1. Math toss up short answer: If 3^4(3^4+3^4+3^4)=3^x, find x.

Answer: 9

2. Math bonus short answer: Saaket creates 27 science bowl questions. The questions are in math, physics, and chemistry, either short answer, multiple choice, or pseudo-multiple choice, and either trivial, medium difficulty, or hard. There is one question for every set of these three attributes. If Saaket elects three questions at random from his list, what is the probability that in each of the three attributes for the questions, they are either all different or all the same?

Answer: 1/25

3. Biology toss up short answer: A plant heterozygous for flower position, stem length, and seed shape is allowed to self fertilize. Given that all three of these have a dominant and recessive possibility, where the dominant is completely dominant over the recessive, what is the probability that an offspring will have 2 of the dominant traits and 1 of the recessive.

Answer: 27/64

4. Biology bonus short answer: A couple planning to start a family comes to you for information. Charles was married once before, and he and his first wife had a child with cystic fibrosis. The brother of his current Elaine died of cystic fibrosis. However, neither Charles nor Elaine has the fatal disease. What is the probability that Charles andElaine will have a baby with cystic fibrosis?

Answer: 1/6

5. Physics toss up short answer: What is the average power in an alternating current with a voltage of 50 volts and a current of 4 Amperes?

Answer: 100 Watts

6. Physics bonus multiple choice: Find the speed of sound in a rod with a young’s modulus of 50 pascals and a density of 2 kg/m^3.

Answer: 5 m/s

7. Chemistry toss up short answer: For each of the following three pairs of acids, predict which of the two will be stronger:

I. H2S, H2 Se

II. H2SO4, H2SO3III. H2SO4, H3PO4

Answer: H2Se, H2SO4, H2SO4

8. Chemistry bonus short answer: To two significant figures, find the solubility of silver chloride in 1.0\* 10-4molar NaCl, given that the Ksp of the Ag+ ions is 1.6\* 10^-10

Answer: 1.6\*10^-6

9. Earth and space toss up short answer: To three significant figures, what is the inclination of the Earth’s axis of rotation?

Answer: 23.4 degrees

10. Earth and space bonus short answer: Name all of the following four statements which is or are true about perihellon and aphellon

I. Perihellon is the earth’s closest point to the sun

II. Perihellon occurs at about July 5th

III. The difference between the distances from the earth to the sun during perihellon and aphellon is about 10%

IV. The distance from the sun to the earth is a large contributor to the different seasons

Answer: I only

11. Math toss up short answer: An isosceles triangle has side lengths of 13, 13, and 10. The base is extended in both directions to form a new isosceles triangle, whose base has length 18. What is the length of the other two sides of the isosceles triangle. This sentence is to give you time to draw a diagram, although you really should have answered by now, especially Yash.

Answer: 15

12. Math bonus short answer: 101 concentric circles are drawn. The first has radius 1, and each circle after has twice the radius of the last. After all circles have been drawn, there is one big circle divided into 100 different regions, ignoring the small circle in the middle. Number these in order from innermost to outermost starting at 1 and ending at 100. What is the ratio of the area contained in the odd numbered regions to even numbered regions.

Answer: ¼

13. Biology toss up multiple choice: Which of the following regulatory processes is the vertebrate liver not a part pf”

W) maintenance of blood sugar concentration

X) detoxification of harmful substance

Y) production of nitrogenous wastes

Z) Osmoregulation by variable excretion of salts

Answer: Z

14. Biology bonus short answer: Name all of the following four which help to maintain the high osmolarity of the renal medulla

I. diffusion of salt from the ascending limb of the loop of Henle

II. active transport of salt from the upper region of the ascending limb

III. The spatial arrangement of juxtamedullary nephrons

IV. Diffusing of urea from the collecting duct.

Answer: All of them

15. Physics toss up short answer: Name all of the following four statements which is or are true about quantum numbers:

1. The x, y, and z components of spin are either 1/2 or -1/2 times plank’s constant
2. A second quantum number of l =1 corresponds to the s state.
3. There are 5 possibilities for the third quantum number when the second is l=2
4. (3,2,2,1/2) is a valid set of quantum numbers for an electron

answer: 3 and 4

16. Physics bonus multiple choice: In an experiment with a single slit diffraction of light where the wavelength is much less than than the slit width, approximately how much of the light will be concentrated in the central maximum?

W. 65%

X. 75%

Y. 85%

Z. 95%

17. Earth and Space toss up multiple choice: Scientists find that 7/8 of the potassium 40 in a sample of rock has decayed into argon. To one significant figure, how old is the rock?

W) 3\*10^6 years

X) 4\*10^6 years

Y) 3\*10^9 years

Z) 4\*10^9 years

Answer: 4000,000,000

18. Earth and space bonus short answer: Order the following four minerals from softest to hardest in accordance with the Mohs hardness scale

I. Fluorite

II. Topaz

III. Apetite

IV. Quartz

Answer: I, III, IV, II

19. Chemistry toss up multiple choice: A sample of benzene is heated to its boiling point. The heat is continued until 15.4 kJ of heat is supplied, vaporizing 39 g of benzene. Which of the following is closest to the enthalpy of vaporization of benzene?

W) 20 kJ/mol

X) 30 kJ/mol

Y) 40 kJ/mol

Z) 50 kJ/mol

20. Chemistry bonus short answer: Which of the following is the closest to the value of delta G for the hydrolysis of 1 mole of ATP

W) -30 J

X) -300 J

Y) -3 kJ

Z) -30 kJ

21. Math toss up short answer: For some positive integer n>1, (2^n)-1 is divisible by 5, 7, and 11. What is the least possible value of n for which this can occur.

W. 15

X. 60

Y. 210

Z. 385

Answer: X

22. Math bonus short answer: Mr. Hill has a pile of papers which he wants his students to grade, and wants to give each person who grades the same number of papers. When he tries to gives 5 papers to each grader, one grader is left with 2. When he tries to give 6 papers to each grader, one grader is left with 4. When he tries to give 7 papers to each grader, each is left with 6. However, when Mr. Hill gives 11 papers to each grader, none are left over. What is the least number of papers that Mr. Hill could have?

Answer: 2222

23. Biology toss up multiple choice: What blood types are possible for a child when one parent has type AB blood and the other has type O blood?

W) AB, A, and B

X) AB and O

Y) A and B

Z) A, B, and O

Answer: Y

24. Biology bonus short answer: Two genes of a flower, one controlling blue (B) versus white (b) petals and the other controlling round (R) versus oval (r) stamens, are linked and are 10 map units apart. A homozygous blue oval plant is crossed with crossed with a homozygous white-round plant. The resulting F1 progeny are crossed with homozygous white-oval plants. If 1000 progeny result from this, how many plants of the four phenotypes would you expect?

450 Br and bR, 50 BR and wr

25. Physics toss up short answer: A block attached to an ideal spring on Earth has a frequency of 10 s. If the same block and spring are moved to mars, where the gravitational pull is half of that of Earth, what will be the new frequency of the system?

Answer: 10 s

26. Physics bonus short answer: A string 10 meters long is attached to a small object of mass 10 kg and displaced an angle of 10 degrees. The resulting motion has frequency f. If instead the massless rope and object are replaced by a 10 meter long rod of uniform density which also has mass of 10 kg and is again displaced by 10 degrees, what will be the new frequency of the motion in terms of f. You may make the assumption that sin(theta) = theta.

Answer: sqrt(2/3) f or sqrt(6)/3 f

27. Earth and Space toss up short answer: What shape do calcite and quartz crystals respectively form?

Answer: rhombohedra, hexagonal

28. Earth and Space bonus short answer: What law shows that the wavelength at which a star radiates the most energy depends only on the stars temperature?  
Answer: Wien’s law

29. Chemistry toss up short answer: What is the vapor pressure of water, in torr, at 100 degrees Celcius?  
Answer: 760 torr

30 Chemistry bonus short answer: If the vapor pressure of water at 25 degrees C is 23.76 torr and its standard enthalpy of vaporization at that temperature is 44.0 kJ/mol, estimate to 2 significant figures the vapor pressure of water at 35 degrees Celsius

Answer: 42 torr

31. Math toss up multiple choice: If the roots of the polynomial x^3+7x^2+5x+12 are r, s, and t, find (1-r)(1-s)(1-t)

W. 7

X. 15

Y. 19

Z. 25

Answer: Z

32. Math bonus short answer: For the same polynomial, x^3+7x^2+5x+12, instead find (1+r)(1+s)(1+t)

Answer: -13

33. Biology toss up short answer: Name all of the following five components present in a prokaryotic cell

I. Mitochondria

II. Ribosomes

III. nuclear envelope

IV. chloroplasts

V. ER

Answer: All but II

34. Biology bonus short answer: Name the components of the cytoskeleton important in each of the following 2 functions 1. guiding transport vesicles from the golgi to the plasma membrane 2. Holding the nucleus in place

Answer: 1. Microtubules 2. Intermediate filaments

35. Physics toss up multiple choice: An R-L circuit starts with both switches open. If the switch next to the source of emf is closed, after L/R time which of the following will be the closest to the percent of the maximum current in the circuit?

1. 20
2. 40
3. 60
4. 80

Answer: Y

36. Physics bonus short answer: A thin layer of benzene, with index of refraction n=1.501, lies on top of a sheet of fluorite, with index of refraction n=1.434. It is illuminated from above with light whose wavelength in benzene is 400 nm. Give all of the following thicknesses of the benzene layer will maximize the brightness of the reflected light.

I 100 nm

II 200 nm

III 300 nm

IV 400 nm

Answer: I and III

37. Earth and Space toss up short answer: During some times, orbits of other planets appear to be going backwards when viewed from the earth. What is this motion called?

Answer: retrograde (motion)

38 Earth and Space bonus short answer: Which of the following four statements is or are true about the Copernican model of the solar system

I. The sun and not the earth was the center of the universe

II. Planets travelled in perfect circular orbits

III. Orbital speeds were slower for planets farther away from the sun

IV. The model was much more accurate than the old model of Ptolemy

Answer: All but IV

39. Chemistry toss up short answer: What law states that the solubility of a gas is directly proportional to its partial pressure?

Answer: Henry’s Law

40. Chemistry bonus short answer: Calculate to one significant figure the molality of zinc chloride in a solution prepared by dissolving 4.11 g of Zinc chloride in 150 g of water

Answer: .201 mol/kg

41. Math toss up multiple choice: The two numbers 3+4i and -3+4i are each squared, and then multiplied. What is the result?

W. 25i

X.-125i

Y. 625

Z. -625

Answer: 625

42. Math bonus short answer: Yash and Saaket are playing a game. On each turn, yash randomly selects a 15th root of unity. Saaket wins a dollar from Yash if the number selected is not a root of unity of any smaller positive integer. Otherwise, Saaket wins a dollar from Yash. The game is played twice. Then, a 16 sided die is rolled, and saaket bets Yash 2 dollars that a one will come up. What is the probability that Saaket will not only win both of the games but the die roll as well.

Answer: 4/225

43. Biology toss up multiple choice: Which of the following contributes to the most of biological diversity?

W) anagenesis

X) phyletic evolution

Y) hybridization

Z) cladogenesis

Answer: Z

44. Biology bonus short answer: For each of the following four, say whether it is a photoautotroph, chemoautotroph, photoheterotroph, or chemoheterotroph.

I. sulfolobus

II. Algae

III. parasites

IV. fungi

Answer: chemoautotroph, photoautotroph, chemoheterotroph, chemoheterotroph

45. Physics toss up short answer: Two balls are thrown from the ground with the same initial speed of 50 m/s The first is thrown with an angle of inclination of 30 degrees. The second is thrown with an angle of inclination of 45 degrees. What is the positive difference between the speeds of the two balls when they hit the ground?

Answer: 0

46. Physics bonus multiple choice: You are 50 meters away from a wall, and your dog is 20 meters in front of you. What is the slowest speed at which you can throw a tennis ball so that it rebounds elastically off the wall and moves directly towards your dog without touching the ground

W) 10 m/s

X) 20 m/s

Y) 30 m/s

Z) 40 m/s

Answer: 20 m/s

47. Earth and Space toss up Short answer: Name all of the following three statements which is or are true about Kirchoff’s laws.

I. The first law states that all matter except for low-density gasses will produce a continuous spectrum if excited

II. The second law states that a low density gas excited to emit light will do so at only one wavelength and will thus produce an emission spectrum

III. The third law states that if light comprising a continuous spectrum passes through a warm, low density gas, the result will be an absorption spectrum

Answer: I only

48. Earth and Space bonus short answer: Pair each of the following four Kelvin temperatures with its spectral class

I. 7500

II. 10000

III. 3000

IV. 40000

Answer: F, A, M, O

49. Chemistry toss up multiple choice Consider the following equation and the associated value for ΔH^°.

2H\_2(g) + 2Cl\_2(g) → 4HCl(g)

ΔH= -92.3kJ

Which statement about this information is incorrect?

W If the equation is reversed, the value ΔH^° equals 92.3kJ.

X The four HCl bonds are stronger than the four bonds in H\_2 and Cl\_2.

Y The ΔH^° value will be -92.3kJ if the HCl is produced as a liquid.

Z 23.1 kJ of heat will be evolved when 1 mol of HCl(g) is produced.

Answer: Y

21. For which process will ΔH° and ΔG° be expected to be most similar?

W 2Al(s) + Fe\_2O\_3(s) → 2Fe(s) + Al\_2O\_3(s)

X 2Na(s) + 2H\_2O(l) → 2NaOH(aq) + H\_2(g)

Y 2NO\_2(g) → N\_2O\_4(g)

Z. 2H\_2(g) + O\_2(g) → 2H\_2O(g)

Answer: W