

TOSS-UP

1. **BIOLOGY** *Short Answer* Using words or numbers, name all of the following four statements that is or are true of the digestive system:
- I. Gastrin stimulates chief cells in the gastric mucosa to produce pepsinogen
 - II. Trypsin may stimulate the activation of pancreatic peptidases
 - III. Cholecystokinin inhibits the acidification of chyme and stimulates the release of bile from the gall bladder
 - IV. Secretin causes contractions of the gall bladder to directly stimulate bile secretion

ANSWER: II, III

TOSS-UP

2. **CHEMISTRY** *Multiple Choice* Which of the following elements does not form ions according to the inert ion effect?
- (W) Aluminum
 - (X) Indium
 - (Y) Tin
 - (Z) Arsenic

ANSWER: Z

TOSS-UP

3. **PHYSICS** *Short Answer* Using words or numbers, identify all of the following 4 statements that is or are true of special relativity:
- I. The twin paradox is resolved because from the perspective of a stationary observer the twin that has traveled to the distant galaxy and returned must be older because he is aging more rapidly as he accelerates to return back to Earth
 - II. The ladder paradox is resolved because in the frame of reference of the ladder, the two gates of the barn are not closing simultaneously
 - III. On a Minkowski diagram, distances in spacetime remain constant regardless of the speed of a frame of reference

- IV. On a Minkowski diagram, lines of simultaneity remain the same regardless of the speed of a frame of reference

ANSWER: I, II, III

TOSS-UP

4. BIOLOGY *Multiple Choice* Which of the following angiosperm families is largest in terms of both species diversity and dispersal?

(W) Orchidaceae

(X) Asteraceae

(Y) Fagaceae

(Z) Liliaceae

ANSWER: W

TOSS-UP

5. CHEMISTRY *Short Answer* A 275 kg block of ice is melting at 0 degrees Celsius. Given that the latent heat of fusion for water is 334 kJ/kg, calculate the change in entropy for the process, to the nearest whole kJ/K.

ANSWER: 334 KJ/K

TOSS-UP

6. PHYSICS *Multiple Choice* Which of the following is not true regarding Lagrangian and Hamiltonian mechanics?

(W) The Schrodinger wave equation is an example of the application of Hamiltonian mechanics

(X) Lagrangian mechanics is based on the principle of least action

(Y) The Lagrangian is a quantity equal to the kinetic energy plus the potential energy

(Z) The Hamilton equations are a set of partial differential equations relating the Hamiltonian, the momentum, and the coordinates of an object

ANSWER: Y

TOSS-UP

7. BIOLOGY *Short Answer* Which graph of enzyme activity compares the reciprocal of substrate concentration and the reciprocal of initial reaction velocity to yield a straight line for enzymes following Michaelis-Menten kinetics?

ANSWER: LINEWEAVER-BURKE PLOT

TOSS-UP

8. CHEMISTRY *Multiple Choice* Which of the following does not have three resonance structures?

(W) Nitrate ion

(X) Thiocyanate ion

(Y) Carbonate ion

(Z) Ozone molecule

ANSWER: X

TOSS-UP

9. PHYSICS *Short Answer* Using words or numbers, identify all of the following that is or are true of nuclear decay:

- I. If n is the number of nucleons and p is the number of protons in any stable nuclide with at least one neutron, then the quantity $n - 2p$ increases with increasing atomic number
- II. Beta decay occurs more frequently in nuclei with low atomic number than in nuclei with high atomic number

- III. Neutron emission occurs only in nuclei with atomic number below 15 and a mass number higher than that of the element's most stable nuclide
- IV. In atoms with a large number of protons, the atom may capture an electron and emit a neutrino, thereby converting a proton to a neutron through the process of electron capture

ANSWER: I, II, III, IV

TOSS-UP

10. BIOLOGY *Multiple Choice* Which of the following terms refers to a character that is present in an entire monophyletic group and not present in any ancestral species or outgroups?

- (W) Synapomorphy
- (X) Sympleisomorphy
- (Y) Homoplasy
- (Z) Homopleisomorphy

ANSWER: W

TOSS-UP

11. CHEMISTRY *Short Answer* Phosphorus can react with chlorine to form phosphorus trichloride. If it reacts with more chlorine, it can form phosphorus pentachloride. Which orbital does phosphorus trichloride use to expand its valence?

ANSWER: 3D

TOSS-UP

12. PHYSICS *Short Answer* Which equation of fluid dynamics is analogous to Kirchoff's current law in electricity and states that the rate at which a mass enters a system is equal to the rate at which it leaves the system, commonly written as $A_1v_1 = A_2v_2$?

ANSWER: CONTINUITY EQUATION

TOSS-UP

13. BIOLOGY *Short Answer* Using words or numbers, name all of the following three animals that are part of genus *Canus*

- I. Gray wolf
- II. Domestic dog
- III. Coyote

ANSWER: I, II, III

TOSS-UP

14. CHEMISTRY *Multiple Choice* Steric hindrance would most likely be present in which of the following compounds?

- (W) 1,2-dichlorobenzene
- (X) 1,3-cyclohexadiene
- (Y) 1-methylnaphthalene
- (Z) 2,4,6-trinitrotolulene

ANSWER: X

TOSS-UP

15. PHYSICS *Short Answer* Calculate the change in entropy of a reversible thermodynamic process that does a total work of 300 J between the temperatures of 200 and 450 Kelvin and pressures of 100 and 400 KPa.

ANSWER: 0

TOSS-UP

16. BIOLOGY *Multiple Choice* Inhibition of the enzyme cyclo-oxygenase would most likely have which one of the following effects?

(W) Increase the rate of catalysis of phospholipase A2
(X) Increase the production of eicosenoid hormones
(Y) Repress the stimulation of protein kinase C
(Z) Increase histamine concentration in blood

ANSWER: Z

TOSS-UP

17. CHEMISTRY *Short Answer* In terms of the gas constant R, Calculate the change in Gibbs free energy for a double displacement reaction with an equilibrium constant e^4 at a constant temperature of 200 K.

ANSWER: -800R J/MOL

TOSS-UP

18. PHYSICS *Multiple Choice* A light is fired from a light source in the frame of reference S. The velocity of the observer O is one half the speed of light. If the frequency of the light in frame S is f , what does the frequency of the light approach to the observer O?

(W) $\sqrt{2}f$
(X) $\sqrt{3}f$
(Y) $\sqrt{\frac{3}{2}}f$
(Z) f

ANSWER: X

TOSS-UP

19. BIOLOGY *Short Answer* Which floral pattern would result from the abnormal expression of the B gene in all four whorls?

ANSWER: PETAL-PETAL-STAMEN-STAMEN

TOSS-UP

20. CHEMISTRY *Short Answer* Which type of microscopy used to visualize large molecules applies a voltage, called a bias, to generate a current that is a function of the local density of states of the sample?

ANSWER: SCANNING TUNNELING MICROSCOPY

TOSS-UP

21. PHYSICS *Short Answer* The empirical formula that Balmer derived to explain the emission lines of hydrogen in the Balmer series is a special case of which empirical and theoretical formula?

ANSWER: RYDBERG FORMULA

TOSS-UP

22. BIOLOGY *Multiple Choice* Which of the following DNA repair mechanisms is not found in placental mammals?

(W) Nucleotide excision repair

(X) Photoreactivation repair

(Y) Base excision repair

(Z) Mismatch repair

ANSWER: X

TOSS-UP

23. CHEMISTRY *Short Answer* Many reactions in biochemistry involve the transfer of a functional group from a donor molecule to a specific receptor molecule or to water. Which concept explains the tendency for such reactions to occur?

ANSWER: GROUP TRANSFER POTENTIAL

TOSS-UP

24. PHYSICS *Multiple Choice* Which of the following quantities approaches zero as a particle approaches relativistic speeds?

(W) Momentum

(X) Force

(Y) Observed time intervals

(Z) Acceleration

ANSWER: Z

TOSS-UP

25. BIOLOGY *Short Answer* Using words or numbers, name all of the following four substances that are found in higher concentrations in intestinal epithelial cells than in the lumen of the small intestine or the blood:

I. Sodium

II. Potassium

III. Glucose

ANSWER: II, III
