

**TOSS-UP**

1. BIOLOGY *Multiple Choice* Which of the following lab techniques is performed only on DNA?

(W) Northern blot  
(X) Western blot  
(Y) rtPCR  
(Z) FISH

ANSWER: Z

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**TOSS-UP**

2. CHEMISTRY *Multiple Choice* Which of the following is not true of the Daniel cell?

(W) Zinc is oxidised at the annode  
(X) Copper is reduced at the cathode  
(Y) Electrons are pulled from the cathode  
(Z) Sulfate ions are commonly used to neutralize the charge of the annode

ANSWER: Y

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**TOSS-UP**

3. PHYSICS *Short Answer* The density of mercury is  $1.5 \times 10^4 \frac{kg}{m^3}$ . A solid block of wood is dipped in mercury at a depth of 2 meters. Assuming  $g = 10 \frac{m}{s^2}$ , what is the difference between the atmospheric pressure on the surface of the mercury and the pressure acting on the walls of the wooden block, in Pascals?

ANSWER:  $3 \times 10^5$  PASCALS

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**TOSS-UP**

4. MATH *Short Answer* 2 black books and 3 red books must be arranged on a bookshelf. All of the black books are the same and all of the red books are the same. The books must also be divided into 3 groups using 2 dividers. How many unique arrangements of the books are possible?

ANSWER: 210

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**TOSS-UP**

5. EARTH AND SPACE SCIENCE *Multiple Choice* Generally, the point at which air becomes saturated and clouds form is known as the...

- (W) Dew point
- (X) Condensation point
- (Y) Aerosol point
- (Z) Saturation point

ANSWER: W

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**TOSS-UP**

6. ENERGY *Short Answer* Which type of thermodynamic cycle consists of adiabatic and isochoric processes, and is the most common cycle found in automobile engines?

ANSWER: OTTO CYCLE

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**TOSS-UP**

7. BIOLOGY *Multiple Choice* Which of the following is not true of cytokinins?

- (W) They are usually produced in the young roots
- (X) When cytokinins and auxins are administered to a callus, their relative ratio determines the organ that will develop
- (Y) Cytokinins promote cell differentiation only in the absence of auxins
- (Z) Cytokinins, strigolactones, and auxins all either stimulate or inhibit apical dominance

ANSWER: Y

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**TOSS-UP**

8. CHEMISTRY *Short Answer* This type of isomerization occurs due to the migration of a proton to elsewhere in the molecule, followed by the switch of a single bond with an adjacent double bond. Types include enol-keto, lactam-lactim, and amide-imidic. Name this type of isomerization.

ANSWER: TAUTOMERISM

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**TOSS-UP**

9. PHYSICS *Multiple Choice* In which of the following cases is the angular frequency of the wave equal to  $10\pi s^{-1}$ ?

(W) The frequency of the wave is 0.2 Hertz

(X) The wavelength of the wave is 5 m and the speed of the wave is 0.04 m/s

(Y) The wave number of the wave is  $\frac{\pi}{10}m^{-1}$  and the speed of the wave is 100 m/s

(Z) The wavelength of the electromagnetic wave is  $\frac{\pi}{20}m$

ANSWER: Y

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**TOSS-UP**

10. MATH *Short Answer* How many rational numbers satisfy the following equation:  $3x^4 - 2x^2 + 12x - 8 = 0$ ?

ANSWER: 2

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**TOSS-UP**

11. EARTH AND SPACE SCIENCE *Short Answer* In glaciology, what is the term for a deep crack in an ice sheet?

ANSWER: CREVASSE

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**TOSS-UP**

12. ENERGY *Multiple Choice* Two solutions have different solute concentrations and are separated by a membrane only permeable to the solvent. How would intermolecular interactions between the solute and the solvent influence osmosis?

(W) They would decrease the water potential

(X) They would increase the water potential

(Y) They would increase the pressure potential

(Z) They would increase the solute potential

ANSWER: W

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**TOSS-UP**

13. BIOLOGY *Short Answer* Which period of the Neoproterozoic Era of the Proterozoic Eon was marked by the appearance of soft-bodied animals just before the Cambrian Explosion?

ANSWER: EDIACARAN PERIOD

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**TOSS-UP**

14. CHEMISTRY *Multiple Choice* Using transition state theory and statistical mechanics, many equations for the rate constant of a reaction similar to the Arrhenius equation can be derived. According to these equations, increasing which of the following quantities increases the rate constant?

- (W) Change in entropy
- (X) Change in Gibbs' free energy
- (Y) Change in enthalpy
- (Z) Free energy of activation

ANSWER: W

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**TOSS-UP**

15. PHYSICS *Short Answer* Assume that as a long metal rod is cooled to 0 Kelvin, its length approaches 3 meters. If the coefficient of linear expansion for the rod is  $5 \times 10^{-5} K^{-1}$ , what is the length of the metal rod at a temperature of  $2 \times 10^6 K$  in terms of e?

ANSWER:  $3E^{100}$  M

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**TOSS-UP**

16. MATH *Multiple Choice* A polygon with non-zero area is constructed inside a circle. A random point X is chosen, and it lies within the circle. In which of the following cases would the point X have the least probability of also lying in the polygon?

- (W) The polygon is a triangle with 2 vertices on the circumference of the circle and one vertex on the center
- (X) The polygon is a concave quadrilateral with 3 vertices on the circumference of the circle and one vertex on the center
- (Y) The polygon is a square inscribed in the circle
- (Z) The polygon is a regular decagon inscribed in the circle

ANSWER: W

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**TOSS-UP**

17. EARTH AND SPACE SCIENCE *Short Answer* What is the term for a fan-shaped deposit formed where a fast flowing stream flattens, slows, and spreads typically at the exit of a canyon onto a flatter plain?

ANSWER: ALLUVIAL FAN

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**TOSS-UP**

18. ENERGY *Multiple Choice* Which of the following processes does not occur in a Carnot Cycle?

- (W) Change in temperature without change in entropy
- (X) Change in entropy without change in temperature
- (Y) Change in pressure without change in temperature
- (Z) Change in pressure without change in volume

ANSWER: Z

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**TOSS-UP**

19. BIOLOGY *Short Answer* Hyperpigmentation in the skin occurs in Addison's Disease because of the overproduction of alpha-MSH from which precursor molecule?

ANSWER: PRO-OPiomELANOCORTIN

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**TOSS-UP**

20. CHEMISTRY *Multiple Choice* A catalyst does not affect the position of equilibrium for a reaction because...

- (W) It reduces the entropy of both the forward and reverse reactions by the same amount
- (X) It does not change how quickly equilibrium is reached
- (Y) It changes the activation energy of both the forward and reverse reactions by the same amount
- (Z) By increasing the rate of the forward reaction, it decreases the concentration of the reactants, which also accelerates the rate of the reverse reaction

ANSWER: Y

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**TOSS-UP**

21. PHYSICS *Short Answer* In terms of  $\epsilon_0$ , give the divergence of the electric field in an enclosed area where the charge density is 10 coulombs per meter cubed.

ANSWER:  $\frac{10 \cdot \frac{C}{M^3}}{\epsilon_0}$

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**TOSS-UP**

22. MATH *Multiple Choice* At which of the following values of  $x$  does the derivative of  $\frac{\sin x}{\ln x}$  equal 0?

- (W) 1.0
- (X) 4.5
- (Y) 6.0
- (Z) 9.0

ANSWER: X

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**TOSS-UP**

23. EARTH AND SPACE SCIENCE *Short Answer* What is the term for a stream or river that flows from a parent stream into another river or lake?

ANSWER: TRIBUTARY

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**TOSS-UP**

24. ENERGY *Short Answer* Which constant, defined as  $\frac{1}{\mu_0 c^2}$ , relates the quantity of electric charge to physical quantities such as length and force, and is found in equations such as Coulomb's Law and capacitance?

ANSWER: PERMITIVITY OF FREE SPACE

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**TOSS-UP**

25. EARTH AND SPACE SCIENCE *Multiple Choice* Which of the following rocks has a Moh's hardness of 9?

- (W) Diamond
- (X) Corundum
- (Y) Quartz
- (Z) Gypsum

ANSWER: X

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