

ROUND ROBIN – ROUND 13

TOSS-UP

1) Chemistry – *Short Answer* The drying step of the freeze-drying process is an example of what type of phase change?

ANSWER: SUBLIMATION

BONUS

1) Chemistry – *Short Answer* What are the IUPAC names of the products of the reaction between hydroiodic [*HIGH-droh-eye-AW-dik*] acid and lithium sulfide?

ANSWER: HYDROGEN SULFIDE AND LITHIUM IODIDE

TOSS-UP

2) Physics – *Multiple Choice* The unit formed by multiplying pounds-force times seconds can be used to measure which of the following quantities?

- W) Momentum
- X) Angular momentum
- Y) Energy
- Z) Force

ANSWER: W) MOMENTUM

BONUS

2) Physics – *Short Answer* A parallel-plate capacitor is being used to store energy between its plates. If the potential difference between the plates is doubled and the charge on the capacitor is tripled, by what number will the energy stored be multiplied?

ANSWER: 6

TOSS-UP

3) Earth & Space – *Short Answer* What are the two largest galaxies in the Local Group?

ANSWER: MILKY WAY AND ANDROMEDA

BONUS

3) Earth & Space – *Multiple Choice* Which of the following best describes the blackbody curve of the Sun plotted as increasing wavelength versus intensity?

- W) Symmetric curve about lambda max
- X) Discrete line at lambda max
- Y) Steeply sloping below lambda max, gently sloping above lambda max
- Z) Gently sloping below lambda max, steeply sloping above lambda max

ANSWER: Y) STEEPLY SLOPING BELOW LAMBDA MAX, GENTLY SLOPING ABOVE LAMBDA MAX

TOSS-UP

4) Math – *Multiple Choice* A function f maps from set A to set B , and a function g maps from set B to set C . If f is injective, and g is bijective, which of the following properties must hold for the composition g of f ?

- W) Bijective
- X) Injective
- Y) Surjective
- Z) Nothing can be established about g of f

ANSWER: X) INJECTIVE

BONUS

4) Math – *Short Answer* What is the cube of the complex number $5 + 2i$?

ANSWER: $65 + 142i$

TOSS-UP

5) Biology – *Short Answer* A cell that fails to pass the G1 checkpoint in the cell cycle will enter what quiescent or senescent [*sen-EH-sent*] state?

ANSWER: G0 [*G-zero or G-naught*]

BONUS

5) Biology – *Short Answer* Crossing over during meiosis [*my-OH-sis*] can be seen under a microscope as an X-shaped structure called what?

ANSWER: CHIASMA [*kye-AZ-ma*] (ACCEPT: CHIASMATA)

TOSS-UP

6) Energy – *Multiple Choice* Los Alamos National Lab scientists are fabricating nanoparticles to produce terahertz radiation. The terahertz band is best described as lying between what two regions of the electromagnetic spectrum?

- W) Microwave and infrared
- X) Infrared and visible
- Y) Visible and ultraviolet
- Z) Ultraviolet and X-ray

ANSWER: W) MICROWAVE AND INFRARED

BONUS

6) Energy – *Short Answer* Scientists at the Joint BioEnergy Institute are studying how organisms synthesize secondary metabolites such as doxycycline [*dawk-see-SIGH-kleen*], erythromycin [*eh-rith-ro-MY-sin*], and aflatoxin [*AF-lah-toxin*]. These are all part of what group of metabolites?

ANSWER: POLYKETIDES

TOSS-UP

7) Chemistry – *Short Answer* What general type of chemical reaction involves two or more substances combining to form a single product?

ANSWER: SYNTHESIS

BONUS

7) Chemistry – *Multiple Choice* According to MO [*M-oh*] theory, which of the following orbitals is the LUMO [*LOO-mo*] acceptor orbital for the major cycloaddition reaction between butadiene [*byoo-tah-DYE-een*] and ethylene?

- W) Butadiene pi-star
- X) Butadiene pi
- Y) Ethylene pi-star
- Z) Ethylene pi

ANSWER: Y) ETHYLENE PI-STAR

TOSS-UP

8) Physics – *Multiple Choice* A capacitor is charged by applying a voltage that linearly increases with time. Which of the following describes the dependence of the stored electric potential energy with time?

- W) Square root
- X) Constant
- Y) Linear but not constant
- Z) Quadratic

ANSWER: Z) QUADRATIC

BONUS

8) Physics – *Short Answer* The decay series of Uranium-238 eventually brings it to Uranium-234. What is the sum of the number of alpha- and beta-decay events that it takes for an atom of Uranium-238 to become Uranium-234?

ANSWER: 3

TOSS-UP

9) Math – *Short Answer* What is the product of the complex number $5 + 3i$ and its conjugate?

ANSWER: 34

BONUS

9) Math – *Short Answer* What is the standard deviation of the following list of 5 numbers:
6, 7, 9, 10, 13?

ANSWER: $\sqrt{6}$

TOSS-UP

10) Biology – *Short Answer* The purpose of fermentation is to recycle what electron-transporting molecule in glycolysis [*glye-KAWL-eh-sis*]?

ANSWER: NAD (ACCEPT: NAD⁺, NADH, NICOTINAMIDE ADENINE DINUCLEOTIDE)

BONUS

10) Biology – *Short Answer* Identify all of the following three forms of reproductive barriers that are postzygotic [*post-zye-GAW-tik*] barriers: 1) Gametic [*gah-MEE-tic*] isolation; 2) Temporal isolation; 3) Hybrid breakdown.

ANSWER: 3

TOSS-UP

11) Energy – *Short Answer* Scientists at SLAC [*slack*] National Accelerator Lab are studying single-atom catalysts. A catalyst can be defined as a substance that lowers what type of energy on a reaction coordinate?

ANSWER: ACTIVATION ENERGY

BONUS

11) Energy – *Multiple Choice* Scientists at Los Alamos National Lab are generating radioactive radium for cancer therapy. Given that radium concentrates in hydroxyapatite [*high-drox-ee-AP-ah-tite*], what type of tumor will radium be most useful for treating?

- W) Liver cancers
- X) Brain metastases [*meh-TAS-stah-seez*]
- Y) Thyroid cancers
- Z) Bone metastases

ANSWER: Z) BONE METASTASES

TOSS-UP

12) Earth & Space – *Multiple Choice* Which of the following changes is most directly responsible for the formation of rock melt at mid-ocean spreading ridges?

- W) Increase in temperature
- X) Increase in pressure
- Y) Decrease in temperature
- Z) Decrease in pressure

ANSWER: Z) DECREASE IN PRESSURE

BONUS

12) Earth & Space – *Short Answer* Place the following three events in the formation of a caldera in chronological order: 1) Roof collapse; 2) Eruption; 3) Magma intrusion.

ANSWER: 3, 2, 1

TOSS-UP

13) Biology – *Short Answer* The single scutellum [*skyoo-TELL-um*] found in corn kernels is analogous to what structure found in pairs in eudicot [*YOO-dih-cots*] seeds?

ANSWER: COTYLEDONS

BONUS

13) Biology – *Short Answer* Identify all of the following three examples of symbiosis that are correctly matched with the type of symbiosis they demonstrate: 1) Pig and tapeworm with commensalism; 2) Oxpecker and cattle with mutualism; 3) Ant and aphid with parasitism [*PARA-sit-izm*].

ANSWER: 2

TOSS-UP

14) Physics – *Multiple Choice* A thick ring of metal is heated and undergoes thermal expansion. Which of the following describes the changes that will occur to the inner and outer radii of the ring?

- W) Both increase
- X) Inner decreases, outer increases
- Y) Inner stays the same, outer increases
- Z) Inner decreases, outer stays the same

ANSWER: W) BOTH INCREASE

BONUS

14) Physics – *Multiple Choice* Which of the following uniform copper objects would have the highest moment of inertia when rotated about its central axis?

- W) A solid cylinder with radius ten inches and length twenty inches
- X) A hollow cylinder with outer radius ten inches, inner radius five inches, and length twenty inches
- Y) A solid sphere with radius ten inches
- Z) A hollow sphere with outer radius ten inches and inner radius five inches

ANSWER: W) A SOLID CYLINDER WITH RADIUS TEN INCHES AND LENGTH TWENTY INCHES

TOSS-UP

15) Chemistry – *Multiple Choice* What additional piece of information can be used in conjunction with an elemental analysis to determine the chemical formula of an unknown pure substance?

- W) The chemical formula can be directly calculated from the elemental analysis
- X) The nuclear magnetic resonance spectrum
- Y) The retention time on a chromatography column
- Z) The mass via mass spectrometry

ANSWER: Z) THE MASS VIA MASS SPECTROMETRY

BONUS

15) Chemistry – *Short Answer* Identify all of the following four compounds that would cause a precipitate to form when added to a solution of 0.1-molar potassium iodide: 1) Silver nitrate; 2) Calcium chloride; 3) Lead acetate; 4) Barium nitrate.

ANSWER: 1, 3

TOSS-UP

16) Earth & Space – *Short Answer* Acetylene [*ah-SET-ihl-een*] and hydrogen gas form in Titan's upper atmosphere primarily from the reactions of what molecule with ultraviolet light?

ANSWER: METHANE (ACCEPT: CH₄)

BONUS

16) Earth & Space – *Multiple Choice* Most of the helium in the universe was created in which of the following?

- W) The Big Bang
- X) Supernovas
- Y) Proton-proton chain in low-mass stars
- Z) CNO cycle in high-mass stars

ANSWER: W) THE BIG BANG

TOSS-UP

17) Math – *Short Answer* What is the limit as x approaches 7 of the function with numerator $7 - x$ and denominator $x^2 - 49$?

ANSWER: $-1/14$

BONUS

17) Math – *Short Answer* What is the quadratic polynomial with integer coefficients and smallest positive leading coefficient that has the same sum and product of all its complex zeroes as $3x^3 + 8x^2 - 5x - 2$?

ANSWER: $3x^2 + 8x + 2$

TOSS-UP

18) Energy – *Short Answer* Fermilab scientists recently reported a methodology to computationally model the interactions between fermions and bosons. Identify all of the following three particles that are fermions: 1) Electron; 2) Photon; 3) Up quark.

ANSWER: 1, 3

BONUS

18) Energy – *Multiple Choice* Scientists at Jefferson Lab recently reported observing a parity violation in an electron scattering experiment. Parity is a type of symmetry that describes the behavior of the laws of physics in which of the following situations?

- W) Observing a system from many different angles
- X) Observing a system forward and backward in time
- Y) Observing a system composed of matter versus a system composed of antimatter
- Z) Observing a system and its mirror image

ANSWER: Z) OBSERVING A SYSTEM AND ITS MIRROR IMAGE

TOSS-UP

19) Earth & Space – *Short Answer* What widespread feature in the rock record represents a gap of up to several hundred million years in the rock record between the Proterozoic [*proh-tair-oh-ZOH-ik*] and the Cambrian?

ANSWER: GREAT UNCONFORMITY

BONUS

19) Earth & Space – *Multiple Choice* In the transport of sediment, what component of the sediment load moves by saltation?

- W) Suspended load
- X) Bed load
- Y) Dissolved load
- Z) Floating load

ANSWER: X) BED LOAD

TOSS-UP

20) Chemistry – *Short Answer* In the standard zinc dry cell, the positive electrode is primarily composed of what element?

ANSWER: CARBON (ACCEPT: C)

BONUS

20) Chemistry – *Multiple Choice* Which of the following ions has the LARGEST radius?

- W) Rubidium [*roo-BID-ee-um*] plus
- X) Indium [*IN-dee-um*] three plus
- Y) Arsenic three minus
- Z) Bromine minus

ANSWER: Y) ARSENIC THREE MINUS

TOSS-UP

21) Physics – *Short Answer* For laser light passed through a diffraction grating, doubling both the wavelength of light and the spacing of the grating will multiply the peak-to-peak separation in the diffraction pattern by what factor?

ANSWER: 1

BONUS

21) Physics – *Short Answer* Consider a perfectly-reflecting mirror being irradiated with light of intensity 300,000 watts per meter squared at normal incidence. Giving your answer in pascals, what is the radiation pressure on the mirror due to this light?

ANSWER: 0.002 (ACCEPT: 1/500)

TOSS-UP

22) Math – *Short Answer* What is the antilog base 4 of 3?

ANSWER: 64

BONUS

22) Math – *Short Answer* What is the cross product of vectors $\mathbf{j} + 2\mathbf{k}$ cross $2\mathbf{i} - \mathbf{j} + 4\mathbf{k}$?

ANSWER: $6\mathbf{i} + 4\mathbf{j} - 2\mathbf{k}$

TOSS-UP

23) Biology – *Short Answer* In skeletal muscle, what ion binds to troponin [*TROH-poh-nin*] to allow actin to bind to myosin?

ANSWER: CALCIUM (ACCEPT: Ca²⁺)

BONUS

23) Biology – *Multiple Choice* Whales and dolphins are most closely related to which of the following groups of mammals?

W) Carnivora [*car-NIV-or-ah*]

X) Manatees

Y) Even-toed ungulates [*UN-gyuh-lets*]

Z) Odd-toed ungulates

ANSWER: Y) EVEN-TOED UNGULATES