1. Math toss up short answer: A rat starts in the bottom front left corner of a three by three grid composed of 27 points. On each move, the rate can move up, right, or forward. How many ways are there for the rat to reach the opposite corner?

Answer: 90

2. Math bonus short answer: A weighted coin with a probability of 3/4 of landing on heads and 9 unweighted coins are in a pile. I pick a coin at random and flip in 4 times. If I get 3 heads, what is the probability that the coin is weighted.

Answer: 27/171

3. Physics toss up multiple choice: A ball with a mass of 2kg is dropped from a height of 80 meters. When it rebounds, it rises to only a height of 45 meters. If the time for the impact of the ball with the ground was .1 seconds, what was the force on the ball during the impact

Answer: 1400 N

4. Physics bonus short answer: A ball is dropped from a height of 90 meters. It hits the ground and rises to a height of 60 meters, then 40 meters, and so on, always reaching 2/3 of this previous maximum height. What will be the total distance travelled by the ball?

Answer: 450 m

5. Biology toss up short answer: Identify all of the following 4 statements which is or are true about signal reception:

I) Ligand binding will generally cause a receptor protein to undergo a change of shape

II) Most signal molecules are water soluble

III) Most signal molecules are small enough to pass freely through the plasma membrane

IV) A G protein, which functions as a switch that is on or off depending on which guanine nucleotide is attached, is inactive when GDP is bound and active when GTP is bound.

Answer: All but 3

6. Biology bonus short answer: Which enzyme catalyzes the transfer of phosphate groups from ATP to the amino acid tyrosine on a substrate protein?

Answer: Tyrosine Kinase

7. Earth and Space toss up multiple choice: Approximately what is the percent albedo of glaciers?

W) 0-20%

X)20-40%  
Y)40-60%

Z)60-80%

Answer: X

8. Earth and space bonus short answer: What glacial formation is made by three cirques

Answer: Horn

9. Chemistry toss up multiple choice: In a spacecraft, the carbon dioxide exhaled by astronauts can be removed by its reaction with lithium hydroxide, LiOH, according to the following chemical equation: CO2(g)+2LiOH(s) yields Li2CO3(s)+H2O(l). How many moles of lithium hydroxide are required to react with 20 mol of CO2, the average amount exhaled by a person each day?

W) 5 moles

X) 10 moles

Y) 20 moles

Z) 30 Moles

Answer: Y

10 Chemistry bonus short answer: In photosythesis, plants use energy to produce glucose and oxygen from the reaction of carbon dioxide and water. What mass of glucose is produced when 3.00 moles of water react with carbon dioxide? Give your answer to 1 significant figure.

Answer: 90

11. Math toss up multiple choice: What is the first positive integer which leaves a remainder of 1 when divided by the first 6 positive integers.

W) 61

X) 121

Y) 421

Z) 1

Answer: 1

12. Math Bonus short answer: Planet Euler uses the same seven days of the week as on earth. However, their months all have 30 days, and their years contain 999,999 months. The first day of the year is a Monday. What day of the week will the last day of the year be?

Answer: Sunday

13. Physics toss up multiple choice: Which of the following is true about the rate of energy radiation from a surface?

W) It is proportional to the square of the surface area

X) It is proportional to the square of the emissivity

Y) It is proportional to the fourth power of the temperature

Z) It is inversely proportional to the emissivity

Answer: Y

14. Physics bonus short answer: Identify all of the following three thermometers which must be in thermal equilibrium with the object being measured to produce an accurate result.

I. A bimetallic strip

II. A resistance thermometer

III. A temporal artery thermometer

Answer: I and II

15. Biology toss up multiple choice: The elongation of the leading strand during DNA synthesis

W) Progresses away from the replication fork

X) Occurs in the 3’ to 5’ direction

Y) Produces Okizaki fragments

Z) Requires a template strand

Answer: Z

16. Biology bonus short answer: Along one strand of a double helix is the nucleotide sequence 5’-GGCATAGGT-3’. What is the corresponding sequence when the above sequence is transcribed?

Answer: (3’)-CCGUAUCCA-(5’)

17. Earth and Space toss up short answer: What is the largest estuary in the United States, and what type of estuary is it?

Answer: Chesapeake Bay, Drowned River Valley Estuary

18. Earth and Space bonus multiple choice: What is the LC-50 maximum concentration for diazinon?

W) .35 grams/liter

X) .35 milligrams per Liter

Y) .35 micrograms per Liter

Z) .35 nanograms per Liter

Answer: X

19. Chemistry toss up short answer: If delta H is -100 kJ/mol, the temperature is 300 Kelvin, and delta S is .1 kJ/(molK), what is delta G?

Answer: -130 kJ/mol

20. Chemistry bonus multiple choice The city government in Wasilla, Alaska has hired you as a scientific consultant to help them remove ice from the sidewalks. Given equal masses of the following substances, which one would you recommend to be most effective at removing the ice?

W) Glucose with MW = 180 g/mol

X) NaBr, with MW = 103 g/mol

Y) KNO3 with MW = 101 g/mol

Z) CaCl2 with MW = 111 g/mol

Answer: Z

21. Math toss up multiple choice: A point is chosen at random from inside a 6 dimensional sphere centered on the origin. What is the probability that the product of the coordinates of the point will be even?

W)1/3

X) 1/2

Y) 35/64

Z) 5/8

Answer: ½

22. Math bonus short answer: 2 rooks are placed randomly on a 8 by 8 chess board. What is the probability that the two rooks will be able to attack each other? Express your answer as a fraction in lowest terms.

Answer: 49/63

23. Physics toss up multiple choice: A spherical charged particle with charge q, radius r, and velocity v is placed in a magnetic field. By what factor will the acceleration of the particle change if it is replaced by a particle of the same material but with q, r, and v all doubled.

W) It will decrease by a factor of 2

X) It will remain the same

Y) It will increase by a factor of 2

Z) It will increase by a factor of 4

Answer: W

24. Physics bonus short answer: A box with a mass of 5 kilograms is attached to a string with force constant 20 Newtons/meter.

Part 1. What is the period of the oscillation which will result if the box is shifted from equilibrium with a force of 500 Newtons.

Part 2. What would be the new period if each of the following 3 changes were made to the system I. The box is pushed with a force of 1000 Newtons II. The spring is replaced by one with a force constant of 5 Newtons per meter. III. The box is replaced by one with a mass of 10 kilograms

Answer: Pi,pi, 2pi, pi(sqrt2)

25. Biology toss up short answer: The product of the genotype is generally not a rigidly defined phenotype, but a range of phenotypic possibilities over which there may be variation due to environmental influence. What is this phenotypic range called for a genotype?

Answer: The norm of reaction

26. Biology bonus short answer All F1 individuals in a tetrahybrid cross are heterozygous in the four traits a, b, c, and d. For these, a capitol letter denotes the dominant allele and a lowercase letter denotes a recessive allele. What is the probability that a F2 offspring will have the following genotype: AABbccDd

Answer: 1/64

27. Earth and Space toss up Short answer What term is used to describe rock weathering in which shells or plates are broken away from a rock leaving it rounded in appearance?

Answer: Exfoliation

28. Earth and Space bonus multiple choice: To the nearest hundred, how many parts per million are there of Carbon dioxide in the atmosphere?

W) 200

X) 400

Y) 600

Z) 800

Answer: X

29. Chemistry toss up multiple choice: If 93.75 percent of a sample of pure 131I decays in 32 days, what is the half-life of 131I?

W) 4 days

X) 8 days

Y) 12 days

Z) 16 days

Answer: X

30. Chemistry Bonus Multiple Choice What is the molar solubility of water in Ag2CO3? The Ksp of Ag2CO3 is 8x10^-12.

W) 2x10^-12

X) The square root of 4x10^-12

Y) The cube root of 4x10^-12

Z) The cube root of 2x10^-12

31. Math toss up multiple choice: Identify all of the following 4 statements which is or are true about complex numbers.

I) The magnitude of the product of two complex numbers equals the product of the magnitudes of the two numbers

II) The nth roots of unity are all of the complex numbers which are real when raised to the nth power.

III) The angle of the product of two complex numbers is always equal to the sum of the angles of the two numbers.

IV) The sum of all nth roots of unity is 0 for all positive n.

Answer: I and III

32. Math bonus short answer: Yash and Matt decide to play a game. Yash has 42 dollars and Matt has 314 dollars. On each turn, a coin is flipped. If the coin lands on heads, Yash takes a dollar from Matt. If it lands on tails, Matt takes a dollar from Yash. The game ends when one of the players has all of the money? What is the probability that Matt will win?

Answer: 157/178

33. Physics short answer toss up: What is the common name for ionized gas?

Answer: Plasma

34. What is the self-inductance, including units, for a circuit with a coil that has 50 coils of water, an average magnetic flux of 500 webers and a current of 200 Amperes?

Answer: 125 henrys

35. Biology toss up short answer: Name the four extra embryonic membranes of a developing chick.

Answer: Amnion, Chlorion, Allantois, and yolk sac

36. Biology bonus short answer: Identify all of the following 4 statements which is or are true about the rate of diffusion in a respiratory surface in animals.

I. It is proportional to the surface area across which diffusion occurs

II. It is proportional to the square of the surface area across which diffusion occurs

III. It is inversely proportional to the distance through which molecules must move

IV. It is inversely proportional to the cube of the distance through which molecules must move.

Answer: I only

37. Earth and Space Toss up short answer: What was the name of the era 225 million years ago, during the time of Pangaea?

Answer: Permean

38. Earth and Space bonus short answer: Identify all of the following four minerals which contain silica tetrahedrons.

I. quartz

II. muscovite

III. halite

IV. orthoclase

Answer: I,II,IV

39. Chemistry toss up multiple choice What volume of 0.300-molar HNO3 is required to neutralize 50.0 milliliters of 0.240-molar Ca(OH)2?

W) 40.0 mL

X) 60.0 mL

Y) 80.0 mL

Z) 120. mL

Answer: 80.0 mL

40. Chemistry bonus multiple choice: What is the concentration of OH- in an aqueous 0.05 M solution of HCN? The Ka for HCN is 5.0x10^-10.

W) 4x10^-10

X) 4x10^-5

Y) 2x10^-5

Z) 2x10^-11

41. Math toss up short answer: An equilateral triangle is drawn with area 256. The triangle’s sides are bisected and the corners are cut off to create a new, smaller triangle. If this process is repeated 4 more times, what will be the area of the remaining triangle?

Answer: ¼

42. Math bonus short answer: A triangle with side-lengths 16, 30, and 34 is drawn in the plane.

Two circles are then drawn. One is internally tangent to all of the sides of the triangle. The other

passes through all of the vertices of the triangle. What is the distance between the centers of the

two circles?

Answer: sqrt(65)

43. Physics toss up short answer: When a ball is thrown with an angle of 45 degree it

lands a distance d away. What would be the final distance if the ball was thrown at an angle of

30 degrees from the horizontal and same initial speed?

Answer: (sqrt3)/2

44. Physics bonus short answer: What instead would be the final distance travelled by the ball in

the previous question if it was thrown at an angle of 37.5 degrees from the horizontal?

Answer: ((sqrt(2)+sqrt(6))/4)\*d

45. Biology toss up short answer: The cerebral cortex is the largest and most complex part of the mammalian brain. Some of its components are found in the brain of reptiles. What part of the cortex is unique to mammals? This part is composes of an outer layer of cortex with six sheets of neurons running tangential to the brain surface.

Answer: neocortex

46. Biology bonus short answer: In what place within the inner ear does the transduction of sound waves to action potentials take place?

Answer: The tectorial membrane

47. What is the name of a glacier that occurs when steep valley glaciers spill into relatively flat plains, where they spread into lobes.

Answer: Piedmont Glaciers

48. Earth and Space bonus short answer What is a glacier outburst flood resulting from the failure of a glacier ice dam, a glacier sediment dam, or from the melting of glacier ice by volcanic eruption?

Answer. Jokulahlaup

49. Chemistry toss up multiple choice: Which of the following comparisons demonstrates that ionic bonds are stronger than hydrogen bonds?

W) The melting point of NaCl (80oC) is higher than the melting point of sugar (186oC).

X) The solubility of NaCl in water and the solubility of sugar in water are both very high.

Y) NaCl does not burn, while sugar caramelizes and chars readily when burned.

Z) A solution of NaCl can be electrolyzed to generate chlorine gas, while a solution of sugar does not even conduct electricity.

Answer: W

50. Chemistry bonus short answer: The thermodynamics of protein-folding is an important topic of current research. Consider a prototypical protein

folding reaction which occurs inside your cells:

Unfolded Protein 🡨🡪Folded Protein

Suppose further that the folded protein is lower in entropy (more ordered) than the unfolded protein. If delta G is negative under cellular conditions, identify all of the following three statements which must be true.

I. delta H is negative.

II. Under equilibrium conditions, [Folded Protein] > [Unfolded Protein].

III. The rate of the protein-folding reaction is so fast that no enzyme is needed.

Answer: I and II