FE!M 2025

Round 5

TOSS UP

1) BIOLOGY *Short Answer* Which biome, found in California and southern Africa, consists of short shrubs with a consistent climate and infrequent rainfall and is naturally moderated by fires?

ANSWER: Chaparral [ArK]

BONUS

1) BIOLOGY *Short Answer* Order the following three sequences by increasing melting point:

1) 5'- GAATTC-3'
2) 5'-GCCAGC-3'
3) 5'-GCTGAC-3'

ANSWER: 1, 3, 2 [TS]

TOSS UP

2) PHYSICS *Short Answer* The Plateau-Rayleigh instability occurs when a falling stream of water breaks up into several smaller droplets. This results from what force acting on the water causing it to minimize its surface area to volume ratio?

ANSWER: Surface tension [RoA]

BONUS

2) PHYSICS *Multiple Choice* The speed of sound in a fluid is 30 m/s. If the bulk modulus of the fluid is multiplied by a factor of 9 and the density is tripled, which of the following is closest to the new speed of sound in m/s in the fluid?

W) 20

X) 30

Y) 40

Z) 50

ANSWER: Z) 50 [RoA]

TOSS UP

3) CHEMISTRY *Multiple Choice* Which of the following molecules has a net dipole moment equal to zero?

W) H_2O

X) NH_3

Y) SO_2

Z) BF_3

ANSWER: Z) BF_3 [AA]

BONUS

3) CHEMISTRY *Multiple Choice* Alex is titrating hydrofluoric acid with sodium hydroxide. Given that the K_b of the fluoride ion is approximately $1.5 \cdot 10^{-11}$, which of the following is closest to the pH at the equivalence point?

W) 7.5

X) 8

Y) 8.5

Z) 9

ANSWER: X) 8 [AA]

TOSS UP

4) MATH *Short Answer* Compute the limit as n approaches infinity of $(1 + 2/n)^{3n}$ (read: *quantity one plus two over n end quantity to the power of three n*)

ANSWER: e^6 [AdM]

BONUS

4) MATH *Short Answer* Which of the following (possibly irregular) polygons can tile the plane with a single congruent shape?

1) Pentagons

2) Septagons

3) Nonagons

ANS: 123 [AdM]

TOSS UP

5) ESS *Multiple Choice* Which of the following best describes how settling velocity for sediment in a stream bed varies with increasing grain size from clay to gravel?

W) Always increases

X) Always decreases

Y) Increases then decreases

Z) Decreases then increases

ANSWER: W) Always increases [RoA]

BONUS

5) ESS *Multiple Choice* The Last Glacial Maximum was the most recent time during the last glacial period where ice sheets were at their greatest extent. Which of the following is closest to how long ago, in years, the Last Glacial Maximum occurred?

W) 6,000

X) 12,000

Y) 24,000

Z) 48,000

ANSWER: Y) 24,000 [RoA]

TOSS UP

6) BIOLOGY *Multiple Choice* Neurons do not divide, and thus are not usually associated with cancers. However, many glial cells do divide and can become cancerous. Which of the following types of glia comprises most types of gliomas?

W) Astrocytes

X) Schwann cells

Y) Oligodendrocytes

Z) Ependymal cells

ANSWER: W) Astrocytes [ArK]

BONUS

6) BIOLOGY *Multiple Choice* A colony of immortalized cells is treated with cytochalasin B, a cytokinetic inhibitor. Which of the following radiolabeled nucleotides could be added to the medium to selectively track the effect of this treatment on DNA synthesis?

W) Adenosine

X) Cytosine

Y) Guanine

Z) Thymidine

ANSWER: Z) Thymidine [TS]

TOSS UP

7) PHYSICS *Short Answer* How much energy, in joules, is stored in a capacitor with charge 10 coulombs and a voltage of 5 volts?

ANSWER: 25 [RoA]

BONUS

7) PHYSICS *Multiple Choice* Which of the following assumptions is necessarily true of an ideal battery?

W) It is square shaped

X) It has no dipole moment

Y) It has no internal resistance

Z) It has no self-inductance

ANSWER: Y) It has no internal resistance [RuA]

TOSS UP

8) CHEMISTRY *Short Answer* Order the following three hydrogen spectrum line series by increasing average emission wavelength:

1) Paschen

2) Lyman

3) Balmer

ANSWER: 231 [AA]

BONUS

8) CHEMISTRY *Short Answer* Rank the following three compounds in terms of increasing boiling point.

1) NH_3
2) H_2O
3) HF

ANSWER: 132 [AA]

TOSS UP

9) MATH *Short Answer* A fixed point x of a function f satisfies the equation $f(x) = x$. Which of the following functions have fixed points? 1) e^x 2) $\ln x$ 3) $\cos x$

ANSWER: 3 only [AdM]

BONUS

9) MATH *Short Answer* A function is said to be Lipschitz continuous if its derivative exists everywhere and is bounded. Which of the following functions are Lipschitz continuous?

1) $\tan x$
2) $\arctan x$
3) $\operatorname{sinc} x$

ANSWER: 23 [AdM]

TOSS UP

10) ESS *Multiple Choice* Minerals belonging to which of the following groups would least likely exhibit a metallic luster?

W) Oxides

X) Native elements

Y) Sulfides

Z) Silicates

ANSWER: Z) Silicates [RoA]

BONUS

10) ESS *Multiple Choice* Objects at the poles of which of the following solar system bodies would experience the strongest Coriolis effect?

W) Sun

X) Saturn

Y) Earth

Z) Jupiter

ANSWER: Z) Jupiter [RoA]

TOSS UP

11) BIOLOGY *Short Answer* Unlike most mesodermally derived bones in the body, teeth are primarily of ectodermal origin. This is because they are seeded by what group of cells that are a byproduct of neurulation?

ANSWER: Neural Crest cells [TS]

BONUS

11) BIOLOGY *Short Answer* Researchers at Savannah River National Labs are studying cyclic electron flow, which is thought to be a photoprotective mechanism in plants. Select ALL of the following proteins that are involved in cyclic electron flow:

1) Ferredoxin
2) Plastoquinone
3) Cytochrome b6f complex

ANSWER: 1 and 3 [TS]

TOSS UP

12) PHYSICS *Multiple Choice* An object has an associated potential function given by $U(x) = x^3 - 3x^2$. Which of the following types of equilibrium is this object in at $x = 2$?

W) Stable
X) Unstable
Y) Metastable
Z) Hyperstable

ANSWER: W) Stable [RuA]

BONUS

12) PHYSICS *Short Answer* Advaith, at his astounding stature of 5 inches, stands on the principal axis 10 centimeters away from a convex lens with a focal length of 15 centimeters. Find the height of the resulting image in inches.

ANSWER: 15 [RuA]

TOSS UP

13) CHEMISTRY *Multiple Choice* Which of the following isoelectronic species has the largest atomic radius?

W) Cl^-

X) K^+

Y) S_2^-

Z) Ca^{2+}

ANSWER: Y) S_2^- [AA]

BONUS

13) CHEMISTRY *Multiple Choice* Which of the following metals is diamagnetic?

W) Zinc

X) Chromium

Y) Iron

Z) Platinum

ANSWER: W) Zinc [AA]

TOSS UP

14) MATH *Short Answer* An unfair coin has a $\frac{2}{3}$ chance of coming up heads, a $\frac{1}{6}$ chance of landing on its side, and a $\frac{1}{6}$ chance of coming up tails. Theenash flips the coin. He wins if it lands heads, loses if it lands tails, and reflips the coin if it lands on its side. What is the probability that Theenash wins?

ANSWER: $\frac{4}{5}$ [AdM]

BONUS

14) MATH *Short Answer* What is the horizontal asymptote of $\tanh(x) / \arctan(x)$ (read: *hyperbolic tangent of x over arctan of x*)?

ANSWER: $2/pi$ (accept: $y = 2/pi$) [AdM]

TOSS UP

15) ESS *Multiple Choice* Which of the following atmospheric variables changes most significantly across a dryline?

W) Air temperature

X) Wind speed

Y) Dew point

Z) Pressure

ANSWER: Y) Dew point [RoA]

BONUS

15) ESS *Short Answer* Advai stumbles upon an exposed dike that formed from the intrusion of felsic magma into a limestone bed. If Advai starts at the center of the dike and walks outward, order the following three rocks in the order he would observe them: 1) Limestone; 2) Rhyolite; 3) Marble

ANSWER: 231 [RoA]

TOSS UP

16) BIOLOGY *Multiple Choice* Which of the following plant nutrient deficiences would NOT result in chlorosis?

W) Phosphorus

X) Potassium

Y) Magnesium

Z) Nitrogen

ANSWER: W) Phosphorus [TS]

BONUS

16) BIOLOGY *Short Answer* After experiencing an unfortunate incident involving a pole, Bob's speech becomes notably less coherent, and he begins to speak in impulsive and nonsensical tirades. Which region of the left temporal lobe is most likely affected?

ANSWER: Wernicke's area [TS]

TOSS UP

17) PHYSICS *Short Answer* The star-delta transform is a special case of the star-mesh transformation for large networks of resistors. How many terminals must a circuit have for the star-delta transform to be applicable?

ANSWER: 3 [RoA]

BONUS

17) PHYSICS *Short Answer* Identify all of the following 4 quantities that are true vectors: 1) Torque; 2) Magnetic dipole moment; 3) Angular velocity; 4) Kinetic energy

ANSWER: None [RoA]

TOSS UP

18) CHEMISTRY *Short Answer* Advaith is setting up a galvanic cell and is attempting to calculate the electromotive force. What equation can he use to do this?

ANSWER: Nernst Equation [AA]

BONUS

18) CHEMISTRY *Short Answer* Order the following three conformations of cyclohexane by increasing stability:

1) Half-chair
2) Twist-boat
3) Chair

ANSWER: 123 [TS]

TOSS UP

19) MATH *Short Answer* The vertices of a polygon are labeled A, B, C, and so on, in that order. If angle BAC is found to be 12 degrees, how many sides does the polygon have?

ANSWER: 15 [AdM]

BONUS

19) MATH *Short Answer* An ellipse with area 32π has a semiminor axis of length 4. What is the distance between the foci of this ellipse?

ANSWER: $8\sqrt{3}$ [AdM]

TOSS UP

20) ESS *Multiple Choice* Diurnal inequality is most pronounced in which of the following types of tidal patterns?

W) Mixed

X) Diurnal

Y) Semidiurnal

Z) Ebb

ANSWER: W) Mixed [RoA]

BONUS

20) ESS *Short Answer* Order the following objects by increasing metallicity: 1) Globular cluster 2) H I (read: *H-one*) region 3) Planetary nebula

ANS: 123 [AS]
