The "MTV Math and Matching" student worksheet was created with two goals in mind:

1st - The Mousetrap Vehicle Design Engineering Competition: to improve student performance on the technical report and interview portions of the SECME competition

2nd - The Seminole Ridge Community High School 2009-2010 School Improvement Plan (SIP): the SRCHS SIP has been developed by teachers, students, parents, administrators, and community members to set a plan of action for the entire Seminole Ridge Community High School community to improve the academic achievement of all students in the school. The objectives in the SIP are a combination of federal, state, and local mandates as well as school designed objectives unique to SRCHS students. SECME is a part of the SRCHS SIP to enhance student problem-solving skills in science and mathematics, and to apply student conceptual learning to reality-based projects.

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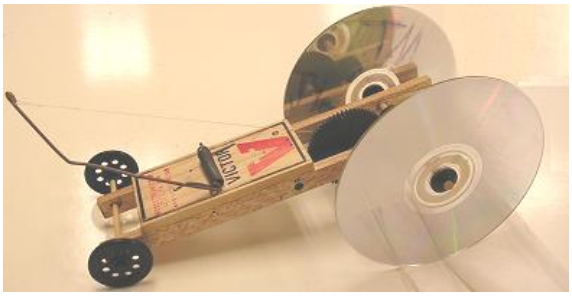
NAME: _____ DATE: _____ **SCORE: _____**

MOUSETRAP MATH



1. Marie and Andrew were testing their mousetrap vehicle (MTV). They set up a trial run to calculate the *N* value of their MTV. The *N* score of the MTV is the product of the ratio of *w* (the weight of the mousetrap) to *W* (the weight of the entire vehicle) multiplied by the square of *D* (the distance the MTV travels) to *L* (the length of the entire mousetrap vehicle).

$$N = \left(\frac{w}{W}\right) X \left(\frac{D}{L}\right)^2$$

Which of the following tools would be best to use to measure the *N* value of their MTV?

A. Stopwatch and balance scale
B. Metric tape and stopwatch
C. Metric tape and balance scale
D. Balance scale and thermometer

_____ 2. What would Maria and Andrew need to know in order to calculate the average speed of their mousetrap vehicle?

F. distance and direction
G. time and acceleration
H. mass and acceleration
I. force and distance

_____ 3. Which of the following is the main force that stops the motion of a mousetrap vehicle?

A. a push or a pull
B. gravity
C. heating
D. friction

_____ 4. The amount of force required to start the mousetrap vehicle moving is

F. less than the force required to keep the vehicle moving
G. the same as the force required to keep the vehicle moving
H. greater than the force required to keep the vehicle moving
I. not related to the force required to keep the vehicle moving

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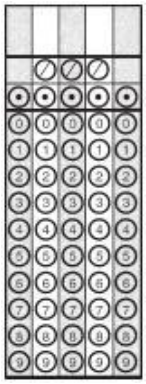
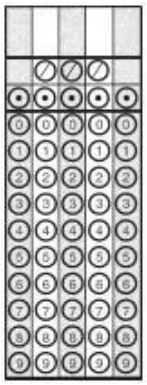
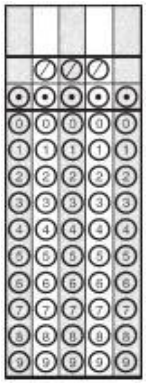
1. In the 2009 SECME National competition, The Crusaders mousetrap vehicle was 0.083 meters long, had a mass of 0.0292 kilograms, and it crossed a distance of 24.625 meters. Suppose the mousetrap vehicle operated for 16 seconds. What speed, in **meters per second**, did the Crusaders mousetrap achieve?



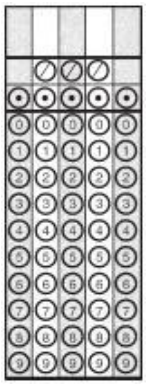
2. In the 2009 SECME National competition, the Blue Devils mousetrap vehicle was 0.152 meters long, had a mass of 0.0572 kilograms, and it crossed a distance of 18.286 meters. Suppose the mousetrap vehicle started from rest and operated for 18 seconds. What acceleration, in **meters per second squared**, did the Blue Devils mousetrap achieve?



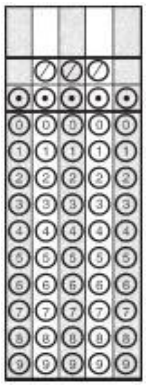
3. In the 2009 SECME National competition, The Anomalies mousetrap vehicle was 0.108 meters long, had a mass of 0.0506 kilograms, and it crossed a distance of 24.765 meters. Suppose the mousetrap vehicle started from rest and operated for 17 seconds. How much horizontal force, in **newtons**, did the Anomalies vehicle apply during its total movement?



4. In the 2009 SECME National competition, The Hybrid Kids mousetrap vehicle was 0.368 meters long, had a mass of 0.0911 kilograms, and it crossed a distance of 12.828 meters. Suppose the mousetrap vehicle started from rest and operated for 20 seconds. How much momentum, in **kilogram-meters per second**, did the Anomalies vehicle create during its total movement?



5. In the 2009 SECME National competition, the Lightening mousetrap vehicle was 0.184 meters long, had a mass of 0.0813 kilograms, and it crossed a distance of 13.720 centimeters. Suppose the mousetrap vehicle started from rest and operated for 18 seconds. How much work, in **Joules**, did the Lightening vehicle achieve during its total movement?



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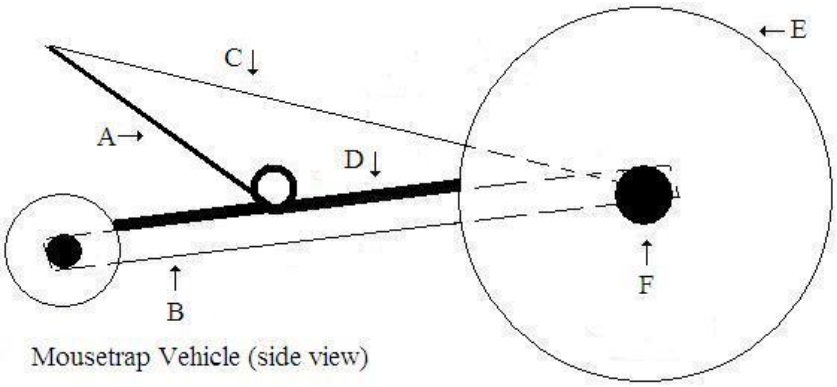
MOUSETRAP VEHICLE MATCHING

Write in the correct vocabulary term that identified the parts of the mousetrap vehicle. Words may be used once, more than once, or not at all.



Mousetrap Vehicle (side view)

A. _____

B. _____

C. _____

D. _____

E. _____

F. _____

Vocabulary Bank		
Axle	Gear	Rail
Mousetrap Base	Locking lever	Spring
Bail arm	Pull string	wheel

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MAIN BODY MATCHING

As a part of the Design Competition, the team is required to write a Technical Report describing the design, construction, and operation of the Mousetrap Car. The Teachnical Report should be a computer printed/typed document, double-spaced, on 8 ½" x 11" white paper with one-inch borders at the top, bottom, and on each side, and in a standard legible text font of 12 pt. type. The main body of the Technical Report should be a maximum of 5 pages total.

Match the four parts of the Technical Report which should be in the main body.

ORGANIZATION OF MAIN BODY	**CONTENTS OF TECHNICAL REPORT**
	A. ABSTRACT
Part 1 _____	B. ACKNOWLEDGEMENTS
	C. APPENDIX
Part 2_____	D. CONCLUSIONS/RECOMMENDATIONS
	E. CONSTRUCTION PROCEDURE
Part 3_____	F. COVER PAGE
	G. DESIGN CONSTRUCTION
Part 4_____	H. INTRODUCTION
	I. OPERATION OF THE MOUSETRAP CAR
	J. TABLE OF CONTENTS

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SECME REFERENCE SHEET

2009 SECME NATIONAL ENGINEERING DESIGN
Mousetrap Car Score - HIGH SCHOOL DIVISION

				w	W	D	L	
Team name	Technical Report	Technical Drawing	Knowledge Interview	weight of mouse trap in grams	total mass of car in grams	distance in cm	longest dimension in cm	
America's Team	50	50	50	25	27.6	2476.5	8.3	
Crusaders	44	32	44	25	29.5	2 462.6	8.3	
Trojans (Taravella)	40	33	41	25	29.6	2476.5	10.2	
Falconators (AKA Team Syracuse)	29	39	39	25	37.3	2 344.8	10.5	
The Anomalies	25	30	43	25	50.6	2476.5	10.8	
Blue Devils	41	31	45	25	57.2	1 828.7	15.2	
Trojans (Hialeah-Miami Lakes)	47	21	50	25	25.6	721.2	9.8	
E-Mays-Zing	29	46	40.5	25	34.7	28.7	10.2	
The Hybrid Kids	29	39	31	25	91.1	1 282.8	36.8	
Lightning	0	41	29	25	81.3	1372.0	18.4	

The *N* score of the MTV is the product of the ratio of *w* (the weight of the mousetrap) to *W* (the weight of the entire vehicle) multiplied by the square of *D* (the distance the MTV travels) to *L* (the length of the entire mousetrap vehicle).

$$N = \left(\frac{w}{W}\right) X \left(\frac{D}{L}\right)^2$$

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Grade 8 FCAT Science Reference Sheet

Equations

Acceleration (a)	=	$\frac{\text{change in velocity (m/s)}}{\text{time taken for this change (s)}}$	a	=	$\frac{v_f - v_i}{t_f - t_i}$
Average speed (v)	=	$\frac{\text{distance}}{\text{time}}$	v	=	$\frac{d}{t}$
Density (D)	=	$\frac{\text{mass (g)}}{\text{Volume (cm}^3\text{)}}$	D	=	$\frac{m}{V}$
Percent Efficiency (e)	=	$\frac{\text{Work out (J)}}{\text{Work in (J)}} \times 100$	%e	=	$\frac{W_{out}}{W_{in}} \times 100$
Force (F)	=	mass (kg) × acceleration (m/s^2)	F	=	ma
Frequency (f)	=	$\frac{\text{number of events (waves)}}{\text{time (s)}}$	f	=	$\frac{n \text{ of events}}{t}$
Momentum (p)	=	mass (kg) × velocity (m/s)	p	=	mv
Wavelength (λ)	=	$\frac{\text{velocity (m/s)}}{\text{frequency (Hz)}}$	λ	=	$\frac{v}{f}$
Work (W)	=	Force (N) × distance (m)	W	=	Fd

Units of Measure

m = meter	g = gram	s = second
cm = centimeter	kg = kilogram	Hz = hertz (waves per second)
J = joule (newton-meter)		
N = newton (kilogram-meter per second squared)		

Author: Erich Landstrom, Seminole Ridge SECME school coordinator

Grade 11 FCAT Science Reference Sheet

Equations

Acceleration (a)	=	$\frac{\text{change in velocity (m/s)}}{\text{time taken for this change (s)}}$	a =	$\frac{v_f - v_i}{t_f - t_i}$
Average speed (v)	=	$\frac{\text{distance}}{\text{time}}$	v =	$\frac{d}{t}$
Density (D)	=	$\frac{\text{mass (g)}}{\text{Volume (cm}^3\text{)}}$	D =	$\frac{m}{V}$
Percent Efficiency (e)	=	$\frac{\text{Work out (J)}}{\text{Work in (J)}} \times 100$	%e =	$\frac{W_{out}}{W_{in}} \times 100$
Force (F)	=	mass (kg) × acceleration (m/s^2)	F =	ma
Frequency (f)	=	$\frac{\text{number of events (waves)}}{\text{time (s)}}$	f =	$\frac{n \text{ of events}}{t}$
Momentum (p)	=	mass (kg) × velocity (m/s)	p =	mv
Pressure (P)	=	$\frac{\text{Force (N)}}{\text{area (m}^2\text{)}}$	P =	$\frac{F}{A}$
Wavelength (λ)	=	$\frac{\text{velocity (m/s)}}{\text{frequency (Hz)}}$	λ =	$\frac{v}{f}$
Work (W)	=	Force (N) × distance (m)	W =	Fd

Units of Measure

m = meter
cm = centimeter
g = gram
kg = kilogram
s = second
Hz = hertz (waves per second)
J = joule (newton-meter)
N = newton (kilogram-meter per second squared)

1 Astronomical Unit (AU) = distance between Earth and the Sun (approximately 150 million kilometers)

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ANSWER KEY

Multiple Choice

1. C
2. G.
3. D.
4. H.

Gridded Response

1. v = 1.54 m/s
2. a = 0.056 m/s2
3. F = 0.004 Newtons
4. p = 0.058 kg-m/s
5. W = 0.047 Joules

Mousetrap Vehicle Matching

A. bail arm
B. rails
C. pull string
D. mousetrap base
E. wheel
F. Axle

Main Body Matching

H. Introduction,
D. Design Construction
E. Construction Procedure
I. Operation of the Mousetrap Car

SSS Science Benchmarks

SC.912.N.3.3
Explain that scientific laws are descriptions of specific relationships under given conditions in nature, but do not offer explanations for those relationships.

SC.912.P.10.3
Compare and contrast work and power qualitatively and quantitatively.

SC.912.P.12.2
Analyze the motion of an object in terms of its position, velocity, and acceleration (with respect to a frame of reference) as functions of time.

SC.912.P.12.3
Interpret and apply Newton's three laws of motion.

SC.912.P.12.5
Apply the law of conservation of linear momentum to interactions, such as collisions between objects.

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Mousetrap Math

Calculations from mousetrap cars

* Total Rolling Friction
* Coefficient of Rolling Friction
* Total Potential Energy
* Maximum Total Kinetic Energy
* Work Done Moving Car
* Gear Ratios
* Mouse Trap Spring Constant
* Rotational Inertia of Wheels
* Pulling Distance and Gear Ratio
* Max Acceleration before Tire Slippage
* Predicted Total Travel Distance
* Efficiency with Distance Cars
* Efficiency with Speed Cars
* Center of Mass
* Normal force on Wheels
* Min String Tension Needed to Move
* Calculate Tire Grip on Floor

Graphing Ideas for mousetrap powered cars

* distance vs. time
* velocity vs. time
* acceleration vs. time
* pulling force vs. degrees of spring angle
* potential energy vs. time
* kinetic energy vs. time
* work vs. time
* string tension vs. traveled distance
* lever arm length vs. time
* lever arm length vs. pulling distance

Author: Erich Landstrom, Seminole Ridge SECME school coordinator