

Developing High-Performance Questions and Orchestrating Engagement: Going Deeper with Think-Pair-Share (TPS)

Dr. Edward Prather

University of Arizona

Center for Astronomy Education (CAE)



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Title: Developing High-Performance Questions and Orchestrating Engagement: Going Deeper with Think-Pair-Share (TPS)

Overview: In this session participants will discuss a range of implementation techniques that significantly increase students' engagement when using Think-Pair-Share (TPS). We'll be jumping right in so a basic understanding of TPS is assumed.

Session Learning Outcomes:

Participants will be able to:

- Describe critical steps with implementing TPS in the classroom.
- Identify different levels for TPS questions.
- Describe how the TPS questions can be sequenced together to improve students' learning.



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Outline for Today's Session

- (1) A very BRIEF overview of Peer-Instruction and Think-Pair-Share.
- (2) Work through a few example questions to demonstrate how to promote discourse and critical thinking
- (3) Look over the “How to Guide” on best practices.
- (4) Critique implementation to discuss critical aspects of implementation and their affordances
- (5) Examine the range of questions, resources and techniques for developing good questions
- (6) Model TPS yourself...



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Think-Pair-Share (TPS) aka Peer Instruction:

A questioning in the classroom technique that makes use of a combination of conceptually challenging multiple-choice questions, and classroom feedback designed to increase student-to-student discourse and provide insight into students' learning for you and them

Crouch, C. H. & Mazur, E. 2001, "Peer Instruction: Ten Years of Experience and Results," *American Journal of Physics*, 69(9), 970, 2001

Development and Application of a Situated Apprenticeship Approach to Professional Development of Astronomy Instructors, Prather, E. E., and Brissenden, G. *The Astronomy Education Review*, 7(2), 2008

Clickers as Data Gathering Tools and Students' Attitudes, Motivations, and Beliefs on Their Use in this Application, Prather, E. E., Brissenden, G., *The Astronomy Education Review*, 8 (1), 2009 .



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Think-Pair-Share (TPS) aka Peer Instruction:

Working with your partner, generate an exhaustive list of all issues/problems you can imagine can occur when one implements TPS (aka Peer Instruction) in the classroom.



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Think-Pair-Share:

A Revised "How-To" Guide

Gina Brissenden & Edward Prather

Center for Astronomy Education (CAE)

Background:

After attending the Austin CAE Teaching Excellence Workshop in January of 2008, Amy Forestell, then a graduate student at UT Austin and now an Assistant Professor at State University of New York at New Paltz, decided to take a look at the Think-Pair-Share (TPS) Teaching Strategy on the CAE website and found that many of the important details we discussed and modeled during the workshop were not included in the basic how-to guide. Using Amy's notes on Think-Pair-Share from the workshop, we updated the how-to guide and highlight the key points that were missing in the previous version that we believe are essential to proper implementation of Think-Pair-Share. Since that time, we've had the opportunity to use TPS in some pretty unique instructional settings, from small groups of Tibetan Monks, to mega-courses of nearly 1000 students, and more, providing us with new insights into best practices in implementing Think-Pair-Share. Based on these insights, we've revised and updated our Think-Pair-Share How-To Guide.

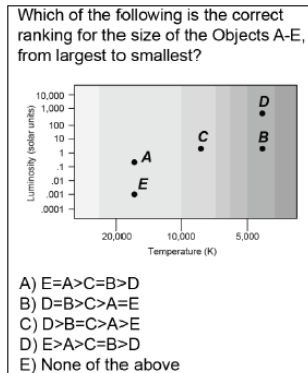
This guide should be a useful reminder for those who have attended a recent workshop, and it will serve as a useful implementation update to those who attended a workshop some time ago. Additionally, it should be helpful for those who have not attended a CAE workshop.

Introduction:

Faculty often ask us what they can do to "get out of lecture mode" in their classrooms. After completing a CAE Teaching Excellence Workshop, participants commonly report back that Think-Pair-Share is the technique they plan to try first. We agree it's a great place to start! So how do you effectively implement Think-Pair-Share in the classroom? Through years of classroom experimentation, we've come up with a set of steps and phrases we find motivate students to earnestly engage with your TPS questions and have meaningful and rich conversations with their fellow students. Here's the "how-to" guide:

Writing Questions:

- Determine the conceptual or reasoning difficulty your question will address. For example, "Students struggle to understand that just because two objects have the same temperature, or the same luminosity, does not mean they also are the same size."
- Create a multiple-choice question that would serve as a good vehicle to promote a cognitively engaging and conceptually rich discussion amongst your students related to that conceptual or reasoning difficulty. See example at right.
- Along with your correct answer choice, create distinct incorrect answer choices that are representative of the likely student conceptual and reasoning difficulties that real students have and so might actually vote for.



Example Think-Pair-Share Question

Think-Pair-Share Implementation and Question Rubric

Implementation Items:

- Did the presenter refrain from reading the question to the students?
- Did the presenter allow time for the students to read and think about the question?
- Did the presenter ask "Do you need more time?" before going to the first vote?
- Did the presenter get the students to vote simultaneously and anonymously?
- Did the presenter appropriately choose to disclose the distribution of answers from the first vote?
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- Did the presenter debrief the final vote results with the students in a pedagogically useful way?

Question Items:

- Did the question serve as a good vehicle to promote a cognitively engaging and conceptually rich discussion amongst the target population?
- Were the answer choices distinct, and representative of likely student conceptual and reasoning difficulties, which a real student might vote for?

Techniques for all classes









Vote on the “*level of discourse*” that the question promotes...

NOT the “answer” to the question.

“A” = will foster a rich discussion

B

C

“D” = nothing really to talk about....



Around which object does the Moon orbit?

A. Earth

B. Mars

C. Jupiter

D. Saturn



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What is the name of the Moon Phase shown at right?



- A. Waxing crescent
- B. First quarter
- C. Third Quarter
- D. Waxing Gibbous
- E. None of the Above



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If the moon is in the waxing gibbous phase today, how many of the moon phases shown above (A-E) would the moon go through during the next 10 days?

- A. Only one
- B. Two
- C. Three
- D. More than three
- E. None

What would the phase of the moon be?

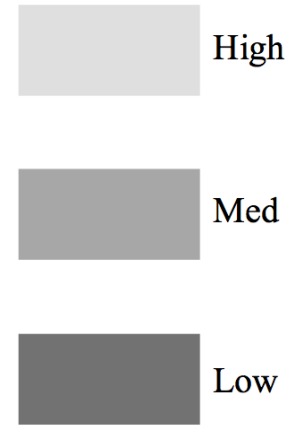
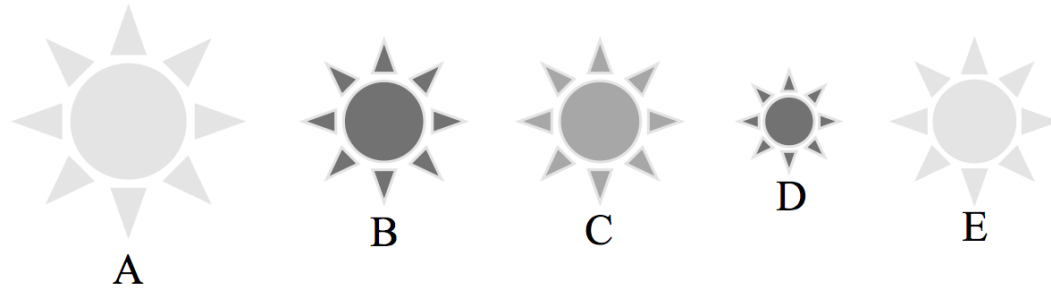
- A. Waxing crescent
- B. Third Quarter
- C. Waxing Gibbous
- D. Waning Crescent
- E. Waning Gibbous



Java Star gives off much more light than Cola Star. Java and Cola are the same size. Which star has the higher temperature?

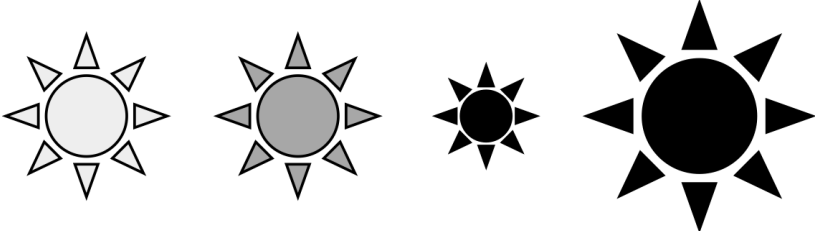
- A. Java
- B. Cola
- C. They have the same temperature.
- D. There is insufficient information to answer this question

Imagine you are comparing the five stars (A-E, shown below) of different sizes and temperatures. The temperature of each star is indicated by a shade of gray (as shown at right), such that the lighter the shade of gray, the higher the temperature of the star.



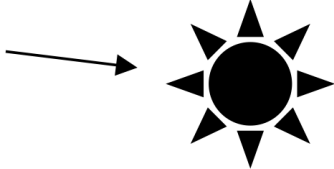
6. Which of the following is the most correct ranking for the luminosity of these stars from greatest to least?
- a. $A > B = C = E > D$
 - b. $E = A > C > D = B$
 - c. $B > C > E > D > A$
 - d. $A > E > C > B > D$
 - e. $D > B > C > E > A$

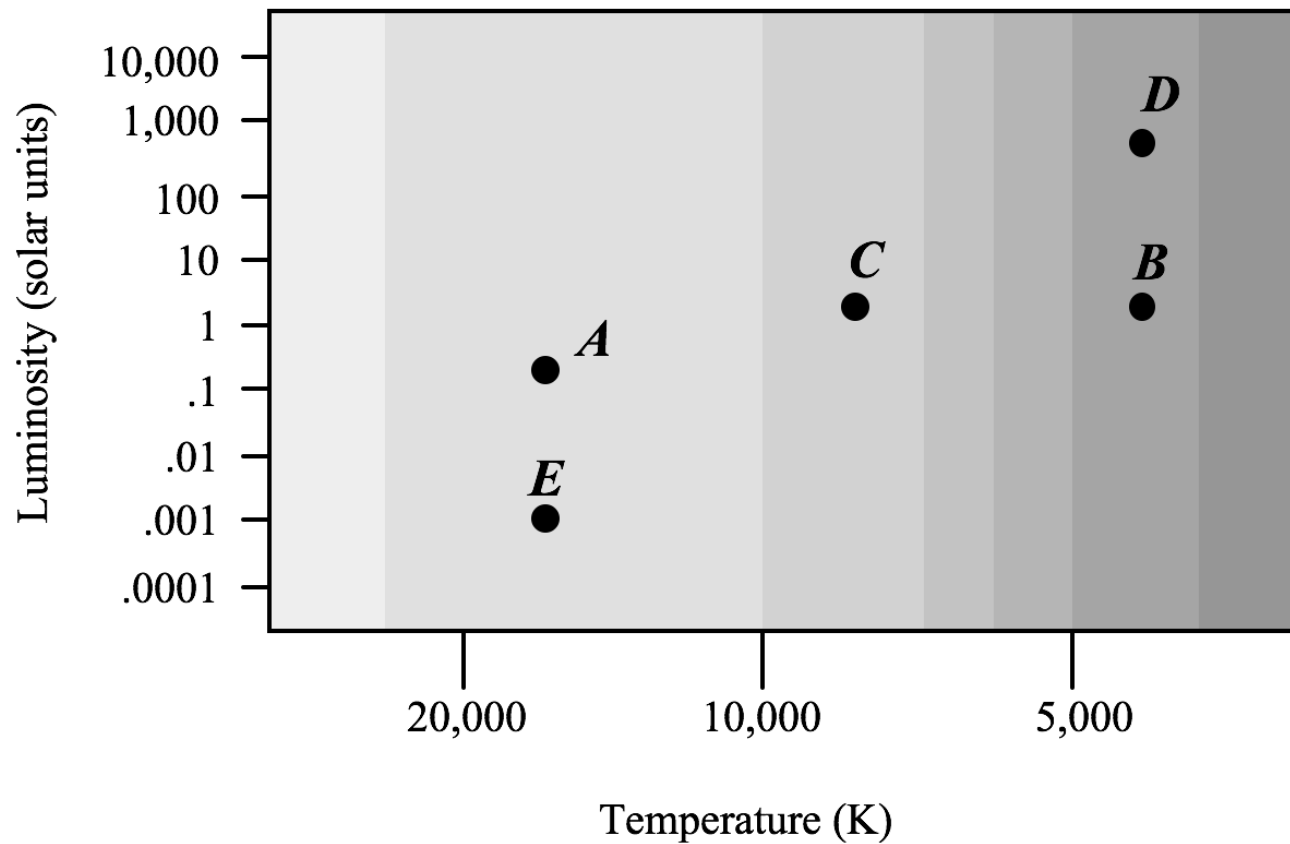
Imagine you are comparing the four stars shown at right. The temperature of each star is indicated by a shade of gray (as shown at right), such that the lighter the shade of gray, the higher the temperature of the star.



7. How many of the stars could have the same luminosity as the star shown at right

- a. only one
- b. two
- c. three or more
- d. none





Which of the following is the correct ranking for the size of the Objects A-E, from largest to smallest.

- $E=A > C=B > D$
- $D=B > C > A=E$
- $D > B=C > A > E$
- $E > A > C=B > D$
- None of the above

An 82.0 kg mountain climber is rappelling down a vertical cliff face. The mountain climber's body is completely horizontal. His rope is attached to a buckle strapped 1.06 m (106 cm) from his feet. His center of gravity is 0.91 m (91 cm) from his feet. The rope makes an angle of $\theta = 19.0^\circ$ with respect to the cliff face. Find the tension in the rope and the x- and y-components of the contact force exerted by the cliff face on the climber's feet.

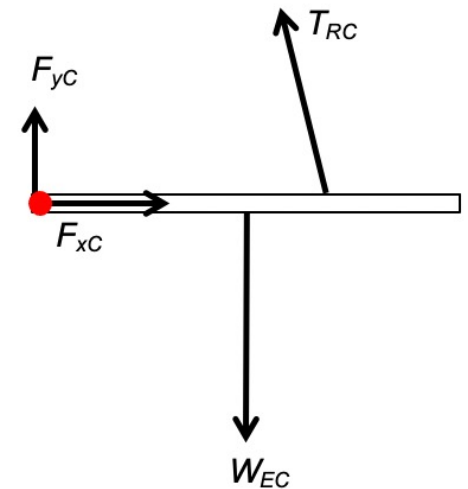
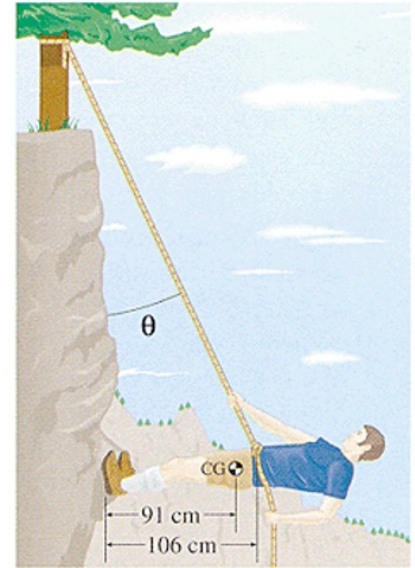
Which of the following correctly relates the vertical forces acting on the climber?

A) $F_{yC} + T_{RC} \sin(19.0^\circ) + W_{EC} = 0$

B) $F_{yC} + T_{RC} \cos(19.0^\circ) + W_{EC} = 0$

C) $F_{yC} + T_{RC} \sin(19.0^\circ) - W_{EC} = 0$

D) $F_{yC} + T_{RC} \cos(19.0^\circ) - W_{EC} = 0$



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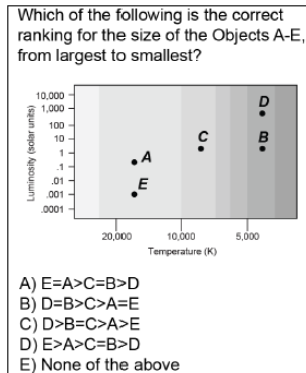
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Example Think-Pair-Share Question

Implementation Items:

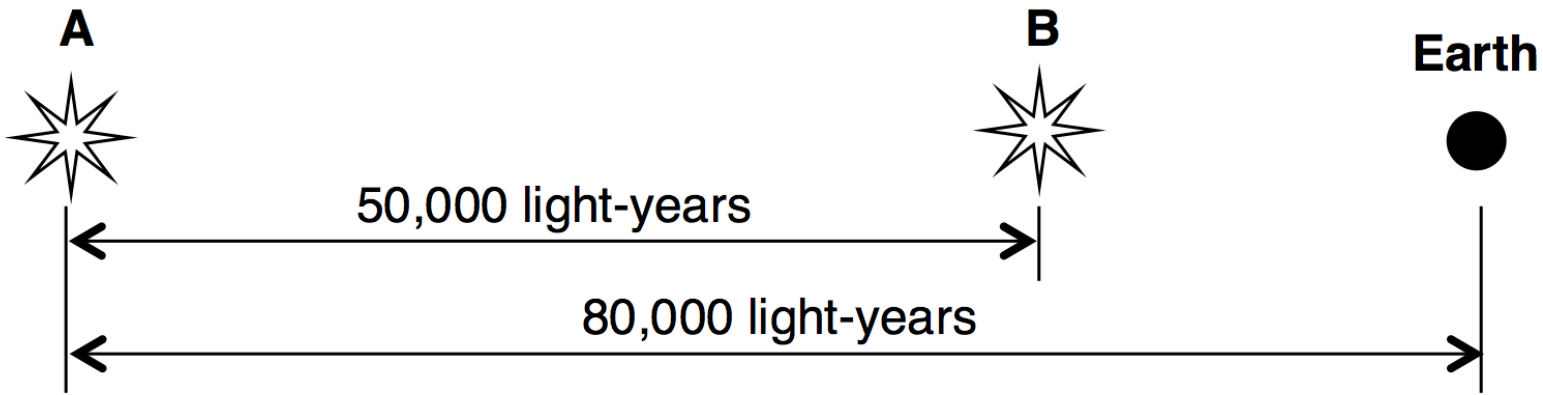
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Idealized (& Shorthand) Implementation of Think-Pair-Share

- Create a cognitively engaging multiple-choice question that challenges students' thinking and has the ability to foster deep discussion amongst your students.
- Present the question to students.
- Ask students to **think** individually about the question (and choose the best answer).
- Have students anonymously and simultaneously vote on their answer to the question.
- Decide if students should **discuss/share** their answers with each other (<70% correct). If so then...
- Ask students to **pair** with someone next to them and to **share their reasoning** with each other :
 - *“Turn to your neighbor and convince them that you are right, if you have the same answer that does not mean you are right, so be sure to explain your reasoning”*
- Give students a **time limit**, and tell them “Go!”, (and maybe start counting down...)
- Again have students anonymously and simultaneously vote on their answer to the question.
- Debrief the results and correct answer with your students.



When Star A appears 90,000 years old to an observer orbiting Star B, how old would Star A appear to an observer on Earth?

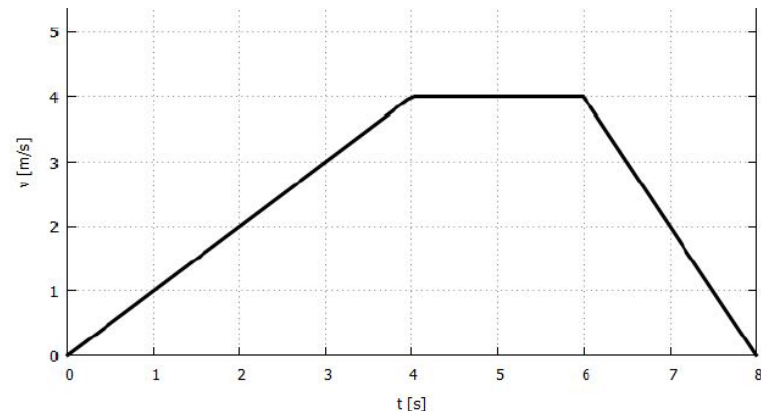
- a. 30,000 years old
- b. 40,000 years old
- c. 50,000 years old
- d. 60,000 years old

Think-Pair-Share Implementation and Question Rubric

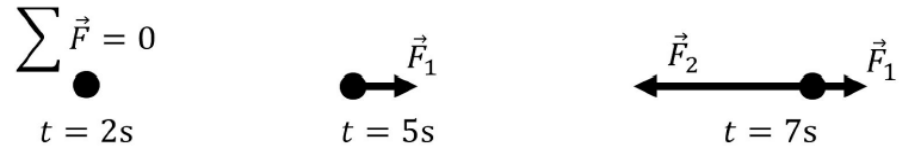
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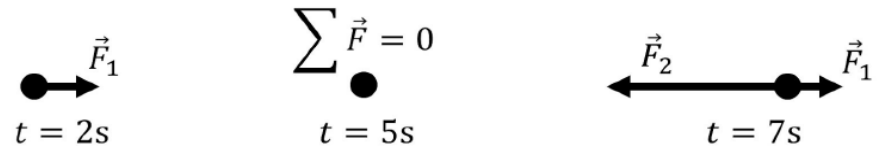
A particle moves in one-dimension with the velocity-vs-time graph shown below. Which of the following sets of free body diagrams could be correct for $t = 2\text{ s}$, $t = 5\text{ s}$, and $t = 7\text{ s}$?



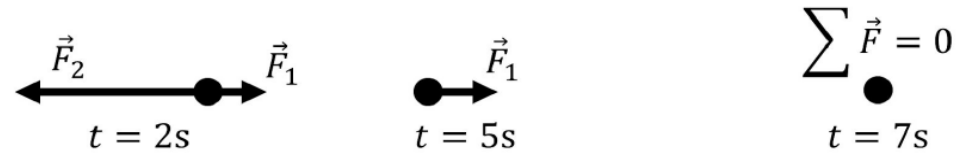
a.



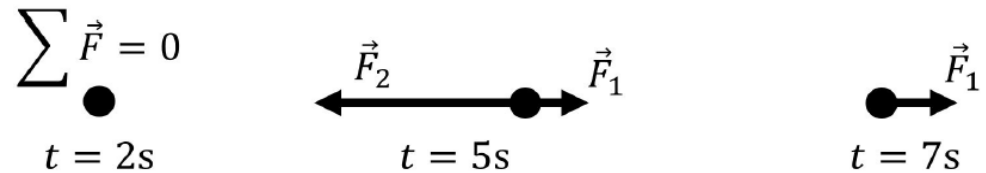
b.



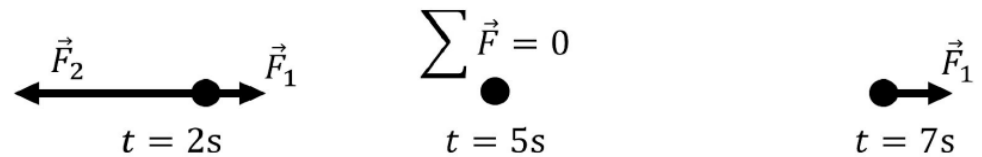
c.



d.

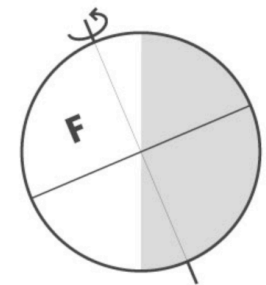
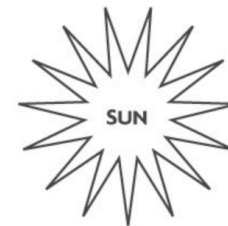
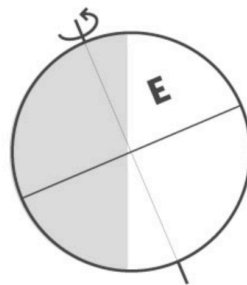
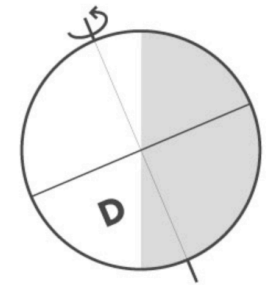
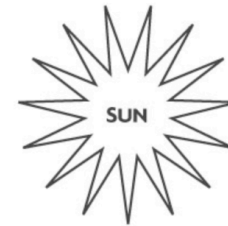
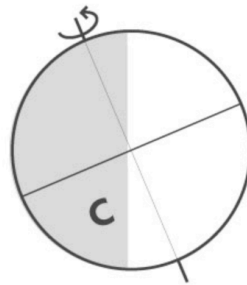
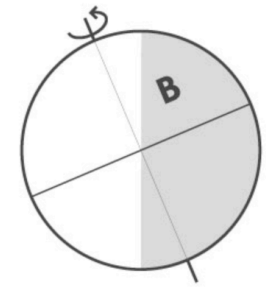
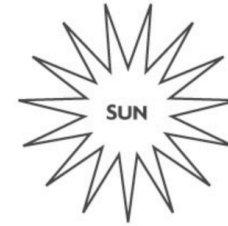
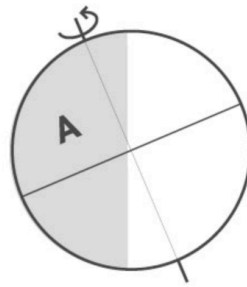


e.

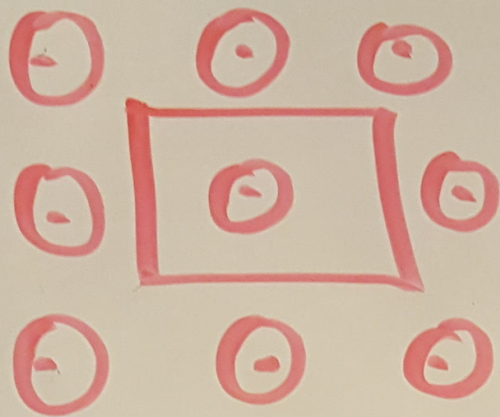


How many of the locations (A-F) would be experiencing Winter?

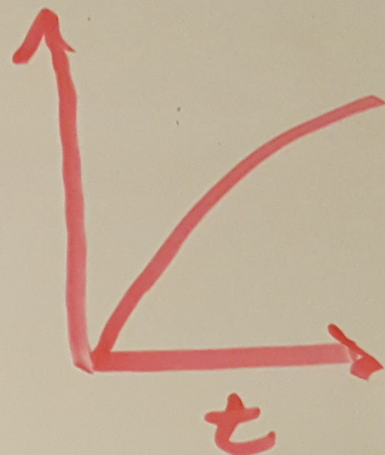
- A. only one**
- B. two**
- C. three**
- D. four**
- E. all the positions are experiencing Winter.**



sup I)

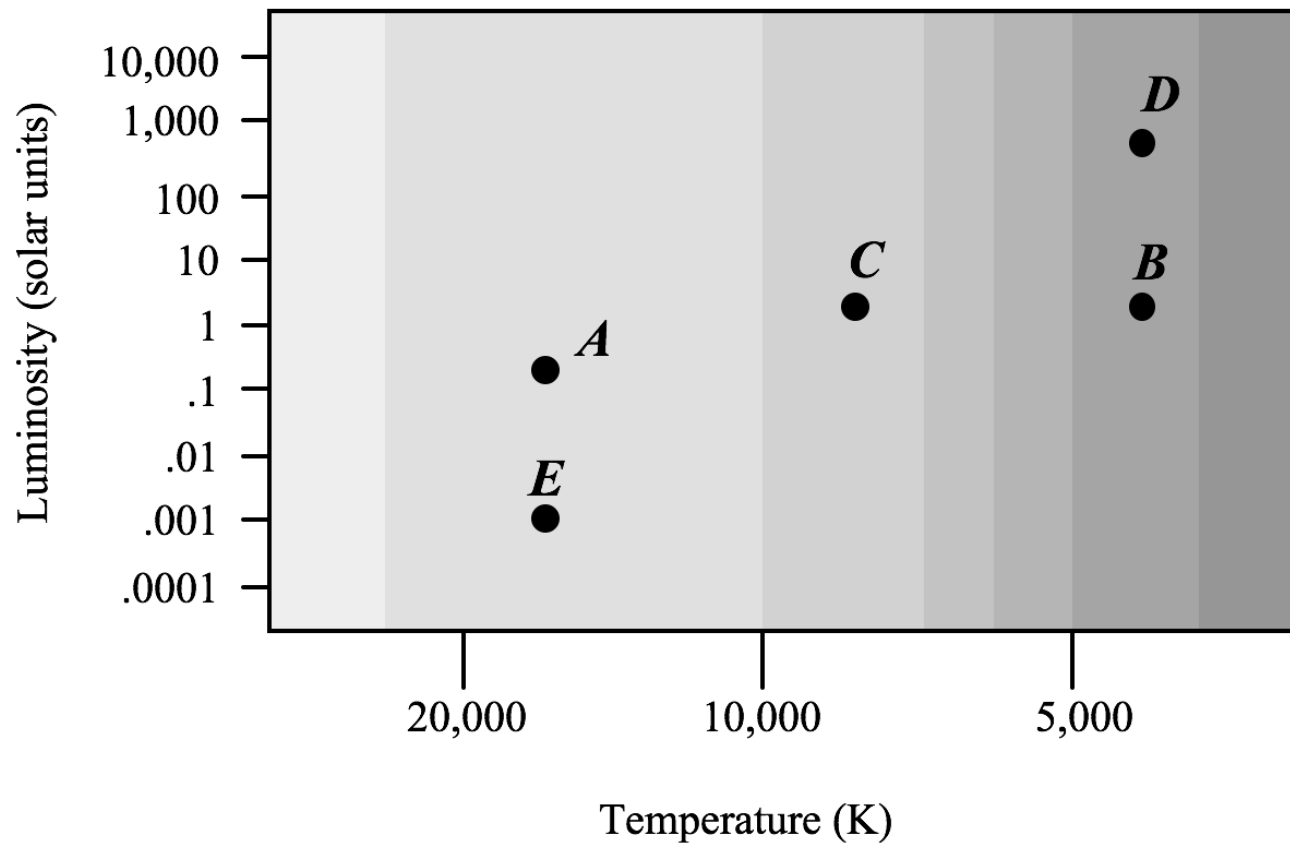


$B(t)$



Given $B(t)$, the Φ_B is _____,
the B_{ind} is _____, and the
 I_{ind} is _____.

- (a) increasing, increasing, CW
- (b) decreasing, decreasing, CW
- (c) increasing, decreasing, CW
- (d) decreasing, increasing, CCW
- (e) none of the above



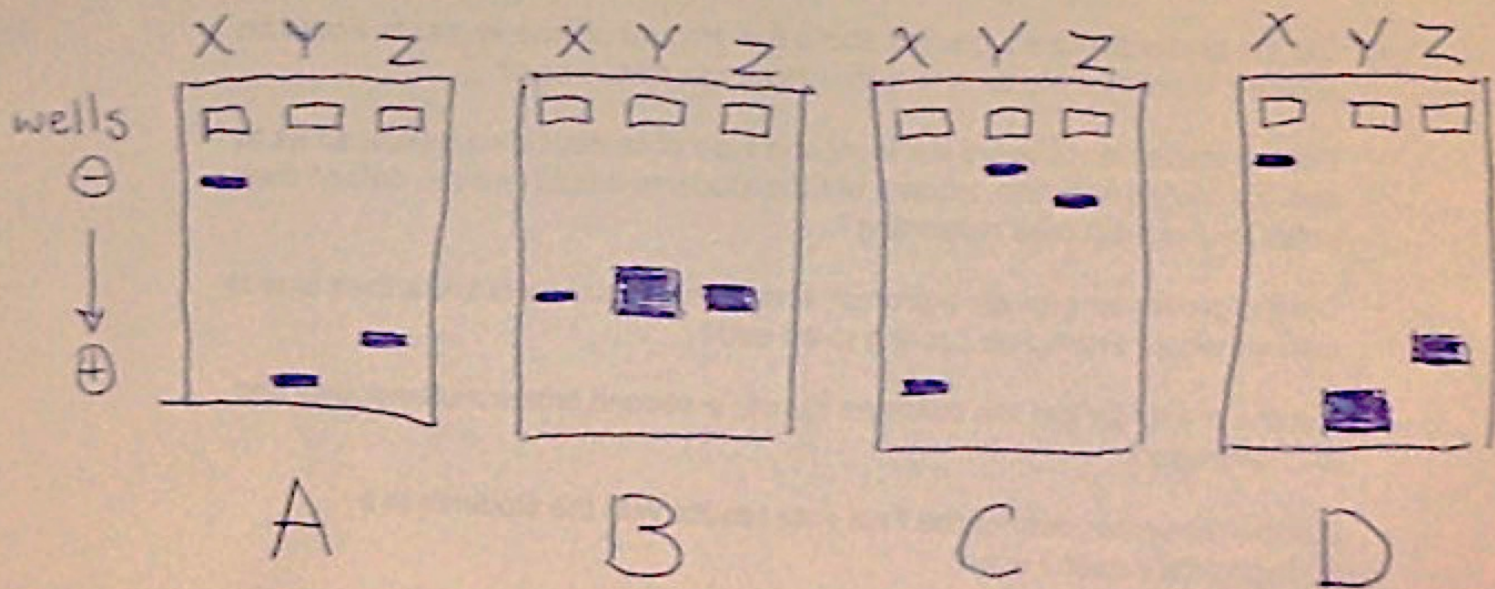
Which of the following is the correct ranking for the size of the Objects A-E, from largest to smallest.

- $E=A>C=B>D$
- $D=B>C>A=E$
- $D>B=C>A>E$
- $E>A>C=B>D$
- None of the above

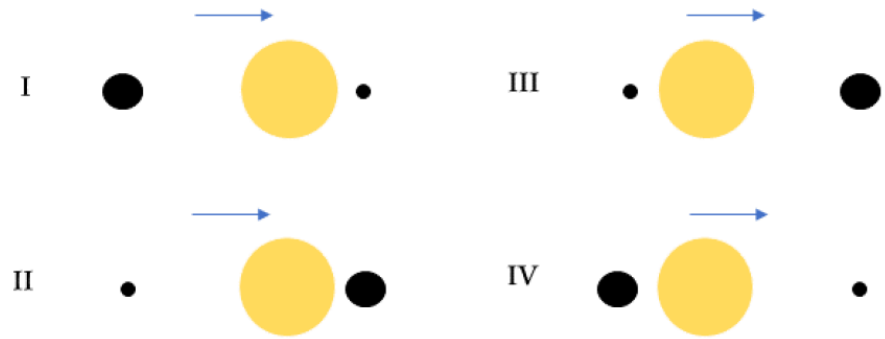
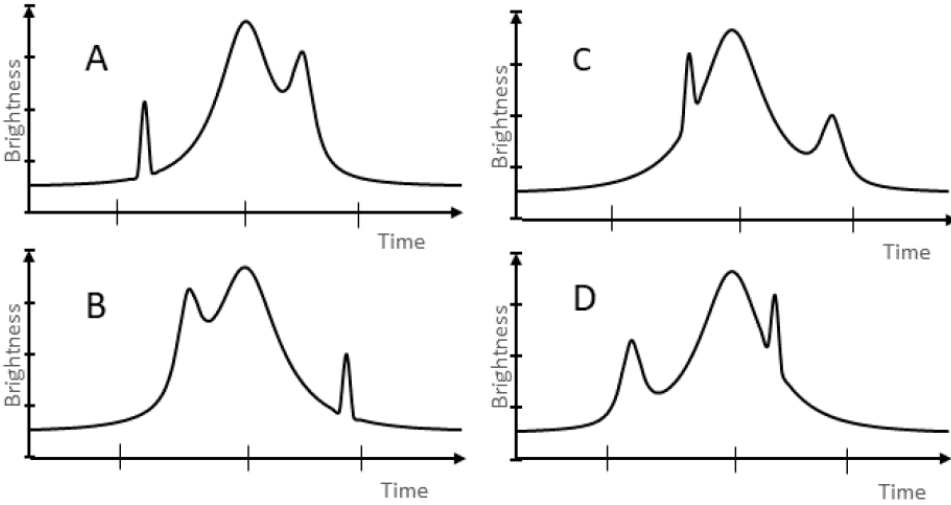
You're studying 3 genes that have lengths shown below. How would you expect them to appear on a gel electrophoresis.

Genes:

X = 400 bp Y = 1000 bp Z = 800 bp



Aliens living in the Andromeda Galaxy are observing a distant star in the Milky Way when our solar system moves across their line of sight from left to right. They detect the presence of Venus and Saturn. Which brightness vs. time graph (A, B, C or D) and which solar system diagram (I, II, III or IV) are correct if Venus is observed first, followed by the Sun, and then Saturn?



- A. Graph A & Diagram II
- B. Graph B & Diagram IV

- C. Graph C & Diagram I
- D. Graph D & Diagram III

The “matching lists” below connect a numbered step in the heat engine process (1-4, shown in the PV graph) with one of the four piston diagram (P-S, where M is a non-negligible mass) and the amount of work done by the gas on the piston (W) during that step of the process. How many of the “matching lists” are possible?

matching lists

3, R, $W = 0$

2, Q, $W < 0$

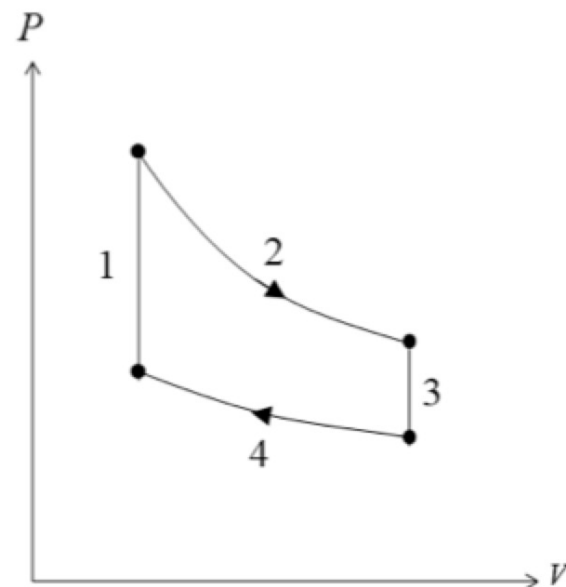
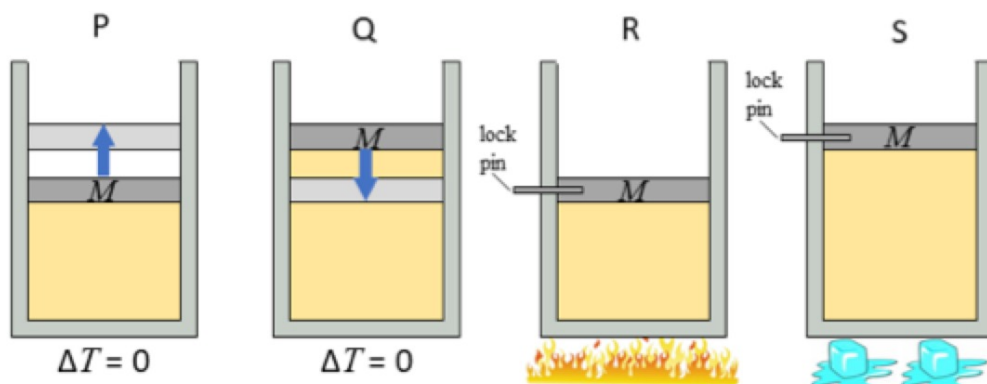
1, R, $W > 0$

4, P, $W < 0$

3, S, $W = 0$

2, Q, $W > 0$

1, S, $W = 0$



- A. only one of the matching lists is possible
 B. two of the matching lists are possible
 C. three of the matching lists are possible
 D. four of the matching lists are possible
 E. more than four of the matching lists are possible

Your friend is interested in whether gluten causes weight gain in rats. He measured gluten metabolites in 3 randomly selected rats and their weights. The heaviest rats had the most metabolites, so he concludes gluten caused weight gain.

How many of the topics below could you use to convince him he needs more evidence?

1. Sample size
2. Correlation vs. causation
3. Temporality
4. Sampling bias

- A. 0
- B. 1
- C. 2
- D. 3
- E. 4

