1. Math toss up short answer: Compute the integral from -5 to 5 of sqrt(25-x^2).

Answer: 25pi/2

2. Math Bonus short answer Given that sin(theta)+cos(theta)=7/5, compute 1/sin(theta)+1/cos(theta)

Answer: 12/35

3. Earth and Space toss up short answer: Give all of the following four wavelengths of ultraviolet which astronomers on earth can observe:

I. 150 nm

II. 250 nm

III. 350 nm

IV. 450 nm

Answer: 3 only

4. Earth and Space bonus short answer: Name all of the following four statements which is or are true about telescopes:

I. The Newtonian focus is used on small rather than large telescopes

II. Thicker mirrors produce better images

III. The VLT, built in the European Southern Observatory in the Andes mountains, stands for very large telescope

IV. The VLT contains the largest single telescope in the world

Answer: 1 and 3

5. Physics toss up multiple choice: An ideal gas is compressed while its temperature remains the same. How does the internal energy of the gas change:

W) It decreases

X) It stays the same

Y) It increases

Z) It either increases or decreases depending on the pressure of the gas.

Answer: X

6. Physics bonus short answer:

The wavelength of yellow sodium light in a vacuum is 5.89\*10^7 m/s. If the light is fired at an angle of 30 degrees to the horizontal into glass with an index of refraction of 2.0, to 2 significant figures what will be the speed of the light inside of the glass?

Answer: 1.5\*10^8 m/s

7. Chemistry toss up short answer: A volume of 9.0 mL of .70 M NH3 neutralizes a 35 mL sample of HClO4 solution. Find the concentration of HClO4.

Answer: .18 M

8. Chemistry bonus short answer: The boiling points of [\ce{CH3COCH3}](http://www.artofproblemsolving.com/Forum/code.php?hash=c2e683e369f95739b87f0287f020312892e8d4ea&sid=d8ff4a0c401720592b58619d33ea4ff3), [\ce{CH3COC2H5}](http://www.artofproblemsolving.com/Forum/code.php?hash=dfaf7bb61b7490a8ec990692bdc11095a311bdf8&sid=d8ff4a0c401720592b58619d33ea4ff3), and [\ce{CH3COC3H7}](http://www.artofproblemsolving.com/Forum/code.php?hash=82acfdaacb76c46dfe282d9be5773be123e1c040&sid=d8ff4a0c401720592b58619d33ea4ff3)are 56°C, 80°C, and 102°C, respectively. Name all of the following three which this increase can be attributed to?  
  
I dipole-dipole interactions  
II dispersion forces  
III hydrogen bonding

Answer: 2 only

9. Biology toss up multiple choiceWhich of the following statements about DNA in brain cells is true?

W) Some DNA sequences are present in multiple copies

X) Most of the DNA codes for protein

Y) The majority of genes are likely to be transcribed

Z) Many genes are grouped into operon-like clusters

Answer: W

10. Biology bonus short answer: What is the name for the attachment of acetyl groups to certain amino acids of histone protein groups?

Answer: Histone acetylation

11. Math toss up multiple choice: Let n= (1111^1111)^1111. n is repeatedly replaced with the sum of its digits until a one digit number remains. What is that 1 digit number?

W)1

X)4

Y)7

Z)8

Answer: X

12. Math bonus short answer: Saaket and Daniel are playing a game. Saaket has 2 beakers of hydrochloric acid, and Daniel has only 1. On each turn, a coin is flipped. If Saaket wins the toss he gets one of Daniel’s beakers of acid, and if Daniel wins, he gets one of Saaket’s beakers. The game continues until a player has all three beakers. I. What is the probability that Saaket wins this game? II. What is the expected number of turns until the game ends.

Answer: 2/3, 2

13. Earth and Space, toss up short answer: Scientists have discovered life in places where it was previously deemed impossible. What is the name of an organism that can survive or even thrive in an inhospitable environment?

Answer: Extremophile

14. Earth and Space bonus short answer: A starship is sent at a speed of 1 parsec per decade to the nearest star to the sun from earth. Within one year, how long does the ship take to arrive from the perspective of a scientist on earth?

Answer: 14 years (accept 15)

15. Physics toss up short answer: At the same time, two tennis balls are each thrown with a speed of 20 meters per second. The first is thrown downward from the top of a building which is 80 meters tall. The second is thrown upward from the ground. How long does it take for the two balls to collide? You may use radicals in your answer.

Answer: 2 seconds

16. Physics bonus short answer: Suppose that when the two balls in the previous example hit, they collide elastically. After the collision, how long will it take each of the two balls to hit the ground? Assume that when the first ball hits the ground, it moves away and does not collide again with the other still in the air. You may use radicals in your answer.

Answer: 2sqrt2-2 seconds, 2 seconds

17. Chemistry toss up short answer: Name all of the following four statements which is or are true about a substance subjected to a lower external pressure at a constant temperature.

I. The liquid will boil at a lower temperature.

II. The liquid will exhibit a lower vapor pressure

III. A gas in an insulated container will change into a liquid.

IV. A gas in a non-rigid container will exhibit a larger volume.

Answer: 1 and 4

18. Chemistry bonus multiple choice: For the reaction 2X+3Y=3Z, the combination of 2 moles of X with 2 moles of T yields 1.75 moles of Z. What is the percent yield of the reaction?

W) 43.8 %

X) 58.3%

Y) 66.7%

Z) 87.5%

Answer: D

19. Biology toss up short answer: Plant species A has a diploid number of 12. Plant species B has a diploid number of 16. A new species, C, arises as an allopolyploid from hybridization of A and B. What would be the most likely diploid number of C?

Answer: 28

20. Biology bonus multiple choice: A land plant which produces flagellated sperm and has a diploid-dominant generation is most likely a

W) fern

X) moss

Y) liverwort

Z) hornwort

Answer: W

21. Math toss up multiple choice: In triangle ABC, AB=BC=128, and <BAC=45 degrees. A line is drawn through B perpendicular to AC which intersects AC at point D. A line is then drawn through pint D perpendicular to line BC which intersects BC at point E. A line is then drawn from point E perpendicular to the hypotenuse which intersects at point F, and this process continues until point Z is drawn on AC on a line from point Y on BC perpendicular to AC. What is the area of triangle YZA?

W)1/4

X) 1/32

Y) 1/128

Z) 1/512

Answer: Z

22. Math bonus short answer: Quadrilateral ABCD is inscribed in circle O. Triangles ABD and CBD are isosceles. If AB=10, AC=12, and BD=15, find BC.

Answer: 9

23. Earth and Space toss up multiple choice: Which of the following is closest to the albedo of Jupiter?

W) .1

X) .3

Y) .5

Z) .7

Answer: Y

24. Earth and Space bonus short answer: How did astronomers first discover Jupiter’s magnetic field?

W) The deflection of solar wind by Jupiter

X) The destruction of electronics of a spacecraft flying past Jupiter

Y) Jupiter’s aurora

Z) Radio noise coming from Jupiter

Answer: Z

25. Physics toss up short answer: A spring is in SHM with frequency f. If the mass on the spring is doubled, in terms of f, what is the period of the new harmonic motion?

Answer: (sqrt2)/f

26. Physics bonus multiple choice: A Newtonian spring has a rock mass m sitting on it. Another rock of mass 10 kg is placed on top of the first rock, and the spring compresses by 12 meter. A second rock of mass 10 kg is then placed on top of the second rock, and the spring compresses by 6 meters. Finally, a third rock of mass 10 kg is placed on the third spring. How much does the spring compress?

W) 3 m

X) 2sqrt6 m

Y) 4 m

Z) 3 sqrt2 m

Answer: Y

27. Chemistry toss up multiple choice: How many moles of oxygen gas are produced by the decomposition of 245 g of potassium chlorate with the decomposition

2KClO3(s)🡺 2KCl(s)+3O2(g)

The molar mass of potassium chlorate is 122.6 g/mol.

W) 1.50

X) 2.00

Y) 2.50

Z) 3.00

Answer: Z

28. Chemistry bonus short answer: What are the signs of delta H and delta S for a reaction that is spontaneous only at low temperatures?

Answer: delta H is negative, delta S is negative

31. Math toss up short answer: A point[P](http://www.artofproblemsolving.com/Forum/code.php?hash=511993d3c99719e38a6779073019dacd7178ddb9&sid=80432e6eaf32d4982b66e5cdade91b0c)is chosen at random in the interior of a unit square [S](http://www.artofproblemsolving.com/Forum/code.php?hash=02aa629c8b16cd17a44f3a0efec2feed43937642&sid=80432e6eaf32d4982b66e5cdade91b0c). Let [d(P)](http://www.artofproblemsolving.com/Forum/code.php?hash=8c0a09b1aed74668e899b5f4a732cce3ff1f2379&sid=80432e6eaf32d4982b66e5cdade91b0c)denote the distance from [P](http://www.artofproblemsolving.com/Forum/code.php?hash=511993d3c99719e38a6779073019dacd7178ddb9&sid=80432e6eaf32d4982b66e5cdade91b0c)to the closest side of [S](http://www.artofproblemsolving.com/Forum/code.php?hash=02aa629c8b16cd17a44f3a0efec2feed43937642&sid=80432e6eaf32d4982b66e5cdade91b0c). The probability that [\frac{1}{5}\le d(P)\le\frac{1}{3}](http://www.artofproblemsolving.com/Forum/code.php?hash=89d8d3c52c10fc08a0c30bcd66cf97d23016b46e&sid=80432e6eaf32d4982b66e5cdade91b0c)is equal to [\frac{m}{n}](http://www.artofproblemsolving.com/Forum/code.php?hash=86609e60f441c339d6763e565a1f2bbf762d109d&sid=80432e6eaf32d4982b66e5cdade91b0c), where [m](http://www.artofproblemsolving.com/Forum/code.php?hash=6b0d31c0d563223024da45691584643ac78c96e8&sid=80432e6eaf32d4982b66e5cdade91b0c)and [n](http://www.artofproblemsolving.com/Forum/code.php?hash=d1854cae891ec7b29161ccaf79a24b00c274bdaa&sid=80432e6eaf32d4982b66e5cdade91b0c)are relatively prime positive integers. Find [m+n](http://www.artofproblemsolving.com/Forum/code.php?hash=56aa848d0008aab01a161b30679c39f37ec7fc1b&sid=80432e6eaf32d4982b66e5cdade91b0c).

Answer:279

29. Biology toss up multiple choice Which angiosperm cell is incorrectly paired with its chromosome count?

W) egg cell: n

X) megaspore: 2n

Y) microspore: n

Z) zygote: 2n

Answer: X

30. What types of symmetry do flatworms and cnidarians have respectively?

Answer: bilateral, radial

32. Math bonus short answer: It is time for two science bowl teams to face off, but both have forgotten when the match begins. They both arrive at some time between 2 and 3 p.m., wait for thirty minutes to see if the other team has come, and then leave if it has not. What is the probability that the two teams will not meet.

Answer: ¼

33. Earth and Space toss up short answer: What compound makes up most of Venus’s atmosphere?

Answer: CO2

34. What is the name of the largest basin on mercury, which is located near one of the two “hot poles” that face the sun at alternate perihelions?

Answer: Caloris Basin

35. Physics toss up multiple choice Two isolated conducting spheres each carry a charge of –Q. The second sphere has a radius 4 times larger than the first. If the two spheres are connected by a conducting wire, what will be the final charge on the first, smaller sphere/

W) -Q

X)-2Q/3

Y)-2Q/5

Z)-2Q/17

Answer: Y

36. Physics bonus short answer: Points A and B have potential difference Va=100 V and Vb=200 V. A charge q of -.05 C is moved from A to B through a curved path with length 20 cm. If the distance between A and B is 10 cm, what is the work done by the field on the charge?

Answer: -5

37. Chemistry toss up short answer: Name all of the following four processes which are exothermic:

I. condensation

II. fusion

III. sublimation

IV. vaporization

Answer: I only

38. Chemistry bonus multiple choice: Which of the following has the highest positive entropy change under standard conditions?

W) H2O­(g)+CO(g) 🡺 H2(g)+CO2(g)

X) CaCO3(s) 🡺 CaO(s)+CO2(g)

Y) NH(g) 🡺 NH3(aq)

Z) C8H18(l) 🡺 C8H18(s)

Answer: X

39. Biology toss up multiple choice: What would be the predicted floral morphology of a mutant lacking activity of the B genes?

W) carpel-petal-petal-carpel

X) petal-petal-petal-petal

Y) sepal-sepal-carpel-carpel

Z) sepal-carpel-carpel-sepal

Answer: Y

40. Biology bonus short answer: After cutting a live twig from a tree and examining the cut surface with a magnifying glass, you locate the vascular tissue and observing a growing droplet of fluid exuding from the cut surface. What, most likely, is this fluid?

Answer: phloem sap

41. How many subsets are there of the set containing the 10 positive integers from 1 to 10.

Answer: 1048576

42. Set S contains all of the integers from 1 to 11. Set T contains all of the subsets of set S. What is the sum of all of the elements of the sum of all of the elements of T.

Answer: 12288

43. Earth and Space toss up multiple choice: The Tunguska River valley was found in 1927 to have flattened trees in an area extending outward for 30 kilometers. No crater was found. How large was the asteroid theorized to be?

W) 3 meters

X) 30 meters

Y) 300 meters

Z) 30 kilometers

Answer: Y

44 Earth and Space bonus short answer: What scientist in his doctoral thesis proved that the Barringer crater was the result of an impact by a meteor?

Answer: (Eugene) Shoemaker

45. Physics toss up short answer: An Object is placed 20 meters away from a mirror with a focal length of 6 meters. What will be the distance between the mirror and the image of the object.

Answer: 60/7 m

46. Physics bonus multiple choice: Two cars going in opposite directions collide with each other, both immediately coming to a stop. If the sum of the masses of the two cars is 60 kg and the sum of the magnitudes of the impulses on the two cars during the collision was 3000 Ns, what was the sum of the speeds of the two cars before the impact?

W) 20 m/s

X) 50 m/s

Y) 80 m/s

Z) The sum of the speeds of the two cars cannot be determined by the information given.

Answer: Z

47. Chemistry toss up multiple choice A 2.00 L balloon at 20.0 degrees C and 745 mm Hg floats to an altitude where the temperature is 10 degrees C and the air pressure is 700 mm Hg. What is the new volume of the balloon?

W) .94 L

X) 1.06 L

Y) 2.06 L

Z) 3.06 L

Answer: Z

48. Chemistry bonus short answer: Arrange the following three acids in order of increasing strength.

I. HClO3

II. H3BO3

III H3PO4

Answer: 2, 3, 1

49. Biology toss up short answer; Carnivorous adaptations of plants compensate for soil having a lack of what element or compound?

Answer: Nitrogen

50 Biology Bonus short answer: The free-running period of the sleep movements of bean leaves is 26 hours. If a bean plant is kept in constant darkness, how many days will it take its leaves to be in the “noon position” when the actual time is midnight”

Answer: 6