

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 ninety (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 **21 numbered pages**.*

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 344 points, composed of 4 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.

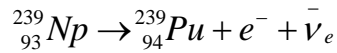
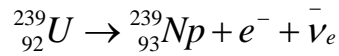
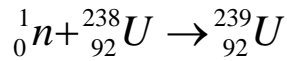
- (a) If you mark only one answer and it is the correct answer, you earn **2** points.
- (b) If you mark the wrong answer or neither answer, you earn **0** points

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

Use the 3-step breeding mechanism for Pu-239 from U-238 shown below to answer questions 7 and 8.

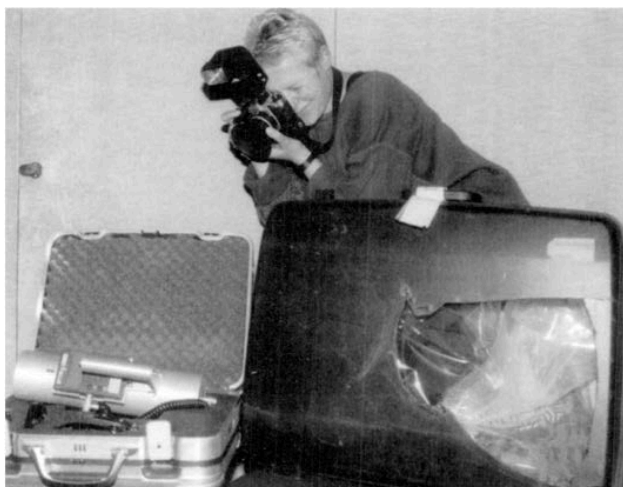


- 7) Which of the following statements correctly describes the three steps above?
- A fertile U-238 nuclide captures an electron-neutrino to become U-239 which then alpha decays twice to produce fissile Pu-239.
 - A fissile U-238 nuclide captures a neutron to become U-239 which then undergoes two steps of gamma decay to produce fissile Pu-239.
 - A fertile U-238 nuclide captures a neutron to become U-239 which then undergoes two steps of gamma decay to produce fissile Pu-239.
 - A fertile U-238 nuclide captures a neutron to become U-239 which then undergoes two steps of beta decay to produce fissile Pu-239.
- 8) Which of the following statements concerning Np-239 becoming Pu-239 is correct?
- ${}_{93}^{239}\text{Np}$ becomes ${}_{94}^{239}\text{Pu}$ because one proton in ${}_{93}^{239}\text{Np}$ decayed into a neutron thus becoming ${}_{94}^{239}\text{Pu}$.
 - ${}_{93}^{239}\text{Np}$ becomes ${}_{94}^{239}\text{Pu}$ because one neutron in ${}_{93}^{239}\text{Np}$ decayed into a proton thus becoming ${}_{94}^{239}\text{Pu}$.
 - ${}_{93}^{239}\text{Np}$ becomes ${}_{94}^{239}\text{Pu}$ because ${}_{93}^{239}\text{Np}$ contains an odd number of electron-neutrinos (i.e. 93) and nuclides with an odd number of electron-neutrinos are unstable.
 - ${}_{93}^{239}\text{Np}$ becomes ${}_{94}^{239}\text{Pu}$ because one electron in ${}_{93}^{239}\text{Np}$ decayed into a proton thus becoming ${}_{94}^{239}\text{Pu}$.
 - ${}_{93}^{239}\text{Np}$ is actually equivalent to ${}_{94}^{239}\text{Pu}$ because they contain the same total number of neutrons and protons, so the last line of the breeding process is merely a rewriting.

- 9) Which of the following statements is correct?
- A. U-235 can capture a neutron, a proton, or an electron to induce nuclear fission; scientists focus on neutrons because they are the heaviest.
 - B. U-238 can capture only a neutron to induce nuclear fission because neutrons are the only elementary particles that exist naturally outside a nuclide.
 - C. Pu-239 can capture either a neutron or a proton to induce nuclear fission since the only noticeable difference between the two particles is their mass.
 - D. Pu-239 undergoes nuclear fission from the capture of a neutron not a proton, as the positive electric field produced by the protons in the nucleus will repel protons but not neutrons.

Questions 10 - 12 are related to the picture and description below

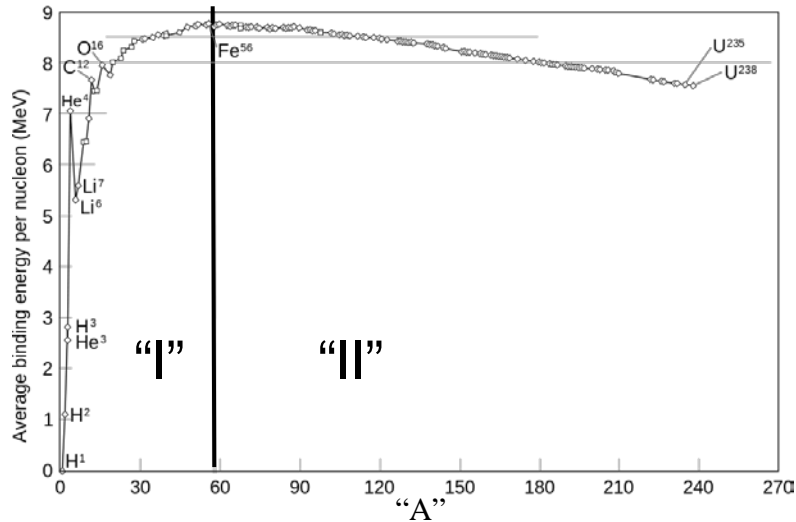
In 1994 the briefcase pictured to the left was confiscated at the Munich airport. Inside, security personnel found 560g of plutonium and uranium oxide, as well as 210g of lithium metal which contained 89.4% Lithium-6.



- 10) Without any additional information which of the following answer describes best which weapons would **not** be possible to make from the material in the briefcase?
- A. A plutonium nuclear fission weapon
 - B. A uranium nuclear fission weapon
 - C. A thermonuclear weapon
 - D. Both, plutonium and uranium nuclear fission weapons
 - E. All three, a plutonium nuclear fission weapon, uranium nuclear fission weapon, and a thermonuclear weapon

- 11) Now one learns that the plutonium was “low burn-up” plutonium whereas the uranium had a low level of U-235 enrichment. Which of the following weapons designs would be the easiest to make starting from the smuggled nuclear-explosive material?
- A. An implosion type plutonium nuclear fission weapon
 - B. An implosion type uranium nuclear fission weapon
 - C. A gun type plutonium nuclear fission weapon
 - D. A gun type uranium nuclear fission weapon
 - E. A thermonuclear weapon
- 12) What would be the **most likely** purpose of the lithium metal in a nuclear weapon?
- A. The Li-6 used as an initiator of an implosion type nuclear fission weapon.
 - B. The lithium metal used as a reflector for an implosion type nuclear weapon to reduce the number of neutrons that escape a configuration of fissile material.
 - C. The Li-6 combined with deuterium used as the fusion packet inside a thermonuclear weapon
 - D. The lithium metal used as the breeder of triton in a gun type nuclear fission weapon.
 - E. The Li-6 used as an impurity in the hollow shell (“pit”) of a thermonuclear weapon.
- 13) The nuclide $^{235}_{92}\text{U}$ has...
- A. 235 neutrons and 92 protons
 - B. 92 neutrons and 143 protons
 - C. 92 neutrons and 235 protons
 - D. 143 neutrons and 92 protons
- 14) Nuclear Binding Energies compared to chemical binding energies are larger by a factor
- A. 10
 - B. 100
 - C. 1,000
 - D. 100,000
 - E. 1,000,000
- 15) Which statement describes best the number of electrons in hydrogen, deuterium and tritium?
- A. H has 1 electron, D has 2 electrons, T has 3 electrons
 - B. All three atoms are isotopes of hydrogen

Use the graph of binding energies to answer questions 16-18.



16) The x-axis label “A” represents the number of...

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

17) The region of binding energy graph where fusion 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 fusion |

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

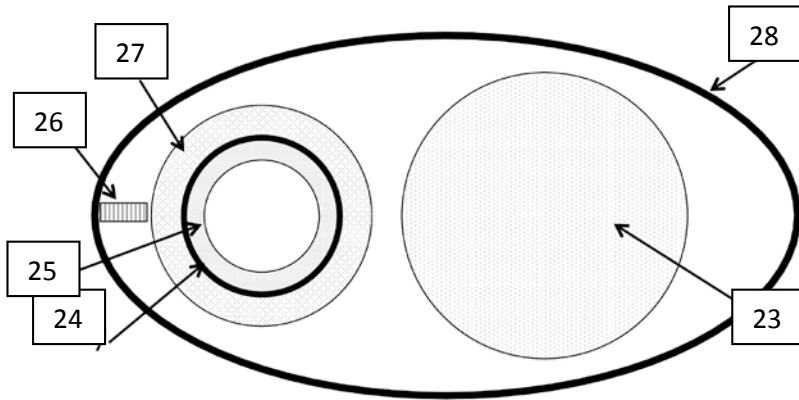
- | | |
|-------------------------------------|---|
| A. region “I” at small values of A | C. regions “I” and “II” |
| B. region “II” at large values of A | D. binding energy is not related to fission |

B. Nuclear weapons

- 19) 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
- 20) 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
- 21) 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
- 22) 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 23-30.

Labeling: Match the weapon components identified by numbers, 23-30, with the correct answer keys, A-E and AB, provided in the list below. [2 points each]



- A. The neutron-emitting initiator
- B. The high-explosive lens assembly
- C. The tamper/reflector
- D. The hollow shell ("pit") of nuclear explosive material
- E. The depleted Uranium shell
- AB. The fusion packet

Each of the **Questions 23-28** 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.

29) 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

30) 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

31) 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

32) According to Al Jazeera, what was Mossad's Conclusion on the Iranian Nuclear Program?

- A. They are producing chemical weapons
- B. They already have multiple nuclear weapons
- C. They currently are not working to produce a nuclear weapon
- D. They have opened a new underground Uranium enrichment plant

33) Congressmen recently supported proposals to rally behind upgrading which leg of the triad?

- A. Nuclear Submarines
- B. Long Range Bombers
- C. Cruise Missiles
- D. ICBMs

34) In the P5+1 negotiations with Iran the "+1" refers to?

- A. United States
- B. Iran
- C. Israel
- D. Germany
- E. Japan

35) According to NPR, in which countries have groups declared affiliation with ISIS/IFL?

- A. Syria
- B. Iraq and Afghanistan
- C. Syria, Iraq, Afghanistan and Libya

36) Which of the following countries recently may have restarted a reactor useable to create Plutonium?

- A. Pakistan
- B. North Korea
- C. Iran
- D. India

D. Nuclear weapon delivery methods

- 37) Why did Pakistan seek to increase the range of its missiles to 1300km?
- A. To achieve nuclear parity with Russia
 - B. To deliver their large supply of plutonium nuclear weapons
 - C. To be able to effectively strike major cities in India
 - D. To supplement its sizeable arsenal of ICBMs
- 38) Which of the following was not a leg of the US Triad during the Cold War?
- A. SLBM on SSBNs
 - B. ICBM in silos
 - C. Cruise Missiles on mobile launchers
 - D. Long Range Bombers
- 39) What does MIRV stand for?
- A. Manual Intercept Reentry Vehicle
 - B. Multiple Independent Reentry Vessel
 - C. Manual Intercept Reentry Vessel
 - D. Multiple Independent Reentry Vehicle
- 40) What is CEP?
- A. Calculated Error Probability
 - B. Circular Estimation of Probability
 - C. Circular Error Probable
 - D. Calculated Engagement Perimeter
- 41) What is the main advantage of SLBMs in their strategic role in the Triad?
- A. They are protected from first strike attacks
 - B. They are more accurate than other delivery systems
 - C. They are cheaper to maintain than other delivery systems
 - D. They are easier to develop than other delivery systems
- 42) Which is not true of cruise missiles?
- A. They can carry nuclear payloads
 - B. They are often deployed on forward based ships or planes
 - C. They are considered very cheap delivery vehicles
 - D. They are exoatmospheric

- 43) The Chinese Silkworm cruise missile has a range of 180 miles. What does this range suggest?
- A. The Chinese have not succeeded of designing an accurate weapon with a longer range.
 - B. The Chinese perceive an enemy navy as a significant threat and this range is sufficient to destroy an enemy carrier group.
 - C. Designed after the Sino-Soviet Split, 180 miles is the distance between the silos in Altay, China and the Soviet Severnaya Satellite Station.
 - D. Chinese nuclear weapons are too heavy and limit the range of all Chinese missiles.
- 44) While some countries still use liquid fuel, recent US missile designs use solid fuel because:
- A. A common chemical in liquid fuel, methyl tert-butyl ether (MTBE) was banned by the EPA.
 - B. Liquid fuel is volatile and has a high potential to explode, leading it to be stored separately from the missile itself.
 - C. Many liquid fuels use technetium-99, a radioactive liquid, to prevent freezing in cold climates.
- 45) During this phase of ballistic missile deployment, the missile re-enters the atmosphere and moves towards its target.
- A. Boost phase
 - B. Midcourse phase
 - C. Terminal phase
 - D. Post-boost phase
- 46) This Soviet missile design, based on the German V2, is the basis for many other nations' missiles.
- A. "November Rain"/N-12
 - B. "Scud"/R-11
 - C. "Big Ivan"/BM-2
 - D. "Hammer"/USSR-2

- 47) What is the primary difference between a hot and cold launch for a missile?
- A. A hot launch refers to procedures used to launch missiles in warm climates like Guam, whereas cold launches are used for Alaskan silos.
 - B. A hot launch occurs from a moving vehicle like an airplane or submarine, while a cold launch occurs from a stationary location like a silo.
 - C. A hot launch requires rocket engines to start within a silo, while a cold launch is initiated by a high-pressure ejection, and then activation of engines.
 - D. A hot launch is initiated by a high-pressure ejection, and then activation of engines, while a cold launch requires rocket engines to start within a silo.
- 48) Why is an oxidizer important for ballistic missiles?
- A. In order to burn fuel in space, an oxidizer must be provided. Within the atmosphere, air serves this purpose.
 - B. Navigation and GPS systems require oxygen to operate, so a small oxygen tank on the missile provides it.
 - C. Oxidizers, like liquid oxygen, are a crude form of boosting the yield of conventional weapons.
 - D. Oxidizers, like liquid oxygen, fire before a two-phase nuclear weapon is used to convert pure deuterium (^2H) pellets into lithium-deuteride before activation.
- 49) An American spy has learned that North Korea has been designing highly-accurate GPS systems and attempting to find digital maps of South Korean cities. Why is this significant?
- A. North Korean cruise missiles can use GPS positioning to make corrections mid-flight to move over terrain and to hit targets more accurately.
 - B. GPS systems can be used to pilot the missile out of the way of incoming anti-missile weapons.
 - C. GPS systems are required for any missile which exits and then re-enters the atmosphere.
- 50) Which of the following is the only delivery method that can be recalled?
- A. Ballistic missiles
 - B. Cruise missiles
 - C. Manned aircraft

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

- A. True
- B. False

E. Nuclear Explosions

52) Which type of burst produces the most radioactive fallout?

- A. Ground burst
- B. Air burst
- C. Subsurface burst consistent with LTBT
- D. Underwater burst

53) 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 fighters can survive with protective equipment in basements
- 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 the area

54) Which year saw the maximum number of nuclear explosions in the world?

- A. 1958
- B. 1968
- C. 1970
- D. 1962

55) Why do surface bursts produce the most radioactive fallout?

- A. The explosion is lower to the ground and therefore has a greater chance of producing a firestorm, which will more effectively spread the radioactive fallout.
- B. The fireball evaporates dirt and other materials, the vaporized matter carries radioactive particles and is ejected into the atmosphere.
- C. Surface bursts don't produce the most radioactive fallout.

- 56) The fundamental limit on the yield of a modern two-stage nuclear weapon is:
- A. 10 kilotons
 - B. 500 kilotons
 - C. 10 megatons
 - D. 100 megatons
 - E. there is none
- 57) A nuclear attack on a country would lift soot into the atmosphere, screening the sunlight and reducing surface temperatures on Earth. How long would it take for half of the soot to fall out of the atmosphere?
- A. 1 month
 - B. 1 year
 - C. 5 years
 - D. 10 years
- 58) The atmospheric effects of a nuclear war between India and Pakistan would likely reduce the length of the growing season in the US Midwest by:
- A. 1-2%
 - B. 5-7%
 - C. 10-15%
 - D. 20-25%
- 59) Which of the following are considered weapons of “mass destruction”? (**mark all correct answers**)
- A. Radiological weapons
 - B. Nuclear weapons
 - C. Biological weapons
 - D. Chemical weapons
- 60) Which of the following aspects of society would collapse in the event of a SORT War?
- A. The medical system
 - B. The government
 - C. The economy
 - D. Agriculture
 - E. All of the above

61) According to the required reading “Environmental consequences of nuclear war”, how many tera-grams of soot would be generated in a nuclear exchange between India and Pakistan?

- A. 1
- B. 5
- C. 35
- D. 75

62) The effect of a nuclear weapon explosion is dependent on: **(mark all correct answers)**

- A. The yield of the weapon
- B. The type of weapon used (uranium, plutonium, or thermonuclear)
- C. The environment in which the energy was released
- D. How long the weapon was in storage before being used

63) Underground nuclear tests can be detected through the monitoring of: **(mark all correct answers)**

- A. The release of radioactive noble gases
- B. Irregular seismic activity
- C. The development of cracks in the Earth’s surface
- D. Underground nuclear tests cannot be detected

64) 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

65) 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

66) 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

67) 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

F. Terrorism and its characteristics

68) According to Richardson, terrorists act with 3 immediate objectives (the “3 Rs”) in mind, what are they?

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

- 69) 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
- 70) What type of nuclear weapon would be most probable for a terrorist organization to construct?
- A. Levitated-pit implosion
 - B. Implosion
 - C. Gun type
 - D. Two-point hollow-pit implosion
- 71) Which of the following is *not* one of Richardson's factors for a "lethal triple cocktail" that leads to terrorism?
- A. a disaffected individual
 - B. an impoverished country
 - C. an enabling community
 - D. a legitimizing ideology
- 72) 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 bomb was likely shielded by a material like lead
 - B. The detector was not powerful enough to detect the bomb
 - C. The border guard did not know how to properly use the device
 - D. Fissile material in warheads are not detectible by portable radiation detectors
- 73) What materials contain naturally radioactive isotopes that can cause a radiological false alarm in the portal monitors on the border?
- A. Bananas, hand soap, cell phones
 - B. Glass, ceramics, fabric
 - C. Hand soap, cell phones, glass
 - D. Kitty litter, ceramics, bananas

- 74) What is the most likely way terrorists would carry out a nuclear attack on the U.S. and why?
- A. Missile Delivery because it would be the least costly, easiest to acquire, and most reliable and accurate
 - B. Missile Delivery because it would instill the most fear, bring about the most renown, and cause the most chaos
 - C. Non-Missile Delivery because it would be the least costly, easiest to acquire, and most reliable and accurate
 - D. Non-Missile Delivery because it would instill the most fear, bring about the most renown, and cause the most chaos
- 75) Which of the following is *not* a reason that an implosion-type bomb would present more technical challenges than other types?
- A. Difficulty in acquiring LEU
 - B. Difficulty in designing high explosive lenses
 - C. Difficulty in machining and assembling precision parts
 - D. Difficulty in triggering the implosion
- 76) Which of the following are *not* one of the “Three No’s” that Graham formulates in his doctrine in order to deny terrorists access to nuclear weapons or materials?
- A. No loose nukes
 - B. No new nascent nukes
 - C. No new nuclear material
 - D. No new nuclear weapon states
- 77) What is the most pressing action required to prevent terrorists from going nuclear?
- A. Ensuring that other countries do not directly sell bombs to any terrorist organizations or non-state actors
 - B. Implementing the “Star Wars” strategic defense initiative that Raegan put into place in the 80s
 - C. Increasing security on HEU stockpiles in places like Russia and Pakistan that are most vulnerable to theft so that they cannot build a bomb
 - D. Improving the protection of nuclear weapons in the United States from possible theft

78) Is there any possibility that a nuclear power reactor could be targeted to cause an explosive nuclear chain reaction?

- A. No, nuclear power reactor walls are five feet thick with reinforced steel and concrete, nothing could get through them
- B. No, a nuclear explosion cannot occur from a nuclear power reactor, but an attack on such a reactor could release a massive amount of radiation
- C. Yes, this would be the appropriate trigger to set off the 82-generation fast-neutron chain reaction
- D. Yes, nuclear power reactors are where all of the NEM is created, so there would be partially constructed weapons there that would immediately detonate

G. Nuclear materials

79) 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

80) 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

81) 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%

- 82) 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%
- 83) Which nuclear materials could serve as a neutron initiator?
- A. Depleted uranium
 - B. Au-197 and Cs-137
 - C. Po-218 and Li-7
- 84) 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
- 85) True or False? Chemical methods can be used to enrich uranium.
- A. True
 - B. False
- 86) 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?**