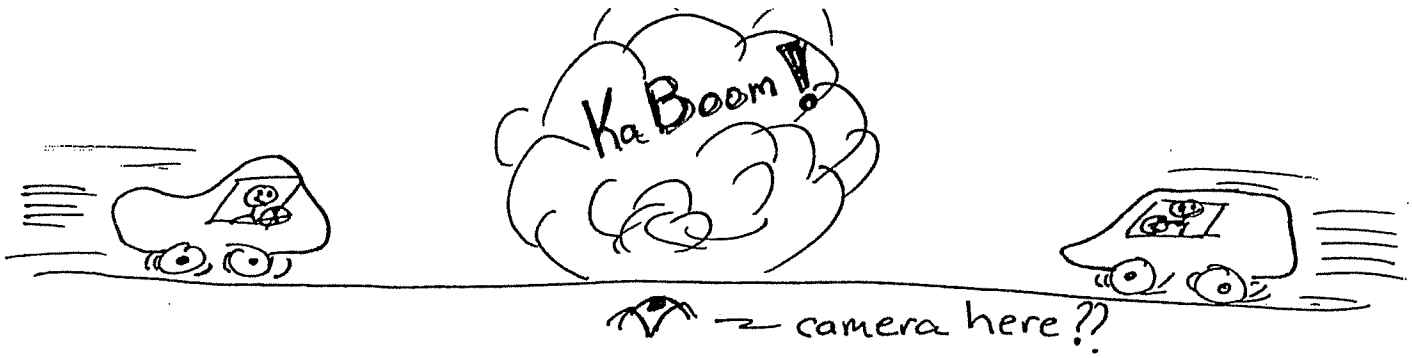
FAX

To: Ross Consulting Engineers
From: Universal Studios, Movie Division
Re: Modeling Car Crash Scene

Dear Ross Consulting Engineers,

We at Universal Studios aim to please our movie audience! We are currently filming a low budget action movie for overseas distribution. The movie title is to be, *"Holy Crap! The Cars are Going to Crash!"* Clearly, we are organizing a car crash scene and are in need of your knowledge and expertise.

One scene in our movie has two cars approaching each other at a constant velocity where a head-on collision is to take place. During the collision a great explosion is to happen too. See sketch below:



We need your help in figuring out where to put the cameras so we get the collision on the first take. Because our staff has limited physics knowledge, we would like to contract you to create a model of this situation then tells us how to set it up for the shoot. We will then use your model with our numbers for our scene.

Thank you for your help on this. We would be so grateful that we would include you in our credits at the end of the movie.

Sincerely,

I.M. Curious

Creative Consultant, Universal Studios

Holy Crap! The Cars Are Going to Crash!!

Name: _____

App/Conn
/20

What to Do

1) Using your whiteboard, first design an experiment where your two cars move toward each other a set distance apart and crash into each other. Identify what you will need to measure and calculate in your experiment.
2) Using a stopwatch and metre stick, find the speed of your two cars.
3) Calculate where the car crash should occur. (See example in your notebook for the idea). This is your *calculated* value.
4) Now conduct the experiment and measure where the car crash actually occurred. This is your *measured* value.
5) Calculate the *Percent Difference* between the calculated and measured values (see below for the formula).
6) Reproduce your measured value result two more times.
7) Comment on your sources of error in the experiment (see your notebook for ideas).

$$Percent\ Difference = \frac{|measured - calculated|}{\frac{measured + calculated}{2}} x100\%$$

Experimental Analysis

Diagram for Two Cars Experiment

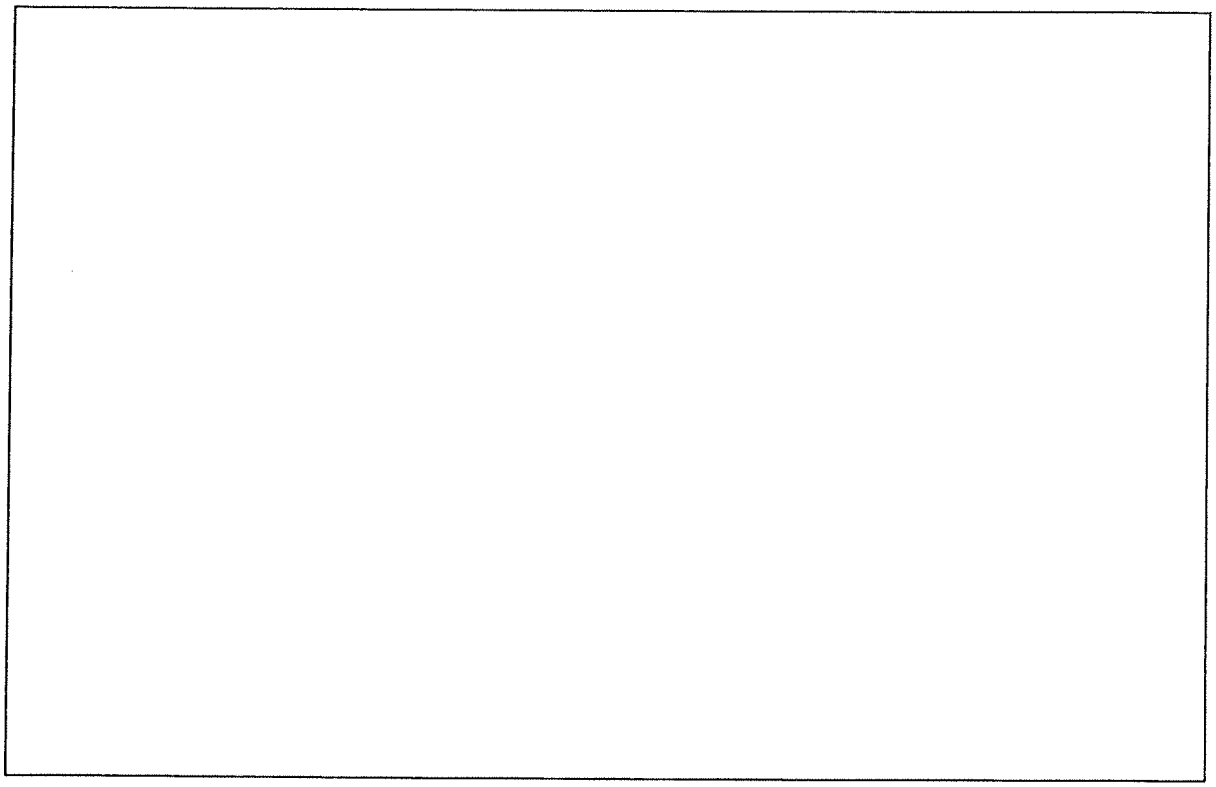
Speed Calculations for the Two Cars

Calculated Value for the Two Cars

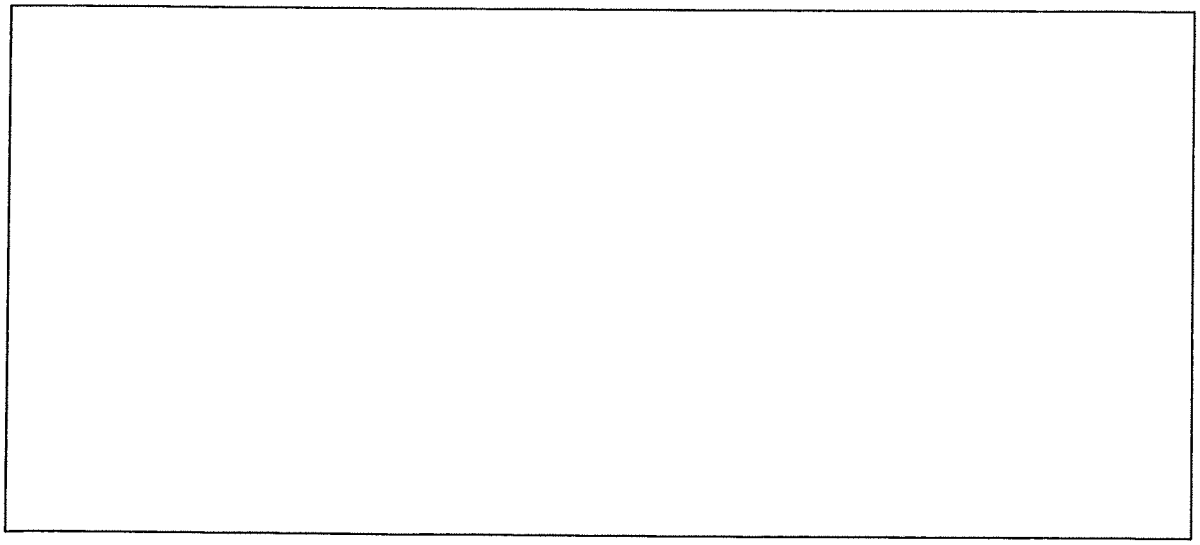
Table 1: Calculated and measured results of the position of impact of the two cars

Trial	Calculated Position	Measured Position	% Difference (Show Your Work)
1			
2			
3			

Sources of Error



Limitations of the Model



FAX

To: Ross Consulting Engineers
From: Crazy Carnival Entertainment
Subject: New Event – Flaming Splash!

Your reputation as a consulting firm for difficult and dangerous projects has reached our corporate office here in Toronto. Because of this we would like to contract you to model a new event for our next carnival tour. The event is to be called '**Flaming Splash**'.

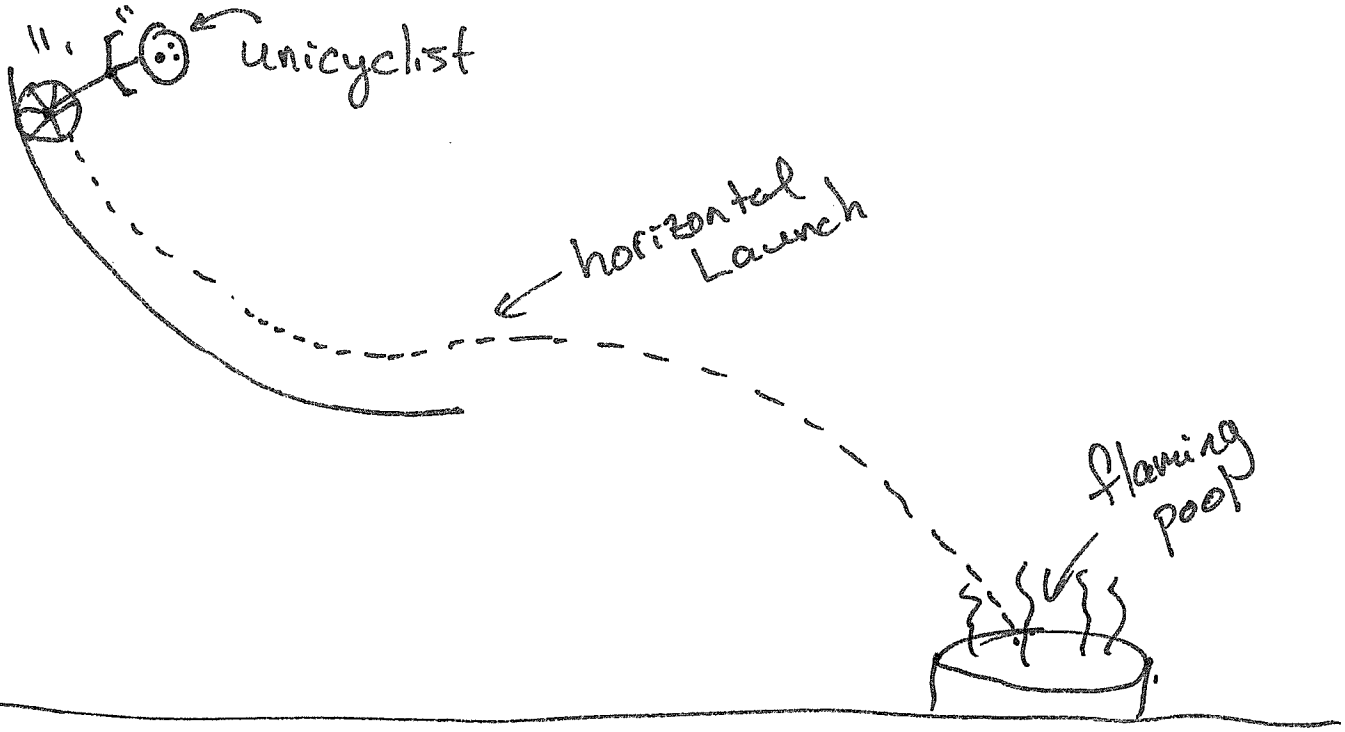
In this event, a person is to ride a unicycle from the top of a large ramp to the bottom where the person is launched into the air horizontally. On the ground is a large pool of flaming liquid. The idea is for the unicyclist to fly through the air and land in the pool of flaming liquid. The person will emerge unharmed from the help of a fire-proof suit. Below is a sketch of the event I threw together.

We would greatly appreciate your modelling insight into this event and to create a working model to test the feasibility of our idea.

Look forward to your response!

Mr. I.M. Crazy

President, Crazy Carnival Entertainment



Product Recall

Product: Shoot Game SUPER GUN

I.D. No. 29926

Dear Ross Consulting Engineers,

We at the Canadian Safety Association (CSA) have released a recall on all Shoot Game SUPER GUN toys found in 'Dollar' stores throughout Canada. Our concern is that the exit speed of the projectile exceeds 4 m/s making the projectile unsafe for children. As a result, significant injury may result from using this product.

We are contracting you to conduct an analysis to determine the exit speed and determine whether the projectile from these toy guns exceeds the critical 4 m/s.

Part of your contract will include a written briefing that includes the rationale for the experiment, experimental design and diagram, relevant data, necessary calculations and concluding statements. Once we analyze the briefing then we will make a decision on whether the product will be released back onto the market.

Sincerely,

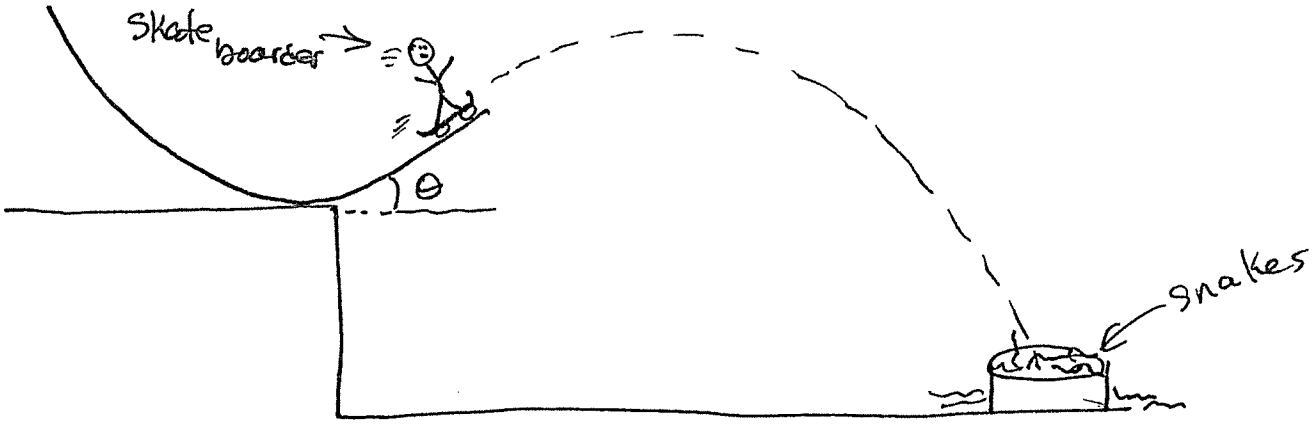
Donna Projectile, Ph.D.
Associate Director CSA

FAX

To: Ross Consulting Engineers
From: Crazy Carnival Entertainment
Subject: Another New Event – Flames and Snakes!

Holy Cow! The model you created and we implemented has been a smashing success. The crowds love it! I have another idea for an event that makes Flaming Splash look like child's play. I call it **'Flames and Snakes'**.

I got this idea from watching this YouTube video: Slip and Fly – Amazing Waterslide Jump! In my event, a skateboarder flies down the ramp and launches into the air at some angle above the platform and falls into a vat of very poisonous snakes. Crazy indeed! See my sketch below.



Could you once again create a working model for our idea demonstrating that it can work in principle. Looking forward to hearing from you.

Sincerely,

Mr. I.M. Crazy

President, Crazy Carnival Entertainment

FAX

To: Ross Consulting Engineers

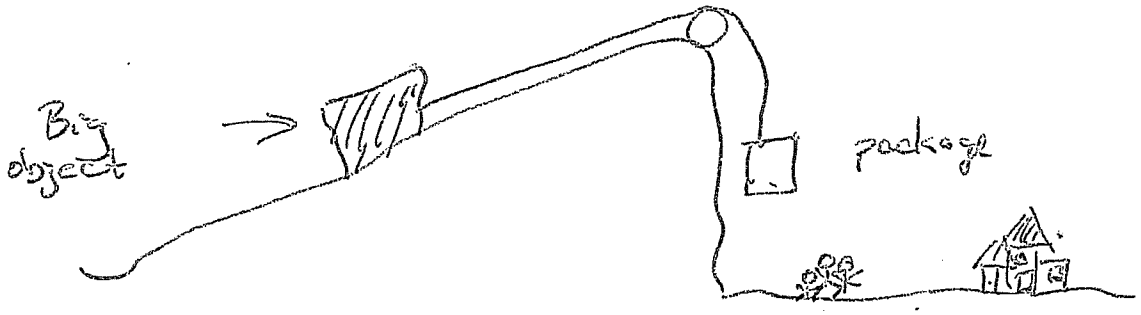
From: Engineers Without Borders

Subject: Moving Large Objects in Africa

Dear Ross Consulting Engineers,

Crazy Carnival Entertainment has passed along your names to us with the hope of helping us solve a problem. We are trying to move large, massive packages from a sloping hill down into a gully. These packages are to be used to develop a village for displaced persons.

We are having some troubles with developing the process. We need to have the packages fall into the gully at a gentle, constant velocity so that they do not crash as they would if they were accelerating down. We would like you to model this problem to show that it can be done so that we do not damage the valuable contents in the packages (see picture below).



Thank you for your efforts on this important project. We look forward to the report from you as to the feasibility of this project.

Thank you!

Greg Grinnings, CEO Engineers Without Borders

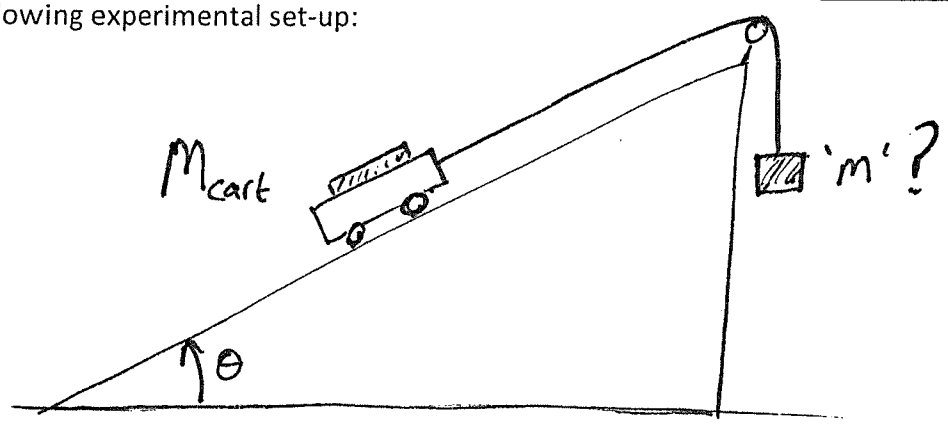
Moving Large Objects in Africa: An Application of the Equilibrium Force Model

Name: _____

Appl./Conn	/10
Comm.	/5

What to Do

Given the following experimental set-up:



- Measure M_{cart} and θ
- Draw schema and FBD for the cart
- Determine the value of 'm' needed such that the system will remain at rest
- Accurately measure out 'm' and connect it to the cart with the string.
- **Do NOT place the cart and 'm' on the track yet!** Call me over when you have measured out 'm'.

Comments

- 1st successful attempt: 10/10. Second successful attempt: 9/10 and so on...
- "Measure twice, cut once!"
- Don't let your incline slip – this changes θ on you.

Submission

- On the reverse side of this page, lay out your solution beginning with a schema, FBD, clearly explained mathematics at how you arrived at 'm', and a concluding statement.

Leonard Creary
Head Caretaker, CWDHS
Phone: 843-2500 ext 316
Voice: ext 516

Just a word to ask all teachers to remind the students that the tile floors are extremely slippery when wet. Runners should be extra cautious as floor conditions vary throughout the school .

This is a real email
b.t.w. - great initial "Hook"!

I still need to re-engineer this one... but you get the idea!

MEMORANDUM

Ross Consulting Engineers

To: Mr. Wagner's SPH 4U Class
From: Upper Grand District School Board
Subject: Sliding, Slipping and Falling

The Occupational Health and Safety Board (OHSB) has identified that the floor tiles of the school are posing a slipping hazard to its students and teachers. There have been reports of students and staff slipping on the tiles and reporting injuries as a result.

Before they arrive to investigate, the OHSB would like you to do some preliminary calculations to determine the co-efficient of kinetic friction, μ_k, between the tiles and a typical shoe. This information can then be used to make recommendations that will help protect the students and teachers.

You and your team are to develop an experiment where you will use the models of physics you have learned to find the value of μ_k between the tiles and a typical shoe. Like any good scientist you will figure out what you need to measure and calculate first before conducting the experiment. Carefully gather your data and note your experimental procedure so as to submit a report to the OHSB discussing the results of your experiment prior to their arrival.

Thank you in advance for all of your efforts in helping us gather information about this serious problem.

Sincerely,

I.M. Sleer.

Ms. I.M. Seareeis
UGDSB Health and Safety Office

FAX

Comm.	T/I
/4	/10

To: Ross Consulting Engineers (RCE)

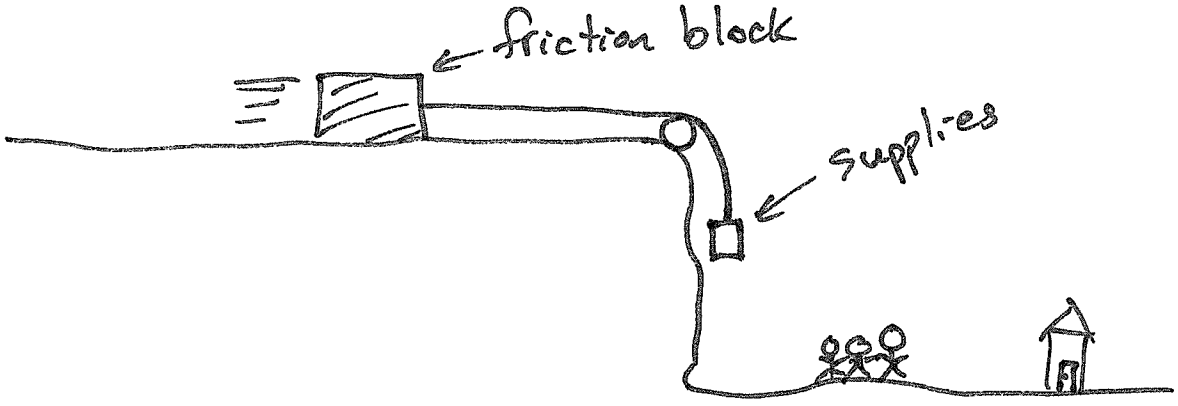
From: Doctors Without Borders

Re: Supplying Medication to Remote areas

Dear RCE,

We are in need of your modeling expertise. Your company was mentioned to us from our colleagues at Engineers Without Borders and they believe that you can help us.

We are currently trying to reach remote areas with much needed medication and supplies. Reaching one area in particular has been very difficult. I have put a sketch of the region below.



We would like to contract you to design and test a model that would allow us to bring packages to the citizens so that the packages gently accelerate into the valley below. Your attention to this matter must be of a timely nature so that the supplies reach those citizens as soon as possible.

Thank you for your efforts. Lives depend on it.

Sincerely,

Dheeraj Gupta, Engineering Senior Manager, Doctors Without Borders

Name: _____

Part 1: Finding μ_k

With the given equipment and model(s), design an experiment to determine μ_k between the block and track

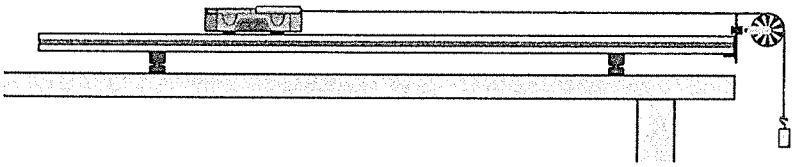
- Block, mass, force probe and Equilibrium Force Model

- FBD
- Calculations
- final μ_k value

Part 2: Predicting Acceleration

- Setup the system shown below
- Measure all masses
- Using the masses and the μ_k value from Part 1 and **predict** what the acceleration of your system will be. Show your work in the space below.

- FBD – do it on the image below
- Calculations – see your notes on how to express your work
- Predicted value for 'a'



Part 3: Measuring Acceleration

- Using a stopwatch and metre stick and the Constant Acceleration Model, what would you need to measure and calculate to determine the experimental acceleration?

- Diagram
- Calculations

Part 4: Calculate the Percent Difference

- Is your model 'valid'? (i.e., the extent to which the results really measure what they are supposed to measure compared to the calculated value)
- Calculate the percent difference between the two values in Parts 2 and 3
- Comment on the validity of your model – how confident do you feel of presenting the model with the goal of creating a full-scale version?

$$Percent\ difference = \frac{|\ value\ 1 - value\ 2\ |}{\frac{value\ 1 + value\ 2}{2}} * 100$$

Comment:

FAX

To: Ross Consulting Engineers (RCE)

From: The Professional Golfers Association (PGA)

Re: Testing golf balls for the tour

Dear RCE,

For the upcoming PGA Tour, we are considering standardizing the golf balls that players use in our tournaments. We want to ensure that the best balls be used for our players. By 'best balls' we mean those that will achieve maximum horizontal distance when struck by the player's golf clubs.

We would like to contract you to model the energy loss of three (3) balls when struck by a club. Specifically, we wish to determine which ball would have the greatest energy efficiency or 'elasticity'. It is our understanding that RCE are world renowned experts on the conservation of energy applied to the sporting world.

After conducting your experiments, we would like a short report on your experimental design, data collected, calculations including the energy efficiency of the balls and your final recommendation.

Thank you for conducting this important work for the Association. We look forward to your reply shortly.

Sincerely,

Sandy Wedge

President, PGA

How is energy efficiency calculated?

The energy efficiency of a device can be calculated using this formula:

$$\text{energy efficiency} = \frac{\text{useful output energy}}{\text{total input energy}}$$

- Useful output energy is measured in **joules** (**J**).
- Total input energy is measured in **joules** (**J**).
- Energy efficiency does not have any units.

  It is a number **between 0 and 1** which can be converted into a percentage by multiplying by 100.