



# Regional Topical Problems

## Part One

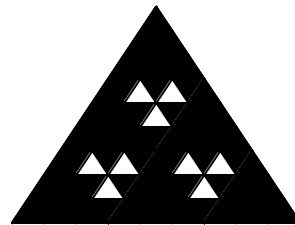
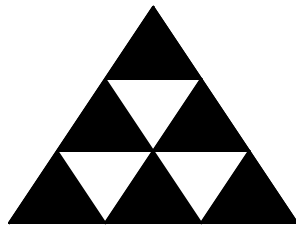
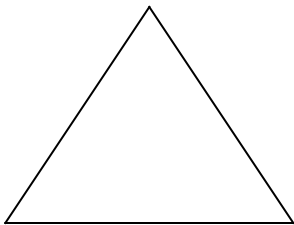
March 10, 2002

**Directions:** Mark on the answer form the letter that is closest to the correct answer. Make sure that your name(s) are on the answer form. If you are on a team put your team number and school name on the answer form. Remember that there are 5 points awarded for a correct response, 1 point for no response, and 0 points for an incorrect response.

$I = \frac{705w}{h^2}$  To the right is a formula for the body fat index, "I". "w" stands for the weight in pounds and "h" stands for height in inches.

1. What is the height in feet of a person with an index value of 27 and a weight of 160 pounds?  
a) 5.4      b) 5.3      c) 5.2      d) 5.5
2. What would the constant have to be changed to for the index to yield the same index values if the height is measured in centimeters and the weight is in kilograms? (455 grams is approximately 1 pound on earth and there are approximately 30.5 centimeters in a foot.)  
a) 10,000      b) 4,000      c) 130      d) 50

In the following progression of equilateral triangles, the first triangle has a side length of 1 meter.



3. What is the ratio of the shaded to the non-shaded in the next (fourth) triangle?  
a) 80:1      b) 8:1      c) 27:1      d) 26:1
4. What is the area in square centimeters of the shaded area in the second triangle?  
a) 1440      b) 2880      c) 5760      d) 3330
5. Which triangle in the progression will be the first to exceed 99.9% shaded?  
a) 5      b) 6      c) 7      d) 8

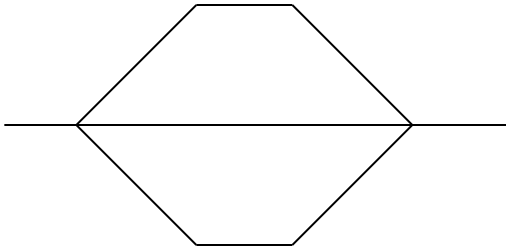
Mrs. Fyodor Vassilyev of Russia (1707-1782) gave birth to 16 sets of twins, in addition to 7 sets of triplets and 4 sets of quadruplets. She gave birth to 69 children in all.

6. What is the probability that one of her children selected at random was not a twin, triplet or a quadruplet?  
a) 0.01      b) 0.05      c) 0.10      d) 0.20
7. The average length of pregnancy is 39 weeks for a single gestation; 35 weeks for twins; 33 weeks for triplets; and 29 weeks for quadruplets. If this linear trend in data continues, what is the gestation period for octuplets?  
a) 27      b) 21      c) 24      d) 18

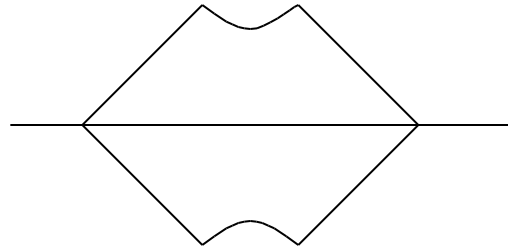
A cube with an edge of 10 centimeters is spun very fast about an axis that passes through two vertices of the cube that are the farthest apart.

8. What does the figure look most like?

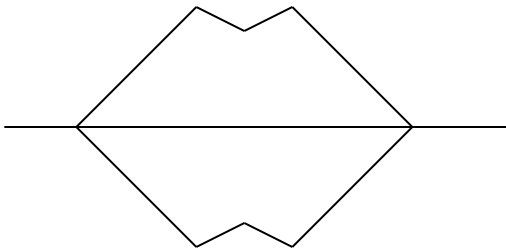
a)



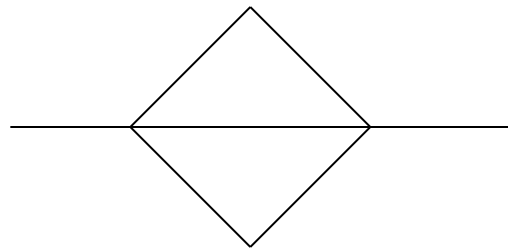
b)



c)



d)



9. What is the maximum distance in centimeters a vertex is from the axis?

- a) 7.0                      b) 8.0                      c) 8.5                      d) 7.5

10. What is the smallest angle in degrees made by a face of the cube and the axis?

- a) 45 degrees              b) 40 degrees              c) 35 degrees              d) 30 degrees

11. If plane R was a perpendicular bisector of the segment joining the two vertices that the axis went through, what is the shape of the cross section of the cube made by plane R?

- a) triangle                  b) square                      c) quadrilateral              d) hexagon

An insurance company expects to pay the dollar amounts in the table on every 100,000 policies and has an overhead of 15% of the amount of sales on policies to cover operating costs

Number of Claims	Amount Paid
1	1,000,000
5	100,000
20	10,000
100	1,000

12. What should the company charge to cover its costs?

- a) \$27                      b) \$32                      c) \$21                      d) \$18

13. What percent of the average (mean) claim is the company's price in problem 12?

- a) 0.14                      b) 0.12                      c) 0.15                      d) 0.13

A set of consecutive positive integers beginning with one is written on the blackboard. A number is erased and the average is exactly  $35 \frac{7}{17}$ .

14. What was the erased number?

- a) 1                              b) 10                              c) 50                              d) 30

In a recent survey, 45% of houses contained two or more people. 35% of those houses containing only one person contained a male. 5% of the houses surveyed were vacant.

15. What percentage of all houses contained exactly one female and no males?

- a) 10%                      b) 15%                      c) 5%                      d) 30%



# Regional Topical Problems

## Part Two

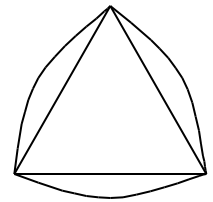
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The cost of 3 regular sandwiches, 7 cups of coffee, and 1 donut is \$13.65. The cost of 4 regular sandwiches, 10 cups of coffee, and 1 donut is \$18.45. All sandwiches cost the same as do the cups of coffee and the donuts.

1. What is the cost of one regular sandwich, a cup of coffee, and a donut?

- a) \$3.50                      b) \$3.75                      c) \$4.00                      d) \$ 4.25

Curves of constant width are formed by making arcs of circles through vertices with the center of the arc at a vertex on the opposite of the polygon. They are used in many different types of engineering applications. To the right is an equilateral triangle with the approximate arcs added.



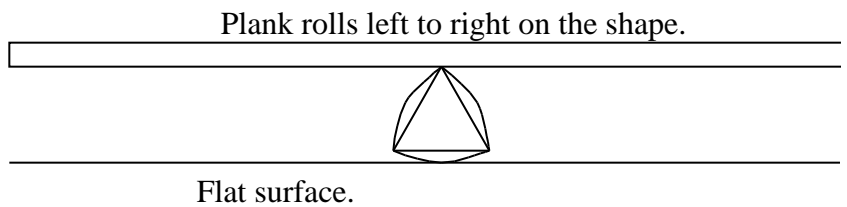
2. What is the circumference of the triangular curve of constant width if the side of the triangle is “s”?

- a)  $s$                       b)  $2 s$                       c)  $5 3^{0.5}$                       d)  $10 3^{0.5}$

3. What is the area of the triangular curve of constant width if the triangle’s sides are all “s”?

- a)  $0.3 s^2$                       b)  $0.9 s^2$                       c)  $0.7 s^2$                       d)  $0.5 s^2$

4. Imagine a long shaft whose cross section was the above curve of constant width and a plank were set on the shaft perpendicular to the shaft. If the curve is on a flat surface and the plank is pushed causing the shaft to roll, which graph would describe the vertical motion of the plank?



- a)  $y = \sin(x)$                       b)  $y = |\sin(x)|$                       c)  $y = -|\sin(x)|$                       d)  $y = \sin^2(x) + \cos^2(x)$

Car A gets 20 miles per gallon of gas and has a tank that holds 11.2 gallons. Car B gets 35 mpg and has a 9.8 gallon tank. Car A takes off east from the same intersection and at the same time that car B leaves the intersection headed south. Both roads are very long and straight. The Car A is traveling 15 miles per hour faster than Car B. After one hour and twenty minutes they are 100 miles apart.

5. How fast in miles per hour is car A traveling?

- a) 40                      b) 48                      c) 55                      d) 62

6. How far apart in miles are they when they both run out of gas?

- a) 550                      b) 500                      c) 450                      d) 400

To the left is a table showing the Beaufort wind scale used in many places around the world. This wind scale was designed in 1805 by Sir Francis Beaufort, a rear admiral in the British navy, to describe the wind's effect on sailing ships. The scale is a series of numbers from 0-17 that indicate wind speed.

Beaufort Number	Name	Wind Speed in Miles/Hour
0	Calm	Less than 1
1	Light air	1-3
2	Light breeze	4-7
3	Gentle breeze	8-12
4	Moderate breeze	13-18
5	Fresh breeze	19-24
6	Strong breeze	25-31
7	Moderate gale	32-38
8	Fresh gale	39-46
9	Strong gale	47-54
10	Whole gale	55-63
11	Storm	64-73
12-17	Hurricane	74 and above

7. Which mathematical model best fits this data?  
 a) Inverse   b) Quadratic   c) Linear   d) Exponential
8. Using the best model above, and matching the Beaufort number to the average wind speed for that number, what is the wind speed in miles per hour for Beaufort number 17?  
 a) 110   b) 120   c) 130   d) 140
9. A 10 Beaufort has about an 8-9 mph wind speed range. What is the range for 15 Beaufort?  
 a) 9   b) 10   c) 11   d) 12

Large blocks of cheese are passed through a 4 cm. by 6 cm. wire grid turning the block into long right rectangular solids. A single programmable chopping wire passes quickly through these cutting them into regular right rectangular solids to be wrapped and sold. The blocks are pushed through the grid at a rate of 0.5 meters per second.

10. What is the length in centimeters of a quarter kilogram of cheddar cheese if the density of cheddar cheese being cut this way is 0.95 grams per cubic centimeter?  
 a) 8   b) 9   c) 10   d) 11
11. If cutting the cheddar cheese above, what is the time in seconds between each cut of the chopping wire.  
 a) 0.20   b) 0.22   c) 4.5   d) 2.0
12. If the 4 cm. spacing of the grid was adjustable, write a function for the relationship between the spacing (w) and the time (t) between the cuts of the chopping wire.  
 a)  $t = 0.9/w$    b)  $t = 17/w$    c)  $t = 1.7/w$    d)  $t = 9/w$
13. If Swiss cheese is pushed through the grid, other problems arise. Swiss cheese has the unique feature of having bubble holes in it. Therefore the density varies. The density is 0.89 grams per cubic centimeter with a standard deviation of .04. What density value should be used to guarantee that the blocks of Swiss cheese are 97.5 % of the time equal to or exceeding a \_ kilogram?  
 a) 0.93   b) 0.89   c) 0.85   d) 0.81

The average age of a group of teachers and professors is 40. The teachers' average age is 35 and the professors' average age is 50.

14. What is the ratio of the number of teachers to the number of professors?  
 a) 20/10   b) 25/10   c) 30/10   d) 15/10

A radioactive chemical decomposes at a rate of 15% in 20 years.

15. What is the half-life in years of this chemical?  
 a) 10   b) 40   c) 50   d) 80

### Key to Regional Topical March 19, 2003

#### Part One

1. A 5.4	6. A 0.01	11. D Hexagon
2. A 10010	7. D 16.4	12. C 20.70
3. D 26	8. B	13. C 0.15%
4. B 2886.75	9. B 8.1	14. B 7
5. E 8TH	10. C 35.26	15. D 37.5%

#### Part Two

1. C 4.05	6. D 409	11. B 0.22
2. A	7. B Quadratic	12. A $t = 0.9/w$
3. C $0.70S^2$	8. D 137	13. D 0.81
4. D	9. D 12.5	14. A 20/10
5. D 60	10. D 10.96	15. D

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