>> I WOULD LIKE TO INTRODUCE

VICKI ROBINSON, WHO IS

SPEAKING THIS AFTERNOON.

SHE HAS BEEN TEACHING AT NTID

SINCE 1978.

SHE IS HERE THIS AFTERNOON TO

TALK TO YOU ABOUT TEACHING

COLLEGE STUDENTS PHYSICS.

SHE TEACHES HERE, PHYSICS

CLASSES AT NTID.

NOW, ONE THING WE WOULD LIKE

TO MENTION, LATER DURING THE

QUESTION AND ANSWER PERIOD,

WHEN YOU DO HAVE A QUESTION,

PLEASE COME TO THE MICROPHONE

SO THAT THE CAPTIONIST IS ABLE

TO HEAR THE QUESTION.

THANK YOU VERY MUCH AND ENJOY

THE PRESENTATION.

>> OKAY.

LET ME SEE IF I CAN DO THIS.

AM I TOO LOUD?

IS THAT OKAY FOR EVERYBODY

LISTENING?

GOOD.

OKAY.

ARE YOU ALL PHYSICS TEACHERS,

SCIENCE TEACHERS, MATH

TEACHERS MAYBE?

CAN I SEE HANDS?

SCIENCE TEACHER?

OKAY.

AND JOHN ALLEN.

AN ENGLISH TEACHER.

I DON'T KNOW WHY YOU'RE HERE!

ANYWAY, WE HAVE ALL TAKEN MATH

OR SCIENCE CLASSES, THOUGH,

AND WE HAVE ALL HAD TO

STRUGGLE WITH WORD PROBLEMS.

REMEMBER WORD PROBLEMS?

LET ME REFRESH YOUR MEMORY A

LITTLE BIT.

IT'S THE FIRST TIME I HAVE

USED THIS MOUSE, SO...

>> ...TRAVELING 30 MILES AN

HOUR, CARRYING 40 PASSENGERS

LEAVES PHOENIX BOUND FOR SANTA

FE.

IT'S EIGHT CARS LONG AND

ALWAYS CARRIES THE SAME

NUMBER.

AN HOUR LATER, A NUMBER

PASSENGERS EQUAL TO HALF THE

NUMBER GET OFF AND THREE TIMES

AS MANY PLUS SIX GET ON... AT

THE SECOND STOP, HALF THE

PASSENGERS PLUS TWO GET ON...

>> COME WITH ME, BOYS.

>> OKAY.

HOW MUCH.

>> (Speaking very quickly)

... TWO-THIRDS OF...

(Evil laughter)

(Loud knocks noises)

>> DOES THAT LOOK FAMILIAR TO

ANYBODY?

I REMEMBER DOING THOSE.

"A TRAIN LEAVES SPRINGFIELD AT

3," KINDS OF PROBLEMS.

THEY STILL SORT OF MAKE ME

FEEL WEIRD.

WELL, IMAGINE THAT YOU'RE

HAVING TO DO PROBLEMS IN A

LANGUAGE THAT YOU DON'T REALLY

UNDERSTAND ALL THAT WELL,

WHICH IS TECHNICAL ENGLISH,

FOR MOST OF MY STUDENTS,

ANYWAY.

SO WHAT MAKES WORD PROBLEMS

TOUGH?

EVERYTHING!

THEIR SYNTAX, SENTENCE

STRUCTURE, TECHNICAL

VOCABULARY, THE NEED TO

VISUALIZE OBJECTS THAT AREN'T

IN FRONT OF YOU, AND THEY MAY

BE CHANGING POSITION RELATIVE

TO EACH OTHER, JUST LIKE THE

TRAINS IN BART'S IMAGINATION.

THE REQUIREMENT OF EXTRACTING

MATHEMATICAL INFORMATION FROM

NON-NUMERICAL SOURCES.

HOW MANY HAVE YOU SEEN DEAF

STUDENTS READING A PROBLEM AND

GOING, "WORD, WORD, WORD...

AH!

HERE'S A NUMBER.

OKAY.

WORD, WORD, WORD... A NUMBER!"

AND THEY HAVE A NICE LIST OF

NUMBERS, BUT THEY DON'T KNOW

WHAT CONNECTS THEM.

THAT'S A PROBLEM.

THAT'S A PROBLEM WITH MY

CLASSES.

OVER 25 YEARS OF DOING THIS, I

HAVE DISCOVERED THIS IS A VERY

COMMON WAY OF READING WORD

PROBLEMS.

HERE'S A PHYSICS PROBLEM AND I

ACTUALLY TOOK IT FROM THE
TEXTBOOK.
"A BULLET TRAVELING
HORIZONTALLY AT A SPEED OF 300
METERS PER SECOND HITS A BOARD
PERPENDICULAR TO THE SURFACE,
PASSES THROUGH IT AND EMERGES
ON THE OTHER SIDE AT A SPEED
OF 210 METERS PER SECOND.
IF THE BOARD IS FOUR
CENTIMETERS THICK, HOW LONG
DOES THE BULLET TAKE TO PASS
THROUGH?"
HOW DO WE PARSE THIS PROBLEM?
WELL, THERE ARE ONE, TWO,
THREE... SIX PIECES OF
INFORMATION, JUST IN THE FIRST
SENTENCE.
THE BULLET IS TRAVELING
HORIZONTALLY; ITS SPEED WHEN
IT HITS THE BOARD; THE FACT
THAT IT HITS PERPENDICULAR AND

IT'S GOING THROUGH-- OH!

THAT'S SUPPOSED TO BE 210

METERS PER SECOND.

I'M SORRY.

THE SECOND, THE BOARD IS FOUR

CENTIMETERS THICK AND HOW LONG

DOES IT TAKE THE BULLET TO

PASS THROUGH THE BOARD?

THAT'S SEVEN ITEMS OF

INFORMATION IN THAT SHORT

PARAGRAPH AND A MISLEADING

QUESTION.

IF YOU ASK "HOW LONG"WHAT DOES

THAT MEAN TO MOST OF YOUR

STUDENTS?

EXACTLY.

HOW LONG?

THIS FAR, THIS FAR, THIS

FAR...

A HEIGHT?

WELL, IT TELLS YOU THE BOARD

IS FOUR CENTIMETERS THICK, SO

MAYBE THEY WANT TO KNOW HOW

FAR IT TRAVELS BEFORE THEY HIT

THE BOARD AND MAYBE THEY WANT

TO KNOW HOW FAR IT'S GOING TO

GO AFTER IT LEAVES THE BOARD.

WHO KNOWS?!

I MEAN THIS IS A SERIOUS

PROBLEM WITH MANY OF MY

STUDENTS.

NOW, TAKE A LOOK AT THIS.

SAME PROBLEM...

WHOOPS!

IT'S NOT GOING TO FIND IT, BUT

I'LL SHOW YOU...

HERE WE GO.

THIS IS THE SAME PROBLEM.

THERE'S A QUESTION UP THERE:

HOW MUCH TIME WILL IT TAKE FOR

THE BULLET TO MOVE THROUGH THE

4-CENTIMETER-THICK BOARD?

WE RUN IT... THERE GOES THE

BULLET THROUGH THE BOARD.

WHAT DID YOU SEE?

LET'S RUN IT AGAIN.

THE BULLET APPROACHES THE

BOARD.

IT MOVES THROUGH IT, AND AS IT

MOVES THROUGH, IT SLOWS DOWN.

WE HAVE A METER HERE THAT

SHOWS YOU THE SPEED.

WE HAVE A GRAPHICAL

REPRESENTATION OF THE SPEED,

TOO, WHICH SHOWS YOU THE

BULLET ACTUALLY SLOWS DOWN,

DOESN'T INSTANTLY GO FROM 350

TO 210 PER SECOND, AND IF WE

WANT TO, WE CAN RUN IT

BACKWARD, JUST LIKE THE FILM.

OKAY.

WHAT HAPPENS TO THE VELOCITY?

HERE IT COMES...

IT HITS... SEE THE VELOCITY?

LOOK AT THE METER.

IT'S GOING DOWN, DOWN, DOWN,

DOWN, TO 210, AND THEN IT

KEEPS GOING AT 210.

NOW, I HAVE TO TRY TO FIND

POWERPOINT AGAIN.

OH, AND IT'S ON THE PROBLEM

NOW.

OKAY.

WELL, WHICH OF THOSE

REPRESENTATIONS OF THAT

PROBLEM ARE YOU GOING TO

PREFER AS A NOVICE

PROBLEM-SOLVER?

THAT PARAGRAPH, THAT WORDY

PARAGRAPH?

OR ARE YOU GOING TO LIKE THAT

NICE PICTURE THAT SHOWS THE

BULLET HEADING TOWARD THE

BOARD AT A CONSTANT VELOCITY,

HITTING THE BOARD,

DECELERATING AS IT PASSES

THROUGH AND THEN CONTINUING

ONWARD AT A CONSTANT VELOCITY?

THE QUESTION IS CLEARLY

STATED.

VOILA!

NOW WE CAN CONCENTRATE ON THE

PHYSICS.

WE DON'T HAVE TO WORRY ABOUT

UNDERSTANDING THE PROBLEM.

HOW DID I DO THAT?

I USED A PROGRAM CALLED

INTERACTIVITY SICS.

IT'S A MODELING PROGRAM THAT

ALLOWS YOU OR YOUR STUDENTS TO

MODEL, SIMULATE AND EXPLORE A

WIDE VARIETY OF PHENOMENA.

I USE IT FOR ALMOST ANYTHING

YOU CAN IMAGINE THAT HAS TO DO

WITH MECHANICAL SYSTEMS.

I USE IT TO ILLUSTRATE WORD

PROBLEMS.

YOU JUST SAW THAT.

LET'S GO BACK TO THE BULLET

PROBLEM.

IT'S GOT DIFFICULT SYNTAX,

UNFAMILIAR VOCABULARY, THE

NEED TO VISUALIZE NOVEL

CIRCUMSTANCE-- AM I GOING TOO

FAST FOR YOU, GAIL?

OKAY.

VERY LITTLE NUMERICAL

INFORMATION, AND AN AMBIGUOUS

QUESTION STATEMENT.

WHOOPS.

OKAY.

THEN I WAS SUPPOSED TO SHOW

YOU THE SIMULATION, WHICH YOU

HAVE ALREADY SEEN.

NOW, COMPARE WHAT YOU SAW,

THAT LITTLE MOVIE, COMPARE

THAT TO THIS:

THIS IS WHAT I USED TO DO WHEN

STUDENTS WOULD SAY, "I DON'T

UNDERSTAND THIS PROBLEM."

I WOULD SAY, "THE SOLUTION IS

SIMPLE, LOOK...

SEE?

GOT IT?

UNDERSTAND?"

WELL, THEY USUALLY ENDED UP

FALLING OVER IN THEIR CHAIRS,

JUST LIKE BART DID.

DOES INTERACTIVITY SICS MEAN

YOU'LL NEVER GET TO THIS

POINT?

OF COURSE NOT.

BUT WHEN YOU GET TO THIS, IT

WILL HAVE SOME CONTEXT.

IT WILL MAKE SOME SENSE BY THE

TIME YOU GET THERE.

AND THAT'S THE ANSWER, BY THE

WAY.

1.43 TIMES 10 TO THE MINUS 4

SECONDS.

WHICH ONE MAKES MORE SENSE?

OKAY.

I USE THIS TO MAKE PROBLEMS A

JUMPING-OFF POINT FOR CLASS

DISCUSSION.

LET ME SEE...

WHOEVER SET UP THIS MONITOR

WAS A MUCH YOUNGER PERSON WITH

MUCH YOUNGER EYES THAN MINE; I

AM TELLING YOU!

OKAY.

THAT CYAN, I HAVE NO IDEA-- I

SWEAR ON MINE AT HOME, THESE

BLUE AREAS WERE TRANSPARENT.

HE'S ACTUALLY HOLDING AN APPLE

IN HIS HAND.

LET'S GO BACK TO THE QUESTION.

OKAY.

HERE'S THE QUESTION: "THE

CEILING OF A CLASSROOM"--

TAKEN FROM THE SAME BOOK-- "IS

3.35 METRES ABOVE THE FLOOR.

A STUDENT TOSSES AN APPLE

VERTICALLY UPWARD, RELEASING

IT .5 METERS ABOVE THE FLOOR.

WHAT IS THE MAXIMUM INITIAL

SPEED IT-- SPEED THAT CAN BE

GIVEN TO THE APPLE IF IT IS

NOT TO TOUCH THE CEILING?"

I DON'T KNOW ANYBODY WHO TALKS

LIKE THAT, BUT THIS IS A

PROBLEM THAT MY STUDENTS HAVE

TO SOLVE.

LET'S SHOW YOU THE

INTERACTIVITY SICS WAY...

OKAY.

HE'S GOING TO TOSS THAT APPLE.

THERE GOES.

IT HIT THE CEILING, DIDN'T IT?

IT'S NOT SUPPOSED TO.

SO WHAT CAN WE DO?

LET'S ERASE THE TRACK AND

LET'S REDUCE THE SPEED.

WE CAN CONTROL THE SPEED OF

THAT APPLE... WHOOPS.

WHAT HAPPENED?

WELL, ZERO, THAT'S NOT GOING

TO BE VERY GOOD, IS IT?

SOMEBODY OVER HERE SAID SET IT

TO NEGATIVE.

I HAD THAT OPTION.

BUT YOU COULD DO THAT, BUT HE

THREW IT AT THE FLOOR INSTEAD.

HOVER, THAT DOESN'T REALLY FIT

THE PROBLEM.

WHAT DOES THIS LOOK LIKE?

IT LOOKS LIKE WE'VE GOT A

PROBLEM HERE.

DO YOU KNOW WHAT IT IS?

THE FACT THAT WE CAN ALSO

ADJUST THE GRAVITY.

THIS ISN'T HAPPENING ON EARTH.

THIS IS HAPPENING ON THE MOON.

LET ME SHOW YOU HOW THAT

WORKS.

AND THIS I COULD NEVER DO IN A

LAB.

OH, ALL RIGHT.

RESET.

I'LL PUT THIS DOWN HERE, AND

LET'S CHANGE THE GRAVITY.

SEE, WE HAVE IT SET ON MOON

GRAVITY.

THAT WAS OUR WHOLE PROBLEM.

LETS PUT IT UP ON THE EARTH.

OKEYDOKE.

NOW, IF WE THROW 3.75 METERS

PER SECOND, IT DOESN'T GO VERY

HIGH AT ALL.

WHAT DO WE NEED TO DO?

WELL, WE CAN KEEP ADJUSTING

THAT SPEED UNTIL WE FIND OUT

THAT IT'S ABOUT 8 METERS PER

SECOND THAT WE THROW IT AT AND

THE APPLE WILL JUST MISS THE

CEILING.

THERE'S A LOT MORE WE CAN DO

WITH THIS.

LET ME SHOW YOU.

I HAVE ALL KINDS OF LITTLE

GOODIES HIDDEN HERE, NOT ONLY

GRAVITY, BUT... THE INITIAL

VELOCITY WE CAN SEE.

THERE'S THE BALL, ABOVE THE

FLOOR.

WE CAN ACTUALLY MEASURE IT,

SEE HOW HIGH IT'S GOING FOR

VARIOUS VELOCITIES AND

DIFFERENT GRAVITIES.

WHAT ELSE CAN WE DO?

WE CAN SEE A GRAPH OF THE

VELOCITY.

HOW DOES THE APPLE'S VELOCITY

CHANGE OVER TIME?

WELL, WE CAN SEE THAT WITH A

GROOVE.

I THINK THAT MAY BE ALL I HAVE

IN THIS ONE.

BUT THINK OF THE DIFFERENT

QUESTIONS YOU CAN BRING OUT OF

YOUR STUDENTS.

IT SEEMS TO ME THAT THERE'S

SOMETHING HERE.

I CAN'T IMAGINE WHAT IT IS...

LET ME SEE.

I THOUGHT I HAD SHOWN YOU

EVERYTHING.

OH!

IT'S A GRAPH OF THE POSITION,

RIGHT.

DUH!

THERE WE GO.

THEY CAN SEE WHAT HAPPENS TO

THE POSITION VERSUS TIME

GRAPHS WHEN THE APPLE HITS THE

CEILING AND BOUNCES BACK DOWN

OR WHEN IT MISSES THE CEILING,

WE CAN SET THE GRAVITY FROM

THE MOON TO JUPITER; WE CAN

SET IT TO NO GRAVITY AT ALL.

WE HAVE A LOT OF RESOURCES

HERE.

HOW AM I DOING ON TIME?

BOBBY, DO YOU KNOW WHAT TIME

IT IS?

2:15.

OKAY.

OF COURSE I PREPARED FAR MORE

THAN I CAN EVER SHOW YOU RIGHT

NOW.

I MUST HAVE 25 OF THESE TO

SHOW YOU.

IT'S NOT GOING TO HAPPEN.

OKAY.

SO JUMPING-OFF POINTS: YOU

CAN START WITH THE PROBLEM AND

THEN SAY, "WHAT HAPPENS IF WE

DO THIS?

WHAT HAPPENS IF WE DO THAT?

WHAT IF WE INCREASE THE SPEED?

WHAT IF WE LOWER THE GRAVITY?"

WE CAN CHANGE THE HEIGHT OF

THE CEILING, THE STARTING

POSITION OF THE APPLE.

WE CAN DO ALL KINDS OF THINGS,

AND WE CAN ACTUALLY DO IT AND

SEE WHAT HAPPENS.

YOU CAN DO IT WITH REAL

EQUIPMENT, TOO, BUT SOMETIMES

IT'S NOT AS EASY, ESPECIALLY

NOT AS EASY TO GENERATE GRAPHS

ON THE FRY, OF POSITION,

VELOCITY, ACCELERATION WE CAN

GRAPH ALMOST ANYTHING YOU

MIGHT BE INTERESTED IN.

WHAT'S NEXT?

WE INTRODUCE CONTROLLED LAB

ACTIVITIES INTO EXAMS.

NOW, LET ME SEE...

I'VE LOST MY PLACE IN MY

NOTES.

ALL RIGHT.

I KNOW WHAT I NEED TO DO.

I NEED TO OPEN A BROWSER.

REID, DO I HAVE ACCESS TO THE

'NET FROM HERE?

GOOD.

I DO A LOT OF TESTING ON-LINE,

AND I'LL SHOW YOU WHY.

OH, THIS IS AWFUL.

MY ALLERGIES ARE GETTING TO

ME.

OKAY.

.../COURSES.

THANK YOU.

THE FINAL FROM LAST WINTER.

YOU HAVE TO LOG ME IN, TOO.

ALL LOWERCASE, vickir,

vickir... AND THEN FOR THE

PASSWORD.

I'M GOING TO HAVE TO CHANGE

THAT!

NOW, PART 3... LET'S GO

DOWN...

HERE WE GO.

"WATCH THE THREE MOVIES BELOW.

EACH MOVIE SHOWS A CONTAINER

OF LIQUID.

THE CONTAINERS HAVE SPECIFIC

GRAVITY-- ALL THE LIQUIDS HAVE

A SPECIFIC GRAVITY, 1.3.

THERE ARE THREE DIFFERENT

OBJECTS, AND ONE, TWO...

WHOOPS, TWO...

AND THREE.

SAME LIQUID, THREE DIFFERENT

OBJECTS.

YOU HAVE SOME INFORMATION

ABOUT THE OBJECTS.

THERE'S A WHOLE SERIES OF

QUESTIONS AFTER THAT ABOUT THE

OBJECTS.

BUT INSTEAD OF DESCRIBING TO

YOU, "WELL, OBJECT ONE FLOATS

ABOUT HALFWAY DOWN IN THE

WATER AND OBJECT TWO DROP TOSS

THE BOTTOM AND OBJECT THREE

FLOATS LOWER THAN OBJECT ONE

BUT DOES NOT..."

COME ON!

GET RID OF THE WORDS; SHOW

EVERYBODY!

THIS WAY THE STUDENTS CAN RUN

IT OVER AND OVER AGAIN, AS

MUCH AS THEY WANT.

THEY DON'T EVEN HAVE TO TAKE

EXAMS IN THE CLASSROOM, IF

THEY WANT.

THEY CAN DO IT FROM THE

LIBRARY, FROM HOME IF THAT'S

WHAT YOU WOULD LIKE TO DO.

IT'S NOT EVEN LIKE SETTING UP

A LAB IN FRONT OF THEM AND

SAYING, "WATCH THIS AND ANSWER

QUESTIONS."

YOU CAN MODEL IT HERE.

THIS IS AN EASY ONE, VOLUME

DISPLACEMENT.

EVERYBODY TELL ME WHAT THE

VOLUME OF THE CUBE IS STRAPPED

IN THE JAR.

YOU NOTICE THE WATER LEVEL IS

47 MILLILITERS?

OKAY.

WHAT'S THE VOLUME OF THE CUBE?

6 MILLILITERS.

THIS IS A GIFT PROBLEM.

BUT ANYWAY...

DO THEY UNDERSTAND THE CONCEPT

OF VOLUME DISPLACEMENT?

THIS WILL TELL ME YES OR NO,

THEY GET IT OR THEY DON'T.

WE DO A LOT OF FUN STUFF WITH

THIS PRINCIPLE.

I'LL SHOW YOU THAT ONE LATER.

HOOKE'S LAW...

I'LL GIVE MYSELF A LITTLE MORE

ROOM.

OKAY.

HOOKE'S LAW: WE HAVE A

SPRING; ATTACHED TO BOB...

TELL ME ABOUT THE SPRING

CONSTANCE OF THESE TWO

SPRINGS.

WHICH HAS A GREATER SPRING

CONSTANT?

WHICH HAS A LESSER?

HOW WOULD I HAVE TO CHANGE THE

BOB ON THE LEFT TO MAKE THAT
SPRING STRETCH AS FAR AS THE
SPRING ON THE RIGHT?
HOW MUCH MORE MATH WOULD I
HAVE TO ADD?
THERE'S A WHOLE LOT OF
QUESTIONS YOU CAN ASK ABOUT
THIS.
I'M PROBABLY RUNNING SHORT ON
TIME.
I'VE GOT A WHOLE BUNCH MORE OF
THESE, TOO.
I USED EXAMS-- I USE THIS
CONSTANTLY IN EXAMS BECAUSE IT
DOES OUTPUT QUICKTIME MOVIES,
SO YOU CAN PUT THEM ON THE
WEB.
I USE THEM FOR HOMEWORK
PROBLEMS, FOR EXAMS, FOR
LABS... ALL KINDS OF THINGS.
BUT LET'S GO BACK AND
CONTINUE.

GO AWAY, DOC.

OKAY.

AND NEXT...

OKAY.

MAKE LABS LESS

METHOD-INTENSIVE, ALLOWING

STUDENTS TO GET DOWN TO THE

PHYSICS.

WHAT DOES THIS MEAN?

FIRST OF ALL, A DISCLAIMER.

THESE SIMULATIONS NEVER, EVER

REPLACE ENTIRELY REAL-LIFE,

HANDS-ON EXPERIENCES WITH

EQUIPMENT.

YOU'VE GOT TO LET STUDENTS

HANDLE THE EQUIPMENT, PLAY

WITH IT, DO THINGS WITH IT.

BUT THIS WAY YOU DON'T HAVE TO

WORRY ABOUT THE QUANTITATIVE

ANALYSIS.

YOU CAN BE A LOT FREER IN YOUR

DEMONSTRATIONS.

YOU CAN BE A LOT FREER-- OH,

THANK YOU, PETER!

WHAT A GUY.

ALLERGIES, THEY REALLY ARE...

BEFORE ALLEGRE, I WOULD BE

STANDING UP HERE GOING...

SO IT'S BETTER.

INTERACTIVITY SICS DOES NOT

STAND IN FOR ACTUALLY WORKING

WITH EQUIPMENT, LETTING THE

STUDENTS PLAY WITH IT, LETTING

THEM DO STUFF, BUILD THINGS,

KNOCK THINGS DOWN, SET UP

CIRCUITS.

YOU HAVE TO LET THEM DO THAT.

BUT YOUR PLAY CAN BECOME PLAY

THEN.

YOU CAN GET IN TOUCH WITH THAT

REALLY-- LAST THE WORD I'M

LOOKING FOR THE INQUISITIVE

SIDE OF THEM THAT TRADITIONAL

PHYSICS INSTRUCTION TENDS TO

SUPPRESS.

YOU CAN ASK, "WHAT HAPPENS IF

YOU DO THIS?

WHAT HAPPENS IF YOU DO THAT?"

LET THEM DO A QUALITATIVE

INVESTIGATION FIRST.

WHEN IT COMES TO QUANTITATIVE,

MOVE OVER TO INTERACTIVITY

SICS.

WHY?

WELL, HERE.

LET ME SHOW YOU WHY.

I'M ABOUT TO SHOW YOU A LAB

PAPER FROM THE UNIVERSITY OF

WISCONSIN.

THIS IS AN EXCELLENT LAB.

IT'S USING GRAVITY-- IF YOU

HAVE EVER TAKEN A BASIC LEVEL

PHYSICS COURSE, ESPECIALLY IN

COLLEGE, YOU HAVE SEEN THIS

ONE.

DOES THAT LOOK FAMILIAR?

PULLS A SPARK TAPE THROUGH A

SPARK GENERATOR?

YOU GET A TAPE... WHOOPS.

THEY HAVE LITTLE SPARKS ON IT

AND THEY GET FURTHER AND

FURTHER APART AS THE SPEED OF

THE PROJECTILE GOES UP.

BUT I MEAN REALLY HOW MANY OF

YOU REALLY BELIEVE YOU'RE

GOING TO GIVE THIS TO YOUR

DEAF STUDENTS?

AND HAVE THEM READ IT AND COME

INTO CLASS AND READY TO GO?

SOMEHOW, I DOUBT IT.

SO INSTEAD, LET'S TAKE A LOOK

AT-- YOU KNOW, I DON'T THINK

I'VE GOT-- I DON'T THINK I

OPENED THE RIGHT ONE.

NO, I DIDN'T.

I NEED TO CLOSE THIS...

OF COURSE THE ONE I NEED I

DIDN'T OPEN.

I OPENED ALL THE OTHERS.

ANYBODY SEE ANYTHING THAT

LOOKS LIKE "FREE-FALL"?

YEAH, THERE IT IS.

ALL RIGHT.

FREE-FALL.

ERASE THE TRACK, GET READY TO

GO...

THAT'S FREE-FALL WITH THE WIND

BLOWING.

HOW DO I TURN OFF THE WIND?

WELL, I'VE GOT TO-- WHOOPS.

I'VE GOT A FORCE FIELD HERE.

I CAN SET IT UP TO BE AIR

RESISTANT, ELECTROSTATIC,

REVERSE GRAVITY, WIND...

I HAVE IT SET UP FOR WIND

RIGHT NOW.

HOWEVER, I'M GOING TO TURN IT

OFF.

HOW DO THINGS CHANGE RIGHT

NOW?

NOW, SEE THAT LOOKS LIKE THAT
SPARK TAPE, DOESN'T IT?
IT'S GOT THE BALLS GOING DOWN;
THE DISTANCE BETWEEN THEM
INCREASES AS THE BALL FALLS.
IT SHOWS THE ACCELERATION
QUITE CLEARLY, BUT IT EVEN
SHOWS IT MORE CLEARLY BECAUSE
OVER HERE I'VE GOT GRAPHS: OF
VERTICAL POSITION, VERTICAL
VELOCITY AND VERTICAL
ACCELERATION AND HORIZONTAL
POSITION, VELOCITY AND
ACCELERATION.
I'VE GOT METERS UP AT THE TOP
THAT SHOW THAT SAME
INFORMATION.
THE STUDENTS DON'T GET ALL
BOGGED DOWN IN MAKING
MEASUREMENTS.
THE POINT OF A PHYSICS CLASS
IS NOT TO LEARN HOW TO MAKE

MEASUREMENTS; IT'S TO LEARN
HOW TO USE MEASUREMENTS.
THE KIND OF MEASUREMENTS YOU
WANT THEM TO LEARN TO MAKE, GO
AHEAD AND TEACH THEM.
BUT THE OTHER STUFF THAT GETS
IN THE WAY LIKE THIS DARN
SPARK TAPE EXPERIMENT--
VALUABLE INFORMATION TO BE GOT
FROM THIS EXPERIMENT, BUT THE
STUDENTS GET SO CONFUSED WITH
MEASURING THE DISTANCE BETWEEN
THE DOTS AND FIGURING IT'S A
TENTH OF A SECOND BETWEEN EACH
TWO AND MAKING THEIR GRAPHS
AND THINGS... LET THE MACHINE
DO IT.
THAT'S WHAT COMPUTERS ARE FOR!
THAT WAY YOU CAN TALK ABOUT
WHY IT'S HAPPENING RATHER THAN
WHAT IT LOOKS LIKE AFTER IT
HAPPENS.

OKAY.

THE BENEFITS OF THIS, THE

DIFFICULTIES IN MEASURING ARE

GONE.

YOU DON'T GET SNARLED UP IN

THE METHOD.

I HAVE KIDS TURN IN BEAUTIFUL

LAB REPORTS THAT TELL ME HOW

THEY MADE EACH MEASUREMENT, I

MEAN SIX OR SEVEN PAGES OF

MEASUREMENT WITH NO DISCUSSION

WHATSOEVER ABOUT WHAT WE WERE

TRYING TO INVESTIGATE.

THEY BECAME VERY GOOD

MEASURERS, BUT THEY HAD NO

IDEA WHY THEY WERE DOING THE

MEASUREMENT.

SO I'M TAKING THE MEASUREMENT

OUT, LETTING THE COMPUTER DO

IT, AND WE CAN CONCENTRATE ON

THE PHYSICS.

HOW MUCH TIME DO I HAVE LEFT?

I HAVE TEN MINUTES LEFT.

OOH!

I CAN SHOW YOU SOME MORE

SIMULATIONS.

THIS PIECE OF SOFTWARE IS, I

THINK, A VERY POTENT TOOL.

IT RUNS ON WINDOWS AND ON

MACS.

AN INDIVIDUAL LICENSE JUST FOR

YOURSELF IS ABOUT $250, AROUND

THAT.

I GOT A 20-LICENSE PACKAGE,

REDUCING THE PRICE FOR EACH

INDIVIDUAL ONE HUGELY.

AND YOU CAN GET DISKS FOR YOUR

STUDENTS, DEPENDING ON HOW

MANY YOU ORDER AT A TIME, DOWN

TO ABOUT $40 THAT THE STUDENTS

BUY, AND THEN THEY CAN INSTALL

THEM ON THEIR OWN COMPUTERS

AND YOU CAN GIVE THEM DISKS

WITH SIMULATIONS TO TAKE HOME.

I HAVEN'T GOTTEN TO THAT POINT

YET.

I DELIVER QUICKTIME MOVIES

OVER THE WEB.

BUT I'M THINKING ABOUT IT.

I'M THINKING ABOUT IT.

IT'S A MARVELOUS PIECE OF

SOFTWARE.

I HAVE BEEN USING IT FOR

YEARS.

I LOVE IT.

LET'S TAKE A LOOK AT SOME OF

MY FAVORITE SIMULATIONS.

I'M SORRY I'M GOING OH SO

FAST.

I JUST WANT TO MAKE SURE I CAN

PACK IN AS MUCH AS I CAN

DURING THIS HALF-HOUR.

OKAY.

ONE OF MY VERY, VERY FAVORITES

IS...

ONE THAT ALSO DIDN'T GET

OPENED, OF COURSE.

LET'S LOOK AT THE COCONUT

SHOOT.

HOW MANY OF YOU HAVE DONE

SHOOT THE MONKEY IN PHYSICS

CLASS BEFORE?

YOU HAVE A METAL CAN ATTACHED

BY AN ELECTROMAGNET, SOMEWHERE

UP HIGH IN YOUR ROOM, AND YOU

HAVE A LITTLE BLOW GUN OR

SOMETHING LIKE THAT THAT HAS A

RELAY ON THE END THAT WHEN THE

METAL BALL COMES THROUGH IT,

YOU BLOW IT THROUGH OR YOU USE

COMPRESSED AIR OR MAYBE IT'S

GOT A LITTLE... WHO KNOWS, A

TIN BALL TRIGGER.

BUT WHEN IT GOES THROUGH, IT

CUTS THE CURRENT TO THE

ELECTROMAGNET; THE METAL CAN

FALLS, AND WHAT YOU WANT TO DO

IS AIM THIS LITTLE BLOW GUN IN

SUCH A WAY THAT IT WILL HIT

THE CAN.

NOW, WHERE DO YOU AIM?

YOU KNOW THAT THE INSTANT THE

BULLET EMERGES FROM THIS

LITTLE GUN THAT THE OBJECT IS

GOING TO START TO FALL.

SO WHERE DO YOU AIM?

STUDENTS ALWAYS SAY, "WELL,

THE CAN IS FALLING.

THE BULLET IS GOING TO TRAVEL

IN A STRAIGHT LINE."

HA HA!

BUT THEY THINK THE BULLET IS

GOING TO TRAVEL IN A STRAIGHT

LINE SO YOU HAVE TO AIM BELOW,

RIGHT?

WELL, LET'S SEE.

LET'S PUT THE COCONUT UP IN A

TREE... THAT LOOKS HIGH

ENOUGH.

WHICH TREE DO YOU WANT IT IN?

THAT ONE?

THAT ONE?

THAT ONE?

OKAY.

LET'S RAISE THE GUN...

LET'S GIVE IT SOME SPEED.

RIGHT NOW IF WE SHOOT IT,

NOTHING IS GOING TO HAPPEN.

THAT'S AIMED A LITTLE BELOW,

ISN'T IT?

IT'S AIMED A LITTLE BELOW THE

COCONUT.

OKAY.

LET'S SEE WHAT HAPPENS.

IT MISSED.

WHY?

BECAUSE WE AIMED BELOW THE

COCONUT.

STUDENTS DON'T BELIEVE THAT

THE BULLET FALLS AT THE SAME

RATE THAT THE COCONUT FALLS

BECAUSE IT'S GOING SO FAST

HORIZONTALLY.

THEY THINK SOMEHOW THAT

SUSPENDS THE LAW OF GRAVITY--

THEY DON'T THINK ABOUT IT

ACTUALLY, BUT THEY JUST

ASSUME.

THIS IS THEIR EXPERIENCE OF

THE WORLD, THAT IF YOU SHOOT A

GUN, THE BULLET TRAVELS A VERY

LONG DISTANCE IN A STRAIGHT

LINE, SO THEY THINK.

BUT IT DOESN'T.

IT BEGINS TO FALL AS SOON AS

IT LEAVES THE GUN, AS MUCH

AFFECTED BY VELOCITY AS

ANYTHING ELSE.

I SUPPOSE IT HAS A LOW

TERMINAL VELOCITY BUT WE WON'T

GET INTO THAT.

I COULD SET IT UP FOR HIGH

RESISTANCE, LOW, CHANGE THE

GRAVITY AGAIN... ALL KINDS OF

FUN THINGS.

BUT LET'S RESET THIS.

LET'S RESET THIS AND MOVE THE

GUN UP A LITTLE BIT.

LET'S JUST MAKE THE SPEED

FASTER.

SEE IF THAT DOES THE TRICK.

MAYBE IT JUST NEEDS TO BE

FASTER.

WHAT DO YOU THINK?

OKAY.

LET'S MOVE THE SPEED WAY UP.

HOW DID THAT HAPPEN?

THAT'S NEVER HAPPENED BEFORE.

THAT'S VERY WEIRD!

LET'S RAISE THE ELEVATION OF

THE GUN AND SEE IF THAT DOES

THE TRICK.

DOES THAT LOOK PRETTY GOOD?

DOES IT LOOK LIKE IT'S AIMED

AT THE COCONUT.

LET'S SEE...

TAH-DAH!

THERE IT GOES.

STUDENTS LOVE THIS.

I DON'T BLAME THEM.

I DO, TOO.

ARCHIMEDES' PRINCIPLE IS ONE

THAT HAS BEATEN BETTER

STUDENTS THAN I.

ONE OF MY FAVORITE EXPERIMENTS

IS TO PUT A SCALE, A VESSEL

CONTAINING USUALLY WATER ON

TOP OF THAT, ZERO THAT SCALE.

WE ALLOW A MAP ON A STRING TO

BE LOWERED INTO THE MASS ON A

STRING TO BE LOWERED INTO THE

WATER.

THERE'S ALSO SOMETHING ABOVE

THAT AND YOU CAN SEE SOME OF

THE WEIGHT OF THE MASS BEING

TRANSFERRED TO THE WATER IN

THE VESSEL.

THAT'S THE WHOLE POINT.

WELL, HA, HA, IF YOU THINK
THAT'S REALLY OBVIOUS TO
NOVICE PHYSICS STUDENTS YOU'D
BE REALLY WRONG.
SO I ALWAYS DO THIS IN CLASS.
I LET THEM PLAY WITH IT, BUT
THIS LETS THEM RUN IT OVER AND
OVER AGAIN, AND WE CAN CHANGE
THINGS.
WE CAN CHANGE THE GRAVITY OF
THE FLUID.
WE CAN MAKE IT WATER IF WE
WANT TO.
THERE IT IS, WATER.
WE CAN CHANGE THE MASS OF THE
OBJECT... WHATEVER WE WANT TO
DO.
HERE IS THE SPRING SCALE.
IT SHOWS THE MASS.
HERE IS THE SCALE THAT THE
VESSEL IS SITTING ON AND LET'S
SEE WHAT HAPPENS.

OKAY.

IT'S COMPLETELY SUBMERGED.

THE BUOYANT FORCE ON THIS

OBJECT OBVIOUSLY IS NOT ENOUGH

TO ALLOW THE OBJECT TO FLOAT.

WE CAN SEE THE SUBMERGED

VOLUME OF THE OBJECT.

WE CAN SEE HOW MUCH OF ITS

MASS IS STILL BEING SUPPORTED

BY THE SPRING SCALE.

ON THE TOP, WE CAN SEE HOW

MUCH OF THE MASS IS BEING

SUPPORTED BY THE BUOYANT

FORCE.

OKAY.

LET'S TRY THIS... LET'S CHANGE

IT FROM WATER TO CARBON

TETRACHLORIDE.

YOU ARE NOT GOING TO USE

CARBON TETRACHLORIDE WITH YOUR

STUDENTS, BUT HERE... HEY!

YOU KNOW WHAT THAT'S GOING TO

SHOW...

YOU CAN CHANGE, BY THE WAY,

THE STIFFNESS OF THIS DAMPER.

THIS DAMPER CAN BE ADJUSTED SO

THAT IT WON'T GO UP AND DOWN

FOREVER; IT WILL GO A COUPLE

OF TIMES.

YOU CAN MAKE IT MUCH STIFFER

AND IT WILL STOP MOVING.

BUT OKAY, NOW WE'RE SHOWING

THAT THE ENTIRE WEIGHT OF THAT

MASS IS BEING BORNE BY THE

FLUID.

HOW DO YOU KNOW?

WELL LOOK RIGHT HERE.

IT'S SUPPORTING AN OBJECT THAT

HAS A MASS OF 25 GRAMS-- THIS

IS BAD.

I'M NOT SHOWING WEIGHT.

ONE OF THESE DAYS I'M GOING TO

GET AROUND TO CHANGING THAT.

I HAVEN'T DONE IT YET.

THE SPRING SCALE ON TOP ISN'T

SUPPORTING ANYTHING ANYMORE.

WHY?

BECAUSE THE OBJECT IS

FLOATING.

WHY IS IT FLOATING?

BECAUSE WE INCREASED THE

SPECIFIC GRAVITY.

AND THE SUBMERGED VOLUME OF

THE OBJECT IS 15.62

CENTIMETERS CUBED.

WHAT HAPPENS IF WE MAKE THIS

MUCH, MUCH LIGHTER?

LET'S MAKE THIS A 5-GRAM

OBJECT.

WELL, IT BARELY GOES INTO THE

WATER-- INTO THE FLUID AT ALL.

WHY?

GOOD QUESTION.

WHAT'S THE FIRST QUESTION YOUR

STUDENTS ARE GOING TO ASK?

WHY?

THE FIRST ONE SANK ALL THE WAY

TO THE BOTTOM.

THE OTHER ONE FLOATED BUT

CERTAINLY NOT LIKE THIS.

WHY IS THIS HAPPENING?

WHY ARE THOSE NUMBERS LIKE

THAT?

ONCE YOU'VE GOT THEM SAYING--

(Gasping) -- "WHY DID THAT

HAPPEN?"

YOU'VE GOT THEM.

BUT FIRST YOU HAVE TO GET

THEM.

HOW AM I DOING ON TIME, BOBBY?

TIME FOR QUESTIONS YET?

A FEW MORE MINUTES?

IS THERE ONE MORE I CAN'T LIVE

WITHOUT SHOWING YOU?

LET ME SEE.

THE PHOTO GAME.

OH, I HAVE INCLINED PLANES AND

COLLISIONS, TOO.

SO LITTLE TIME, SO MUCH FUN.

THIS IS AN AIR TRACK.

YOU HAVE ALL PLAYED WITH AIR

TRACKS.

IT'S GOT A GLIDER...

IT'S ACTUALLY MADE FOR A

SCREEN WITH BETTER RESOLUTION

THAN THIS ONE HAS, BUT IT'S

ATTACHED TO A HANGING MASS.

I'M GOING TO GIVE IT A LITTLE

JERK BECAUSE THAT MASS IS

GOING TO COME DOWN ON THE

SURFACE.

IT'S GOING TO KEEP IT FROM

FALLING.

IT'S GOING TO GET THE GLIDER

MOVING, BUT THEN THE GLIDER IS

GOING TO CONTINUE TO MOVE AT A

CONSTANT VELOCITY.

WE DID THIS IN THE LAB WITH AN

AIR TRACK, AND WE HAD

PHOTOGATES THAT TIMED THE

DISTANCE.

WE MOVED THE PHOTOGATES AROUND

AND WE DID THAT WHOLE LAB.

BUT I ACCEPT THEM HOME WITH

THIS ONE BECAUSE WE CAN CHANGE

PHOTOGATE NUMBER 2's POSITION.

WE CAN MOVE IT CLOSER... WE

CAN MOVE IT FURTHER AWAY.

WE CAN CHANGE THE MASS OF

THESE HANGING MASS.

WE CAN GIVE IT A STRONGER TUG

OR A LIGHTER TUG, WHATEVER WE

DECIDE TO DO.

WHEN WE RUN IT... THERE'S THE

TIME.

HERE'S THE.

TO GO 4.5 METERS, IT TOOK 2.30

SECONDS.

TAH-DAH!

THIS ONE IS EASY TO DO IN THE

LAB.

BUT THERE ARE STUDENTS WHO

WILL WANT TO DO IT OVER AGAIN

BECAUSE THEY WANT TO REALLY

PACK IT IN THERE.

YOU CAN MAKE THIS AVAILABLE

ANYWHERE.

AND THEY USE IT!

IT'S 2:39 IF.

I'VE GOT ONE MORE MINUTE.

EVERYBODY KNOWS ABOUT THE

ATWOOD MACHINE.

ONE GOES UP, ONE GOES DOWN.

WITH THIS ONE, WE CAN OF

COURSE CHANGE THE MASSES.

THAT'S NOT SO HARD TO DO IN A

LAB.

WHAT IS HARD TO DO IN A LAB IS

TO ADJUST THE GRAVITY.

WE CAN ADJUST THE GRAVITY...

NOW, IF WE WERE DOING THIS ON

THE MOON, ON JUPITER, IF WE

WERE DOING THIS WITH NO

GRAVITY AT ALL, WHAT WOULD IT

LOOK LIKE?

WHAT'S HARD TO DO IS MEASURE

THE TENSION IN THE STRING

THAT'S CONNECTING THOSE TWO

MASSES.

YOU CAN CALCULATE IT.

YOU CAN CALCULATE IT, AND

THAT'S A NICE PROBLEM TO DO.

AND I WOULD CALCULATE IT.

BUT THEY ALREADY KNOW THE

ANSWER THEY'RE LOOKING FOR, SO

THE CALCULATIONS MAKE MORE

SENSE BECAUSE THEN THEY CAN

GO, "AHA!

IT CAME OUT THE SAME.

ISN'T THAT AMAZING?"

WE HAVE THE POSITIONS EASILY

AVAILABLE HERE.

WE HAVE THE SPEEDS... LET ME

RUN IT.

YOU ALL KNOW WHAT AN ATLAS

MACHINE LOOKS LIKE, NO BIG

DEAL.

I GAVE THEM THE SAME MATH--

THAT WAS PRETTY SMART, WASN'T

IT?

I'M A COLLEGE PROFESSOR.

(Chuckling)

OKAY.

LET'S TRY THAT.

WHAT HAPPENS?

SEE, WHEN IT HITS THE PULLEY

AT THE TOP, IT STARTS SWINGING

AROUND WILDLY.

YOU DON'T WANT THAT GOING ON

IN YOUR LAB BECAUSE YOU KNOW

ONE OF THE STUDENT'S HEADS

WOULD GET IN THE WAY.

THIS WAY, NO DANGER.

WE CAN SEE WHAT'S HAPPEN TO

VELOCITY, CAN MEASURE

ACCELERATION... THIS IS A

WONDERFUL PIECE OF SOFTWARE.

IT MAKES PHYSICS OBVIOUS,

CLEAR, AND MUCH MORE REAL TO
STUDENTS, ESPECIALLY COUPLED
WITH REAL WORLD, REAL LIFE
EQUIPMENT.
CAN'T DO WITHOUT THAT, OKAY?
DON'T GO HOME AND TRY TO USE
THIS INSTEAD OF REAL LAB
EXPERIENCES.
YOU NEED REAL LAB EXPERIENCES,
BUT THIS CAN SURE BE A HELPFUL
ADJUNCT.
ARE THERE ANY QUESTIONS,
COMMENTS OR...
I WAS THAT GOOD?!
ANYBODY WANT TO SEE ANY MORE?
SEE, THIS LADY UP HERE, YOU
CAN BLAME HER.
SHE SAID YES!
OKAY.
LET'S SEE WHAT ELSE DO I HAVE
HERE?
THE BALL AND CAR, THIS IS

ALWAYS FUN.

WE DO THIS IN CLASS.

I SET UP A CHANNEL WITH A BALL

THAT ROLLS DOWN IT.

WHAT'S THAT?

ACCELERATED MOTION.

I HAVE A LITTLE TOY CAR THAT

MOVES ACROSS THE FRONT OF THE

LAB TABLE.

WHAT'S THAT?

THAT'S MORE OR LESS CONSTANT

MOTION.

IT'S THIS LITTLE TOY THAT YOU

BUY AT TOYS R US.

YOU PUSH THE BUTTON AND IT

GOES-- (Making beeping noise)

-- AND TAKES OFF.

SO IF WE ADJUST THE RAMP...

AND THE POINT IS TO COMPARE

THE MOTION, TO SEE IF WE CAN

GET THE BALL AND THE CAR TO

THE END OF THE TABLE AT THE

SAME TIME, FIRST OF ALL, AND

WE END UP GRAPHING THE MOTION

TO SEE WHAT IT LOOKS LIKE.

I CAN MAKE THE COMPUTER GRAPH

IT IF I WANT TO, BUT... LET'S

SEE.

THAT'S A LITTLE HIGH.

LET'S PUT IT DOWN A LITTLE

BIT.

OKAY, LET'S RUN.

WELL, THAT BALL IS CLEARLY

GOING MUCH SLOWER THAN THE CAR

IS.

SO LET'S RESET THIS.

OOPS...

WELL, NOW THE BALL GOT TO THE

END BEFORE THE CAR DID.

BY THE WAY, YOUR STUDENTS WILL

TELL YOU THAT MEANS THE BALL

IS GOING FASTER THAN THE CAR.

IF YOU SAY "AT WHAT POINT IS

IT GOING FASTER THAN THE CAR?"

"WELL, IT GOT THERE FIRST.

THE CAR WAS BEHIND.

IT MUST HAVE BEEN GOING

FASTER."

AND YOU'LL GO, "REALLY?

HOW INTERESTING BECAUSE IT

LOOKS TO ME THAT THE BALL

SPEED STARTED OUT AT ZERO

METERS PER SECOND.

THE CAR SPEED STARTED OUT AT

2.2 METERS PER SECOND.

PRAY TELL IN WHICH UNIVERSE IS

ZERO LARGER THAN 2?"

(Gasping)

"BUT THEN HOW DID IT GET THERE

FIRST?

THEN YOU'VE GOT THEM.

THAT'S A GOOD QUESTION, ISN'T

IT?

HOW DID IT GET THERE FIRST?

NOW YOU'VE GOT THEM HOOKED.

YOU CAN TAKE THE NUMBERS FROM

THIS, GRAPH VELOCITY, GRAPH
POSITION, AND THAT'S WHAT WE
DO.
I USED TO HAVE A VERSION OF
THIS WHERE THE COMPUTER
GENERATED THOSE GRAPHS.
I DECIDED IT WOULD BE A BETTER
EXERCISE FOR THE STUDENTS TO
GRAPH THEM THEMSELVES BECAUSE
THEY CAN SEE WHAT'S GOING ON
HERE.
LET ME SEE IF I HAVE ANYTHING
ELSE.
I HAVE ONE MINUTE LEFT BEFORE
WE HAVE TO BE OUT OF HERE.
COLLISIONS... THIS LOOKS
INTERESTING.
I DON'T REMEMBER THIS.
OH!
I HAVEN'T TAUGHT THIS FOR A
LONG TIME.
WHOOPS.

WE CAN ADJUST THE RED SPHERE'S
VELOCITY; WE CAN ADJUST THE
BLUE SPHERE'S VELOCITY.
AND WE CAN MAKE IT INELASTIC
OR AN ELASTIC COLLISION.
RIGHT NOW, THAT'S A PRETTY
ELASTIC COLLISION.
LET'S SET IT TO ZERO.
THAT SHOULD BE PERFECTLY
INELASTIC.
LET'S SEE WHAT WE'VE GOT.
COOL!
DO YOU KNOW HOW HARD THAT IS
TO DO IN A LAB?
ANYBODY TRIED TO DO THAT WITH
BILLIARD BALLS AND BALLS OF
CLAY?
UH-HUH.
OR TWO BALLS OF CLAY AND TWO
BILLIARD BALLS?
BUT THAT MAKES IT HARD.
AGAIN, YOU'VE GOT THOSE DARN

MEASUREMENTS IN THERE.

IT'S HARD TO MEASURE THAT KIND

OF THING.

THIS WAY, STUDENTS CAN PLAY

WITH IT AS MUCH AS THEY WANT.

THEY CAN MAKE IT VERY ELASTIC.

WE DID THAT ALREADY.

I'VE GOT IT MEASURING KINETIC

ENERGY AND MOMENTUM, TOO, SO

WE CAN SEE THAT MOMENTUM IS

ALWAYS CONSERVED BUT ENERGY

ISN'T ALWAYS.

ENERGY CAN BE WASTED.

INELASTIC OR ELASTIC, ONE

CONSERVES ENERGY AND ONE

DOESN'T.

I COULD FIGURE IT OUT LOOKING

AT THIS, COULDN'T I?

ANY QUESTIONS?

PROBLEMS?

YOU CAN FIND INFORMATION ABOUT

THE SOFTWARE AT... LET ME GET

THIS OPEN AGAIN...

AT HTTP://

WWW.INTERACTIVEPHYSICS.COM.

IS THAT GOING TO OPEN UP FOR

ME?

IT DID.

THERE IT IS...

THEY HAVE A SIMULATION

LIBRARY.

I HAVE NOT FOUND IT USEFUL.

THEIR SIMULATIONS DO NOT

EXCITE ME.

THE ONES YOU HAVE SEEN ARE

ONES I DID MYSELF.

I HAVE LOTS OF FUN DOING THEM.

I CAN SPEND HOURS ON THESE

THINGS.

A GUY NAMED RICHARD VAWTER HAS

A LARGE WEB SITE.

HE'S A PROFESSOR, I THINK IN

OREGON OR WASHINGTON.

WASHINGTON, PERHAPS.

I'M NOT SURE.

HE HAS ALL KINDS OF

SIMULATIONS OUT THERE THAT ARE

FREE FOR DOWNLOAD.

JUST BORROW THEM AND LET HIM

KNOW HOW YOU LIKED THEM.

I'M SURE THERE ARE OTHER

SOURCES.

I LIKE DOING MY OWN, SO I

DON'T BORROW TOO MUCH, BUT...

ANY QUESTIONS, COMMENTS?

>> (Inaudible)

>> YES, YOU CAN.

YOU MEAN HAVE IT AUTOMATICALLY

GO INTO A SPREADSHEET?

THE STUDENTS OFTEN COLLECT IT.

BUT WHAT YOU CAN DO AND I

FORGOT ABOUT THIS?

HOW MANY OF YOU USE

CALCULATOR-BASED LAB, C.B.L.,

OR THE SONIC RANGER KIND OF

THINGS AND YOU CAN TAKE THE

OUTPUT FROM THAT AND TAKE IT

TO INTERACTIVITY SICS AND

MODEL THE THING.

IF YOU HAVE BEEN INVESTIGATING

USING SONIC RANGER, YOU CAN

USE THAT DATA AND IT WILL

MODEL IT FOR YOU, SHOW YOU HOW

THAT WORKED.

SO YOU CAN MODEL EXACTLY

REAL-LIFE THINGS.

IT WILL TAKE ALL KINDS OF

INFORMATION FROM A C.B.L.

I HAD FORGOTTEN ABOUT THAT.

I HADN'T DONE THAT FOR AWHILE.

IT'S A PRETTY FLEXIBLE

PROGRAM.

IF YOU USE A MacINTOSH, THEY

DON'T HAVE IT SET UP FOR

SYSTEM 10 YET, BUT IT RUNS

PRETTY WELL UNDER CLASSIC 9.

I'M WAITING.

THEY BETTER GET IT UP FOR 10.

ANYTHING ELSE?

THANK YOU ALL FOR COMING AND I

HOPE YOU ENJOY THE REST OF THE

SYMPOSIUM.

(Applause)

>> THANK YOU SO MUCH, VICKI.

Close