Question Design Patterns

A toolkit of effective question types to meet a variety of teaching goals

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Question design patterns are general ways of building TEFA questions that successfully achieve specific instructional aims. They are not quite "fill in the blanks" templates, but they are more specific than general strategies or qualities. Some patterns suit certain circumstances and instructional objectives better than others.

The goal of each pattern is to direct students to engage in a particular kind of thinking, since different kinds of thinking both reveal and develop different aspects of students' knowledge. The patterns have been divided into groups promoting similar kinds of thinking. *Caveat 1:* The boundaries between patterns, and also between groups, are neither sharp nor well-defined. *Caveat 2:* This list of patterns is not complete, though we believe it contains most of the common types as well as a few unusual, stimulating ones. Our goal is to provide a useful tool for stimulating ideas, not a clean taxonomy for categorizing questions. A question may very well fit two or more patterns.

We hope that reviewing this list will help you when you know what you want to accomplish in class, but aren't sure how best to do that, or when you feel your CRS use is stuck in a rut and you want to try something new.

The reader will note that no "recall the fact" or "demonstrate ability to execute a process" pat-

Why "Design Patterns"?

Architects and structural engineers solve problems when they design: how to provide a certain desired functionality, given specific constraints, as efficiently (and often attractively) as possible. If the same general kinds of problems come up again and again, differing only in superficials, why should designers start over each time? That was the premise of *A Pattern Language: Towns, Buildings, Construction*, a 1977 book by Christopher Alexander, Sara Ishikawa, and Murray Silverstein of the Center for Environmental Structure in Berkeley, CA. The book contained 253 architectural design patterns coupled to specific needs and circumstances. It provides general descriptions and pictures, and leaves the specific details to be worked out according to a specific project's environment. More than 25 years later, the book remains one of the best-selling books on architecture.

In 1987, Kent Beck and Ward Cunningham carried the idea into software engineering. Here too, they argued, similar programming problems arise over and over; why should programmers re-invent solu-

terns are included. While occasionally useful, these do nothing to exercise student *thinking*.

Evaluative Thinking

SOLVE

– *If X, determine Y. [list choices, or numeric response]*

This apparently "right/wrong" pattern, often over-used, can be useful at times: perhaps to quickly check for competence, or to set up a discussion, or to motivate a new idea or technique, or to sensitize students to the importance of a particular assumption. ***Variant:*** Ask for the answer option "closest to" the true result. ***Variant:*** Provide a "none of the above" option, and have it be the best choice often enough that students learn to respect it.

EVALUATE

– *[Context.] Which of the following statements are true? Pick all that apply. [list assertions]*

Students are accustomed to being told, and to remembering, what is true. They are less used to assessing the truth of statements, but this is a necessary higher-level skill for scientific and mathematical thinking. ***Variant:*** List similar statements that all seem reasonable, so students must focus on the significance of the differences. ***Variant:*** Include a reason in the assertions ("*X*, because *Y*"), so students must evaluate the truth of the assertion and of the reason.

ENUMERATE

– *How many X are Y? [list possible integers, or numerical response]*

– *How many X does Y have? [list or numerical response]*

Unlike for *SORT/CLASSIFY*, students are not given a list of possible *X*, so they are involved in *generative* thinking. The pattern is useful for helping them learn to identify relevant things (forces, components, characteristics, etc.). The situation should usually be clear-cut and simple, or counting possibilities can become unrealistic. ***Variant:*** Include options like "less than *N*," "more than *N*," or "impossible to determine."

Comparative Thinking

JUDGE SIMILARITY

– *Which of the following X is most like Y?*

– *X is to Y as Z is to which of the following?*

This pattern stimulates compare-and-contrast thinking, which is powerful for helping students explore and relate things, and also for revealing how they perceive or think about something. Questions in this pattern have two levels of comparison: students must compare each answer choice to the standard (*X*), and must compare the response choices to each other based on how well they fit the standard. ***Variant:*** Use a photo or other alternative representation for *Y*. ***Variant:*** Make it a "big stretch," with *Y* a very different kind of thing than the options.

SORT/CLASSIFY

– *Which of the following are X? [list cases, things, or situations]*

– *For which of the following is X true?*

Sorting or classifying helps students begin to structure their knowledge, sensitizing them to similarities and differences. It also helps you discover what features they are keying on, which may not be the features you consider important. ***Variant:*** Don't provide a criterion, but simply ask students to divide a set of things into two subsets, and then explain the criterion they chose.

RANK/COMPARE

– *Which of the following (is/has/would have) the (most/least/greatest) X? [list]*

– *Which X is most Y? [list]*

Like *SORT/CLASSIFY*, this pattern elicits comparative thinking, but it does so by having students compare the relative magnitudes of something rather than membership in a set. It is particularly useful when helping students to develop a sense of the strength of effects. ***Variant:*** Have students pick the 2 (or 3 or etc.) largest/

tions each time? In 1994, Erich Gamma et al. published *Design Patterns: Elements of Reusable Object-Oriented Software*, describing 23 classic software design patterns that can be adapted to different programming languages and specific circumstances. Several other collections of software design patterns have since appeared.

We believe that TEFA-using teachers, too, face the same instructional problems over and over, with the specific topic at hand being the only significant differences. "Good" TEFA questions are effective for specific reasons, and their design can be generalized and applied to help create good questions on other topics.

smallest cases. ***Variant:*** Have students rank the entire set, either using multiple choice and having each option represent a possible ordering, or by using *Interwrite Response*'s "Answer Series" question type.

COMPARE WAYS

- *Which X is best for accomplishing Y? [list possibilities]*
- *In order to X [most Y], which Z (should/could) you use? [list]*

This pattern also involves comparative thinking, and helps students reflect upon and structure their knowledge as a "toolkit" of useful ideas and techniques. You can ask about models, principles, procedures, strategies, problem-solving choices, experimental tools, reagents, etc. ***Variant:*** Ask which can "most efficiently" or "most reliably" be used to bring in different criteria for judgment, or leave the criteria unstated to allow different interpretations of "best" to arise in discussion.

PREFER

- *If you (had/wanted) to choose one X in order to Y, which would you pick? [list options]*
- *If X, would you Y? [yes, no, it depends]*

This pattern can be powerful in making a topic more personal to students, and in helping you understand what thinking they bring to it. ***Variant:*** Include emotionally loaded and conflicting factors to create a difficult dilemma. ***Variant:*** Omit "it depends" from the second version in order to force students to commit, at least provisionally, to a hard choice.

Representational Thinking

RELATE REPRESENTATIONS

- *Which X best (describes/represents/fits) Y? [list possible representations]*

Alternative (often graphical) representations are powerful tools for scientific and mathematical thinking, often under-used by students. Questions that require connecting different representations help make them useful, and solidify understanding. The choices can be pictorial diagrams, topic-specific diagrams like cardiograms, schematics, equations, graphs, etc. ***Variant:*** Include an "it depends" option to stimulate consideration of contingencies—but be careful this doesn't distract from your primary point.

DEPICT

- *[Have students draw or otherwise represent a specific situation or process.] Which of the following is most like your drawing? [list possibilities]*

Having students draw—forcing them to re-represent something—helps them digest it, and the results can be very revealing for you, especially if you can walk around and inspect their drawings. It can also help them learn to see visual representations as a thinking tool they can use. ***Variant:*** Include a "none of the above" option to handle unanticipated (often interesting) cases.

GESTALT

- *Which of the following might X represent? [list possibilities]*

This pattern is the inverse of *DEPICT*. *X* is a graphical or other non-textual representation of some kind, possibly quite ambiguous, and the list of choices are situations or things that it might fit. *X* can be a Venn diagram, schematic, spectrum diagram, sonogram, cardiogram, DNA test result, equation, graph, or even an inkblot. ***Variant:*** Use "choose all that apply" to unleash creativity, at the expense of rigorous evaluation and comparison of options. ***Variant:*** Present the question without answer options, and have students brainstorm possibilities; then collect a set of possibilities, number them, and have students choose their favorite via CRS.

Causal Reasoning

DETERMINE IMPLICATION

- *If you want X, should you Y? [yes, no, it depends]*

This pattern engages students in the question of what their new knowledge means. "Should" is a power word that can bring in a range of criteria and considerations, opening up rich discussion. ***Variant:*** For a tough dilemma, omit the "it depends" option to eliminate the easy out and force at least provisional commitment to a side.

PREDICT & VERIFY

- *[Present a concrete situation.] What will happen if Y? [list possibilities]; after students answer, do a demo or otherwise confirm/refute their predictions*

This pattern asks students to apply causal reasoning or their intuition to a system or situation, in order to reveal, test, and refine that reasoning and intuition and help connect it to scientific or mathematical ideas. ***Variant:*** Have students predict via CRS responses, discuss their reasons,

poll again, then do the demo/check. ***Variant:*** Confront deeply-held beliefs and biases with counterintuitive evidence.

DIAGNOSE

- *[Describe a case.] Which of the following (might/is most likely to) be the (cause/problem/reason)? [list possibilities]*

This pattern gets students to apply their knowledge in a (hopefully) engaging, deductive manner. It also develops the scientific habit of hypothesis inference. A natural follow-up question is to ask how students might test their diagnoses or hypotheses (cf. *COMPARE WAYS*). ***Variant:*** Include "other" as an option to open speculation about other possible causes.

RECOMMEND

- *[Describe a situation.] What (decision/advice) would you (make/give)? [list possibilities]*

Similar to *DIAGNOSE*, this pattern asks students to apply their knowledge and consider its implications. It encourages more open-ended thinking than *DIAGNOSE*. ***Variant:*** Mix multiple ideas or factors, especially ones that suggest conflicting recommendations. ***Variant:*** Address personally meaningful or emotionally loaded topics and beliefs to stimulate engagement and help the subject hit home. ***Variant:*** Include an option for "other" to encourage creative thinking.

HYPOTHESIZE CHANGE

- *[Describe a situation.] How (would/might) X differ if Y?*

This is similar to *INFER FROM A MODEL*, but doesn't require a detailed model (though we can argue that a model is still implied). It focuses students on the causal effect of specific factors, which can help them understand relationships between ideas.

Model-Based Reasoning

INFER FROM A MODEL

- *[Describe or summarize a model, system, or mechanism.] If X, will Y? [yes, no, it depends]*
- *[Describe…] What will happen if Y? [list possibilities]*
- *[Describe…] What X is necessary for Y to (happen/be true)? [list possibilities]*
- *[Describe…] (Where/how/when) should X be Y in order to Z? [list possibilities]*

Many sciences involve teaching students about specific models, or about tools for creating models for situations: cellular processes, physiological systems, food webs, physical models, etc. Even algebraic equations can be conceived as models for something. Asking students to make inferences about something based on a model—to reason with the model—both develops and illuminates their understanding of the model. The model presented can be known, new to students, or a new elaboration or variation of a familiar one. ***Variant:*** Provide the model graphically, rather than textually.

EXTEND A MODEL

- *[Describe or summarize a familiar model.] How must the model be (extended/changed) in order to Y? [list possibilities]*

To see how well students really understand a model of something, and to help them practice real scientific thinking, ask them to change it to explain or predict something new, or to model the original thing better. ***Variant:*** Combine with *COMPARE WAYS* by listing several models or systems, and asking which could most easily be modified to fit the new situation.

Introspective Thinking

REFLECT

- *How (confident/confused) do you feel about X? [list various degrees/amounts]*
- *Which of the following are you (confused/uncertain) about? [list ideas/procedures]*
- *How do you (do/like to) X best? [list possible preferences]*
- *Etc…*

Any question that directly asks students for an honest reporting of their feelings, opinions, or self-assessment of something fits this pattern. It can help you better understand your students and where they are at the moment, and can help your students become more self-aware. The question can inquire about self-evaluation of knowledge and understanding, preferred tools and procedures learning styles, hopes and fears, or many other things. Discussion is not necessary, and is often inappropriate, unless students want an opportunity to explain themselves or vent more extensively.

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Given the following equations:

$$3a = 24$$
$$a + b = 16$$

What is the value of b?

Enter a number, or enter (0) for Impossible to determine.

credit: Wiliam, D. (2007). Keeping learning on track: Classroom assessment and the regulation of learning. In F. K. Lester (Ed.), Second Handbook of Mathematics Teaching and Learning. (pp. 1051-98). Greenwich, CT: Information Age Publishing.

solve

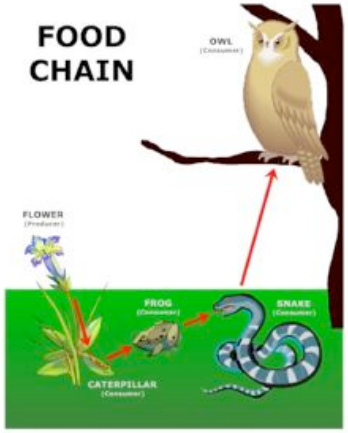
A volleyball (circumference=66cm) is inflated to a pressure of 4.5psi. The number of moles of gas inside the volleyball is CLOSEST to:

1. 0.02
2. 0.06
3. 0.10
4. 0.14
5. 0.18
6. 0.22
7. 0.26
8. 0.30

solve

credit: Bill Leonard, UMass Amherst

In this food chain, would you expect to have more owls or more frogs? Why?



1. More owls because they are good hunters and can catch more food than frogs can.
2. More frogs because they are lower on the food chain.
3. More owls because they are higher on the food chain.
4. More frogs because they have more food to eat.
5. More frogs because they are smaller and need less food.
6. More owls because no predators eat them.

evaluate

credit: Cathy Wanat, Northampton High School

The sky appears to be blue during the day because:

1. Air absorbs blue light less than other frequencies (i.e., acts like a blue filter).
2. Air molecules emit blue light after being struck by sunlight.
3. The sky reflects blue light from the oceans.
4. The temperature high in the Earth's upper atmosphere is 1000 K.
5. None of the above.

evaluate

credit: Bill Gerace, UMass Amherst

A block m sits on a rough surface, with a spring attached and extended. As the block moves up the incline a small distance, how many forces are exerted on the block?

1. one force
2. two forces
3. three forces
4. four forces
5. five forces
6. six forces
7. seven forces
8. more than seven forces
9. impossible to determine
0. none of the above

enumerate

credit: Bill Gerace, UMass Amherst

You are hiking, and have run out of water. You are overheated and thirsty. How many of your body's systems (digestive, excretory, endocrine, nervous, muscle, circulatory, etc.) are involved in restoring homeostasis?

Enter a number from 0 to 8, or "9" to mean "more than 8").

enumerate

credit: adapted from a question by Kate Dollard, Northampton High School

Which component(s) of the digestive system are most like the pictures below?

Enter all that apply.

1. Mouth
2. Pharynx
3. Esophagus
4. Stomach
5. Small Intestine
6. Large Intestine
7. Rectum
8. Liver
9. Gall bladder
10. Pancreas

judge similarity

credit: Cathy Wanat, Northampton High School

Skin:Wall as Mucus:_____

1. Welcome mat
2. Storm door
3. Moat
4. Room
5. mailbox
6. vaseline
7. no pest strip
8. none of the above
9. other

judge similarity

credit: Kate Dollard, Northampton High School

In which of the following situations is the object accelerating? Choose ALL that apply; enter "0" for "none".

1. a car slowing down at a stop sign
2. a ball being swung in a circle at constant speed
3. a vibrating string
4. the Moon orbiting the Earth
5. a skydiver falling at terminal speed
6. an astronaut in an orbiting space station
7. a ball rolling down a hill
8. a person driving down a straight section of highway at constant speed with her foot on the accelerator
9. a molecule in the floor of this room

sort/classify

credit: Bill Leonard, UMass Amherst

Which of the following are alive? Choose ALL that apply. (Enter "0" for "none".)

1. a seed
2. a leaf on a tree
3. a leaf immediately after it has fallen
4. a tree in spring (no leaves; just buds)
5. a tree in summer (lots of leaves)
6. a tree in fall (leaves are not green)
7. a tree in winter (no leaves)

sort/classify

credit: Bill Leonard, UMass Amherst

Which of the following are ambiguous? Choose ALL that apply.

1. origin
2. function
3. equilibrium
4. f(x)
5. x
6. m
7. $\sin^{-1}(x)$
8. relationship
9. power
0. none fothese

sort/classify

credit: Bill Leonard, UMass Amherst

Pick the 2 groups that would have the biggest effect on water quality in a watershed.

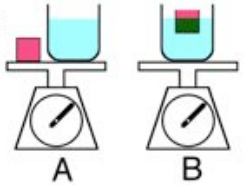
Enter up to two.

1. **Homeowners**
2. **Factory owners**
3. **Pet owners**
4. **Vehicle owners**
5. **Boat owners**
6. **Farmers**
7. **Loggers**
8. **City wastewater treatment plant operators**

rank/compare

credit: Cathy Wanat, Northampton High School

A block and a beaker of water are placed side-by-side on a scale (case A). The block is then placed into the beaker of water, where it floats (case B). How do the two scale readings compare?



1. Scale A reads more than scale B.
2. Scale A reads the same as scale B.
3. Scale A reads less than scale B.
4. Not enough information.

rank/compare

credit: Bill Gerace, UMass Amherst

Which kind of reproduction is best for species survival?

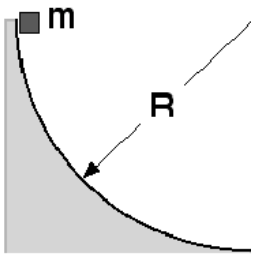
1. Asexual
2. Sexual
3. Neither

compare ways

credit: Kate Dollard, Northampton High School

b) A mass *m* slides down a frictionless circular track of radius *R*. Which of the following would let you <u>most efficiently</u> find its angular velocity relative to the center of curvature when it reaches the bottom?

1) Kinematics only
2) $F = ma$ or Newton's laws
3) Work-energy theorem
4) Impulse-momentum theorem
5) Angular impulse-angular momentum theorem
6) More than one of the above
7) None of the above



compare ways

credit: Bill Gerace, UMass Amherst

If you could only have one system left, which would it be?

1. Circulatory
2. Nervous
3. Endocrine
4. Immune
5. Digestive
6. Respiratory
7. Excretory
8. Muscle/Skeletal

prefer

credit: Kate Dollard, Northampton HS (based on a question by Chevy Seney of Frontier Regional School)

If you were walking along a road and passed a piece of trash, would you pick it up?

1. yes
2. no
3. it depends

prefer

credit: vaguely recollected from a question described by Kate Dollard, Northampton HS

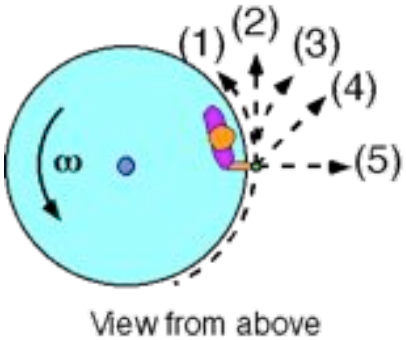
The diagrams below show two uniformly charged spheres. The charge on the right sphere is 3 times as large as the charge on the left sphere. Which force diagram best represents the magnitudes and directions of the electric forces on the two spheres?

1. 
2. 
3. 
4. 
5. 

relate representations

credit: Bill Gerace, UMass Amherst

A child is standing at the rim of a disk holding a rock. The disk rotates freely without friction. At the instant shown, the child throws the rock radially outward. Which of the indicated paths most nearly represents the trajectory of the rock as seen from above?

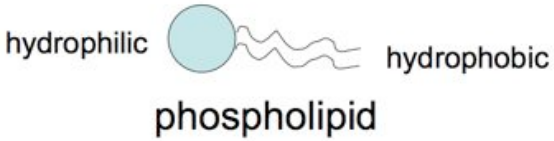


6. none of the above
7. cannot be determined

relate representations

credit: Bill Gerace, UMass Amherst

the set-up…



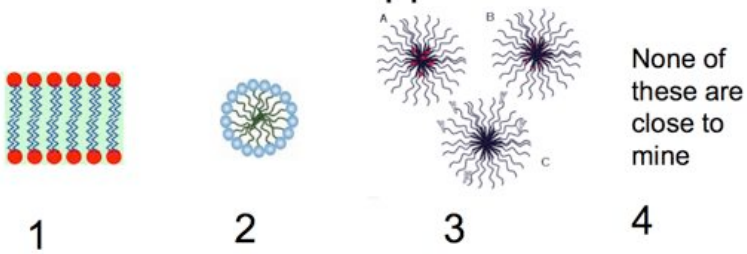
Hundreds of phospholipids are dropped in water and, under the water, form a sphere with water trapped inside. Draw a possible arrangement of the phospholipids to form this sphere

depict (step 1)

credit: Kate Dollard, Northampton High School

…and the question.

Which drawing is closest to your idea of how the phospholipids could be arranged into a sphere in water with water trapped inside?

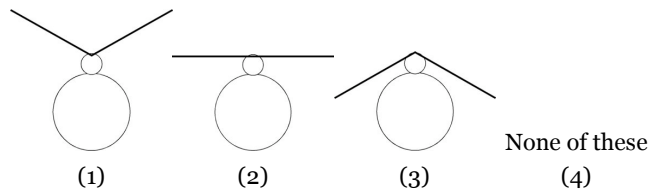


depict (step 2)

credit: Kate Dollard, Northampton High School

[Context: Students have been shown how to connect two forks to a quarter, and balance the assembly counter-intuitively on the edge of a cup. After experimenting with this for a bit:] Make a drawing of the top view of the arrangement of 2 forks, 1 quarter, and 1 cup.

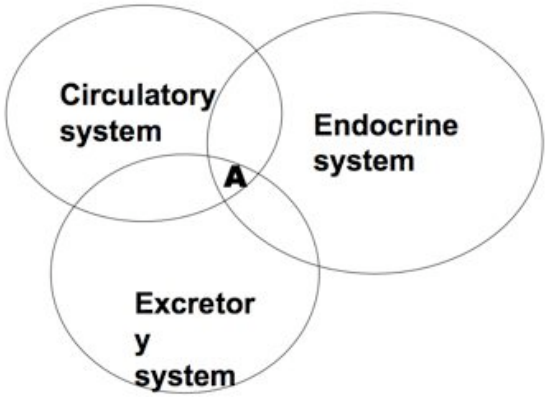
[after drawing:] Which drawing below most closely resembles yours?



depict (both steps)

credit: Bill Leonard, UMass Amherst

What could A represent? [Students discussed Q in groups, responses were collected on board, class discussed, and then used the CRS to vote on their top 2 picks from the list.]



gestalt

credit: Kate Dollard, Northampton High School

What physiological problem might this electrocardiogram indicate?

[imagine an appropriate list of possible health conditions]

gestalt

credit: Idea by Ian Beatty, UMass Amherst, who doesn't have the content knowledge to invent a good set of choices.

If you want to have strong, athletic children, you should work out at the gym a lot.

Enter one response.

1. Agree
2. Disagree
3. It depends.

determine implication *credit: Cathy Wanat, Northampton High School*

If you want to do as little work as possible while carrying a heavy box, should you be careful not to let it move up and down at all as you walk?

1. yes
2. no
3. it depends

determine implication *credit: Ian Beatty, UMass Amherst*

A coin has just been flipped 1000 times, and it landed heads 600 times and tails 400 times. What is the probability that the next flip of the coin will land heads?

1. 10%
2. 20%
3. 30%
4. 40%
5. 50%
6. 60%
7. 70%
8. 80%
9. impossible to determine
0. none of the above

predict & verify *credit: Bill Leonard, UMass Amherst*

Two identical steel balls are released from rest from the same height and travel along tracks as shown and labeled below.

Which ball reaches the end of its track first?

1. The ball on track A.
2. The ball on track B.
3. Neither; it's a tie.
4. Not enough information.

predict & verify *credit: Bill Gerace, UMass Amherst*

You are a doctor, and a patient comes to you complaining that she's unusually short of breath after exercising. What health problems might be responsible? Choose all that apply.

1. leaky heart valve(s)
2. damaged heart muscle
3. hardened arteries
4. high blood pressure
5. low red blood cell count
6. obstructed veins in heart muscle
7. poor diet
8. high cholesterol levels
9. heartbeat arrhythmia
0. none of the above

diagnose

credit: Ian Beatty, UMass Amherst

You are a dietician helping a teen-ager with his diet. Here is a typical day's meal:

Breakfast: bagel and orange juice

Lunch: Pita with lettuce, tomato, peppers & olives and banana

Supper: pasta with tomato sauce, salad with low-fat dressing, Coke

What advice would you give this person?

Choose ALL that apply.

1. Keep up the good choices!
2. Add more fat to your diet.
3. Remove fat from your diet.
4. Add more carbohydrates to your diet.
5. Remove carbohydrates from your diet.
6. Add more calcium to your diet.
7. Reduce the calcium in your diet
8. Add more protein to your diet.
9. Remove protein from your diet.

recommend

credit: Cathy Wanat, Northampton High School

To minimize the work you do getting a heavy bag of groceries from the first floor to the second floor of a building, should you:

1. carry the bag up the stairs?
2. carry the bag up in an elevator?
3. put the bag on the floor of an elevator, ride up with it, and then pick up the bag again?
4. carry the bag up a ramp?
5. put the bag in a cart and push it up a ramp?

recommend

credit: Bill Gerace, UMass Amherst

How would a giraffe's heart be different from a human's? Choose all that apply.

1. it would be larger
2. it would be proportionally larger
3. it would have thicker walls
4. it would have proportionally thicker walls
5. it would beat faster
6. it would beat more slowly
7. it would have more chambers
8. it would have different valve mechanisms
9. it would be located somewhere else in the body

hypothesize change

credit: Ian Beatty, UMass Amherst

In a beaker, a saturated salt solution is in equilibrium with undissolved salt lying on the bottom of the container. If some alcohol is now poured into the beaker, what will happen?

1. More salt will dissolve, leaving less on the bottom.
2. Some salt will crystallize out of solution, leaving more on the bottom.
3. All the salt will crystallize out of solution.
4. Something else will happen.
5. Nothing will change.

hypothesize change

credit: Ian Beatty, UMass Amherst

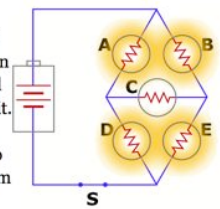
Methotrexate is an antimetabolite drug that interferes with the formation of nucleotides. At what stage would it be most effective?

1. G_1
2. G_0
3. S
4. G_2
5. Prophase
6. Metaphase
7. Anaphase
8. Telophase
9. Cytokinesis

infer from a model

credit: Sue Lincoln, Northampton High School

A battery and 5 bulbs are arranged as shown, and when the switch is closed 4 of the bulbs are lit. Which bulbs **change** when bulb B is unscrewed from its socket?



1. Bulb E goes out. (Bulbs A and D stay on; bulb C stays off.)
2. Bulb E goes out; bulb C goes on. (Bulbs A and D stay on.)
3. Bulb A goes out; bulb C goes on. (Bulbs D and E stay on.)
4. Bulb C goes on. (Bulbs A, D, and E stay on.)
5. Bulb C goes on; bulb D goes out. (Bulbs A and E stay on.)
6. I have no idea!

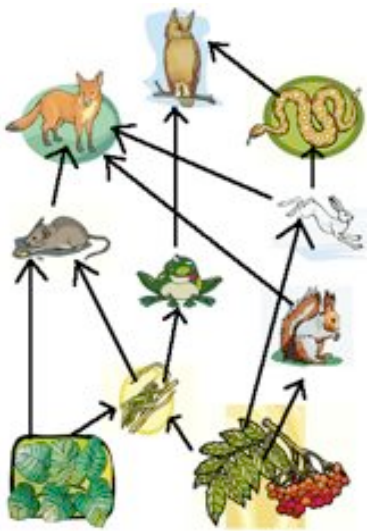
infer from a model

credit: Bill Leonard, UMass Amherst

the set-up…

Observations of a particular ecosystem lead you to propose this food web. If a disease causes the population of frogs to decrease, what would you expect to happen to the population of rabbits?

1. increase
2. decrease
3. stay the same



extend a model, set-up

credit: Ian Beatty, UMass Amherst

…and the primary question.

Now, if you observe that the population of rabbits <u>increases</u> but the population of squirrels does not, which of these changes to the food web is most likely to explain this?

1. decide frogs eat rabbits
2. decide owls don't eat frogs
3. decide squirrels eat crickets
4. decide owls eat rabbits
5. decide foxes eat frogs
6. decide snakes eat trogs
7. decide we're missing an important plant or animal (that fits where?)

extend a model, completion

credit: Ian Beatty, UMass Amherst

A simple pendulum is released from rest with the string at an angle A. It swings back and forth with frequency f. The angle θ that the string makes with the vertical as a function of time can be described by the equation $\theta(t) = A\cos(2\pi f\, t)$. Which of the following equations might describe a real pendulum whose oscillations gradually die out as time passes? ("B" is some constant.)

1. $\theta(t) = A\cos(2\pi f\, t)$
2. $\theta(t) = A\cos(2\pi f \sqrt{t})$
3. $\theta(t) = A\cos^2(2\pi f\, t)$
4. $\theta(t) = A\, e^{-Bt}\cos(2\pi f\, t)$
5. $\theta(t) = A\cos(2\pi f\, e^{-Bt}\, t)$
6. $\theta(t) = A\cos(2\pi f t) - Bt$
7. none of the above

extend a model

credit: Ian Beatty, UMass Amherst

Which of the following are you least comfortable using to solve problems?

1. Kinematics
2. Newton's Laws
3. Work-Energy Theorem
4. Momentum-Impulse Theorem
5. Angular Momentum-Angular Impulse Theorem

reflection

credit: Ian Beatty, UMass Amherst

Which of the following skills are you confident about right now? Mark ALL that apply. Enter "9" for "None of these".

1. operating the PRS hardware and software
2. creating PRS questions
3. managing small-group work
4. managing whole-class discussions
5. anticipating students' answers and explanations
6. interpreting students' answers and explanations
7. adjusting instruction based on students' answers & explanations
8. integrating PRS with classroom and curricular constraints

reflection

credit: Bill Leonard, UMass Amherst