



# Topical Problems

## Part One

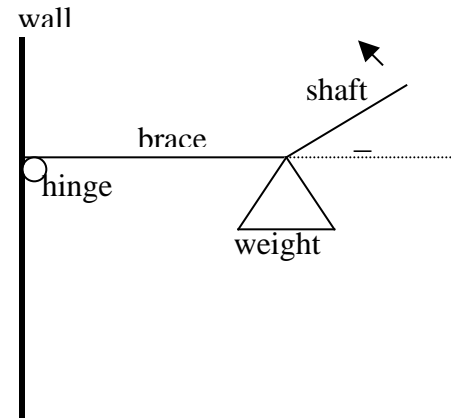
**Directions:** Mark on the answer form the letter that is closest to the correct answer. Make sure that your name(s) are on the answer form. If you are on a team put your team number and school name on the answer form. Remember that there are 5 points awarded for a correct response, 1 point for no response,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

The track lanes for a high school are being constructed around the football/soccer field. It will consist of two straight sections and two congruent, semicircular sections. The straight sections will each be 100 meters in length.

- If the inside edge of the lane closest to the field needs to be 400 meters, what is the radius in meters of the curvature for this lane?  
A) 32      B) 48      C) 64      D) 58
- If a runner always runs 25 centimeters from the inside edge on the turn, how much further (in meters) than 1600 meters is the 4 laps?  
A) 6.4      B) 3.2      C) 0.8      D) 1.6
- If each lane is 60 centimeters wide, and the difference in length of each adjacent lane is calculated, how much longer is the difference between lanes 7 and 8 than between lanes 1 and 2? Lanes are numbered from 1 to 8 starting from the inside lane.  
A) 1      B) 2      C) 4      D) 8

A one meter brace has one end attached with a hinge to a wall. A weight is fastened to the other end. A second shaft is tied to the end of the brace at the same point as the weight is tied. The shaft is moved in a circle as shown. As the angle    increases the values of the forces needed in the shaft to hold the brace horizontal are recorded in the table.

Angle in Degrees	Force in Newtons
30	1250
45	900
60	725
90	625
120	725
135	900
150	1250



- What would be the value of the pulling force in the table for 240 degrees?  
A) 725      B) 900      C) -725      D) -900
- If  $x$  is the angle in degrees and  $y$  is the pulling force, which function would best model this situation?  
A)  $y = 0.181x^2 - 32.6x + 2039$       B)  $y = -0.000023x^4 - 0.0086x^3 + 1.25x^2 - 85.26x + 2899$   
C)  $y = 10|x - 90| + 625$       D)  $y = 630 \csc(x)$

For the next set of questions, imagine a circle of radius 1 meter. For each of the separate problems a different number of points will be evenly spaced around this circle. Then each of the points in a particular problem will be connected with a segment to each of the other points on the circle in the same problem. The result will be a regular polygon with all of its diagonals drawn.

6. With 10 points evenly spaced on the circle, how many segments are needed to make all of the connections between the points?  
A) 45      B) 100      C) 90      D) 50
7. With 6 points evenly spaced on the circle, what is the total length of all of the segments needed to connect all of the points?  
A) 35      B) 12      C) 17      D) 22
8. With 5 points evenly spaced on the circle, how many triangles are formed using all or parts of the segments needed to connect all of the points to one another?  
A) 10      B) 20      C) 30      D) 25
9. With 4 points evenly spaced on the circle, if any three points are selected at random to make a triangle, what is the probability that a random point chosen inside the circle will be inside the triangle?  
A) 0.71      B) 0.32      C) 0.45      D) 0.64

The number of atoms in a mole of atoms was determined by Avagadro to be  $6 \times 10^{23}$ . The size of this number is amazing even though this number of water molecules has a volume of 18 milliliters. The formula for surface area of a sphere is  $SA=4 r^2$  and the formula for the volume of a sphere is  $V=(4/3) r^3$ .

10. If a person spent \$1000 every second, how long would it take to spend  $6 \times 10^{23}$  cents?  
A) 1 million weeks    B) 1 million days      C) 1 million millennia      D) 1 million years
11. The radius of the earth is  $6 \times 10^6$  meters. If  $6 \times 10^{23}$  cubic meters of dirt were spread evenly over the surface of the earth (assuming you could do so even over the oceans) what would be the increase of the radius of the earth?  
A) 50 megameters    B) 500 kilometers      C) 5 kilometers      D) 50,000 megameters

A unit cube is shape #1. A unit cube is attached to each exposed face of shape #1 to make shape #2. A unit cube is attached to each exposed face of shape #2 to make shape #3. The pattern is continued.

12. On shape #2, points A and B are two points as far apart as possible. How far apart are they?  
A) 3      B) 3.5      C) 5      D) 11
13. If an ant were to walk from point A to B along edges of the unit cubes, how many shortest paths are there?  
A) 4      B) 8      C) 16      D) 20
14. What is the surface area of shape #3?  
A) 90      B) 70      C) 80      D) 60
15. How many cubes are in shape #6?  
A) 240      B) 230      C) 130      D) 380



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This table is from the US Census Bureau. The last column is the difference between the second and third column. The men's and women's salaries grow exponentially.

1. From 1991 and 1997, what is the difference between the average increase for the men's median salary and the women's median salary?

A) 500            B) 1000  
C) 100            D) 200

2. What is the annual percentage growth for the women's median salary?

A) 3.4            B) 5.2            C) 4.3            D) 1.5

3. If both the men's and the women's salaries continue to increase at the same exponential rates through 2030, what will be the difference between the predicted men's median salary and the women's predicted median salary in 2030?

A) \$11000    B) \$15000    C) \$19000    D) \$21000

<b>Year</b>	<b>Women's Median Salary</b>	<b>Men's Median Salary</b>	<b>Difference between Men's Salaries and Women's Salaries</b>
<b>1991</b>	\$11,580	\$23,686	\$12,106
<b>1992</b>	\$11,922	\$23,894	\$11,972
<b>1993</b>	\$12,234	\$24,605	\$12,525
<b>1994</b>	\$12,766	\$25,465	\$12,371
<b>1995</b>	\$13,821	\$26,346	\$12,699
<b>1996</b>	\$14,682	\$27,248	\$12,566
<b>1997</b>	\$15,573	\$28,919	\$13,346

A company is considering advertising on the radio. Upon investigating pricing, it discovers that ads played between 6 AM and Noon cost \$300 per minute. Ads splayed between Noon and 6 PM cost \$125 per minute. The station claims it has 70,000 listeners on average during the AM time slot.

4. If the station charges the same amount per listener per minute in the AM as in the PM, How many listeners does the station have in the PM time slot?

A) 30,000    B) 29,000    C) 28,000    D) 31,000

5. The advertiser has \$10,000 to spend on advertising and never wants less than 25% of its ads to be in the morning or the afternoon. How many 1 minute ads should it play in the morning to reach the most listeners?

A) 10            B) 16            C) 46            D) 29

A triangle is defined by the functions  $f(x) = -|x| + 10$  and  $g(x) = 0$ .

6. Find the area of the largest rectangle that fits in the triangle.  
 A) 75      B) 25      C) 100      D) 50
7. If the triangle is rotated about the y axis, find the volume in units cubed of the largest cylinder that would fit in the cone formed by the rotated triangle.  
 A) 7      B) 465      C) 393      D) 785

The formula for the vertical,  $V(t)$ , and horizontal,  $H(t)$ , position of a projectile launched on the moon are given below where  $v_0$  is the starting speed,  $h_0$  is the starting height, and  $\theta$  is the launch angle of the projectile. The  $V(t)$  and  $H(t)$  functions are measured in meters,  $t$  is measured in seconds,  $v_0$  is in meters per second and the angle is measured in degrees.  $V(t) = -0.8t^2 + (v_0 \sin(\theta))t + h_0$ .  $H(t) = v_0 \cos(\theta) t$ .

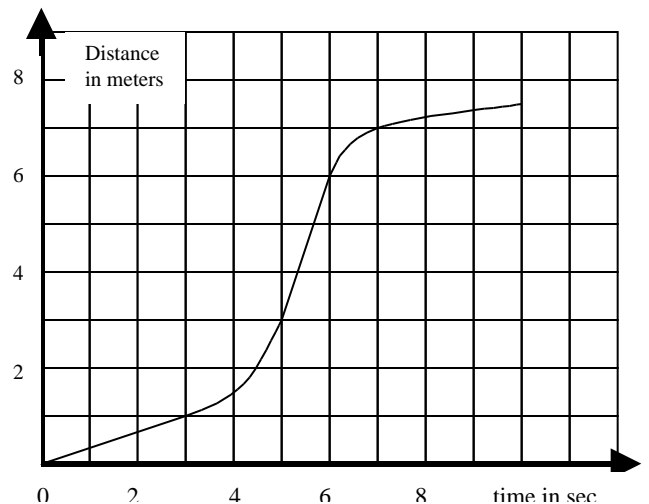
8. If a projectile is launched from ground level with a  $v_0 = 300$  m/s at 30 degrees, what is the maximum height it will reach?  
 A) 7000      B) 300      C) 3000      D) 150
9. If a projectile is launched from ground level with a  $v_0 = 300$  m/s at 30 degrees, what is the maximum distance it will reach from its launch site if it is launched over flat ground?  
 A) 500 km.      B) 50 km.      C) 5 km.      D) 10 km.
10. If  $v_0 = 100$  m/s, what launch angle in degrees will get the projectile to land 2000 meters away?  
 A) 18.6      B) 12.3      C) 80.5      D) 10.2

A fair coin is flipped 5 times.

11. What is the probability that it comes up heads at least 4 times?  
 A) 0.20      B) 0.10      C) 0.15      D) 0.05
12. If the coin's cylindrical shape suddenly changed so that 40% of the time the coin lands on its edge, what is the probability that it lands 3 of 5 times as heads?  
 A) 0.01      B) 0.90      C) 0.12      D) 0.05

Use the distance time graph to the right for the following questions.

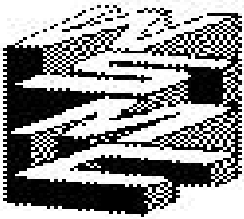
13. What was the total change in distance in meters?  
 A) 2      B) 4      C) 6      D) 8
14. What was the average speed in meters per second between 5 seconds and 10 seconds?  
 A) 0.9      B) 0.2      C) 1.1      D) 3
15. Which time interval had the greatest positive acceleration?  
 A) 5-6      B) 3-4      C) 6-7      D) 4-5





**Answers to the State Topical  
April 26<sup>th</sup>, 2003**

<b>Part One</b>		<b>Part Two</b>	
1 A	9 B	1 D	9 B
2 A	10 C	2 B	10 C
3 A	11 A	3 A	11 A
4 C	12 B	4 B	12 C
5 D	13 D	5 D	13 D
6 A	14 C	6 D	14 A
7 D	15 B	7 B	15 D
8 C		8 A	



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5 D	13 D	5 D	13 D
6 A	14 C	6 D	14 A
7 D	15 B	7 B	15 D
8 C		8 A	