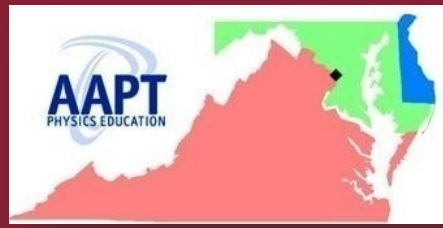
Fostering Critical Thinking Through Cartoon Clicker Questions

Dr. Kausik S Das

Department of Natural Sciences,

University of Maryland Eastern Shore



CSAAPT Fall 2022 Semi-Virtual Meeting
Saturday, October 22, 2022
@ VT/UVA Northern Virginia Center
in Falls Church, VA

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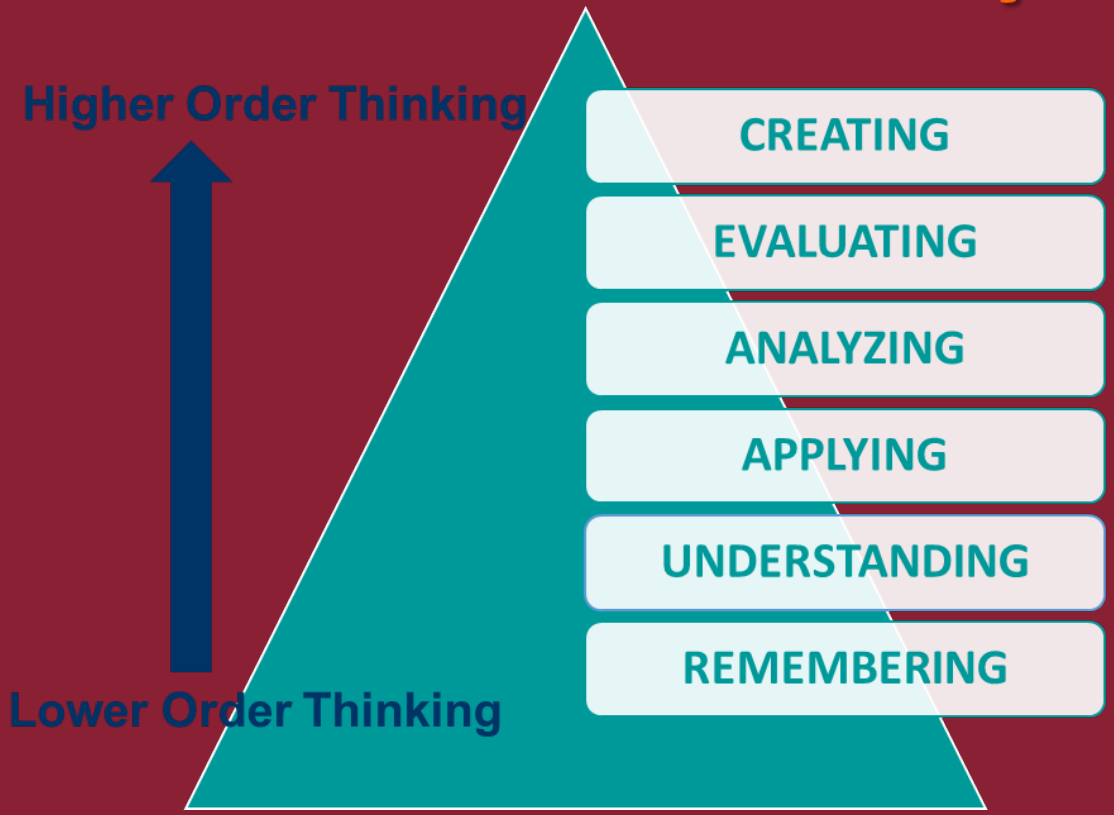
Critical Thinking

Ability to understand, apply, analyze, evaluate facts or principles.

Critical Thinking

Bloom's Taxonomy



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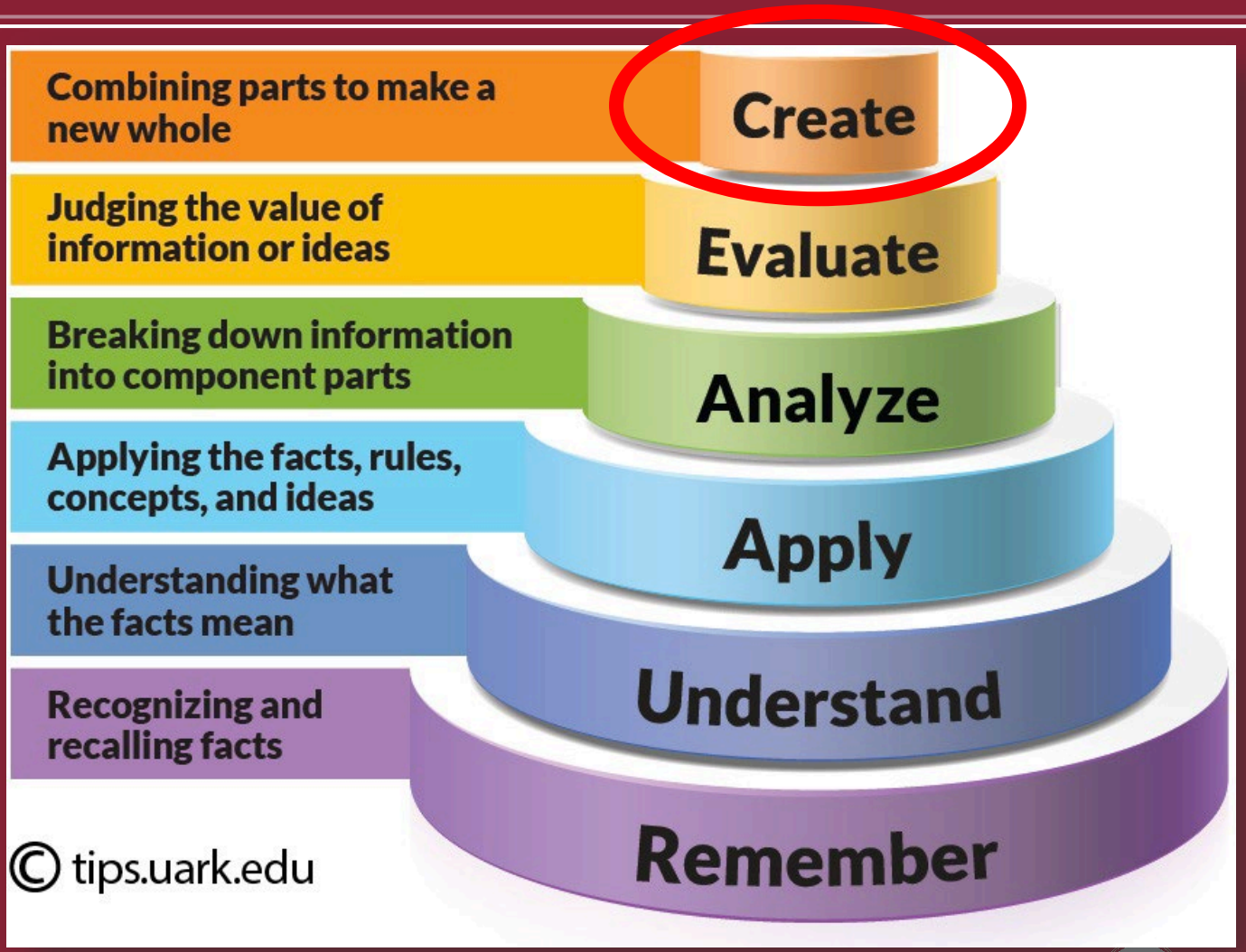

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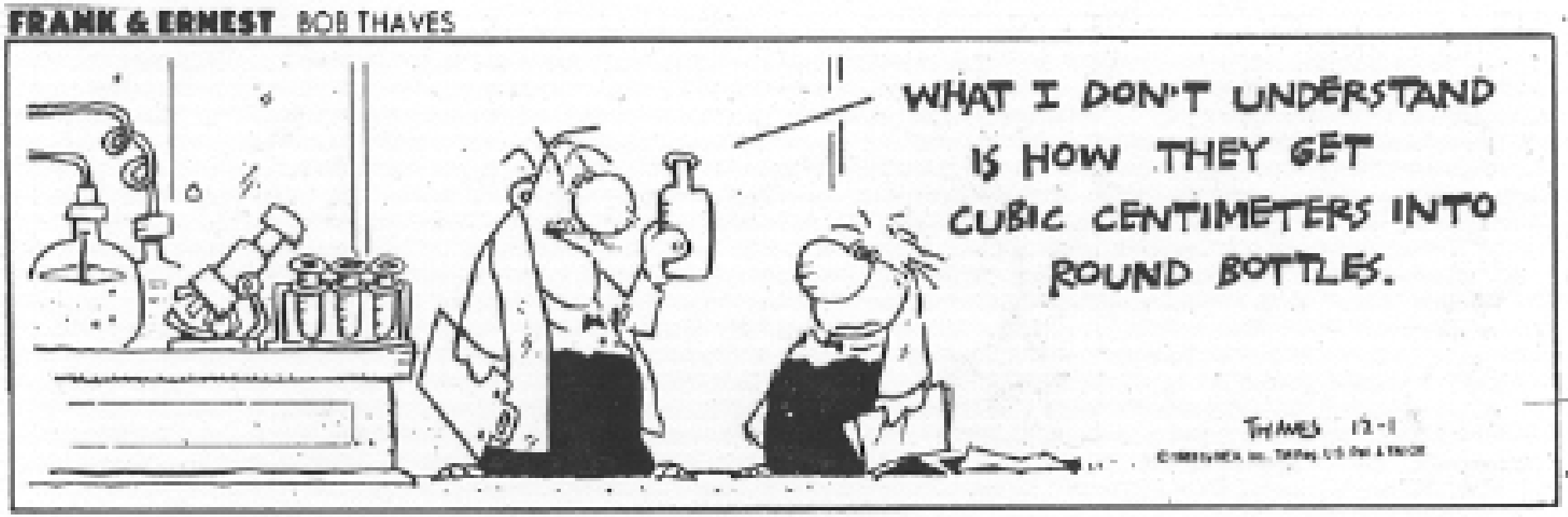
"Intellectual growth" without critical thinking

"*progression from ignorant certainty to intelligent confusion*"

- Kroll



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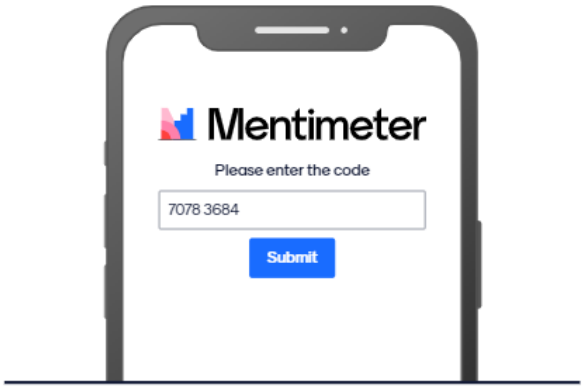

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Steph steadily reels in a fish, which rises with **constant speed.** What is true of the upward **force** exerted by the line on the fish? Ignore friction.

upward speed
is constant

A) It is greater than the downward force of gravity.

B) It is equal to the downward force of gravity.

C) It is less than the downward force of gravity.

D) It is greater than the downward force of gravity plus the downward force due to the air.

E) There is no upward force. The fish rises because the line is getting shorter.

Supported by National Science Foundation Grant # 1719425. Conceived and illustrated by Dr. Kausik S. Das and Larry Gonick Some questions are inspired by Hestenes, Wells, & Wackhamer, *The Physics Teacher*, 1992; 30(3): 141

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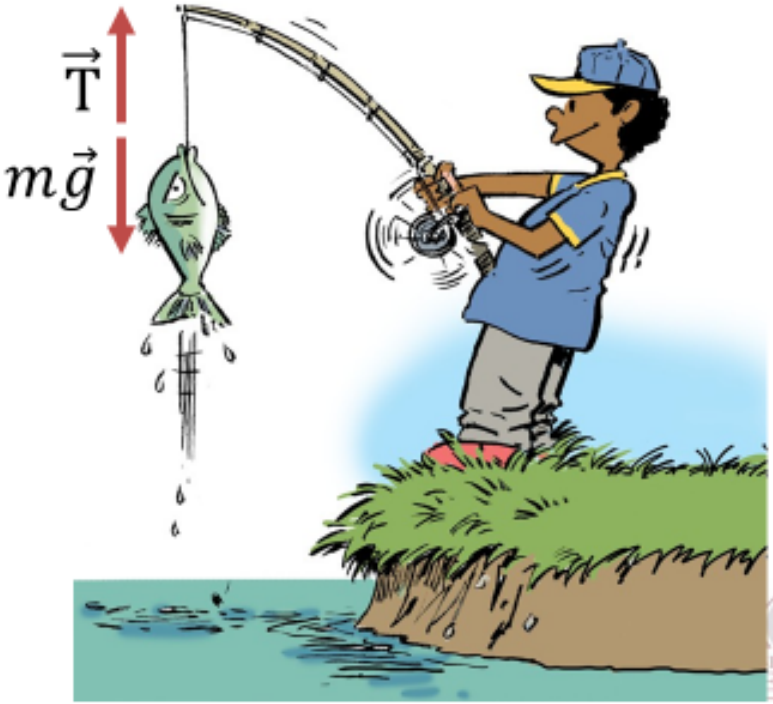
$$\vec{T} - m\vec{g} = m\vec{a} = 0$$



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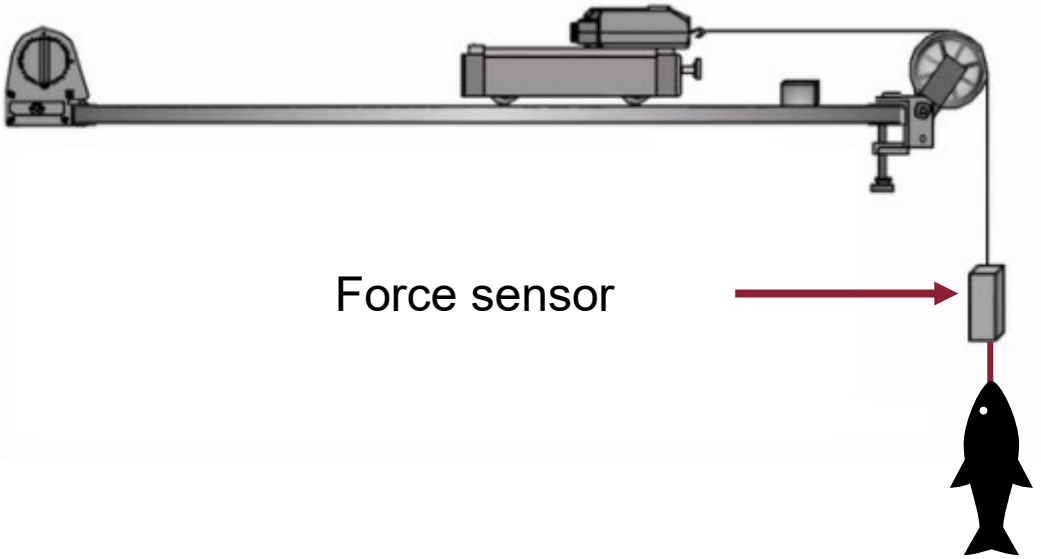
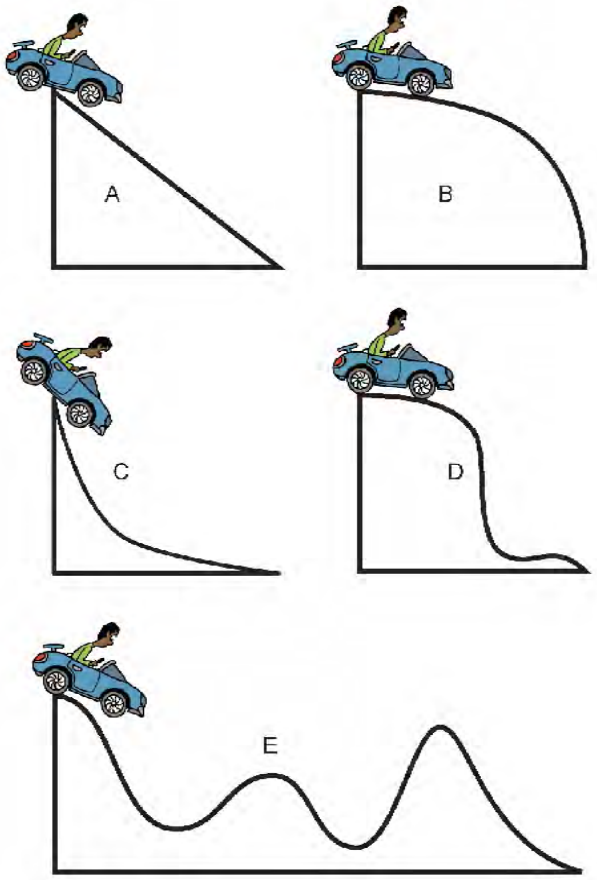
Constant speed



Force sensor



A car, starting at rest, comes down these ramps, which are all the same height. Which car will have the highest speed when it reaches the ground? Ignore friction.

A) A

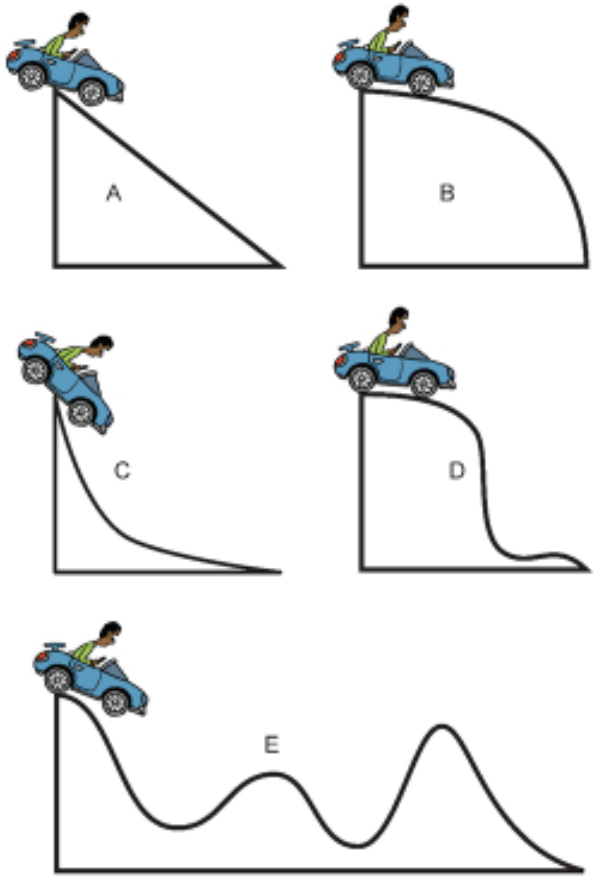
B) B

C) C

D) D

E) E

F) All will have the same speed.



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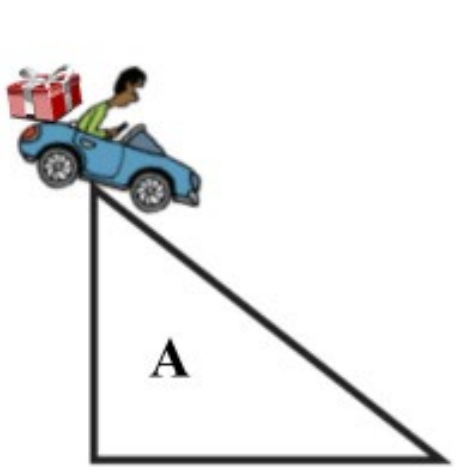
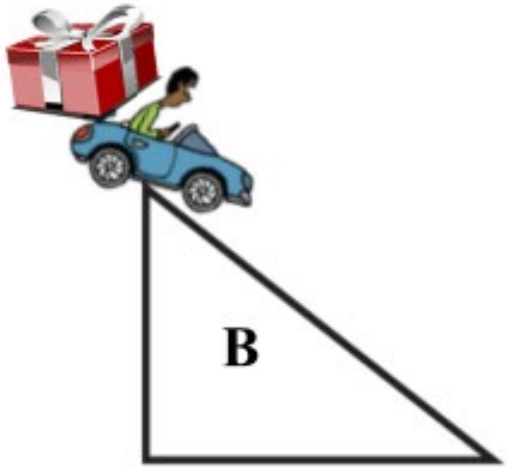
$$\mathrm{ME}_i = \mathrm{ME}_f$$

$$0 + mgh = \frac{1}{2}mv^2 + 0$$

$$v = \sqrt{2gh}$$

Two cars with different masses , both of them starting from rest, roll down these ramps, which are all the same height and same slope. Which car will have the highest speed when they reach the ground?





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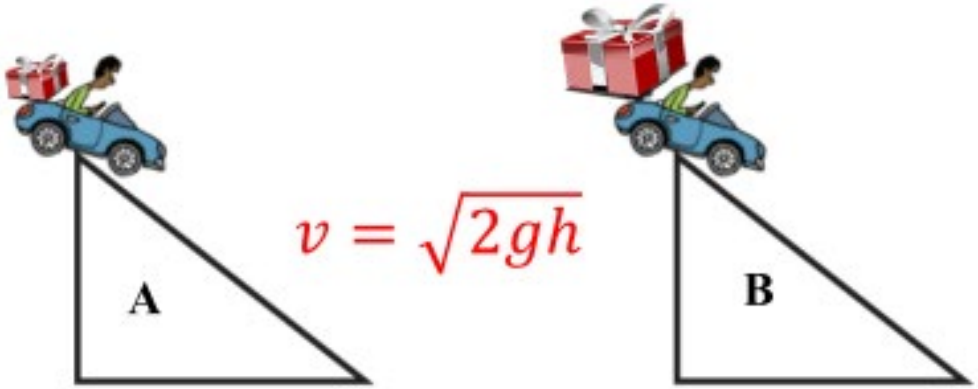


$$v = \sqrt{2gh}$$

A) A

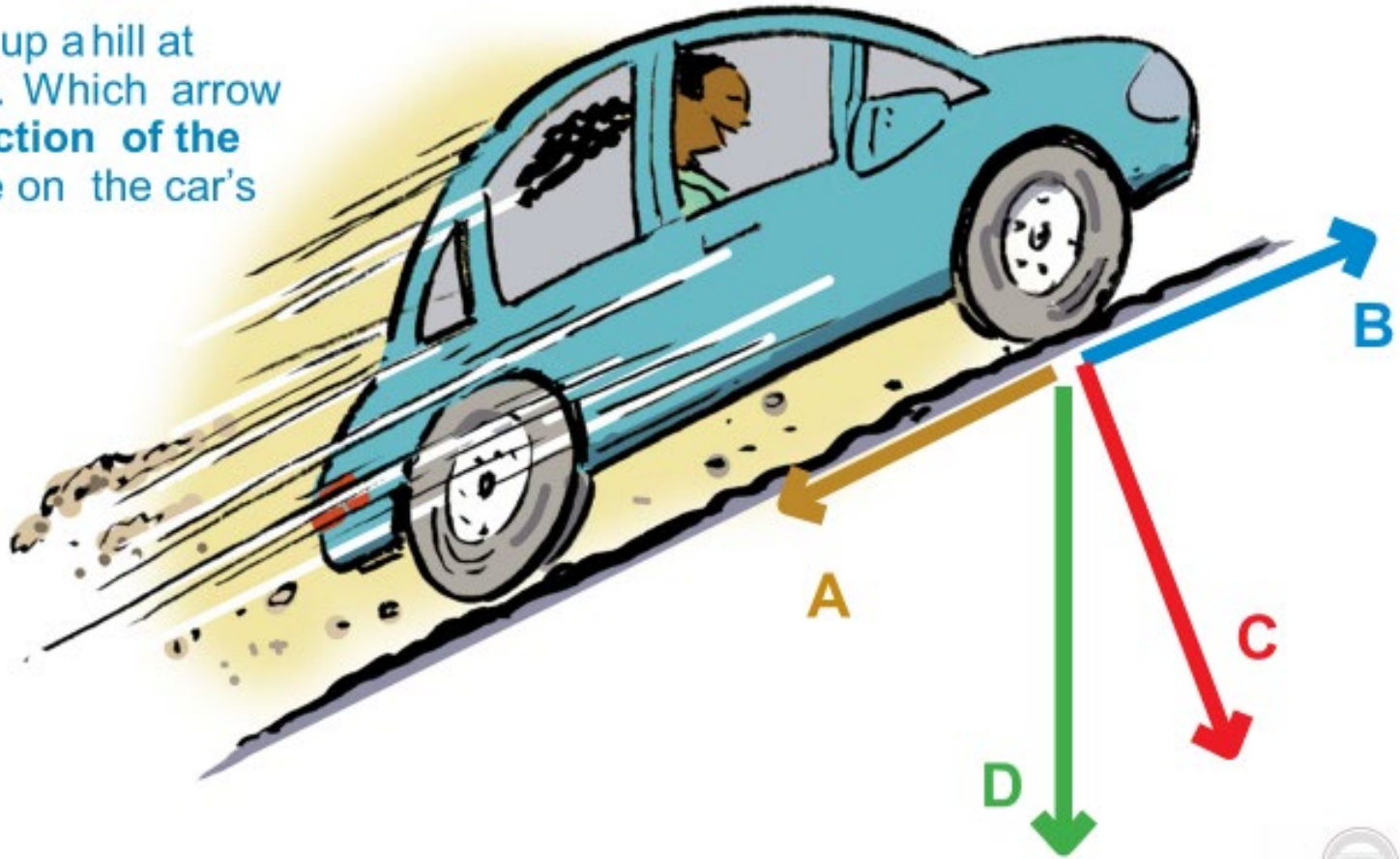
B) B

C) Both will have the same speed.


START
START
1
2


HOT WHEELS
+1
+1

A car is driving up a hill at constant speed. Which arrow shows the **direction of the frictional force** on the car's tires?



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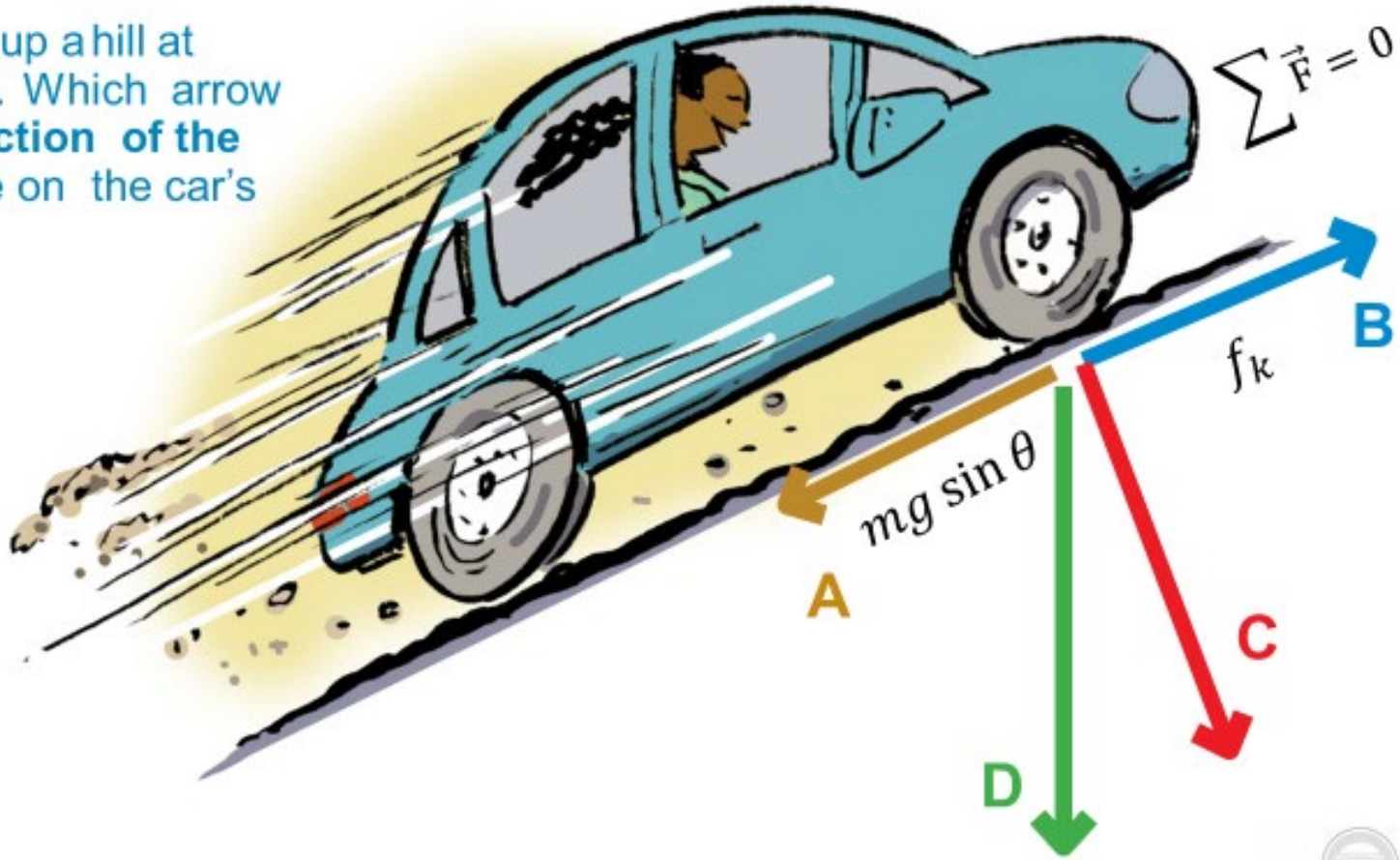

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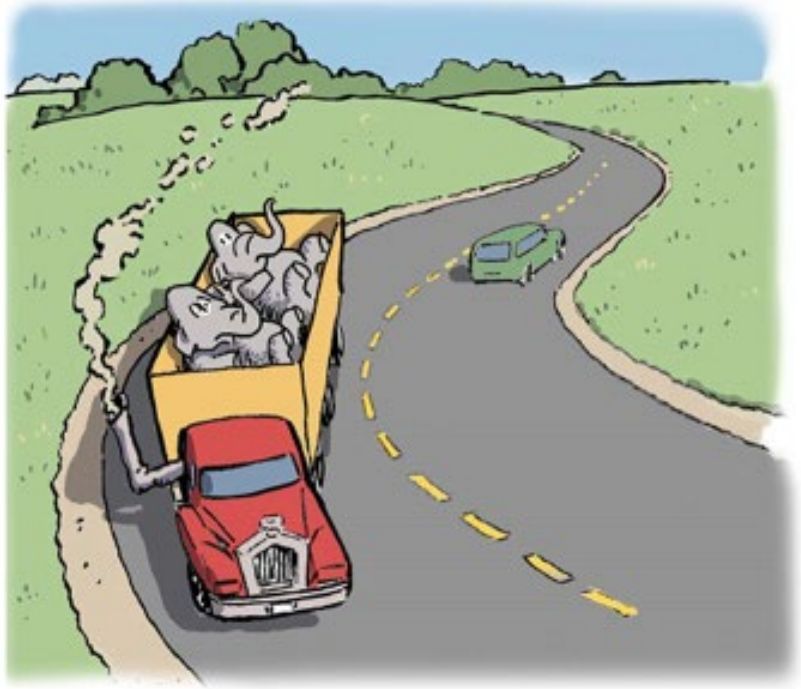

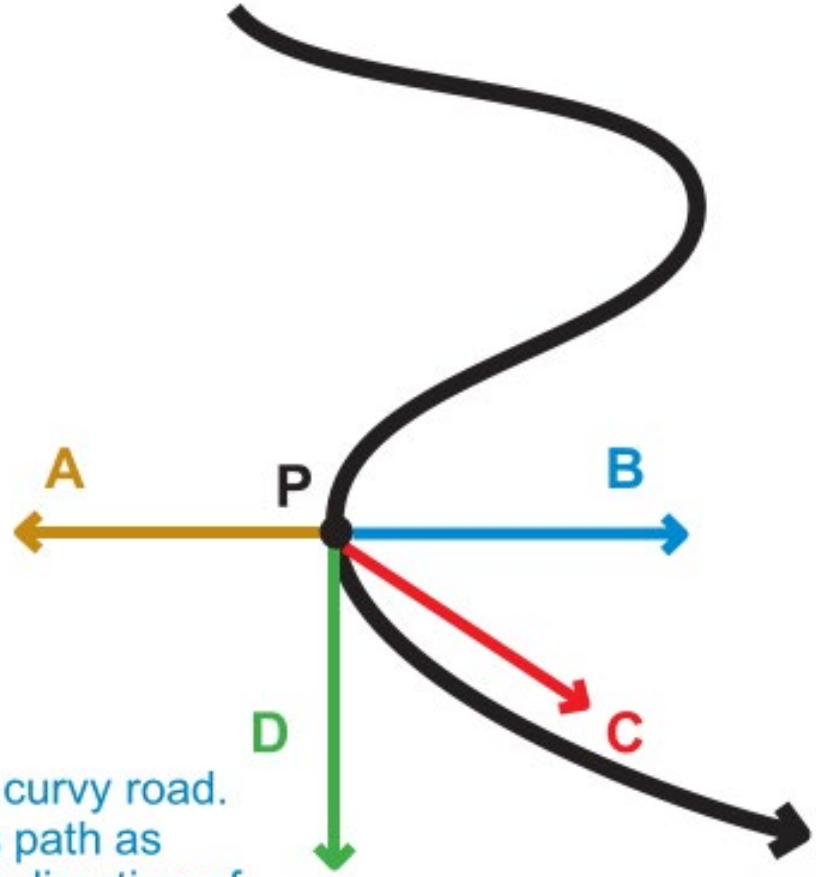

A truck is driving **at constant speed** along a curvy road. The heavy line on the right shows the truck's path as seen from above. Which arrow describes the direction of friction on the truck at point **P**?

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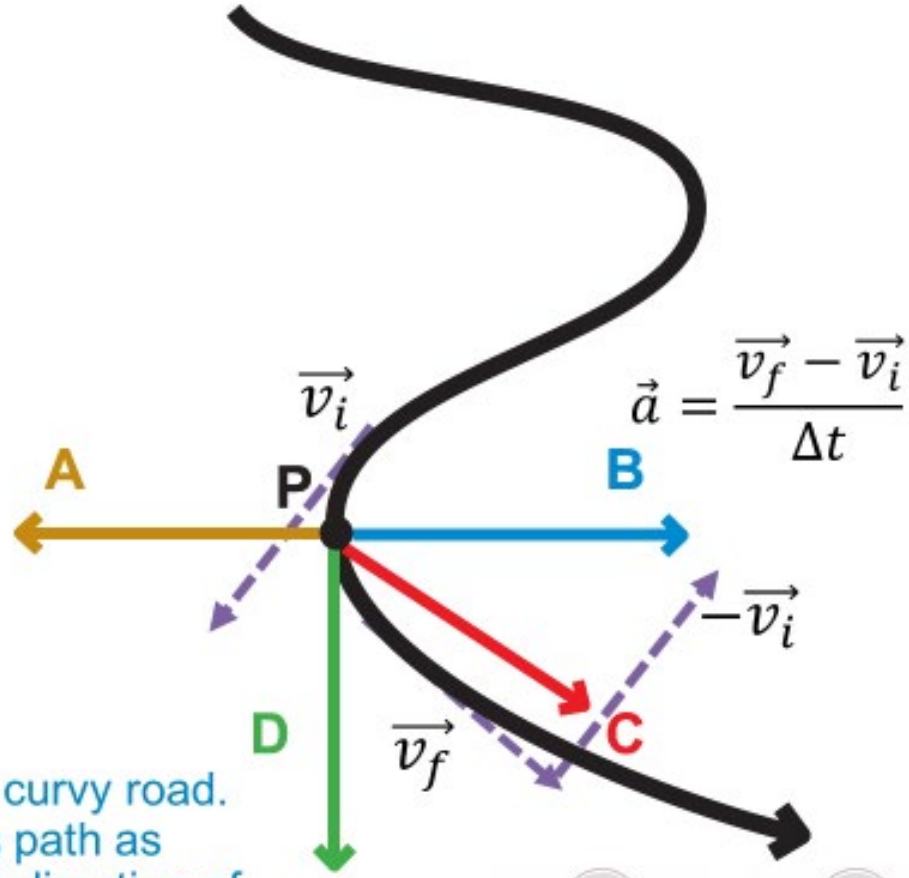

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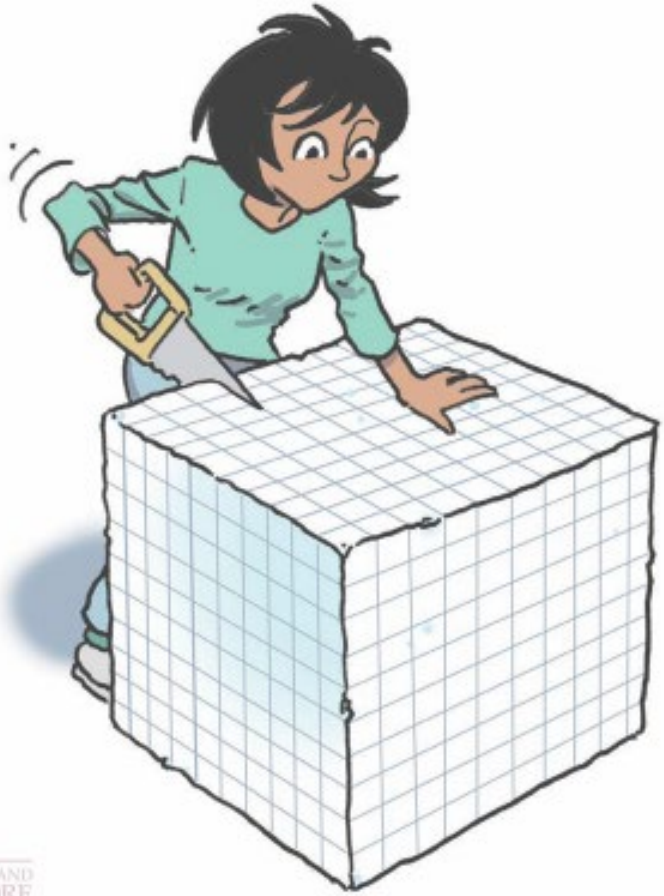
Scaling, Dimension, Growth & Form



7. Lucky Anita has a cubical block of sugar one meter on a side. She carefully cuts it into smaller cubes 0.1 cm. on a side. How many smaller cubes does she end up with, **assuming she doesn't eat any?**

A. 10 B. 10^2 C. 10^5 D. 10^9

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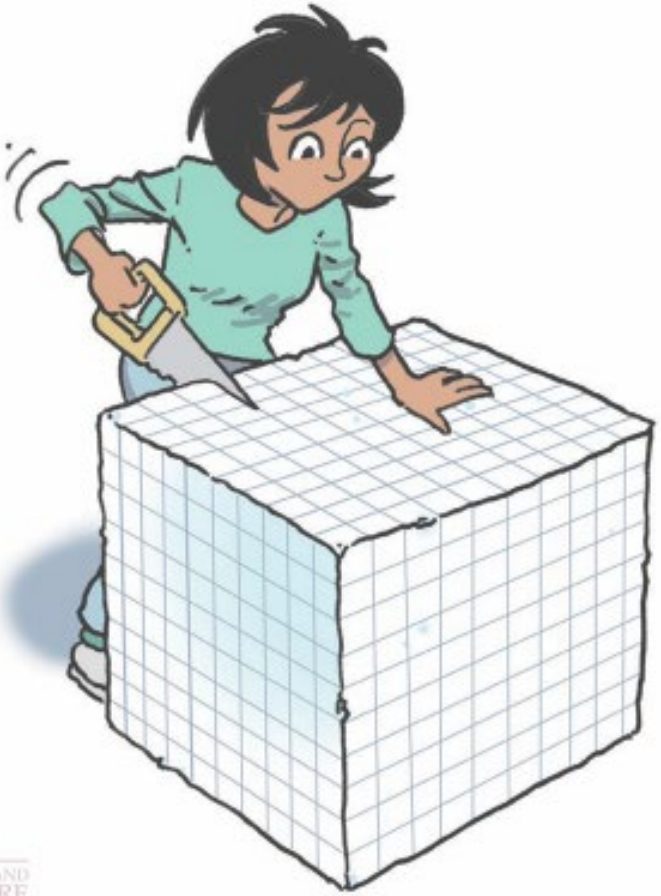
Scaling, Dimension, Growth & Form



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Scaling, Dimension, Growth & Form

8. After Anita cuts her 1-meter cube of sugar into smaller cubes 1 mm. on a side, what is the total **surface area** of the small cubes, compared to the surface area of the original cube?

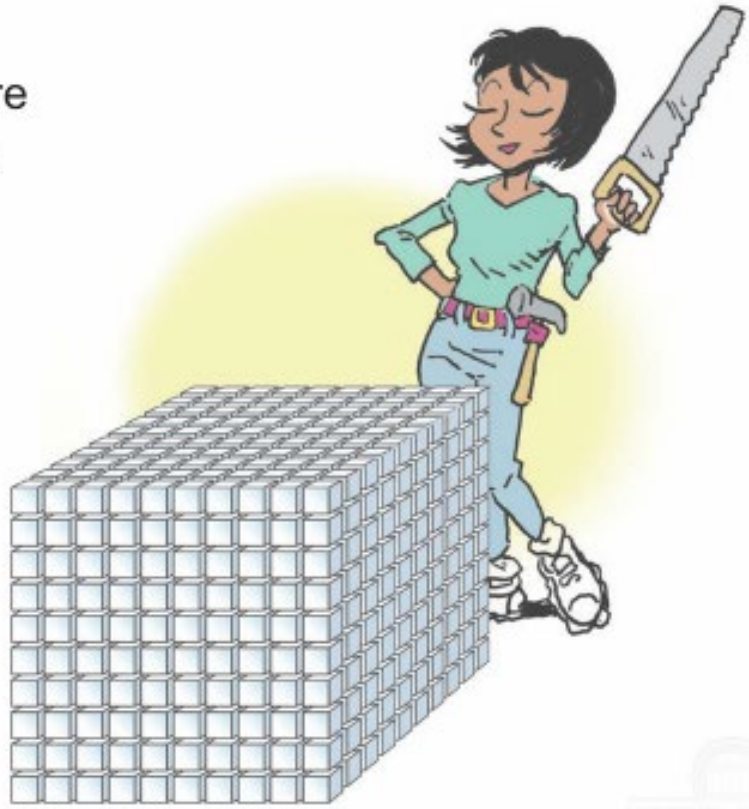
A. 1,000 times more

B. 100 times more

C. 10 times more

D. 1/10 as much

E. The same



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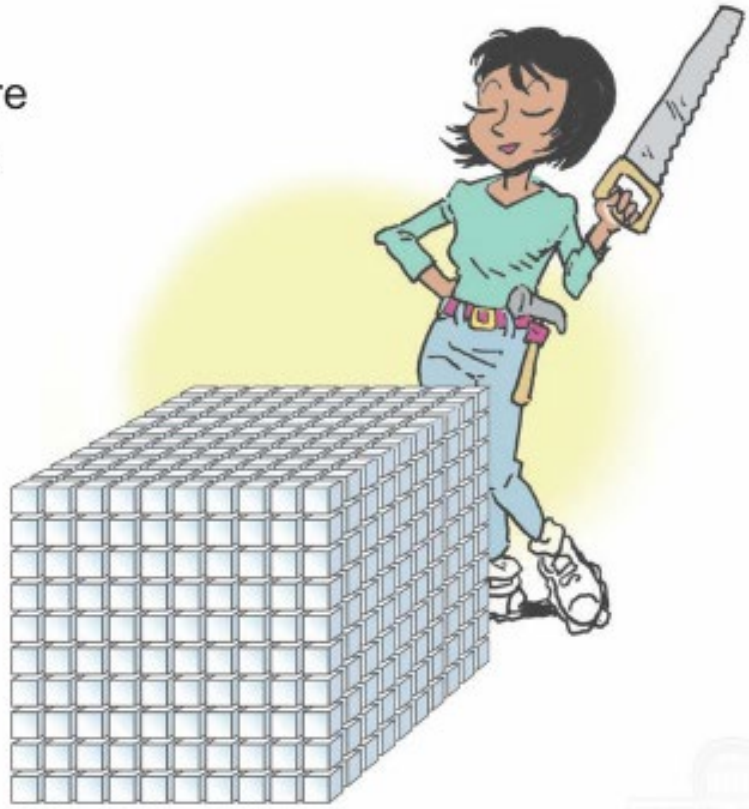
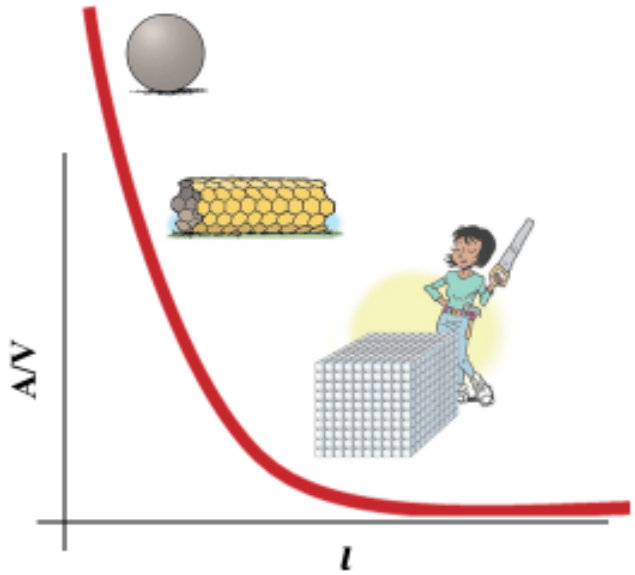


Scaling, Dimension, Growth & Form

9b. The surface to volume ratio for a sphere, cylinder or cube is $\sim \frac{1}{l}$, where l is the characteristic length scale. What exactly does it mean by $\frac{A}{W} \rightarrow \propto$, when $l \rightarrow 0$?



A. It's just a mathematical expression, doesn't mean anything.

B. It means that if the large sphere, cylinder or the cube is broken down into nanoparticles, nanowires or nanocubes, the percentage gain in effective surface area would be very large.

C. I have no idea.

Scaling, Dimension, Growth & Form

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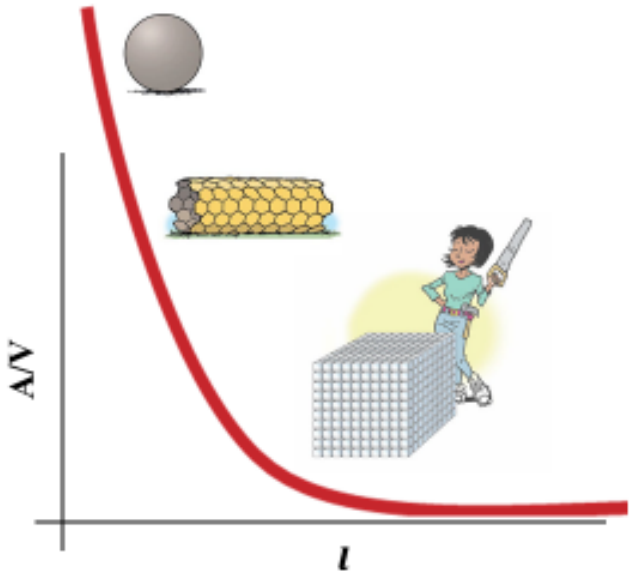

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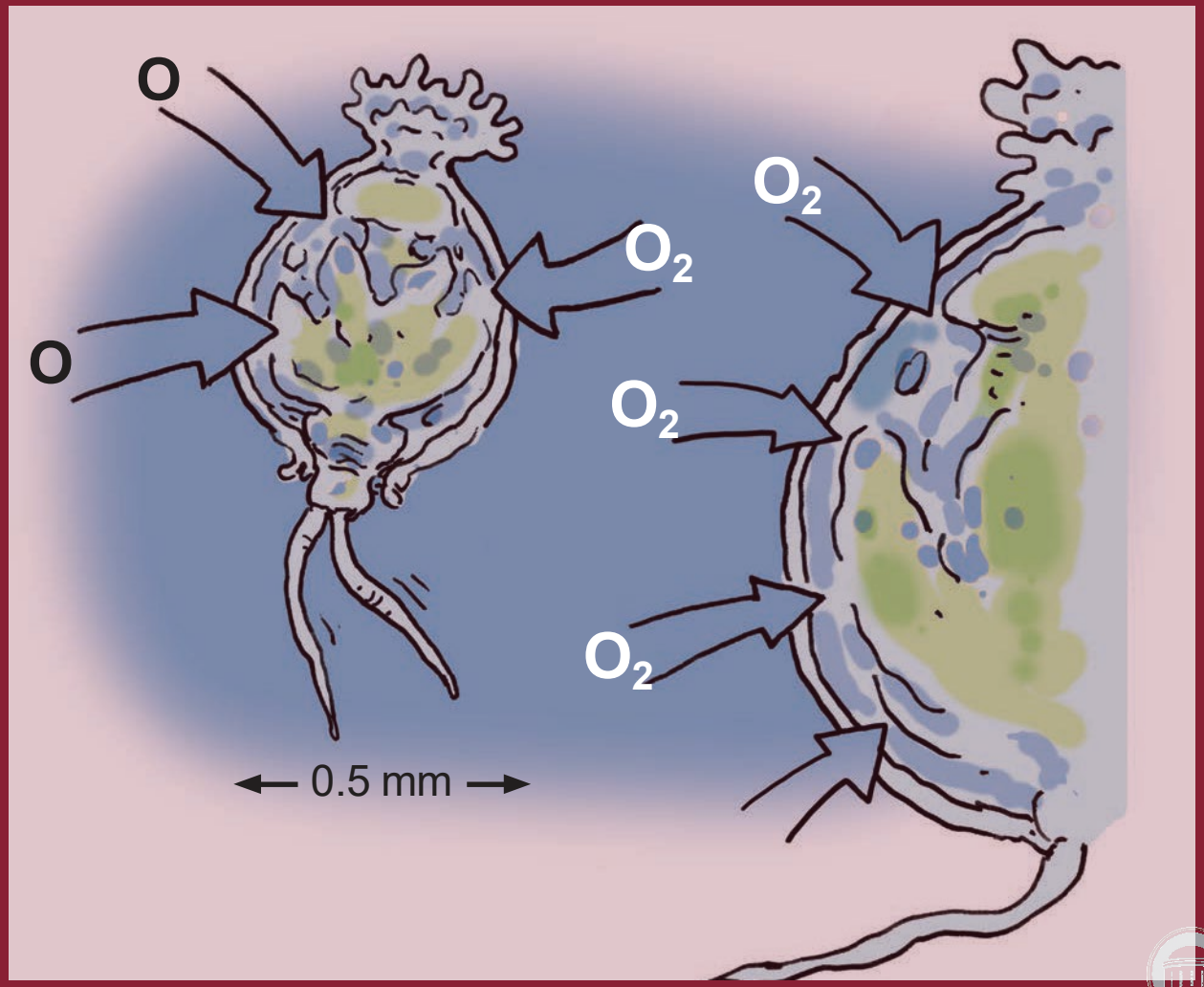
Scaling, Dimension, Growth & Form



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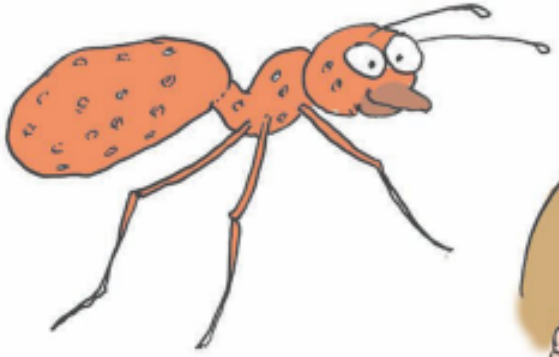
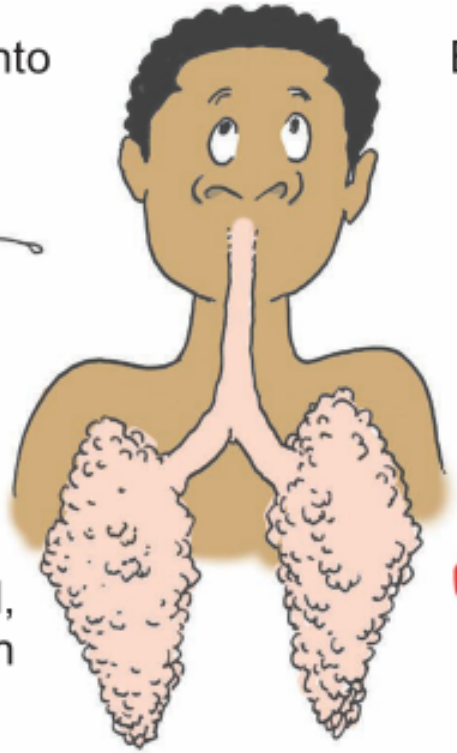
Scaling, Dimension, Growth & Form

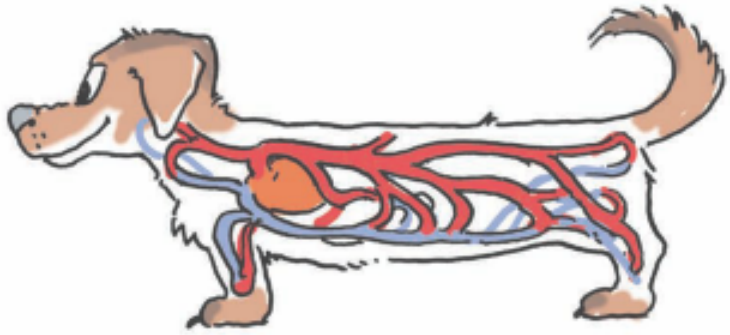
13. Some microscopic animals can supply their own tissues with oxygen by simple diffusion through the skin. For a larger animal, do any of the following evolutionary adaptations help to improve oxygen supply?

A. Many tiny passageways into the body, exposing more surface area to the air.





B. A network of long blood vessels that move oxygen deeper into the animal.



C. Lungs with a complicated, spongy surface having an enormous surface area.

D. All of the above.

E. None of the above.

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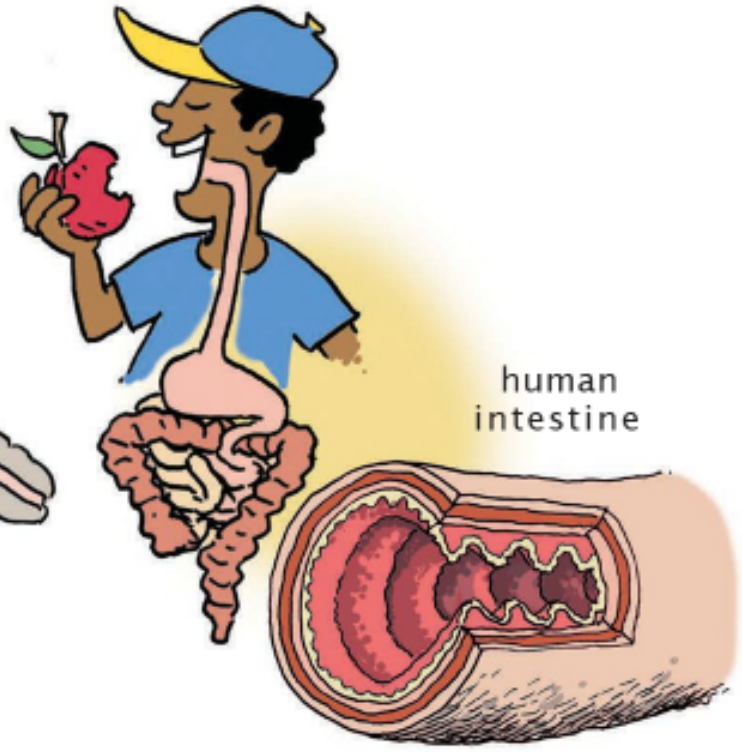
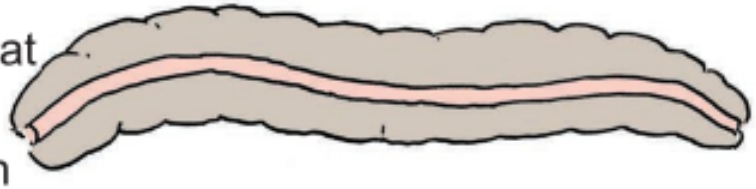
Scaling, Dimension, Growth & Form

14. In an animal, nutrients reach the body by passing through the walls of the intestine. An earthworm has a straight intestine with smooth walls. Due to evolutionary adaptations a human has a long, coiled intestine, with highly reticulated, or folded, inner walls. What might account for the difference?



A. Earthworms only eat dirt.



B. Humans are much larger and need an intestine with extra surface area to supply nutrients to the large body mass. Straight intestine won't have enough surface area.

C. Humans have a lot of room in their abdomen and have to fill it with something.

D. Earthworms lack a mouth.

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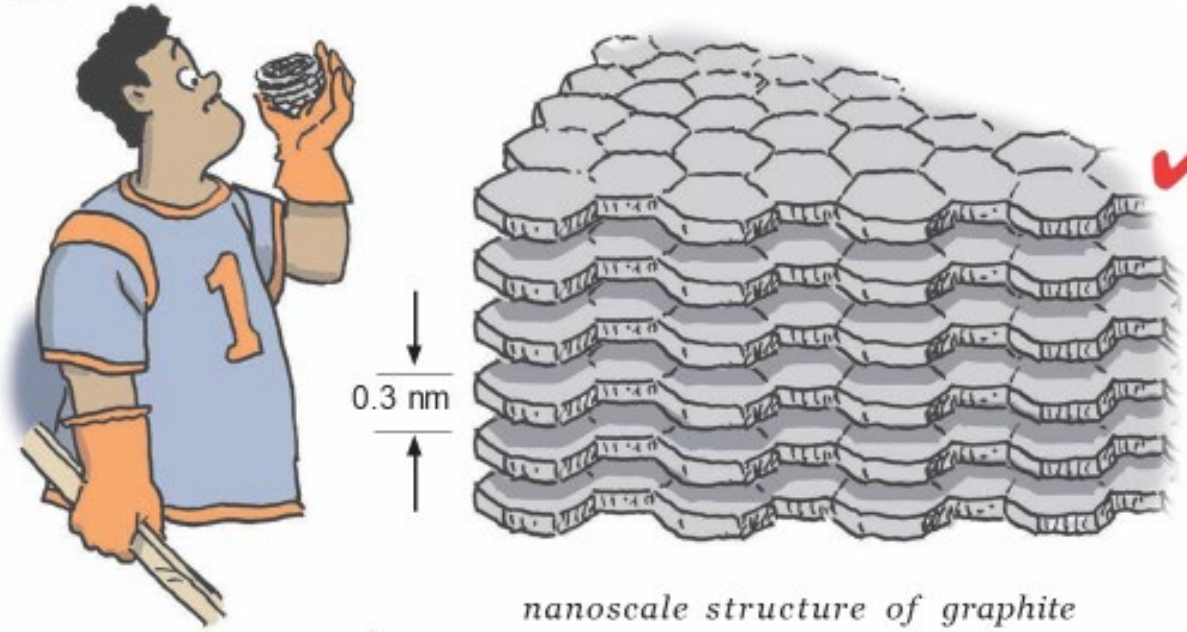
Scaling, Dimension, Growth & Form

15. Lester has a cubical hockey puck made of **graphite,** exactly 1 cm on a side. Graphite is a layered stack of **graphene** sheets, each a monolayer of carbon atoms. The thickness of one sheet is **0.3 nm** or **3 x 10^{-10} m**. If all the sheets in Lester's puck were peeled off one by one, what would their total surface area be, top and bottom, versus the surface area of the original cube? Ignore the edges of the sheets. A soccer field has nearly 7,000 m^2 surface area.



nanoscale structure of graphite

A. sheet area = 6,667 m^2
cube area = 10^{-4} m^2 ✔

B. sheet area = 6,667 m^2
cube area = 6 x 10^{-4} m^2

C. sheet area = 3,333 m^2
cube area = 6 x 10^{-2} m^2

D. sheet area = 6,66,667 m^2
cube area = 6 x 10^{-4} m^2

Innovation: Authentic discovery-based laboratories

- In authentic discovery-based courses, a group of students from diverse background conduct interdisciplinary research where they make an original intellectual or creative contribution to the discipline.

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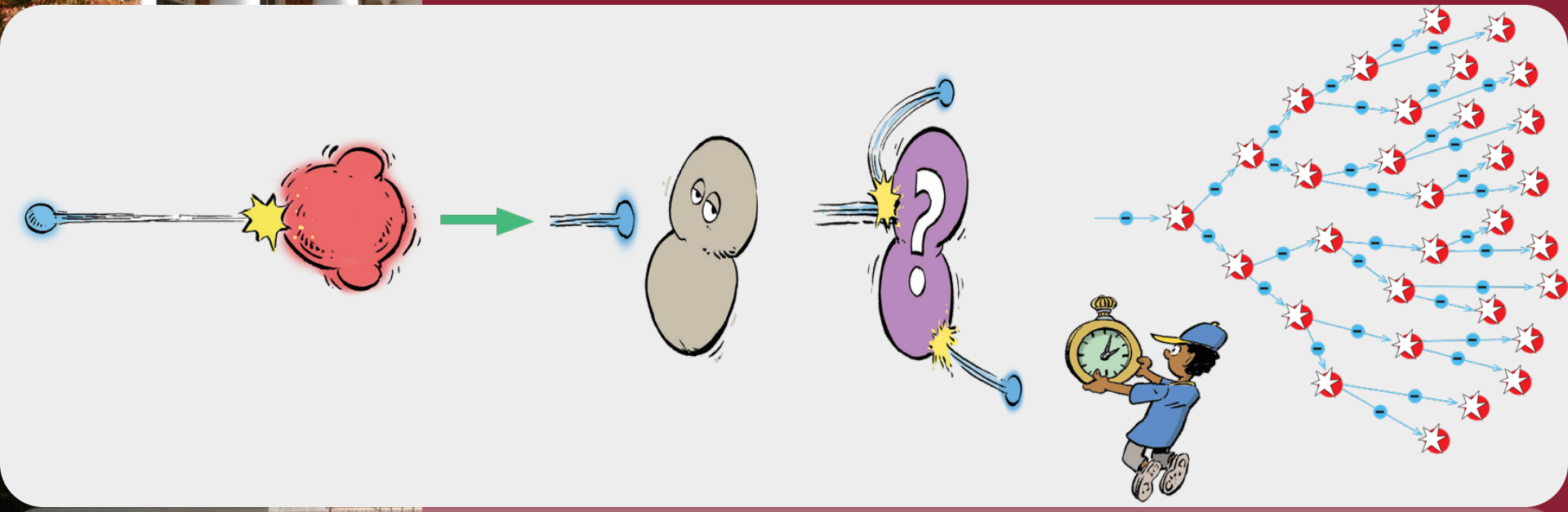
Plasma generation using a kitchen microwave oven

- Microwave plasma



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Plasma generation using a kitchen microwave oven

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Open • Submitted: 29 November 2018 • Accepted: 31 October 2020 • Published Online: 22 March 2021

Plasma generation by household microwave oven for surface modification and other emerging applications

American Journal of Physics **89**, 372 (2021); https://doi.org/10.1119/10.0002706

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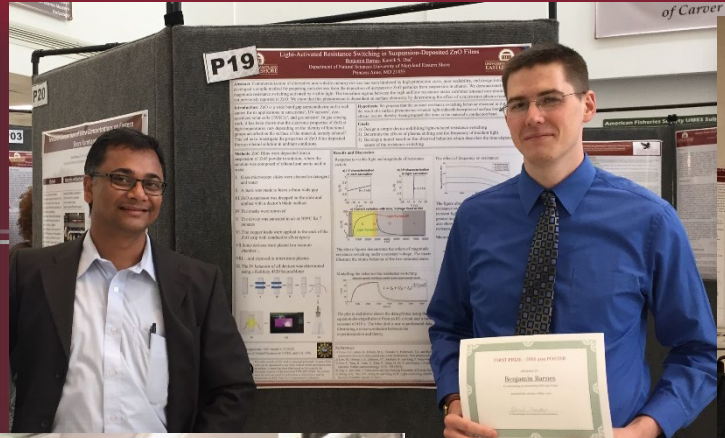
Resistance Switching and Memristive Hysteresis in Visible-Light-Activated Adsorbed ZnO Thin Films

Received: 20 July 2017
Accepted: 22 January 2018
Published online: 01 February 2018

Benjamin Kerr Barnes & Kausik S. Das

The discovery of resistance switching memristors marks a paradigm shift in the search for alternative non-volatile memory components in the semiconductor industry. Normally a dielectric in these bistable memory cells changes its resistance with an applied electric field or current, albeit retaining the resistive state based on the history of the applied field. Despite showing immense potential, sustainable growth



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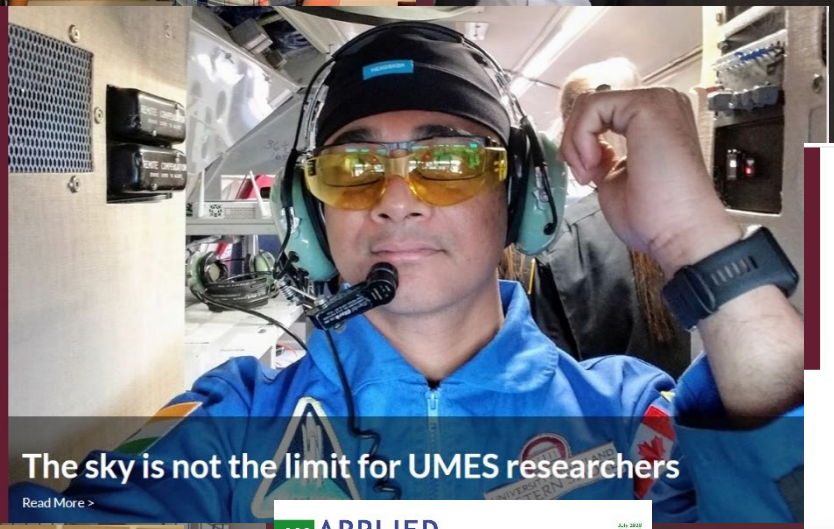

The sky is not the limit for UMES researchers

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Ivy League School Pursues UMES Student

Getting accepted to an Ivy League school is a dream come true; having them pursue you is unimaginable. That's just the position Ayobami Ogunmolasuyi, a senior engineering major with a mechanical specialization from Nigeria, was fortunate to find himself in.

Following his December 2019 graduation from UMES, Ogunmolasuyi will be an Engineering Sciences Ph.D. student in the Thayer School of Engineering at Dartmouth College in New Hampshire. Dartmouth offered the UMES student a full scholarship and stipend to attend the prestigious institution starting in January.

"It was a good feeling," Ogunmolasuyi said upon being contacted by Dartmouth. "God is at work."

Ogunmolasuyi was "discovered" when he

***

About the Program

Selection Criteria

Application Process

Activities/Workshops

2020 Program Participants

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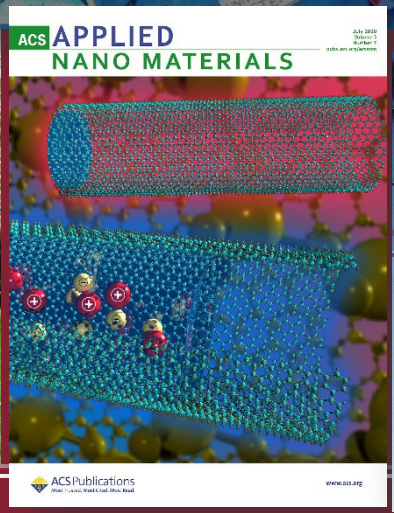

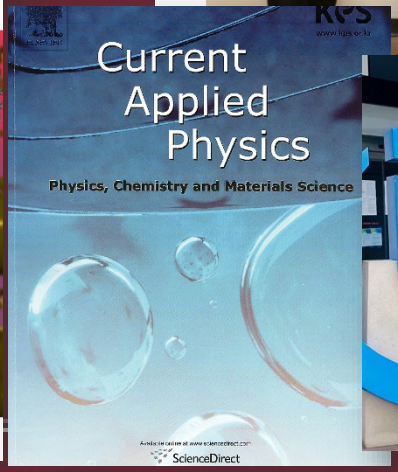

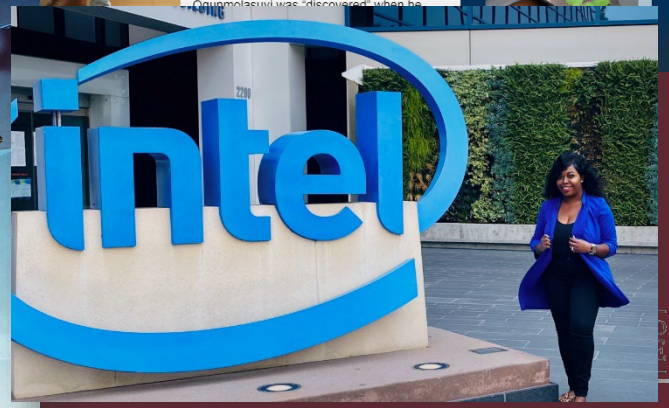

Dynamics of solid body rotation in zero gravity

Asymmetric top rotations give very interesting results in zero gravity.

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Some Success Stories

UMES entrepreneurs win business funding event

SALISBURY, MD – (Nov. 18, 2015) – Four UMES entrepreneurs were among eight winners in the fall 2015 edition of a start-up business funding competition sponsored twice annually by Salisbury University.

- Ahmed Malik, a mechanical engineering major, received $5,000 from the Philip E. and Carole R. Ratcliffe Foundation "Shore Hatchery" event after pitching his idea to use gel technology in medical "sleeves" that he envisions can accelerate healing joint sprains and muscle strains.
- Jamar Jackson and Christopher Toney, who graduated this past May, also received $5,000 for their plan to develop bio-degradable energy-efficient batteries using a 3-D printer.
- Jean-Paul Badjo, a senior, walked away with $20,000, which he will use to continue fine-tuning his vision of designing and manufacturing custom, high-tech suits for live-action role playing.

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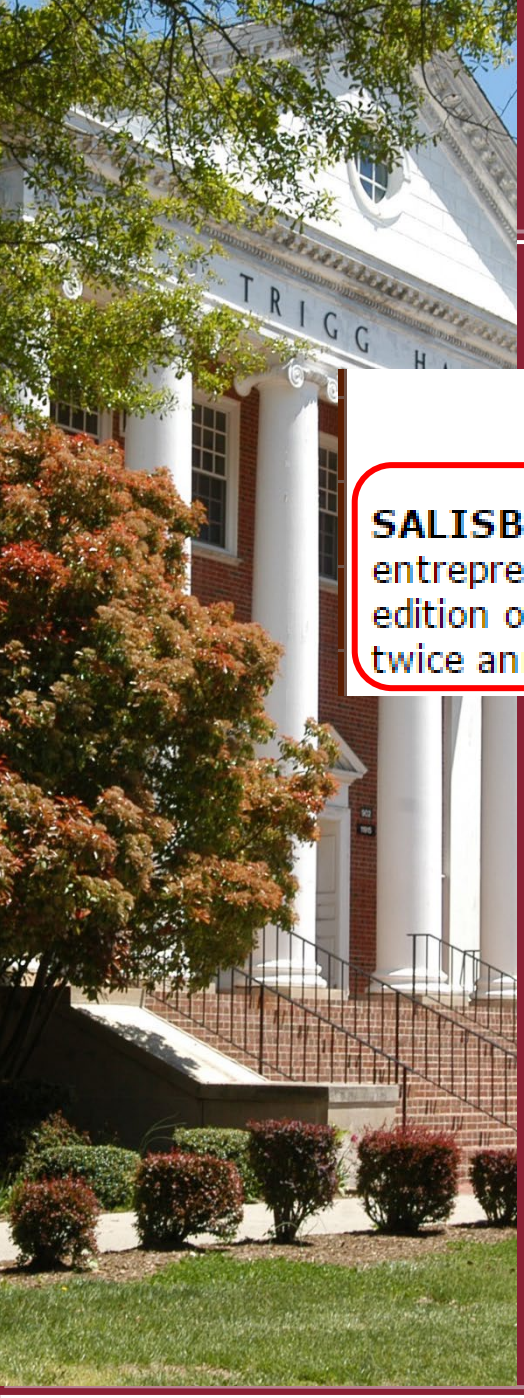

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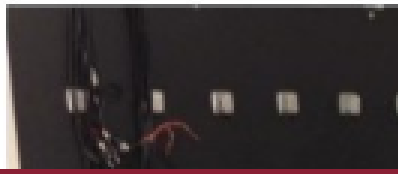

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'Badjo Suit' lives on

High-tech haberdashers

Friday, December 9, 2016

UMES alum & professor aim to make the 'Badjo Suit' marketable

PRINCESS ANNE, MD - (Dec. 9, 2016) - A University of Maryland Eastern Shore professor and an upstart company founded by a 2015 alumnus have been awarded a $100,000 grant from the Maryland Industrial Partnerships (MIPS) Program to underwrite a technology-product development project involving bio-degradable batteries.

The MIPS funding will support a research partnership between Salisbury-based Badjo-T Industries LLC and Dr. Kausik S. Das to create a graphene-based supercapacitor both hope can power an exoskeletal suit designed by Jean-Paul Badjo when he was a UMES student.

MIPS jointly funds projects to support Maryland businesses that partner with University System of Maryland faculty in developing high-potential, technology-based commercial products.

Badjo's fondness for video games and evolving technology as an adolescent inspired the so-called "Badjo Suit." As an undergraduate, Badjo occasionally trotted out his suit from an obscure campus lab for demonstrations, including a stunt where one of the gloved hands doubled as a flame-thrower.

UMES alum Jean-Paul Badjo and professor Kausik Das are partners in a research venture to find a reliable power source for an exoskeletal suit Badjo designed.

Badjo, who received a UMES degree in electrical engineering in December 2015, has single-mindedly pursued the design and development of a prototype he envisions someday could lead to versions that

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Thank you for your attention.

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