

Physics FIRST!

POWER
watt (W)

GAMMA /
photon

ENTROPY/
ACTION
J/K

HEAT
CAPACITY or
SPEED of sound
(JK⁻¹)

(m/s)
meter per
second

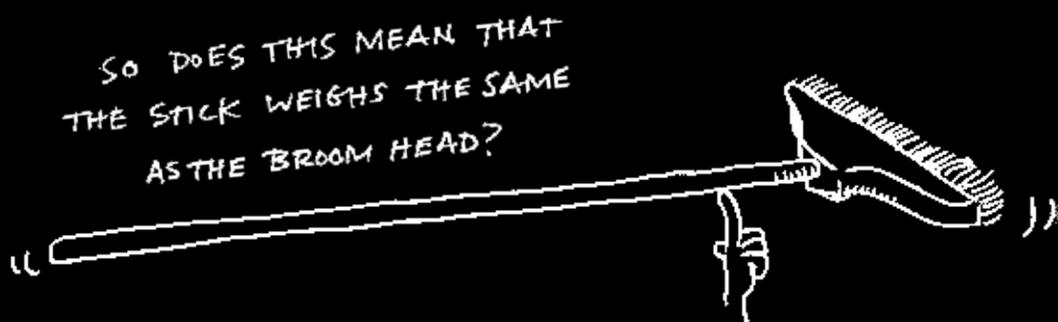
PERIOD
in seconds (s)

PLANCK'S
CONSTANT
joule second
(J_s)

INTENSITY - watt per SQUARE
or imaginary unit meter (W/m²)

SCHOOL'S SCIENCE PROGRAM BUILDS CONFIDENCE, SKILLS THROUGH FRESHMAN-LEVEL PHYSICS / BY MARY CUNNINGHAM

To balance a broom horizontally on your finger, your hand must be very close to the bristled end.



The question sparked a debate in Dr. Mark Pennybacker's freshman Conceptual Physics class this winter. To reveal the answer, Mark and students sawed a broom at the balancing point and placed each piece on a scale. Students discovered that the broom head *did* weigh more and learned that torque, not weight, balances the broom.



BERNARD GRIGGS / PHYSICS TEACHER



PROJECTILE MOTION LAB



DAN STUHLMANN / PHYSICS TEACHER

$$E = \frac{AMA}{W \text{ in}}$$

$$G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

$$\bar{a} = \frac{\Delta v}{t}$$

At Visitation, this scene is common. On a near-daily basis, freshmen are getting their hands on and wrapping their brains around complex physics concepts, and all the while, they're building a formidable foundation in the sciences.

In most high schools across the country, biology is the first science students encounter, often as freshmen. Conversely, physics is an upperclassman course, traditionally considered too advanced for the first year of high school. Since 2005, though, Visitation has been a "Physics First" school, boasting a strong science program that begins with freshman-year physics, then progresses to chemistry and biology.

Physics teacher Bernard Griggs explains that this series simply makes more sense. "In terms of science," he says, "physics is more basic, as it discusses the fundamental laws of nature. Every other science is based on interactions in physics."

He also adds that physics is better suited to younger minds than today's biology. Decades ago, biology classes consisted of memorizing classifications such as species and families; students learned whether a mushroom is a plant or fungi. Now, the subject is very molecularly focused and often requires a microscope to observe. Physics concepts, on the other hand, can often be seen through the naked eye; girls can watch and feel heat, electricity, motion, and magnetism every day, so related lessons can provide a seamless and engaging introduction to high-school sciences.

The Physics First model has been around since the early 1990s. In 2002, the American Association of Physics Teachers adopted a statement of support for Physics First, citing it as a way to "lay the foundation for more advanced high-school courses in chemistry, biology, or physics." In the D. C. area, Our Lady of Good Counsel and the National Cathedral School were both early adopters.

Pre-2005, Visitation's mandatory science program started with biology for sophomores, and the program as a whole was a complicated web of choices with only two science courses required for graduation. The school's two physics teachers in the early 2000s, Tim Smith and Father Jose Medina, saw this system as flawed and recommended Physics First as a stronger alternative. With the school's support, the Science Department recognized that classroom science had evolved, and chose to adapt.

Many parents, teachers, and alumnae who took physics as high-school upperclassmen or in college often worry that physics is too complex for freshmen. But Visitation's science teachers all agree that the subject isn't too hard; it's all about how it's taught.

Bernard explains that the school's freshman-level course is designed "so that everyone can succeed." He admits that since students at this age haven't yet had any advanced math classes, the mathematical side of the subject is probably the most challenging. "So we do things to make sure math is not the barrier," he says. For example, students are given the equations they need for tests and quizzes, and rather than being asked to solve for X, they're asked, "How would you do this?"

The resulting course heavily relies on and sharpens critical-thinking ability. Mark says, "It's different from other subjects because you're not learning a narrative, like English or history, or learning a skill, like math or foreign language. In physics, you're taking a set of assumptions and applying them to a situation. Students can't memorize their way through this class."

While building knowledge and reasoning skills, students are also having a lot of fun through interactive labs—a natural match for the

$$\Delta x = \bar{v}t$$

$$v = at = v_0 + at$$

$$E_f = E_i$$

$$\Delta x = \frac{1}{2}at^2 + v_0t$$

$$E =$$

$$\sum F = ma$$

$$F_c = \frac{mv^2}{r}$$

$$F_G = \frac{GMm}{r^2}$$

$$G = 6.67 \times 10^{-11} \frac{N \cdot m^2}{kg^2}$$

subject matter. To learn about projectile motion, girls launch water balloons across the soccer field. During the free-fall lesson, they drop tennis balls from the Nolan Center catwalk. For acceleration, they push each other in rolling chairs around the tennis courts.

"Tell me, I'll forget. Show me, I'll remember. Involve me, I'll understand," says Bernard. He and his fellow physics teachers agree that students learn and comprehend more when they are engaged in an activity, and the girls are more enthusiastic on lab days. They know that rather than sitting in their seats, they'll be measuring, throwing, timing, and launching—"doing big things that create a lot of noise and dust" and experiencing the excitement of physics for themselves, says physics teacher Dan Stuhlmann.

The advantages of Visitation's Physics First program also stretch beyond the school's physics classrooms.

"The biggest benefit I see is the chemistry background that they're coming to me with," says Science Department Head and

biology teacher Eileen Perkins. Because her students already have a grounding in physics and chemistry, they understand her lessons better. Chemistry teacher Quillian Haralson agrees. Before Physics First, he had to talk on a superficial level about certain concepts or spend whole class periods giving background because

students hadn't yet learned related physics. Now he can stick to teaching chemistry.

Academic Dean Sue Foreman has always supported Physics First. She believes that a girl who only has the option of taking physics as a senior (formerly the norm at Visitation) might be too daunted by the class to enroll, but required freshman-level physics proves that every girl is capable of succeeding.

"We're making a statement that all girls can do well in science. That's why we teach Physics First," says Mark. He's observed that since Visitation moved to Physics First, switching the order of its courses and adding a third required science, more students have enrolled in a fourth year of science. This new model, he thinks, gives girls more opportunities to excel in STEM (science, technology, engineering, and math), and Eileen hears more students considering engineering.

Bernard sees delight and satisfaction in girls upon successfully completing freshman-year physics. And they should be proud; at the end of the year, they can conduct an experiment, think critically, interpret a graph, evaluate evidence, draw a logical conclusion, present a conceptual argument, and have confidence in understanding more of the universe. They are better prepared for future classes—science or otherwise—and can explain concepts they encounter in daily life.

"Do I think Physics First is the way to go?" Dan asks. "I definitely do." Well into its ninth year, Visitation's Physics First experiment is proving to be a great success. //

$$\frac{AMA}{IMA} = \frac{W_{out}}{W_{in}}$$

$$\cos(\theta) = \frac{adj}{hyp}$$

$$F_G = \frac{GMm}{r^2}$$

ARE YOU SMARTER THAN A FRESHMAN?



Physics is all around us—all Visitation freshmen know this. They also know that the subject isn't always easy, but it sure can be interesting.

Here, physics teacher Mark Pennybacker (pictured) shares a few questions that might seem simple but highlight common misconceptions often tackled in the classroom. Put on your thinking caps and see if you can pass the test!

- 1** The entire senior class challenges Mr. Kerns to a tug-of-war. The senior class easily wins. Which side pulled on the rope with more force?
- 2** Which weighs more: a Visi student or the earth?
- 3** The windshield of a van traveling on the highway at 60 miles per hour collides with a bug. Which experiences the greater force, the bug or the van?
- 4** A 1,000-kilogram spaceship is traveling at a constant velocity of 100,000 miles per hour. How much force is needed to maintain its velocity?

HOW'D YOU DO?

- 1 Neither.** They pulled with the same force. The side that wins a tug-of-war doesn't pull harder on the rope; they push harder against the ground. (Which is why you'll always lose a tug-of-war if you wear roller skates.)
- 2 Trick question; they weigh the same.** Weight is equal to the force of gravity. If the earth pulls on you with a force of 120 pounds, then you pull on the earth with a force of 120 pounds according to Newton's Third Law.
- 3 Neither.** They both experience one force. The bug is smashed because it has less mass. The van continues on because it has more mass.
- 4 No force needed;** an object in motion stays in motion according to Newton's First Law.