

Last Name: _____ First Name _____ Network-ID _____

Writing Lab Section: _____ Writing Lab TA Name: _____

Turn off your cell phone and put it out of sight.

Calculators cannot be used.

This is a closed book exam. You have eighty (80) minutes to complete it.

1. Use a #2 pencil. Do not use a mechanical pencil or pen. Darken each circle completely, but stay within the boundary. If you decide to change an answer, erase vigorously; the scanner sometimes registers incompletely erased marks as intended answers; this can adversely affect your grade. Light marks or marks extending outside the circle may be read improperly by the scanner. Be especially careful that your mark covers the **center** of its circle.
2. **This Exam Booklet is Version A.** Mark the **A** circle in the **TEST FORM** box near the middle of your answer sheet. **DO THIS NOW!**
3. Print your **NETWORK ID** in the designated spaces at the *right* side of the answer sheet, starting in the left most column, then **mark the corresponding circle** below each character. If there is a letter "o" in your NetID, be sure to mark the "o" circle and not the circle for the digit zero. If and only if there is a hyphen "-" in your NetID, mark the hyphen circle at the bottom of the column. When you have finished marking the circles corresponding to your NetID, check particularly that you have not marked two circles in any one of the columns.
4. Print **YOUR LAST NAME** in the designated spaces at the *left* side of the answer sheet, then mark the corresponding circle below each letter. Do the same for your **FIRST NAME INITIAL**.
5. Do not write in or mark the circles in any of the other boxes (STUDENT NUMBER, DATE, SECTION, SCORES, SPECIAL CODE).
6. Sign your name (**DO NOT PRINT**) on the **STUDENT SIGNATURE line**.
7. On the **SECTION line**, print your **Writing Lab Section**. You need not fill in the COURSE or INSTRUCTOR lines.

Before starting work, check to make sure that your test booklet is complete. You should have 18 numbered pages plus three Formula Sheets.

Academic Integrity—Giving assistance to or receiving assistance from another student or using unauthorized materials during a University Examination can be grounds for disciplinary action, up to and including dismissal from the University.

Exam Grading Policy—

The exam is worth a total of 300 points, composed of 6 types of questions.

Rules for partial credit

Note: there will be no partial credit for problems with multiple correct answers. These problems are marked and all correct answers need to be marked correctly on the answer sheet in order to obtain credit.

MC5: *multiple-choice-five-answer questions, each worth 6 points.*

Partial credit will be granted as follows.

- (a) If you mark only one answer and it is the correct answer, you earn **6** points.
- (b) If you mark *two* answers, one of which is the correct answer, you earn **3** points.
- (c) If you mark *three* answers, one of which is the correct answer, you earn **2** points.
- (d) If you mark no answers or the wrong answer, or more than *three*, you earn **0** points.

MC4: *multiple-choice-four-answer questions, each worth 4 points.*

Partial credit will be granted as follows.

- (a) If you mark only one answer and it is the correct answer, you earn **4** points.
- (b) If you mark *two* answers, one of which is the correct answer, you earn **2** points.
- (c) If you mark a wrong answer or no answers or more than two, you earn **0** points.

MC3: *multiple-choice-three-answer questions, each worth 3 points.*

No partial credit.

- (a) If you mark only one answer and it is the correct answer, you earn **3** points.
- (b) If you mark a wrong answer or no answers, you earn **0** points.

MC2: *multiple-choice-two-answer questions, each worth 2 points.*

No partial credit.

- (a) If you mark only one answer and it is the correct answer, you earn **2** points.
- (b) If you mark the wrong answer or neither answer, you earn **0** points

A. Nuclear Physics

Definitions. The following table will be used for questions 1-6. The table lists 6 terms that need to be defined. Each row in the table corresponds to one question, 1-6. The 1st column lists for each questions the term to be defined. The 2nd column contains different possible definitions and an answer key for each question, A-E and AB. On your answer sheet bubble for each question the matching answer key from the 2nd column. The key “AB” requires to bubble both answers A & B. [2 points each]

_____ 1) Atomic Weight	A. <u>The number of protons in a nucleus</u>
_____ 2) <i>Fertile</i>	B. <u>A nuclide that can be fissioned by bombardment with neutrons</u>
_____ 3) <u>Isotope</u>	C. <u>A nuclide that can be fissioned by neutrons of any energy</u>
_____ 4) Atomic Number	D. The total number of nucleons in a nucleus
_____ 5) <u>Fissile</u>	E. <i>Nuclides can be transformed into fissile nuclides through neutron capture</i>
_____ 6) Fissionable	AB. <u>Different nuclides with the same number of protons, but different numbers of neutrons</u>

7) Which subatomic particle is not present in any atomic nucleus?

- A. proton B. neutron **C. electron** D. deuteron

8) Nuclear explosive materials can be composed of ...

- A. fissile nuclides only
 B. fissile and fertile nuclides only
C. fissile nuclides and some fissionable but not-fissile nuclides
 D. any fissionable nuclide

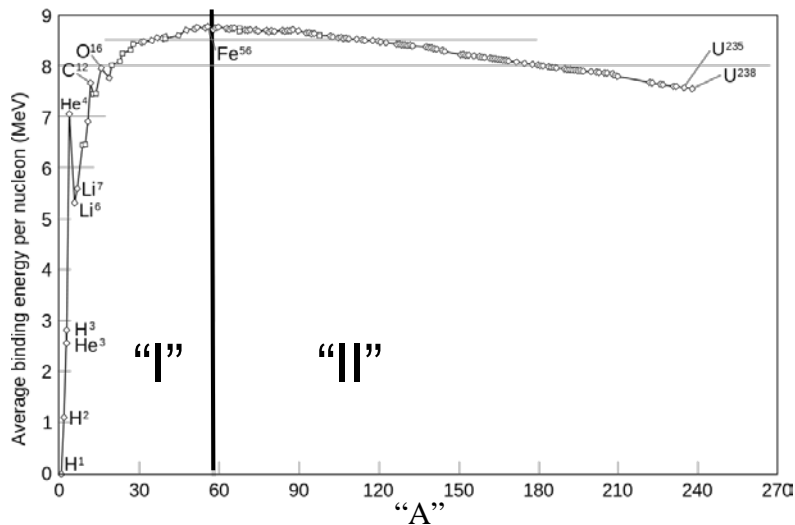
9) U-238 and U-235 have different...

- A. total number of nucleons but the same number of protons
- B. total number of nucleons but the same number of neutrons
- C. numbers of protons and neutrons
- D. number of protons but the same number of total nucleons

10) The nuclide ${}^3_1\text{H}$ has...

- A. 3 neutrons and 1 proton
- B. 1 neutron and 3 protons
- C. 2 neutrons and 1 proton
- D. 1 neutrons and 2 protons

Use the graph of binding energies to answer questions 11-13.



11) The x-axis label "A" represents the number of...

- A. protons in the nuclide
- B. neutrons in the nuclide
- C. protons plus neutrons in the nuclide
- D. neutrons minus protons in the nuclide

12) The region of binding energy graph where fusion can occur is...

- A. region "I" at small values of A
- B. region "II" at large values of A
- C. regions "I" and "II"
- D. binding energy is not related to fusion

13) The region of binding energy graph where fission can occur is...

A. region "I" at small values of A C. regions "I" and "II"

B. region "II" at large values of A D. binding energy is not related to fission

14) U-238 is used...

A. as the explosive material in gun-type weapons

B. to breed Pu-239 in reactors

C. as the explosive material in implosion weapons

D. both "A" and "B"

B. Nuclear weapons

15) What best describes the mechanism of a gun-type weapon?

A. Two sub-critical pieces of NEM combine to make a super-critical mass

B. Radioactive material is dispersed using a conventional explosive

C. A sub-critical piece of NEM is compressed to make a super-critical mass

D. A neutron initiator starts a fast-neutron chain reaction

16) Why do gun-type weapons use U-235 for fuel?

A. The critical mass for U-235 is smaller than that of Pu-239

B. U-235 is easier to obtain than Pu-239

C. U-235 has a slow rate of spontaneous fission and decay

D. conventional explosives are only compatible with U-235

17) Where is the neutron initiator located in an implosion weapon?

A. Outside the ring of high-explosives

B. Between the conventional explosive and the NEM

C. At the center of the NEM "pit"

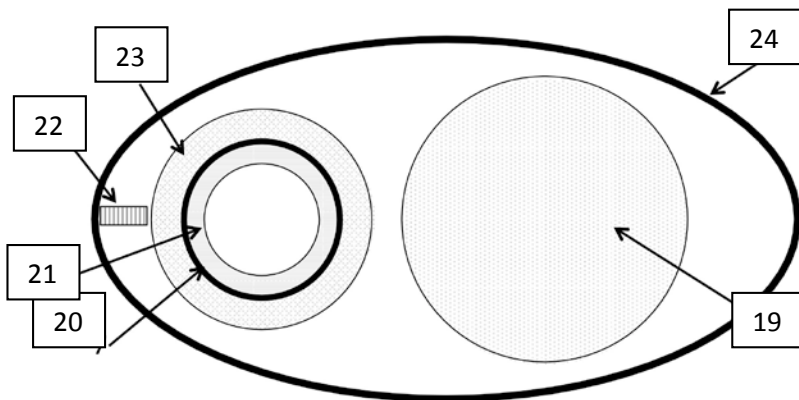
D. There is no neutron initiator in an implosion weapon

18) What kind of radioactive material can be used in a “dirty bomb”?

- A. Only fissile material
- B. Any nuclear explosive material
- C. Any material that undergoes radioactive decay**
- D. Any fissionable nuclide

Use the diagram of the thermonuclear bomb to answer questions 19-27.

Labeling: Match the weapon components identified by numbers, 19-24, with the correct answer keys, A-E and AB, provided in the list below. [2 points each]



- A. The neutron-emitting initiator-22
- B. The high-explosive lens assembly-23
- C. The tamper/reflector-20
- D. The hollow shell (“pit”) of nuclear explosive material-21
- E. The depleted Uranium shell-24
- AB. The fusion packet-19

Each of the **Questions 19-24** should be answered with the correct answer key A-E and AB from the list above. The key “AB” requires to bubble both answers A & B.

25) What is the function of the initiator?

- A. Compresses the pit to start the chain reaction
- B. Provide additional neutrons to start the chain reaction**
- C. Provide additional energy to maintain the chain reaction
- D. Keep the chain reaction from starting prematurely

26) What role does the bomb casing play if it is made of uranium?

- A. Start the fission reaction in the primary
- B. Contribute additional energy to the yield via fission reactions**
- C. Add generations to the fission chain reaction
- D. Initiate the fusion reaction in the secondary

- 27) What is the theoretical maximum yield of a thermonuclear weapon?
- A. 100 kilotons
 - B. 1 Megaton
 - C. 50 Megatons
 - D. There is none**

C. Current events

- 28) Find Crimea on a map of Ukraine. On your scantron, mark the letter closest to Crimea.



- 29) Russia successfully test fired an ICBM on Tuesday, March 4, 2014. Why is this test not thought to be related to Russia's military intervention in Ukraine?

- A. The test occurred in desolate locations in Siberia.
- B. Initial notification of the test to Western powers pre-dated the crisis in Crimea.**
- C. The International Atomic Energy Agency confirmed that the test was a routine test.
- D. An ICBM could not reach Ukraine from probable launch sites in Russia.

- 30) The theft of Co-60 in Mexico in November caused international concern as...?

- A. Co-60 is a fertile material and can be used to breed fissile nuclides.
- B. Co-60 is an NEM and can be used in nuclear weapons.
- C. Co-60 could be used in a radiological weapon.**
- D. Co-60 is radioactive, highly toxic and can be dispersed easily as a chemical weapon.

- 31) How were three peace activists almost able to break into a building that holds about 400 tons of HEU in Tennessee?

- A. They cut through four fences.**
- B. They drove through security checkpoints without stopping.
- C. They coordinated their attack with the assistant director of security.
- D. They used guns.

32) North Korea test-launched four Scud short-range ballistic missiles in late February and early March. The United States claims this is a violation of what?

- A. The Treaty on the Non-Proliferation of Nuclear Weapons
- B. United Nations sanctions and resolutions**
- C. Bilateral agreements with the United States
- D. The Korean Armistice Agreement

33) Negotiations between Iran and the P5+1 may fail because of which unsupportive leader?

- A. Iranian President Hassan Rouhani
- B. Supreme Leader Ayatollah Ali Khamenei**
- C. Iranian Deputy Foreign Minister Abbas Araqchi
- D. Former Iranian President Mahmoud Ahmadinejad

D. Nuclear weapon delivery methods

34) Which of the following is the only delivery method that can be recalled?

- A. Ballistic missiles
- B. Cruise missiles
- C. Manned aircraft**

35) What were the three legs of the Cold War nuclear “Triad”?

- A. Submarine-launched ballistic missiles, land-based ICBMs, bombers**
- B. Surface-ship-launched ballistic missiles, land-based ICBMs, bombers
- C. Submarine-launched ballistic missiles, land-based ICBMs, cruise missiles
- D. Surface-ship-launched ballistic missiles, land-based ICBMs, cruise missiles

36) MIRV technology allows for multiple weapons to be in one delivery system. True or False: the United States uses MIRV technology with multiple weapons in one delivery system.

- A. True**
- B. False

37) True or False: the United States is the only country with significant refueling capabilities for its bombers.

- A. **True**
- B. False

38) The Minuteman III launches hot, that is its rocket engines start in the silo and propel the missile out. Instead the Trident launches cold from submarines. What is a cold launch?

- A. **Missile is ejected with high pressure gas before rocket engines are started**
- B. Missile is ejected with high pressure gas while the rocket engines start

39) Which completes the blank?

“Several countries could develop a mechanism to launch SRBMs, MRBMs, or land-attack cruise missiles from forward-based ships or other platforms; a few are likely to do so — more likely for _____ — before 2015.”

- *Foreign Missile Developments and the Ballistic Missile Threat Through 2015*,
Unclassified Summary of a National Intelligence Estimate, December 2001

- A. SRBMs
- B. MRBMs
- C. **Land-attack cruise missiles**

E. Nuclear Explosions

40) The explosive energy of a given mass of nuclear explosive material is about how many times greater than the energy of an equal mass of conventional high explosives?

- A. 100 times
- B. **1 million times**
- C. 10,000 times
- D. 1,000 times
- E. 100,000 times

41) Which Statement is correct for most modern two stage weapons (prior to detonation)?

- A. Deuterium and Tritium are present as fusion fuel ,both in the primary and secondary stage
- B. LiD is present as fusion fuel in both stages
- C. There is only fission in the primary stage and LiD is present as fusion fuel in the secondary stage
- D. There is only fission in the primary stage and Deuterium and Tritium are present as fusion fuel in the secondary stage
- E. Deuterium and Tritium are present as fusion fuel in the primary stage and LiD in the secondary stage**

42) For a 1 MT explosion which statements are correct concerning the final energy distribution? **(mark all correct answers)**

- A. The energy in residual nuclear radiation is small and can be neglected
- B. Thermal Radiation carries the largest fraction of energy
- C. Electromagnetic pulse (EMP) carries only about 1% of the energy**
- D. Blast carries the largest fraction of energy.**
- E. The energy in prompt nuclear radiation is less than the energy for the EMP

43) Which of the following statements are correct for a 100 kT explosion. **(mark all correct answers)**

- A. A surface burst produces greater fallout than an airburst**
- B. The fireball touches the ground unless HOB > 3000ft
- C. Seismic waves caused by the explosion can be detected even at large distances**
- D. If tested at a sufficient depth, an underground nuclear weapon test can be carried out undetected
- E. For a fully contained (no venting) underground nuclear explosion, no radioactivity (except noble gases) are released**

44) What is the expected change in global surface temperatures that would be produced if the weapons in the current strategic arsenals of the U.S and Russia were exploded?

- A. -10 to -7 C
- B. -6 to -3 C
- C. -2 to 0 C
- D. 0 to +2 C
- E. +3 to +6 C

45) Which statements are correct with regards to a firestorm? (**mark all correct answers**)

- A. The central fire becomes very intense, creating a strong updraft; air at ground level rushes inward**
- B. Fire dies out where fuel has been consumed
- C. Fire spreads outward from the ignition point
- D. Temperatures at ground level exceed the boiling point of water and heat is fatal to biological life**
- E. Occurs when fires are started over a sizeable area and fuel is plentiful in and surrounding in the area**

46) Which statements are correct with regards to a conflagration? (**mark all correct answers**)

- A. The central fire becomes very intense, creating a strong updraft; air at ground level rushes inward
- B. Fire dies out where fuel has been consumed**
- C. Fire spreads outward from the ignition point**
- D. Temperatures at ground level exceed the boiling point of water and heat is fatal to biological life
- E. Occurs when fires are started over a sizeable area and fuel is plentiful in and surrounding in the area

- 47) If Soot is transported to the upper atmosphere by an explosion or eruption, what is the meantime for the soot to return to earth's surface?
- A. 2 years
 - B. 5 years**
 - C. 10 years
 - D. It will not return
- 48) Which of the following statements pertaining to effects of thermal radiation **is incorrect**?
- A. Thermal effects are felt before the blast wave arrives
 - B. Ignition of clothing ,structures, surroundings are examples for direct effects
 - C. For yield less than 10 KT, direct effects of thermal radiation are lethal well beyond the range where the impact from the blast is lethal**
 - D. Direct (flash) burns are caused by radiation emitted from the fire ball
 - E. Direct effects if thermal radiation are greatly reduced by shielding
- 49) Following a 1 MT nuclear explosion varying fall out levels will be observed. Which statements are correct with regards to the fall out levels? **(mark all correct answers)**
- A. 90 rem will lead to significantly increased cancer risk for the population - area will be habitable in 2-3 years**
 - B. 300 rem – severe radiation sickness**
 - C. 900 rem – death in 2 to 14 days**
 - D. 3000 rem - death within hours – more than 10 years before area will be habitable**
- 50) Which year saw the maximum number of nuclear explosions in the world?
- A. 1958
 - B. 1945
 - C. 1970
 - D. 1961**

51) A regional conflict between India and Pakistan with ~100 15 kT warheads will reduce the length of the growing season in U.S mid-west by about:

- A. 40%
- B. 10%**
- C. 70%
- D. 0%

F. Terrorism and its characteristics

52) Which of the statements below is NOT one of the six basic rules Richardson gives for countering sub-state terrorism:

- A. Have patience and keep your perspective
- B. Have a defensible and achievable goal
- C. Know your strategy**
- D. Know your enemy

53) Which of the following is *not* one of the “lethal triple cocktail” of factors that Richardson argues leads to terrorism?

- A. Extreme poverty**
- B. A disaffected individual
- C. A legitimizing ideology
- D. An enabling community

54) Which of the following is NOT a defining characteristic of terrorism?

- A. The act must be violent or threaten violence
- B. The violence must be against civilians
- C. The individual victims must be randomly chosen**
- D. The violence must be deliberate
- E. The violence must have a political purpose

55) Which definition best fits the term “State-sponsored terrorism”?

- A. Use of terrorism by a government against its own citizens, to coerce them into accepting the government’s authority.
- B. Use of terrorism by a government against the civilians of another country with which it is at war.
- C. State sponsorship of terrorist acts against inhabitants of other countries as an instrument of foreign policy.**
- D. Use of terrorism by a citizenry against its own government in order to bring about regime change.

56) Which is NOT one of the three (3) standard phases in an initially inexperienced society's reaction to terrorism?

- A. Polarization of politics
- B. Demonstration of resolve by adopting draconian responses that largely go unchallenged by the public
- C. Reasoned reflection on the nature of the threat and measured and efficient response
- D. Societal lack of concern regarding the seriousness of the threat**

57) According to Richardson, when terrorists act, they are seeking 3 immediate objectives (the “3 Rs”), which are:

- A. Revenge, Renown, Reaction**
- B. Relevance, Retribution, Reconciliation
- C. Righteousness, Redress, Redemption
- D. Revenge, Retribution, Reaction

58) Which of the statements below best matches our “PHYS 280” definition of terrorism?

- A. The use of violence and intimidation in the pursuit of political aims.
- B. Deliberately and violently targeting civilians for political purposes**
- C. The use of force or violence and/or threat, of any person or group of persons in connection with political, religious or ideological purposes.
- D. The unlawful use of violence or threat of violence to instill fear and coerce governments or societies.

59) According to our discussion in class, what is the best way to forge effective counterterrorism policies?

- A. **Understanding the appeal of terrorism**
- B. Creating comprehensive intelligence networks
- C. Initiating harsh laws and policies that raise the costs of engaging in terrorism to intolerable levels
- D. Find commonality with terrorist organizations' leadership and ideologies

G. Nuclear Terrorism

60) A difficulty in screening for nuclear bombs is that some common innocuous substances are radioactive and cause alarms. What is one such substance that we discussed in class?

- A. Bowling balls
- B. **Bananas**
- C. Chewing gum
- D. Fruitcake

61) In his book *Nuclear Terrorism*, Graham Allison lists three "No's" that he argues must be accomplished to prevent nuclear terrorism. What are they?

- A. No new nuclear weapon states, No new nascent nukes, No new nuclear weapon tests
- B. No insecure nuclear storage facilities, No new nascent nukes, No new nuclear weapon states
- C. No loose nukes, No new nascent nukes, No new nuclear weapon tests
- D. **No loose nukes, No new nascent nukes, No new nuclear weapon states**

62) In *Nuclear Terrorism*, Allison also lists seven "Yes's" that he argues must be accomplished to achieve his three "No's". Which of the below is NOT one of his seven "Yes's"?

- A. Making the prevention of nuclear terrorism an absolute national priority
- B. Building a global alliance against nuclear terrorism
- C. Dealing with dirty bombs
- D. **Conducting a forceful and proactive foreign policy**

- 63) What type of nuclear weapon design would be easiest for a terrorist group to construct?
- A. **Gun type**
 - B. Implosion
 - C. Levitated-pit implosion
 - D. Two-point hollow-pit implosion
- 64) What type of nuclear explosive material would the group need to make this design work?
- A. **Enriched uranium**
 - B. Plutonium
- 65) In the award-winning docudrama “Last Best Chance” shown in class, although the border guard scanned the cargo with a radiation detector, he failed to detect the nuclear bomb. Why?
- A. The detector was not powerful enough
 - B. The border guard did not know how to properly use the device
 - C. **The bomb was likely shielded by a material like lead**
 - D. The bomb was not detectible by a portable radiation device

H. Nuclear materials

- 66) What is the currently preferred technology for producing weapons-grade uranium?
- A. Electromagnetic isotope separation
 - B. **Gas centrifuge isotope separation**
 - C. Laser isotope separation
 - D. Chemical separation
 - E. Gaseous diffusion isotope separation
- 67) Which is not a step in creating weapons-grade plutonium?
- A. Chemical separation of plutonium from other elements
 - B. Briefly irradiating uranium in a reactor
 - C. **Gas centrifuge isotope separation of the fissile isotopes of plutonium**

68) Which would not influence the amount of nuclear explosive material needed to have a critical mass?

- A. Density of the mass
- B. The addition of a neutron initiator to the mass**
- C. Purity of nuclear explosive isotope in the mass
- D. Presence of a neutron reflector surrounding the mass
- E. Geometry of the mass

69) The minimum amount of weapons-grade plutonium needed to make a nuclear bomb is about the same size as a

- A. Pea
- B. Marble
- C. Baseball**
- D. Basketball
- E. Large beach ball

70) Reactor grade plutonium contains what percentage of Pu-239?

- A. greater than 20%
- B. less than 80%**
- C. 80-93%
- D. greater than 90%
- E. greater than 93%

71) Weapons-grade HEU contains what percentage of U-235?

- A. greater than 20%**
- B. less than 80%
- C. 80-93%
- D. greater than 90%
- E. greater than 93%

- 72) The preferred amount of U-235 in a nuclear weapon
- A. greater than 20%
 - B. less than 80%
 - C. 80-93%
 - D. greater than 90%**
 - E. greater than 93%
- 73) Is the term 'critical configuration' the same as the term 'critical mass'?
- A. Yes! They both carry the same information.
 - B. No! Critical configuration is different because it specifies the geometry of the NEM and provides information with regards to the assembly mechanism.**
- 74) Which nuclear materials could serve as a neutron initiator?
- A. Depleted uranium
 - B. Au-197 and Cs-137
 - C. Po-218 and Li-7**
- 75) Which is not an issue associated with using plutonium in a nuclear weapon
- A. The toxicity of plutonium
 - B. The heat generated by plutonium
 - C. The weight of the plutonium pit**
 - D. The large amount of spontaneous fission from plutonium
- 76) True or False? Chemical methods can be used to enrich uranium.
- A. True
 - B. False**
- 77) All techniques for enriching uranium depend on
- A. The mass difference between uranium isotopes**
 - B. The binding energy per nucleon difference between uranium isotopes
 - C. How different uranium isotopes behave in a magnetic field
 - D. How different uranium isotopes behave in an electric field
 - E. How different uranium isotopes behave chemically

78) Can a nuclear weapon be created using reactor grade plutonium?

- A. No! Reactor grade plutonium is far too radioactive to be used in a bomb.
- B. No! Reactor grade plutonium.
- C. Yes! There was a bomb created and tested with reactor grade plutonium.**
- D. Yes! Nuclear weapons are usually made of reactor grade plutonium.

**Check to make sure you bubbled in all your answers.
Did you bubble in your name, exam version and network-ID?**