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1. Biology

Toss Up: Short Answer

Motor proteins transport vesicles along which cytoskeletal fiber?

Toss Up Answer: microtubules

Bonus: Short Answer

Shape abnormalities of the nuclear lamina are most likely a result of a defect in which cytoskeletal structure?

Bonus Answer: intermediate filaments

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2. Physics

Toss Up: Multiple Choice

The process in which an atom reradiates a photon after interacting with an incident photon of the same energy is called:

- W) Cooleo Theorem
- X) the Cherenkov effect
- Y) Bragg's Law
- Z) Thomson scattering

Toss Up Answer: Z

Bonus: Multiple Choice

A protanomalous person has decreased sensitivity of the red cones in his or her eyes. Which of the following color pairs will this person have difficulty distinguishing between:

- W) black and yellow
- X) blue green
- Y) purple blue
- Z) red and yellow

Bonus Answer: Y

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3. Mathematics

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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4. Chemistry

Toss Up: Multiple Choice

Which of the following elements are Lanthanides?

- W) Lawrencium
- X) Meltnerium
- Y) Seaborgium
- Z) Terbium

Toss Up Answer: Z

Bonus: Short Answer

What unit does electronegativity use?

Bonus Answer: No unit

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5. Mathematics

Toss Up: Short Answer

Find $x/y + y/x$ in simplest form if $x=7$ and $y=3$

Toss Up Answer: 58/21

Bonus: Short Answer

Positive integers a and b satisfy $ab \mid a^2 + 4ab + 4b^2$ [" a b divides a squared plus four a b plus four b squared"]. The smallest possible value of $a+b$ is 2, which occurs when $a=b=1$ [" a equals b equals 1"]. What is the second smallest possible value of $a+b$?

Bonus Answer: 6: $a=4$, $b=2$

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6. Biology

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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7. Physics

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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8. Biology

Toss Up: Multiple Choice

Which of the following is a bacteriostatic antibiotic that works by disrupting protein synthesis?

- W) Erythromycin
- X) Penicillin
- Y) Trimethoprim
- Z) Nalidixic acid

Toss Up Answer: W

Bonus: Multiple Choice

In India, during a cholera epidemic of 1926, European men poured a treatment for cholera into village wells unbeknownst to the villagers. What was the treatment?

- W) Alcohol
- X) antibiotics
- Y) Phages
- Z) Iodine

Bonus Answer: Y

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9. Mathematics

Toss Up: Short Answer

Factor $(mn)^2 - p^2$.

Toss Up 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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10. Earth and Space Science

Toss Up: Multiple Choice

A stream can lengthen its channel by:

- W) hydraulic action
- X) headward erosion
- Y) downcutting
- Z) vertical accretion

Toss Up Answer: X

Bonus: Multiple Choice

In uniform flat rocks, drainage patterns are typically

- W) Radial
- X) dendritic
- Y) trellis
- Z) braided

Bonus Answer: X

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11. Biology

Toss Up: Short Answer

After 12 weeks of gestation, what is the principal source of estrogen and progesterone to a human fetus?

Toss Up Answer: corpus luteum

Bonus: Multiple Choice

Fat enters the venous system from the digestive system via the:

- W) hepatic artery
- X) hepatic vein
- Y) thoracic duct
- Z) hepatic portal system

Bonus Answer: Y

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12. Chemistry

Toss Up: Multiple Choice

Permalloy steel is an alloy which is 21.2% Fe by mass. How many grams of Fe are present in 1 kg of steel?

- W) 212 g
- X) 21.2 g
- Y) 4.7 g
- Z) .212 g

Toss Up Answer: W

Bonus: Short Answer

Astatine, having atomic number 85 on the periodic table, is a radioactive member of the halogens. Give the full electron configuration of At. Arrange the orbitals in order of increasing energy. (Do not use noble gas abbreviations, such as [Xe], for this problem.)

Bonus Answer: 1s22s22p63s23p64s23d104p65s24d105p66s24f145d106p5

13. Physics

Toss Up: Multiple Choice

A certain spring is known to obey Hooke's Law. If a force of 10 newtons stretches the spring 2 meters, how far will a 30 newton force stretch the spring?

- W) 1 meter
- X) 60 meters
- Y) 6 meters
- Z) 16 meters

Toss Up Answer: Y

Bonus: Multiple Choice

A block of metal which weighs 60 newtons in air and 40 newtons under water has a density, in kilograms per meter cubed, of:

- W) 1000
- X) 3000
- Y) 5000
- Z) 7000

Bonus Answer: X

14. Chemistry

Toss Up: Multiple Choice

Which quantum number describes the specific orbital of an electron within a subshell?

- W) Spin Projection
- X) Magnetic
- Y) Principal
- Z) Azimuthal

Toss Up Answer: X

Bonus: Short Answer

What scientist disproved the caloric theory, which stated that an invisible gas transferred heat between objects?

Bonus Answer: James Prescott Joule (accept: James Joule)

15. Earth and Space Science

Toss Up: Multiple Choice

Which type of weather front is represented by alternating purple spikes and semicircles?

- W) Cold front
- X) Warm front
- Y) Occluded front
- Z) Stationary front

Toss Up Answer: Y

Bonus: Short Answer

What weather front is formed as a cold air mass pushes under a warm air mass?

Bonus Answer: Cold front

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16. Biology

Toss Up: Short Answer

What is the process of electrons being shuttled between Photosystem I and the cytochrome complex called?

Toss Up Answer: cyclic electron flow

Bonus: Multiple Choice

In linear electron flow during the light reactions, electrons shuttled by Plastocyanin reduce what molecule?

W) P700

X) P680

Y) Plastoquinone

Z) Ferredoxin

Bonus Answer: W

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17. Mathematics

Toss Up: Short Answer

Convert CD from hexadecimal to decimal

Toss Up Answer: 205

Bonus: Short Answer

Convert CD from hexadecimal to binary

Bonus Answer: 11001101

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18. Physics

Toss Up: Multiple Choice

Whose law defines the relationship between angle of incidence and of refraction?

W) Snell's

X) DeBroglie's

Y) Kepler's

Z) Carnot's

Toss Up Answer: W

Bonus: Short Answer

What are the names of Hydrogen's three isotopes?

Bonus Answer: Protium, Deuterium, Tritium (accept: Hydrogen, Deuterium, Tritium)

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19. Earth and Space Science

Toss Up: Multiple Choice

The San Andreas fault is what specific type of fault line?

W) Transform plate boundary

X) Normal fault

Y) Reverse fault

Z) Strike slip fault

Toss Up Answer: Z

Bonus: Short Answer

There are different types of seismic waves, body waves and surface waves. Name the two different types of body waves.

Bonus Answer: P waves and S waves

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20. Mathematics

Toss Up: Short Answer

In what type or types of triangle can the angle bisector, the altitude and the median be the same line?

Toss Up Answer: Isosceles and equilateral triangle

Bonus: Short Answer

Find the other roots of $x^3 + 6x^2 - 13x - 42$ if one of them is -2

Bonus Answer: -7, 3

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21. Chemistry

Toss Up: Short Answer

What element is in all alloys classified as amalgam?

Toss Up Answer: Mercury (accept: Hg)

Bonus: Short Answer

You have a solution of 5 molar Sodium Phosphate and need to prepare a solution of 500 millimolar Sodium Phosphate. How much water would you add to 100 milliliter of the original 5 molar solution to produce the 500 millimolar solution?

Bonus Answer: 900 MILLILITERS (or 0.9 LITERS)

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22. Earth and Space Science

Toss Up: Multiple Choice

Which of these is till?

W) fine flacial lake clay

X) well-sorted outwash sand

Y) a polished rock outcrop

Z) unsorted sand, gravel, and clay in a moraine

Toss Up Answer: Z

Bonus: Short Answer

There are 5 officially recognized dwarf planets in our solar system. Name 3 of them.

Bonus Answer: Accept 3 of the following: Ceres, Pluto, Haumea, Makemake and Eris

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23. Chemistry

Toss Up: Multiple Choice

In the following redox reaction: $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$ which compound is the oxidizing agent?

W) 2O_2

X) CH₄

Y) CO₂

Z) H₂O

Toss Up Answer: W

Bonus: Short Answer

Given the organic molecule C₆H₁₄ how many different structural isomers can be formed?

Bonus Answer: Five

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24. Earth and Space Science

Toss Up: Short Answer

How long does it take for a satellite in geosynchronous orbit to travel once around the Earth?

Toss Up Answer: One day

Bonus: Short Answer

What is the orbital period, to the nearest year, of Halley's Comet?

Bonus Answer: 75 years

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25. Physics

Toss Up: Short Answer

A step-down transformer has a turns ratio less than

Toss Up Answer: One

Bonus: Multiple Choice

By design, wires with the highest resistance are built into

W) Clocks

X) Toasters

Y) Telephones

Z) Stereo Speakers

Bonus Answer: X

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