

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 28 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 an essay question and 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 Physics

- 1) Which of the 4 basic forces that govern the structure of matter is the strongest?
- A. Gravitational Force
 - B. Electromagnetic Force
 - C. Weak Nuclear Force
 - D. Strong Nuclear Force**
 - E. Protonic Force
- 2) Which force holds the nucleus of an atom together, overcoming the electromagnetic repulsion of the positively-charged protons?
- A. Gravitational Force
 - B. Electromagnetic Force
 - C. Weak Nuclear Force
 - D. Strong Nuclear Force**
 - E. Protonic Force
- 3) What is the smallest/most fundamental component (known to man) that makes up nuclear matter?
- A. Protons and neutrons
 - B. Electrons
 - C. Atoms
 - D. Quarks**
 - E. Deuterons and tritons
- 4) Uranium-235 and uranium-238:
- A. Have the same number of neutrons and a different number of protons.
 - B. Have the same number of protons and a different number of neutrons.**
 - C. Have the same number of protons and a different number of electrons.
 - D. Have the same number of electrons and a different number of protons.
- 5) Which of the following statements about radioactive decay are true?
- [Mark all correct answers]**
- A. Radioactive decay is a probabilistic process. This means one can only predict probabilities at what time a decay will occur.**
 - B. Radioactive decay is a deterministic process, meaning one can always predict with certainty when the decay will happen.
 - C. The four types of radioactive decay are alpha-, beta-, gamma-, and delta-decay.
 - D. The lifetime of radioactive nuclei is often characterized through the nuclei's half-life.**
 - E. The decay process is spontaneous, meaning it happens without outside influence.**

6) Gamma radiation is best described as:

- A. Emission of a helium nucleus with a charge of +2 elementary charge units.
- B. Emission of a beta-positron “twinned” pair.
- C. Emission of a high-energy photon.
- D. Emission of a high-energy neutron.

7) Which of these statements about Fission and Fusion processes is incorrect?

- A. Spontaneous fission happens when an isolated nucleus splits into two smaller nuclei, releasing energy.
- B. Induced fission happens when neutron capture causes the nucleus to become unstable, allowing the nucleus to split into two smaller nuclei.
- C. Fusion happens when two nuclei combine into one larger nucleus, releasing energy.
- D. Fission always produces more energy per nucleon than fusion.

8) IAEA inspectors have arrived at a nuclear facility in the Republic of Dontexistia for a routine inspection. The video feed taken before the arrival of the inspectors shows the Dontexistians dismantling what appears to be an old Soviet plutonium implosion weapon and placing the plutonium pit into a lead box, but it is rumored that they sold the plutonium to the terrorist organization HYDRA and replaced the pit with nuclear waste from a reactor in the country. Which of the following methods would be INEFFECTIVE at verifying that the material in the box is actually the Soviet *weapons-grade plutonium*? [Mark all correct answers.]

- A. The inspectors scrape a piece of the material and verify using chemical methods that the material contains plutonium.
- B. Using a suitable radiation detector and a rough estimate of the amount of plutonium-239 that should be in the box, the inspectors verify the expected amount of radiation at the energy levels emitted by Pu-239.
- C. Using a radiation detector, the inspectors detect a large amount of radiation coming from inside the box.
- D. Subtracting the mass of the lead box, the inspectors weigh the radioactive material and determine that the fifteen-kilogram mass of the plutonium pit is accounted for.
- E. Inspectors run a sample of the material through a mass spectrometer and observe that 95% of the material has an atomic weight of 239 and 5% has a weight of 240.

B. Nuclear weapons

9) A group of rogue physicists claim that they have created a nuclear weapon which does not use uranium-235 or any isotope of plutonium for fuel. Which of the following statements are true?

- A. It is impossible to create a nuclear weapon using any combination of isotopes other than U-235/U-238 or plutonium isotopes.
- B. It is possible to create an explosion using Np-237 or U-233, but these designs require around 10% plutonium as a “starter” in order to begin the fission chain reaction.
- C. It is possible to create a weapon using U-233, but no one has ever successfully tried.
- D. U-233, Am-241, and Np-237 could all be used to make fission weapons, although obtaining and managing sufficient amounts of any of them are difficult.**
- E. A large neutron source (eg. Am/Be) could be inserted into a mass of thorium-232 and dropped from a plane to produce a small (~50 kiloton) nuclear yield by using “in-situ breeding” technology.

10) Approximately how much weapons-grade plutonium is necessary to build a nuclear weapon?

- A. 1 kg
- B. 10 kg**
- C. 50 kg
- D. 100 kg

11) The country of Assumeria has no nuclear weapons or enrichment capability and operates a single nuclear reactor to power its largest city. Uranium fuel (5% U-235) has been provided for several years by an international consortium, and spent fuel stays in-country for disposal.

Assumeria’s leader, Victor Von Doom, announces that Assumeria has successfully tested a nuclear weapon. How did Assumeria obtain nuclear-explosive material?

- A. The Assumerian reactor was modified to selectively fission U-238, leaving an enriched U-235 component in nuclear waste.
- B. Assumeria melted down several years of new fuel and manufactured a very large but low-yield nuclear weapon.
- C. Instead of disposing of its spent fuel, Assumeria has been covertly extracting plutonium from its spent fuel.**

12) A thermonuclear weapon uses a fission weapon to trigger a fusion reaction in a packet of fusion fuel. How is this fusion fuel stored, and why?

A. Deuterium-tritium (D-T) liquid; these are the isotopes which generate the most energy from fusion and come in liquid form.

B. Lithium metal (Li); lithium metal is not the most energetic element for fusion, but it is not radioactive and therefore is easiest to store and handle.

C. Heavy water (D₂O); heavy water can be easily produced, handled, and stored (and provides cooling for the internal bomb components during the re-entry in the terminal phase).

D. Lithium deuteride (LiD); LiD is not radioactive, but the absorption of a neutron by lithium produces tritium for fusion fuel as the weapon detonates.

13) The minimum concentration of U-235 that can be used to make a nuclear explosion is:

A. 15%

B. 20%

C. 50%

D. 80%

14) Which of the following statements best describes the role of the high explosive lenses in an implosion-type fission weapon?

A. The lenses redirect neutrons from the outside of the bomb to the inside.

B. The lenses reflect neutrons emitted from the nuclear material which would otherwise escape from the bomb.

C. The lenses protect the NEM, which is initially in a subcritical state, from accidentally going supercritical by shielding the NEM from stray neutrons.

D. The lenses focus the outgoing gamma rays to increase the yield of the weapon.

E. The lens configuration of high speed conventional explosives produces a converging spherical blast wave, which will compress the NEM.

15) What is the distinguishing feature of uranium isotopes used by molecular laser isotope separation?

A. The difference in the mass of U-235 and U-238.

B. The different charge to mass ratio of U-235 and U-238.

C. Differences in molecular energy levels of UF₆ for U-235 vs. U-238.

D. The different number of electrons in U-235 vs. U-238.

E. The different physical size of uranium hexafluoride with U-235 vs. U-238.

- 16) Where is the neutron initiator located in an implosion weapon?
- A. Outside the ring of high explosives.
 - B. Between the convention explosive and the NEM.
 - C. At the center of the NEM pit.
 - D. There is no neutron initiator in an implosion weapon.

C. Nuclear Explosions

17) True or false: Earth's human population has a much greater vulnerability to the indirect effects of nuclear war than to the direct effects of nuclear war

- A. True
- B. False

18) Scientists of the CTBTO detected unusual seismic activity in North Korea. They also detected traces of radioactive noble gasses in the air over the Chinese Sea, but no radioactive fallout is present on the ground. 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 carried out an underground weapon test that fizzled.
- E. No, North Korea did not test a nuclear weapon.

19) Which effect of a nuclear air burst carries the largest fraction of total energy?

- A. EMP
- B. Thermal Radiation
- C. Prompt nuclear radiation
- D. Residual fallout
- E. Blast wave

20) *Mark each* factor that determines the seriousness of a burn injury after a nuclear explosion.

[Mark all correct answers.]

- A. Total energy released.
- B. Transparency of atmosphere.
- C. Whether the person is inside a building or not.
- D. The slant distance of the burst to the person.
- E. What the person is wearing.

- 21) 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
- 22) True or false: A nuclear weapon has never been detonated in space.
- 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 teragrams 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.

D. Terrorism

- 25) True or False: Richardson argues that all terrorist groups share the same long-term political objectives.
- A. True
 - B. **False**
- 26) Non-missile delivery of nuclear weapons are: **[Mark all correct answers]**
- A. **More reliable and accurate**
 - B. **Can be used without attribution**
 - C. **Less costly**
 - D. More difficult to acquire

27) Which of the following are *not* one of the “Three No’s” that Allison 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.

28) Which of the following is a problem that terrorist organizations wishing to construct a nuclear explosive would confront? [Mark all correct answers.]

- A. Assembling a team of technical personnel.
- B. Substantial financial costs.
- C. Radiation and chemical hazards.
- D. Acquisition of nuclear-explosive material.

29) Richardson argues that there are six basic rules for containing terrorism. Which of the following are some of these rules? [Mark all correct answers.]

- A. Have a defensible and achievable goal.
- B. Separate the terrorists from their communities.
- C. Engage in covert military action.
- D. Know your enemy.
- E. Have patience and keep your perspective.

30) The three initiatives to secure vulnerable nuclear materials include all *except*:

- A. Converting or shutting down research reactors and isotope production facilities from use of HEU to LEU.
- B. Transferring material to states with higher security facilities.
- C. Removing the disposition of excess nuclear and radiological materials.
- D. Protecting high priority and radiological materials from theft.

31) Richardson argues that the declaration of a “global war on terror” has been a mistake and is likely to fail. She argues for different approaches, which *TWO* of these approaches did she suggest?

- A. Increase counterterrorist initiatives and engage in more clandestine operations.
- B. Appreciate the factors driving the terrorists.
- C. Attack towns and cities that are known to contain terrorist cells.
- D. Deprive them of what they need.

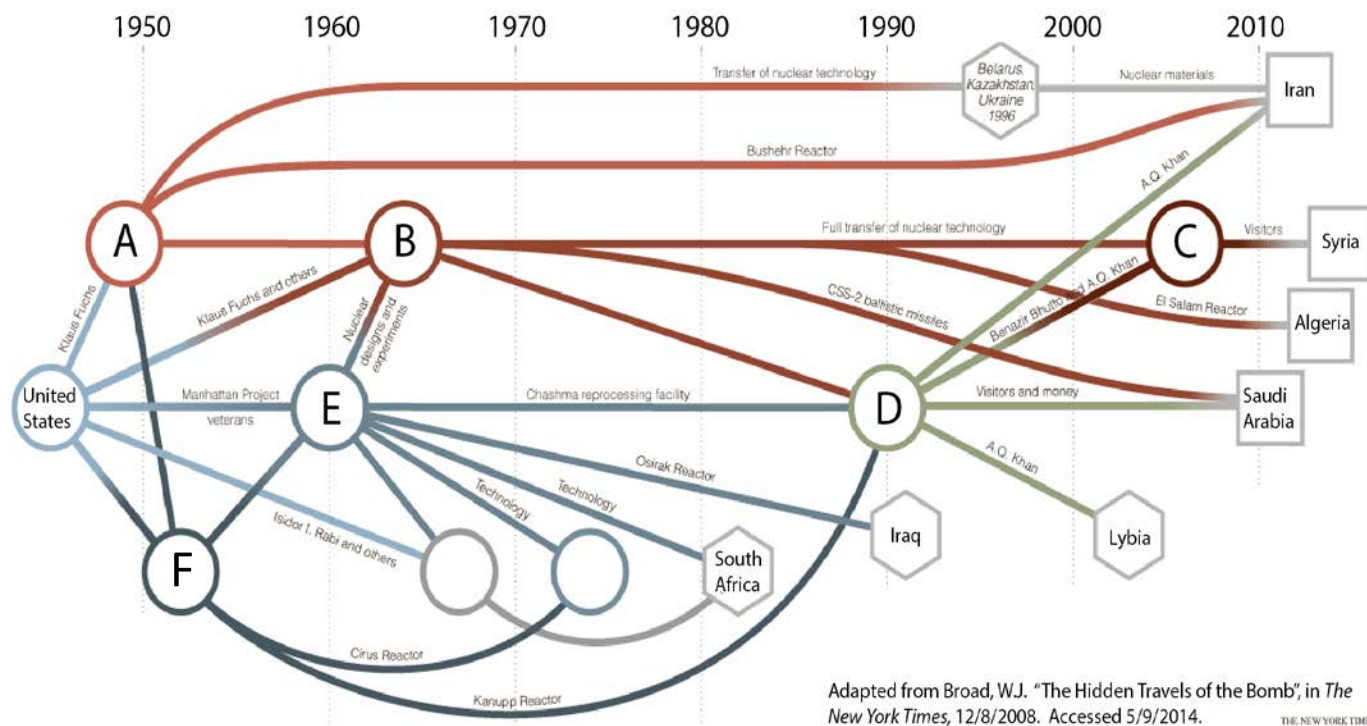
- 32) Which of the following is the definition of state terrorism?
- A. The state sponsorship of terrorist acts against inhabitants of other countries as an instrument of foreign policy.
 - B. The use of terrorism by a government against its own citizens, to coerce them into accepting the government's authority.**
 - C. The use of terrorism by a government against the civilians of another country with which it is at war.
 - D. The sponsorship of terrorist acts by a private organization that is not recognized as a nation by the rest of the international community.

E. Nuclear Weapon Delivery Methods

- 33) 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.
- 34) 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, Ballistic phase, Re-entry phase, and Engagement phase
 - C. Boost phase, Midcourse phase, Post-Midcourse phase, and Re-entry phase
 - D. Boost phase, Engagement phase, Strategic phase, and Terminal phase
 - E. Boost phase, RV-launch phase, Midcourse phase, and Terminal phase
- 35) Which are the nuclear armed heavy bombers in the US air force at this time?
- A. FB-111, B-1, B-2 and B-52
 - B. B-1, B-2 and B-52**
 - C. B-1, B-2 and FB-111
 - D. B-2 and FB-111
 - E. B-1 and B-21
- 36) Which set of performance parameters characterizes the US Tomahawk cruise missile best?
- A. speed: 350 mph, payload: 500 lbs, range: 2500 miles
 - B. speed: 1200 mph, payload: 2000 lbs, range: 3200 miles
 - C. speed: 550 mph, payload: 1000 lbs, range: 1550 miles**
 - D. speed: 350 mph, payload: 1000 lbs, range: 1550 miles

- 37) 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
- 38) If Iran was to acquire medium and intermediate range missiles it could reach targets in the following set of countries.
- A. Saudi Arabia and Israel.
 - B. Saudi Arabia, Israel and the United Kingdom.
 - C. Saudi Arabia, Israel, the United Kingdom and the United States of America.
- 39) Which of the following is **not** an attribute of ballistic missiles?
- A. Use either liquid or solid propellant.
 - B. Can be launched by fixed or mobile bases.
 - C. Can have single or multiple warhead payloads.
 - D. Can operate only endo-atmospherically.
- 40) What is CEP?
- A. Circular Estimated Precision, a measure for the targeting error of missiles.
 - B. Circular Estimated Precision, a measure for the targeting error of gravity bombs.
 - C. Circular Error Probable, a measure for the targeting accuracy of gravity bombs.
 - D. Circular Error Probable, a measure for the targeting accuracy of missiles.

F. 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
- B. China
- C. USSR
- 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. China
 - C. Russia/USSR
 - 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.
- 45) Fill in the following blanks. There were _____ total nuclear weapons at their peak and _____ total nuclear weapons (deployed and stored) currently.
- A. 100,000 & 17,000
 - B. 70,000 & 17,000
 - C. 30,000 & 10,000
 - D. 50,000 & 5,000
- 46) During the past two presidential administrations, U.S. spending on nuclear weapons and delivery systems has:
- A. stayed about the same.
 - B. increased substantially.
 - C. decreased substantially.
- 47) The United States has approximately how many “tactical” nuclear weapons based in Europe?
- A. 200
 - B. 1,000
 - C. 1,500
 - D. 2,000
 - E. 5,000
- 48) Due to Russia’s geopolitical and territorial situation, the country deploys more of which type of nuclear weapon delivery system?
- A. SLBMs
 - B. ICBMs
 - C. Bombers
- 49) Russia has approximately how many “tactical” nuclear weapons?
- A. 200
 - B. 1,000
 - C. 1,500
 - D. 2,000
 - E. 5,000

50) Which of the following states gave up their nuclear weapons (for various reasons)? Select all that apply. **[Mark all correct answers.]**

- A. Libya
- B. Ukraine
- C. Uzbekistan
- D. South Africa

51) The Treaty on the Non-Proliferation of Nuclear Weapons (NPT) includes which five countries as Nuclear Weapon States:

- A. US, Russia, China, South Africa, UK
- B. Pakistan, Israel, US, Russia, UK
- C. India, South Africa, US, Russia, France
- D. China, France, Russia, UK, US
- E. US, Russia, China, France, India

52) Which of these following four countries are Non-NPT Nuclear Weapons States?

- A. Iran, North Korea, Pakistan, Israel
- B. China, France, Russia, UK
- C. India, South Africa, Pakistan, Israel
- D. Pakistan, Israel, India, and North Korea
- E. Pakistan, Israel, North Korea, South Africa

53) Which countries are believed to keep their nuclear warheads separately from military delivery systems?

- A. Pakistan
- B. India and Pakistan
- C. India, Pakistan and China

54) What best describes the nuclear arsenal of the United Kingdom?

- A. The U.K. maintains a full nuclear triad.
- B. The U.K. only maintains submarine launched ballistic missiles.
- C. The U.K. only maintains land-based ballistic missiles.
- D. The U.K. has given up its nuclear arsenal.

55) About how many weapons do China, India, and the United States have in their current nuclear arsenals (deployed and stored), respectively?

- A. 90, 240, 7700
- B. 240, 90, 10000
- B. 1100, 50, 6000
- D. 240, 90, 7700
- E. 50, 1100, 10000

- 56) Which statement best describes the strategy behind the Chinese nuclear program?
- A. China aims building 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.
- 57) What statement best describes the motivation behind Pakistan's 1998 nuclear test?
- A. It was a response to increased tensions with Iran.
 - B. It was a response to increased tensions with the US.
 - C. It was a response to increased tensions with China.
 - D. It was a response to increased tensions with India.
 - E. It was a joint test with Russia.
- 58) About how many years after the UK built their first nuclear weapon, did France start building their own nuclear weapons?
- A. Both countries started building nuclear weapons at the same time.
 - B. About one year.
 - C. About five years.
 - D. About ten years.
 - E. About twenty years.

G. 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.
- 60) What is **not** a non-technical reason why building a missile defense system could make the world less safe from nuclear attacks?
- A. The installation of an ABM system could trigger increases in offensive nuclear weapons systems.
 - B. A missile defense system could be used to fire interceptor missiles at civilian targets in addition to shooting down incoming missiles.
 - C. In fear of losing second-strike capability, a nuclear nation might strike first before a defense system is completed.

61) Which countries currently have a Ballistic missile program that could threaten the United States with a nuclear missile?

- A. Russia
- B. North Korea
- C. China
- D. North Korea and Russia
- E. **Russia and China**

62) Suppose the year is 2040, the United States has just revealed that it has developed a ballistic missile defense system that is 100 percent effective, and meets all of the Nitzze Criteria. True or False, the United States is now safe from nuclear attack?

- A. TRUE, because it meets all the Nitzze Criteria, the system will be cost effective at any scale.
- B. TRUE, because now no matter how many missiles an aggressor nation has, the US will be able to stop them striking home.
- C. **FALSE, because states or non-state actors could still deliver a nuclear weapon using non-standard means.**
- D. FALSE, because the more powerful missiles of the Soviet Union could still penetrate such a defense.

63) What were the three “Nitzze 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.

64) What is the “shortfall management problem” in regards to ballistic missile defense?

- A. Shortfall of resources from underfunding the federal Missile Defense Agency.
- B. Impact ICBM failures under battle conditions have on the credibility of nuclear weapon defense.
- C. **Reentry vehicles traveling on altered trajectories after their rocket has been destroyed by a boost phase defense system.**

65) Which of the following is a potential way of reducing the threat of nuclear-armed ICBMs?

- A. Implementing an Iron Dome-type missile defense system.
- B. **Developing friendly relations with other countries.**
- C. Deploying the Air borne laser missile defense system.
- D. Both A and B

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

- A. None of them.
- B. Nixon's safeguard system.
- C. Nixon's safeguard and Bush's Patriot systems.
- D. Bush's Patriot system.

67) The United States slightly overestimated the accuracy of the missile defense system we mentioned in problem 62). It turns out the accuracy is closer to 90 percent than 100 percent. Does the system still act as a deterrent?

- E. YES, with 90 percent less nuclear incoming missiles a nuclear war is winnable.
- F. YES, because the missiles in the system can be used offensively.
- G. NO, because even one nuclear weapons hitting a US city is an unacceptable price to pay, and can be used for coercion.
- H. NO, because the system is too expensive to implement.

68) Which of the following are important challenges for a boost-phase intercept system? **[Mark all correct answers.]**

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

H. Arms Control

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.

70) Which of the following statements concerning the NPT is correct?

- A. It has the broadest scope of any arms control agreement.
- B. It includes all of the nuclear weapons states with the exception of North Korea.
- C. It relies on the IAEA as organization to enforce safeguard agreements.
- D. All of the above.

71) Arms Control includes security instruments in the following realms: **[Mark all correct answers.]**

- A. Political
- B. Economic
- C. Social
- D. Environmental

72) Issues between Non-Weapons States and IAEA that can be directly referred to the UN Security Council include all *except*:

- A. Detection of undeclared activities.
- B. Refusing inspectors access to interview security personnel.
- C. Noncompliance with the safeguard agreement.
- D. Detection of a significant amount of missing nuclear material.

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.

74) What is the main goal of the IAEA safeguards system?

- A. To establish a “freeze” on existing levels of nuclear delivery systems.
- B. To limit the number of MIRVed missiles and Heavy Bombers (HB) armed with cruise missiles.
- C. To prohibit defenses against non-strategic ballistic missiles or cruise missiles.
- D. To detect and deter diversion of nuclear materials from the civilian nuclear fuel cycle.

75) What is the duration of the current Chemical Weapons Convention (CWC)?

- A. 15 years
- B. Indefinite
- C. 20 years
- D. 5 years

76) Which of the following states are not parties to the NPT: **[Mark all correct answers.]**

- A. Israel
- B. Pakistan
- C. South Africa
- D. India
- E. North Korea

- 77) Which of the following is *not* a motivation for controlling nuclear weapons?
- A. It would reduce the threat of nuclear weapons being used in war or in terrorist attacks.
 - B. It decreases spending also for conventional defense systems.**
 - C. It would enhance international security and stability.
 - D. It would facilitate international cooperation.
- 78) Why would the CTBT be beneficial to the United States?
- A. The US already has the technology to realistically model tests with computers, and does not need to perform live tests.
 - B. It would hold back the nuclear programs of other states.
 - C. It allows only the United States to test nuclear weapons.
 - D. The CTBT will be based in New York, which will make the US the focus of discussions on nonproliferation.
 - E. A and B**
- 79) What is the difference between horizontal and vertical proliferation?
- A. Horizontal Proliferation is the increase in the number or capabilities of nuclear weapons, while Vertical Proliferation is the spread of technology to new states.
 - B. Horizontal Proliferation is the spread of technology to new states, while Vertical Proliferation is the increase in the number or capabilities of nuclear weapons.**
 - C. Horizontal Proliferation is the increase in the number of bilateral nuclear deals, while Vertical Proliferation is the spread of nuclear technology within a country.
 - D. Horizontal Proliferation is spread of nuclear technology within a country, while Vertical Proliferation is the increase in the number of bilateral nuclear deals.
- 80) Where have nuclear explosions not been banned by an international treaty in force?
- A. The Ocean
 - B. The Moon
 - C. The Arctic
 - D. Underground**
- 81) Put the following treaties in order of their entry into force
- A. LTBT-SALT-START-NewSTART**
 - B. LTBT-START-SALT-NewSTART
 - C. SALT-LTBT-START-NewSTART
 - D. SALT-START-LTBT-NewSTART

- 82) Which of the following is NOT an international Treaty
- A. Biological Weapons Convention
 - B. Limited Test Ban Treaty
 - C. Strategic Arms Limitation Treaty
 - D. All of the above are Treaties
- 83) At what point in treaty negotiations is a country obligated to obey the spirit of a treaty?
- A. Upon signature.
 - B. Upon ratification.
 - C. Upon approval by the UN General Assembly.
 - D. Upon agreeing to enter into negotiations.
- 84) What was the main impetus for the Limited Test Ban Treaty?
- A. The US wanted to limit Soviet Nuclear development.
 - B. The US and the Soviet Union wanted to prevent other countries from developing advanced nuclear capabilities.
 - C. Public outcry over the environmental effects of nuclear testing.
 - D. The Soviet Union wanted to signal that it was willing to negotiate.
- 85) What was the significance of the 1997 Additional Protocol to the NPT?
- A. It expanded the NPT to include new members.
 - B. It reinforced export controls over dangerous dual use technology.
 - C. It expanded the IAEA's powers to perform facility inspections and environmental sampling.
 - D. It removed North Korea from the NPT.
 - E. It removed Iraq from the NPT.
- 86) What major factor prevented an agreement between Reagan and Gorbachev at Reykjavik?
- [Mark all correct answers.]**
- A. Internal Russian politics.
 - B. The US's refusal to give up ballistic missile defense.
 - C. Russian refusal to reduce offensive nuclear weapons.
 - D. Russian anger over the expansion of NATO.

E. Current Events

87) China recently enacted trade restrictions and sanctions against North Korea. Why has China been reluctant to push even harder against North Korea? **[Mark all correct answers.]**

- A. Fear of potential conventional retaliation from North Korea.
- B. Fear of potential nuclear retaliation from North Korea.
- C. Fear that a collapse of Kim's government could set off a flood of refugees.
- D. Fear that a collapse of Kim's government could lead to U.S. and South Korean troops being stationed near China's border.

88) In response to North Korea's missile tests, some senior South Korean politicians have pushed for which of the following?

- A. South Korea to obtain nuclear weapons.
- B. US to station troops in South Korea capable of striking Pyongyang.
- C. South Korea to build up its naval forces.
- D. South Korea to invest in intercontinental ballistic missile defense systems.

89) True or False: The Obama administration proposed replacing the ageing Minuteman III land-based missile force at a cost of \$62 billion.

- A. True
- B. False

90) Israeli Defense Minister Moshe Ya'alon discussed that Israel is seeing signs of which of the following as a result of the JCPOA deal?

- A. Eased tensions among surrounding Arab nations.
- B. Improved relations between Iran and Israel.
- C. Arab nations considering acquiring nuclear weapons leading to a regional arms race.
- D. Increased participation between Iran and the Gulf Cooperation Council (GCC).

91) India has frequently had issues with securing its nuclear materials. Select examples of potential threats posed by this.

- A. Threat of acquisition and use by criminal or terrorist groups.
- B. Threat of diversion by nuclear custodians to a nuclear black market.
- C. Transfer of nuclear materials across borders to neighboring countries.
- D. All of the above.

92) "Moderate" candidates made strong gains in recent Iranian elections following the signing of the JCPOA deal. The Obama administration is hopeful that which of the following will occur?

- A. That Iran will cease hostilities throughout the region.
- B. That these changes will gradually bring Iran out of its confrontational posture with the United States.
- C. That Iran will increase trade with Israel.
- D. That Iran will eventually publicly release the possible military dimensions of their nuclear program.

93) Washington DC was home to the 4th Nuclear Security Summit this year. In the past six years many significant achievements have resulted from the summits. Which of the following **has not** been achieved?

- A. The summits persuaded 14 countries to give up their weapons-usable plutonium and highly enriched uranium.
- B. Nuclear detection equipment has been installed at more than 300 international border crossings, airports, and seaports.
- C. Attendance from Russian President Vladimir Putin.
- D. Attendance from Chinese Leader Xi Jinping.

94) Under the framework agreement Iran will **not** possess uranium over ____ % U-235

- A. 5.5%
- B. 3.0%
- C. 2.1%
- D. 3.7%

95) Iran is selling 32 metric tons of Iranian heavy water following the requirements under the JCPOA deal. This heavy water can be used to do which of the following not consistent with the JCPOA?

- A. Produce weapons-grade uranium.
- B. Produce fuel used in Iranian missiles.
- C. Produce nuclear energy to power Iranian homes.
- D. Produce weapons-grade plutonium.

96) Iran's Fordow facility is an underground uranium enrichment plant. It is now being considered to be changed into an international research lab similar to SESAME in Jordan or CERN in Switzerland. Which of the following are some potential benefits to such a lab? Select all that apply. [Mark all correct answers.]

- A. Reduce alignment of research at Fordow with needs of nuclear weapons program.
- B. Reduce alignment between technical and political elite.
- C. Bring foreign scientists into Iran for exchange, helping to break Iranian propaganda myths.
- D. Improved development of Iranian enrichment technology

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

Please answer the prompt based on the Congressional Research Service (CRS) report on the naval Aegis system discussed in the writing labs and your knowledge from class. Use the three empty sheets attached to the exam booklet for your answer. Write your name and netID at the top of each page of your essay.

Prompt: in four paragraphs, i-iv, combined not to exceed three handwritten pages, describe the Aegis system, its performance in tests and its future use and deployment. The audience for your essay are 280 students.

i. Describe the Aegis system.

1. What was it originally designed for?
2. In what two environments can these systems be deployed?

ii. Contrast mid-course and terminal-phase intercept strategies.

1. Is there a difference in the incoming missiles intercepted for mid-course and terminal-phase defense applications of the Aegis system?
2. In the Aegis system, mid-course and terminal-phase interceptors destroy their target in different ways - describe both.

iii. Issues with the current missile defense program.

1. Describe past testing procedures for BMD systems and evaluate differences between tests and the future real world use of the systems.

iv. Future of the US missile defense program.

1. In addition to a potential modification of the Hawaii BMD test facility, in what region are the two Aegis Ashore systems set to be built? Comment on the motivation for the ashore deployment sites.
2. Discuss the feasibility of boost phase missile defense using Aegis interceptors.
3. Describe how the Aegis system relates to other missile defense systems and the overall US missile defense posture?

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?**