APPENDIX A STUDENT INFORMATION SHEET & APTITUDE SURVEY

Student Information Sheet

Student

First Name:_____MI:_____
Last Name:_____
Address:_____
City:_____St.:_____
Zip:_____
Cell:_____
NSBE Jr. Advisor:_____
NSBE Jr. Advisor member #:_____

Member Number_____
Region : 1 2 3 4 5 6
School Name:_____
Grade Level:_____
Highest Math Class Taken:_____
NSBE Jr. Chapter:_____
Email:_____
TMAL Coach:_____
TMAL Coach member #:_____

Parent or Legal Guardian

First Name:_____
Last Name:_____
Address_____
City:_____St.:_____
Email (1):_____

Home Phone:_____
Work Phone:_____
Cell:_____
Zip Code:_____
Email (2):_____

Aptitude Survey

What was your score on the practice SAT? Writing_____ Math_____ Verbal_____	
My math ability is: (Circle only one) 1 2 3 4 5 Poor Exceptional	My feeling about math is: (Circle only one) 1 2 3 4 5 I hate it I love it
The likelihood that I will pursue a career in some sort of Science, Technology, Engineering, or Math (STEM) related field is: (Circle only one) 1 2 3 4 5 (1 = no chance, 5= definitely will)	
Have you taken the ACT/SAT? Yes or No If so, what was the score? ACT_____SAT Writing_____ Math _____ Verbal _____	
When do you plan to take the ACT/SAT? Please specify month and year. _____ Do you plan to go to college? (If yes, when and where)_____	
What are your goals for participating in this program?	

APPENDIX B TMAL TEAM LIST

Try-Math-A-Lon 2009-2010

TEAM LIST

TMAL Team Name_____

Select Region: 1 2 3 4 5 6

Chapter Name _____

TMAL TEAM LIST

First Name **Last Name** **Age & Grade**

1) _____

2) _____

3) _____

4) _____

5) Alternate

_____

Team Captain Name

_____

Print Name Email Hm & Cell

COACH INFORMATION

Name: _____

Last First Middle Initial

Address: _____

Street City State Zip

Phone: (_____) _____ Email:_____

Cellular (if applicable) (_____) _____ Age (if under 30 years): _____

Coach's NSBE Member Number:_____

·····Alternative COACH (in case of emergency) ·····

Name: _____

Last First Middle Initial

Address: _____

Street City State Zip

Phone: (_____) _____ Cellular (if applicable) (_____) _____

Age (if under 30 years): _____Email:_____

APPENDIX C CHAPERONE INFORMATION SHEET

Try-Math-A-Lon 2009-2010 Chaperone Information Sheet

Name: _____
Last First Middle Initial

Address: _____
Street City State Zip

Phone: (_____) _____ Email:_____

Cellular (if applicable) (_____) _____ Age (if under 30 years): _____

····· Alternative Chaperone (in case of emergency) ·····

Name: _____
Last First Middle Initial

Address: _____
Street City State Zip

Phone: (_____) _____ Cellular (if applicable) (_____) _____

Age (if under 30 years): _____Email:_____

TMAL Team Name_____
Select Region: 1 2 3 4 5 6

Students YOU are Chaperoning (please print the full names of the students that you will be coaching

	First Name	**Last Name**	**Age & Grade**
1)			
2)			
3)			
4)			
5) Alternate			

Continued on Next Page

Chaperone

I, _____, understand that by agreeing to be a **Chaperone** I will temporarily be assuming complete legal responsibility of the students listed above. At the National Society of Black Engineers event, I will be available for emergencies concerning these students, as well as general guidance. Therefore, I know that I will not be able to participate in many aspects of the event as a whole, because of these responsibilities. I will act as an escort, when required, to aid my students in traveling from event to event, and as such will provide advice concerning mature behavior in the required setting. I understand that if any of my students are excluded from the Pre-College Initiative events due to improper behavior, I understand that my students will become my responsibility, and I will act as their full time escort throughout the remainder of this conference. I have no medical, psychological, or physical conditions that would prevent me from fulfilling the above duties.

Chaperone

_____

Print Name **Signature** **Date**

Alternate Chaperone

As an **Alternate Chaperone,** I, _____, understand that I might be asked to complete the duties detailed in the above paragraph, in the case of any emergency, and I am able to do so, and I commit to fulfilling all of its terms if such a need arises.

Alternate Chaperone

_____

Print Name **Signature** **Date**

APPENDIX D PERMISSION SLIP AND MEDICAL FORM

This permission slip should be completed and returned to the TMAL Coordinator before any TMAL related activity and AFTER the student has registered. THIS IS NOT A REGISTRATION FORM.

Please contact your TMAL Coordinator or the National TMAL Coordinator at tmal@nsbe-ae.org if you have questions about this form.

This form has legal consequences. Read it carefully before signing. If you do not understand any of its provisions, ask for an explanation. Please print legibly or type.

Event: _____

Event Location:_____

Chaperone Name:_____

Student First Name: _____ **Last Name:** _____

Student Cell Phone: (_____)_____ **Student Email:** _____

Student Membership No. _____

Student Chapter Code/Name _____

This is to certify that my child/ward, _____, has permission to participate in the above described event at the above stated location on the date(s) of _____.

Student is not allowed to participate in any activity until all information below is completed. If you wish any further information or wish to supply further details of your child/ward's needs, please use the reverse side of this form.

Parent/Guardian Information

Name:_____

Address: _____

Day Phone: (____)_____ Evening/Cellular Phone: (____)_____

Email:_____

To best meet your needs, please fill out the following information in its entirety.

Student's Full Name

_____

Does he/she have any allergies that should concern us? Yes No

If yes, please list them below:

_____

_____

_____

Does he/she have any ongoing medical or psychological conditions that should concern us?

Yes No

If yes, please list them below:

_____

_____

_____

Is he/she currently taking any medication(s)? Yes No

If yes, please list them below:

_____

_____

_____

Emergency Contact Information

Parent/Guardian Name

_____

Address _____

Day Phone (_____) _____

Evening Phone (_____) _____

Other Contact(s) Information

_____

Insurance Information

Is your child covered by medical insurance? Yes No

If yes, please fill out the following information:

Insurance Provider _____

Insurance Account Number

_____

Does your child/ward have a copy of the insurance card? Yes No

I, _____, the parent or legal guardian of _____ understands that at this conference the National Society of Black Engineers (NSBE) will not be responsible or be able to provide any medical care for my child/ward. I further understand that NSBE will try to aid my child/ward in getting any medical attention needed in case of an emergency, and the Chaperone will take responsibilities for any emergency decision making that is necessary. I understand that I will be immediately contacted in the case of such emergency, however my child will be treated as best as possible until I or any of the other authorized emergency contacts have been contacted.

I am the parent, one of the parents or guardian with whom the above child/ward resides and have legal custody. I assume all risks associated with participation in this event. I, the parent and anyone entitled to act on my behalf, waive and release the National Society of Black Engineers including regional, chapter, or other subdivisions thereof, their agents, employees, chaperones, representatives and successors from all claims or liabilities of any kind arising out or of my child/ward's participation in this event.

In addition, I grant permission to all of the foregoing to use my child/ward or my photographs, motion pictures, recordings, or any other record of this event for any related purpose.

_____ _____

Signature of Parent/Guardian Date

APPENDIX E TMAL WORLD ENTRY FORM

Try-Math-A-Lon 2009-2010
TMAL WORLD NATIONAL COMPETITION ENTRY FORM
(FOR REGIONAL WINNING TMAL TEAMS ONLY)

TMAL Team Name_____

TMAL Coach Name _____

Chapter Name _____
Select Region: 1 2 3 4 5 6

TMAL TEAM LIST

First Name **Last Name** **Age & Grade**

1) _____

2) _____

3) _____

4) _____

5) _____
5) is Alternate

COACH INFORMATION

Name: _____
Last First Middle Initial

Address: _____
Street City State Zip

Phone: (_____) _____ Email:_____

Cellular (if applicable) (_____) _____ Age (if under 30 years): _____

Coach's NSBE Member Number:_____
····· Alternative COACH (in case of emergency) ·····

Alternate Coach Name, Phone, & Email_____

APPENDIX F TMAL USA ENTRY FORM

Try-Math-A-Lon 2009-2010
TMAL USA COMPETITION ENTRY FORM
(Alternate Competition for All Other TMAL Teams)

TMAL Team Name_____

TMAL Coach Name _____

Chapter Name _____
Select Region: 1 2 3 4 5 6

TMAL TEAM LIST

First Name	Last Name	Age & Grade

1) _____

2) _____

3) _____

4) _____

5) _____
5) is Alternate

COACH INFORMATION

Name: _____
Last First Middle Initial

Address: _____
Street City State Zip

Phone: (_____) _____ Email:_____

Cellular (if applicable) (_____) _____ Age (if under 30 years): _____

Coach's NSBE Member Number:_____

····· Alternative COACH (in case of emergency) ·····

Alternate Coach Name, Phone, & Email_____

TMAL SAMPLE PROBLEMS, CONVERSIONS, & ACRONYMS

APPENDICES

APPENDIX G PRE-TEST

Name_____ Team Name_____

Directions:
This test is to be taken individually, and is used as a mathematics assessment. No calculators are allowed. Each question is worth 10 points. **You have 30 minutes to complete problems 1-10.** (Show all of your work). Please note that there will be an additional 5 to 10 NSBE facts and or history questions added to the PAT at competitions.

1. For all values of x, $(3x-4)(4x-3)=$

(a) $7x+1$
(b) $7x-12$
(c) $12x^2-12$
(d) $12x^2-25x-12$
(e) $12x^2+7x-12$

2. In a certain set of numbers, the ratio of integers is 2:3. What percent of the numbers in the set are integers?

(a) 20%
(b) $33\frac{1}{3}$ %
(c) 40%
(d) 60%
(e) $66\frac{2}{3}$%

3. What is the y-intercept of the line with the equation $2x-3y = 18$?

(a) -9
(b) -6
(c) -3
(d) 6
(e) 9

4. In the sequence 2, 6, 18, x, 162…, what is the most likely value of x?

(a) 36
(b) 48
(c) 54
(d) 81
(e) 98

5. There are 3 routes from Bay City to Riverville. There are 4 routes from Riverville to Straitstown. There are 3 routes from Straitstown to Frog Pond. If a driver must pass through Riverville and Straitstown exactly once, how many possible ways are there to go from Bay City to Frog Pond?

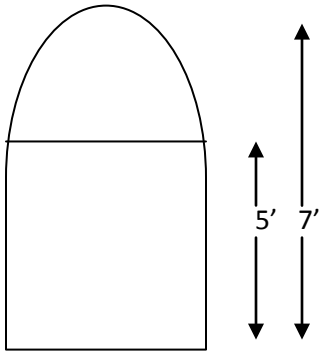
(a) 6
(b) 10
(c) 12
(d) 24
(e) 36

6. In a list of seven integers, 13 is the lowest member, 37 is the highest member, the mean is 23, the median is 24, and the mode is 18. If the numbers 8 and 43 are then included in the list, which of the following will change?

I. The Mean
II. The Median
III. The Mode

(A) I only
(B) I and II only
(C) I and III only
(D) II and III only
(E) I, II, and III

7. Find the area of a window in the shape of a rectangle with a semicircle top.



(a) 20 square feet
(b) 20 + 2π square feet
(c) 20 + 4π square feet
(d) 10 + 2π square feet
(e) 10 + 4π square feet

8. What is equal to the product $\sqrt{54x^4y^5} \cdot \sqrt{2x^2y^4}$ of radicals in the simplest radical form? (Assume that x and y are nonnegative.)

(a) $6x^3y^4\sqrt{3y}$
(b) $3x^3y^2\sqrt{12y^5}$
(c) $6x^3\sqrt{3y^9}$
(d) $2y^3\sqrt{27x^6}$
(e) None of these

9. What is the real value of x in the equation $\log_3 45 - \log_3 5 = \log_7 x$

(a) 49
(b) 16
(c) 5
(d) 7
(e) 81

10. The edges of a cube are each 4 inches long. What is the surface area, in square inches, of this cube?

(a) 66
(b) 60
(c) 76
(d) 96
(e) 65

APPENDIX H ALGEBRA AND FUNCTIONS

Problem 1. If 9b = 81, then $\sqrt{b} \bullet \sqrt[3]{3b} =$

A) 9
B) 27
C) 81
D) 243
E) 729

Problem 2. If $\sqrt{x} = 2^2$, then x =

A) 1
B) 2
C) 4
D) 8
E) 16

Problem 3. If $f(x) = \left|\left(|x| - 3\right)\right|$, what is the value of $f(1)$?

A) -2
B) -1
C) 1
D) 2
E) 3

Problem 4. If $\frac{2x}{x^2+1} = \frac{2}{x+2}$, what is the value of x?

A) $-\frac{1}{4}$
B) $\frac{1}{4}$
C) $\frac{1}{2}$
D) 0
E) 2

Problem 5. If $f(x) = x^2 + 2$, which of the following could be a value of $f(x)$?

A) -2
B) -1
C) 0
D) 1
E) 2

Problem 6. If $2 + a = 2 - a$, what is the value of a?

A) -1
B) 0
C) 1
D) 2
E) 4

Problem 7. If $x + y = z$ and $x = y$, then all of the following are true EXCEPT

A) $2x + 2y = 2z$
B) $x - y = 0$
C) $x - z = y - z$
D) $x = \frac{z}{2}$
E) $z - y = 2x$

Problem 8. If $3x - 5 = 4$, what is the value of $9x - 15$?

A) 3
B) 4
C) 9
D) 12
E) 15

Problem 9. Which of the following is equivalent to $\frac{4a}{3} \bullet 6a$?

A) $\frac{8a^2}{3}$

B) $\frac{10a^2}{3}$

C) $\frac{24a}{3}$

D) $8a^2$

E) $24a^2$

Problem 10. If $a = b^{\frac{2}{3}}$ and $b = c^{-2}$, what is the value of a in terms of c?

A) $\sqrt[4]{c^3}$

B) $\frac{1}{\sqrt[3]{c^4}}$

C) $-\sqrt[3]{c^4}$

D) $\frac{4}{c^3}$

E) $-\sqrt[4]{c^3}$

Algebra and Functions Solutions

Problem1. If 9b = 81, then $\sqrt{b} \bullet \sqrt[3]{3b} =$

F) 9

$b = \frac{81}{9}$

$\sqrt{9} \bullet \sqrt[3]{3(9)} = 3 \bullet \sqrt[3]{(3)(3)(3)}$

$= (3)(3) = 9$

Problem 2. If $\sqrt{x} = 2^2$, then x =

E) 16

$\sqrt{x} = 2^2$

$\sqrt{x} = 4$

$\left(\sqrt{x}\right)^2 = 4^2$

$x = 16$

Problem 3. If $f(x) = \left|\left(|x| - 3\right)\right|$, what is the value of $f(1)$?

D) 2

$f(1) = \left|\left(|1| - 3\right)\right|$

$= \left|(1 - 3)\right|$

$= |-2|$

$= 2$

Problem 4. If $\frac{2x}{x^2+1} = \frac{2}{x+2}$, what is the value of x?

C) $\frac{1}{2}$

$$\frac{2x}{x^2+1} = \frac{2}{x+2}$$
$$2x(x+2) = 2(x^2+1)$$
$$x(x+2) = x^2+1$$
$$x^2+2x = x^2+1$$
$$2x = 1$$
$$x = \frac{1}{2}$$

Problem 5. If $f(x) = x^2 + 2$, which of the following could be a value of $f(x)$?

E) 2

A squared number must be zero or positive, therefore the least possible value for x^2 is 0. This means that the least possible value of x^2 +2 is 2. So $f(0) = 2$.

Problem 6. If $2 + a = 2 - a$, what is the value of a?

B) 0

$$2 + a = 2 - a$$
$$2a = 0$$
$$a = 0$$

Problem 7. If $x + y = z$ and $x = y$, then all of the following are true EXCEPT

E) $z - y = 2x$

$$x = y$$
$$z - y = 2x$$
$$z = 2x + y$$
$$z \neq x + y$$

Problem 8. If 3x – 5 = 4, what is the value of 9x – 15?

D) 12

$3x-5=4$
$3x=9$
$x=3$
$9(3)-15=27-15=12$

Problem 9. Which of the following is equivalent to $\frac{4a}{3}\bullet 6a$?

D) $8a^2$

$\frac{4a}{3}\bullet 6a$
$\frac{24a^2}{3}$
$8a^2$

Problem 10. If $a=b^{\frac{2}{3}}$ and $b=c^{-2}$, what is the value of a in terms of c?

B) $\frac{1}{\sqrt[3]{c^4}}$

$a=b^{\frac{2}{3}}$
$b=c^{-2}$
$a=\left(c^{-2}\right)^{\frac{2}{3}}$
$=c^{-\frac{4}{3}}$
$=\sqrt[3]{c^{-4}}$
$=\frac{1}{\sqrt[3]{c^4}}$

APPENDIX I DATA ANALYSIS, STATISTICS & PROBABILITY

If I do not have any flour, I am not able to make cookies.

Problem 1. If the statement above is true, which of the following statements must be true?

A) If I did not make cookies, I must not have had flour.
B) If I made cookies, I must have had flour.
C) If I have flour, I must be able to make cookies.
D) If I was able to make cookies, I must not have had any flour.
E) If I am not able to make cookies, I must not have any flour.

MERCHANDISE SALES		
Type	Amount of Sales	Percent of Total Sales
Shoes	$12,000	15%
Coats	$20,000	25%
Shirts	$x	40%
Pants	$y	20%

Problem 2. According to the table above, x + y =

A) $32,000
B) $48,000
C) $60,000
D) $68,000
E) $80,000

Problem 3. A survey of Town *X* found a mean of 3.2 persons per household and a mean of 1.2 televisions per household. If 48,000 people live in Town *X*, how many televisions are in Town *X*?

(A) 15,000
(B) 16,000
(C) 18,000
(D) 40,000
(E) 57,6000

Problem 4. A square is inscribed in a circle with radius *r*. What is the probability that a randomly selected point within the circle will not be within the square?

(A) $\frac{\pi - 2}{\pi r^2}$

(B) $\frac{\pi - 2}{\pi}$

(C) $\frac{\pi - \frac{1}{2}}{\pi}$

(D) $\frac{1 - r}{\pi}$

(E) $\frac{r}{\pi}$

Problem 5. In a list of seven integers, 13 is the lowest member, 37 is the highest member, the mean is 23, the median is 24, and the mode is 18. If the numbers 8 and 43 are added to the list, which of the following will change?

I. The mean
II. The median
III. The mode

A) I only
B) I and II only
C) I and III only
D) II and III only
E) I, II, and III

	Computer Production	
	Morning Shift	Afternoon Shift
Monday	200	375
Tuesday	245	330
Wednesday	255	340
Thursday	250	315
Friday	225	360

Problem 6. Computer production at a factory occurs during two shifts, as shown in the chart above. If computers are only produced during the morning and afternoon shifts, on which pair of days is the total number of computers produced greatest?

A) Monday and Thursday
B) Tuesday and Thursday
C) Tuesday and Wednesday
D) Tuesday and Friday
E) Monday and Friday

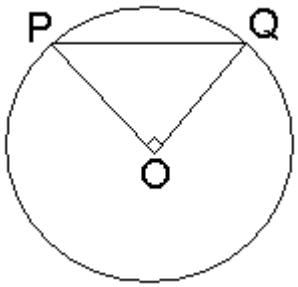
Price of Buttons in Store *X*	
Color	Price
Black	$2 per 5 buttons
Blue	$2 per 6 buttons
Brown	$3 per 8 buttons
Orange	$4 per 12 buttons
Red	$4 per 7 buttons

Problem 7. In Store *X*, which color costs the most per button?

A) Black
B) Blue
C) Brown
D) Orange
E) Red

Problem 8. *S* is the set of all positive numbers *n* such that $n < 100$ and $\sqrt{n}$ is an integer. What is the median value of the numbers of set *S*.

A) 5
B) 5.5
C) 25
D) 50
E) 99



Problem 9. Points *P* and *Q* lie on the circle with center *O*, as shown in the figure above. What is the probability that a randomly selected point inside the circle does NOT lie inside ΔOPQ?

A) $\frac{1}{2}$
B) $\frac{\pi - 1}{2}$
C) $\frac{2 - \pi}{\pi}$
D) $\frac{1}{2\pi}$
E) $\frac{2\pi - 1}{2\pi}$

Problem 10. The Tyler Jackson Dance Company plans to perform a piece that requires 2 dancers. If there are 7 dancers in the company, how many possible pairs of dancers could perform the piece?

A) 13
B) 21
C) 36
D 42
E) 49

Data Analysis, Statistics, and Probability Solutions

If I do not have any flour, I am not able to make cookies.

Problem 1. If the statement above is true, which of the following statements must be true?

B) If I made cookies, I must have had flour.

MERCHANDISE SALES		
Type	Amount of Sales	Percent of Total Sales
Shoes	\$12,000	15%
Coats	\$20,000	25%
Shirts	\$$x$	40%
Pants	\$$y$	20%

Problem 2. According to the table above, $x + y =$

B) \$48,000

$40\% + 20\% = 60\% = (4)(15\%)$

The amount of sales that were shoes is \$12,000, which is 15% of the total sales. Since $x + y$ is equal to four times the amount of shoe sales, we arrive at (\$12,000)(4) = \$48,000.

An alternative solution would be to calculate the total amount of sales then calculate what 60% of that value would be. Since we know that 25 goes into 100 four times, we can calculate the total sales from the amount of sales of coats.

$(\$20{,}000)(4) = \$80{,}000$

$\left(\frac{60}{100}\right)(\$80{,}000) = \$48{,}000$

Problem 3. A survey of Town *X* found a mean of 3.2 persons per household and a mean of 1.2 televisions per household. If 48,000 people live in Town *X*, how many televisions are in Town *X*?

(C) 18,000

$\frac{48{,}000}{3.2} = 15{,}000$

$(15{,}000)(1.2) = 18{,}000$

Problem 4. A square is inscribed in a circle with radius *r*. What is the probability that a randomly selected point within the circle will not be within the square?

(B) $\dfrac{\pi - 2}{\pi}$

To calculate the area of the square you will need to do a little geometry. The diagonal of the square is equal to the diameter of the circle. This diagonal forms a 45-45-90 triangle, the sides of which are equal to $r\sqrt{2}$. This would make the area of the square $2r^2$. The area of the circle in this problem is πr^2. The area of the figure not occupied by the square is $\pi r^2 - 2r^2 = r^2(\pi - 2)$. The probability that the point will be in the circle but not in the square is $\dfrac{r^2(\pi - 2)}{\pi r^2} = \dfrac{\pi - 2}{\pi}$.

Problem 5. In a list of seven integers, 13 is the lowest member, 37 is the highest member, the mean is 23, the median is 24, and the mode is 18. If the numbers 8 and 43 are added to the list, which of the following will change?

I. The mean
II. The median
III. The mode

A) I only

Since 8 is lower than every other number in the list and 43 is higher, they won't change the median. This means option II is incorrect, and answer choices B, D, and E can be eliminated. The mode is the number most repeated, and since 8 and 43 were not in the original list, they cannot change the mode. Therefore, option III is not valid. This eliminates answer choice C and leaves answer choice A remaining.

	Computer Production	
	Morning Shift	Afternoon Shift
Monday	200	375
Tuesday	245	330
Wednesday	255	340
Thursday	250	315
Friday	225	360

Problem 6. Computer production at a factory occurs during two shifts, as shown in the chart above. If computers are only produced during the morning and afternoon shifts, on which pair of days is the total number of computers produced greatest?

C) Tuesday and Wednesday

$Monday + Thursday$

$200 + 375 + 250 + 315 = 1140$

$Tuesday + Thursday$

$245 + 330 + 250 + 315 = 1140$

$Tuesday + Wednesday$

$245 + 330 + 255 + 340 = 1170$

$Tuesday + Friday$

$245 + 330 + 225 + 360 = 1160$

$Monday + Friday$

$200 + 375 + 225 + 360 = 1160$

Price of Buttons in Store *X*	
Color	Price
Black	\$2 per 5 buttons
Blue	\$2 per 6 buttons
Brown	\$3 per 8 buttons
Orange	\$4 per 12 buttons
Red	\$4 per 7 buttons

Problem 7. In Store *X*, which color costs the most per button?

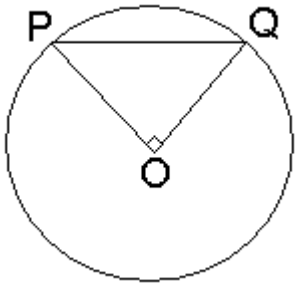
E) Red

The fraction representing the cost per red button is greater than one-half. The remaining fractions of costs per button are all less than one-half.

Problem 8. *S* is the set of all positive numbers *n* such that $n < 100$ and $\sqrt{n}$ is an integer. What is the median value of the numbers of set *S*.

C) 25

$\sqrt{n}$	n
1	1
2	4
3	9
4	16
5	25
6	36
7	49
8	62
9	81



Problem 9. Points *P* and *Q* lie on the circle with center *O*, as shown in the figure above. What is the probability that a randomly selected point inside the circle does NOT lie inside ΔOPQ?

E) $\dfrac{2\pi - 1}{2\pi}$

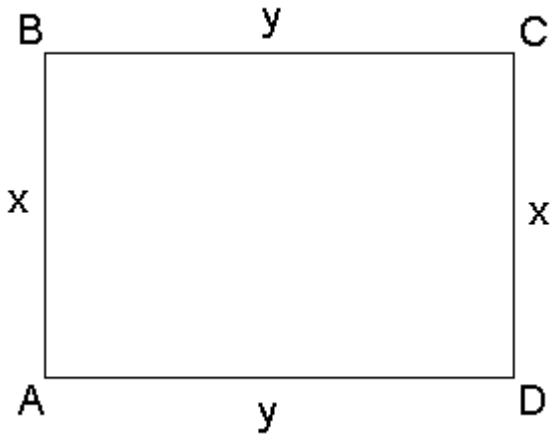
Solve this problem the same as Problem 4. The area of the circle is $\pi\overline{OP}^2$. The area of the triangle is $\frac{1}{2}\left(\overline{OQ}\right)\left(\overline{OP}\right) = \frac{1}{2}\left(\overline{OP}\right)^2$. The probability that the point will lie in the circle but outside the triangle is $\dfrac{\pi\left(\overline{OP}\right)^2 - \frac{1}{2}\left(\overline{OP}\right)^2}{\pi\left(\overline{OP}\right)^2} = \dfrac{\pi - \frac{1}{2}}{\pi} = \dfrac{2\pi - 1}{\pi}$.

Problem 10. The Tyler Jackson Dance Company plans to perform a piece that requires 2 dancers. If there are 7 dancers in the company, how many possible pairs of dancers could perform the piece?

B) 21

There are $(7)(6) = 42$ possible combinations; however pair 1 – 2 is the same as pair 2 – 1, so we will need to divide this number by two to eliminate duplicate pairs. This means the number of distinct possible pairs is 21.

APPENDIX J GEOMETRY AND MEASUREMENTS



Problem 1. If the perimeter of rectangle *ABCD* is equal to *p*, and $x = \frac{2}{3}y$, what is *y* in perms of *p*?

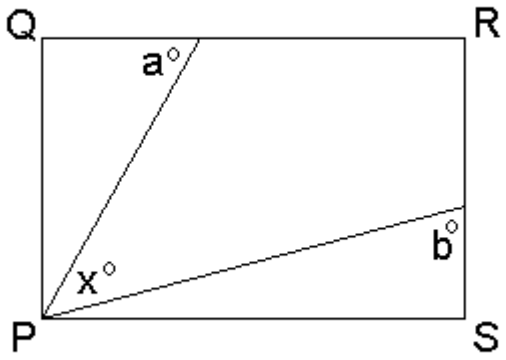
A.) $\frac{p}{10}$

B.) $\frac{3p}{10}$

C.) $\frac{p}{3}$

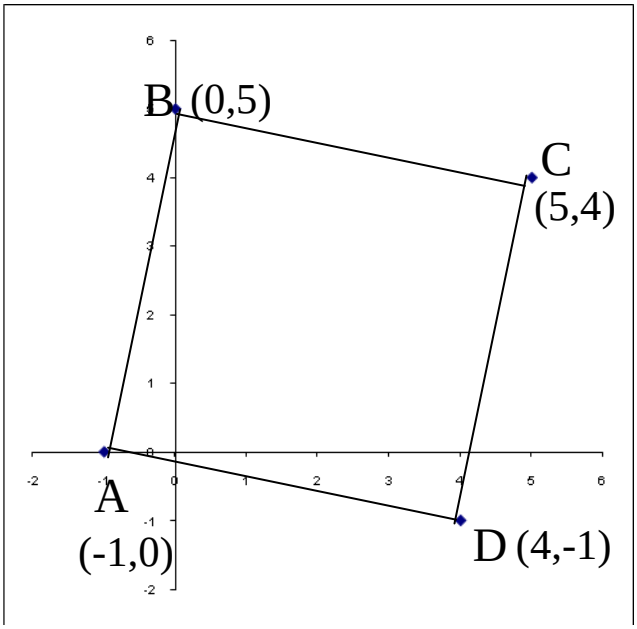
D.) $\frac{2p}{5}$

E.) $\frac{3p}{5}$



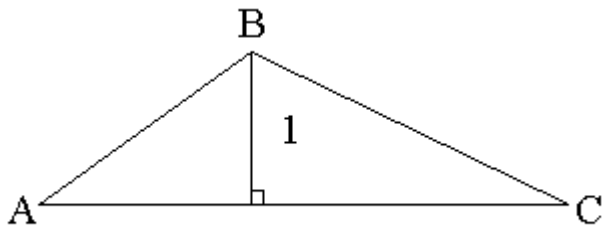
Problem 2. In rectangle *PQRS* above, what is $a + b$ in terms of x?

A.) $90 + x$
B.) $90 - x$
C.) $180 + x$
D.) $270 - x$
E.) $360 - x$



Problem 3. What is the area of square *ABCD*?

A.) 25
B.) $18\sqrt{2}$
C.) 26
D.) $25+\sqrt{2}$
E.) 36



Problem 4. If $AC = 4$, what is the area of ABC above?

A.) $\frac{1}{2}$
B.) 2
C.) $\sqrt{7}$
D.) 4
E.) 8

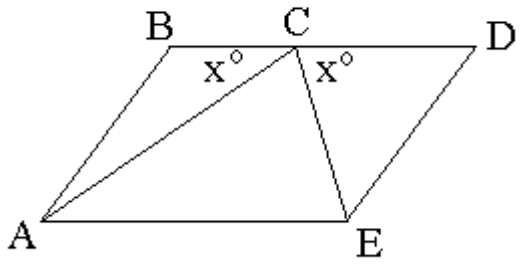
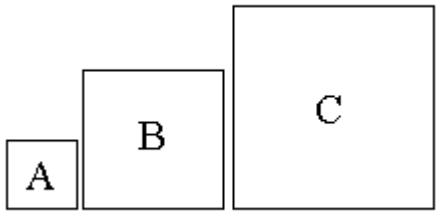


Figure not drawn to scale.

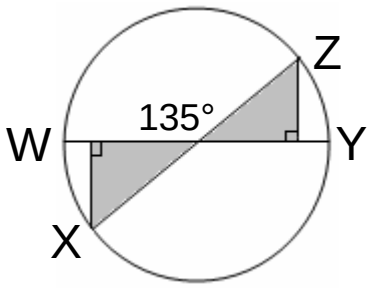
Problem 5. In the figure above, $\overline{BD} \| \overline{AE}$. If the length of $\overline{CE}$ is 3, what is the length of $\overline{AC}$?

A.) 3
B.) 4
C.) 5
D.) $3\sqrt{3}$
E.) It cannot be determined from the information given.



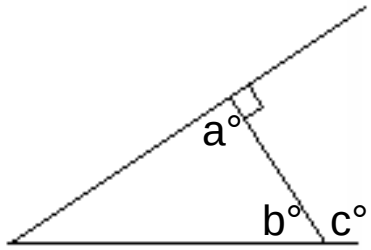
Problem 6. In the figure above, the perimeter of square A is $\frac{2}{3}$ the perimeter of square B, and the perimeter of square B is $\frac{2}{3}$ the perimeter of square C. If the area of square A is 16, what is the area of square C?

A.) 24
B.) 36
C.) 64
D.) 72
E.) 81



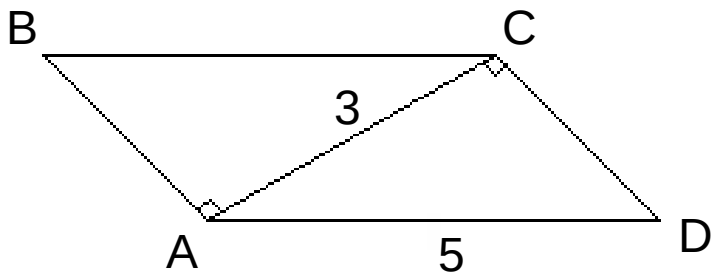
Problem 7. If $\overline{WY}$ and $\overline{XZ}$ are diameters with lengths of 12, what is the area of the shaded region?

A.) 36
B.) 30
C.) 18
D.) 12
E.) 9



Problem 8. In the figure above, what is the value of $a + b + c$?

A.) 180
B.) 240
C.) 270
D.) 360
E.) It cannot be determined from the information given.



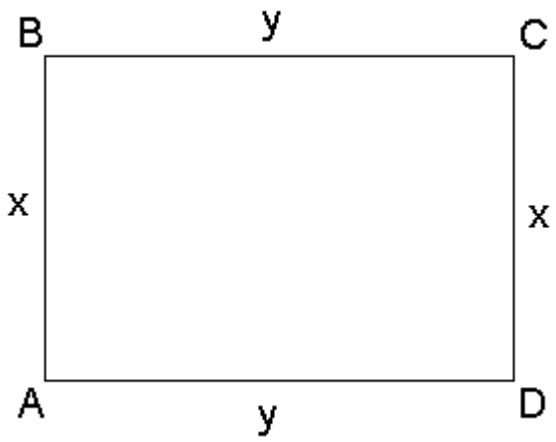
Problem 9. In the parallelogram *ABCD* above, $AC = 3$ and $AD = 5$. What is the area of *ABCD*?

A.) 12
B.) 15
C.) 18
D.) 20
E.) It cannot be determined from the information given.

Problem 10. $\overline{AB} \perp \overline{BD}$, and $\overline{AB}$ bisects $\overline{CD}$ at point *X*. If $AB = 8$ and $CD = 10$, what is the length of $\overline{BD}$?

A.) 3
B.) 5
C.) 8
D.) 12
E.) 15

Geometry and Measurements Solutions



Problem 1. If the perimeter of rectangle *ABCD* is equal to *p*, and $x = \frac{2}{3}y$, what is *y* in perms of *p*?

B.) $\frac{3p}{10}$

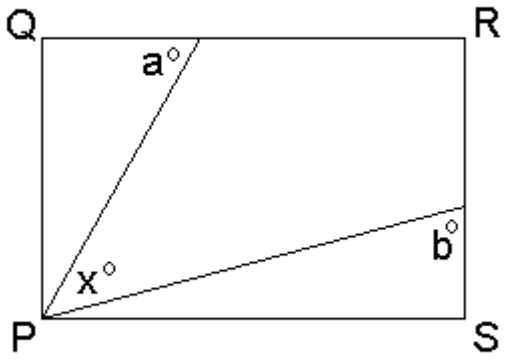
$p = 2x + 2y$

$x = \frac{2}{3}y$

$p = \frac{4}{3}y + 2y$

$= \frac{10}{3}y$

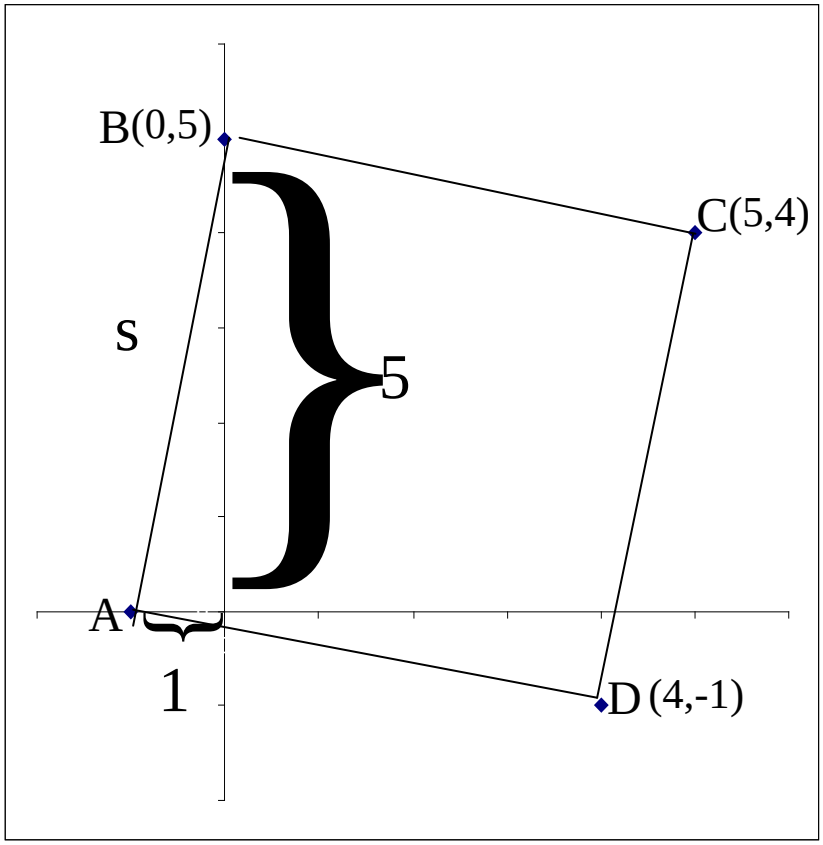
$y = \frac{3p}{10}$



Problem 2. In rectangle *PQRS* above, what is $a + b$ in terms of x?

A.) 90 + *x*

$\alpha + \theta + x = 90$
$\alpha + a = 90$
$\theta + b = 90$
$\alpha + a + \theta + b = 180$
$-(\alpha + \theta + x = 90)$
$= a + b - x = 90$
$a + b = 90 + x$



Problem 3. What is the area of square *ABCD*?

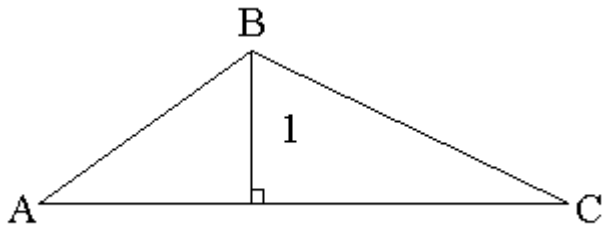
C.) 26

$A = s^2$

$s^2 = 5^2 + 1^2$

$= 25 + 1$

$= 26$



Problem 4. If $AC = 4$, what is the area of ABC above?

B.) 2

$$A = \frac{1}{2}bh$$
$$= \frac{1}{2}(4)(1)$$
$$= 2$$

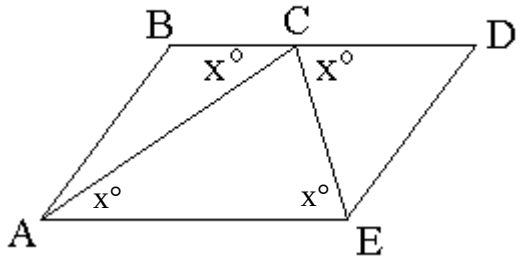
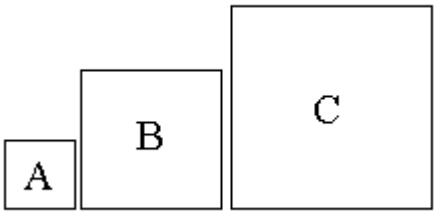


Figure not drawn to scale.

Problem 5. In the figure above, $\overline{BD} \| \overline{AE}$. If the length of $\overline{CE}$ is 3, what is the length of $\overline{AC}$?

A.) 3

Alternate interior angles are equivalent, therefore the two bottom angles of triangle ACE are equal to $x°$. Since these two angles are equal, the two sides are equal, therefore the length of AC is 3.



Problem 6. In the figure above, the perimeter of square A is $\frac{2}{3}$ the perimeter of square B, and the perimeter of square B is $\frac{2}{3}$ the perimeter of square C. If the area of square A is 16, what is the area of square C?

E.) 81

$A_A = 16 = s_A^2$

$s = 4$

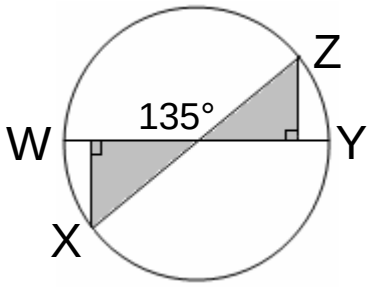
$P_A = 4 + 4 + 4 + 4 = 16$

$P_B = \frac{3}{2} P_A = \frac{3}{2}(16) = 24$

$P_C = \frac{3}{2} P_B = \frac{3}{2}(24) = 36$

$s_C = \frac{36}{4} = 9$

$A_C = s_C^2 = 9^2 = 81$



Problem 7. If $\overline{WY}$ and $\overline{XZ}$ are diameters with lengths of 12, what is the area of the shaded region?

C.) 18

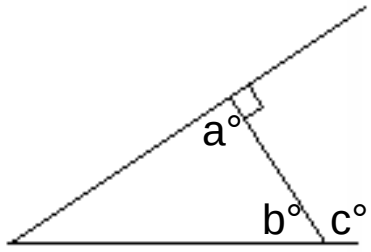
$$\sin 45^\circ = \frac{a}{6} = \frac{\sqrt{2}}{2}$$

$$a = 3\sqrt{2}$$

$$area = \frac{1}{2}bh = \frac{1}{2}\left(3\sqrt{2}\right)\left(3\sqrt{2}\right)$$

$$area = \frac{1}{2}(9)(2) = 9$$

$$2 \times area = 18$$



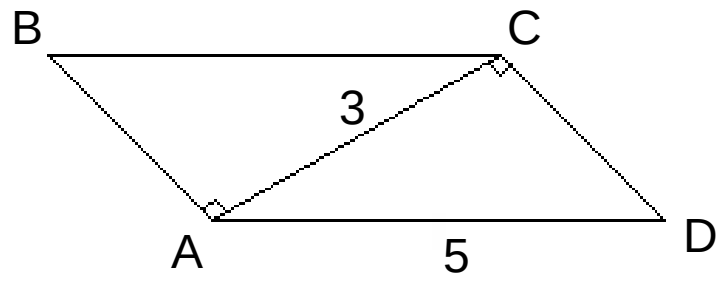
Problem 8. In the figure above, what is the value of $a + b + c$?

C.) 270

$$b^\circ + c^\circ = 180^\circ$$

$$a^\circ = 90^\circ$$

$$a^\circ + b^\circ + c^\circ = 270$$



Problem 9. In the parallelogram *ABCD* above, *AC* = 3 and *AD* = 5. What is the area of *ABCD*?

A.) 12

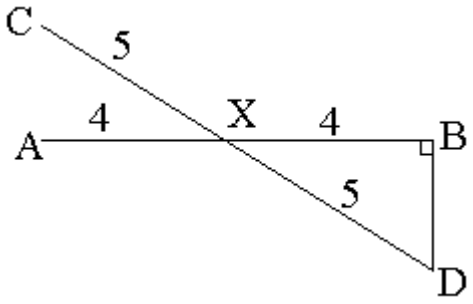
$5^2 = 3^2 + b^2$

$b^2 = 52 - 9 = 16$

$b = 4$

$area = \frac{1}{2}bh = \frac{1}{2}(4)(3) = 6$

$2 \times area = 12$



Problem 10. $\overline{AB} \perp \overline{BD}$, and $\overline{AB}$ bisects $\overline{CD}$ at point *X*. If *AB* = 8 and CD = 10, what is the length of $\overline{BD}$?

A.) 3

You have to draw the figure to solve this problem. After drawing the bisected line segments it is obvious that this is a 3-4-5 right triangle.

APPENDIX K NUMBERS AND OPERATIONS

Problem 1. What is the sum of the positive even factors of 12?

A.) 8
B.) 12
C.) 16
D.) 24
E.) 28

Problem 2. If $|x| \neq 0$, which of the following statements must be true?

A.) x is positive
B.) $2x$ is positive
C.) $\frac{1}{x}$ is positive
D.) x^2 is positive
E.) x^3 is positive

Problem 3. $\frac{900}{10} + \frac{90}{100} + \frac{9}{1000} =$

A.) 90.09
B.) 90.099
C.) 90.909
D.) 99.09
E.) 999

Problem 4. Which of the following must be true?

I. The sum of two consecutive integers is odd.
II. The sum of three consecutive integers is even.
III. The sum of three consecutive integers is a multiple of 3.

A.) I only
B.) II only
C.) I and II only
D.) I and III only
E.) I, II, and III

Problem 5. Which of the following is equivalent to $5^5 \times 2^2 \times 10^{10}$?

A.) $5^3 \times 10^{12}$
B.) $5^2 \times 10^{15}$
C.) 10^{15}
D.) 100^{17}
E.) 100^{100}

Problem 6. If $n \neq 0$, which of the following could be true?

I. $2n < n^2$
II. $2n < n$
III. $n^2 < -n$

A.) I only
B.) II only
C.) I and II only
D.) I and III only
E.) I, II, and III

Problem 7. If x is an integer, which of the following could be x^3?

A.) 2.7×10^{11}
B.) 2.7×10^{12}
C.) 2.7×10^{13}
D.) 2.7×10^{14}
E.) 2.7×10^{15}

Problem 8. If b is a prime number such that $3b > 10 > \frac{5}{6}b$, what is the lowest possible value of b?

A.) 2
B.) 3
C.) 5
D.) 7
E.) 9

Problem 9. What is 45.867 rounded to the nearest hundredth?

A.) 46
B.) 45.8
C.) 45.9
D.) 45.86
E.) 45.87

Problem 10. If $x = 8^{\frac{4}{3}}$, what is the value of x?

A.) $4\frac{3}{4}$
B.) 6
C.) $10\frac{2}{3}$
D.) 12
E.) 16

Numbers and Operations Solutions

Problem 1. What is the sum of the positive even factors of 12?

D.) 24

The factors of 12 are 1, 2, 3, 4, 6, and 12. The positive even factors of 12 are 2, 4, 6, and 12, whose sum is 24.

Problem 2. If $|x| \neq 0$, which of the following statements must be true?

D.) x^2 is positive

The square of any non-zero number, either positive or negative, is always positive.

Problem 3. $\frac{900}{10} + \frac{90}{100} + \frac{9}{1000} =$

C.) 90.909

$\frac{900}{10} = 90$

$\frac{90}{100} = 0.9$

$\frac{9}{1000} = 0.009$

$90 + 0.9 + 0.009 = 90.909$

Problem 4. Which of the following must be true?

I. The sum of two consecutive integers is odd.
II. The sum of three consecutive integers is even.
III. The sum of three consecutive integers is a multiple of 3.

D.) I and III only

Answer this question by plugging in.

$$\text{I. } 2+3=5$$
$$3+4=7$$
$$\text{II. } 2+3+4=9$$
$$\text{III. } 2+3+4=9$$
$$3+4+5=12$$
$$4+5+6=15$$

Problem 5. Which of the following is equivalent to 5^5 x 2^2 x 10^{10}?

A.) 5^3 x 10^{12}

$$5^5 \times 2^2 \times 10^{10}$$
$$= (5\times 2)^2 \times 5^3 \times 10^{10}$$
$$= 10^2 \times 5^3 \times 10^{10}$$
$$= 5^3 \times 10^{12}$$

Problem 6. If $n \neq 0$, which of the following could be true?

I. $2n < n^2$
II. $2n < n$
III. $n^2 < -n$

E.) I, II, and III

This is a COULD be question, so you have to be careful. Plugging in is the way to answer this question. In this instance, $n = -\frac{1}{2}$ was chosen.

I. $2n = 2\left(-\frac{1}{2}\right) = -1 < n^2 = \left(-\frac{1}{2}\right)^2 = \frac{1}{4}$

True

II. $2n = 2\left(-\frac{1}{2}\right) = -1 < n = \left(-\frac{1}{2}\right)$

True

III. $n^2 = \left(-\frac{1}{2}\right)^2 = \frac{1}{4} < -n = -\left(-\frac{1}{2}\right) = \frac{1}{2}$

True

Problem 7. If x is an integer, which of the following could be x^3?

C.) 2.7 x 10^{13}

You know that 3^3 is equal to 27, therefore the correct answer has to be some multiple of three. Since the lowest answer choice is multiplied by 10 to the 11^{th} power, you can start guessing at 3000.

$3000 = 3 \times 10^3$

$\left(3 \times 10^3\right)^3 = (3)^3\left(10^3\right)^3 = 27 \times 10^9 = 2.7 \times 10^{10}$

$30{,}000 = 3 \times 10^4$

$\left(3 \times 10^4\right)^3 = (3)^3\left(10^4\right)^3 = 27 \times 10^{12} = 2.7 \times 10^{13}$

Problem 8. If b is a prime number such that $3b > 10 > \frac{5}{6}b$, what is the lowest possible value of b?

C.) 5

Solve this problem by plugging in.

$b = 2$

$3b = (3)(2) = 6 > 10 > \frac{5}{6}b = \left(\frac{5}{6}\right)(2) = \frac{10}{6} = 1\frac{2}{3}$

False

$b = 3$

$3b = (3)(3) = 9 > 10 > \frac{5}{6}b = \left(\frac{5}{6}\right)(3) = \frac{15}{6} = 2\frac{1}{3}$

False

$b = 5$

$3b = (3)(5) = 15 > 10 > \frac{5}{6}b = \left(\frac{5}{6}\right)(5) = \frac{25}{6} = 4\frac{1}{6}$

True

Problem 9. What is 45.867 rounded to the nearest hundredth?

E.) 45.87

The hundredths place is two places past the decimal. In this case you round up to the next highest number because the number in the thousandths place is greater than 5. Therefore 45.867 rounded to the nearest hundredth is 45.87.

Problem 10. If $x = 8^{\frac{4}{3}}$, what is the value of x?

E.) 16

Remember that $8^{\frac{4}{3}} = \left(\sqrt[3]{8}\right)^4$. From here the problem is easy. The cube root of 8 is 2, and $2^4 = 16$.

APPENDIX L PROBLEM SOLVING

Problem 1. A researcher found that the number of bacteria in a certain sample doubles every hour. If there were 6 bacteria in the sample at the start of the experiment, how many bacteria were there after 9 hours?

A) 54
B) 512
C) 1,536
D) 3,072
E) 6,144

Problem 2. Carol subscribed to four publications that cost $12.90, $16.00, $18.00, and $21.90 per year, respectively. If she made an initial down payment of one-half of the total yearly subscription cost, and paid the rest in four equal monthly payments, how much was each of the four monthly payments?

A) $8.60
B) $9.20
C) $9.45
D) $17.20
E) $34.40

Problem 3. A basketball team had a ration of wins to losses of 3:1. After the team won six games in a row, its ration of wins to losses became 5:1. How many games had the team won before winning six games in a row?

A) 3
B) 6
C) 9
D) 15
E) 24

Problem 4. Fifteen Percent of the coins in a piggy bank are nickels and five percent are dimes. If there are 220 coins in the bank, how many are not nickels or dimes?

A) 80
B) 176
C) 180
D) 187
E) 200

Problem 5. A bakery uses a special flour mixture that contains corn, wheat, and rye in the ratio of 3:5:2. If a bag of the mixture contains 5 pounds of rye, how many pounds of wheat does it contain?

A) 2
B) 5
C) 7.5
D) 10
E) 12.5

Problem 6. At the beginning of 1999, the population of Rockville was 204,000. and the population of Springfield was 216,000. If the population of each city increased by exactly 20% in 1999, how many more people lived in Springfield than in Rockville at the end of 1999?

A) 9,600
B) 10,000
C) 12,000
D) 14,400
E) 20,000

Problem 7. Rock climbing routes are rated on a scale of difficulty with the higher the number the more difficult the route. Sally tried several shoe sizes on each of several routes of varying difficulty and found that when she wore smaller shoes, she could climb routes of greater difficulty. If D represents the difficulty rating of a rock climbing route Sally could climb, and s represents the size of the shoes Sally wore on such a route, then which of the following could express D as a function of s?

A) $D(s) = s^2$
B) $D(s) = \sqrt{s}$
C) $D(s) = 4s$
D) $D(s) = s - 3.5$
E) $D(s) = \frac{45}{s}$

Problem 8. Steve ran a 12-mile race at an average speed of 8 miles per hour. If Adam ran the same race at an average speed of 6 miles per hour, how many minutes longer than Steve did Adam take to complete the race?

A) 9
B) 12
C) 16
D) 24
E) 30

Problem 9. A college student bought 11 books for fall classes. If the cost of his anatomy textbook was three times the mean cost of the other 10 books, then the cost of the anatomy textbook was what fraction of the total mount he paid for the 11 books?

A) $\frac{2}{13}$
B) $\frac{3}{13}$
C) $\frac{3}{11}$
D) $\frac{3}{10}$
E) $\frac{10}{13}$

Problem 10. On a map, 1 centimeter represents 6 kilometers. A square on the map with a perimeter of 16 centimeters represents a region with what area?

A) 64 square kilometers
B) 96 square kilometers
C) 256 square kilometers
D) 576 square kilometers
E) 8,216 square kilometers

Problem Solving Solutions

Problem 1. A researcher found that the number of bacteria in a certain sample doubles every hour. If there were 6 bacteria in the sample at the start of the experiment, how many bacteria were there after 9 hours?

D) 3,072

The growth rate can be expressed as 6×2^x.
$6 \times 2^9 = (6)(512) = 3{,}072$

Problem 2. Carol subscribed to four publications that cost $12.90, $16.00, $18.00, and $21.90 per year, respectively. If she made an initial down payment of one-half of the total yearly subscription cost, and paid the rest in four equal monthly payments, how much was each of the four monthly payments?

A) $8.60

$12.90 + 16.00 + 18.00 + 21.90 = 68.80$

$\frac{68.80}{2} = 34.40$

$\frac{34.40}{4} = 8.60$

Problem 3. A basketball team had a ratio of wins to losses of 3:1. After the team won six games in a row, its ratio of wins to losses became 5:1. How many games had the team won before winning six games in a row?

C) 9

$\frac{w}{l} = \frac{3}{1}$

$\frac{w+6}{l} = \frac{5}{1}$

$w = 3l$

$\frac{3l+6}{l} = \frac{5}{1}$

$3l + 6 = 5l$

$2l = 6$

$l = 3$

$w = 3l = 9$

Problem 4. Fifteen Percent of the coins in a piggy bank are nickels and five percent are dimes. If there are 220 coins in the bank, how many are not nickels or dimes?

B) 176

$100\% - 20\% = 80\%$
$(220)(0.8) = 176$

Problem 5. A bakery uses a special flour mixture that contains corn, wheat, and rye in the ratio of 3:5:2. If a bag of the mixture contains 5 pounds of rye, how many pounds of wheat does it contain?

E) 12.5

$\frac{5}{2} = \frac{w}{5}$
$25 = 2w$
$w = 12.5$

Problem 6. At the beginning of 1999, the population of Rockville was 204,000. and the population of Springfield was 216,000. If the population of each city increased by exactly 20% in 1999, how many more people lived in Springfield than in Rockville at the end of 1999?

D) 14,400

$(216{,}000)(0.2) + 216{,}000 = 259{,}200$
$(204{,}000)(0.2) + 204{,}000 = 244{,}800$
$259{,}200 - 244{,}800 = 14{,}400$

Problem 7. Rock climbing routes are rated on a scale of difficulty with the higher the number the more difficult the route. Sally tried several shoe sizes on each of several routes of varying difficulty and found that when she wore smaller shoes, she could climb routes of greater difficulty. If *D* represents the difficulty rating of a rock climbing route Sally could climb, and *s* represents the size of the shoes Sally wore on such a route, then which of the following could express *D* as a function of *s*?

E) $D(s)=\frac{45}{s}$

Since smaller shoes allow Sally to climb more difficult routes, the relationship between shoe size and route difficulty is inverse. The only answer choice that represents an inverse relationship is E, $D(s)=\frac{45}{s}$.

Problem 8. Steve ran a 12-mile race at an average speed of 8 miles per hour. If Adam ran the same race at an average speed of 6 miles per hour, how many minutes longer than Steve did Adam take to complete the race?

E) 30

distance = rate x time

$$t_S=\left(\frac{12}{8}\right)(60)=\left(1\frac{1}{2}\right)(60)=90$$

$$t_A=\left(\frac{12}{6}\right)(60)=(2)(60)=120$$

$$120-90=30$$

Problem 9. A college student bought 11 books for fall classes. If the cost of his anatomy textbook was three times the mean cost of the other 10 books, then the cost of the anatomy textbook was what fraction of the total mount he paid for the 11 books?

B) $\frac{3}{13}$

$$c_A=3\overline{c_{10}}$$

$$c_T=c_A+10\overline{c_{10}}$$

$$c_T=3\overline{c_{10}}+10\overline{c_{10}}=13\overline{c_{10}}$$

$$\frac{c_A}{c_T}=\frac{3\overline{c_{10}}}{13\overline{c_{10}}}=\frac{3}{13}$$

Problem 10. On a map, 1 centimeter represents 6 kilometers. A square on the map with a perimeter of 16 centimeters represents a region with what area?

D) 576 square kilometers

$A = s^2 = ((4)(6))^2 = 24^2 = 576$

APPENDIX M ENGINEERING PROBLEMS

Helpful Equations:	**Variables (units)**
1. $\rho = \frac{m}{V}$	$\rho = density \quad (kg/m^3)$
2. $W = m \cdot g$	$m = mass \quad (kg)$
3. $v = \frac{d}{t}$	$V = Volume \quad (m^3)$
4. $a = \frac{v_2 - v_1}{t_2 - t_1} = \frac{\Delta v}{\Delta t}$	$v = velocity \quad (m/s)$ or (mi/h)
5. $\sum F = m \cdot a$	$W = weight \quad (N)$ or (lbs)
6. $p^2 = p_x{}^2 + p_y{}^2$	$a = acceleration \quad (m/s^2)$
7. $p = m \cdot v$	$\pi = Normal\ Force \quad (N)$
8. $K = \frac{1}{2} m_x \cdot v_x{}^2 + \frac{1}{2} m_y \cdot v_y{}^2$	$F = Force \quad (N)$
9. $W_{tot} = K_2 - K_1 = \Delta K$	$g = gravity \quad (m/s^2)$
10. $\%_{lost} = \frac{\Delta K}{K_{initial}}$	$p = momentum \quad (kg \cdot m/s)$ or $(kg \cdot mi/h)$
	$K = Kinetic\ Energy \quad (kg \cdot \frac{mi^2}{h^2})$
	$W_{tot} = Work\ Total \quad (1\ J)$ or $(1N \cdot m)$
	$1\text{Newton} = 1\frac{kg \cdot m}{s^2}$
	$d = dis\tan ce \quad (m)$
	$t = time \quad (s)$
	$\rho_{air} = 1.2\ kg/m^3$
	$\rho_{H_2O} = 1000\ kg/m^3$

Problem 1. Newton's Law

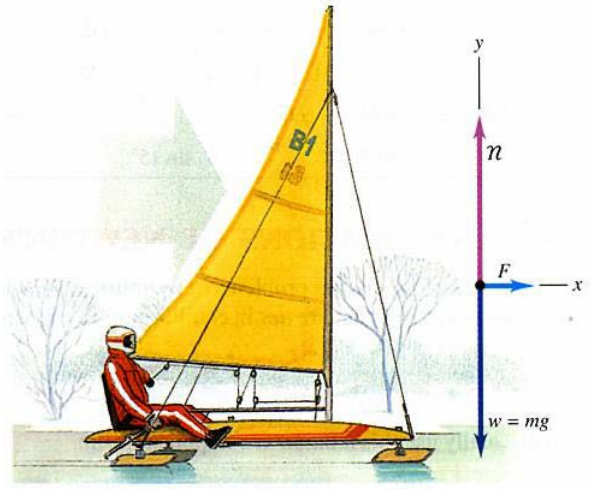
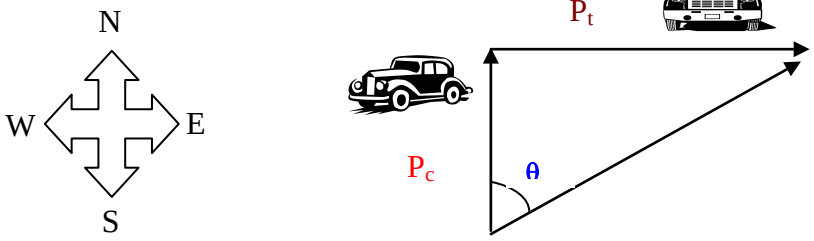


Figure 1: Iceboat is starting from rest.

NOTE: Illustration of the free-body diagram for the iceboat has "NO" friction.

An iceboat is at rest on a perfectly frictionless horizontal surface. What constant horizontal force ***F*** do we need to apply (along the direction of the runners) to give the iceboat a velocity of 4.0 m/s at the end of 2.0 s? The mass of the iceboat and rider is 200,000 g.

Problem 2. Mechanics



A 1400 kg car, heading north and moving at 35 miles per hour collides in a *perfectly inelastic* collision with a 4000 kg truck going East at 20 miles per hour.

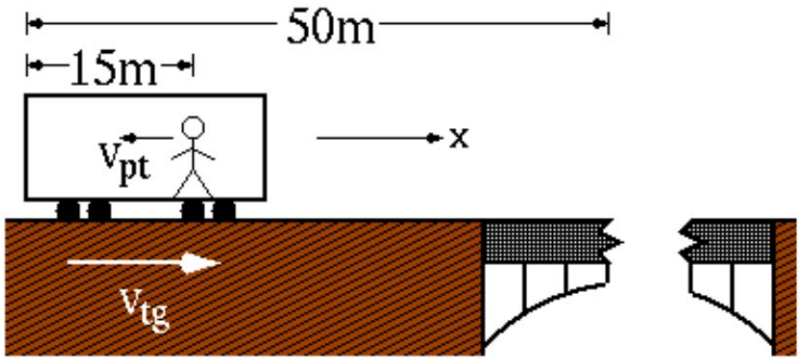
a. What is the speed and direction of the wrecked vehicles just after collision?

b. What percentage of the total mechanical energy is lost from the collision?

Use the following units when solving this problem:

p (momentum) by using $(kg \cdot mi/h)$ and for energy $(kg \cdot mi^2/h^2)$

Problem 3. Kinematics



A train is moving towards a destroyed bridge. The velocity of the train remains constant at 20m/s. A person inside the train realizes that they will die unless they run to the back of the train and jump out. If the person is 15m from the back of the train and the back of the train is 50m from the break in the track, what velocity must the person run with to make it to the back of the train just as the back of the train goes over the break in the bridge?

Problem 4. Fluid Mechanics

Find the mass of air, and its weight, in a Recreational Vehicle with a 4.0 m x 5.0 m floor and a ceiling 3.0 m high. Also, what would be the mass and weight of an equal volume of water?

Engineering Problems Solutions

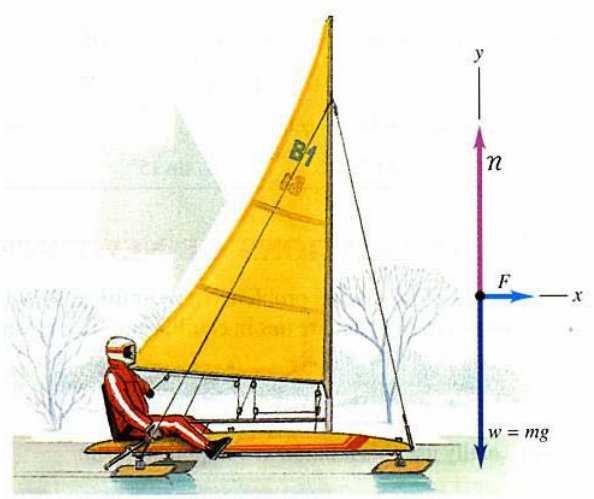


Figure 1: Iceboat is starting from rest.

NOTE: Illustration of the free-body diagram for the iceboat has "NO" friction.

An iceboat is at rest on a perfectly frictionless horizontal surface. What constant horizontal force ***F*** do we need to apply (along the direction of the runners) to give the iceboat a velocity of 4.0 m/s at the end of 2.0 s? The mass of the iceboat and rider is 200,000 g.

$$a = \frac{v - v_0}{t} = \frac{4.0\ m/s \ - \ 0}{2.0\ m/s} \quad = \quad \underline{\underline{2.0\ m/s^2}}$$

The sum of the x-component of force is simply

$$\sum F_x = F\ ,$$

and Newton's second law gives

$$\sum F_x = F \quad = \quad ma_x\ ,\ F = (200\,kg)(2.0\ m/s^2) \quad = \quad 400\ kg \cdot m/s^2 = \underline{\underline{400\ N}}$$

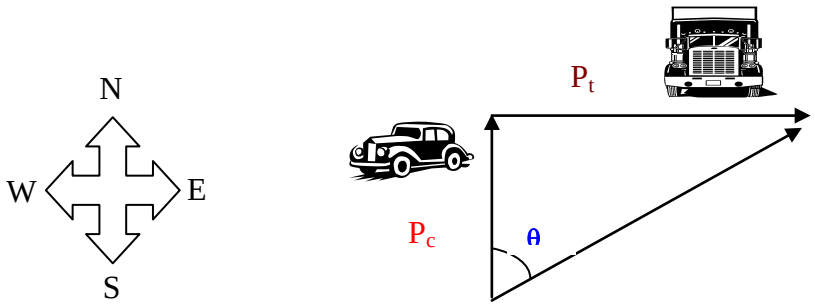
Note that you do not need the y-component at all in this problem. Here they are anyway:

$$a_y \quad = \quad 0,$$

$$\sum F_y = \eta + (-mg) \quad = \quad ma_y = 0,$$

$$\eta \quad = \quad mg = (200\ kg)(9.8\ m/s^2) \quad = \quad \underline{\underline{1960\ N}}\ .$$

Problem 2. Mechanics



A 1400 kg car, heading north and moving at 35 miles per hour collides in a *perfectly inelastic* collision with a 4000 kg truck going East at 20 miles per hour.

a. What is the speed and direction of the wrecked vehicles just after collision?

b. What percentage of the total mechanical energy is lost from the collision?

Use the following units when solving this problem:

p (momentum) by using $(kg \cdot mi/h)$ and for energy $(kg \cdot mi^2/h^2)$

Part 1: Momentum is conserved in an inelastic collision, which means the total momentum of the entire system will be the same before and after the crash. If we find the sum of the momenta of the car ($\mathbf{P_c}$) & the truck ($\mathbf{P_t}$) before the crash, we will have the momentum of the resulting "MERGEMOBILE" ($\mathbf{P_{res}}$) afterwards.

$$\begin{aligned} p_c &= m_c v_c \\ &= (1400\,kg)(35\,mi/h) \\ &= \underline{\underline{49000\ kg \cdot mi/h}} \end{aligned}$$

$$\begin{aligned} p_t &= m_t v_t \\ &= (4000\,kg)(20\,mi/h) \\ &= \underline{\underline{80000\ kg \cdot mi/h}} \end{aligned}$$

Since the two vectors are perpendicular (north & east) we can use the Pythagorus' equation to find the total momentum of the system, and therefore the momentum of the smashed mess (merged vehicles).

$$\begin{aligned} p_{res}^2 &= P_t^2 + P_c^2 \\ p_{res} &= \sqrt{49000^2 + 80000^2} \\ &= \underline{\underline{93800\ kg \cdot mi/h}} \end{aligned}$$

Now to find the velocity of the whole mass

$$p_{res} = m \cdot v_{res}$$

$$v_{res} = \frac{p}{m}$$

$$= \frac{93800\ kg \cdot mi/h}{400\ kg + 4000\ kg}$$

$$= \underline{\underline{17.4\ mi/h}}$$

Of course, you need to know the angle:

$$\tan\theta = \frac{p_t}{p_c}$$

$$\theta = 58.5°$$

$$v = 17.4\ mi/h\ at\ 58.5°$$

Part 2:

First, the total initial kinetic energy:

$$KE_i = \frac{1}{2} m_c v_c^2 + \frac{1}{2} m_t v_t^2$$

$$= \frac{1}{2}\left[1400\ kg(35\ mi/h)^2 + 4000\ kg(20\ mi/h)^2\right]$$

$$= \underline{\underline{1.66\ x\ 10^6\ kg \cdot mi^2/h^2}}$$

Then the final Kinetic Energy:

$$KE_f = \frac{1}{2}\left[1400\ kg(35\ mi/h)^2 + 4000\ kg(17.4\ mi/h)^2\right]$$

$$= \underline{\underline{81700\ kg \cdot mi^2/h^2}}$$

$$\Delta KE = KE_f - KE_i$$

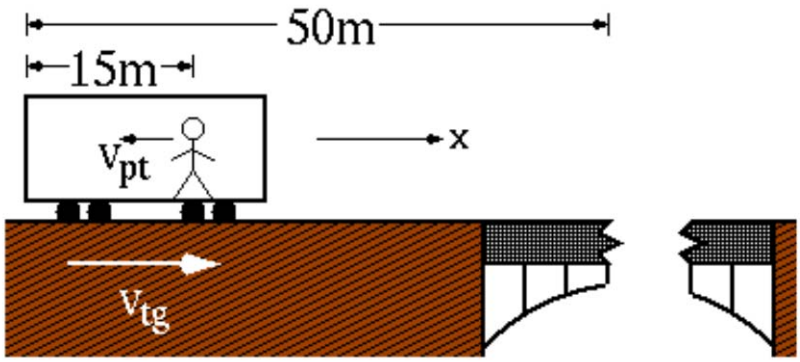
$$= \underline{\underline{-84300\ kg \cdot mi^2/h^2}}$$ And the % by which it changed

$$= \frac{\Delta KE}{KE_i}\ x\ 100$$

(you don't really need to worry about the sign here, as long as you day that energy is "lost".)

$$\boxed{KE_{lost} = 50.8\%}$$

Problem 3. Kinematics



A train is moving towards a destroyed bridge. The velocity of the train remains constant at 20m/s. A person inside the train realizes that they will die unless they run to the back of the train and jump out. If the person is 15m from the back of the train and the back of the train is 50m from the break in the track, what velocity must the person run with to make it to the back of the train just as the back of the train goes over the break in the bridge?

We find the time it takes for the train to get to the hole. Note: That the subscripts for the velocities show how the velocities are measured. v_{tg} means the velocity of the train (t) relative to the ground (g) and so on, with p = person.

$$v_{tg} = 20\,m/s \qquad dt = 50\,m$$

$$t = \frac{d}{v} = \frac{50\,m}{20\,m/s} = 2.5\,s$$

The person needs to go 15m relative to the train in 2.5s

$$v_{pt} = \frac{d}{t} = \frac{-15\,m}{2.5\,s}$$

$$\underline{\underline{v_{pt} = -6.0\,m/s}}$$

SOLUTION – PART 2

The person's velocity relative to the ground is the trains velocity relative to the ground added to the persons velocity relative to the train:

$$v_{pg} = v_{pt} + v_{tg} = -6.0\,m/s + 20\,m/s$$

$$\underline{\underline{v = 14\,m/s}}$$

Problem 4. Fluid Mechanics

Find the mass of air, and its weight, in a Recreational Vehicle with a 4.0 m x 5.0 m floor and a ceiling 3.0 m high. Also, what would be the mass and weight of an equal volume of water?

SOLUTION – PART 1

The volume of the recreational vehicle is

$$V = (3.0\,m)(4.0\,m)\cdot(5.0m) = \underline{\underline{60\,m^3}}$$

The mass (m) is given by the following equation:

$$m = \rho_{air}\cdot V = (1.2\,kg/m^3)(60m^3) = 72\,kg$$

The weight of air is

$$w = mg = (72\,kg)(9.8/s^2) = 706\,N = \underline{\underline{160\,lb}}$$

SOLUTION – PART 2

The mass of an equal volume of water is

$$m = \rho_{H_2o}\cdot V = (1000\,kg/m^3)(60m^3) = 6.0\,x\,10^4\,kg$$

The weight is

$$w = mg = (6.0\,x10^4\,kg)(9.8/s^2) = 5.9\,x10^5\,N = 1.33\,x10^5\,lb = \underline{\underline{66\,tons}}$$

Basically, this much weight would certainly collapse the floor of an ordinary recreational vehicle.

APPENDIX O NSBE HISTORY

TMAL teams should study the NSBE History provided on these links. This includes all documents found on the history page as well as current news within the organization.

http://national.nsbe.org/AboutUs/TheHistory/tabid/68/Default.aspx
http://national.nsbe.org/Home

APPENDIX P TRY-MATH-A-LON ACRONYM LISTING

AE - Alumni Extension
AEB - Alumni Extension Board
AEC - Academic Excellence Committee
AEO - Alumni Executive Officers
APC - Administrative and Personnel Committee
BCA - Board of Corporate Affiliates
BD - Business Diversity
CCI - Community College Initiative
CDP - Chapter Development Program
CEB - Chapter Executive Board
CI – College Initiative
CPC - Conference Planning Committee
FAQ – Frequently Asked Questions
FRC - Fall Regional Conference
GTA - Golden Torch Awards
IC - International Committee
LRP - Long Range Plan
NAB - National Advisory Board
NEB - National Executive Board
NEO - National Executive Officers
NEW - National Engineers Week
NOL – NSBE On-line
NLI - National Leadership Institute
PAT – Progress Assessment Test
PCI - Pre-College Initiative
PDC – Professional Development Conference
RAB - Regional Advisory Board
RAEB – Regional Alumni Executive Board
REB - Regional Executive Board
REO - Regional Executive Officers
RLC - Regional Leadership Conference
SCC – Summer Camping Conference
SRC - Spring Regional Conference
SPSRC – Strategic Planning and Spring Research Conference
STEM Science, Technology, Engineering and Mathematics
TEC – The Engineering Contest
TMAL – Try-Math-A-Lon
USTR – Undergraduate Studies in Technical Research

APPENDIX Q TRY-MATH-A-LON SCORE SHEET

TMAL SAMPLE SCORE

	Individual PAT Score
SAMPLE TEAM SCORE	
1 Charlita	100
2 Tony	100
3 Stacey	100
4 John	100
Total PAT Group Score	400
TEC Score	95
Quizbowl Score	305
Overall Total TMAL Score	800

NOTE: The total PAT score, TEC score, and the Quizbowl score are added together to determine each team's overall final TMAL score.

TMAL SCORE SHEET

Date: Location: Region:

TMAL	Individual PAT Score	TMAL	Individual PAT Score
Team 1		**Team 2**	
1		1	
2		2	
3		3	
4		4	
Total PAT Group Score		**Total PAT Group Score**	
TEC Score		**TEC Score**	
Quizbowl Score		**Quizbowl Score**	
Overall Total TMAL Score		**Overall Total TMAL Score**	
TMAL	**Individual PAT Score**	**TMAL**	**Individual PAT Score**
Team 3		**Team 4**	
1		1	
2		2	
3		3	
4		4	
Total PAT Group Score		**Total PAT Group Score**	
TEC Score		**TEC Score**	
Quizbowl Score		**Quizbowl Score**	
Overall Total TMAL Score		**Overall Total TMAL Score**	
TMAL	**Individual PAT Score**	**TMAL**	**Individual PAT Score**
Team 5		**Team 6**	
1		1	
2		2	
3		3	
4		4	
Total PAT Group Score		**Total PAT Group Score**	
TEC Score		**TEC Score**	
Quizbowl Score		**Quizbowl Score**	
Overall Total TMAL Score		**Overall Total TMAL Score**	