

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 180 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 26 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 composed of 96 multiple choice questions, there are 5 different types of questions. In addition there is one essay writing question: problem 97, worth 30% of the final exam grade.

**Rules for different problem types and partial credit:**

**A) Problems with multiple correct answer:** *multiple-choice-five (or four)-answer questions, each worth six (or four) points.*

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

**B) 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.

**C) 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.

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

**No partial credit.**

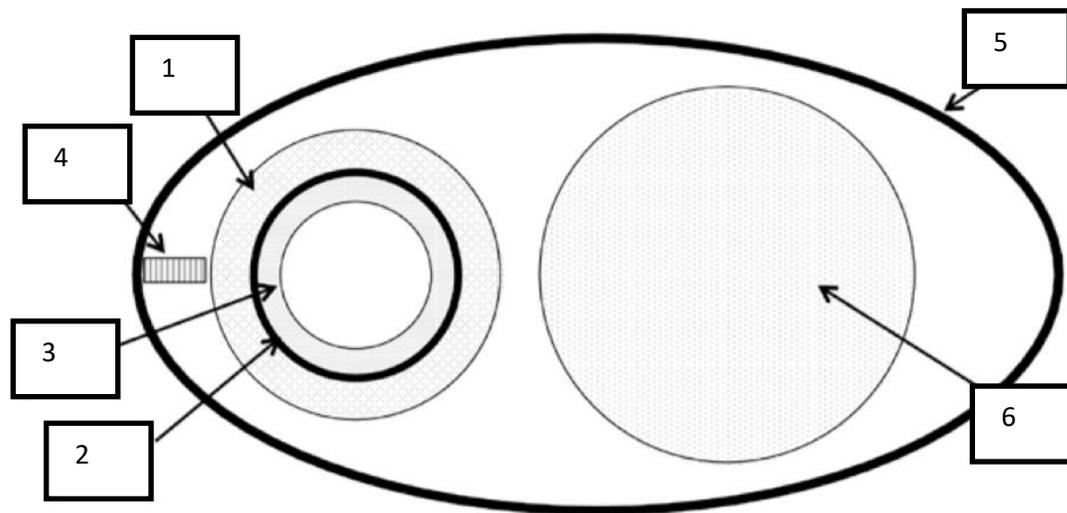
- (a) If you mark only one answer and it is the correct answer, you earn **3** points.
- (b) If you mark a wrong answer or no answers, you earn **0** points.

**E) 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 weapons



**Questions 1-6** Match the weapon components identified by numbers in the figure above, 1-6, with the correct answer keys, A-E and AB, provided in the list below. The key “AB” requires bubbling both answers A and B. [2 points each].

- A. Neutron initiator
- B. High-explosive lens assembly
- C. Tamper/reflector
- D. Hollow “pit”
- E. DU (depleted uranium) shell
- AB. Fusion packet

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

- A. Starts the fission reaction in the primary
- B. Contributes additional energy to the yield via fission reactions
- C. Adds generations to the fission chain reaction
- D. Initiates the fusion reaction in the secondary

8) Which weapon design is a non-state group more likely to employ?

- A. An implosion-type design; it is easier to produce
- B. An implosion-type design; its configuration allows for a larger yield
- C. A gun-type design; it is easier to produce
- D. A gun-type design; its configuration allows for a larger yield

- 9) Can a nuclear weapon be built using reactor-grade plutonium?
- A. Yes, the US tested a bomb using reactor-grade plutonium
  - B. Yes, the USSR tested bombs using reactor-grade plutonium
  - C. Yes, it is theoretically possible but has never been tested
  - D. No, it is impossible to build a bomb using reactor-grade plutonium
- 10) To be used in a nuclear weapon, uranium must be enriched to what percentage U-235?
- A. 10%
  - B. 20%
  - C. 62%
  - D. 80%
  - E. 93%
- 11) Which enrichment method separates nuclides based on their charge-to-mass ratio?
- A. Molecular laser isotope separation
  - B. Gaseous diffusion isotope separation
  - C. Electromagnetic isotope separation
  - D. Gas centrifuge isotope separation
- 12) Which of the following statements about fusion weapons is **false**?
- A. X-rays from the 'primary' compress and heat the 'secondary,' causing thermonuclear fusion of tritium and deuterium
  - B. There is no fundamental limit to the yield that is possible from a fusion secondary
  - C. Fissions during the second stage are produced by high-energy neutrons from the fusion reactions and greatly increase the yield
  - D. Li-6D is used as the fusion fuel
  - E. All of the above statements are true
- 13) What is the main reason plutonium is not used in gun-type weapons?
- A. Neutrons released from the plutonium might set off the weapon prematurely
  - B. Plutonium is more dangerous to handle than uranium
  - C. The materials used in a gun-type weapon cannot handle the heat emitted from plutonium
  - D. Plutonium is used in gun-type weapons

14) Surveillance of a nuclear power plant in a hostile state reveals that the reactor is being powered down every two to three months. Is this a proliferation concern?

- A. Yes, it is possible the fuel is being reprocessed to isolate HEU
- B. Yes, it is possible that the fuel is being reprocessed to isolate Pu-239
- C. Yes, it is possible that the power plant is being used to create fusion fuel
- D. No, this is normal procedure for a nuclear power plant

## B. Nuclear Physics

15) Which force holds the nucleus of an atom together?

- A. Gravitational force
- B. Weak nuclear force
- C. Strong nuclear force
- D. Electro-magnetic force

16) Which of the know force is always attractive?

- A. Gravitational force
- B. Weak nuclear force
- C. Strong nuclear force
- D. Electro-magnetic force

17) **Reaction A:**  ${}^2_1H + {}^3_1H \rightarrow \text{Result A}$  , **Reaction B:**  ${}^{235}_{92}U + n \rightarrow \text{Result B}$

Choose all that apply to **BOTH** Reaction A and Reaction B:

[Mark all correct answers.]

- A. Fission
- B. Fusion
- C. Energy is released
- D. Decrease in binding energy per nucleon of resultant isotope(s)
- E. Increase in binding energy per nucleon of resultant isotope(s)

18) What allows a neutron to interact directly with a nucleus?

- A. A neutron is much smaller than a proton
- B. A neutron weighs much less than a proton
- C. A neutron has no charge
- D. A neutron is too small to interact with electrons

19) Gamma radiation is best described as:

- A. Emission of a beta-positron “twinned” pair.

- B. Emission of a high-energy proton.  
C. Emission of a high-energy photon.  
D. Emission of a high-energy neutron
- 20) Which of the following is **NOT** a form of radiation?  
A. Spontaneous fission  
B. Delta radiation  
C. Positron annihilation  
D. Gamma radiation  
E. Beta-decay
- 21) Which isotope has the highest average binding energy per nucleon?  
A. Fe-56  
B. He-3  
C. U-235  
D. Ag-107
- 22) What isotope of uranium is most common in nature?  
A. U-233  
B. U-234  
C. U-235  
D. U-236  
E. U-238  
F. U-239
- 23) What isotope of plutonium is formed if U-238 absorbs a neutron and then undergoes double beta-decay?  
A. Pu-235  
B. Pu-236  
C. Pu-238  
D. Pu-239
- 24) The nuclide  ${}^2_1\text{H}$  has...  
A. 2 neutrons and 1 proton  
B. 2 protons and 1 neutron  
C. 1 neutron and 1 proton  
D. 1 proton and 1 electron

**C. Nuclear Explosions**

22) The correct order in which the effects from a large airburst are felt are:

- A. Thermal radiation, EMP, blast wave, fallout
- B. Fallout, blast wave, thermal radiation, EMP
- C. EMP, thermal radiation, blast wave, fallout
- D. EMP, blast wave, thermal radiation, fallout
- E. Blast wave, thermal radiation, EMP, fallout

24.) If a nuclear weapon were detonated in space, which nuclear weapon effect would cause the most damage to satellites at significant distances from the location of the explosion?

- A. EMP
- B. Blast wave
- C. Thermal radiation
- D. Fallout

26.) Geologists in the United States detected unusual seismic activity in North Korea. They also detected traces of various Xenon isotopes in the air over North Korea, but no radioactive fallout is present. Is it likely that North Korea tested a nuclear weapon, and if so, which type of burst did they use?

- A. Yes, North Korea tested a weapon using a surface burst.
- B. Yes, North Korea tested a weapon using a partially contained underground burst.
- C. Yes, North Korea tested a weapon using a fully contained underground burst.
- D. Yes, North Korea tested a weapon using an underwater burst.
- E. No, North Korea did not test a nuclear weapon.

21) In a few seconds, a small (10-kiloton) nuclear device that is detonated in a large city would destroy \_\_\_\_\_ square kilometers and kill \_\_\_\_\_ people.

- A. 1 / 1,000
- B. 30 / 30,000
- C. 30 / 100,000
- D. 300 / 1,000,000

22) In a few seconds, a large (1-megaton) nuclear device that is detonated in a large city would destroy \_\_\_\_\_ square kilometers and kill \_\_\_\_\_ people.

- A. 1 / 1,000
- B. 30 / 30,000
- C. 30 / 100,000
- D. 300 / 1,000,000

30) There is no theoretical limit to the yield of a thermonuclear weapon.

- A. True
- B. False

23) When the energy released by a nuclear explosion is stated in “kilotons”, what other explosive material is it being compared to?

- A. Astrolite
- B. TNT
- C. Nitroglycerin
- D. Gunpowder

24) A SORT war between Russia and the United States could generate 200 tera-grams of soot which would effectively reduce the average temperature by \_\_\_\_\_°F and reduce precipitation by \_\_\_\_\_%

- A. 14°F, 45%
- B. 25°F, 65%
- C. 5°F, 20%
- D. 10°F, 35%
- E. There would be no effect on temperature or precipitation.

1.) The *direct* effects of nuclear war would have greater consequences for the Earth’s human population than the *indirect* effects of nuclear war.

- A. True
- B. False

2.) Which of the following affect the severity of a burn injury from thermal radiation in a nuclear explosion? [**Mark all correct answers.**]

- A. The total energy released (the yield)
- B. The transparency of the atmosphere
- C. The slant distance to the center of the burst
- D. Whether a person is inside or outside
- E. The type of clothes a person is wearing

3.) Which of the following statements is true?

- A. Chemical, biological, nuclear and radiological weapons should all be considered weapons of mass destruction since they possess relatively equal lethal power and capability to destroy infrastructure.
- B. The amount of deaths shortly after a radiological weapon and a nuclear weapon attack are about the same; the only difference is the damage to infrastructure.
- C. The effects of a chemical or biological weapon attack on a city *cannot* be reduced significantly by actions taken before or after the attack
- D. The effects of a nuclear weapon attack on a city *cannot* be reduced significantly by actions taken before or after the attack

4.) Which of the following statements is true?

- A. The blast wave of a nuclear explosion is considered the militarily *most* significant effect of a nuclear explosion in the atmosphere because it carries the largest percentage of the energy.
- B. The blast wave of a nuclear explosion is considered the militarily *most* significant effect of a nuclear explosion in the atmosphere because it arrives first.

C. The blast wave of a nuclear explosion is considered the militarily *least* significant effect of a nuclear explosion because it contains the least amount of radiation.

#### D. Terrorism

1) 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

2) In the movie, “Last Best Chance” the terrorist group justified usage of nuclear weapons against the West due to which of the following?

- A. U.S. forces stationed in the Middle East
- B. Demands made by senior leadership of the group
- C. Sum of all Muslims killed by Western troops
- D. Inspiration from U.S. bombing of Japan in WWII

3) 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

4) 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

5) 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

6) 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
- 7) 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
- 8) Which of these phrases best describes the concept of War Terrorism?
- A. A government using its armed forces to suppress internal dissent and maintain social and political order.
  - B. A government supporting a sub-state group with monetary or physical resources within another state's borders.
  - C. A group pushing for changes within a state or pushing to keep a status quo via violent means and threats against civilian populations.
  - D. A government using its armed forces against the civilian population of another country in order to force that state to surrender.
- 9) How did the Peruvian government defeat the Shining Path, a pervasive terror organization in the Andes Mountains.
- A. The Peruvian government used its military to crush the Shining Path with brute force.
  - B. The Shining Path completed negotiations with Peru and entered the political process as the Communist Party of Peru.
  - C. Peru established a taskforce to deal with the group and decapitated it by capturing its leader.
  - D. None of these, the Shining Path achieved its goals and forced the President of Peru to step down.
- 10) Which one of these is not a requirement of the Hague Convention to be a regular armed forces group?
- A. Have a fixed distinctive banner recognizable at a distance
  - B. Be commanded by a legitimate political authority

- C. Be commanded by a person responsible to a party to the conflict
  - D. Conduct operations in accordance with the laws and customs of war
- 11) Which was not a mistake made by the United States following 9/11?
- A. Combining the threat of Al-Qaeda and the threat of the Hussain regime in Iraq
  - B. Declaring a 'Global War on Terror'
  - C. Invading Afghanistan in 2001 and dismantling the Taliban power structure rapidly
  - D. Investing resources in intelligence gathering on global terror groups
- 12) What is the most likely pathway to a bomb for a terror group?
- A. Buying a bomb
  - B. Building a bomb
  - C. Stealing a bomb
  - D. Terrorist groups cannot obtain a nuclear weapon
- 13) How do the United States, France, the UK, and China secure their nuclear weapons?
- A. They use Permissive Action Links to prevent non-authorized users from triggering the detonation mechanism
  - B. Their weapons are dismantled unless needed, when they are then assembled
  - C. All of these states secure their weapons by placing them in fortified bunkers across their territory
  - D. The weapons are not always secured, only a portion of the devices at any one time are especially guarded.
- 14) Which state is the most vulnerable to having its weapons stolen or sold to terror organizations?
- A. China
  - B. Russia
  - C. India
  - D. Pakistan
- 15) How much highly enriched uranium would a terror group require to build a simple gun-type weapon?
- A. 100kg
  - B. 10kg
  - C. 50kg
  - D. 25kg

### **E. Nuclear Weapon Delivery Methods**

51) Is there any barrier to prevent the crew of a U.S. submarine carrying nuclear-armed long-range ballistic missiles from launching them without Presidential authority?

- A. Yes
- B. No

53) Which one of the following strategic nuclear delivery vehicles can be recalled after launch?

- A. Submarine-launched ballistic missiles
- B. Land-based intercontinental ballistic missiles
- C. Land-based intercontinental bombers

54) Which list of attributes correctly describes cruise missiles?

- A. Cruise missiles fly within the atmosphere at supersonic speeds
- B. Cruise missiles fly within the atmosphere at subsonic speeds
- C. Cruise missiles fly within and above the atmosphere at supersonic speeds
- D. Cruise missiles fly within and above the atmosphere at subsonic speeds

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

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

50) Which of the following are the correct phases of flight for an ICBM and are also in the correct order?

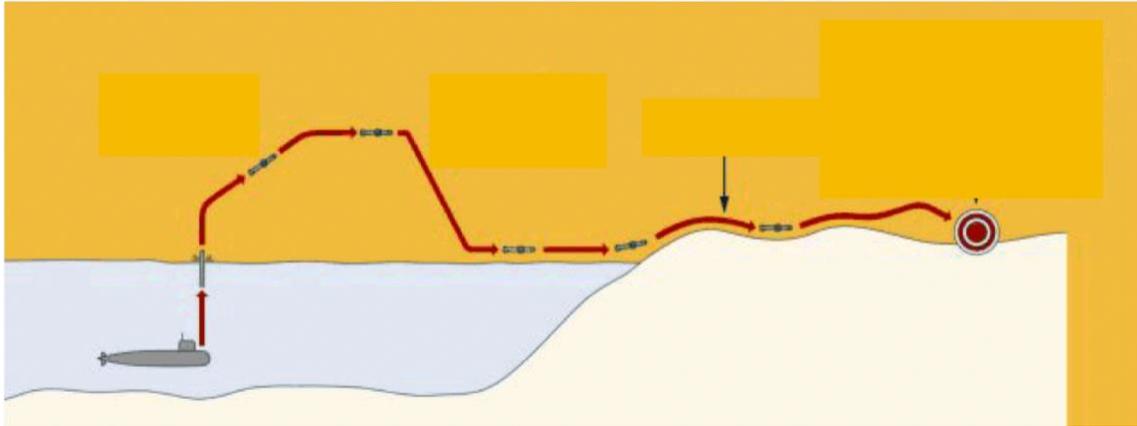
- A. Boost phase, Post-Boost phase, Midcourse phase, and Terminal phase
- B. Boost phase, Strategic phase, Re-entry phase, and Engagement phase
- C. Ascension phase, Midcourse phase, Boost phase, and Post-Boost phase
- D. Boost phase, Engagement phase, Strategic phase, and Terminal phase
- E. Ascension phase, Stellar phase, Midcourse phase, and Terminal phase

52) Which of the following is **not** an atmospheric phenomenon that could cause drag variations in a missile?

- A. Jet streams
- B. Pressure fronts
- C. Rayleigh Scattering
- D. Surface winds

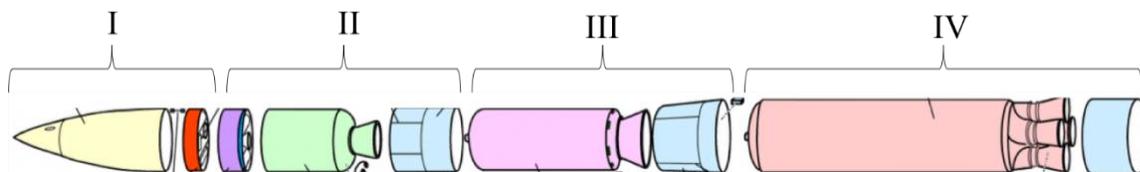
56) What is the range of an ICBM?

- A. 1,000 km to 3,000 km
- B. 3,000 km to 5,500 km
- C. 4,000 km to 8,000 km
- D. 4,500 km to 6,500 km
- E. 5,500 km to 12,000 km



Questions 1 and 2 refer to the diagram above

- 1.) The diagram above displays the path for what kind of missile?
  - A. Submarine-based ballistic missile
  - B. Cruise missile
  - C. Tactical ballistic missile
  - D. MIRV missile
  
- 2.) What is occurring at the arrow in the diagram?
  - A. Satellite-guided Stealth Mode
  - B. Terrain Contour Matching
  - C. Boost Phase
  
- 3.) What does Circular Error Probable (CEP) mean?
  - A. 80% of gravity bombs land within CEP
  - B. 50% of gravity bombs land within CEP
  - C. 80% of missiles land within CEP
  - D. 50% of missiles land within CEP
  - E. 25% of missiles land within CEP
  
- 4.) Which of the following statements is correct?
  - A. CEP is equal to the miss distance
  - B. CEP is one measure of miss distance, but there are others
  - C. CEP is not a measure of miss distance; CEP is only an upper bound
  - D. CEP is not a measure of miss distance; CEP is only a lower bound
  - E. CEP is not related to the miss distance



- 5.) Above is a schematic of Minuteman ICBM. Where are the re-entry vehicles (RVs) located?
  - A. Region I, the front
  - B. Region II

- C. Region III
- D. Region IV, the back
- E. There are no RVs on an ICBM

## F. Defense

59) Oscorp Industries has designed a scanner which can detect 100% of illegal radioactive and nuclear materials passing through the US ports. The scanner can be easily attached to the cranes which offload containers from ships. What is a potential problem with this system?

- A. The weapon can be detonated before being offloaded and still cause a large amount of damage.
- B. Terrorists can import non-radioactive materials and then use those to produce plutonium in the United States.
- C. Both A and B.

81) Which of the following are important challenges for a boost-phase intercept system?

**[Mark all correct answers.]**

- A. ICBM boost phases are short.
- B. Geographical constraints require high interceptor speeds.
- C. ICBMs in powered flight accelerate unpredictably.
- D. A successful intercept is unlikely to destroy the warhead.

66) Which of the missile defense systems the US has tested or deployed were shown to be effective under battlefield conditions?

- A. Nixon's safeguard system.
- B. Nixon's safeguard and Bush's Patriot systems.
- C. Bush's Patriot system.
- D. Neither

80) Obama's European Midcourse Intercept system will initially primarily rely on:

- A. Ground-based interceptor rockets
- B. Ship-based lasers
- C. Ship-based interceptor rockets
- D. Airborne lasers

85) On March 9th, 2012, Israel was attacked with over 300 rockets from Gaza. It has been estimated that 177 rockets would have hit targets in Israel. The Iron Dome missile defense

system engaged 71 rocket that were identified has potentially harmful to people and/or property. Reportedly, how many of the 71 rockets targeted were successfully intercepted?

- A. 36 or about 50%
- B. 43 or about 60%
- C. 56 or about 80%
- D. 71 or 100%

63) What were the three “Nitze Criteria” an anti-ballistic missile defense system needed to fulfill before deployment?

**[Mark all correct answers.]**

- A. The system must be effective.
- B. The system must be able to survive an attack.
- C. The system must be cost effective at the margin.
- D. The system must be stationed in a different country.
- E. The system must be a mid-course intercept system.

90) What is the principal reason for the high success rate for the Iron Dome missile defense system compared to the PATRIOT system during the first Gulf War?

- A. Technological progress with battle control systems
- B. Technological progress with interceptor rockets
- C. The fact that Hamas SRBMs travel 500 m/s, less than a Mach 2 jet

1.) Which would be a more effective approach to developing missile defense?

- A. Stronger governmental oversight to guarantee steady progress
- B. Steadier investment focused on longer term goals
- D. Increased funding

2.) Over the last 50 years, the U.S. has spent approximately how much (in current dollars) on technology to intercept long range ICBM's?

- A. 50 Billion
- B. 100 Billion
- C. 300 Billion
- D. 1 Trillion

3.) The U.S. is currently spending approximately how much per year on missile defense?

- A. 1 Billion
- B. 3 Billion
- C. 10 Billion
- D. 20 Billion

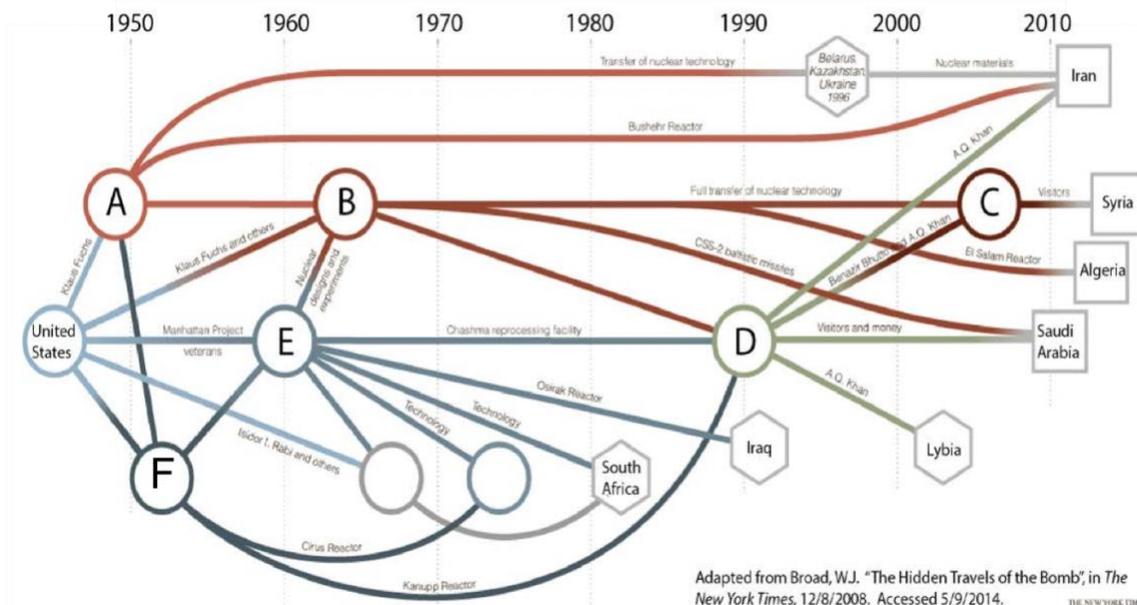
4.) Which of the following was **not** a consequence of Reagan’s launch of the “Star Wars” program?

- A. Led to doubling and tripling of expenditures on ABM weapon research and development, increasing budget deficits
- B. Raised public hopes and expectations that could not be fulfilled
- C. Closed off pursuit of alternative approaches to reducing the threat of nuclear weapons
- D. Decelerated building of offensive weapons

5.) Which of the following is **not** a way in which testing scenarios for Ground Based Missile Defense have been unrealistic?

- A. The “attacking missile” was traveling too slow
- B. No countermeasures were allowed
- C. Launch time of “attacking missile” was known
- D. Trajectory of “attacking missile” was known

**G. Arsenals**



**Use the graphic above and your knowledge to answer questions 41-44.**

The place of each circle on the timeline represents the year of the country’s first nuclear test.

“Circles” represent states with known nuclear weapons capabilities.

“Squares” represent states thought to be developing nuclear weapons.

“Hexagons” represent states with abandoned nuclear weapons programs

- 41) Which country is represented by circle “A”?
- A. North Korea
  - C. USSR
  - B. China
  - D. Pakistan
- 42) Which statements describe the country represented by circle “D”?
- [Mark all correct answers.]**
- A. It is North Korea.
  - B. It is Pakistan.
  - C. It shared Uranium centrifuge technology with several other countries.
  - D. It shared ballistic missile technology with many other countries.
  - E. It is an NPT weapons state.
- 43) Which country is represented by circle “F”?
- A. France
  - B. Russia/USSR
  - C. China
  - D. United Kingdom
- 44) Which statement best describes the relationship between countries “B” and “D”?
- A. Pakistan shared centrifuge technology with North Korea.
  - B. Pakistan shared centrifuge technology with India.
  - C. China shared missile technology with Iran.
  - D. China helped India developing its nuclear program.
  - E. China helped Pakistan in developing its nuclear program.
- 51) About how many *total* nuclear weapons are there currently?
- A. 2,000
  - B. 17,000
  - C. 33,000
  - D. 70,000
- 52) How many *total* nuclear weapons were there at their peak?
- A. 17,000
  - B. 33,000
  - C. 70,000
  - D. 112,000
- 58) Which statement best describes the strategy behind the Chinese nuclear program?
- A. China wishes to build a program on par with the programs of the US and Russia
  - B. China is de-emphasizing its nuclear program
  - C. China is primarily concerned with internal threats
  - D. China is mostly concerned with maintaining a second-strike capability
- 1) Which statement best describes the strategy behind the United Kingdom nuclear program?

- A. The U.K. relies on a nuclear deterrent in the form of a naval submarine based nuclear arsenal
  - B. The U.K. relies on a nuclear deterrent in the form of a land-based ICBM nuclear arsenal
  - C. The U.K. relies on all three legs of the “Triad” just like the United States
  - D. The U.K. has given up all its nuclear weapons
- 2) Pakistan’s nuclear weapons
- A. mainly use HEU and can only be delivered by aircraft
  - B. mainly use HEU and can be delivered by aircraft or missile
  - C. mainly use weapons-grade plutonium and can only be delivered by aircraft
  - D. mainly use weapons-grade plutonium and can be delivered by aircraft or missile
  - E. have been confiscated by the IAEA
- 3) How many nuclear weapons tests has North Korea conducted?
- A. 1
  - B. 2
  - C. 6
  - D. 15
  - E. None
- 4) North Korea could have a thermonuclear weapon, based on the yield estimate from the latest test.
- A. True
  - B. False
- 5) Israel’s nuclear weapons
- A. mainly use HEU and can only be delivered by aircraft
  - B. mainly use HEU and can be delivered by aircraft, missile, or submarine
  - C. mainly use weapons-grade plutonium and can only be delivered by aircraft
  - D. mainly use weapons-grade plutonium and can be delivered by aircraft, missile, or submarine
  - E. have been confiscated by the IAEA

## H. Current Events

70) During a joint French-British-American retaliatory attack on Syria in April 2018, 103 missiles and cruise missiles were fired. Moscow claimed that Syrian missile defense engaged 71 of the incoming missiles successfully. According to Russia, which missile defense interceptors were used?

**[Mark all correct answers.]**

- A. S-050
- B. S-100

- C. S-125
- D. S-200
- E. S-300
- F. S-400

71) Which of the following is a missile defense system that Israel has either deployed or is currently developing?

- A. Iron Shield
- B. David's Strike
- C. Arrow III
- D. Arrow IV

72) On March 26<sup>th</sup>, 2018 over 100 national security veterans in a letter to President Trump strongly endorsed

- A. Economic sanctions on North Korea
- B. Economic sanction on Iran
- C. The JCPOA with Iran
- D. To return to the 1994 agreed framework with North Korea

73) On March 1<sup>st</sup>, 2018, President Putin presented several new Russian nuclear weapon systems in a public speech. By doing so, he was trying to influence:

- A. The deliberations at the 2018 Munich Security Conference
- B. The deliberations at the NATO security summit in Brussels
- C. The Russian presidential elections on March 18<sup>th</sup>
- D. The Crimean state assembly elections on March 18<sup>th</sup>

74) Why is China concerned about the stationing of the THAAD missile defense system in South Korea?

- A. THAAD interceptors threaten the Chinese nuclear second-strike capability
- B. THAAD radar can be used to monitor Chinese ballistic missile testing
- C. THAAD radar can be used to guide GMD interceptors against Chinese missiles
- D. THAAD defense system threatens balance of forces along the DMZ in North Korea, increasing the probability of an armed conflict between the Koreas.

75) In accordance with strict UN sanctions against North Korea in February, 2018, Russia expelled:

- A. The DRPK ambassador in Moscow
- B. All DRPK military personnel training at Russian military schools
- C. All DRPK engineering student enrolled in Russian engineering programs
- D. All DRPK migrant laborers in its far east region

76) In February, Sandia National Laboratory presented new radiological monitoring equipment to be used for

- A. the verification of the Iran Nuclear Deal
- B. the verification of IAEA safeguard agreements

- C. the verification of the New START treaty
- D. the verification of the CTBT

77) A team of scientists at Virginia Tech has studied human behavior in the aftermath of a nuclear attack on Washington DC. In a scenario labelled “heroic-behavior” the researchers assume that private citizens act on their own with the emergency response. This behavior would

- A. have no impact on the death toll from the nuclear explosion
- B. increase the death toll by 25,000
- C. decrease the death toll by 25,000

78) The doomsday clock of the Bulletin of the Atomic Scientist was set to 2 minutes before midnight in January, 2018. The following concerns contributed to the decision to move the time up by half a minute:

- A. Concerns over the situation in Korea
- B. Increasing nuclear arsenals in India and Pakistan
- C. Climate change
- D. Increasing Tensions between the US and Russia
- E. All of the above

79) In response to North Korean missile tests US Airforce General Paul Selva pointed out in January that the DPRK has not demonstrated all steps needed for the delivery of a nuclear weapon using an ICBM. The demonstration missing according to General Selva is

- A. Deploying decoys and RVs together
- B. Successful missile launch of a miniaturized nuclear warhead
- C. Successful re-entry of an RV
- D. Demonstrating the payload capacity for an RV + decoys and countermeasures

## I. Arms Control

81) Which of the following would not be a motivation for controlling nuclear arms?

- A. Reducing threat of nuclear weapons being used in war
- B. Enhance international security
- C. Facilitate international cooperation
- D. Reduce the cost of a nuclear arms race
- E. All of the above are possible motivations

91) Which of the following is the most complete list of nuclear weapon states not recognized as such by the Treaty on the Non-Proliferation of Nuclear Weapons (NPT)?

- A. North Korea
- B. Israel, North Korea

- C. China, India, North Korea, and Pakistan
  - D. India, Israel, North Korea, and Pakistan
- 97) Which treaty was the first to require actual reductions of strategic nuclear forces?
- A. Comprehensive Nuclear Test Ban Treaty (CTBT)
  - B. Treaty on the Non-Proliferation of Nuclear Weapons (NPT)
  - C. The Strategic Arms Reduction Treaty (START)
  - D. The Limited Test Ban Treaty (LTBT)
  - E. Strategic Arms Limitation Treaty (SALT-I)
- 100) The current arms control treaty in force between the US and Russia is...
- A. Strategic Offensive Reductions Treaty (SORT)
  - B. START I
  - C. START II
  - D. New START
- 109) From the date it went into force, the New Start Treaty is in force for...
- A. Five years
  - B. Ten years
  - C. Fifty years
  - D. Indefinitely
- 107) Which of the following goals is not included in the basic structure of the INF Treaty?
- A. Total global ban of a whole class of ground-based nuclear weapons
  - B. Applies to delivery systems with a range between 500 and 5,500 km
  - C. Fully remove the ABM systems of all nuclear weapons states
  - D. Disarmament by destruction of in total 2,695 missiles
  - E. Complete elimination of intermediate-range missiles (including cruise missiles)
- 73) What is the “supreme national interest clause” in regards to treaties?
- A. Treaties must be publicly available and not created in secret.
  - B. The obligation to announce in advance when a country will withdraw from a treaty.
  - C. Treaties are only valid when signed by democratically elected representatives.
  - D. The duty of the most powerful countries to contribute the majority of resources for the implementation and enforcement of treaties.
- 69) Why was the North Korean regime trying to contain radioactive emissions from their nuclear test in 2006?
- A. They were testing an illegal nuclear weapon and were afraid of the international response.
  - B. They didn't want the international community to know whether they tested a plutonium or uranium weapon.
  - C. The DRPK is a signatory state to the LTBT and is bound to fully contain emissions from underground nuclear tests.

- 1) Why did the 2015 NPT review fail to establish a final communique?
  - A. Disagreement over approaches to North Korean disarmament
  - B. Disagreement over legality of JCPOA
  - C. Disagreement over establishment of a nuclear weapons free zone in the Middle East
  - D. U.S. failure to ratify the CTBT
  
- 2) Approximately how much time after North Korea's nuclear weapons test in 2006 was radioactive Xenon detected in the atmosphere?
  - A. 2 hours
  - B. 1 day
  - C. 1 week
  - D. 2 months
  
- 3) Which is a weakness of the NPT with regards to horizontal proliferation?
  - A. Inspection is limited to declared materials and facilities.
  - B. There are no provisions for limiting the number of nuclear weapons in the U.S. and Russia
  - C. The IAEA spends a disproportionate amount of money in India and Pakistan.
  - D. Only nuclear weapons states are allowed to enrich Uranium.
  
- 4.) Which is **not** a new verification method in the New Start treaty as compared to SORT?
  - A. Site inspections
  - B. Data exchange
  - C. Satellite monitoring
  - D. Notification protocols with regards to monitored sites
  
- 5.) Atoms for Peace was established under which American President?
  - A. Eisenhower
  - B. Nixon
  - C. Carter
  - D. Reagan

## J. Nuclear Materials

The next three questions are related to the following scenario: 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.

- 64) 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

65) 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

66) 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 tritium in a gun type nuclear fission weapon
- E. The Li-6 used as an impurity in the hollow shell (“pit”) of a thermonuclear weapon

67) Which would influence the amount of nuclear explosive material needed to have a critical mass?

**[mark all correct answers]**

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

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

- A. greater than 3.67%
- B. greater than 20%
- C. greater than 80%
- D. greater than 90%
- E. greater than 93%

1.) Why is use of a reactor for generation of weapons grade plutonium incompatible with generation of energy?

- A. The reactor overheats when producing weapons grade plutonium and energy is wasted for re-cooling
- B. Producing weapons grade plutonium requires short cycles
- C. Producing weapons grade plutonium requires long cycles
- D. Daisy-chaining so many centrifuges together reduces efficiency
- 2.) How is U-238 most commonly obtained?
- A. Through Mining
- B. As a nuclear reaction byproduct
- C. Through Laser Isotope Separation
- D. Through Gas Centrifuge Separation
- 3.) How is Pu-239 most commonly obtained?
- A. Through Mining
- B. As a nuclear reaction byproduct
- C. Through Laser Isotope Separation
- D. Through Gas Centrifuge Separation
- 4.) Which is **not** true about Laser Isotope Separation compared to Gas Centrifuge Separation?
- A. Requires fewer stages
- B. More compact
- C. More readily available on the Black Market and A.Q. Khan Network
- D. Relies on differences in energy levels between U-235 and U-238

97) **Essay** (30% of the final exam grade).

You are a U of I student known for your superior performance in GLOBL/PHYS 280. You are awoken in the middle of the night by a call informing you of the hijacking of a semi-truck carrying a set of nuclear fuel rods. These rods are a new design and have spent the last month undergoing irradiation testing inside a research reactor. The rods are known to contain 12.4% U-235 and 20% Pu-239 and Pu-240. The total mass of the fuel rods is 183kg. You are told that the hijacking occurred in southern New Mexico. You are also told that the Al-Nusra Front has claimed responsibility for the attack and demands that all US forces be removed from the Middle East within one month or a nuclear attack on the US will occur. Your task is to brief federal investigators on the legitimacy of the threat and to help in the recovery of the stolen nuclear material.

The head of the investigative team has sent you a list of questions she has. You should address these in detail and add any additional details that you believe would assist in the recovery of the nuclear material.

- Could this material be used to make a nuclear weapon?
  - If so, what kind of weapon(s) could be made?
    - Why could other types of weapons not be made?
  - Could the weapon be built within the given timeframe?

- What type of facilities would the terrorists need to build the weapon(s)?
- What would be a highly likely target for this weapon?
  - Why would the terrorists choose this location?
  - What are likely delivery methods the terrorists will use?
  - What securities can be put in place to protect that target?
- How can the weapon be found before it is used?
  - Does the nuclear material have any traceable qualities?
  - Are there any specialized items the terrorists would have purchased recently that could be used to identify them?

Instructions:

Each main bullet point should be covered in a paragraph. In answering the questions, your reasoning should be based on class material.

Essay page 1, Name:

Essay page 2, Name:

Essay page 3, Name:

Essay, spare page (do not exceed three pages), Name:

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