

## ROUND 13

---

### TOSS-UP

1) BIOLOGY *Short Answer* Recently, the number of American bee colonies has been seriously diminished due to sudden, massive, unexplained die-offs. The agent of this epidemic has not yet been conclusively identified. What is the name of this disease?

ANSWER: COLONY COLLAPSE DISORDER (ACCEPT: CCD)

### BONUS

1) BIOLOGY *Multiple Choice* While hiking in Arizona, you come over a rise, hear a rattling sound and see a western diamondback rattlesnake coiled and ready to strike. Indicate which of the following physiological responses would NOT occur in you?

- W) Gluconeogenesis would occur in the liver
- X) Blood vessels in the gut and skin would constrict
- Y) Heart rate and blood pressure would increase
- Z) Adipose tissue would release fatty acids to the blood stream

ANSWER: W) GLUCONEOGENESIS WOULD OCCUR IN THE LIVER

---

### TOSS-UP

2) PHYSICS *Multiple Choice* Which of the following best describes why arches and domes are more stable than flat roofed structures?

- W) They transmit compressive forces along their length to the ground, uniformly bearing the load of gravity upon the structure
- X) Each section is under great tension, using the stronger dimension of the components
- Y) Torsional resistance to sideways swaying ensures that such structures are stable, even in high winds
- Z) The surface tension of the arched shape allows the building components to be hollowed out, saving weight

ANSWER: W) THEY TRANSMIT COMPRESSIVE FORCES ALONG THEIR LENGTH TO THE GROUND, UNIFORMLY BEARING THE LOAD OF GRAVITY UPON THE STRUCTURE

### BONUS

2) PHYSICS *Short Answer* Given a piece of glass with an index refraction of 2, what is the optimal index of refraction, to one decimal place, for an antireflection coating?

ANSWER: 1.4

### TOSS-UP

3) CHEMISTRY *Short Answer* Providing your answer as a decimal, what is the bond order for the oxygen-oxygen bonds in ozone?

ANSWER: 1.5

### BONUS

3) CHEMISTRY *Short Answer* Which of the following is the local VSEPR geometry of a triply-bonded alkyne carbon?

- W) Tetrahedral
- X) Trigonal planar
- Y) Linear
- Z) Bent

ANSWER: Y) LINEAR

---

### TOSS-UP

4) EARTH AND SPACE *Multiple Choice* Which of the following best describes the absorption characteristics of dust in the interstellar medium?

- W) Its effects are strongest in radio wavelengths
- X) It absorbs light at all wavelengths with about the same efficiency
- Y) It preferentially absorbs optical light at redder wavelengths
- Z) It preferentially absorbs optical light at bluer wavelengths

ANSWER: Z) IT PREFERENTIALLY ABSORBS OPTICAL LIGHT AT BLUER WAVELENGTHS

### BONUS

4) EARTH AND SPACE *Short Answer* A binary star system has one star with an apparent magnitude of 5 and a brown dwarf companion with an apparent magnitude of 15. The first star is how many times as luminous as the brown dwarf?

ANSWER: 10,000

**TOSS-UP**

5) MATH *Short Answer* If  $\log_b(5) = c$  [**log base b of 5 equals c**], then what does  $b^{4c}$  [**b to the power of 4 c**] equal?

ANSWER: 625

**BONUS**

5) MATH *Short Answer* The three sides of a triangle are 5 centimeters, 6 centimeters, and 8 centimeters. What is the cosine of the smallest angle in reduced fractional form?

ANSWER: 25/32

---

**TOSS-UP**

6) ENERGY *Short Answer* Gasoline is sold as “unleaded gas,” which is a misnomer because gasoline does not naturally contain lead. Lead was added to gasoline from the 1940s to 1980s. What was the reason for adding lead to gasoline?

ANSWER: STOP ENGINE KNOCK (ACCEPT: KNOCKING, AUTOIGNITION, INCREASE OCTANE RATING)

**BONUS**

6) ENERGY *Short Answer* Given  $g$  as 10 meters per second squared, how much power in megawatts can a perfectly efficient dam 100 meters high produce if 2000 kilograms of water pass through its turbines every second?

ANSWER: 2

### TOSS-UP

7) BIOLOGY *Multiple Choice* Horseshoe crabs are most closely related to which of the following organisms?

- W) Spiders
- X) Millipedes
- Y) Centipedes
- Z) Insects

ANSWER: W) SPIDERS

### BONUS

7) BIOLOGY *Multiple Choice* Cloning a gene into a plasmid often requires you to amplify the target DNA sequence, then digest and paste the target sequence into the plasmid. Several purified enzymes are important in this process. Which of the following enzymes would act LAST in the cloning process?

- W) Polymerase [**POL-uh-muh-rays**]
- X) Ligase [**LY-gays**]
- Y) Exonuclease [**eks-uh-NOO-kee-ays**]
- Z) Restriction endonuclease [**en-duh-NOO-kee-ays**]

ANSWER: X) LIGASE

### TOSS-UP

8) PHYSICS *Multiple Choice* A nubbin-on-a-spring keeps a door from hitting the wall. If the nubbin is flicked, such that the nubbin passes its rest point more than once before coming to rest, which of the following is true?

- W) It is undamped
- X) It is underdamped
- Y) It is critically damped
- Z) It is overdamped

ANSWER: X) IT IS UNDERDAMPED

### BONUS

8) PHYSICS *Short Answer* A potential of 10 volts is applied to a parallel plate capacitor with capacitance of 1 microfarad and a plate separation of 10 micrometers. What is the electrical force in newtons between the plates?

ANSWER: 10

### TOSS-UP

9) CHEMISTRY *Multiple Choice* Which of the following is NOT an aliphatic hydrocarbon?

- W) Benzene
- X) Propane
- Y) Cyclopropane
- Z) Cyclopentene

ANSWER: W) BENZENE

### BONUS

9) CHEMISTRY *Short Answer* Determine the entropy, in calories per mole Kelvin, of a system that is at 27° Celsius and which has undergone a 1500 calorie per mole decrease in Gibbs free energy accompanied by a negligible change in enthalpy.

ANSWER: -5

---

### TOSS-UP

10) EARTH AND SPACE *Multiple Choice* In special relativity, Lorentz contraction states that for an object moving relative to an observer, the observer will measure the object's length to be which of the following?

- W) Longer
- X) Shorter
- Y) Exactly the same
- Z) Impossible to tell

ANSWER: X) SHORTER

### BONUS

10) EARTH AND SPACE *Short Answer* With regard to Earth's axis, what are the two principal reasons that the Sun's position in the sky traces an analemma [*an-l-EM-uh*] from a fixed position at the same time each day?

ANSWER: EARTH IS TILTED AND EARTH HAS A ELLIPTICAL ORBIT

### TOSS-UP

11) MATH *Multiple Choice* Which of the following is  $\lim_{x \rightarrow 0} \frac{|x|}{x}$  [the limit as  $x$  approaches 0 of the absolute value of  $x$  over  $x$ ]?

- W) -1
- X) 0
- Y) 1
- Z) The limit does not exist

ANSWER: Z) THE LIMIT DOES NOT EXIST

### BONUS

11) MATH *Short Answer* A square has a side of 8 millimeters. Providing your answer in terms of  $\pi$  and in square millimeters, what is the difference between the areas of its circumscribed circle and its inscribed circle?

ANSWER:  $16\pi$

---

### TOSS-UP

12) ENERGY *Multiple Choice* OTEC is which of the following?

- W) A method of producing hydrogen gas using solar energy
- X) A form of tidal energy that harnesses the ebb and flow of ocean water
- Y) An organization of oil-rich countries
- Z) A method of energy generation from the thermal gradient of ocean waters

ANSWER: Z) A METHOD OF ENERGY GENERATION FROM THE THERMAL GRADIENT OF OCEAN WATERS

### BONUS

12) ENERGY *Multiple Choice* There are several ways to store wind energy for non-windy days. Which of the following methods is NOT currently being used?

- W) Pumping air into underground storage
- X) Pumping water up to elevated storage and then releasing it to drive an electric generator
- Y) Pumping water into underground storage
- Z) Charging batteries

ANSWER: Y) PUMPING WATER INTO UNDERGROUND STORAGE

### TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following does the enzyme aminoacyl-tRNA synthetase [*uh-mee-noh-AS-il T-R-N-A SIN-thuh-tays*] catalyze?

- W) Base-pairing between the tRNA and the mRNA
- X) Transfer of the amino acid from the tRNA to form a peptide bond
- Y) Charging of a tRNA with an amino acid
- Z) Synthesis of tRNA molecules

ANSWER: Y) CHARGING OF A tRNA WITH AN AMINO ACID

### BONUS

13) BIOLOGY *Short Answer* DNA replication involves many different steps. By number, arrange the following four steps in order from start to finish: 1) DNA polymerase [*POL-uh-muh-rays*] synthesizes a new DNA strand, 2) DNA ligase [*LY-gays*] repairs nicks in the phosphodiester [*fos-foh-dy-ES-tuhr*] backbone, 3) replication bubble opens at origin, 4) primase builds the primer.

ANSWER: 3, 4, 1, 2

---

### TOSS-UP

14) EARTH AND SPACE *Multiple Choice* Which of the following is NOT true about the outer core of the Earth?

- W) It is composed of iron and nickel
- X) It is highly viscous and ductile
- Y) Its temperature is greater than 4000 degrees Celsius
- Z) It is the source of Earth's magnetic field

ANSWER: X) IT IS HIGHLY VISCOUS AND DUCTILE

### BONUS

14) EARTH AND SPACE *Short Answer* The Himalayas are the result of the collision between which two tectonic plates?

ANSWER: INDIAN AND EURASIAN

### TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following is an example of a covalent bond or bonds?

- W) The bond between two adjacent amino acids in a polypeptide chain
- X) The bond between a tRNA anticodon and an mRNA codon
- Y) The bonds between the large subunit and the small subunit of the ribosome **[RY-buh-sohm]**
- Z) The bonds between the small ribosomal subunit and the mRNA

ANSWER: W) THE BOND BETWEEN TWO ADJACENT AMINO ACIDS IN A POLYPEPTIDE CHAIN

### BONUS

15) BIOLOGY *Short Answer* An F1 individual plant is heterozygous for each of four traits and is allowed to self-fertilize. The plant produces 128 offspring. How many of the offspring would you expect to have the genotype AaBBccDd **[big A little a big B big B little c little c big D little d]**?

ANSWER: 2

---

### TOSS-UP

16) PHYSICS *Multiple Choice* Work  $W$  is done to extend a spring beyond its natural length by a small distance  $x$ . Assuming a spring constant of 1, which of the following is the magnitude of the maximum force done by the person stretching the spring?

- W)  $x$
- X)  $x/2W$
- Y)  $2W/x$
- Z)  $2W/x^2$

ANSWER: Y)  $2W/x$

### BONUS

16) PHYSICS *Short Answer* If a spaceship moving at relativistic speed  $v$  appears to be shortened to  $4/5$  its original length, what is its speed as a fraction of the speed of light,  $c$ , in lowest terms?

ANSWER:  $3c/5$  OR  $(3/5)c$

### TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following has the lowest freezing point?

- W) Water
- X) Chloroform
- Y) Acetic acid
- Z) Ethanol

ANSWER: Z) ETHANOL

### BONUS

17) CHEMISTRY *Short Answer* Given that the  $K_b$  of a particular solvent is  $2.53\text{ }^\circ\text{C}$  per molal and providing your answer to two decimal places, by how many degrees Celsius would the boiling point of a solution be raised if it contains 3.0 moles of a nonelectrolyte in 6.0 kilograms of solvent?

ANSWER: 1.27 (ACCEPT: 1.26)

---

### TOSS-UP

18) EARTH AND SPACE *Short Answer* What protects Earth's atmosphere from being directly struck by solar wind?

ANSWER: EARTH'S MAGNETIC FIELD (ACCEPT: MAGNETOSPHERE)

### BONUS

18) EARTH AND SPACE *Short Answer* List the three most common gases in dry atmosphere on Earth from highest percentage to least.

ANSWER: NITROGEN, OXYGEN, AND ARGON (ANSWERS MUST BE IN THIS ORDER)

### TOSS-UP

19) MATH *Short Answer* Find the measure in degrees of the largest angle of a triangle with sides of 24 centimeters, 7 centimeters, and 25 centimeters.

ANSWER: 90°

### BONUS

19) MATH *Short Answer* Providing your answers as improper fractions in lowest terms, solve  $-7 + |3 - 2x| = 15$  [**negative 7 plus the absolute value of the quantity 3 minus 2x equals 15**] for  $x$ .

ANSWER: -19/2 AND 25/2

---

### TOSS-UP

20) ENERGY *Short Answer* What is the common name of the process by which heavy hydrocarbons are broken down into simpler molecules such as light hydrocarbons?

ANSWER: CRACKING

### BONUS

20) ENERGY *Short Answer* What is the name for the prediction that an ideal blackbody would emit short wavelength radiation with infinite power?

ANSWER: ULTRAVIOLET CATASTROPHE (ACCEPT: RAYLEIGH-JEANS CATASTROPHE)

### TOSS-UP

21) MATH *Short Answer* How many points of intersection exist for the graphs of  $y = 2^x$  [**y equals 2 to the power of x**] and  $y = -x^2 + 2$ ?

ANSWER: 2

### BONUS

21) MATH *Short Answer* A different universe has nine spatial dimensions. If an object travels four meters in all nine dimensions, then what is the object's displacement in meters in this universe?

ANSWER: 12

---

### TOSS-UP

22) PHYSICS *Short Answer* What two word phrase describes an electromagnetic wave in which the electric field lies in a single plane along the direction of propagation?

ANSWER: LINEARLY POLARIZED

### BONUS

22) PHYSICS *Multiple Choice* Planets A and B are in circular orbits about the same star. Planet A's orbital radius is three times as large as Planet B's. Which of the following is the ratio of Planet A's orbital period to Planet B's?

W)  $\sqrt{3}$

X)  $\sqrt{3}/2$

Y)  $3^{3/2}$  [**three to the power of the quantity three over two**]

Z)  $3^{2/3}$  [**three to the power of the quantity two over three**]

ANSWER: Y)  $3^{3/2}$

**TOSS-UP**

23) CHEMISTRY *Short Answer* Carbon nanotubes are potentially useful in applications such as nanotechnology, optics, and electronics. What allotrope of carbon makes up these cylinders?

ANSWER: FULLERENE (ACCEPT: BUCKMINSTERFULLERENE OR BUCKYTUBE)

**BONUS**

23) CHEMISTRY *Short Answer* The wavelength of light emitted from a quantum dot generally depends on what feature of the dot?

ANSWER: SIZE (ACCEPT: DIAMETER)

---

**TOSS-UP**

24) EARTH AND SPACE *Multiple Choice* During the Earth's equinoxes, which of the following is NOT true?

- W) Daytime and nighttime are equal in length
- X) They occur at the perihelion and aphelion of Earth's orbit
- Y) They occur during fall and spring
- Z) The Sun is directly overhead at the equator

ANSWER: X) THEY OCCUR AT THE PERIHELION AND APHELION OF EARTH'S ORBIT

**BONUS**

24) EARTH AND SPACE *Multiple Choice* Which of the following is NOT used as evidence for plate tectonic theory?

- W) Deposition of glacial dropstones in Australian bedrock
- X) Elevation and increased heat flow at the Mid-Atlantic Ridge
- Y) Correlation of fossils between Africa and South America
- Z) Successively deeper earthquakes at the Peru-Chili trench

ANSWER: W) DEPOSITION OF GLACIAL DROPSTONES IN AUSTRALIAN BEDROCK

### TOSS-UP

25) BIOLOGY *Short Answer* On a phylogenetic [*fy-LOJ-uh-neek*] tree, two species are grouped in the same clade. What is represented by the branch point that joins these two species?

ANSWER: COMMON ANCESTOR

### BONUS

25) BIOLOGY *Multiple Choice* You're investigating guinea pig coat genetics, and you've found an interesting new phenotype: spiral guinea pig fur. If you take a purebred wavy-hair guinea pig and cross it with a purebred kinked-hair guinea pig, you get all spiral-hair progeny. If you mate spiral-hair guinea pigs with each other, the progeny have a phenotypic ratio of 9 spiral: 3 wavy: 3 kinked: 1 straight. Which of the following is most likely to be true given your experimental results?

W) There are two different genes that result in the wavy and kinked phenotypes, and there is an epistatic interaction between them

X) There are two different genes that result in the wavy and kinked phenotypes, and they are linked

Y) There are two different genes that result in the wavy and kinked phenotypes, and they are independently assorting

Z) There is only one gene with a number of different alleles

ANSWER: Y) THERE ARE TWO DIFFERENT GENES THAT RESULT IN THE WAVY AND KINKED PHENOTYPES, AND THEY ARE INDEPENDENTLY ASSORTING