

## ROUND 11

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### TOSS-UP

1) BIOLOGY *Multiple Choice* In elephant seals, sexual selection favors competition among males for female mates. Which of the following is a likely result of this phenomenon?

- W) Sexual monomorphism [*mon-uh-MOHR-fis-uhm*]
- X) Evolution of female handicap structures
- Y) Directional selection toward large male size
- Z) Conspicuous coloration of females

ANSWER: Y) DIRECTIONAL SELECTION TOWARD LARGE MALE SIZE

### BONUS

1) BIOLOGY *Short Answer* What is the name of the principle that describes the asymmetric fitness pressures between males and females that can lead to sexual selection and evolution?

ANSWER: BATEMAN'S

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### TOSS-UP

2) EARTH AND SPACE *Multiple Choice* Which of the following minerals is NOT typically found in the rock granite?

- W) Olivine
- X) Plagioclase [*PLAY-jee-uh-kays*]
- Y) Quartz
- Z) Hornblende

ANSWER: W) OLIVINE

### BONUS

2) EARTH AND SPACE *Multiple Choice* If two black holes orbit one another at a distance of a few Schwarzschild radii [*RAY-dee-eye*], their orbits will slowly shrink until they merge. By which of the following processes does this occur?

- W) Dynamic friction
- X) Gravitational radiation
- Y) Third-body interactions
- Z) Drag from the accretion disks

ANSWER: X) GRAVITATIONAL RADIATION

### TOSS-UP

3) PHYSICS *Multiple Choice* The electron transitions responsible for the generation of light have durations on the order of  $10^{-8}$  seconds. Which of the following best represents the natural linewidth in hertz of the resulting visible light?

- W)  $10^{-8}$
- X) 3
- Y)  $10^8$
- Z)  $10^{16}$

ANSWER: Y)  $10^8$

### BONUS

3) PHYSICS *Multiple Choice* Which of the following types of thermometer is based on the difference in the voltage induced by a temperature gradient in two metals?

- W) Beckman
- X) Silicon band gap
- Y) Thermistor
- Z) Thermocouple

ANSWER: Z) THERMOCOUPLE

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### TOSS-UP

4) MATH *Multiple Choice* Which of the following is equivalent to  $\sin 24^\circ \cos 17^\circ + \cos 24^\circ \sin 17^\circ$  [*sine of 24 degrees times cosine of 17 degrees plus cosine of 24 degrees times sine of 17 degrees*]?

- W) Sine of  $7^\circ$
- X) Cosine of  $41^\circ$
- Y) Sine of  $41^\circ$
- Z) Tangent of  $41^\circ$

ANSWER: Y) SINE OF  $41^\circ$

### BONUS

4) MATH *Short Answer* Solve for  $x$ :  $5 + \sqrt{x + 14} = x + 7$  [*5 plus the square root of the quantity x plus 14 equals x plus 7*].

ANSWER: 2 (DO NOT ACCEPT: -5)

### TOSS-UP

5) CHEMISTRY *Multiple Choice* Which of the following is false regarding the reaction  $A_{(g)} + B_{(s)} \rightarrow C_{(s)}$ ? **(READ IS: A gaseous plus B solid yields C solid)**

- W) As pressure decreases, reaction rate decreases
- X) As temperature increases, reaction rate increases
- Y) As surface area increases, reaction rate decreases
- Z) When a catalyst is added, reaction rate increases

ANSWER: Y) AS SURFACE AREA INCREASES, REACTION RATE DECREASES

[NOTE:  $\rightarrow$  = YIELDS; (G) = GASEOUS; (S) = SOLID]

### BONUS

5) CHEMISTRY *Short Answer* Calculate the change in energy from a hydrogen atom's ground state to its first excited state in Rydbergs.

ANSWER: +3/4

### TOSS-UP

6) ENERGY *Short Answer* When processing mined uranium ore, it is first crushed to a fine powder and then processed with concentrated acid, alkaline, or peroxide solutions to leach out the uranium. What is the common term for the remaining coarse powder?

ANSWER: YELLOWCAKE (ALSO ACCEPT: URANIA)

### BONUS

6) ENERGY *Multiple Choice* Which of the following metabolites has the most negative standard Gibbs free energy of hydrolysis [*hy-DROL-uh-sis*]?

- W) Phosphocreatine [*fohs-foh-KREE-uh-teen*]
- X) Pyrophosphate [*py-roh-FOS-fayt*]
- Y) Glucose 1-phosphate
- Z) Phosphoenolpyruvate [*fohs-foh-uh-nol-py-ROO-vayt*]

ANSWER: Z) PHOSPHOENOLPYRUVATE

### TOSS-UP

7) BIOLOGY *Short Answer* Name the water soluble vitamin found in nuts, grains, and meats that functions in vertebrates as a component of the coenzyme NAD<sup>+</sup>.

ANSWER: VITAMIN B3 (ACCEPT: NIACIN, NICOTINIC ACID, NICOTINAMIDE, VITAMIN PP; DO NOT ACCEPT: VITAMIN B7, BIOTIN)

### BONUS

7) BIOLOGY *Multiple Choice* Which of the following is most likely to cause sympatric speciation?

- W) Mountain building
- X) Habitat fragmentation
- Y) Polyploidy [**pol-ee-PLOI-dy**]
- Z) Urbanization

ANSWER: Y) POLYPLOIDY

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### TOSS-UP

8) EARTH AND SPACE *Short Answer* Name the three quantities that can completely describe any black hole.

ANSWER: SPIN, MASS, CHARGE (ACCEPT: ANGULAR MOMENTUM OR ANGULAR VELOCITY INSTEAD OF SPIN)

### BONUS

8) EARTH AND SPACE *Multiple Choice* Which of the following is the dominant cooling mechanism in a core-collapse supernova?

- W) X-rays and gamma-rays
- X) Synchrotron emission
- Y) Neutrinos
- Z) Electron evaporation

ANSWER: Y) NEUTRINOS

### TOSS-UP

9) PHYSICS *Short Answer* In your interferometry [*in-ter-fuh-ROM-i-try*] experiment, you measure a minimum intensity of 1 watt per meter squared and a maximum intensity of 19 watts per meter squared. What is the visibility of your fringes?

ANSWER: 0.9

### BONUS

9) PHYSICS *Short Answer* The sound source of a ship's sonar system operates at a frequency 22 kilohertz. The speed of sound in water is 1482 meters per second. Providing your answer to the nearest hundredth, what is the wavelength of the waves in meters emitted by the source?

ANSWER: 0.07

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### TOSS-UP

10) MATH *Short Answer* If the exterior angle of a base angle of an isosceles [*eye-SOS-uh-lees*] triangle measures  $141^\circ$ , what is the measure of the vertex angle?

ANSWER:  $102^\circ$

### BONUS

10) MATH *Short Answer* If  $f(x) = -2x - e^x$  [*f of x equals negative 2x minus e to the x*], what is the range of  $f'$  [*the derivative of f*]?

ANSWER:  $(-\infty, -2)$  (ACCEPT:  $x < -2$  or THE OPEN INTERVAL FROM NEGATIVE INFINITY TO -2)

### TOSS-UP

11) CHEMISTRY *Multiple Choice* Which of the following compounds would be insoluble in an aqueous **[AY-kwee-uhs]** solution?

- W) Calcium carbonate
- X) Sodium nitrate
- Y) Ammonium hydroxide
- Z) Potassium perchlorate

ANSWER: W) CALCIUM CARBONATE

### BONUS

11) CHEMISTRY *Multiple Choice* Which of the following accurately depicts the hybridization **[HY-bri-dy-zay-shuhn]** of each atom in the molecule krypton difluoride?

- W) Krypton:  $sp^3$ ; each fluorine:  $sp^3$
- X) Krypton:  $sp^3d$ ; each fluorine:  $sp^3$
- Y) Krypton:  $sp^3d^2$ ; each fluorine:  $sp^2$
- Z) Krypton:  $sp^3d$ ; each fluorine:  $sp^2$

ANSWER: X) KRYPTON:  $sp^3d$ ; EACH FLUORINE:  $sp^3$

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### TOSS-UP

12) ENERGY *Multiple Choice* Which of the following was NOT an effect of removing sulfur from diesel fuel?

- W) It lowered the nitrous oxides and soot emissions
- X) It slightly increased gas mileage in diesel engines
- Y) It allowed the use of advanced emissions control systems
- Z) It reduced the lubricity of the fuel

ANSWER: X) IT SLIGHTLY INCREASED GAS MILEAGE IN DIESEL ENGINES

### BONUS

12) ENERGY *Multiple Choice* Which of the following most accurately describes an advantage of a nuclear fusion reactor over a nuclear fission reactor?

- W) A failure of control systems shuts down the fusion reactor
- X) Fusion based nuclear plants are much less expensive than fission plants
- Y) Fusion reactors operate at a lower temperature than fission reactors
- Z) The fuel rods in the fusion reactor can be reused

ANSWER: W) A FAILURE OF CONTROL SYSTEMS SHUTS DOWN THE FUSION REACTOR

### TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following best exemplifies secondary endosymbiosis [*en-doh-sim-bee-OH-sis*]?

- W) Human white blood cell phagocytosis [*fag-uh-sy-TOH-sis*] of a pathogenic bacterium
- X) Cyanobacterium [*sy-uh-noh-bak-TEER-ee-uhm*] is engulfed by a heterotrophic eukaryote [*het-er-uh-TROF-ik yoo-KAR-ee-oh*]
- Y) A heterotrophic eukaryote engulfs a green algal eukaryote
- Z) Receptor mediated endocytosis [*en-doh-sy-TOH-sis*]

ANSWER: Y) HETEROTROPHIC EUKARYOTE ENGULFS A GREEN ALGAL EUKARYOTE

### BONUS

13) BIOLOGY *Short Answer* In cladistics [*kluh-DIS-tiks*], what is the term for a group of organisms used as a standard for comparison in constructing a phylogenetic [*fy-luh-JEN-uh-tik*] tree?

ANSWER: OUTGROUP

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### TOSS-UP

14) EARTH AND SPACE *Multiple Choice* The curve that the position of the Sun at noon traces on the sky over the course of a year most closely resembles which of the following?

- W) Line
- X) Figure 8
- Y) Ellipse
- Z) Circle

ANSWER: X) FIGURE 8

### BONUS

14) EARTH AND SPACE *Multiple Choice* Which of the following should NEVER occur?

- W) Mercury at inferior conjunction
- X) Venus at opposition
- Y) Mars at eastern quadrature
- Z) Jupiter at conjunction

ANSWER: X) VENUS AT OPPOSITION

### TOSS-UP

15) PHYSICS *Multiple Choice* According to Maxwell's equations, which of the following does NOT exist?

- W) Infinitely separated charges
- X) Magnetic monopoles
- Y) Magnetically contained plasma
- Z) Superconductivity

ANSWER: X) MAGNETIC MONOPOLES

### BONUS

15) PHYSICS *Short Answer* A person who weighs 200 pounds on Earth, where acceleration due to gravity is 9.8 meters per second squared, is standing in a circular rotating space station in outer space, with a tangential speed of 300 meters per second. If the radius of the station is 9184 meters, what will the person weigh in the space station?

ANSWER: THE SAME (ACCEPT: 200 POUNDS)

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### TOSS-UP

16) MATH *Short Answer* Providing your answer as a fraction in lowest terms, if a family has exactly four children, what is the probability of having three girls and one boy?

ANSWER:  $\frac{1}{4}$

### BONUS

16) MATH *Short Answer* If the radius of a spherical balloon is expanding at the rate of 5 inches per second, assuming the initial volume is 0 and providing your answer as an improper fraction in lowest terms, what is its volume in inches cubed in terms of  $\pi$  after 2 seconds?

ANSWER:  $4000\pi/3$



### TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following is the molarity of a 3.0 liter solution that contains 21 grams of methane?

- W) 0.15
- X) 0.32
- Y) 0.44
- Z) 0.56

ANSWER: Y) 0.44

### BONUS

17) CHEMISTRY *Short Answer* Given that the  $K_a$  of benzoic acid is  $6.4 \times 10^{-5}$  and its  $pK_a$  is 4.2, providing your answer to one decimal place, what is the pH of a solution of 0.1 molar benzoic acid and 0.10 molar sodium benzoate?

ANSWER: 3.2

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### TOSS-UP

18) ENERGY *Short Answer* What microscopy technique uses energy transfer between two molecules to measure the distance between the molecules?

ANSWER: FLUORESCENCE RESONANCE ENERGY TRANSFER (ACCEPT: FRET OR FORSTER RESONANCE ENERGY TRANSFER)

### BONUS

18) ENERGY *Multiple Choice* Fatty acid synthesis uses which of the following kinds of metabolic pathways?

- W) Spiral
- X) Branched
- Y) Linear
- Z) Cyclic

ANSWER: W) SPIRAL

**TOSS-UP**

19) BIOLOGY *Multiple Choice* Which of the following bird species feeds their young crop milk for the first few days after hatching?

- W) Pigeons
- X) Gulls
- Y) Ostriches
- Z) Hawks

ANSWER: W) PIGEONS

**BONUS**

19) BIOLOGY *Short Answer* What is the common name of one mammal species that is not viviparous [*vy-VIP-ayr-uhs*]?

ANSWER: DUCK BILLED PLATYPUS OR SPINY ANTEATERS (ACCEPT: ECHIDNAS)

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**TOSS-UP**

20) EARTH AND SPACE *Short Answer* The North Star today is Polaris. In the time of the Babylonians, it was Thuban. What is the reason for this change?

ANSWER: PRECESSION OF THE EQUINOXES (ACCEPT: PRECESSION OR AXIAL PRECESSION)

**BONUS**

20) EARTH AND SPACE *Short Answer* What kind of telescope mount requires motion along only one axis to track a celestial object?

ANSWER: EQUATORIAL

### TOSS-UP

21) PHYSICS *Short Answer* A 2 kilogram box is pushed starting from rest along a horizontal surface with a force of 10 newtons. If the frictional force is 4 newtons, how long in seconds will it take the box to reach a speed of 15 meters per second?

ANSWER: 5

### BONUS

21) PHYSICS *Short Answer* A rock is tied to the end of a 1 meter long string and spun in a vertical circle. Providing your answer as a decimal to the nearest hundredth, what is the minimum speed in meters per second it can travel and just get around the top, given acceleration due to gravity as 10 meters per second squared?

ANSWER: 3.16

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### TOSS-UP

22) MATH *Multiple Choice* Given triangle ABC with right angle A, angle B with a measure of  $30^\circ$ , and AC equal to  $3\sqrt{3}$ , which of the following is the length of side AB?

W) 9

X)  $6\sqrt{3}$

Y)  $9\sqrt{3}$

Z)  $12\sqrt{3}$

ANSWER: W) 9

### BONUS

22) MATH *Short Answer* What are the radius and the coordinates of the center of the circle with equation  $x^2 + 6x + y^2 + 8y = 0$ ?

ANSWER: RADIUS = 5; CENTER = (-3, -4)

### TOSS-UP

23) CHEMISTRY *Multiple Choice* What stress applied to an equilibrium [**ee-kwuh-LIB-ree-uhm**] causes the equilibrium to shift to the side with fewer moles of gas?

- W) Increase in pressure
- X) Increase in volume
- Y) Increase in temperature
- Z) Addition of a catalyst

ANSWER: W) INCREASE IN PRESSURE

### BONUS

23) CHEMISTRY *Multiple Choice* Which of the following would be most likely to undergo an S<sub>N</sub>1, reaction?

- W) Methyl bromide
- X) 2-propyl bromide
- Y) Isopropyl chloride
- Z) Tert-butyl chloride

ANSWER: Z) TERT-BUTYL CHLORIDE

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### TOSS-UP

24) BIOLOGY *Short Answer* Who is credited with creating the binomial system for naming species?

ANSWER: KARL VON LINNE OR CAROLUS LINNEAUS

### BONUS

24) BIOLOGY *Multiple Choice* Which of the following plant hormones is NOT correctly matched with hormone effect?

- W) Cytokinin [**sy-tuh-KY-nin**]: promotes seed dormancy
- X) Abscisic acid: promotes stomata closing
- Y) Ethylene [**ETH-uh-leen**]: promotes fruit ripening
- Z) Auxin [**AWK-sin**]: gravitropism

ANSWER: W) CYTOKININ: PROMOTES SEED DORMANCY

### TOSS-UP

25) EARTH AND SPACE *Multiple Choice* Surface temperature of the Earth is NOT dependent upon which of the following?

- W) Heat loss from the interior of the Earth
- X) Amount of incident sunlight
- Y) Planet's reflectivity
- Z) Greenhouse effect of the atmosphere

ANSWER: W) HEAT LOSS FROM THE INTERIOR OF THE EARTH

### BONUS

25) EARTH AND SPACE *Short Answer* The basic building block of the silicates, the silicon-oxygen tetrahedron, carries what overall charge?

ANSWER: -4