

Question Writer Workshop



Basic Item Type

- Multiple-choice question with a single correct answer



All exam items should be:

Focused

Each item should be focused on one concept. Each part of the item should relate to that specific area of knowledge.

Clear

Use language that is straightforward, easy to interpret, and unambiguous, so it will **not** confuse or trick the candidate.

Concise

Include only the information that is necessary for answering the question.



Components of a multiple-choice, single-correct-answer item

Stem = Background and situational information; images, diagrams, or tables; question

Options = KEY (correct answer) and 3 or 4 DISTRACTORS (incorrect answers)

Aim for 4 or 5 total options per item. It is acceptable to have only 3 options, especially for test items for which there are only 3 plausible choices.



Horizontal lines for notes

What makes a good stem?

- 1. Linear delivery of information
- 2. Complete, clear question
- 3. Focus on a single concept
- 4. Positively worded format
- 5. Relevant to medical physics
- 6. Noncontroversial



Horizontal lines for notes

STEM

1. Linear Delivery of Information

Background + situational information + request for answer

A 32-year-old woman is treated for . . .

+ One year later, she requests radiation dose . . .

+ What is the most appropriate response?

Note: Cases should be written in present tense, when possible.



Horizontal lines for notes

STEM

1. Linear Delivery of Information

Background + situational information + request for answer

INCORRECT:

• What is the probability that a child will have a defect due to induced genetic damage to the ovum, if the mother gets pregnant 30 days after receiving an ovarian dose of 110 mGy from two CT scans of the pelvis?

CORRECT:

• A woman has two CT scans of the pelvis and receives an ovarian dose of 110 mGy. Thirty days later, she becomes pregnant. What is the probability that the child will have a defect due to induced genetic damage to the ovum?

STEM

2. Complete, Clear Question

Stems should be written in complete sentences and end with a question.

INCORRECT:

- Kerma:
- The dose-rate constant:

CORRECT:

- What does kerma measure?
- What is the definition of the dose-rate constant?

Why? Because the stem has to pass the "cover test."

STEM

2. Complete, Clear Question

What is the "cover test"?

The cover test means that the candidate can cover the options and still know what the question is about just from the stem.

STEM

2. Complete, Clear Question

If you were asked:

Which of the following statements about electron capture radioactive decay is true?

Would you know what type of answer was required?

STEM

3. Focus on a Single Concept

Which of the following statements about electron capture radioactive decay is true?

- A. It occurs when an atomic electron ventures inside the nuclear volume, is captured by a proton, and triggers a proton-neutron transformation.*
- B. It occurs when an atomic electron ventures inside the nuclear volume, is captured by a neutron, and triggers a neutron-proton and β^- transformation.
- C. It occurs in a neutron-rich unstable parent nucleus. (location)
- D. It occurs when the "L" shell electron has the greatest probability of venturing into the nuclear volume because of its binding energy. (timing)

STEM

3. Focus on a Single Concept

- Without knowing what they're looking for, candidates have to read each option and then ask themselves "Is this true?"
- If the options pertain to several different aspects of the topic, we're essentially testing their knowledge of each of those areas, instead of just one.
- These types of items can be fixed by looking at the answer, figuring out what the central idea is, and then turning that into the question.

STEM

3. Focus on a Single Concept

The key from the previous example: It occurs when an atomic electron ventures inside the nuclear volume, is captured by a proton, and triggers a proton-neutron transformation.

New stem: In electron capture radioactive decay, an atomic electron ventures inside the nuclear volume, and triggers what type of transformation?

- A. Proton-neutron*
- B. Neutron-proton
- C. β^-
- D. β^+

This passes the cover test and is effectively testing knowledge of a single concept.

STEM

4. Positively Worded Format

- Negatively worded items can be confusing. In most cases, items should be structured to ask for something that is true, not false.
- Negatively worded items, if used, should be limited to situations that *require* a negative emphasis.
- Preferred wording: Which of the following should be **EXCLUDED** from the differential diagnosis?

If used, negative words in the question (e.g., **NOT, LEAST, EXCEPT**) are capitalized and bolded to make sure the candidate sees them.

STEM

4. Positively Worded Format

- INCORRECT:**
- According to the NRC, for each occupationally overexposed individual involved in a reportable event, which of the following does **NOT** have to be reported?
- There are two problems with this stem:
1. It doesn't pass the cover test.
 2. It's not relevant to practice. Clinicians need to know what to report, not everything that shouldn't be reported.

STEM

4. Positively Worded Format

INCORRECT: Negatively worded AND unfocused

Which of the following statements about the design of shielded facilities for x-ray sources used in radiation therapy is **FALSE**?

- A. For units operating above 500 kV, the workload (W) is described as a weekly dose (Gy/week) delivered at 10 m from the source.*
- B. Room surfaces that are **not** exposed to the primary beam are called "secondary barriers."
- C. The use factor (U) is the fraction of the operating time during which the primary radiation beam is directed towards a particular protective barrier.
- D. The rule that radiation intensity decreases with $(1/\text{distance})^2$ applies exactly for only a point radiation source under conditions of good (narrow beam) geometry.

Options are unfocused (and wordy), and the key has a **qualifying clause**.

STEM

4. Positively Worded Format

CORRECT:

In the design of shielded facilities for x-ray sources used in radiation therapy, the workload (W) for units operating above 500 kV is described as a weekly dose (Gy/week) delivered at what distance from the source?

- A. 0.5 m
- B. 1.0 m*
- C. 5.0 m
- D. 10.0 m

STEM

5. Clinically Relevant

INCORRECT:

What NCRP report discusses the ionizing radiation exposure of the population of the United States?

- A. 147 B. 156 C. 160* D. 175

CORRECT:

According to NCRP Report No. 160, Ionizing Radiation Exposure of the Population of the United States, there was a sevenfold increase in radiation exposure to Americans from the early 1980s to 2006. What was the main cause of this increase?

STEM

6. Noncontroversial

Avoid topics that are:

- Trendy, but not yet proven
- Not yet accepted in the mainstream
- Dependent on or specific to the work or studies of a particular person/group/institution

NOTE: Do NOT use second person

Write in third person NOT second person. Why?

INCORRECT:

You suspect that your colleague has been coming to work intoxicated. How would you handle this situation?

CORRECT:

A medical physicist suspects that a colleague has been coming to work intoxicated. What is the most appropriate course of action?

Second-person construction is subjective. We want to ask the candidates for facts, not for their opinions.

What makes a good key?

1. Clearly the right answer
2. Similar to distractors in length and structure
3. Not controversial or dependent on regional or institutional practice patterns
4. Supported by medical research

For each item, please provide at least one credible reference that supports the key.

What makes a good distractor?

1. Same category as the key
2. Same part of speech as the key
3. Similar in length and structure to the key
4. Plausible to some degree



DISTRACTORS

1. Same Category

- All of the options should be conceptually related to each other.
- If the stem asks for a radiation dose, all the options should be radiation doses; if it asks for a type of artifact, they should all be types of artifacts, etc.

DISTRACTORS

1. Same Category

INCORRECT: Mixed options

Which of the following statements about receiving a package containing radioactive materials is true?

- A. It does not have to be monitored for radioactive contamination. (requirement)
- B. If received after normal working hours, the package must be monitored no later than 3 hours from the beginning of the next working day.* (requirement)
- C. An external survey is conducted using an ionization chamber. (technique)
- D. A wipe test for removable contamination is carried out by smearing a 100-cm² area of the package surface using absorbent paper and counting the swabs in a CsI well counter. (technique)



DISTRACTORS

1. Same Category

CORRECT:

If received after normal working hours, a package containing radioactive materials must be monitored how soon after the beginning of the next work day?

- A. Within 1 hour
- B. Within 3 hours*
- C. Within 6 hours
- D. Within 8 hours



DISTRACTORS

2. Same Part of Speech

The distractors should be the same part of speech as the key.

What is the most appropriate next step in management?

INCORRECT:

- A. Obtain a radiograph
- B. Performing MRI
- C. Observation
- D. The patient should be sent home.

CORRECT:

- A. Radiography
- B. MRI
- C. Observation
- D. Discharge

DISTRACTORS

3. Similar in Length and Structure

In television viewing of fluoroscopic images, what ensures that the electron scanning beams in the camera and the monitor are exactly synchronized?

- A. Transmission channel
- B. Camera control unit*
- C. Image storage device
- D. Digital detectors such as charge-coupled devices that provide a direct readout of electrical charge

A longer and/or more specific option draws attention to itself, which might trick a candidate into thinking it's the correct answer.

DISTRACTORS

4. Plausible to Some Degree

- To the unprepared or underprepared examinee, there should be enough feasibility in the option for it to be considered.
- Ideally, distractors should be written to represent the compelling, rational, logical *wrong* answers that examinees would come up with if no choices were provided.
- Distractors must be real things. Don't use invented terms or phrases.

Option Lists: Things to Avoid

1. Multiple and overlapping parts
2. Pairs
3. Ambiguity



OPTION LISTS

1. Multiple and overlapping parts

INCORRECT:

For ultrasound harmonic abdominal imaging, which of the following combinations of transmit/receive center frequency values is the most appropriate?

- A. 6 MHz/6 MHz
- B. 4 MHz/4 MHz
- C. 2 MHz/4 MHz*
- D. 2 MHz/3 MHz

This type of construction does not discriminate very well between candidates who know the answer and those who are just good at guessing.

OPTION LISTS

1. Multiple and overlapping parts

CORRECT:

For ultrasound harmonic abdominal imaging, with a transmit center frequency of 2 MHz, what is the most appropriate receive center frequency?

- A. 2 MHz
- B. 4 MHz*
- C. 6 MHz
- D. 8 MHz

Now there is clearly one correct answer and no "tricks" or "clues."

OPTION LISTS

2. Pairs

INCORRECT:

Cyclotrons accelerate ions by using which of the following?

- A. Pulsed electric fields*
- B. Pulsed magnetic fields
- C. Standing waveguide
- D. Microwaves

Pairs can lead the candidate to think that one of the options in the pair must be the answer, or that neither is the answer. Either way, this format narrows the chances of guessing right to 50/50. We want to test knowledge, not test-taking savvy. On the other hand . . .

OPTION LISTS

2. Pairs

CORRECT:

Cyclotrons accelerate ions by using which of the following?

- A. Pulsed electric fields*
- B. Pulsed magnetic fields
- C. Standing waveguide
- D. Traveling waveguide

Two sets of pairs negate the clue. This format will discriminate effectively.

OPTION LISTS

3. Ambiguity

INCORRECT:

The disease shown in the images typically affects what age group?

- A. Young adults
- B. Centenarians
- C. Infants
- D. Mature adults
- E. Generation Z

These descriptors may not be interpreted exactly the same way by everyone, and some of them may not be understood by every candidate.

OPTION LISTS

3. Ambiguity

CORRECT:

The disease shown in the images typically affects what age group?

- A. 0 to 5 years
- B. 10 to 15 years
- C. 20 to 25 years
- D. 40 to 50 years
- E. > 80 years

Wordings the options this way guarantees that everyone will understand what group of people each option represents. Note also that the options are arranged in numerical order and do not overlap, which further increases rapid comprehension.

NOTE: SPELL OUT ACRONYMS

What's wrong with acronyms? We use them all the time!



If an acronym is not clearly in common use among medical physicists, spell it out.

Summary

1. Keep it focused.
2. Make it linear.
3. Use complete sentences in the stem and end with a complete question.
4. Ask for the correct answer.
5. Use clear and accurate phrasing.
6. Spell out acronyms and abbreviations.

ABR

Question Writer Workshop

- Review questions from 1992 RAPHEX Exam
 - Identify deficiencies
 - Propose improvements
- Write some contemporary medical physics questions for
 - MP graduate students
 - MP Residents
 - Technologists

ABR