, find x^128+(1/x)^128

W) 256

X) 128

Y) 64

Z) 2

Toss Up Answer: Z

Bonus: Short Answer

Given the quadratic x^2-20x+9 and its roots p and q, find (1/p)^2+(1/q)^2

Bonus Answer: 382/81

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7. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

In Triangle ABC the angle bisector of A intersects BC at D. Given AB=9, AC=21, and DB=15, compute DC.

Bonus Answer: 35

Bonus: Short Answer

In triangle ABC, AB=14, AC=13, and BC=15. Let the incenter be I. Compute CI in simplest radical form.

Bonus Answer: square root of 65

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8. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the value of the quantity ((sin^4)x) + 2(cos^2)x(sin^2)x + (cos^4)x)^2?

Bonus Answer: 1

Bonus: Multiple Choice

Which of the following assumptions are made in chaos theory?

W) The initial parameters are unknown and the future is deterministic

X) The initial parameters are known and the future is deterministic

Y) The initial parameters are not all known and the future is randomly determined

Z) The initial parmeters are all known and the future is randomly determined

Bonus Answer: X

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9. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Which of the following transformations is a wallpaper group

1 Rotation by 90 degrees

2 Glide Reflection

3 Dilation

4 Reflection

Bonus Answer: 1,2, and 4

Bonus: Short Answer

In a circle O, diameter AB is drawn. Chord CD intersects AB at E.

If CP =3, DP =6, AP =x, and BP =x+4, compute the radius of the circle.

Bonus Answer: sqrt(22)

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10. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which of the following refers to the fact that when we have experienced a conditioned stimulus by itself many times, it can be difficult to later condition to another stimulus?

W) Blocking

X) Dormant Inhibition

Y) Extinction

Z) Latent Inhibition

Toss Up Answer: Z

Bonus: Short Answer

What is the corepressor molecule in the trp operon?

Bonus Answer: tryptophan

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11. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

In which fluid-filled cavity do organs develop in organisms such as earthworms?

W) Ring

X) Column

Y) Coelom

Z) Peritoneal cavity

Toss Up Answer: Y

Bonus: Short Answer

What is the specific name for the motion that pythons and boas undergo?

Bonus Answer: Rectilinear Motion

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12. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Where might a proteasome be found?

W) Nucleus

X) Plasma membrane

Y) Extracellular Matrix

Z) Lysosome

Toss Up Answer: W

Bonus: Short Answer

Which small protein tags other proteins for degradation?

Bonus Answer: Ubiquitin

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13. BIOLOGY

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which of the following genetic diseases is not matched correctly with the type of inheritance it has?

W) Hemophilia; X-linked recessive

X) PKU; Autosomal dominant

Y) Sickle cell anemia; Autosomal recessive

Z) Rett Syndrome; X-linked dominant

Toss Up Answer: X

Bonus: Short Answer

What are the names for the two processes that, respectively, inhibit and promote gene expression by regulating access to a chromosome?

Bonus Answer: Methylation; Acetylation (only accept this order)

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14. CHEMISTRY

Writer: Andrew Chen

Toss Up: Short Answer

What metal is the least reactive?

Bonus Answer:

Platinum

Bonus: Multiple Choice

Which of the following is closest to the percentage of the isotope Uranium-235 in nature?

W) 20%

X) 5%

Y) 1%

Z) 0.10%

Bonus Answer: Y

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15. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Short Answer

What material is used in a flame test to filter out light from yellow flames?

Bonus Answer: Cobalt glass (accept smalt or cobalt blue glass)

Bonus: Short Answer

What is the name for the effect that describes why under certain conditions, hot water will freeze faster than cold water?

Bonus Answer: The Mpemba effect

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16. CHEMISTRY

Writer: Andrew Chen

Toss Up: Multiple Choice

Which of the following is more soluble in ethanol than in water?

W) I_2

X) HCl

Y) $AgNO_3$

Z) NH_3

Toss Up Answer: W

Bonus: Short Answer

Reactions of which order are typically associated with catalysts?

Bonus Answer: zeroth

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17. CHEMISTRY

Writer: William Chan

Toss Up: Multiple Choice

Which compound, made from the indicated pairs of ions, will be insoluble?

W) Iron (III) and phosphate ion

X) Bromide ion and ammonium ion

Y) Calcium ion and bromide ion

Z) Bromide ion and iron (III)

Toss Up Answer: W

Bonus: Multiple Choice

When the combustion reaction for benzene is properly balanced with the smallest whole-number coefficients, the sum of the coefficients is

W) 15
X) 12
Y) 35
Z) 17.5

Bonus Answer: Y

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18. CHEMISTRY

Writer: William Chan

Toss Up: Multiple Choice

Which of the following factors will contribute to a decrease in oxygen in a pond?
W) decreasing salinity
X) increasing acidity
Y) increasing temperature
Z) increasing surface tension of the water

Toss Up Answer: Y

Bonus: Multiple Choice

When KCl dissolves in water, the solution cools noticeably to the touch. It may be concluded that
W) the entropy increase overcomes the unfavorable heat of dissolution
X) KCl is relatively insoluble in water
Y) the entropy decreases when KCl dissolves
Z) the boiling point of the solution will be less than 100 degrees Celsius

Bonus Answer: W

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19. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Most non-metals are
W) paramagnetic
X) ferromagnetic
Y) diamagnetic
Z) antiferromagnetic

Toss Up Answer: Y

Bonus: Short Answer

It is hard to find temperatures at which oils and fats boil because before they boil, they begin to break down. What is the name of this point?

Bonus Answer: Smoke Point

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20. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

Which of the following parts of the sun has the lowest temperature
W) Corona
X) Chromosphere
Y) Transition region
Z) Photosphere

Toss Up Answer: Z

Bonus: Short Answer

Throughout the second half of the 20th century, the number of neutrinos measured coming from the Sun was a third of the theoretically predicted number. What behavior of neutrinos revealed that the predicted number of neutrinos were, indeed, being released?

Bonus Answer: Neutrino oscillation (accept: neutrinos change flavor)

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21. EARTH and SPACE

Writer: Andrew Chen

Toss Up: Short Answer

What month does earth's perihelion occur in?

Bonus Answer: January

Bonus: Multiple Choice

What is the name of the supercontinent that formed about 600 million years ago, just before Pangaea?

W) Pannotia

X) Ur

Y) Laurentia

Z) Columbia

Bonus Answer: W

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22. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

In August 2012, it was announced that Voyager 1 had exited the Solar System. What boundary did the spacecraft cross to merit this announcement?

W) Termination Shock

X) Heliosheath

Y) Heliopause

Z) The Oort Cloud

Toss Up Answer: Y

Bonus: Multiple Choice

What is Voyager 1's primary source of power?

W) Solar cells

X) Radioactive decay

Y) Thermal cells

Z) Voyager 1 is not generating power

Bonus Answer: X

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23. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Short Answer

Order the following structures by descending concentration of stars:

1. Globular cluster
2. Arms of the Milky Way

3. Bulge of the Milky Way
4. Halo of the Milky Way

Bonus Answer: 1, 3, 2, 4

Bonus: Short Answer

What stellar Population is most common in globular clusters?

Bonus Answer: Population II (accept "2")

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24. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Short Answer

After reaching what mass can a white dwarf no longer remain stable?

Bonus Answer: The Chandrasekhar Limit

Bonus: Short Answer

What is the pressure that prevents the gravitational collapse of a stable white dwarf?

Bonus Answer: Electron degeneracy pressure

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25. ENERGY

Writer: Andrew Chen

Toss Up: Multiple Choice

What type of battery is the typical modern car battery?

W) nickel cadmium

X) lead acid

Y) lithium ion

Z) unrechargable

Toss Up Answer: X

Bonus: Short Answer

Name either of the two countries that are currently carbon neutral, having net zero carbon emissions.

Bonus Answer: bhutan, vatican city

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