



# Multiple Choice Questions and Higher Order Learning



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UBC - Vancouver  
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# Land Acknowledgement native-land.ca

Native Land  

Territory Acknowledgement Teacher's Guide Join or Donate Blog About Language

Territories  Languages  Treaties

Search your address, or toggle switches above to add shapes. Click around! [Think critically about this map](#)

Territories

Languages

Treaties

You are on the land of:

- [səlilwətaʔ təməx\\* \(Tseil-Waututh\)](#)
- [S'ólh Téméxw \(Stó:lō\)](#)
- [Stz'uminus](#)
- [x'məθk'əyəm](#)
- [səlilwətaʔ təməx\\* \(Tseil-Waututh\)](#)

Qayqayt

S'ólh Téméxw (Stó:lō)

səwaθenəʔ təməx\* (Tsawwassen)

Katzie

Export Map  Colors  Labels

mapbox

© Mapbox © OpenStreetMap

# Protocols

- Will go quickly
  - Slides provided after the workshop
- Judy or Carrie will be monitoring Chat
  - We aim to address the questions at designated pauses throughout the workshops
  - Remember, you can send chats directly to individuals (not the group)
- Feel free to MUTE when not speaking
- Video or No video: Your Choice



# Learning Outcomes

At the end of this workshop, you will be able to:



- Define and give examples of higher order thinking/learning
- Explain the importance of aligning learning outcomes, instructional methods and assessment
- Write good learning outcomes that aid in assessment
- Identify and apply best practices in writing MCQs
- Assess the appropriateness of using a MCQ to assess a learning outcome
- Write MCQs that assess higher order thinking/learning



## **Agenda** *60 min*

Higher Order Thinking and its relationship with Learning Outcomes and Assessment

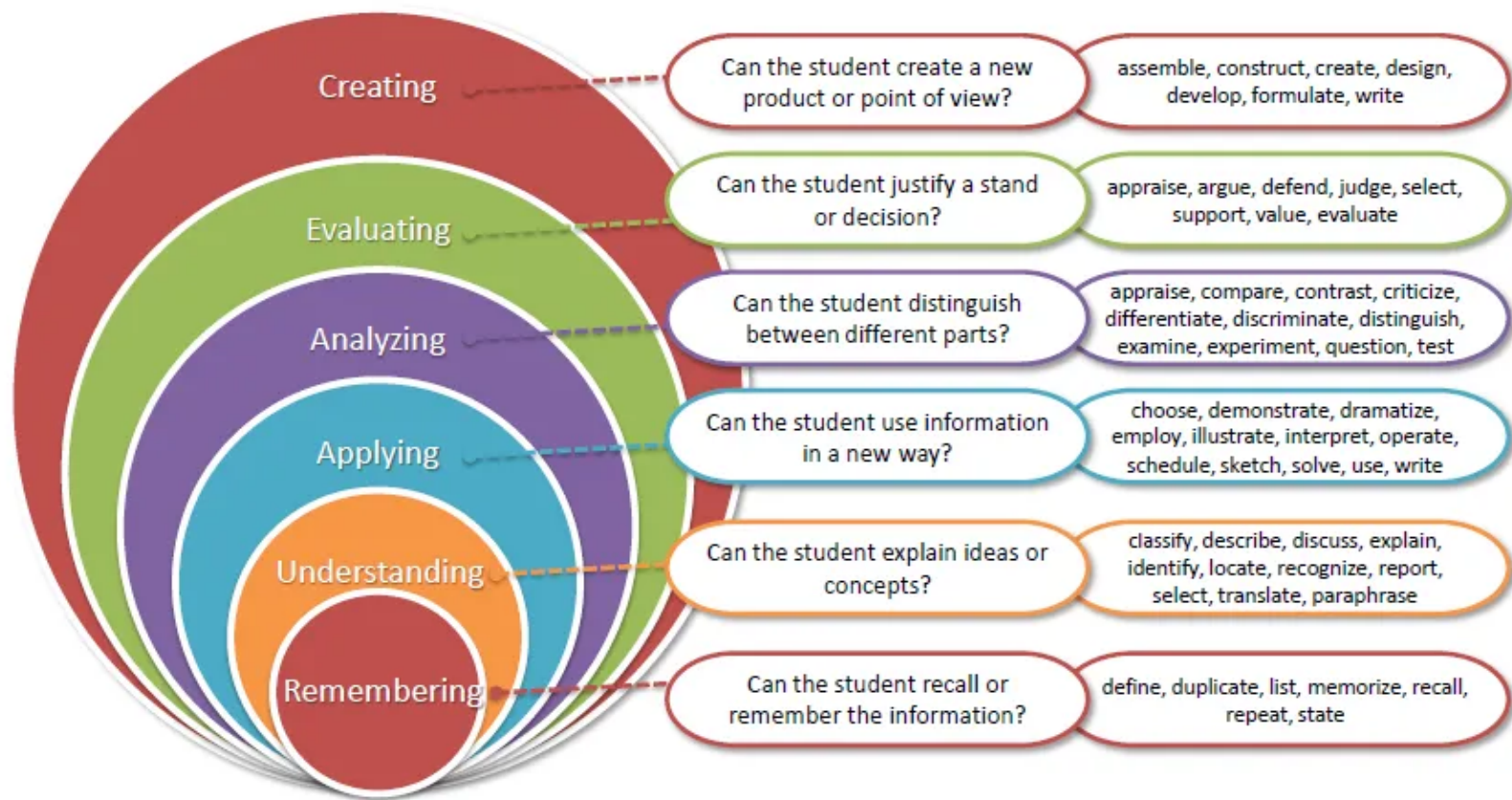
Best Practices in writing MCQs

Tips for Developing HOL MCQs

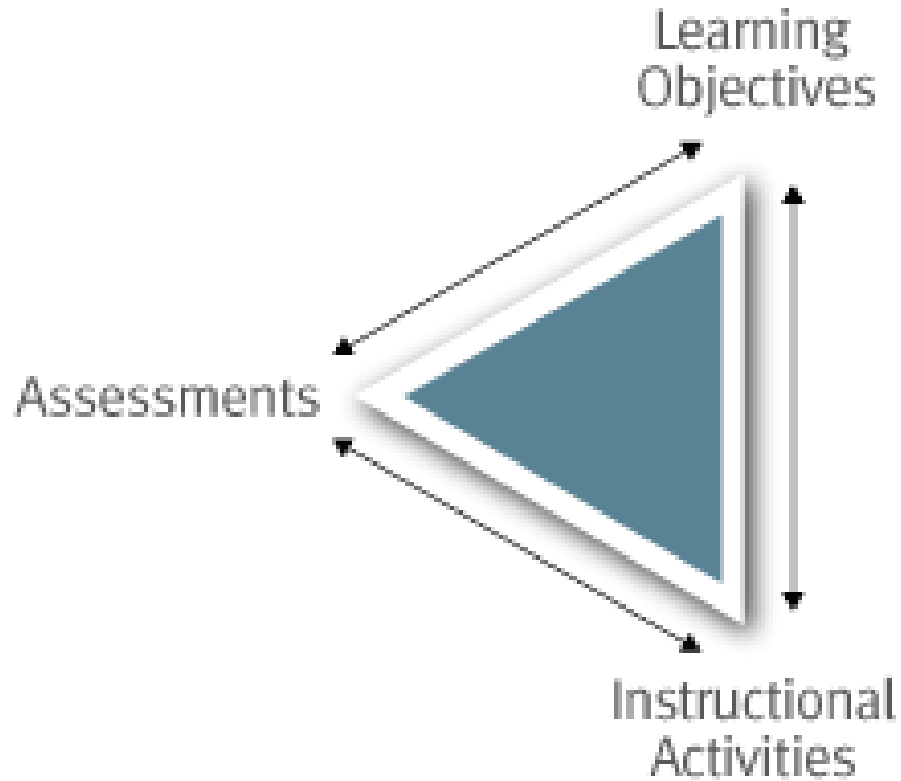
Breakout - Take one or two of these strategies and apply it to one or two of the questions/content you brought

Share back

# Bloom's Taxonomy (Revised)



# CONSTRUCTIVE ALIGNMENT



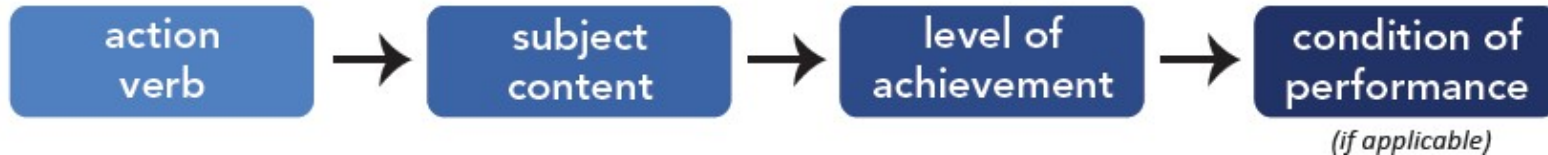
# GOOD LEARNING OUTCOMES

.....Make Assessment Questions Easier

A *Learning Outcome (LO)* is a

- **measurable**, **observable**, and **specific** statement that clearly indicates what a student should know and **be able to do** as a **result** of learning.

Well-written LOs involve the following parts:



**So, Step 1: Clarify your Learning Outcome!**





# Example

Learning Outcome:

Identify the artists responsible for major contemporary musical pieces.

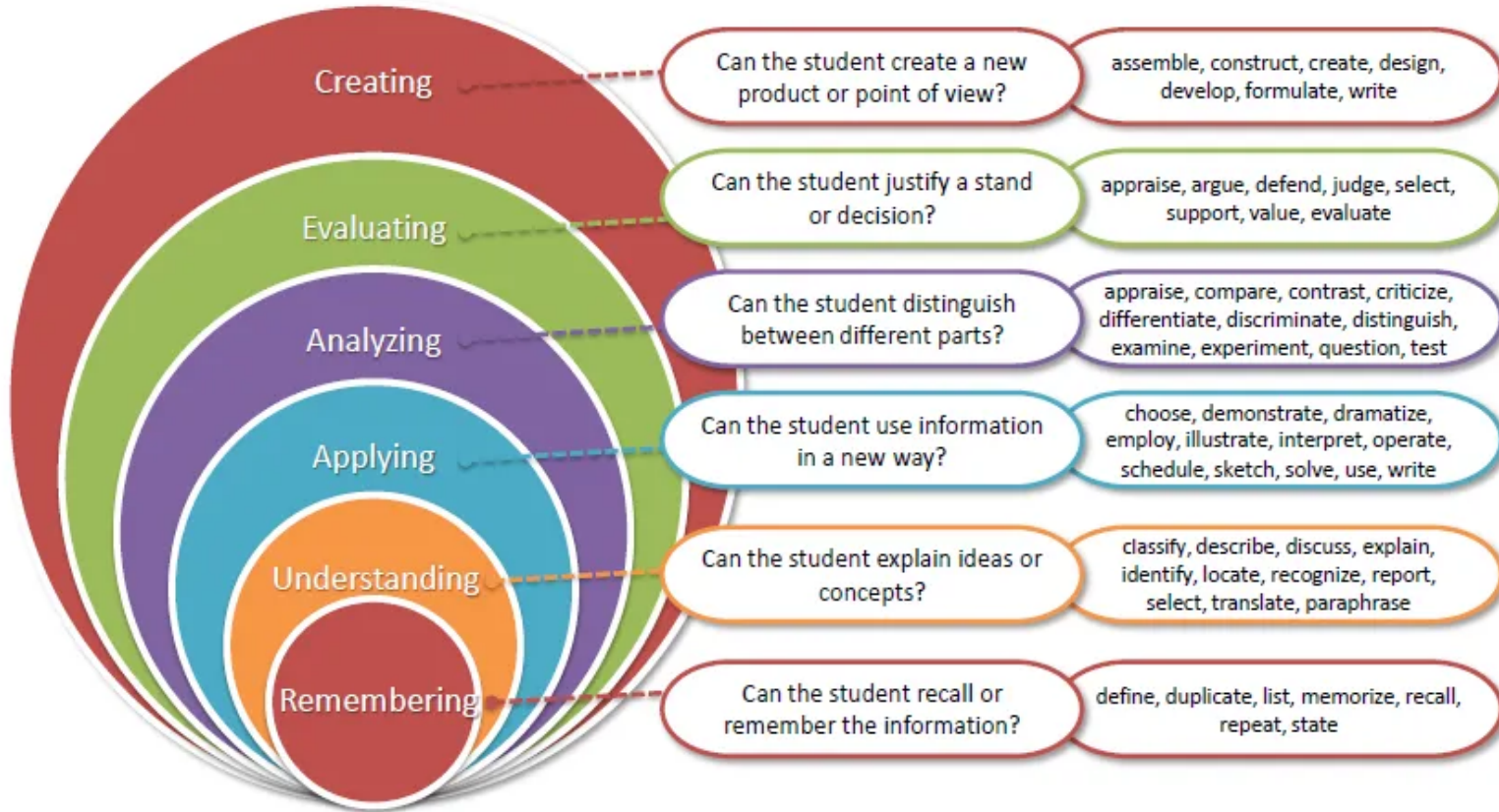
Possible Question:

What band first recorded the song “Let It Be”?

- a) The Rolling Stones
- b) The Beatles
- c) The Beach Boys
- d) The Who
- e) The Kinks



# Are MCQs appropriate for every Learning Outcome?



# Best Practices in Writing MCQs



What is the primary purpose of this workshop?

- a. Generate multiple choice question banks
- b. Mingle with other instructors
- c. Create good learning outcomes
- d. Expand your capacity to create good MCQs for higher order thinking outcomes

One-Best-Answer Question Format  
Scope of Question



# Which of the following shows an appropriately shaped question?

A.

Short Stem

A.

B.

C. Long Options

D.

E.

B.

Long Stem

A.

B.

C. Short Options

D.

E.

Length of Stem  
Length of Options



Which option is most often the 'correct' answer?

- A. A
- B. B
- C. C
- D. D
- E. E
- F. I don't know

Right Answer Frequencies  
Testwise-ness & Guesswork

Which of the following statement(s) is/are **FALSE** about multiple choice questions:

- A. Consists of a stem, lead-in question, and options
- B. Can be used to assess higher order learning, such as application and synthesis
- C. Easy to construct for assessing recall of facts
- D. Tests literacy skills
- E. I don't know

True/False Question Format  
Ambiguous Options

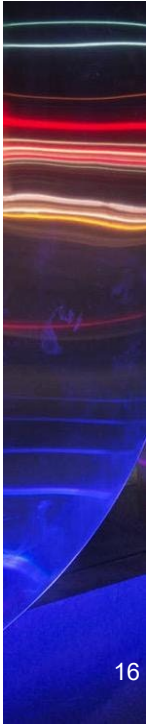
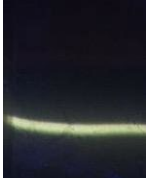


## When writing your options, make sure that they are:

- A. Homogeneous in content (eg, all are diagnoses; all are next steps in patient care)
- B. Incorrect or inferior to the correct answer
- C. Plausible and attractive to the uninformed
- D. Similar to the correct answer in construction and length
- E. Grammatically consistent and logically compatible with the stem
- F. All of the above
- G. I don't know

## Formulating the Options

All of the above/None of the above





## Use plausible distractors (wrong-response options)

- (i) Only list plausible distractors, even if the number of options per question changes
- (ii) Write the options so they are homogeneous in content
- (iii) Use answers given in previous open-ended exams to provide realistic distractors

- A. (i) only
- B. (ii) only
- C. (i) and (ii)
- D. (ii) and (iii)
- E. (i) , (ii), and (iii)
- F. I don't know

Variation of One-Best-Answer  
Formulating Distractors  
(common misconceptions)



# In summary: University of Waterloo & Vanderbilt



## Do's: Stem

- Informative and concise
- Ask students to pick 'best' answers

## Do's: Alternatives

- Plausible alternatives (3 to 5)
- Meaningful and logical distribution
- Consistent grammar, length, and language
- Include: "I don't know."

## Don'ts: Stem

- Negative wording
- Word association
- Trick question
- "Which of the following is correct?"

## Don'ts: Alternatives

- "Always", "Never", "None", etc
- "All of the above", "None of the above"



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# Tips for developing MCQs For Higher Order Thinking

# Use Real World Scenarios

Original Question	MCQ
What symbol does a formula always start with in Excel?	If you want to total the first ten data cells in column B, which one of the following formulas should you use?
What is the first concern of an emergency worker?	You arrive at the scene of an accident where people are panicked and yelling. Three people appear to be injured. One person has scrapes and bruises, a second is lying on the ground moaning in pain and a third is quickly losing blood from a skull injury. Which person will you take care of first?
When writing a CSS style sheet, what property is used to position an element to the left or right?	How will the text and photo be aligned using the code below? CSS: .photo {float: right;} HTML: My Cat



# Evaluation of a Solution to a Problem

A student was asked the following question: "*List and explain the stages of the creative process.*" The student answered: "*It takes place in 5 stages, in the following order: orientation, when the problem must be identified and defined, preparation, when all the possible information about the problem is collected, incubation, when no solution seems in sight and the person is often busy with other tasks, illumination, when the person experiences a general idea of how to arrive at a solution to the problem, and finally verification, when the person determines whether the solution is the right one for the problem.*"

How would you judge this answer?

- a) **EXCELLENT** (all stages correct in the right order with clear and correct explanations)
- b) **GOOD** (all stages correct in the right order, but the explanations are not as clear as they should be)
- c) **MEDIOCRE** (one or two stages are missing OR the stages are in the wrong order, OR the explanations are not clear OR the explanations are irrelevant)
- d) **UNACCEPTABLE** (more than two stages are missing AND the order is incorrect AND the explanations are not clear AND/OR they are irrelevant)



## Premise-Consequence

If nominal gross national product (GNP) increases at a rate of 10% per year and the GNP deflator increases at 8% per year, then real GNP:

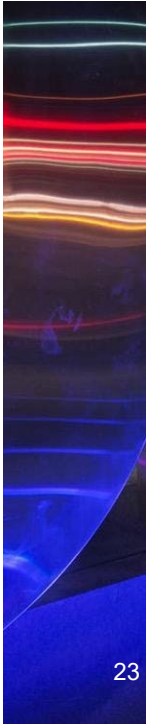
- a) Remains constant.
- b) Rises by 10%.
- c) Falls by 8%.
- d) Rises by 2%.



# Analogy

E-mail is to an unmoderated listserv as office hours are to:

- a) Class lecture.
- b) Class discussion.
- c) Review sessions.
- d) Tutorials.



## Switching between Principle and Example

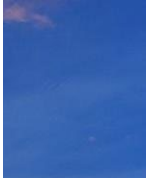
Original MCQ	Higher Order MCQ
Which of the following is a symptom of the flu?	<p>A patient presents with the following symptoms: X, Y, Z</p> <p>What is the most likely diagnosis:</p> <ul style="list-style-type: none"><li>a) The flu</li><li>b) A cold</li><li>c) Seasonal Allergies</li><li>d) Covid-19 (<i>too soon?</i>)</li></ul>





## Analysis of Visuals

Original	MCQ
What are the components of a computer's video system? (Select all that apply.)	Using the repair flowchart shown here, what should you check if the monitor stops working?
Which country has the largest population?	What does this graph predict about world population in the year 2020?
Select the best definition of <i>active listening</i> .	Which video best demonstrates <i>active listening</i> during a call with an irate customer?
Choose the best definition of rate card.	Using the rate card, what is the best time for a customer in the United States to make an international call to Brazil?



## Two Tiered Questions

The following table describes 4 trials of an experiment to determine if new fertilizer affects the number of tomatoes a plant can produce. Which trials should be compared?

Variable	trial 1	trial 2	trial 3	trial 4
<i>fertilizer mix</i>	<i>old</i>	<i>new</i>	<i>old</i>	<i>new</i>
<i>sunlight (hours/day)</i>	8	12	8	8
<i>water ( ml/day)</i>	500	300	300	300
<i># tomatoes produced</i>	80	140	100	100

Which of the following explanations most closely explains your choice?

- a) We should compare trials that show the new fertilizer yields more tomatoes than the old
- b) We should compare trials that show a difference in the number of tomatoes
- c) We should compare all trials because conclusions can only be drawn from experiments repeated
- d) We should only compare trials that isolate the variable tested
- e) We should only compare trials that support the hypothesis tested



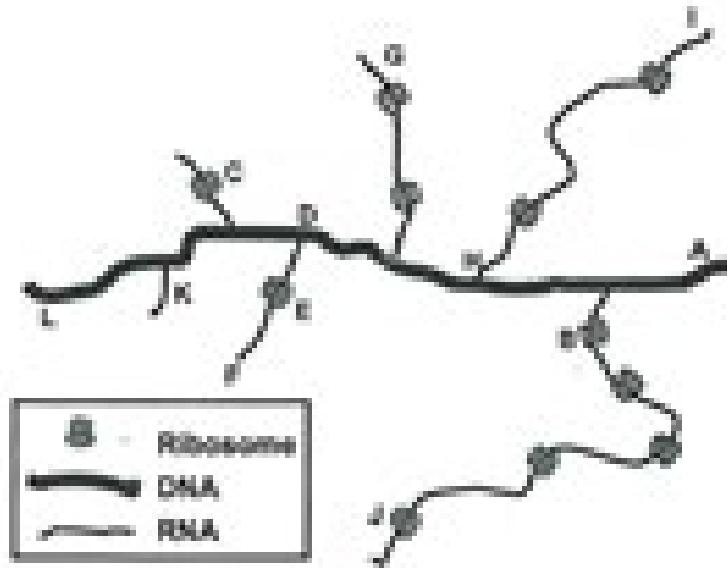
## The Answer Plus The Reason Why

<b>Original</b>	<b>MCQ</b>
What are three signs of edema?	A patient entered the hospital with edema of both lower extremities. What action should the nurse take and why?
Select the most effective tone for writing technical documentation.	Select the paragraph and reasoning that best demonstrate how to start a technical document.
Name three qualities of effective entrepreneurs.	Review the financials of these three startup companies. Which one would you invest in and why?



# Multiple True False

A cartoon of an electron micrograph is shown below. A piece of chromosomal DNA containing a single gene is illustrated as a thick line. Thin lines radiating from the DNA are mRNA molecules in the process of being transcribed. Ribosomes are attached to the mRNA. Newly synthesized peptides are not shown.



Refer to the drawing when answering the true (T)-false (F) questions below.





- f* The sequence of bases in the mRNA labeled K is complementary to the sequences of bases in the mRNA labeled F.
- t* The promoter for this gene is closer to L than to A.
- t* Ribosome J has made fewer peptide bonds than ribosome B.
- f* In the RNA transcript labeled H-I, the 5' end of the RNA is at H.
- t* The RNA polymerase located at position D (directly above E) is moving toward the right.
- f* The cell from which this chromosomal DNA was isolated is eukaryotic.
- t* The distance between ribosome E and end F is increasing.
- f* Ribosome C has just synthesized the carboxy terminus of the protein.

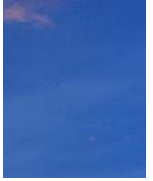
# Multi-logical Questions

Tim's second grade teacher is concerned because of the following observations about Tim's behaviour in class:

- Withdraws from peers on the playground and during group work
- Often confuses syllables in words (ex: says mazagine instead of magazine)
- Often confuses b and d, p and q, etc. when writing or recognizing letters
- Loses his place when reading

The teacher has arranged a meeting with Tim's mother to discuss these concerns. Which of the following statements is best for the teacher to say to Tim's mother?

- A. Tim needs extra practice reading and writing problematic letters and words at home at least 30 minutes per day.
- B. Please discuss the importance of schoolwork to Tim so that he will increase his efforts in classwork.
- C. These are possible symptoms of dyslexia so I would like to refer him to a specialist for diagnosis.
- D. Please adjust Tim's diet because he is most likely showing symptoms of ADHD due to food allergies.



# Bury the Verb

Original	MCQ
Describe...	Select the best <i>description</i> .
Interpret.....	Which of the following is the most accurate <i>interpretation</i> ?
Evaluate....	Which of the following is a correctly constructed sentence?



## K Type Questions

CD is a 40 yr old woman living alone and suffering trauma from previous sexual assaults. While intoxicated one evening, she shot her tenant, who she thought was an intruder. Which of the following cases could be viably be used in her defense?

- I. Steele v. The State of Virginia, 2011
- li. Grosvenor v. British Columbia, 1974
- lii. Mervin v. Gordini, 2019

- a) I. only
- b) I. and iii only
- c) li. and iii only
- d) All of i, ii, and iii
- e) None of these cases could viably be used.







## Break Out - 15 min

Consider unmuting and sharing video in break out rooms.

Share your Questions or Content or Issue you brought.

Help each other write an MCQ for that Content.

Return to main room prepared to share an example or two.

<b>Break out Room</b>	<b>Participants</b>
1	
2	
3	
4	

# Sharing



We would like to invite a couple of you to share your experience 'transforming' your question in your small group.

# Questions?



Use annotation or type in Chat!

# Additional Resources on MCQs



University of Waterloo, Designing Multiple Choice Questions:  
<https://uwaterloo.ca/centre-for-teaching-excellence/teaching-resources/teaching-tips/developing-assignments/assignment-design/designing-multiple-choice-questions>

McGill University, Designing Effective Multiple-Choice Questions:  
[https://www.mcgill.ca/skillsets/files/skillsets/mcq\\_handout3.pdf](https://www.mcgill.ca/skillsets/files/skillsets/mcq_handout3.pdf)

Vanderbilt University, Writing Good Multiple Choice Test Questions:  
<https://cft.vanderbilt.edu/guides-sub-pages/writing-good-multiple-choice-test-questions/>

Yale University, Designing Quality Multiple Choice Questions:  
<https://poorvucenter.yale.edu/MultipleChoiceQuestions>

# Additional Resources on MCQs and Higher Order Thinking

[http://thelearningcoach.com/elearning\\_design/multiple-choice-questions/](http://thelearningcoach.com/elearning_design/multiple-choice-questions/)  
<https://teaching.uwo.ca/pdf/programs/Writing-Higher-Order-MCQ-Fall-2018.pdf>

[http://www.sfu.ca/sfublogs-archive/departments/fhs-teaching/527\\_multiple-choice-questions-that-assess-higher-order-cognition.html](http://www.sfu.ca/sfublogs-archive/departments/fhs-teaching/527_multiple-choice-questions-that-assess-higher-order-cognition.html)

<https://cft.vanderbilt.edu/guides-sub-pages/writing-good-multiple-choice-test-questions/>

Canvas How to MCQ: [https://community.canvaslms.com/docs/DOC-10460-canvas-instructor-guide-table-of-contents#jive\\_content\\_id\\_Quizzes](https://community.canvaslms.com/docs/DOC-10460-canvas-instructor-guide-table-of-contents#jive_content_id_Quizzes)





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## Case

*A 34-year-old woman has had severe watery diarrhea for the past four days. Two months earlier she had infectious mononucleosis. She abuses drugs intravenously and has antibodies to HIV in her blood. Physical examination shows dehydration and marked muscle weakness.*

## Recall

- Laboratory studies are most likely to show
  - decreased serum  $K^+$  concentration
  - decreased serum  $Ca^{2+}$  concentration
  - increased serum  $HCO_3^-$  concentration
  - \*D. increased serum  $Na^+$  concentration
  - increased serum pH
- In evaluating the cause of the diarrhea, which of the following is most appropriate?
  - Colonic biopsy to identify *Giardia lamblia*
  - Culture of the oral cavity for *Candida albicans*
  - Duodenal biopsy to identify *Entamoeba histolytica*
  - Gastric aspirate to identify *Mycobacterium avium-intracellulare*
  - \*E. Stool specimen to identify *Cryptosporidium*
- Further studies to evaluate her HIV infection show the ratio of helper T lymphocytes to suppressor T lymphocytes to be 0.3. This occurs because HIV
  - induces proliferation of helper T lymphocytes
  - induces proliferation of suppressor T lymphocytes
  - \*C. infects cells with CD4 receptors
  - infects macrophages
  - stimulates the synthesis of leukotriene

## Recall

## Application

Building Complexity &  
Knowledge Integration

## Other Examples

From the graph shown here, determine when maximal carrying capacity has been reached. a. point A on the graph b. point B on the graph c. point C on the graph d. point D on the graph

Which of the following compounds should have the highest boiling point? a.  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$  b.  $\text{CH}_3\text{NH}_2$  c.  $\text{CH}_3\text{OH}$  d.  $\text{CH}_2\text{F}_2$

During an otherwise normal pregnancy, a woman begins to experience light-headedness and a decline in energy levels near the end of the first trimester. Which of the following is the most likely cause of her symptoms? a. lack of B vitamins due to poor diet b. decline of blood pH due to overuse of muscles c. decrease in blood pressure due to expanding fetal circulation d. decline in estrogen levels due to ovarian shutdown





Your fitness regimen involves jogging on the school track 2–3 miles per day with a friend. On a particular day, about 15 minutes into your jog, your friend suddenly pulls up and falls down, grasping her right calf in pain.

What should you do at that moment? a. apply ice to the calf b. apply heat to the calf c. tell her to get up and walk slowly d. get emergency help stat



# Assess the quality of these questions

Which of the following statements does not have the unit equivalent with “pascal”?

- a) Newton per square meter
- b) Kilogram per meter per square second
- c) Kilogram per cubic meter multiplied by meter per square second
- d) Joule per cubic meter

Determine the true statement(s) about equilibrium reactions:

- 1. The fractional conversion of the limiting reactant is always 100%
- 2. If the fractional conversion of the limiting reactant is 70%, it is possible that other components have fractional conversion greater than 70%
- 3. The reaction extent of the limiting reactant is always 1
- 4. If the reaction extent of the limiting reactant is  $X$ , other components will have reaction extent that is less than  $X$
- 5. None of the above

