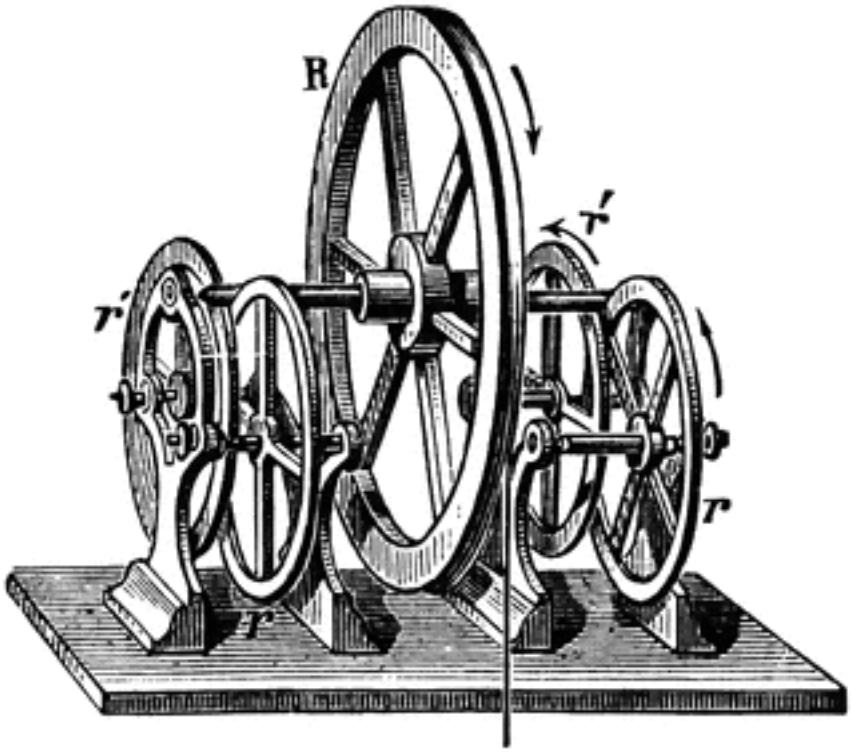
Independent

Physics Final Project

Handbook



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Independent Project Checklist and Timeline

Start NOW!

- ❒ Research topics and choose one
  - On the web
    - Instructibles, Make, YouTube, HyperPhysics, Science Buddies
  - In your textbook
  - In the classroom collection of articles and former student papers
  - Discuss general ideas with your teacher, who may suggest specifics.
  - Explore thoroughly, as your decision is a firm commitment; changes in topic are not permitted.

Due Thurs. 4/6 or before

- ❒ Write your **Project Proposal**
  - Use the doc in Schoology (also shown in this packet)
  - Be specific and detailed
  - Discuss with your teacher if you have questions or need help
  - It is worth 10 points as a 4th Quarter HW assignment

- ❒ START WORKING ON YOUR PROJECT!
  - Background research
  - Gather materials if building
  - Plan experiments, borrow equipment if needed
  - Try out equipment and apparatus
  - Accomplish something before you…

APRIL				17
M	T	W	Th	F
3	4	5	6	7
10	11	12	13	14
Apri	Vac	ati	on	!!
24	25	26	27	28

Due Friday 4/28

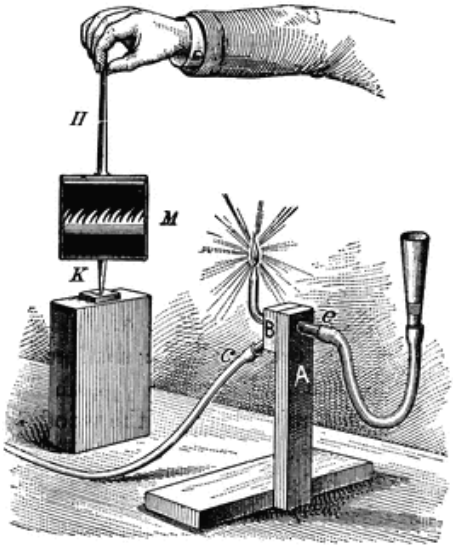
- ❒ Write **Progress Report #1**
  - Use the doc in Schoology.
  - It is worth 5 points as a 4th Quarter HW assignment.
  - The more you get done, the higher your grade!

- ❒ KEEP WORKING ON YOUR PROJECT!
  - If you are building, start assembling your machine or device
  - If you are measuring, start recording data
  - Have a conference with your teacher, if you need help or advice.
  - Start analyzing your data and see if it makes sense.
  - Keep researching and start your paper introduction
  - Get a lot of work done before you…

MAY				
M	T	W	Th	F
1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
X	30	31	1	2

Due Friday 5/12

- ❒ Write **Progress Report #2**
  - Use the doc in Schoology.
  - It is worth 10 points as a 4th Quarter HW assignment.
  - You are expected to have more work done, since the first progress report!



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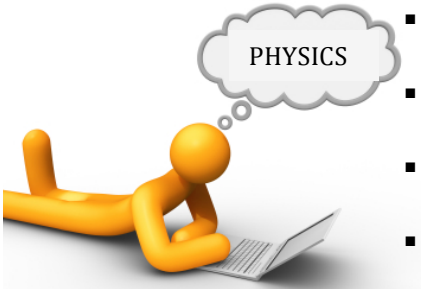
- ❒ GET REALLY SERIOUS ABOUT WORKING ON YOUR PROJECT!
  - Have a conference with your teacher, if you haven't already.
  - Start analyzing your data to see if it makes sense.
  - Fix problems and measure a second set of data.
  - Analyze your data and think about how to display and explain it.
  - Think about extending your project by doing more experiments.
    - Can you vary something else and see what effect this has?
    - Can you compare your results to accepted values in the literature?
    - Can you calculate something two different ways and compare?
    - Did you come across anything surprising that you want to research or investigate with more experiments?



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MAY				
M	T	W	Th	F
1	2	3	4	5
8	9	10	11	12
15	16	17	18	19
22	23	24	25	26
X	30	31	1	2

- ❒ Start writing your **Paper.** Use the template doc in Schoology.
  - See the paper rubric in this packet
    - Use the sections given in the rubric and address everything listed in a thorough, detailed way.
    - Think about what data and results to include and how to explain and summarize them
    - Work on clear and complete sample calculations
    - Edit and revise for clarity and completeness
- ❒ Plan your **Presentation** to the class
  - See the presentation rubric in this packet
    - Use the sections given in the rubric and address everything listed in a thorough, detailed way
    - Think about what data and results to include and how to explain them
    - Produce clear and explanatory visual aids that will teach your class about your topic.
    - Practice your presentation!

Presentations begin on or around Weds. 5/24

JUNE				
M	T	W	Th	F
			1	2
5	6	7	8	9
12	13	14	15	16

- ❒ Finish your **Paper**
  - Check your paper with the rubric in this packet
    - Is every section included and does it address the things listed?
    - Does your introduction provide the background knowledge that another student needs to understand your project?
    - Are your data and results complete, clearly labeled, and explained in text?
    - Does your conclusion address error thoroughly and quantitatively?
  - Proofread your paper
  - TURN IT IN, with Schoology!

Final Papers are Due Friday 6/2

- ❒ **CONGRATULATIONS!** You finished your physics project!

Graduation is Friday 6/9

Independent Physics Project Ideas

The total possible points of your project will depend upon, the **DIFFICULTY** of the physics concepts, the **PROBLEM SOLVING** done, the **DEPTH and BREADTH** of your project, and whether or not you work with a partner.

Mechanics

Physics of Skateboarding
Physics of Baseball, Hockey, etc.
Physics Engines of Video Games
Measuring Rotational Speed of a Top
Acceleration due to Gravity
Range Finder by Parallax
Measuring "G" with Cavendish method
Coefficient of Friction
Bouncing (Coefficient of Restitution)
Simple Harmonic Motion
Coupled Pendulums
Pendulums or Pendulum Wave
Use of Pendulum to Measure "g"
Newton's Cradle
Motor Vehicle Accident Reconstruction
Physics of Bowling
Rotational Inertia /Angular Momentum
Using a Line to Pull Truck from a Ditch
Projectiles with air resistance and wind
Physics of Pitching a Baseball/Softball
Ski Friction vs. temperature and waxes

Solids

Vibrational modes of solid objects
Chladni Plates
Young's Modulus (Stress vs. Strain)

Fluids

Archimedes Principle (buoyancy)
Surface Tension
Viscosity
Stokes Law (fluid friction)
Reynolds # (Turbulent/Laminar Flow)
Poiseuilles Law (Fluid in a Tube)
Bernoulli's Equation (v vs. Pressure)
Lifetime of Droplets on Hot Surfaces
Viscous Drag

Thermodynamics

Mechanical Equivalent of Heat
Determining Specific Heat of Metals
Convection (heat transfer)
Conduction (heat transfer)
Radiation (color vs. heat loss)
Heat of Fusion (melting)
Heat of Vaporization
Perpetual motion machines
Efficiency of human work
Heat Loss from the Human Body
Evaporative cooling

Light and Optics

Thin Film Interference
Index of Refraction of Fluids
Wein's Radiation Law
Parabolic Reflectors
Build a telescope or microscope
Camera Optics
Build & Study a Solar Oven
Physics of Soap Films
Diffraction of a laser pointer
Measuring the speed of light
Emissivity Studies of various materials

Aerodynamics

Air Foils & Lift
Physics of Kites
Rockets and the Rocket Equation
Vehicle aerodynamics

EcoPhysics

Heat storage by phase transitions of oils
Heat transfer in a greenhouse or bioshelter
Testing materials of greenhouse night curtain
Aeration of aquaculture tanks

Waves, Sound, and Music

Doppler Effect (speed vs. pitch)
Physics of the Human Voice
Acoustical Resonance
Speed of Sound in different materials
Vibrations of Metal Plates
Sound Interference
Electric Guitar Effects
Resonance in musical instruments
Sound Resonance of singing in the shower
Sound Control in Auditoriums
Guitar Amplifier
Pipe Organ Physics
Building and testing the Hurdy Gurdy
Physics of string musical instruments
Physics of wind/tubed instruments
Build a model ear that detects sound
Build a PVC pipe instrument

Engineering

Build and characterize a Hero engine
Spring Wound Toy Cars
Building & Physics of an Electric Car
Why Tacoma Narrows Bridge Failed
Design and build a bridge
Arches and Domes in buildings

Modern Physics

Large Hadron Collider
Standard Model of Particle Physics
Special and General Relativity
Time Travel: Is it Possible?
The Big Bang
Medical Physics
(MRI, x-rays, PET, radiation therapy)
Double Pendulum (Chaotic motion)
Cosmic Rays with Cloud Chamber

Electricity and Magnetism

Build a simple Electrical Generator
Magnetic Induction Bike Dynamo
RLC Electrical Circuits
Build a Volt-Ohm Meters
Electrical Transformers
Electrical resistance vs. temperature
Electric Motors
Transistors & Amplification
Water Powered Electrical Generators
Wind Turbine
Make and characterize a speaker
Build & characterize an electromagnet
Helmholtz coils
Building a lifting electromagnet
Magnetizing metal objects
Ferrous metal separator
Lenz's Law jumping disk demo
Aurora Borealis

Some Cross-Disciplinary Topics

Physics of Mobiles (e.g. Calder)
Balancing sculptures
Mechanical sculpture
Plays about physicists
(Copenhagen by Frayn, Life of Galileo by Brecht, The Physicists by Durrenmatt)
The Physics of Weather
Sunspots and Solar "Weather"

Physics Ethics and Economics

Radiation, Nuclear Energy
Environmental ethics/resource distribution
Energy Distribution among the population of the Earth
Spending on "Big Physics" vs. health and human services
Cost/Benefit analysis of space travel

History of Physics

Profile a physicist (Marie Curie, Albert Einstein, Galileo, Newton, Robert Oppenheimer, Lise Meitner)
Recreate a historical physics experiment (Measuring G, Mechanical Equivalent of Heat, Thomson's m/e of electron)
World War II and the development of the atomic bomb

Physics Project Proposal Form

Please complete on Schoology, not on paper. Thank you.

Name(s) _____ Class Period(s) 1 2 3 4 5 6 7

- ❒ Independent Topic _____
- ❒ Catapult Trebuchet (circle one) Large Scale Small Scale (circle one)
- ❒ Amusement Park

⇨ Proposals are due **Thurs. April 6,** or before. *Late proposals receive no credit.*

⇨ Submit ***one*** proposal for the project, if you are working with a partner.

⇨ For catapult, or amusement park, please show that you have read the instructions and understand the project's steps and requirements.

⇨ Explain your project by discussing the following in clear, well-organized, and detailed paragraphs. Please complete this form on Schoology.

Questions to be answered or ideas to be investigated:

_____
_____
_____
_____

In your project will you: measure something build something both

What will you measure?

_____
_____

What tools or apparatus will you use for your measurements or data collection?

_____
_____

Explain how the data will be measured.

_____
_____
_____
_____
_____
_____
_____
_____

Physics Project Proposal Form

Please complete on Schoology, not on paper. Thank you.

What apparatus will you build?
(If you are not building anything, leave this blank)

_____

_____

How do you propose to design, build, use, and test your device or apparatus?
(If you are not building anything, leave this blank)

_____

_____

_____

_____

_____

_____

_____

_____

How will you analyze the data you collect? What theories, equations, or calculations will you use?

_____

_____

_____

_____

_____

_____

_____

_____

Can you compare your results to known values or Hanover High records? Yes No
What are these values or records?

_____

_____

What safety considerations are a part of your project planning?

_____

_____

_____

Is there anything you want to ask your teacher about your topic?

_____

_____

_____

Independent Progress Report #1

Please complete on Schoology, not on paper. Thank you.

Have you done library or on-line research and started a bibliography? Y N
# of references:

Have you decided on exactly what you will measure and how? Y N

Have you gathered materials for your apparatus or experiments? Y N

Have you assembled or built your apparatus or experiment? Y N

Have you done preliminary experiments or tests? Y N

Have you met with any difficulties? Y N

Have you solved these difficulties? Y N
Explain:

Have you recorded any data? Y N

Have you analyzed any of your data? Y N
Describe:

Write a paragraph or two summarizing your work on the project, so far. Include an overview of any measured results you have obtained. **Type this information below.**

Please **write a list** of the things you need to do to complete your project.

Grading Rubric	Grading Scale		
Research Book, online research, started bibliography	**1** Yes, with more than one reference.	**0.5** Started, one reference	**0** No Research
Experimental Design Clear plans for experiments, simulations begun, design of catapult or other device underway.	**1** Yes, great progress!	**0.5** Some progress	**0** No design progress
Experimental Materials Gathered building materials, borrowed equipment from Physics Room	**1** Yes, great progress!	**0.5** Some progress	**0** No progress with materials or equipment
Other Progress Problem set for amusement park, building for catapult or trebuchet, experimenting for independent projects.	**1** Yes, great progress!	**0.5** Some progress	**0** No progress in other areas
Planning Clear and comprehensive list of what needs to be done to complete the project.	**1** Yes, very clear and complete.	**0.5** Clear but not complete	**0** Missing

Total pts: 5

Independent Progress Report #2

Please complete on Schoology, not on paper. Thank you.

Date:

Have you done library or on-line research and started a bibliography? Y N
# of references:

Have you decided on exactly what you will measure and how? Y N

Have you gathered materials for your apparatus or experiments? Y N

Have you assembled or built your apparatus or experiment? Y N

Have you done preliminary experiments or tests? Y N

Have you met with any difficulties? Y N
Have you solved these difficulties? Y N
Explain:

Have you recorded any data? Y N

Have you analyzed any of your data? Y N
Describe:

Have you evaluated your results? Y N

Write a paragraph or two summarizing your work on the project, so far. Include an overview of any measured results you have obtained. **Type this information below.**

Please **write a list** of the things you need to do to complete your project.

Criteria	Grading Scale		
Research Book, online research, started bibliography	**2** Yes, with more than one reference.	**1** Started, one reference	**0** No Research
Experimental Design Clear plans for experiments, simulations begun, design of catapult or other device underway.	**2** Yes, great progress!	**1** Some progress	**0** No design progress
Experimental Materials Gathered building materials, borrowed equipment from Physics Room	**2** Yes, great progress!	**1** Some progress	**0** No progress with materials or equipment
Other Progress Problem set for amusement park, building for catapult or trebuchet, experimenting for independent projects.	**2** Yes, great progress!	**1** Some progress	**0** No progress in other areas
Planning Clear and comprehensive list of what needs to be done to complete the project.	**2** Yes, very clear and complete.	**1** Clear but not complete	**0** Missing

Total pts: 10

Independent Physics Project Presentation Grading

Name(s): Topic:

Class: HP P 1 2 3 4 5 6 7

Introduction • Problem defined, questions posed, goals of project outlined. • Review physics background of project learned in class. • Explains new physics concepts to the audience.		**5**

Materials and Methods
• Details of the experimental design are described and illustrated.
• Diagrams and images make apparatus clear to the viewer.
• Description of decision-making process, including
  • alternatives considered.
  • research methods.
  • reasons for any modification.
		5

Data and Results • Data and results summarized in well-organized tables and clearly-labeled graphs. • Data, results, and calculations clearly described.		**5**

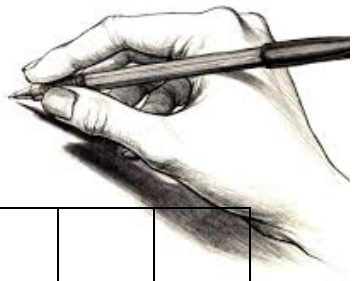
Conclusion
• To what extent were your original questions answered, problems solved, or goals met?
• How did your results compare to expected results or theoretical values?
• Report any new or unexpected conclusions or discoveries.
• Sources of error described and discussed, including
  • type of error and whether random or systematic.
  • calculate or estimate magnitude of error using percent error, if possible.
• Summarize physics concepts learned and illustrated in project.
		5

Visual Aids • Clear. • Engaging. • Beneficial to audience attention and understanding.		**1**
Answers to Audience Questions • Clear, thoughtful, accurate, and complete. • Shows good understanding and knowledge of project topic.		**2**
Overall Clarity • Organized. • Smoothly presented. • Clearly communicated.		**2**
TOTAL Points		**25**

Independent Physics Project Paper Grading

Name(s): Topic:

Class: HP P 1 2 3 4 5 6 7



Introduction • Describes problem, questions, and/or goals of project. • Reviews physics background of the topic learned in physics course. • Explains new physics concepts needed to understand project. • Includes figures, diagrams, or examples as needed for clear explanation.		**10**

Materials and Methods
• Details of the experimental design are described.
• All materials listed. Equipment named correctly.
• Scale diagrams (with dimensions), circuit diagrams, and/or figures make apparatus clear.
• Includes safety precautions.
• Description of decision-making process, including
  • alternatives considered,
  • research methods,
  • reasons for any modification.
		10

Data and Results
• Data and results fully presented in
  • Well-organized tables.
  • Clearly-labeled graphs.
• Sample calculations included.
• All data, results, and calculations described in clear text.
• Final results summarized clearly, in text and table if needed.
		10

Conclusion
• How well were questions answered, problems solved, or goals met?
• Sources of error described and discussed, including
  • Type of error.
  • Random or systematic.
  • Calculated or estimated the magnitude of error using percent error or other method.
• How did results compare to expected results or theoretical values?
• Reported any new or unexpected conclusions or discoveries.
• Summarized how project illustrated physics concepts learned.
		10

Citations and Bibliography • At least 5 sources, cited parenthetically in text of paper. • Clear and complete citations in APA or MLA format. • All images, figures, and photos credited.		**4**
Format • Typed, turned in with Schoology. • Spell Checked. No grammatical errors. • Well organized, readable.		**2**
Understanding of Physics Communicates solid understanding of physics concepts without misconceptions, vagaries, or mistakes.		**4**
TOTAL Points for Paper		**50**

Independent Project Performance Points

Name(s): Topic:

Class: HP P 1 2 3 4 5 6 7

Performance Points = 25 total

	3	3.5	4	4.5	5
Apparatus	Assembled apparatus from lab equipment or performed basic video analysis.	Built apparatus from simple materials, like glue, string, and tape OR used more than one experimental method	Built a more complex apparatus requiring tools, wood, mechanical ability OR rebuilt apparatus from simple materials to improve it.	Built and fine-tuned a more complex apparatus so it worked better.	Beautiful execution of a complex design. Apparatus works reliably and well
Problem Solving	Problem solving of some type required to build the device or complete the project.	Persistent problem solving required to complete project experiments. Everything didn't go smoothly but one set of problems was addressed.	Persistent problem solving required that addressed a second set of problems, resulted in improvement of the device, or experiments with a new method.	Significant degree of repeated problem solving, reiteration, and improvement of initial experiments. >2 problem-solving iterations.	Problem solving above and beyond the expectations for the physics project.
Depth and Breadth	Project includes physics concepts.	Project includes physics concepts from more than one area of physics.	Project used more than one method with a second type of analysis.	Project addressed areas of physics with depth greater than that of the course.	Project went beyond the expectations of the HHS physics project in either depth or breadth.
Level of analysis	Used simple physics with qualitative analysis of results.	Used simple physics with quantitative analysis of results.	Used physics with more involved quantitative analysis of results such as graphical analysis.	Used more complex physics with mathematical analysis of results.	Used concepts, techniques, or mathematics beyond the level of the course and did it well.
Understanding and Difficulty	Project showed understanding of at least one basic physics concept.	Project showed good understanding of more than one physics concept.	Project showed excellent understanding of two or more physics concepts.	Project demonstrated good understanding of more complex physics concepts.	Project demonstrated mastery of complex physics beyond the level of the course.

Project Overall Grade

Name(s): Topic:

Class: HP P 1 2 3 4 5 6 7

Class Presentation (25% of total)		25
Final Paper (50% of total)		50
Performance Points (25% of total)		25
Bonus for working without a partner		+5
Deductions		
Attendance (-5 per unexcused absence)		
Lateness (-5 per day late for paper)		
Materials left at school (-5 to -10)		
TOTAL		100

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