

## ROUND 9

---

### TOSS-UP

1) EARTH AND SPACE *Short Answer* What is the spectral type of the Sun?

ANSWER: G (ACCEPT: G2, G2V)

### BONUS

1) EARTH AND SPACE *Multiple Choice* When a strong south wind occurs along the west coast of North America, Ekman transport causes water to move to which of the following?

- W) Onshore
- X) Offshore
- Y) Alongshore to the south
- Z) Alongshore to the north

ANSWER: W) ONSHORE

---

### TOSS-UP

2) BIOLOGY *Multiple Choice* Which of the following marine microbe groups has a cell membrane mainly comprised of lipids?

- W) Foraminiferans [*for-uh-MIN-uh-fer-uhns*]
- X) Radiolarians [*ray-dee-oh-LAIR-ee-uhns*]
- Y) Ciliates [*SIL-ee-ayts*]
- Z) *Tritaxis*

ANSWER: Y) CILIATES

### BONUS

2) BIOLOGY *Multiple Choice* Which of the following habitat and life history combinations would select for the production of a large brood size?

- W) Arctic, precocial young [*pri-KOH-shuhl*]
- X) Arctic, altricial young [*al-TRISH-uhl*]
- Y) Tropics, precocial young
- Z) Tropics, altricial young

ANSWER: W) ARCTIC, PRECOICIAL YOUNG

**TOSS-UP**

3) MATH *Short Answer* If  $f(x) = 3^x$  [**f of x equals 3 to the power of x**], find the value of  $f(\log_3 7)$  [**f of log base 3 of 7**].

ANSWER: 7

**BONUS**

3) MATH *Short Answer* Find the product of complex numbers  $(1 - i) \times (2 - i)$  [**open parenthesis 1 minus i close parenthesis times the quantity 2 minus i**].

ANSWER:  $1 - 3i$

---

**TOSS-UP**

4) ENERGY *Multiple Choice* What percentage of the world's production of rare earth metals is produced by China?

- W) 57%
- X) 68%
- Y) 83%
- Z) 95%

ANSWER: Z) 95%

**BONUS**

4) ENERGY *Multiple Choice* Which of the following is NOT a benefit of distributed generation?

- W) Decreased transmission investment
- X) Greater grid resiliency
- Y) Elimination of distribution system investment
- Z) Reduction in line losses

ANSWER: Y) ELIMINATION OF DISTRIBUTION SYSTEM INVESTMENT

### TOSS-UP

5) CHEMISTRY *Multiple Choice* In atomic orbital overlap, which of the following is true of destructive interference?

- W) It gives a bonding orbital and no nodes
- X) It gives an antibonding orbital and a node parallel to the internuclear axis
- Y) It gives an antibonding orbital and a node perpendicular to the internuclear axis
- Z) It gives an antibonding orbital and no nodes

ANSWER: Y) IT GIVES AN ANTIBONDING ORBITAL AND A NODE PERPENDICULAR TO THE INTERNUCLEAR AXIS

### BONUS

5) CHEMISTRY *Multiple Choice* In order to enhance the activity of the catalyst, a textural or chemical promoter may be used in ammonia synthesis. Which of the following is an example of a chemical promoter?

- W) Calcium oxide
- X) Potassium oxide
- Y) Aluminum oxide
- Z) Silicon dioxide

ANSWER: X) POTASSIUM OXIDE

---

### TOSS-UP

6) PHYSICS *Multiple Choice* How many types of quarks are there in nature?

- W) 3
- X) 5
- Y) 6
- Z) 10

ANSWER: Y) 6

### BONUS

6) PHYSICS *Multiple Choice* Which of the following is the approximate distance in kilometers covered by a photon in one year?

- W) 9 thousand
- X) 9 million
- Y) 9 billion
- Z) 9 trillion

ANSWER: Z) 9 TRILLION

### TOSS-UP

7) EARTH AND SPACE *Multiple Choice* On July 4, under modern conditions, the planet is at which of the following in relation to the Sun?

- W) Perihelion [*per-uh-HEE-lee-uhn*]
- X) Aphelion [*a-FEE-lee-uhn*]
- Y) Perigee [*PER-i-jee*]
- Z) Apogee [*A-puh-jee*]

ANSWER: X) APHELION

### BONUS

7) EARTH AND SPACE *Multiple Choice* During La Niña events, which of the following is most likely?

- W) Drought in northeast Brazil
- X) Drought in most of Australia
- Y) Drought in the southwestern U.S.
- Z) Wetter than normal in Oregon and Washington

ANSWER: Y) DROUGHT IN THE SOUTHWESTERN U.S.

---

### TOSS-UP

8) BIOLOGY *Multiple Choice* During meiosis [*my-OH-sis*], when a cell has lost both members of a homologous [*huh-MOL-uh-guhs*] pair of chromosomes, which of the following types of aneuploidy [*an-yoo-PLOI-dee*] would apply to the cell?

- W) Tetrasomy
- X) Nullisomy
- Y) Monosomy
- Z) Trisomy

ANSWER: X) NULLISOMY

### BONUS

8) BIOLOGY *Short Answer* By number, place the following steps necessary for cloning a gene into bacteria from genomic DNA in order from first to last: 1) Cut the target gene and the cloning vector with restriction enzymes; 2) Transform bacteria with the plasmid; 3) Ligate the target gene and the cloning vector with DNA ligase; 4) Amplify the target gene using PCR.

ANSWER: 4, 1, 3, 2

**TOSS-UP**

9) MATH *Multiple Choice* In how many ways can a committee of 7 be seated along one side of a table if the chair of the committee must sit in the middle?

- W) 49
- X) 120
- Y) 720
- Z) 5040

ANSWER: Y) 720

**BONUS**

9) MATH *Short Answer* How many three-digit numbers can be made using digits 0 through 4, provided the first digit is not zero?

ANSWER: 100

---

**TOSS-UP**

10) ENERGY *Multiple Choice* From 2001 to 2011, the installed wind power in the U.S. in megawatts has increased by approximately what factor?

- W) 3
- X) 6
- Y) 10
- Z) 15

ANSWER: Y) 10

**BONUS**

10) ENERGY *Short Answer* The characteristics of heating oil and diesel fuel are similar, except for which of the following?

- W) Evaporation
- X) Sulfur composition
- Y) Volatility
- Z) BTU

ANSWER: X) SULFUR COMPOSITION

### TOSS-UP

11) CHEMISTRY *Multiple Choice* Which of the following statements is true of the compression of a system?

- W) Work is done on the system, and  $dV$  and  $dw$  are greater than 0
- X) Work is done on the system,  $dV$  is less than 0, and  $dw$  is greater than 0
- Y) Work is done by the system,  $dV$  is greater than 0, and  $dw$  is less than 0
- Z) Work is done by the system, and  $dV$  and  $dw$  are less than 0

ANSWER: X) WORK IS DONE ON THE SYSTEM,  $dV$  IS LESS THAN 0, AND  $dw$  IS GREATER THAN 0

### BONUS

11) CHEMISTRY *Multiple Choice* Polycatenane [*pol-ee-KAT-n-ayn*] and polyrotaxane [*pol-ee-ro-TUH-ksayn*] are examples of what type of unconventional polymer?

- W) Supramolecular
- X) Branched
- Y) Network
- Z) Dendrimer [*DEN-druh-mer*]

ANSWER: W) SUPRAMOLECULAR

---

### TOSS-UP

12) PHYSICS *Short Answer* You are traveling down a level highway in your car with mass 1000 kilograms at 30 meters per second when you see a deer and hit the brakes. How much time, in seconds, would it take to stop fully if the applied braking force is 5000 newtons?

ANSWER: 6

### BONUS

12) PHYSICS *Multiple Choice* Epsilon naught,  $\epsilon_0$ , and mu naught,  $\mu_0$ , are permittivity and permeability constants of free space, respectively. The speed of light is found in terms of these constants as which of the following?

- W)  $1/\sqrt{\epsilon_0\mu_0}$  [*1 over the square root of the quantity epsilon naught mu naught*]
- X)  $\sqrt{\epsilon_0\mu_0}$  [*the square root of the quantity epsilon naught mu naught*]
- Y)  $\frac{\mu_0}{4\pi\epsilon_0}$  [*the fraction with numerator mu naught and denominator 4 pi epsilon naught*]
- Z)  $\epsilon_0/\mu_0$  [*epsilon naught over mu naught*]

ANSWER: W)  $1/\sqrt{\epsilon_0\mu_0}$

### TOSS-UP

13) EARTH AND SPACE *Multiple Choice* Which of the following rocks is most effective at neutralizing acid rain?

- W) Limestone
- X) Shale
- Y) Granite
- Z) Sandstone

ANSWER: W) LIMESTONE

### BONUS

13) EARTH AND SPACE *Multiple Choice* As a hurricane approaches the east coast of Florida from the east, the storm surge waves would be greatest at which of the following?

- W) Northeast of the eye
- X) Southeast of the eye
- Y) Southwest of the eye
- Z) Northwest of the eye

ANSWER: Z) NORTHWEST OF THE EYE

---

### TOSS-UP

14) BIOLOGY *Multiple Choice* If you have a white horse mate with a white horse that has many spots called leopard spots and half of their offspring have a little bit of leopard spotting, which of the following is your likely conclusion about the leopard-spotting allele?

- W) Co-dominant
- X) Low penetrance
- Y) Incompletely dominant
- Z) Low expressivity

ANSWER: Y) INCOMPLETELY DOMINANT

### BONUS

14) BIOLOGY *Short Answer* DNA replication requires that the DNA that has been pulled apart stays single-stranded until the polymerase [**POL-uh-muh-rays**] is able to use it as a template. What is the name of the protein that keeps the DNA single-stranded during replication?

ANSWER: SINGLE STRAND BINDING PROTEIN (ACCEPT: SSB OR SINGLE STRANDED BINDING PROTEIN)

### TOSS-UP

15) PHYSICS *Multiple Choice* The power input in a perfectly efficient step-up transformer is which of the following?

- W) Larger than the power output
- X) Equal to the power output
- Y) Smaller than the power output
- Z) Not related to the power output

ANSWER: X) EQUAL TO THE POWER OUTPUT

### BONUS

15) PHYSICS *Multiple Choice* A high energy photon near a nucleus can produce an electron-positron pair. What is the minimum energy a photon must have for this to happen?

- W) Half of the proper energy of the electron
- X) The proper energy of the electron
- Y) Two times the proper energy of the electron
- Z) Ten times the proper energy of the electron

ANSWER: Y) TWO TIMES THE PROPER ENERGY OF THE ELECTRON

### TOSS-UP

16) MATH *Multiple Choice* What is the coefficient of the  $xy^2$  term in the expansion of  $(x + 2y)^3$  [*open parenthesis x plus 2y close parenthesis to the power of 3*]?

- W) 3
- X) 8
- Y) 12
- Z) 18

ANSWER: Y) 12

### BONUS

16) MATH *Short Answer* What is the area of a square inscribed in a circle of radius  $k$ ?

ANSWER:  $2k^2$

**TOSS-UP**

17) CHEMISTRY *Multiple Choice* Which of the following is an example of an A+1 isotope?

- W) Nitrogen
- X) Oxygen
- Y) Sulfur
- Z) Fluorine

ANSWER: W) NITROGEN

**BONUS**

17) CHEMISTRY *Multiple Choice* Which of the following techniques in the field of nanotechnology is considered to be non-destructive, non-volatile, and easy to integrate?

- W) Molecular electronic switch
- X) Room temperature single electron transistor
- Y) Ovonics unified memory
- Z) Spin resonance transistor

ANSWER: Y) OVONICS UNIFIED MEMORY

---

**TOSS-UP**

18) PHYSICS *Multiple Choice* The Fahrenheit and Kelvin scales give the same reading at approximately which of the following temperatures?

- W) 0
- X) 212
- Y) 273
- Z) 575

ANSWER: Z) 575

**BONUS**

18) PHYSICS *Short Answer* In neutron decay, a neutron decays into a proton, an electron, and what else?

ANSWER: AN ELECTRON ANTI-NEUTRINO (DO NOT ACCEPT: NEUTRINO, ELECTRON NEUTRINO, OR ANTI-NEUTRINO)

### TOSS-UP

19) BIOLOGY *Multiple Choice* The absence of which of the following transcript components would decrease eukaryotic [**yoo-KAR-ee-oh-tik**] translational initiation?

- W) Poly(A) tail
- X) Intron
- Y) Stop codon
- Z) Internal exon

ANSWER: W) POLY(A) TAIL

### BONUS

19) BIOLOGY *Multiple Choice* Leghemoglobin [**leg-HEE-muh-gloh-bin**] functions as an oxygen binding protein in which of the following?

- W) Plant roots
- X) Bacteria
- Y) Human legs
- Z) Lactating mothers

ANSWER: W) PLANT ROOTS

---

### TOSS-UP

20) EARTH AND SPACE *Multiple Choice* Which of the following stream types best describes the Columbia River along the Columbia River Gorge?

- W) Meandering
- X) Braided
- Y) Ephemeral
- Z) Antecedent

ANSWER: Z) ANTECEDENT

### BONUS

20) EARTH AND SPACE *Multiple Choice* The Columbia River Gorge primarily cuts through what type of rock?

- W) Granite
- Y) Sandstone
- X) Basalt
- Z) Schist [**SHIST**]

ANSWER: X) BASALT

### TOSS-UP

21) MATH *Multiple Choice* Find the radius of a circle in which a  $30^\circ$  arc is  $2\pi$  units long.

- W) 12
- X) 15
- Y)  $15\pi$
- Z)  $60\pi$

ANSWER: W) 12

### BONUS

21) MATH *Multiple Choice* What is the exact value of  $\tan(120^\circ) + \cot(30^\circ)$  [**tangent of 120 degrees plus cotangent of 30 degrees**]?

- W)  $-2\sqrt{3}$
- X) 0
- Y)  $2\frac{\sqrt{3}}{3}$  [**2 times the square root of 3 over 3**]
- Z)  $2\sqrt{3}$

ANSWER: X) 0

### TOSS-UP

22) ENERGY *Multiple Choice* If my current annual heating bill of natural gas is \$800 with a furnace that is 70% efficient, approximately what will be my new bill if I install a 95% efficient furnace?

- W) \$500
- X) \$600
- Y) \$700
- Z) \$800

ANSWER: X) \$600

### BONUS

22) ENERGY *Short Answer* What is the term for the point at which solar photovoltaic technology produces power at a cost that is equal to the price of purchasing power from the grid?

ANSWER: GRID PARITY

### TOSS-UP

23) BIOLOGY *Multiple Choice* A child who excretes black urine is born to two normal parents. The child has a recessive homozygous genotype. What is the most likely explanation for the genotype?

- W) Spontaneous mutations
- X) Consanguinity [*kon-sang-GWIN-i-tee*]
- Y) Anticipation
- Z) Environmental exposure

ANSWER: X) CONSANGUINITY

### BONUS

23) BIOLOGY *Multiple Choice* Which of the following situations might cause disruptive selection to occur in a population of seed-eating finches on an island?

- W) A hurricane that wipes out plants that produce medium-sized seeds
- X) A hurricane that wipes out plants that produce small and large seeds
- Y) A hurricane that wipes out plants that produce small seeds
- Z) A hurricane that reduces equally plants that produce all sizes of seeds

ANSWER: W) A HURRICANE THAT WIPES OUT PLANTS THAT PRODUCE MEDIUM-SIZED SEEDS

---

### TOSS-UP

24) CHEMISTRY *Short Answer* According to valence bond theory, we assume that in methane, each pair of electrons is confined to the region between the carbon and hydrogen nuclei, where the bond is strongest. What is the term used to describe this regional confinement?

ANSWER: LOCALIZED (ACCEPT: LOCALIZED BOND AND LOCALIZED BONDING)

### BONUS

24) CHEMISTRY *Multiple Choice* Steam cracking is one process used in the manufacture of lighter olefins. Which of the following is NOT true of steam cracking?

- W) Increasing temperature shifts cracking to the ends of molecules
- X) Short residence times cause more olefin formation
- Y) The reaction is favored by high pressure
- Z) To minimize coke formation, steam may be added

ANSWER: Y) THE REACTION IS FAVORED BY HIGH PRESSURE

### TOSS-UP

25) PHYSICS *Multiple Choice* Which of the following is true when light enters a denser medium and is refracted?

- W) Wavelength remains unchanged
- X) Wave speed increases
- Y) Wavelength increases
- Z) Frequency remains unchanged

ANSWER: Z) FREQUENCY REMAINS UNCHANGED

### BONUS

25) PHYSICS *Short Answer* A one-dimensional electrical potential has the form  $V(x) = 4x^2 - x$ . What is the electrical field associated with this potential in terms of  $x$ ?

ANSWER:  $-8x + 1$  (DO NOT ACCEPT:  $8x - 1$ )