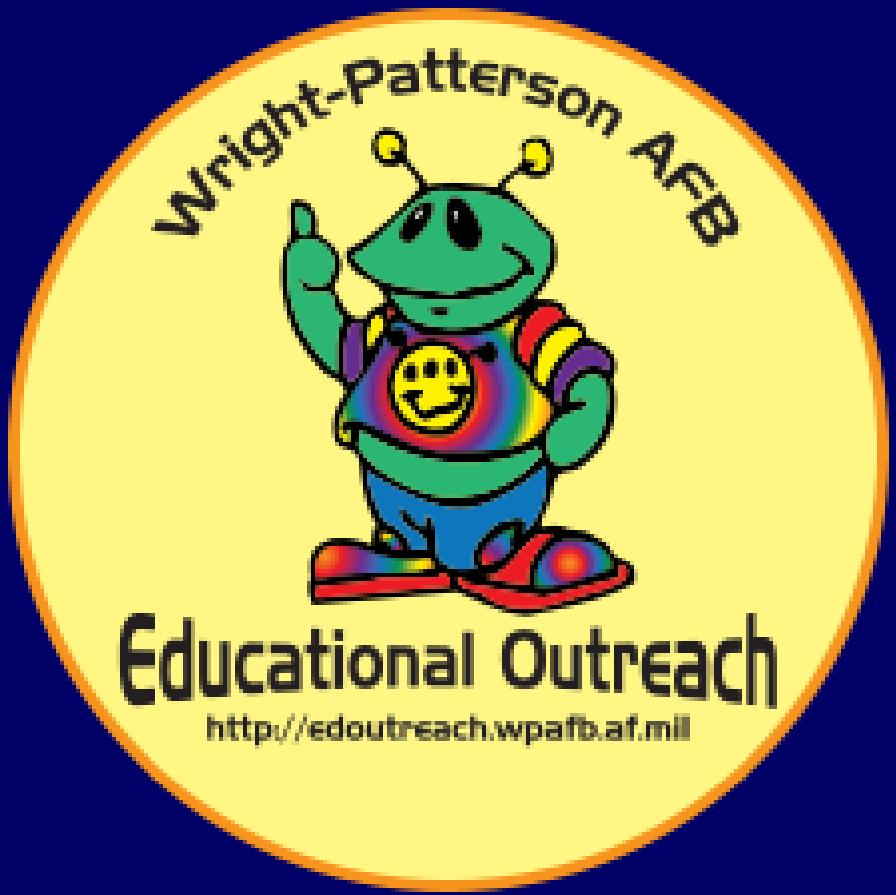
Science & Engineering Fairs:
A Practical Approach



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When Somebody Says "Science Fair" . . .

What's the first thought that pops into your head???

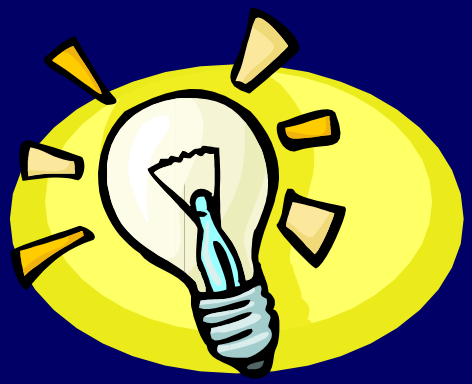
A Science Fair Is…

- More work!
- Required for a grade
- Only for geeks/nerds
- Confusing!!
- Fear of unknown!!!

What should you think?

How you'll feel after the Science Fair:

- I'm proud of myself for doing a great job!
- It was fun to be in charge of my own project.
- I showed Mom and Dad what I can really do.
- Wow - I never realized _____!
- I want to learn more about _____.

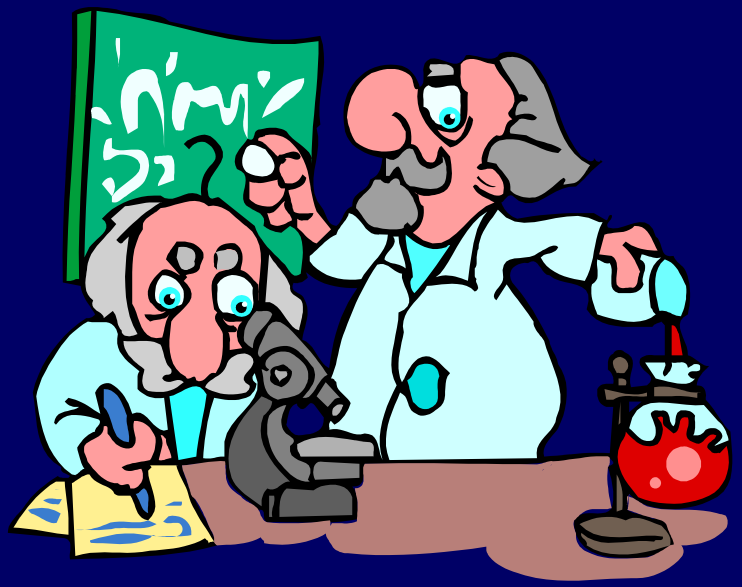


Computers? Cell phones? Rockets to Mars, probes to the ocean floor, GPS systems, X-boxes?

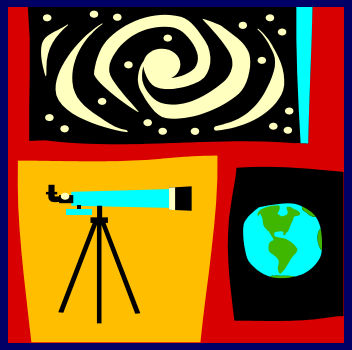
All developed by scientists and engineers.

A Science Fair Project Is An Opportunity

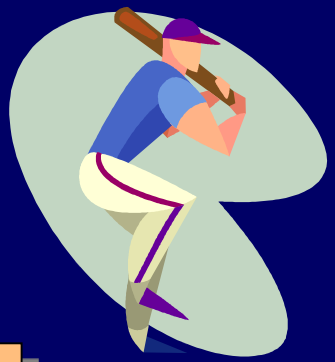
- Explore something YOU are interested in
- Work independently
- Develop valuable skills
- Improve self-confidence
- Meet interesting people
- Sometimes win prizes/money

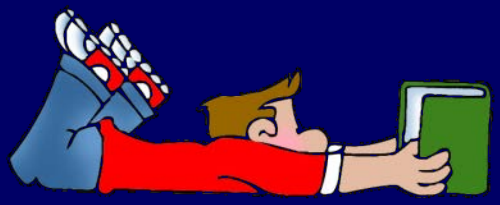


A Science Fair Project Involves Many Subjects



- Science
- Math
- Reading
- English/writing
- Art/design
- Social Studies
- Music/sports/etc.



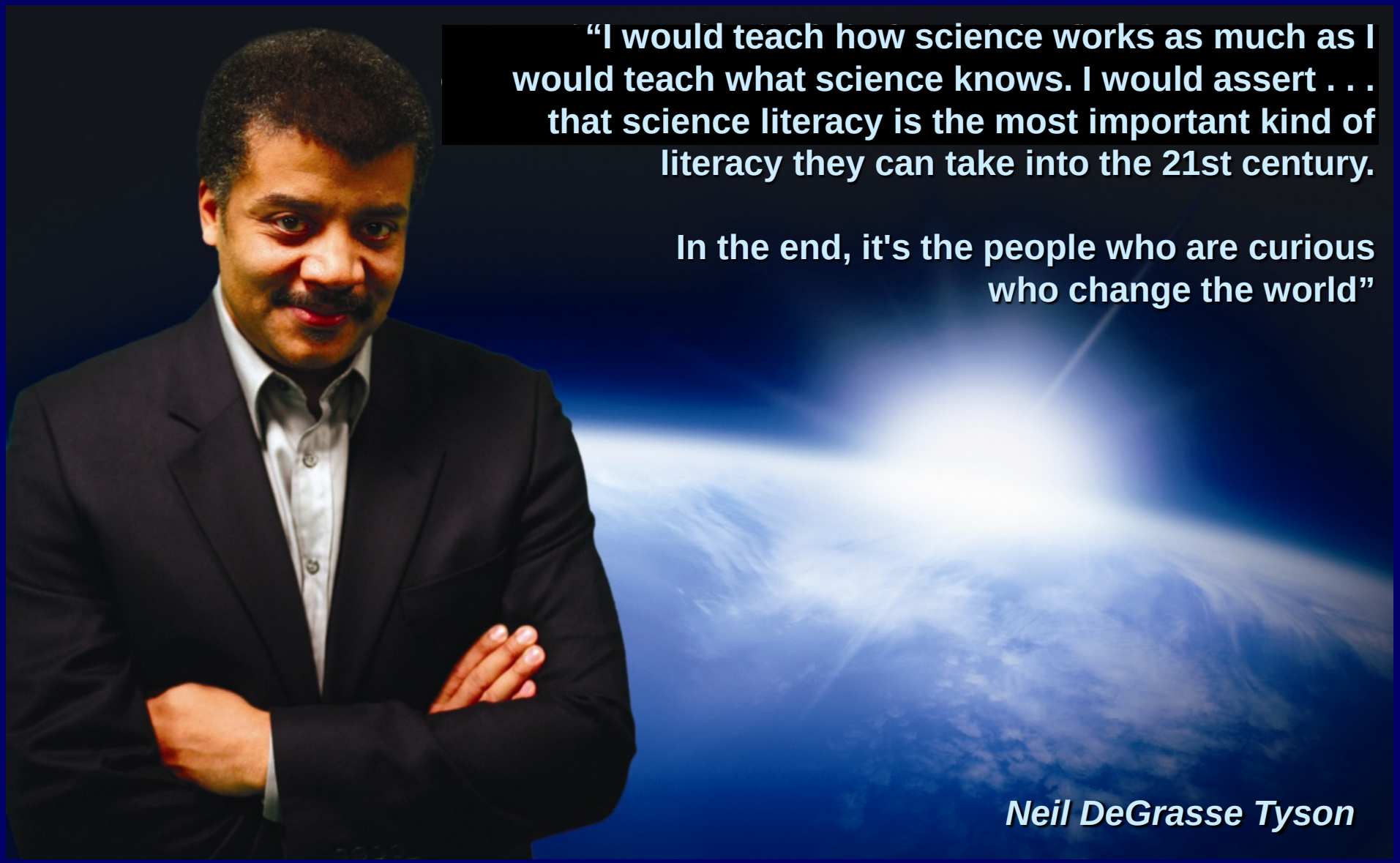


A Science Fair Project Develops Useful Skills

- Using the scientific method
- Critical thinking skills
  - fact vs. opinion
  - logic vs. assumption
- Creative problem solving
- Time and project management
- Communication - writing and speaking
- Wise and efficient use of information
- Confidence, poise and thinking on your feet.

Every human being can benefit from these

Science is a way of finding things out. It's a way of testing what's real. It's what Richard Feynman called "A way of not fooling ourselves."


“I would teach how science works as much as I would teach what science knows. I would assert . . . that science literacy is the most important kind of literacy they can take into the 21st century.
In the end, it's the people who are curious who change the world”
Neil DeGrasse Tyson

The Science Fair Recipe

QUESTION

RESEARCH

HYPOTHESIS

PROCEDURE

EXPERIMENT

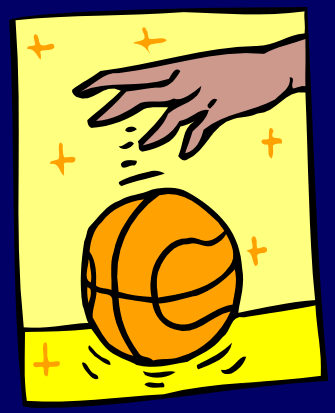
RESULTS

ANALYSIS

CONCLUSION

Scientific Method

Developing a Question



A good science fair topic is:

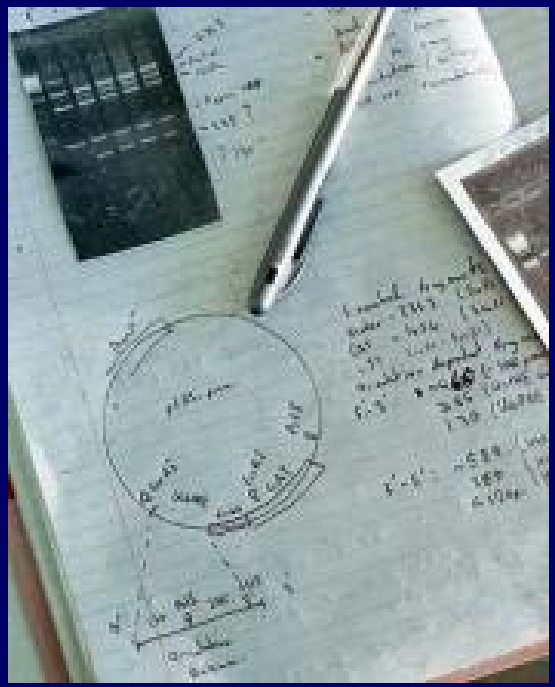
- **Interesting and exciting to you**
- **Manageable for your grade/age**
- **Doable with available resources**
- **Experimental**
- **Measures something quantifiable**
- **Original and creative* (what can you do that is different?)**

** Don't overlook ordinary, everyday activities and phenomena; original needn't be flashy*

STEP #1 - QUESTION

Doing Research

- **Commit to documenting your work**
  - Get a notebook and keep EVERYTHING in it
  - Record everything, even if it seems inconsequential
  - No one ever puts enough detail in their notebook
- **Research your topic**
  - This will help you predict what you think will happen
  - Also helps you design your experiment
- **Internet searches are great… but don't forget books, journals, and people**
  - Record your sources in your notebook
  - List sources in your report
  - Print out articles that are especially useful

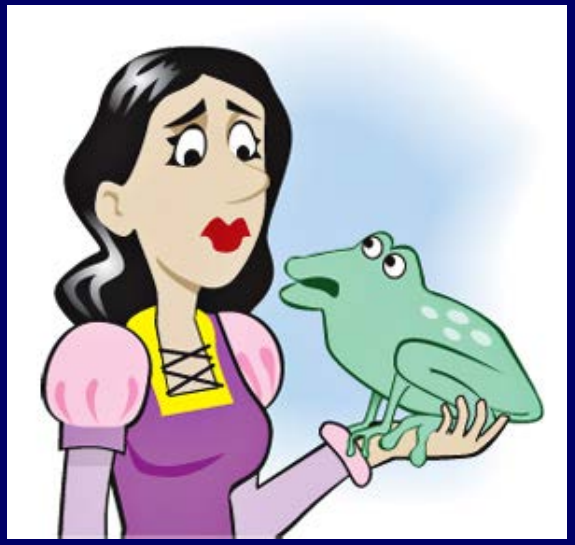


STEP #2 - RESEARCH

Forming a Hypothesis

The hypothesis rewords your question in a way to help you do your experiment

- **It is <u>not</u> a wild or uninformed guess**
- **It <u>should</u> be based upon what you already know about your question**
- **Be prepared to explain it**
- **Engineering projects use a different approach**



STEP #3 - HYPOTHESIS

Procedure/Experiment – Design Is Critical

Measure something that can be quantified

- What are you measuring?
- How will you collect the data?
  - equipment
  - method
- How many data points do you need?
- How many times will you repeat the experiment?
- What is the error/uncertainty in the data?

STEP #4, 5 – PROCEDURE/EXPERIMENT

"It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts."

Sherlock Holmes in
Arthur Conan Doyle's
A Scandal in Bohemia (1891)

Getting Results

- The better you prepare, the more straightfoward the test
- Follow your procedure carefully and consistently
- Record everything – even failures
  - Record all experimental conditions
  - Record observations like noises/smells
  - Take pictures of test setup
- Document anything that might have an impact (someone opened an outside door and let cold air in)

STEP #6 - RESULTS

Analysis – one step at a time

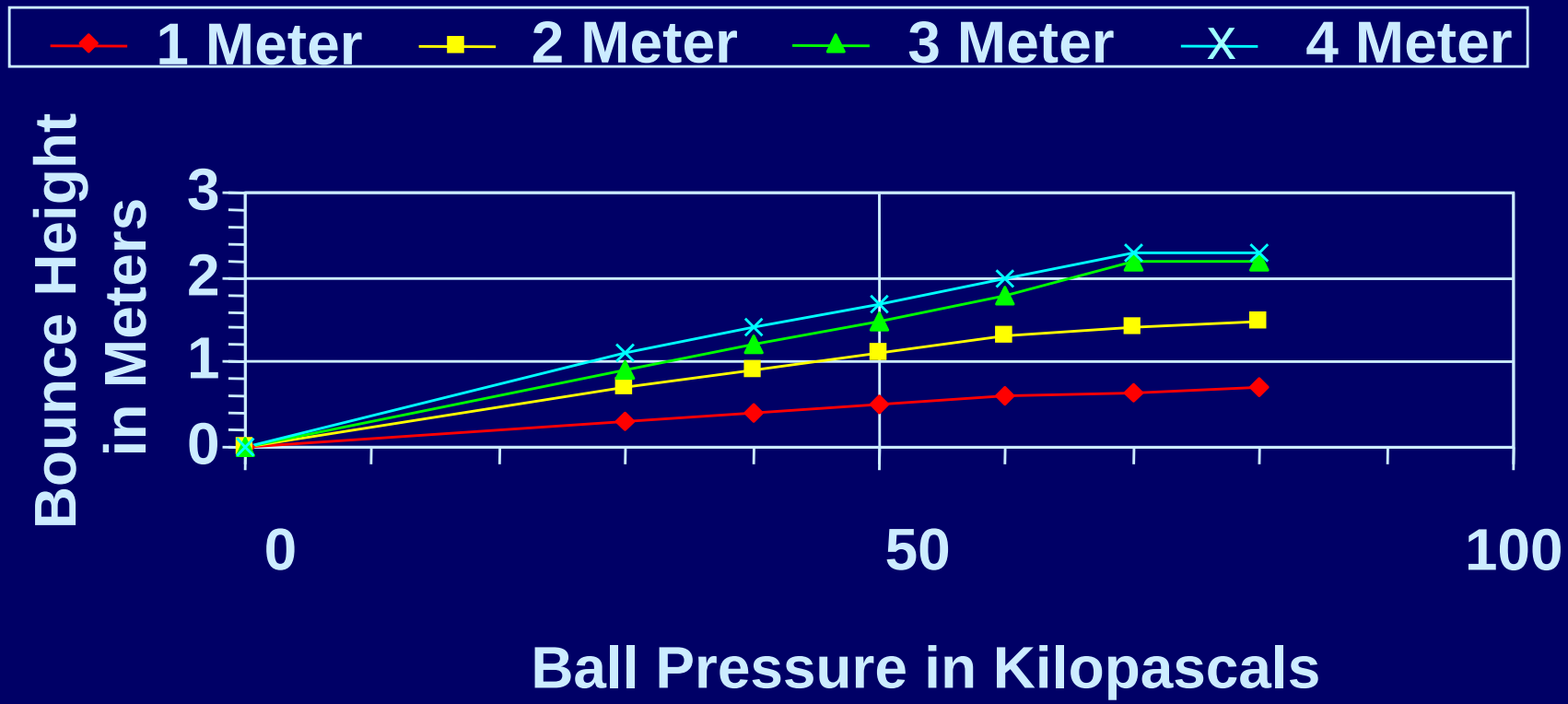
Start by plotting your data

- Is the plot linear? What are the slope, intercepts, max and min values? What do these mean?
- How do plots of different runs compare?
- Plot the same data different ways to highlight different observations
- Use statistics if helpful to combine data
- Spreadsheets are powerful tools - but make sure you know how to plot data by hand first!!!

STEP #7 - ANALYSIS

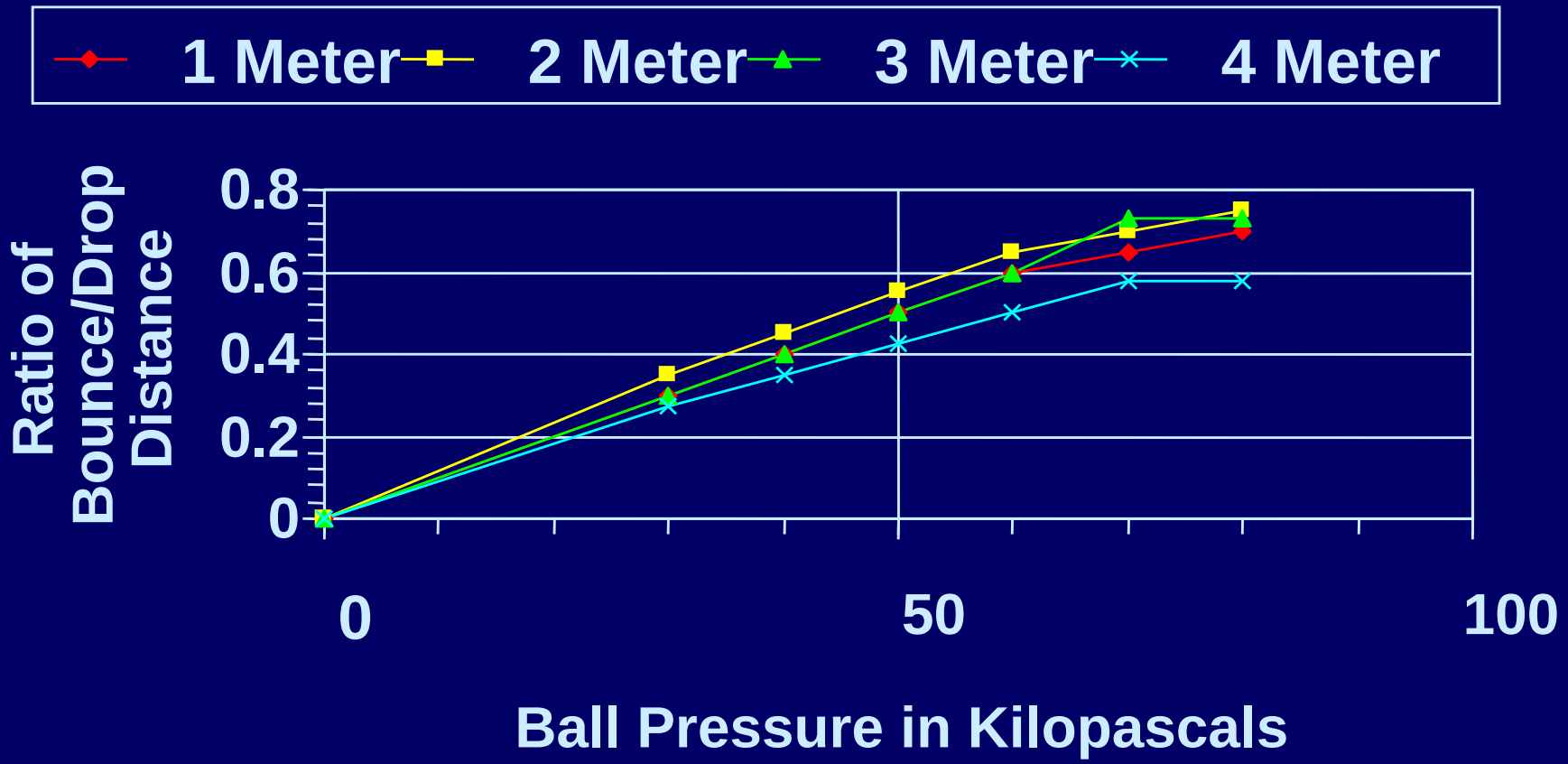
Example 1 - obvious

Bounce height for various basketball pressures and drop heights



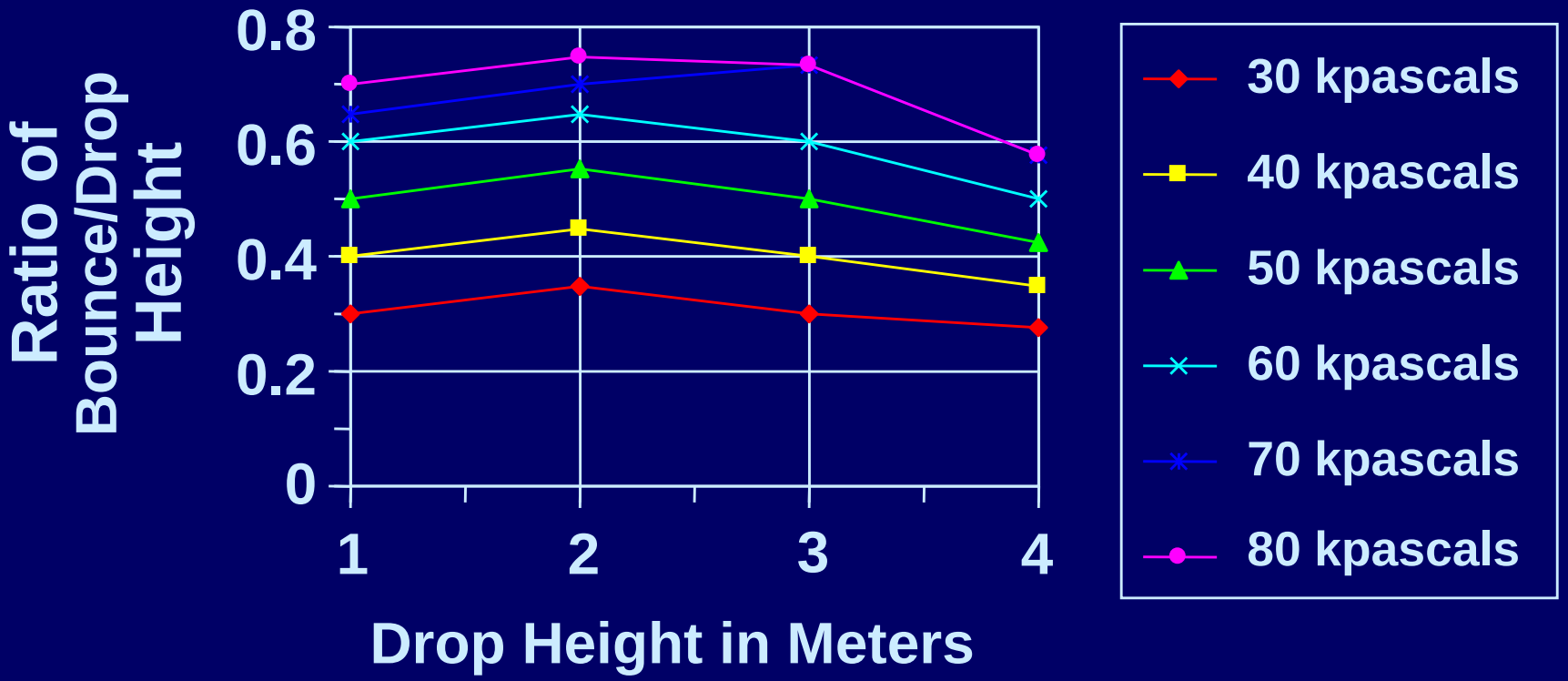
Example 2

Bounce ratio vs. ball pressure for various drop heights



Example 3

Bounce ratio vs. drop height for various ball pressures



Conclusions

- Don’t just repeat yourself
- Summarize key points from your results
  - How accurate are they?
  - What is their meaning or significance?
- Focus on answering your question/hypothesis
  - Your project is not a failure if your hypothesis was wrong
  - If your hypothesis is disproven, offer an explanation
  - Now that you have an answer, what is it good for?
- How might you do things differently, or expand upon your results? Suggest future tests, or related projects

Avoid Common Mistakes

- Sample size too small – need more trials
- More than 1 uncontrolled variable at a time
- Nothing readily quantifiable in project
- Scope too broad - can't cover parameter space with time, resources available
- Scope too narrow/project too simple
- Plots not labelled right, not explained, wrong type, too many
- Conclusions not explained
- Display contains errors or is too flashy

How is Science Done in the Real World?

- No one is the lone ranger
  - Everyone has help: colleagues, mentors, technicians, etc.
  - Crediting the work of others is essential
- No idea is entirely original
  - Everything builds upon what came before
  - Much valuable research is incremental
- We can't always formulate a specific hypothesis
- Experiments rarely work the first time
- "Failures" really can be valuable
- Communication is as important as results

Did We Mention "Having Fun"? :

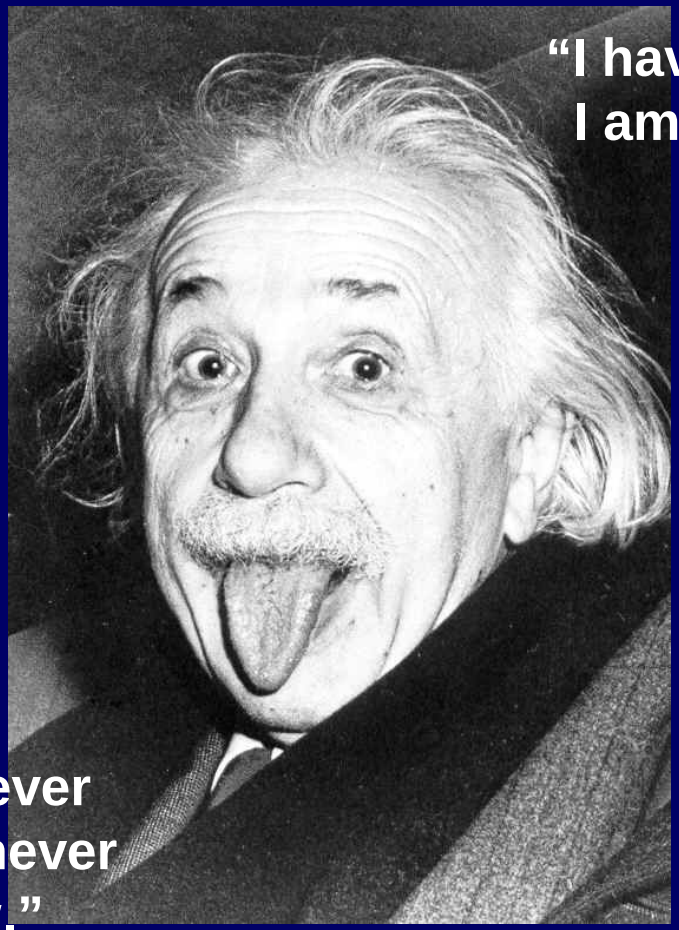
- People throughout history have experimented with science and engineering "for fun"
- Imagine getting paid for doing something you enjoy doing
- To avoid stress: start your project early, be ready… then kick back and enjoy

“It's not that I'm so smart, it's just that I stay with problems longer.”

“I have no special talent. I am only passionately curious.”

“Anyone who has never made a mistake has never tried anything new.”

“It's not that I'm so smart, it's just that I stay with problems longer.”



“I have no special talent. I am only passionately curious.”

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Making the Most of Mentors (including parents):

- Find mentors with ability, expertise to meet your needs
  - relatives, neighbors, friends
  - teachers, coaches
  - internet contacts (ask your parents first)
- Be respectful of their time
- Be prepared with specific questions
- Listen to them!
- Arrange to meet again; ask for more leads
- Thank and acknowledge them

Scientists and engineers enjoy sharing what they love with young people . . . like YOU!

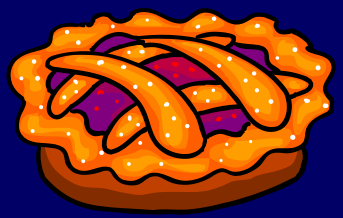
Prepare For Presentation

- Prepare and practice your presentation
  - Follow the scientific method outline
  - Explain what you did and why, what you saw, and what it means
  - Identify what is original about your project
  - Use your poster as a cheat sheet
  - Practice on friends, parents, etc.
- Anticipate likely questions
  - Research the answers
  - Make note cards as reminders
  - Practice/memorize them

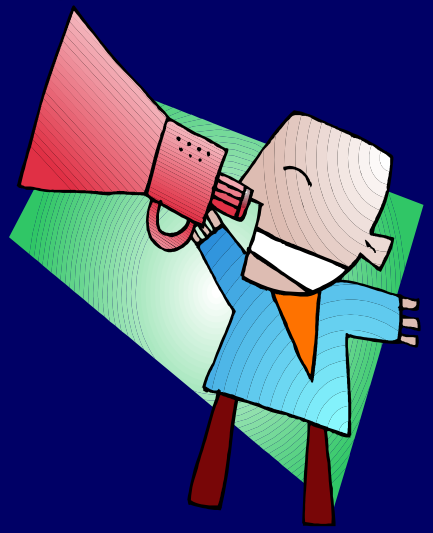
Typical Questions

- Where did the idea for this project come from?
- What did you learn from your research?
- What were the most important sources used in your research?
- How much time did you spend on the project? What took most of your time?
- Where did items used in your project come from?
- How many times did you run the experiment on each configuration?
- Did you use any statistics such as averaging?
- How constant were conditions during experiments?
- What would you do differently, or in addition?

Selling Yourself – Use PIE!



- Performance – already covered
- Image - impression you give in appearance, actions
  - Help the judges see their history in your future
  - Speak, act, dress like a young professional
  - Show them you enjoy what you are doing; tell stories, share extra things you have learned
  - Ask questions – play to their expertise
- Exposure – grab attention with your display
  - But take note of any rules and restrictions
  - Make sure it is free of errors, typos, etc.



I HOPE TO SEE YOU AT A SCIENCE AND ENGINEERING FAIR!

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