

## Multiple Choice Items that Test Higher Learning Objectives

To assess higher learning objectives with multiple choice items you must use questions that students cannot answer by relying solely on memory.

Learning Objective	Definition	Example Question Stems
<b>REMEMBER</b>	Retrieve relevant information from long term memory	Remembering is not a higher learning objective and we will not deal with it in this workshop.
<b>UNDERSTAND</b>	Construct meaning from material	
Interpret	Change from one form of representation to another—clarify, paraphrase, translate, represent	Which equation corresponds to the following statement, using $T$ for total cost and $P$ for number of pounds? The total cost of mailing a package is \$2.00 for the first pound plus \$1.50 for each additional pound.
Exemplify	Identify a specific example or illustration of a concept or principle—illustrate, instantiate	Which of these is an inorganic compound? Which of the following paintings represents the impressionist style?
Classify	Determine that something belongs to a category—categorize, subsume	Based on a patient's symptoms described below, identify the most likely mental disorder.
Summarize	Abstract a major theme or major point—abstract, generalize	Read the following paragraph from a passage about the California Gold Rush and select the most appropriate title (or rank the titles in order of "fit").
Infer	Draw a logical conclusion from presented information—conclude, extrapolate, interpolate, predict	Schema theory predicts that people will remember
Compare	Detect correspondences between two ideas, objects, etc—contrast, map, match	Similarities between an electrical circuit and water flowing through a pipe include
Explain	Construct a cause effect model of a system	What would happen if . . . (e.g., you increased the diameter of the cylinder in a bicycle pump?)
<b>APPLY</b>	Carry out or use a procedure in a given situation	
Execute	Apply a procedure to a familiar task	Given a problem select correct answer (standardized tests often use this format)
Implement	Apply a procedure to an unfamiliar task	Based on your knowledge of interest rates which of the following three financing packages would be best for a consumer?
<b>ANALYZE</b>	Break material into its constituent parts and determine how the parts relate to one another and to an overall structure or purpose	

Differentiate	Distinguish relevant from irrelevant parts or important from unimportant parts of presented material—discriminate, distinguish, focus, select	Given some material choose which parts are most important or relevant
Organize	Determine how elements fit or function within a structure—finding coherence, integrating outlining, parsing, structuring	Which of the following graphic hierarchies is the best representation of the paragraph below?
Attribute	Determine a point of view, bias, values, or intent underlying presented material—deconstruct	The author's purpose in writing this essay is; The excerpt below exemplifies which of the following theoretical perspectives; the author of the article would most likely agree with which of the following policies?
<b>EVALUATE</b>	Make judgments based on criteria and standards	
Check	Detecting inconsistencies or fallacies within a process or product; determining whether a process or product has internal consistency; detecting the effectiveness of a procedure as it is being implemented—coordinating, detecting, monitoring, testing	The most important logical inconsistency in the print advertisement below is
Critique	Detecting inconsistencies between a product and external criteria, determining whether a product has external consistency; detecting the appropriateness of a procedure for a given problem	The solution/procedure/process/argument described below would be more effective if . . .
<b>CREATE</b>	Put elements together to form a coherent or functional whole; recognize elements in a new pattern or structure	
Generate	Come up with alternative hypotheses based on criteria—hypothesize	Not amenable to a MC format because the student must generate the response rather than select a response from among alternatives
Plan	Devise a procedure for accomplishing some task—design	Not amenable to MC format but could ask students to select a solution plan from several alternatives for a given problem
Produce	Invent a product—construct	Not amenable to a MC format

Adapted from: *A Taxonomy for Learning, Teaching and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. L. Anderson, D. Krathwohl, P. Airasian, K. Cruikshank, R. Mayer, P. Pintrich, J. Raths, & M. Witrock. Addison Wesley Longman, Inc. 2001.

## Examples of multiple choice item formats that test for complex thinking/higher learning objectives

From: Davis, B. (2009). *Tools for Teaching, 2<sup>nd</sup> Edition*. San Francisco. Jossey Bass, Publisher and Mazur, E. (1997). *Peer Instruction: A User's Manual*. Prentice Hall.

### Types of Multiple-Choice Questions

**Include some items that require complex thinking.** For example, write a question that requires students to predict the outcome of a situation, or ask students to select examples that illustrate an abstraction or a principle. Or give examples and ask students to select the principle or theory that the examples illustrate.

The following multiple-choice items probe a range of learning outcomes (adapted from Welsh, 1978).

Question 1 requires students to make comparative generalizations.

1. Which of the following has contributed most to long-term economic growth in the United States?
  - A. Increasing personal income tax rates.
  - B. Reducing hours worked per week to spread employment among more people.
  - C. Increasing tariffs on imported goods that compete with domestically produced goods.
  - D. Increasing levels of education and technological improvement.

Question 2 asks students to apply supply-and-demand principles to a specific situation.

2. A large city is investigating the elimination of rent controls on housing at a time when the vacancy rate is extremely low—only 1 percent. Which of the following is most likely to occur if rent controls are eliminated?
  - A. An increase in the demand for housing, followed by a decrease in the supply of housing.
  - B. An increase in rents, followed by an increase in the supply of housing.
  - C. A decrease in rents and a decrease in the supply of housing.
  - D. No change in rents because price controls are usually set where supply and demand intersect.

For question 3, students must analyze the situation, select the most appropriate policy, and predict the expected effects of the policy.

3. Because of rapidly rising national defense expenditures, the country of Parador will experience price inflation unless measures are taken to restrict the growth of aggregate private demand. If Parador wishes to minimize the adverse effects of anti-inflationary policies on economic growth, it should implement

- A. A tight monetary policy because that would restrict consumption expenditures more than investment.
- B. A tight monetary policy because that would restrict consumption expenditures.
- C. An increase in personal income taxes because that would restrict consumption expenditures more than investment.
- D. Either a tight monetary policy or an increase in personal income taxes because both depress investment equally.

**Create "You are the teacher" questions.** Some multiple-choice items require students to evaluate the response to a short-answer question (from Jensen et al., 2006, p. 69):

Pretend you are a science teacher who is correcting the following answer on a quiz. How many scientific errors does the answer contain? *Note:* There is a maximum of one error per sentence.

During the depolarization phase of an action potential, sodium gates are open and sodium diffuses from the extra-cellular fluid to the intra-cellular fluid. At the end of the depolarization phase, sodium gates close and potassium gates open. Repolarization begins when potassium moves by active transport from the intra-cellular fluid to the extra-cellular fluid of the cell. After the action potential passes, ion gradients are maintained by the sodium/potassium pump.

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

Jensen et al. (2006) recommend that this type of question be used only after students have done practice sets before the exam.

**Experiment with assertion-reason questions (ARQs).** An ARQ consists of two statements—an assertion and a reason—linked by *because*. The student selects from five response options that indicate the correctness of each statement and the validity of the reasoning. Here is an example (adapted from Williams, 2006, p. 292):

*(Assertion)* In a small open economy, if the prevailing world price of a good is lower than the domestic price, the quantity supplied by the domestic producer will be greater than the domestic quantity demanded, increasing domestic producer surplus.

Because

*(Reason)* In a small open economy any surplus in the domestic market will be absorbed by the rest of the world. This increases domestic consumer surplus.

- A. The assertion and reason are both correct, and the reason is valid.
- B. The assertion and reason are both correct, but the reason is invalid.
- C. The assertion is correct, but the reason is incorrect.
- D. The assertion is incorrect, but the reason is correct.
- E. Both the assertion and the reason are incorrect.

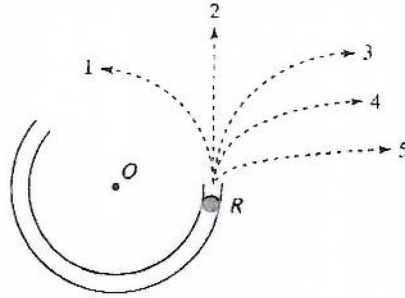
If you want to use ARQs, give your students time to become familiar with the format and offer examples and practice quizzes. ARQs pose special problems for students whose reading comprehension skills are below average. (Source: Williams, 2006)

## Constructing Multiple-Choice Test Items

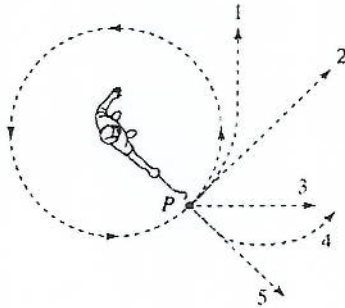
***Instruct students to select the “best answer” rather than the “correct answer.”*** Asking for the correct answer may invite arguments from contentious students that their selections are correct as well. If you ask for the best answer, you can acknowledge that other responses have some element of truth or accuracy but that the keyed response is the best. (Source: Jacobs and Chase, 1992)

***In the instructions, state the rewards or penalties for guessing.*** Some instructors encourage students to make their best guess, even when they are unsure about the correct answer. Other instructors penalize students for guessing. Some faculty award partial credit for reasoned but flawed answers. (Source: Baranchik and Cherkas, 2000)

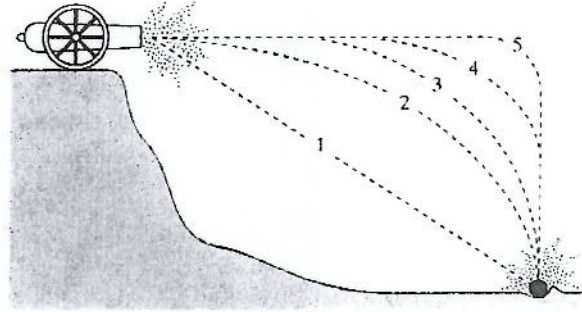
6. Which of the paths 1–5 below would the ball most closely follow after it exits the channel at  $R$  and moves across the frictionless table top?



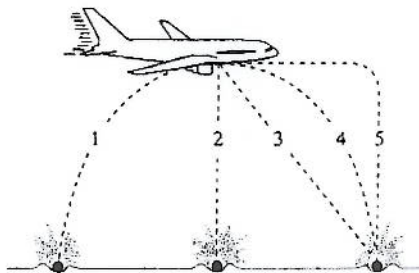
7. A steel ball is attached to a string and is swung in a circular path in a horizontal plane as illustrated in the figure below. At point  $P$ , the string suddenly breaks near the ball. If these events are observed from directly above, which of the paths 1–5 below would the ball most closely follow after the string breaks?



12. A ball is fired by a cannon from the top of a cliff as shown below. Which of the paths 1–5 would the cannon ball most closely follow?

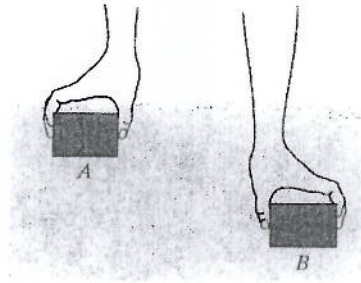


13. A boy throws a steel ball straight up. Consider the motion of the ball only after it has left the boy's hand but before it touches the ground, and assume that forces exerted by the air are negligible. For these conditions, the force(s) acting on the ball is (are)
1. a downward force of gravity along with a steadily decreasing upward force.
  2. a steadily decreasing upward force from the moment it leaves the boy's hand until it reaches its highest point; on the way down there is a steadily increasing downward force of gravity as the ball gets closer to Earth.
  3. an almost constant downward force of gravity along with an upward force that steadily decreases until the ball reaches its highest point; on the way down there is only an almost constant downward force of gravity.
  4. an almost constant downward force of gravity only.
  5. none of the above. The ball falls back to ground because of its natural tendency to rest on the surface of the Earth.
14. A bowling ball accidentally falls out of the cargo bay of an airliner as it flies along in a horizontal direction. As observed by a person standing on the ground and viewing the plane as in the figure below, which of the paths 1–5 would the bowling ball most closely follow after leaving the airplane?



## BUOYANCY

Imagine holding two identical bricks under water. Brick *A* is just beneath the surface of the water, while brick *B* is at a greater depth. The force needed to hold brick *B* in place is



1. larger than
2. the same as
3. smaller than

the force required to hold brick *A* in place.

**Figure 2.1** *ConceptTest* question on Archimedes' principle. For an incompressible fluid such as water, the second choice is correct.



## Summary of Technical Flaws in Test Items

### Issues Related to Testwiseness

- Grammatical cues one or more distractors don't follow grammatically from the stem
- Logical cues a subset of the options is collectively exhaustive
- Absolute terms terms such as "always" or "never" are in some options
- Long correct answer correct answer is longer, more specific, or more complete than other options
- Word repeats a word or phrase is included in the stem and in the correct answer
- Convergence strategy the correct answer includes the most elements in common with the other options

### Issues Related to Irrelevant Difficulty

- Options are long, complicated, or double
- Numeric data are not stated consistently
- Terms in the options are vague (eg, "rarely," "usually")
- Language in the options is not parallel
- Options are in a nonlogical order
- "None of the above" is used as an option
- Stems are tricky or unnecessarily complicated
- The answer to an item is "hinged" to the answer of a related item

### General Guidelines for Item Construction

- Make sure the item can be answered without looking at the options OR that the options are 100% true or false.
- Include as much of the item as possible in the stem; the stems should be long and the options short.
- Avoid superfluous information.
- Avoid "tricky" and overly complex items.
- Write options that are grammatically consistent and logically compatible with the stem; list them in logical or alphabetical order.
- Write distractors that are plausible and the same relative length as the answer.
- Avoid using absolutes such as always, never, and all in the options; also avoid using vague terms such as usually and frequently.
- Avoid negatively phrased items (eg, those with except or not in the lead in). If you must use a negative stem, use only short (preferably single word) options.
- And most important of all: Focus on important concepts; don't waste time testing trivial facts.

From: *Constructing Written Test Questions For the Basic and Clinical Sciences* National Board of Medical Examiners 3750 Market Street Philadelphia, PA 19104