

WSMC High School Regional Competition

Topical Problems

Part One

March 10, 2010

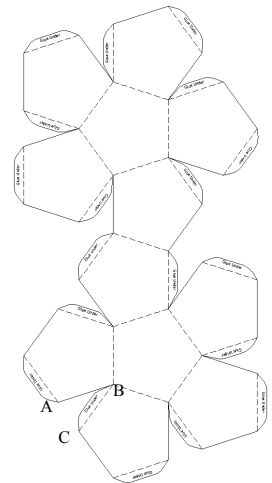
Directions: Mark on the answer form the letter that is closest to the correct answer. Make sure that your name(s) are on the answer form. If you are on a team put your team number and school name on the answer form. Remember that there are 5 points awarded for a correct response, 1 point for no response,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

A new windmill is being erected on a monopole. The pole is supported halfway up by three cables that are anchored to the ground at three points equidistant to each other and all three are on a circle centered at the base of the pole. The circle has a radius of 20 feet and the angle the cable makes with the ground is 60° .

- How tall is the pole?
A. 35 B. 40 C. 80 D. 70
- If each cable needs to be an extra four feet longer for tying, how many feet of cable is needed?
A. 130 B. 80 C. 120 D. 44
- What is the distance in feet between the anchor points?
A. 30 B. 20 C. 50 D. 40
- If each anchor is a block of concrete 4 feet by 4 feet by 2 feet and the base of the pole is a 6 foot by 6 foot by 2 foot block and the concrete is \$150 for a cubic yard, how much will the concrete cost in dollars?
A. 950 B. 750 C. 1050 D. 600

A dodecahedron is a twelve-sided regular polyhedron where the faces are regular pentagons. They are often used to put the calendar for a year on. A template for cutting one out of paper and folding it together is shown.

- How many edges does a dodecahedron have?
A. 48 B. 24 C. 30 D. 60
- How many vertices are there?
A. 48 B. 24 C. 30 D. 20
- How many diagonals pass through the interior of the dodecahedron? (A diagonal is a segment with endpoints on two vertices.)
A. 200 B. 50 C. 100 D. 75
- If the dodecahedron were a planet where the edges were roads of equal length (L) and the vertices were cities, what is the minimum number of road lengths (L) a traveler have to travel to be able to visit all of the cities and return home.
A. 30 B. 20 C. 60 D. 40
- What is the measure of angle ABC?
A. 15° B. 20° C. 35° D. 30°
- Visualize a dodecahedron sitting on top of a table. Then imagine the dodecahedron being crushed so that the faces on the opposite sides of the dodecahedron (the faces parallel to the table top) are in the same plane. Which of the following angles of rotation would be required to align the vertices of the top face with the opposite bottom face it has been pushed onto?
A. 360° B. 72° C. 180° D. 144°



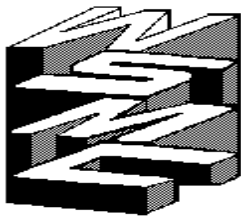
The distance in feet a car skids as it comes to a locked brake stop for different speeds in miles per hour is listed in the table titled Stopping Distance. This table is for a vehicle on an average dry asphalt surface. The speed is related to the distance by a polynomial function.

Speed (mph)	Distance (feet)
10	4
20	18
30	40
50	111
70	218

11. What is the stopping distance in feet for a speed of 40 mph?
A. 75 B. 72 C. 73 D. 74
12. What is the speed in miles per hour for a car that took 150 feet to stop?
A. 58 B. 56 C. 60 D. 62
13. The stopping distance is inversely proportional to the drag factor of the surface. If the drag factor for the asphalt in the previous questions is 0.75 and the drag factor for concrete is 0.90, what is the stopping distance in feet for 30 mph speed on concrete?
A. 36 B. 45 C. 30 D. 33

According to a website, approximately 7400 teenagers (16-20 years old) died in auto accidents in 2004. Teenagers (16-20 years old) were 7% of the licensed drivers, 14% of the fatalities, and 20% of the reported accidents that year.

14. What was the number of auto accident fatalities in 2004?
A. 40,000 B. 44,000 C. 48,000 D. 52,000
15. If an insurance company uses only 7% and 20% figures given above and insures 100,000 drivers and paid a total of \$50,000,000 in claims a year, how much more should a teenager pay per year than an adult would pay in insurance premiums for similar policies?
A. \$1000 B. \$600 C. \$1200 D. \$800



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Part Two

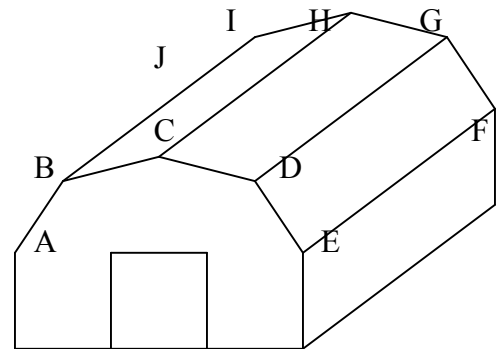
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Assume that the only types of U.S. coins worth less than a dollar are a penny, nickel, dime, quarter, and half-dollar.

- What is the maximum number of current U.S. coins each worth less than dollar can you have without having change for a dollar if you have at least one of each?
A. 99 B. 60 C. 12 D. 15
- What is the maximum amount of money in current U.S. coins (each worth less than a dollar) you can have without having change for a dollar?
A. \$1.19 B. \$0.99 C. \$1.09 D. \$0.89

A barn has a rather traditional looking roof. The angle that the two outermost roof sections make with the horizontal is 60 degrees while the upper middle sections make a 30 degree angle with the horizontal. We want to hang strings of lights along the roof line of both ends and both sides (A-B-C-D-E-F-G-H-I-J-A). The building is 40 feet wide and 60 feet long. Point E to the ground is 10 feet. Each section of the roof is of equal area.



- What is the area in square feet of one roof section?
A. 900 B. 1200 C. 1500 D. 1800
- How high in feet is the top of the barn?
A. 25 B. 20 C. 35 D. 30
- If the lights come in lengths of 25 feet and cost \$5.99 plus 8% sales tax, how much will the lights cost?
A. \$65 B. \$60 C. \$55 D. \$70
- In preparation for painting next summer, determine the area in square feet of all of the vertical walls excluding the 12 foot by 12 foot doors on each end.
A. 1500 B. 2700 C. 3000 D. 1350

The table shows the results of testing 4000 patients for a disease. The test like most tests occasionally tests positive when the disease is not present and occasionally tests negative when the disease is present.

	Disease	No Disease
Test positive	58	778
Test negative	15	3149

- Of those with the disease, what percent tested positive?
A. 80% B. 70% C. 100% D. 90%
- If a patient tested positive for the disease, what is the chance in percentage that the patient does not have the disease?
A. 98% B. 90% C. 10% D. 70%

The change in pitch or frequency of sound as the source of the sound travels was explained by Austrian Christian Doppler. The formula for the frequency heard in front of a source moving toward the listener is:

$$f_{in-front} = f_{source} \left(\frac{v_{sound}}{v_{sound} - v_{source}} \right)$$

$f_{in-front}$ is the frequency heard in front of the moving source in hertz

f_{source} is the frequency produced by the source in hertz

v_{sound} is the speed of sound 345 m/s

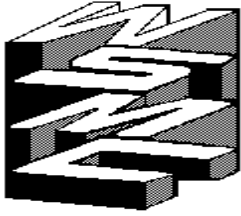
v_{source} is the speed of the source in m/s

Wavelength is related by the following formula to frequency and the speed of sound:

$$v_{sound} = \lambda_{in-front} f_{in-front} \quad \text{OR} \quad v_{sound} = \lambda_{source} f_{source}$$

where λ = wavelength in meters and f = frequency of the sound in hertz

9. If a source is moving toward a listener at 40 m/s and emitting a sound with a frequency of 512 hz, what is the frequency in hertz heard by the listener?
A. 530 B. 510 C. 570 D. 550
 10. If the frequency heard in front of a moving source is 20% more than the frequency of the source, what is the speed in m/s of the source?
A. 48 B. 32 C. 58 D. 54
 11. If the source's speed increases to near the speed of sound, what would the Doppler Effect formula predict for the frequency heard in front of the source?
A. Approaches zero B. Approaches infinity C. Approaches f_{source} D. Is undefined
 12. Which formula predicts the wavelength of sound for a listener in front of a moving source?
A. $\lambda_{in-front} = \lambda_{source} (1 - v_{source})$ B. $\lambda_{in-front} = \frac{(v_{sound} - v_{source})}{f_{source}}$
C. $\lambda_{in-front} = \lambda_{source} \left(\frac{v_{sound}}{(v_{sound} - v_{source})} \right)$ D. $\lambda_{in-front} = \lambda_{source} \left(\frac{(v_{sound})^2}{(v_{sound} - v_{source})} \right)$
- Let's assume that you just won a million dollar lottery. You have one option of taking \$500,000 now or a second option of taking twenty annual payments of \$50,000. If you choose the second option, the state will pay you immediately your first payment of \$50,000. The state will then invest just enough in an account with an interest rate of 6% compounded annually so that the account balance after the final payment will be zero.
13. If you took the half option, used \$200,000 to pay off bills and treat yourself and invested the rest at 6% compounded monthly for 20 years, how much would the investment balance in dollars be after 20 years?
A. 962,000 B. 662,000 C. 828,000 D. 993,000
 14. Assume you took half, spent \$200,000, and then invested the rest at 6% compounded monthly but withdrew \$2,000 per month. How many years could you do this before the funds were gone?
A. 15 B. 18 C. 24 D. 21
 15. How much does the state have to invest if you take the \$50,000 for twenty years option?
A. \$500,000 B. \$450,000 C. \$600,000 D. \$550,000



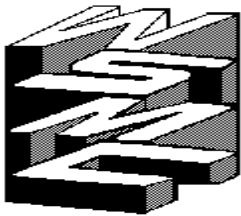
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Answer Key

March 10, 2010

Part One		Part Two	
1.	D 69.28°	1.	C 13
2.	A 132'	2.	A \$1.19
3.	A 34.6'	3.	A 876 sq ft
4.	A \$933.33	4.	D 30 feet
5.	C 30	5.	A \$64.69
6.	D 20	6.	B 2726 sq ft
7.	C 100	7.	A 79%
8.	B 20	8.	B 93%
9.	C 36°	9.	C 579 hz
10.	C 180°	10.	C 57.5 m/s
11.	B 71.2'	11.	B
12.	A 58 mph	12.	B
13.	D 33.3'	13.	D \$993,061
14.	D ~52,857	14.	C 23 1/6 years
15.	A \$1000	15.	D \$557,905.82



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**WSMC High School
Math Contest
Answer Form for Part One**

School

Team Number

Name(s)

1.

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**WSMC High School
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Answer Form for Part Two**

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