FE!M 2025

Round 1

TOSS UP

1) BIOLOGY *Multiple Choice* Which of the following features used for waste excretion are found in insects?

W) Flame Bulbs

X) Metanephridia

Y) Intestines

Z) Malpighian Tubules

ANSWER: Z) MALPIGHIAN TUBULES [ArK]

BONUS

1) BIOLOGY *Short Answer* In a population of 100 red pandas at Hardy-Weinberg Equilibrium, the blue-eyed allele is dominant to the black-eyed allele. If 49 red pandas are black-eyed, how many pandas are heterozygous for this trait?

ANSWER: 42 [ArK]

TOSS UP

2) PHYSICS *Short Answer* What is the coefficient of performance of an ideal Carnot refrigerator with a low temperature reservoir at 400 K and a high temperature reservoir at 500 K?

ANSWER: 4 [RuA]

BONUS

2) PHYSICS *Multiple Choice* An object in the solar system is traveling in such a way that its velocity is always equal to the escape velocity from that position. Which of the following best describes the body's trajectory?

W) Circular

X) Elliptical

Y) Parabolic

Z) Hyperbolic

ANSWER: Y) Parabolic [RuA]

TOSS UP

3) CHEMISTRY *Short Answer* What is the formal charge of carbon in methanol?

ANSWER: 0 [AA]

BONUS

3) CHEMISTRY *Multiple Choice* Which of the following best explains why amides are planar around the nitrogen atom?

W) Steric hindrance

X) Resonance

Y) The complete presence of a double bond

Z) The presence of a positive charge

Answer: X) Resonance [AnA]

TOSS UP

4) MATH *Short Answer* In base 4, what is the value of 0.121212 ... repeating?

ANSWER: $\frac{2}{5}$ [AdM]

BONUS

4) MATH *Short Answer* A square with side length 2 is rotated about one of its diagonals. What is the volume of the resulting shape?

ANSWER: $\frac{4\pi\sqrt{2}}{3}$ [AdM]

TOSS UP

5) ESS *Short Answer* Order the following three forms of water found in glaciated regions by increasing albedo: 1) Fresh water; 2) Fresh snow; 3) Glacial ice

ANSWER: 132 [RoA]

BONUS

5) ESS *Short Answer* Which specific type of supernova is most directly associated with a white dwarf exceeding the Chandrasekhar limit?

ANSWER: Type Ia (DO NOT ACCEPT: Type I) [RoA]

TOSS UP

6) BIOLOGY *Short Answer* Nate uses a DNA microarray to visualize differential gene expression between healthy and cancerous cells. Identify ALL of the following three genes that would display markedly increased expression in a tumor cell:

1) Telomerase
2) P53
3) Ras

ANSWER: 1 and 3 [TS]

BONUS

6) BIOLOGY *Short Answer* Place the following four events of mammalian digestion in the order that they occur:

1) Food enters the mouth
2) Peristalsis pushes the bolus down
3) Amylase begins digestion of polysaccharides
4) Gastrin is released into the bloodstream and promotes gastric acid production and secretion

ANSWER: 4, 1, 3, 2 [ArK]

TOSS UP

7) PHYSICS *Short Answer* A material has an absorptivity of 60%. If 70 watts of light are shined on this material, then how many watts of incident light are reflected?

ANSWER: 28 [RoA]

BONUS

7) PHYSICS *Short Answer* Rutvik modifies a rope by inserting a spring scale in the middle. Roshan and Theenash then pick up the rope and start playing tug of war with it. Because Theenash is stronger than Roshan, he exerts a 200N force on the rope while Roshan only exerts a 100 N force. In Newtons, what is the measurement on the spring scale?

ANSWER: 100 [RuA]

TOSS UP

8) CHEMISTRY *Short Answer* When P_4O_{10} is added to water, what is the oxidation of phosphorus in the final product?

ANSWER: +5 [AA]

BONUS

8) CHEMISTRY *Short Answer* When the peroxide ion (O_2^{2-}) undergoes disproportionation in water, it forms hydroxide ions and what other species?

ANSWER: O_2 (ACCEPT: Oxygen gas) [AA]

TOSS UP

9) MATH *Short Answer* Order the following three shapes by increasing area, given that they all have the same perimeter:

1) Circle
2) Equilateral triangle
3) Square

ANSWER: 231 [AdM]

BONUS

9) MATH *Short Answer* If rotations and reflections are considered distinct, how many ways are there to color the faces of a cube with at most 4 colors such that no two opposite faces have the same color?

ANSWER: 1728 [AdM]

TOSS UP

10) ESS *Multiple Choice* Which of the following types of faults occurs when the primary direction of stress in a fault system is parallel to the fault line?

W) Normal
X) Reverse
Y) Thrust
Z) Strike-slip

ANSWER: Z) Strike-slip [RoA]

BONUS

10) ESS *Multiple Choice* Roshan notices his well water has become salty and wants to measure its salinity. Which of the following measurements would give the most direct measure of salinity?

W) Density

X) pH

Y) Conductivity

Z) Turbidity

ANSWER: Y) Conductivity [AS]

TOSS UP

11) BIOLOGY *Multiple Choice* Which of the following proteases would be most stable if transported to the lysosome?

W) Pepsin

X) Trypsin

Y) Thrombin

Z) Papain

ANSWER: W) Pepsin [TS]

BONUS

11) BIOLOGY *Short Answer* Mission San Jose students are performing dissections of organisms from polluted ecosystems. They find that the concentration of methylmercury in a tuna is significantly higher than that of a shrimp. What ecological term describes this increase in concentration of certain substances in organisms in higher trophic levels?

ANSWER: Biomagnification (DO NOT ACCEPT: Bioaccumulation) [ArK]

TOSS UP

12) PHYSICS *Short Answer* A particle has an initial velocity of 2 m/s at time $t = 0$ and moves along a straight line with an acceleration given by $a(t) = 6t$. In meters, what is the displacement of the particle after 3 seconds?

ANSWER: 33 [RuA]

BONUS

12) PHYSICS *Multiple Choice* A rocket fired from Earth travels directly towards the sun. Which of the following best describes the gravitational acceleration experienced by this rocket?

W) Always increases

X) Always decreases

Y) Increases then decreases

Z) Decreases then increases

ANSWER: Z) Decreases then increases [RuA]

TOSS UP

13) CHEMISTRY *Short Answer* What is the molecular formula for ammonium dichromate?

ANSWER: $(NH_4)_2Cr_2O_7$

BONUS

13) CHEMISTRY *Multiple Choice* Researchers are studying the properties of seesaw-shaped molecules to create nanoscale molecular switches. Which of the following is closest to the percentage s character of a hybrid orbital in the seesaw molecular geometry?

W) 20%

X) 30%

Y) 40%

Z) 50%

ANSWER: W) 20% [TS]

TOSS UP

14) MATH *Short Answer* The diagonals of which of the following types of quadrilaterals are necessarily perpendicular?

1) Parallelogram

2) Rectangle

3) Rhombus

4) Square

ANSWER: 34 [AdM]

BONUS

14) MATH *Short Answer* What is the sum from $n = 1$ to $n = 2025$ of i^n, where i is the imaginary unit?

ANSWER: i [AdM]

TOSS UP

15) ESS *Short Answer* During a core-collapse supernova, the stellar core contracts and rotates faster, leaving a rapidly spinning stellar remnant. What fundamental physical law explains this phenomenon?

ANSWER: Conservation of angular momentum [RoA]

BONUS

15) ESS *Multiple Choice* Which of the following minerals commonly exhibits rhombohedral cleavage, in which it splits across three planes not all at right angles?

W) Hornblende

X) Calcite

Y) Granite

Z) Pyrite

ANSWER: X) Calcite [RoA]

TOSS UP

16) BIOLOGY *Short Answer* Upon the recognition of another red belly, Red-bellied male stickleback fish orchestrate an agonistic response against fellow males. This is an example of what general instinctual behavior?

ANSWER: Fixed action pattern [ArK]

BONUS

16) BIOLOGY *Multiple Choice* Which of the following is NOT an anchoring cell junction?

W) Adherens junction

X) Tight junction

Y) Desmosome

Z) Hemidesmosome

ANSWER: X) Tight junction [ArK]

TOSS UP

17) PHYSICS *Short Answer* Order the following three scenarios by increasing magnitude of change in momentum:

1) 10 N force applied for 5 seconds

2) 5 kg ball speeding up from 2 m/s to 9 m/s

3) 4 kg ball 1 second after being dropped from rest off of a tall cliff

ANSWER: 231 [AdM]

BONUS

17) PHYSICS *Short Answer* Planet Berth has twice the radius of Earth and three times the density. Assuming surface gravitational acceleration on Earth is 10 m/s^2, what is the surface gravitational acceleration on Berth?

ANSWER: 60 [RoA]

TOSS UP

18) CHEMISTRY *Multiple Choice* Which of the following compounds is polar?

W) CO_2

X) O_2

Y) SO_3

Z) SO_2

ANSWER: Z) SO_2 [AA]

BONUS

18) CHEMISTRY *Multiple Choice* Which of the following carbon containing compounds contains carbon in the highest oxidation state?

W) Carbon dioxide

X) Ethanoic acid

Y) Carbon monoxide

Z) Methanol

ANSWER: W) Carbon dioxide [AA]

TOSS UP

19) MATH *Short Answer* What is the 2025^{th} digit to the right of the decimal point of the fraction $\frac{5}{7}$?

ANSWER: 4 [AdM]

BONUS

19) MATH *Short Answer* Theenash wants to buy a new science bowl buzzer set for $300. He has 4 coupons, each of which can either halve the current cost or reduce it by $20. What is the lowest possible price that Theenash can buy the buzzer set for?

ANSWER: $17.50 [AdM]

TOSS UP

20) ESS *Multiple Choice* Roshan lives on the California coast, while Peter lives 10 miles inland. Roshan experiences mild temperatures year-round, but Peter has hotter summers and colder winters. Which of the following best explains Roshan's moderate climate?

W) Ocean currents carry warm water from the tropics

X) The nearby ocean moderates air temperature

Y) Coastal mountains block storms

Z) Higher humidity increases evaporation cooling

ANSWER: X) The nearby ocean moderates air temperature [AS]

BONUS

20) ESS *Multiple Choice* Which of the following best explains why ground-based ultraviolet telescopes are uncommon?

W) UV light is absorbed by the Earth's atmosphere

X) UV light is too faint compared to visible light

Y) UV detectors cannot function at low altitudes

Z) UV light is completely reflected by clouds

ANSWER: W) UV light is absorbed by the Earth's atmosphere [AS]
