

Round 10

1. PHYSICS

Toss Up: Multiple Choice

Monochromatic light is normally incident on a diffraction grating that is 1cm wide and has 10,000 slits. The first order line is deviated at a 30° angle. What is the wavelength, in nm, of the incident light?

- W) 300
- X) 500
- Y) 877
- Z) 1000

Toss Up Answer: X

Bonus: Multiple Choice

A spectral line of a certain star is observed to be "red shifted" from a wavelength of 500nm to a wavelength of 1500nm. Interpreting this as a Doppler effect, the speed of recession of this star is:

- W) .33c
- X) .5c
- Y) .71c
- Z) .8c

Bonus Answer: Z

2. EARTH and SPACE

Toss Up: Multiple Choice

What is the name for the apparent line dividing night and day

- W) Seperator
- X) Day-Night Meridian
- Y) Terminator
- Z) Prime Meridian

Toss Up Answer: Y

Bonus: Short Answer

What Gas Giant emits the least amount of energy percentage-wise, based on the total amount of energy it receives from the sun?

Bonus Answer: Uranus

3. PHYSICS

Toss Up: Multiple Choice

The equation of continuity for fluid flow can be derived from the conservation of:

- W) Energy
- X) Mass
- Y) Angular momentum
- Z) Volume

Toss Up Answer: X

Bonus: Multiple Choice

A coil has a resistance of 60Ω and an impedance of 100Ω . Its reactance, in ohms, is:

- W) 40
- X) 60

Y) 80
Z) 117

Bonus Answer: Y

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4. ENERGY

Toss Up: Multiple Choice

16) Which uranium oxide is most commonly used in light water reactors?

- W) uranium(IV) oxide
- X) uranium(V) oxide
- Y) uranium(VI) oxide
- Z) Yellowcake

Toss Up Answer: W

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Bonus: Multiple Choice

If a 1 kg mouse runs at 5 m/s, what is its approximate energy in electronvolts?

- W) 4.8×10^{-3}
- X) 2.9×10^{15}
- Y) 7.8×10^{19}
- Z) 4.4×10^{22}

Bonus Answer: Y

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5. CHEMISTRY

Toss Up: Multiple Choice

Which of the follow is true regarding complex ions?

- W) Their formation constants are usually very small and they often form colored coordination compounds.
- X) Their formation constants are usually very small and they often form colorless coordination compounds.
- Y) Their formation constants are usually very large and they often form colored coordination compounds.
- Z) Their formation constants are usually very large and they often form colorless coordination compounds.

Toss Up Answer: Y

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Bonus: Multiple Choice

Which of the following is a monodentate ligand?

- W) Oxalate
- X) Chloride Ion
- Y) Aluminum (III) Ion
- Z) Ammonium Ion

Bonus Answer: X

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6. EARTH and SPACE

Toss Up: Short Answer

What star has the greatest apparent magnitude

Bonus Answer: Sun

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Bonus: Multiple Choice

Which planet or planets rotate in retrograde?

- W) Venus
- X) Uranus
- Y) Venus and Uranus
- Z) Uranus and Jupiter

Bonus Answer: Y

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7. BIOLOGY

Toss Up: Multiple Choice

Which mollusk does not possess a radula?

- W) Squid
- X) Scallop
- Y) Snail
- Z) Chiton

Toss Up Answer: X

Bonus: Short Answer

What is the scientific name for the job or role an organism plays in its habitat?

Bonus Answer: Niche

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8. MATHEMATICS

Toss Up: Short Answer

Compute the dot product of the following vectors:

$\langle 2, 1, 3 \rangle$ and $\langle 10, -1, -5 \rangle$

Bonus Answer: 4

Bonus: Multiple Choice

$(64 + 196 + 81)(49 + 256 + 49) > (56 + 224 + 63)^2$ [Read "the quantity $64+196+81$ times the quantity $49+256+49$ strictly greater than the quantity $56+224+63$ squared] is most directly an example of what inequality?

- W) Triangle inequality
- X) Power Mean Inequality
- Y) Cauchy-Schwarz inequality [COW-SHEE sch-WARTS]
- Z) Jensen's inequality [YEN-SIN]

Bonus Answer: Y

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9. EARTH and SPACE

Toss Up: Short Answer

Which planet has the least eccentric orbit?

Bonus Answer: Venus

Bonus: Short Answer

What are the two densest planets in our solar system?

Bonus Answer: Earth and Mercury (accept in any order)

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10. MATHEMATICS

Toss Up: Short Answer

If the log of n is 10, what is the log of $100n$?

Bonus Answer: 12

Bonus: Short Answer

How many ways are there to seat 5 people around a circular table, if rotations are ignored?

Bonus Answer: 24

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11. PHYSICS

Toss Up: Short Answer

The Curie temperature is the temperature at which ferromagnets become paramagnets. What is the name for the point at which antiferromagnets become paramagnets?

Bonus Answer: The Neel temperature

Bonus: Multiple Choice

A hall probe measures which of the following:

- W) Capacitance
- X) Viscosity
- Y) Magnetic Field
- Z) Electric Field

Bonus Answer: Y

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12. MATHEMATICS

Toss Up: Short Answer

If the first term in an arithmetic sequence is 2 and the third term is 6, find the 10th term.

Bonus Answer: 20

Bonus: Short Answer

Compute the sum of the first 100 positive integers.

Bonus Answer: 5050

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13. BIOLOGY

Toss Up: Multiple Choice

What branching nerve fibers receive messages?

- W) Axons
- X) Axes
- Y) Dendrons
- Z) Dendrites

Toss Up Answer: Z

Bonus: Multiple Choice

What protein was first isolated in red blood cells?

- W) Myoglobin
- X) Hemocyanin
- Y) Spectrin
- Z) Collagen

Bonus Answer: Y

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14. MATHEMATICS

Toss Up: Short Answer

Find the perimeter of a right triangle with legs 11 and 60.

Bonus Answer: 132

Bonus: Short Answer

In a 15-75-90 degrees right triangle with hypotenuse 4, what are the lengths of the shorter and longer leg, respectively? Exact answers please.

Bonus Answer: radical 6 - radical 2, radical 6 + radical 2

15. PHYSICS

Toss Up: Short Answer

What is the name for the effect that explains the small attractive force that acts between two close parallel uncharged conducting plates in a vacuum?

Bonus Answer: The Casimir Effect

Bonus: Multiple Choice

According to Beer's law:

W) the energy of a photon of light is inversely proportional to its wavelength

X) the concentration of a species that absorbs light can be measured by the amount of light absorbed

Y) the energy of characteristic X-rays increases with increasing atomic number of the emitting element

Z) excitation of the electrons in a molecule takes place on a shorter time scale than motion of the nuclei

Bonus Answer: X

16. EARTH and SPACE

Toss Up: Short Answer

What type of rock comes in layers?

Bonus Answer: Sedimentary

Bonus: Short Answer

What color is a flame of lithium?

Bonus Answer: red

17. CHEMISTRY

Toss Up: Short Answer

In complex of manganese (II) ion exhibiting a low spin state, how many d electrons are paired?

Bonus Answer: Four

Bonus: Short Answer

What is the conjugate base of HPO_4^{2-} (Read as: Hydrogen Phosphate)?

Bonus Answer: PO_4^{3-} (Accept: Phosphate, PO four 3 minus)

18. BIOLOGY

Toss Up: Short Answer

Give the genus and species name of the organism that Beadle and Tatum worked with.

Bonus Answer: Neurospora crassa

Bonus: Short Answer

Archibald Garrod is credited with the discovery of which disease, characterized by blackened urine?

Bonus Answer: Alkaptonuria

19. CHEMISTRY

Toss Up: Multiple Choice

For compounds with the same number of carbon atoms, the compound with the lowest boiling point is expected to be

- W) a ketone
- X) an amine
- Y) an ether
- Z) an alcohol

Toss Up Answer: Y

Bonus: Multiple Choice

To have cis and trans isomers, a compound must have

- W) sp bonded carbon atoms
- X) sp³ bonded carbon atoms
- Y) sp² bonded carbon atoms
- Z) (W) and (X)

Bonus Answer: Y

20. PHYSICS**Toss Up: Short Answer**

How many bosons are in a regular hydrogen atom?

Bonus Answer: 1 (it's the electron)

Bonus: Short Answer

Two forces have magnitudes of 15 newtons and 5 newtons. Using interval notation, what is the range of the possible magnitudes of their sum?

Bonus Answer: [10, 20], accept: between 10 and 20 Newtons inclusive

21. CHEMISTRY**Toss Up: Multiple Choice**

Which of the following pairs of constants are NOT mathematically related to each other?

- 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

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following is FALSE?

- W) Reduction involves a gain of electrons
- X) Batteries are galvanic cells
- Y) A thermodynamically favored reaction always has a positive E
- Z) Electrolysis reactions always produce a gas at at least one electrode.

Bonus Answer: Z

22. BIOLOGY**Toss Up: Short Answer**

Name the two types of cell death.

Bonus Answer: Apoptosis, Necrosis

Bonus: Short Answer

In C4 and CAM photosynthesis, which specific enzyme is used to fix CO₂ in lieu of RuBisCO?

Bonus Answer: PEP Carboxylase

23. CHEMISTRY

Toss Up: Multiple Choice

The evaporation of any liquid is expected to have

- W) a positive ΔH and a negative ΔS
- X) a negative ΔH and a negative ΔS
- Y) a positive ΔH and a positive ΔS
- Z) a positive ΔH and a negative ΔS

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following is most likely to be true?

- W) Combustion of organic compounds has a negative ΔH
- X) A positive ΔG indicates a thermodynamically favorable reaction.
- Y) A positive ΔS always means that the reaction is thermodynamically favored.
- Z) A thermodynamically favored reaction always goes to completion.

Bonus Answer: W

24. CHEMISTRY

Toss Up: Multiple Choice

Diamond is classified as

- W) a covalent crystal
- X) an ionic crystal
- Y) a molecular crystal
- Z) a metallic crystal

Toss Up Answer: W

Bonus: Multiple Choice

A liquid substance that exhibits low intermolecular attractions is expected to have

- W) low viscosity, low boiling point, and low heat of vaporization
- X) high viscosity, low boiling point, and low heat of vaporization
- Y) low viscosity, high boiling point, and low heat of vaporization
- Z) low viscosity, low boiling point, and high heat of vaporization

Bonus Answer: W

25. CHEMISTRY

Toss Up: Multiple Choice

Modern automobiles use a catalytic converter to

- W) increase horsepower by burning more gasoline
- X) absorb pollutants from the exhaust
- Y) complete the combustion of unburned gases

Z) cool the exhaust gases

Toss Up Answer: Y

Bonus: Multiple Choice

A catalyst will NOT

W) increase the forward reaction rate

X) shift the equilibrium to favor the products

Y) alter the reaction pathway

Z) increase the speed at which equilibrium will be achieved

Bonus Answer: X
