

## TOSS-UP

1) Math — *Short Answer* What is the slope of the line that passes through the points (11, 3) and (8, 4)?

ANSWER:  $-1/3$

## BONUS

1) Math — *Short Answer* If an exterior angle adjacent to a base angle of an isosceles triangle measures 133 degrees, what is the degree measure of the vertex angle?

ANSWER: 86



## TOSS-UP

2) Physics — *Short Answer* A solid, spherical object is floating in equilibrium in the water with one-third of the object submerged. What is the ratio of the magnitude of the buoyant force on the object to the magnitude of the force of gravity on the object?

ANSWER: 1 (ACCEPT: 1 TO 1)

## BONUS

2) Physics — *Short Answer* A 1500-kilogram car requires the engine to provide a 4000-newton force to maintain a constant speed of 30 meters per second. In watts, what is the power that is being exerted by the engine?

ANSWER: 120,000

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## TOSS-UP

3) Biology — *Short Answer* Medusa and polyp are the two life stages found in most animals from what phylum [*FYE-lum*]?

ANSWER: CNIDARIA (ACCEPT: CNIDARIANS)

## BONUS

3) Biology — *Multiple Choice* Which of the following terms best describes humans?

- W) Viviparous [*vye-VIP-ir-us*]
- X) Ovoviviparous [*oh-voh-vye-VIP-ir-us*]
- Y) Oviparous [*oh-VIP-ir-us*]
- Z) Vivioviparous [*viv-ee-oh-VIP-ir-us*]

ANSWER: W) VIVIPAROUS

## TOSS-UP

4) Chemistry — *Short Answer* According to Arrhenius [*ah-REE-nee-us*] theory, a base produces what ion in solution?

ANSWER:  $\text{OH}^-$  (ACCEPT: HYDROXIDE)

## BONUS

4) Chemistry — *Multiple Choice* Sherry is performing elemental analysis on a compound she knows is composed of only hydrogen and oxygen. She finds that the compound is 5.9% hydrogen by mass. Which of the following might be the identity of the compound?

- W)  $\text{H}_2\text{O}$
- X)  $\text{H}_2\text{O}_2$
- Y)  $\text{H}_3\text{O}^+$
- Z)  $\text{HO}_3$

ANSWER: X)  $\text{H}_2\text{O}_2$

## TOSS-UP

5) Earth and Space — *Multiple Choice* Which of the following reservoirs of Earth's water contains the least total water?

- W) The oceans
- X) The cryosphere
- Y) Surface waters
- Z) The atmosphere

ANSWER: Z) THE ATMOSPHERE

## BONUS

5) Earth and Space — *Short Answer* Identify all of the following three minerals that have a single well-defined cleavage plane:

- 1) Pyroxene [*pie-ROX-eeen*];
- 2) Olivine [*AW-liv-eeen*];
- 3) Mica.

ANSWER: 3

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## TOSS-UP

6) Energy — *Multiple Choice* Scientists at Brookhaven National Lab are researching the balance between liquid water and ice within clouds in the Arctic, in which temperatures range from  $-3$  to  $-8$  degrees Celsius. Liquid water droplets within these clouds are said to be in what state?

- W) Supercooled
- X) Supercritical
- Y) Saturated
- Z) Seeded

ANSWER: W) SUPERCOOLED

## BONUS

6) Energy — *Multiple Choice* Scientists at Brookhaven National Laboratory are studying the spin dynamics of electrons in thin films of iron. Which of the following is closest to the thickness of an iron film composed of ten monolayers?

- W) 2 angstroms
- X) 20 nanometers
- Y) 2 microns
- Z) 0.2 millimeters

ANSWER: X) 20 NANOMETERS

### TOSS-UP

7) Math — *Short Answer* A bag contains 20 socks that are identical except for color: 8 are red and 12 are white. Without looking, how many socks must you take out of the bag to be certain that you will have at least one pair of white socks?

ANSWER: 10

### BONUS

7) Math — *Short Answer* What is the  $y$ -intercept of the line with slope 7 that contains the point  $(2, 5)$ ?

ANSWER:  $-9$  (ACCEPT:  $(0, -9)$ )

## TOSS-UP

8) Physics — *Multiple Choice* Which of the following best describes Bernoulli's principle?

- W) Fluid pressure increases as speed increases
- X) Fluid pressure decreases as speed increases
- Y) Fluid pressure is proportional to speed
- Z) Fluid pressure is inversely proportional to speed

ANSWER: X) FLUID PRESSURE DECREASES AS SPEED INCREASES

## BONUS

8) Physics — *Short Answer* A glass of ice water contains 250 milliliters of liquid water in thermal equilibrium with 200 grams of ice. In degrees Celsius, what will the temperature of the ice water be after 2 kilocalories of heat are added to the system?

ANSWER: 0

## TOSS-UP

9) Biology — *Short Answer* What is the primary organ of photosynthesis in most plants?

ANSWER: LEAVES

## BONUS

9) Biology — *Short Answer* What molecule was the transforming component in Griffith's experiments that caused formerly avirulent [*a-VEER-yoo-lent*] *Pneumococcus* [*NEW-moh-cock-us*] cells to become virulent [*VEER-yoo-lent*]?

ANSWER: DNA (ACCEPT: DEOXYRIBONUCLEIC ACID, PLASMID)

## TOSS-UP

10) Chemistry — *Multiple Choice* Which of the following is a triprotic [*try-PRO-tic*] acid?

- W) Sulfuric acid
- X) Phosphoric acid
- Y) Hydrochloric acid
- Z) Ethanoic acid

ANSWER: X) PHOSPHORIC ACID

## BONUS

10) Chemistry — *Short Answer* What is the hybridization [*HIGH-brih-dye-ZAY-shun*] of the carbon atom in formaldehyde [*for-MAL-deh-hide*]?

ANSWER:  $SP^2$

## TOSS-UP

11) Earth and Space — *Short Answer* Some exoplanets can be detected due to their effect on the motion of their parent star. These perturbations result in changes in the frequencies of emitted starlight due to what phenomenon?

ANSWER: DOPPLER EFFECT (ACCEPT: DOPPLER SHIFT)

## BONUS

11) Earth and Space — *Multiple Choice* Which of the following is the primary source of the helium-4 in the universe?

- W) Fusion in main sequence stars
- X) Fusion during supernovae [*super-NOH-vee*]
- Y) Fusion during the Big Bang
- Z) Neutron star mergers

ANSWER: Y) FUSION DURING THE BIG BANG

## TOSS-UP

12) Energy — *Multiple Choice* Scientists at Oak Ridge National Lab are searching for a protein catalyst that can degrade plant cell walls. What is the term for a protein catalyst?

- W) Enzyme
- X) Channel
- Y) Active transporter
- Z) Mitigator

ANSWER: W) ENZYME

## BONUS

12) Energy — *Multiple Choice* Oak Ridge National Laboratory is producing actinium-225 [*ak-TIN-ee-um two twenty five*], which decays via alpha decay, for cancer treatments. Which of the following best explains why alpha particle radiation is effective in cancer treatment?

- W) Alpha particles are large and can kill an entire cancer cell given a direct collision
- X) Alpha particles have a short range in matter and therefore deposit a large amount of energy directly in the tumor
- Y) Alpha particles are helium nuclei and can thus readily escape from the patient's body without accumulation
- Z) Alpha particles can travel long distances within the human body and are more likely to reach the tumor than other types of radiation

ANSWER: X) ALPHA PARTICLES HAVE A SHORT RANGE IN MATTER AND THEREFORE DEPOSIT A LARGE AMOUNT OF ENERGY DIRECTLY IN THE TUMOR

### TOSS-UP

13) Math — *Short Answer* What is the second derivative with respect to  $x$  of  $5x^2 + 7x - 3$  evaluated at  $x = 4$ ?

ANSWER: 10

### BONUS

13) Math — *Short Answer* Expressing your answer in terms of  $m$ , evaluate the function  $f$  of  $x = 3x^2 - 12x - 7$  when  $x$  is  $m - 2$ .

ANSWER:  $3m^2 - 24m + 29$

## TOSS-UP

14) Physics — *Multiple Choice* If the Sun had the same mass but one-half its current radius, by which of the following factors would the radius of Earth's orbit be multiplied?

W) 1/4

X) 1/2

Y) 1

Z) 2

ANSWER: Y) 1

## BONUS

14) Physics — *Short Answer* The total intensity emitted from the surface of a blackbody is proportional to what power of the absolute temperature?

ANSWER: FOURTH POWER (ACCEPT: 4)

## TOSS-UP

15) Biology — *Short Answer* Anterograde trafficking of proteins within a cell involves entry of proteins at the cis *[sis]* face and exit from the trans face of what organelle?

ANSWER: GOLGI (ACCEPT: GOLGI BODY, GOLGI APPARATUS, GOLGI COMPLEX)

## BONUS

15) Biology — *Short Answer* Receptor tyrosine *[TIE-row-seen]* kinases *[KYE-nayses]* mediate their cellular signaling effects by catalyzing the addition of what functional group onto target proteins?

ANSWER: PHOSPHATE (ACCEPT:  $\text{PO}_4^{3-}$ )

## TOSS-UP

16) Chemistry — *Multiple Choice* What is the oxidation state of nitrogen in nitric acid?

- W) -2
- X) 0
- Y) +2
- Z) +5

ANSWER: Z) +5

## BONUS

16) Chemistry — *Multiple Choice* Which of the following compounds has the smallest bond angle?

- W) Ammonia
- X) Water
- Y) Methane
- Z) Phosphane

ANSWER: Z) PHOSPHANE

## TOSS-UP

17) Earth and Space — *Short Answer* What type of tide results when the Sun and the Moon are at right angles to each other with respect to Earth?

ANSWER: NEAP TIDE (ACCEPT: NEAP)

## BONUS

17) Earth and Space — *Multiple Choice* Which of the following major wind belts occurs between 0 degrees and 30 degrees North latitude?

- W) Westerlies
- X) Coriolis winds
- Y) Northeast trade winds
- Z) Southeast trade winds

ANSWER: Y) NORTHEAST TRADE WINDS



## TOSS-UP

18) Energy — *Multiple Choice* Scientists at SLAC Linear Accelerator Facility are studying flavoproteins. What vitamin is required for the function of flavoproteins?

- W) A
- X) B2
- Y) E
- Z) K

ANSWER: X) B2

## BONUS

18) Energy — *Short Answer* Researchers at Brookhaven National Lab are studying the catalytic activity of platinum in the water-gas shift reaction. In this reaction, water vapor and carbon monoxide are reacted to form carbon dioxide and what diatomic molecule?

ANSWER: HYDROGEN GAS (ACCEPT: HYDROGEN, DIHYDROGEN, H<sub>2</sub>)