

ROUND ROBIN – ROUND 11

TOSS-UP

1) Energy – *Short Answer* Researchers at the National Renewable Energy Lab have computationally screened hundreds of new nitride compounds in the hope of synthesizing them in the lab. They focused on compounds that are theoretically unstable but last long enough to be stable for practical purposes. What is the term for such compounds?

ANSWER: METASTABLE

BONUS

1) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab have designed a particular implementation of a controlled-NOT, or CNOT, gate to enable future work in quantum information processing. In general, if the TARGET qubit is ket 1, which of the following is a transformation that can be performed by the CNOT gate?

- W) If the CONTROL qubit is ket 0, the target qubit will remain ket 1
- X) If the CONTROL qubit is ket 0, the target qubit will become ket 0
- Y) It will always remain ket 1
- Z) It will always become ket 0

ANSWER: W) IF THE CONTROL QUBIT IS KET 0, THE TARGET QUBIT WILL REMAIN KET 1

TOSS-UP

2) Physics – *Short Answer* In a rotating frame of reference, what fictitious force is proportional to the cross product of the frame's angular velocity with the velocity of an object?

ANSWER: CORIOLIS

BONUS

2) Physics – *Short Answer* Alice, who has a mass of 50 kilograms, runs with a speed of three meters per second and jumps onto a stationary skateboard with mass two kilograms. In meters per second, what is Alice's speed after jumping on the skateboard?

ANSWER: 75/26 (ACCEPT: 2 23/26)

TOSS-UP

3) Math – *Multiple Choice* If f of x equals the square root of open parenthesis $x + 6$ close parenthesis and g of x equals the square root of open parenthesis $x - 6$ close parenthesis, which of following intervals represents the domain of the function f of x divided by g of x ?

- W) x greater than -6
- X) x greater than or equal to -6
- Y) x greater than 6
- Z) x greater than or equal to 6

ANSWER: Y) x GREATER THAN 6

BONUS

3) Math – *Short Answer* Starting with a cube, one dimension is increased by 4, another is decreased by 4, and the other is left unchanged. If the new solid has a volume 112 less than that of the original cube, what was the volume of the original cube?

ANSWER: 343

TOSS-UP

4) Biology – *Short Answer* Reptiles, birds, and mammals all develop from what type of egg with four specialized extra-embryonic membranes?

ANSWER: AMNIOTIC

BONUS

4) Biology – *Multiple Choice* HIV primarily targets CD4-positive lymphocytes. Which of the following best describes the normal function of these cells?

- W) Receive presented antigens and stimulate other cells
- X) Send signals to infected cells to apoptose *[ay-POP-tows]*
- Y) Phagocytose *[fag-oh-sye-tows]* pathogens and debris
- Z) Produce antibodies

ANSWER: W) RECEIVE PRESENTED ANTIGENS AND STIMULATE OTHER CELLS

TOSS-UP

5) Chemistry – *Short Answer* What law states that you can add the enthalpy changes associated with component reactions to determine the enthalpy change of a multi-step reaction?

ANSWER: HESS'S LAW

BONUS

5) Chemistry – *Short Answer* Place the following four elements in order of increasing electron affinity:
1) Sodium; 2) Gold; 3) Oxygen; 4) Fluorine.

ANSWER: 1, 3, 2, 4

TOSS-UP

6) Earth & Space – *Short Answer* The uppermost, white clouds on Neptune are generally composed of ices of what molecule?

ANSWER: METHANE (ACCEPT: CH₄)

BONUS

6) Earth & Space – *Short Answer* Identify all of the following three descriptions of chondrites [**KON-drites**] that are true: 1) They contain silicate [**SILL-ih-kate**] minerals; 2) They formed very early in the solar system; 3) They often have an iron core.

ANSWER: 1, 2

TOSS-UP

7) Energy – *Multiple Choice* Scientists at the Joint Genome Institute are studying giant viruses like Pandoravirus [*pan-DORE-ah virus*]. How many base pairs are in the genome of Pandoravirus?

- W) 2.5 billion
- X) 2.5 million
- Y) 25,000
- Z) 2,500

ANSWER: X) 2.5 MILLION

BONUS

7) Energy – *Short Answer* Scientists at Idaho National Lab are developing molten salt reactors that use chloride salts as coolant. Identify all of the following three reasons to use salts in a nuclear reactor:

- 1) High melting point; 2) Low corrosivity; 3) High electrical conductivity.

ANSWER: 1

TOSS-UP

8) Math – *Short Answer* If f of x equals e to the power open parenthesis $4x$ close parenthesis, what is f triple prime of zero?

ANSWER: 64

BONUS

8) Math – *Short Answer* What is the 12th power of the complex number $1 - i$?

ANSWER: -64 (ACCEPT: $-64 + 0i$)

TOSS-UP

9) Earth & Space – *Short Answer* In what ocean is the Sargasso Sea located?

ANSWER: ATLANTIC

BONUS

9) Earth & Space – *Multiple Choice* Which of the following describes the stability of an air parcel when the environmental lapse rate is between the moist and dry adiabatic **[ad-ee-ah-BAT-ik]** lapse rates?

- W) Statically stable
- X) Conditionally unstable
- Y) Absolutely unstable
- Z) Absolutely stable

ANSWER: X) CONDITIONALLY UNSTABLE

TOSS-UP

10) Biology – *Short Answer* In the human brain, what structure controls the secretions of the pituitary gland?

ANSWER: HYPOTHALAMUS

BONUS

10) Biology – *Short Answer* Order the following three organs in a bird in the order through which food will pass: 1) Proventriculus; 2) Crop; 3) Gizzard.

ANSWER: 2, 1, 3

TOSS-UP

11) Physics – *Multiple Choice* Consider an ideal electric circuit consisting of a capacitor and an inductor. Which of the following types of oscillators would best describe its behavior?

- W) Simple harmonic
- X) Underdamped harmonic
- Y) Overdamped harmonic
- Z) Critically damped harmonic

ANSWER: W) SIMPLE HARMONIC

BONUS

11) Physics – *Short Answer* A beam of light emerges from a clear liquid with index of refraction of 1.7 into a vacuum. If the incident angle is 30 degrees, then to the nearest multiple of ten degrees, what will be its angle of refraction?

ANSWER: 60

TOSS-UP

12) Chemistry – *Multiple Choice* A student is using mass spectrometry to identify an unknown sample of rock. Which of the following does mass spectrometry not directly quantify?

- W) Mass to charge ratio of ions
- X) Isotope abundance
- Y) Polarity of the material
- Z) Presence of known functional groups

ANSWER: Y) POLARITY OF THE MATERIAL

BONUS

12) Chemistry – *Short Answer* Order the following three solvents from least polar to most polar:

1) Acetonitrile [*ah-SEE-toh-NYE-trile*]; 2) Toluene; 3) Tetrahydrofuran [*tetra-high-droh-FYUR-an*].

ANSWER: 2, 3, 1

TOSS-UP

13) Biology – *Multiple Choice* G-protein-coupled receptors and receptor tyrosine **[TIE-row-seen]** kinases are typically found on which of the following structures?

- W) Endoplasmic reticulum **[reh-TIK-yoo-lum]**
- X) Nuclear envelope
- Y) Cell wall
- Z) Plasma membrane

ANSWER: Z) PLASMA MEMBRANE

BONUS

13) Biology – *Short Answer* Secondary xylem **[ZYE-lum]** is derived from what specific meristem tissue?

ANSWER: VASCULAR CAMBIUM

TOSS-UP

14) Energy – *Short Answer* Scientists supported by the DOE are studying nanoparticles that absorb light and, after a short delay, emit light of a longer wavelength. What is the term for these nanoparticles with discrete electronic states?

ANSWER: QUANTUM DOTS

BONUS

14) Energy – *Short Answer* Brookhaven National Lab researchers are using quadrupole magnets to shape electron beams. The field potential due to this magnet is directly proportional to distance raised to what power?

ANSWER: NEGATIVE THREE

TOSS-UP

15) Earth & Space – *Short Answer* A star located 10 parsecs away has an absolute magnitude of 3.5. To two significant figures, what is the apparent magnitude of the star?

ANSWER: 3.5

BONUS

15) Earth & Space – *Multiple Choice* Which of the following regions of the Sun's atmosphere has the highest temperature?

- W) Photosphere
- X) Chromosphere
- Y) Inner corona
- Z) Outer corona

ANSWER: Z) OUTER CORONA

TOSS-UP

16) Physics – *Short Answer* Many substances, when exposed to an external magnetic field, will induce a magnetic field that weakly repels the external one. What is the term for such substances?

ANSWER: DIAMAGNETIC

BONUS

16) Physics – *Short Answer* A Carnot [*CAR-noh*] engine operates with a cold reservoir temperature of zero degrees Celsius, and an efficiency of two-thirds. In degrees Celsius, what is the temperature of the hot reservoir?

ANSWER: 546

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following molecules is non-planar in its lowest energy conformation?

- W) Ethene
- X) Benzene
- Y) Cyclohexane
- Z) Xenon **[ZEE-non]** tetrafluoride

ANSWER: Y) CYCLOHEXANE

BONUS

17) Chemistry – *Short Answer* Identify all of the following four molecules that would be expected to exhibit *cis /sisJ-trans* isomerism **[eye-SAW-mer-izm]** at standard temperature: 1) Ethene; 2) Propene; 3) 2-methylprop-1-ene; 4) 2-butene.

ANSWER: 4 ONLY

TOSS-UP

18) Math – *Short Answer* A polyhedron has 12 vertices and 30 edges. How many faces does it have?

ANSWER: 20

BONUS

18) Math – *Short Answer* A line contains 6 points *A, B, C, D, E, and F*. A second line contains 3 other points *X, Y, and Z*. For a tenth point *P*, no other line contains more than two of these 10 points. What is the maximum number of lines that contain at least two of these 10 points?

ANSWER: 29

TOSS-UP

19) Biology – *Short Answer* While most immune cells survive only for days or weeks, some B cells can persist for years or even decades. What is the term for this family of B cells?

ANSWER: MEMORY

BONUS

19) Biology – *Multiple Choice* The lobster claw plant has red upper leaves. Which of the following pollination vectors does the lobster claw plant use?

- W) Bees
- X) Wind
- Y) Birds
- Z) Water

ANSWER: Y) BIRDS

TOSS-UP

20) Chemistry – *Short Answer* Rank the following three nitrogen-containing species in order of increasing oxidation number on their nitrogen atom: 1) Nitrate; 2) Nitrogen dioxide; 3) Nitric oxide.

ANSWER: 3, 2, 1

BONUS

20) Chemistry – *Short Answer* Consider the water-gas shift reaction, in which three molecules of hydrogen can be exothermically *[ex-oh-THERM-ik-lee]* combined with carbon monoxide to yield methane and gaseous water. Identify all of the following three changes that would shift the reaction equilibrium towards the reactants: 1) Adding methane to the reaction vessel; 2) Reducing the volume of the system; 3) Increasing the temperature of the reaction.

ANSWER: 1, 3

TOSS-UP

21) Earth & Space – *Short Answer* What is the collective term for all of the chemical, physical, and biological changes that a sedimentary **[sed-ih-MEN-taree]** rock undergoes after it has been deposited?

ANSWER: DIAGENESIS

BONUS

21) Earth & Space – *Short Answer* Identify all of the following three criteria that must be true for a substance to be considered a mineral: 1) It has at least two elements; 2) It is naturally occurring; 3) It does NOT contain carbon.

ANSWER: 2

TOSS-UP

22) Math – *Short Answer* In order, four points on a circle are named *A*, *B*, *C*, and *D*. If angle *BAD* measures 87 degrees and angle *BAC* measures 36 degrees, what is the degree measure of minor arc *CD*?

ANSWER: 102

BONUS

22) Math – *Short Answer* If the probability of event A is 0.4, the probability of event B is 0.7, and the probability of both A and B occurring is 0.3, what is the probability of event A given that B has already occurred?

ANSWER: 3/7

TOSS-UP

23) Physics – *Short Answer* If the radius of a cylindrical uniform wire is doubled, by what number is the resistance of that wire multiplied?

ANSWER: 1/4 (ACCEPT: 0.25)

BONUS

23) Physics – *Short Answer* A vinyl record with a 50-centimeter diameter makes ten complete rotations every minute on its record player. In meters per second squared, what is the centripetal acceleration acting at the outer edge of the record?

ANSWER: $\pi^2/36$