The 40-watt bulb and the 100-watt bulb are connected in series to the battery. Which bulb will glow brighter?
Wisdom from one of the greatest physics teachers ever
Three Key Themes from Hewitt’s work (and Physics!)

- Good Questions
- Mathematics, Equations and Physics
- Explanations
Good Questions – Thinking

**Next-Time Question**

The 40-watt bulb and the 100-watt bulb are connected in series to the battery. Which bulb will glow brighter?
The 40-watt bulb and the 100-watt bulb are connected in series to the battery. Which bulb will glow brighter?

**Answer:** 40-watt bulb

The 40-watt bulb will glow brighter when connected in series. To understand this you must first understand that the filament in a 40-watt bulb is thinner and therefore of higher resistance than the filament of a 100-watt bulb. It is the higher resistance of the 40-watt bulb that keeps the current to only $\frac{40}{100}$ the current in a 100-watt bulb when both are properly connected in parallel. Then more current flows in the 100-watt bulb and it glows brighter. But when connected in series, the current is less but is the same in each. The same amount of current "squeezing" through the finer filament of the 40-watt bulb heats it more and makes it glow brighter than the lower-resistance 100-watt bulb.
Good Questions are Powerful

These Next-Time Questions are for you!

Supplementary Resources for Conceptual Physics from Paul Hewitt

- Supplementary Lab Activities
- Conceptual Physics Alive! DVD series
- 60 questions Physics Students Should Know
Other good questions - Thinking
TIME REVERSAL

A motion picture film is made of a falling object which shows the object accelerating downwards. Now if the film is run backwards, it will show the object accelerating

a) upward
b) still downward
ANSWER: TIME REVERSAL

Surprise! The answer is: b. If the film is run backwards it will show the object moving up, but its acceleration will still be downward. Run the film backwards in your head. The ball is seen moving upwards initially fast, and then more slowly, just as if you threw it upward. Clearly the upward motion is not increasing so it could not be accelerating upwards. But the speed is changing so it is accelerating, and a decrease of upward speed is a downward acceleration.
EXPANSION OF NOTHING

A metal disc with a hole in it is heated until the iron expands one percent. The diameter of the hole will

a) increase
b) decrease
c) not change
ANSWER: EXPANSION OF NOTHING

The answer is: a. The hole is nothing, but nothing expands, too. There is no way to avoid it. Every dimension of the ring expands in proportion. To visualize the expansion, suppose a photo of the ring were made and the photo was then enlarged one percent. Everything in the photo would be enlarged, even the hole.
14. A bowling ball accidentally falls out of the cargo bay of an airliner as it flies along in a horizontal direction.

As observed by a person standing on the ground and viewing the plane as in the figure below, which of the paths 1–5 would the bowling ball most closely follow after leaving the airplane?
Research-evidence informed progression toolkits...

...to help you develop the big ideas of science.
Applying physics education research to the classroom

In this column James de Winter (University of Uppsala and University of Cambridge) and Richard Brock (King’s College London) highlight accessible and usable resources based on research into physics education.

**Concept inventories**

Concept inventories are research-based assessments that aim to probe conceptual understanding. They usually consist of multiple-choice questions, which have been developed through rigorous scrutiny, much more than is commonly used for questions in textbooks or exams. They are typically used in research as pre- and post-tests when a particular approach or teaching strategy is being evaluated. As they are intended to be used as research instruments, they need to be used cautiously and won't be able to replace “normal” class questions. However, they provide a rich resource for physics education, particularly for teachers who are looking for ways to try to measure the impact of an intervention. They can also provide exemplars of well targeted questions to probe understanding.

**Credentials**

The most well known concept inventory, covering Newtonian mechanics, is the Force Concept Inventory (FCI), which has been taken by over 50,000 students in the US as part of many research projects (Von Korff et al. 2016). Madsen, McKagan and Sayre (2017) have written a useful catalogue of different concept inventories in physics and their degree of research validation.

**More information**

There are more than 60 research-based assessments across all topics in physics available through PhysPort at physport.org/assessments (registration required). Some are aimed at US undergraduates, but many are suitable for secondary-school students.


If you would like to join other physics teachers interested in engaging with the latest research, discussing classroom applications, attending seminars and getting involved with research, email us at PER@IOP.org or join the Physics Education Research (PER) group on Talk Physics at talkphysics.org/groups/physics-education-research-per.
Mathematics, Equations and Physics

The LAWS of PHYSICS are NATURE’S RULES

0.00 – 2.15
The laws of nature

\[ U = \frac{\Delta u}{\Delta t} \]
\[ F t = \Delta m u \]
\[ Q = mc \Delta T \]
\[ \alpha = \frac{\Delta u}{\Delta t} \]
\[ \alpha = \frac{F_{\text{net}}}{m} \]
\[ F = G \frac{m_1 m_2}{r^2} \]
\[ KE = \frac{1}{2} m u^2 \]
\[ PE = m g h \]
\[ r \times F = I = \frac{V}{R} \]
\[ E = hf \]
\[ E = m c^2 \]
\[ W = \Delta KE \]
Mathematical does not mean computational
\[ \frac{F}{M} = a \]

BAM!

\[ \frac{F}{m} = F = A \]
A closing thought from 1982

Why is it common for students to avoid basic physics and instead take biology? Biology is much more complicated than physics. Physics is so simple, in fact, that it’s easily expressed in mathematical form. But that’s the problem for most people; because it can be expressed mathematically, it is. And for most people, mathematics is a foreign language. The reason more students elect biology is because it’s common knowledge that biology is taught qualitatively while physics is taught quantitatively. Physics is easy to teach mathematically, but we make a mistake by then assuming it is easy to learn mathematically.
Explanations

7.00 – 7.35
Explanations
Explanations (with numbers)

\[ F_d = F_d \]

\[ 50 \times 25 = 5000 \times 0.25 \]
Explanations

FREE FALL

\[ a = \frac{\Delta u}{\Delta t} \]
149 Screencasts at http://hewittdrewit.com/

COMPLETE LIST

1. Equilibrium Rule
2. Equilibrium Problems
3. Net Force and Vectors
4. Nellie’s Rope Tension
5. Nellie’s Ropes
6. Force Vector Diagrams
7. Force Vectors on an Incline
8. Linear Motion Definitions
9. Bikes-and-Bee Problem
10. Unit Conversion
11. Velocity Vectors
12. Free Fall
The best book on mechanics that money can buy
A final message from Paul

We learn best from teachers who know their subject well, explain it beautifully, and most of all—who care about us.
Questions

Now or later Jad26@cam.ac.uk