

ROUND 6

TOSS-UP

1) BIOLOGY *Multiple Choice* Which of the following methods of dissemination of bacterial genetic material is mismatched to its description?

- W) Transduction: viral transfer of one cell's DNA to another
- X) Binary fission: cellular division
- Y) Conjugation: through physical interaction, a donor cell transfers genetic material to a recipient cell
- Z) Transformation: one bacteria engulfs another to integrate its DNA

ANSWER: Z) TRANSFORMATION: ONE BACTERIA ENGULFS ANOTHER TO INTEGRATE ITS DNA

BONUS

1) BIOLOGY *Multiple Choice* In one form of epigenetics called genomic imprinting, DNA is silenced by what mechanism?

- W) Methylation
- X) Acetylation [*uh-SET-l-ay-shuhn*]
- Y) Phosphorylation [*FOS-for-uh-lay-shuhn*]
- Z) Ubiquitylation [*yoo-bi-kwi-ty-LAY-shuhn*]

ANSWER W) METHYLATION

TOSS-UP

2) PHYSICS *Multiple Choice* A box of proper length l , proper width w , and proper height h is falling right-side up without tumbling toward the ground. The Lorentz contraction predicts that which of the following dimensions will be contracted?

- W) Only height
- X) Only height and length
- Y) Only length and width
- Z) Height, width and length

ANSWER: W) ONLY HEIGHT

BONUS

2) PHYSICS *Short Answer* A curve banked at 45° has a radius of 62.5 meters. Assuming $g = 10$ meters per second squared, if a car is to navigate through the curve with no friction needed, with what speed, in meters per second, should the car travel?

ANSWER: 25

TOSS-UP

3) MATH *Short Answer* A cube painted red on all sides has an edge length of 4 inches. If the cube is then cut into 64 cubes of edge length 1 inch, how many of the 1 inch cubes have exactly one face painted red?

ANSWER: 24

BONUS

3) MATH *Multiple Choice* A point has rectangular coordinates (3, 3). What are its equivalent polar coordinates?

W) $(3, \pi/6)$

X) $(3, \pi/4)$

Y) $(3\sqrt{2}, \pi/6)$

Z) $(3\sqrt{2}, \pi/4)$

ANSWER: Z) $(3\sqrt{2}, \pi/4)$

TOSS-UP

4) ENERGY *Multiple Choice* What percentage of the world's geothermally produced electricity is produced in the United States?

W) 11%

X) 17%

Y) 24%

Z) 30%

ANSWER: Z) 30%

BONUS

4) ENERGY *Multiple Choice* Which of the following is NOT a type of vacuum pump?

W) Scroll pump

X) Roots blower

Y) Diaphragm compressor

Z) Turbomolecular pump

ANSWER: Y) DIAPHRAGM COMPRESSOR

TOSS-UP

5) EARTH AND SPACE *Multiple Choice* Which of the following are the latitudes most favorable for tornadogenesis [*tohr-nuh-doh-JEN-uh-sis*]?

- W) 30 – 50 degrees north and south
- X) 45 – 60 degrees north
- Y) 0 – 10 degrees north and south
- Z) 0 – 60 degrees north

ANSWER: W) 30- 50 DEGREES NORTH AND SOUTH

BONUS

5) EARTH AND SPACE *Multiple Choice* The rest frame lifetime of a muon is 2.2 microseconds. Muons are produced in the upper atmosphere by collisions with cosmic rays. The light travel time from the upper atmosphere to the ground is about 150 microseconds. Nevertheless, a substantial fraction of muons produced in the upper atmosphere are observed on the ground. For an observer on the ground, which of the following principles best explains this phenomenon?

- W) Length contraction
- X) Atmospheric scintillation
- Y) Time dilation
- Z) Pair production

ANSWER: Y) TIME DILATION

TOSS-UP

6) CHEMISTRY *Multiple Choice* Which of the following molecules can NOT be isolated as an optically pure sample?

- W) Valine [*VAL-een*]
- X) Tartaric acid
- Y) Epichlorohydrin [*ep-i-klawr-uh-HY-drin*]
- Z) *Trans*-4-chlorocyclohexanol [*klohr-oh-SY-kloh-HEK-suh-nol*]

ANSWER: Z) TRANS-4-CHLOROCYCLOHEXANOL

BONUS

6) CHEMISTRY *Short Answer* What two chemists, in 2001, were awarded half the Nobel Prize for their work on asymmetric hydrogenation?

ANSWER: KNOWLES AND NOYORI

TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following infectious agents should a human be least concerned about contracting?

- W) Prion
- X) Viroid
- Y) Retrovirus
- Z) RNA virus

ANSWER: X) VIROID

BONUS

7) BIOLOGY *Multiple Choice* Which of the following molecules catalyzes the formation of peptide bonds between amino acids?

- W) Protease
- X) Ribosome
- Y) Pepsin
- Z) Kinase

ANSWER: X) RIBOSOME

TOSS-UP

8) PHYSICS *Multiple Choice* Which of the following statements is NOT true?

- W) Electrons, protons, and neutrons obey the Pauli exclusion principle
- X) The Pauli exclusion principle applies to all fermions
- Y) All fermions have a spin of $1/2$
- Z) Electrons, protons, and neutrons obey Fermi-Dirac distribution

ANSWER: Y) ALL FERMIONS HAVE A SPIN OF $1/2$

BONUS

8) PHYSICS *Short Answer* Two light waves travel the same distance of 6×10^{-7} meters but in mediums of refractive indices 1.54 and 1.00. Providing your answer in scientific notation to one significant figure, what is the time delay in seconds between waves?

ANSWER: 1×10^{-15}

TOSS-UP

9) MATH *Multiple Choice* The price of an item is discounted by 10% and then the new price is further discounted by 20%. What single discount is equivalent to this double discount?

- W) 15%
- X) 28%
- Y) 30%
- Z) 72%

ANSWER: X) 28%

BONUS

9) MATH *Short Answer* Let $g(x) = (x - 1)^2$ [g of x equal the square of the quantity x minus 1]. What is the set of all real values of x for which $g(x) > 4$ [g of x is greater than 4]?

ANSWER: $x < -1$ OR $x > 3$ (MUST GIVE BOTH ANSWERS)

TOSS-UP

10) ENERGY *Multiple Choice* Which of the following metals reacts violently with water?

- W) Gold
- X) Lithium
- Y) Iron
- Z) Mercury

ANSWER: X) LITHIUM

BONUS

10) ENERGY *Multiple Choice* How many electrons are transferred for the complete electrochemical oxidation of one hydrogen molecule in a fuel cell?

- W) 1
- X) 2
- Y) 4
- Z) 6

ANSWER: X) 2

TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Which of the following factors is most important in controlling the density of seawater?

- W) Temperature
- X) Salinity
- Y) Pressure
- Z) Amount of oxygen in water

ANSWER: W) TEMPERATURE

BONUS

11) EARTH AND SPACE *Short Answer* The Palmer Drought Severity Index is based on five factors: precipitation, evapotranspiration, the amount of water needed for soil recharge, the amount of runoff needed to keep bodies of water at normal levels and what other factor?

ANSWER: STORED SOIL MOISTURE (ACCEPT: SOIL MOISTURE)

TOSS-UP

12) CHEMISTRY *Multiple Choice* Which of the following statements is NOT true of polyunsaturated fatty acids?

- W) They are highly concentrated in cell membranes of the nervous system
- X) They are the most prevalent fatty acid found in the human body
- Y) They contain two or more double bonds
- Z) They play a crucial role in brain function

ANSWER: X) THEY ARE THE MOST PREVALENT FATTY ACID FOUND IN THE HUMAN BODY

BONUS

12) CHEMISTRY *Multiple Choice* Which of the following is NOT true of conjugated dienes [**DI-*eens***]?

- W) Increasing conjugation is proportional to increased UV wavelength absorption
- X) Heats of formation are lower than unconjugated dienes
- Y) *s*-trans dienes participate in Diels-Alder cyclization
- Z) At lower temperatures, 1, 2-addition products predominate

ANSWER: Y) *s*-TRANS DIENES PARTICIPATE IN DIELS-ALDER CYCLIZATION

TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following portions of a gene could ultimately be translated to protein?

- W) Exon
- X) Terminator
- Y) Intron
- Z) Promoter

ANSWER: W) EXON

BONUS

13) BIOLOGY *Multiple Choice* What is the reason why many modern crop-producing plants, such as wheat, have much larger cell volumes than the ancestral wild plants from which they were derived?

- W) Plants can tolerate trisomy [*TRY-soh-mee*]
- X) Plants can tolerate polyploidy [*pol-ee-PLOI-dee*]
- Y) Plants have been genetically engineered
- Z) Plants tolerate gene duplications

ANSWER X) PLANTS CAN TOLERATE POLYPLOIDY

TOSS-UP

14) PHYSICS *Multiple Choice* A projectile is launched tangentially to the Earth's surface with a speed such that it will neither collide with the Earth nor escape its gravity. Ignoring air resistance, this projectile's trajectory will have what shape?

- W) Parabolic
- X) Circular
- Y) Elliptical
- X) Hyperbolic

ANSWER: Y) ELLIPTICAL

BONUS

14) PHYSICS *Multiple Choice* A 100 meter spaceship moves past you with speed $\sqrt{3}c/2$. At what length in meters do you measure the spaceship?

- W) 50
- X) $50\sqrt{3}$
- Y) 100
- Z) 200

ANSWER: W) 50

TOSS-UP

15) MATH *Multiple Choice* In the mid-state football conference, each team plays every other team exactly once during a calendar year. If a total of 45 conference games were played in 2012, how many teams were in the conference?

- W) 8
- X) 9
- Y) 10
- Z) 11

ANSWER: Y) 10

BONUS

15) MATH *Short Answer* Given $f(x) = \sqrt{2-x}$ [f of x equals the square root of the quantity 2 minus x], for what value or values of x does $f(x+2) = 1$ [f of the quantity x plus 2 equals 1]?

ANSWER: $x = -1$

TOSS-UP

16) ENERGY *Multiple Choice* Which of the following will generally cause the kinetics of a reaction to increase?

- W) Decreasing surface area
- X) Decreasing concentration
- Y) Increasing temperature
- Z) Increasing number of side reactions

ANSWER: Y) INCREASING TEMPERATURE

BONUS

16) ENERGY *Short Answer* In megajoules, how much energy does a 2.5 kilowatt stove use if turned on for two hours?

ANSWER: 18

TOSS-UP

17) EARTH AND SPACE *Multiple Choice* The Coriolis effect causes objects moving in the Northern Hemisphere to veer in which of the following ways?

- W) To the right, or clockwise when viewed from above
- X) To the left, or counterclockwise when viewed from above
- Y) In an upward direction
- Z) In a downward direction

ANSWER: W) TO THE RIGHT, OR CLOCKWISE WHEN VIEWED FROM ABOVE

BONUS

17) EARTH AND SPACE *Short Answer* The average kinetic energy of ions in the solar core is too low to overcome the Coulomb barrier between the ions. What phenomenon allows nuclear fusion to take place nevertheless?

ANSWER: QUANTUM TUNNELING

TOSS-UP

18) CHEMISTRY *Multiple Choice* Which of the following is generally NOT considered to be an appropriate S_N2 electrophile?

- W) Benzyl bromide
- X) Allyl bromide
- Y) Propargyl bromide
- Z) Vinyl bromide

ANSWER: Z) VINYL BROMIDE

BONUS

18) CHEMISTRY *Short Answer* What is the major organic product formed when 1-butanol is treated with the Collins reagent?

ANSWER: BUTANAL

TOSS-UP

19) BIOLOGY *Multiple Choice* In a landmark 1958 study by researchers Meselson and Stahl involving nitrogen isotope labeling, which of the following important DNA replication mechanisms was supported by their data?

- W) Semiconservative
- X) Dispersive
- Y) Conservative
- Z) Transformative

ANSWER: W) SEMICONSERVATIVE

BONUS

19) BIOLOGY *Multiple Choice* What is the term for deposition of solid matter composed of mineral substances and salts, formed in any portion of the human body, such as kidney stones?

- W) Calculus
- X) Caries
- Y) Carbuncle
- Z) Cachexia [*kuh-KEK-see-uh*]

ANSWER: W) CALCULUS

TOSS-UP

20) PHYSICS *Short Answer* Ryan, who weighs 150 pounds, and Kate, who weighs 50 pounds, are standing on slippery ice and push off from each other. Ignoring friction, if Ryan moves off at 1 meter per second, Kate moves off with what speed in meters per second?

ANSWER: 3

BONUS

20) PHYSICS *Multiple Choice* The orbit of Mercury has a semi major axis of 0.4 AU and an eccentricity of 0.2. At which of the following distances from the Sun in AU will Mercury move the slowest?

- W) 0.3
- X) 0.4
- Y) 0.5
- Z) 0.8

ANSWER: Y) 0.5

TOSS-UP

21) MATH *Short Answer* The IQ of a Martian varies directly with the square of the number of tentacles it has. If a Martian with 5 tentacles has an IQ of 75, what is the IQ of a Martian having 8 tentacles?

ANSWER: 192

BONUS

21) MATH *Multiple Choice* If $y = 2\cos^2x$ [**y equals 2 cosine squared of x**], what is dy/dx at $x = \pi/4$?

- W) -2
- X) -1
- Y) 1
- Z) 2

ANSWER: W) -2

TOSS-UP

22) EARTH AND SPACE *Short Answer* What two underwater events can cause tsunamis?

ANSWER: EARTHQUAKES AND VOLCANIC ERUPTIONS (ACCEPT: SUBMARINE LANDSLIDES, MASS WASTING EVENTS, LANDSLIDES)

BONUS

22) EARTH AND SPACE *Multiple Choice* Even if nothing was done to clean up the 2010 Deepwater Horizon oil spill in the Gulf of Mexico, which of the following areas would likely remain unaffected by the oil floating on the surface?

- W) Brazil
- X) Florida
- Y) Cape Hatteras
- Z) Yucatan Peninsula

ANSWER: W) BRAZIL

TOSS-UP

23) CHEMISTRY *Multiple Choice* According to the integrated form of the Clausius **[KLOU-zee-uhs]**-Clapeyron equation solved for the natural logarithm of vapor pressure, vapor pressure and absolute temperature data can be plotted to give a straight line. Which of the following corresponds to the slope?

W) $-\Delta H_{\text{vap}}/R$ **[negative delta H of vaporization over R]**

X) $\Delta H_{\text{vap}}/R$ **[delta H of vaporization over R]**

Y) $-R/\Delta H_{\text{vap}}$ **[negative R over delta H of vaporization]**

Z) $R/\Delta H_{\text{vap}}$ **[R over delta H of vaporization]**

ANSWER: W) $-\Delta H_{\text{vap}}/R$

BONUS

23) CHEMISTRY *Short Answer* Place the following four substances in order from lowest to highest boiling point: 1) carbon tetrachloride, 2) ethane, 3) propane, 4) water.

ANSWER: 2, 3, 1, 4 (ACCEPT: ETHANE, PROPANE, CARBON TETRACHLORIDE, WATER)

TOSS-UP

24) BIOLOGY *Short Answer* What is the one type of infectious agent that contains no nucleic acid?

ANSWER: PRION

BONUS

24) BIOLOGY *Multiple Choice* Loss of the retinoblastoma gene product, Rb, causes cancer by affecting which of the following portions of the cell cycle?

W) G1/S checkpoint

X) S/G2 checkpoint

Y) G2/M checkpoint

Z) M/G1 checkpoint

ANSWER: W) G1/S CHECKPOINT

TOSS-UP

25) PHYSICS *Multiple Choice* Which of the following quantities has an inverse-cubic relationship with distance?

- W) The magnitude of the gravitational force between two point masses
- X) The electric potential energy for a point charge
- Y) The magnetic field strength at an axial point from the center of a current loop
- Z) The speed of a satellite in circular orbit around the Earth

ANSWER: Y) THE MAGNETIC FIELD STRENGTH AT AN AXIAL POINT FROM THE CENTER OF A CURRENT LOOP

BONUS

25) PHYSICS *Short Answer* A horizontal water pipe tapers so that the cross-sectional area of the pipe decreases. If the water moves at 3 meters per second in the larger portion of the pipe and at 15 meters per second in the smaller portion, what is the change in pressure, in pascals, as the water moves from the larger portion to the smaller portion of the pipe? Assume the density of water is 1000 kilograms per cubic meter and incompressible.

ANSWER: -108000 (DO NOT ACCEPT: 108000)