

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 22 numbered pages. There is an additional booklet of 4 pages for the essay writing.

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 Physics

- 1) Which of the following particles exists in atoms besides the nucleus?
 - A. Electron
 - B. Proton
 - C. Neutron
 - D. Neutrino

- 2) Which of the 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. Strong Protonic Force

- 3) What determines the chemical properties of an atom?
 - A. Number of neutrons
 - B. Number of electrons
 - C. Combined number of neutrons and protons
 - D. Combined number of neutrons, protons and electrons

- 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 particles does not have a charge?
 - A. Proton
 - B. Neutron
 - C. Electron
 - D. Alpha particles
 - E. All of the above have a charge.

- 6) During alpha decay, a parent nucleus releases what?
 - A. Li-6 nucleus
 - B. He-4 nucleus
 - C. Deuterium nucleus
 - D. Proton
 - E. Positron

- 7) Which type of reaction is responsible for the creation of ^{239}Pu from ^{239}Np in nuclear reactors?
- A. Alpha decay
 - B. Beta decay
 - C. Spontaneous fission
 - D. Gamma decay
 - E. ^{239}Pu is not produced in nuclear reactors
- 8) Gamma radiation is best described as:
- A. Emission of a helium nucleus with a charge of +2 elementary charge units.
 - B. Emission of a high-energy beta-positron “twinned” pair.
 - C. Emission of a high-energy photon.
 - D. Emission of a high-energy neutron.
- 9) Which element is at the peak of the binding energy curve, i.e. has the most stable nucleus?
- A. Fe
 - B. Ar
 - C. U
 - D. H
- 10) 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 releases more energy per nucleon than fusion.

B. Nuclear weapons

- 11) 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 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.

- 12) 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
- 13) 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.
- 14) Which of the following nuclear weapon designs cannot work? **[Mark all that apply.]**
- A. uranium gun-type
 - B. uranium implosion
 - C. plutonium implosion
 - D. plutonium gun-type
- 15) The minimum concentration of Pu-239 in a sphere of plutonium theoretically required to create a nuclear explosion is:
- A. 20% Pu-239
 - B. 60% Pu-239
 - C. 80% Pu-239
 - D. 93% Pu-239
- 16) Which of the following methods of uranium enrichment **IS NOT** mass-dependent?
- A. electromagnetic isotope separation
 - B. gas centrifuge
 - C. gaseous diffusion
 - D. molecular laser isotope separation

C. Nuclear Explosions

17) Which effect of a nuclear airburst carries the largest fraction (~50%) of the released energy?

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

18) *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.

19) The 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

20) A fully contained underground nuclear explosion releases radioactive debris:

- A. True
- B. False

21) Name the year between 1951 and 1992, with the least number of nuclear tests (possibly including zero tests) _____ and the year with the highest number of nuclear tests _____.

- A. 1953; 1989
- B. 1959; 1962
- C. 1985; 1960
- D. 1992; 1955

22) Place China, Russia, and the USA in order of **MOST to LEAST** human casualties to least if 1000 100kT nuclear weapons were detonated on each.

- A. Russia, USA, China
- B. USA, Russia, China
- C. China, USA, Russia
- D. China, Russia, USA
- E. USA, China, Russia

23) A SORT war between the USA and Russia could generate 200 Tg of soot. This is sufficient to reduce precipitation in the Midwest by _____.

- A. 5%
- B. 20%
- C. 45%
- D. 85%

24) An effective way to disable an enemy's communications is to detonate a nuclear device, which emits a/an _____ pulse.

- A. Electro-magnetic
- B. Electro-muonic
- C. Hadronic
- D. Electro-multiplied

D. Terrorism

25) Which type of nuclear weapon would a terrorist organization be most likely to construct?

- A. Implosion
- B. Two-point hollow-pit implosion
- C. Levitate-pit implosion
- D. Gun type

26) Which is not one of the three immediate objectives (the "3 Rs") that Richardson argues terrorists want?

- A. Response
- B. Renown
- C. Reaction
- D. Revenge

- 27) Which of the following are part 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. A and B only
 - E. A, B and C
- 28) 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? **[Mark all correct answers.]**
- A. Deprive terrorists of what they need.
 - B. Increase counterterrorist initiatives and engage in more clandestine operations.
 - C. Attack towns and cities that are known to contain terrorist cells.
 - D. Appreciate the factors driving the terrorists.
- 29) Which of the following is the definition of state terrorism?
- A. The use of terrorism by a government against its own citizens, to coerce them into accepting the government’s authority.
 - B. The use of terrorism by a government against the civilians of another country with which it is at war.
 - C. The state sponsorship of terrorist acts against inhabitants of other countries as an instrument of foreign policy.
 - D. The sponsorship of terrorist acts by a private organization that is not recognized as a nation by the rest of the international community.
- 30) A terrorist organization is most likely to obtain an operational nuclear weapon by stealing it
- A. True
 - B. False
- 31) Which is a defining characteristic of terrorism?
- A. The individual victims must be randomly chosen.
 - B. The violence must be religiously based.
 - C. The violence must be targeted at government officials and/or structures.
 - D. The violence must have a political purpose.

E. Nuclear Weapon Delivery Methods

- 32) 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.
- 33) 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-2 and B-52
 - C. B-1, B-2 and B-52
 - D. B-2 and B-1
 - E. B-1 and B-52
- 34) 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
 - D. Carrier based long range bombers
- 35) Which of the following distinguishing characteristic allows a ballistic missile to operate exo-atmospherically?
- A. Onboard GPS.
 - B. Supersonic speeds.
 - C. Onboard gyroscope.
 - D. Fuel and oxidizer are carried by the missile.
- 36) Which of the following is the primary nuclear-powered ballistic submarine deployed by the USA?
- B. Poseidon (Ohio-Class)
 - A. Trident (Ohio-Class)
 - C. Poseidon (Yankee-Class)
 - D. Trident (Typhoon-Class)
- 37) Cruise missiles _____ than ICBMs. **[Mark all correct answers.]**
- A. Are cheaper
 - B. Are easier to conceal
 - C. Reach higher speeds
 - D. Can be targeted more accurately
 - E. Have a longer range

38) The total miss distance of a ballistic missile includes both random and systematic errors, also known as:

- A. Circular error probable and bias.
- B. Circular error bias and skew.
- C. Circular error skew and probability factor.
- D. Random error factor and static error factor.

39) Which of the following are the correct phases of flight for an ICBM in the correct order?

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

F. Defense

40) 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.

41) 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.

42) Wayne Enterprises has developed a missile defense system which destroys enemy missiles during the boost phase. Which of the following is a potential description of the system?

- A. As the missile has engaged booster jets in the last phase of descent, a series of electromagnetic pulses disrupt the guidance system and disable the weapon.
- B. As the missile has left its silo and is moving towards the upper atmosphere, a laser targets and destroys the missile's guidance system and it falls to Earth.
- C. While in space, an interceptor vehicle approaches the missile and engages an electromagnet, which causes the interceptor vehicle to stick to the missile, which then detonates prematurely.
- D. A helicopter positions itself between the missile and the target. After disabling the thrusters, the helicopter lifts the disabled bomb off the ground and flies it away from the target before it detonates.

43) 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.

44) 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.

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

- A. Reagan's Strategic Defense Initiative
- B. Nixon's safeguard system
- C. Bush's Patriot systems
- D. Obama's AEGIS system
- E. None of the above

46) The United States slightly overestimated the accuracy of the missile defense system we mentioned in problem 43). It turns out the accuracy is closer to 90 percent than 100 percent. Does the system still act as a deterrent?

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

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

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

48) The United States spends roughly how much money each year on missile defense?

- A. \$70 million to \$100 million
- B. \$700 million to \$1 billion
- C. \$7 billion to \$10 billion
- D. \$70 billion to \$100 billion

49) The key difference between early (e.g. Nixon-era) missile interceptors and modern interceptors is that:

- A. Early interceptors were armed with nuclear warheads, while modern ones are not.
- B. Modern interceptors are armed with nuclear warheads, while old ones were not.
- C. Trick question: both early and modern interceptors are nuclear-armed.
- D. Trick question: neither early nor modern interceptors are nuclear-armed.

50) Israel's Iron Dome system serves primarily as a defense against:

- A. ICBMs from a resurgent Egypt or Iran.
- B. Short-range (or theater-range) ballistic missiles from nearby states.
- C. Chemical, biological, and nuclear threats entering via ports and highways.
- D. Short-range missiles with ranges under 50 miles.

51) Which of the following are issues with midcourse ballistic missile defense.

[Mark all that apply.]

- A. A ballistic missile can deploy countermeasures which may be indistinguishable from the missile itself.
- B. The interceptors must be based very close to the site of the launch.
- C. Supporting radar may not be able to distinguish rocket stages debris from the warheads themselves.
- D. The ballistic missiles move too fast in the midcourse phase to be reliably intercepted.
- E. It is impossible to track any items in space because radar is inoperable when there is no oxygen present.

G. Arsenals

52) 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 United States 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.

53) 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.

54) Fill in the blank: All other things being equal, the effort required to go from 20% U-235 to weapons grade Uranium is _____ the effort required to go from natural Uranium to 20% U-235.

- A. much less than
- B. about the same as
- C. much greater than

55) Which delivery methods are employed in the Indian nuclear arsenal?

[Mark all correct answers.]

- A. Submarine launched ballistic missiles.
- B. Bomber launched weapons.
- C. Land-based short and/or medium range ballistic missiles.
- D. Land-based intercontinental ballistic missiles.
- E. Space-based intercontinental ballistic missiles

56) 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

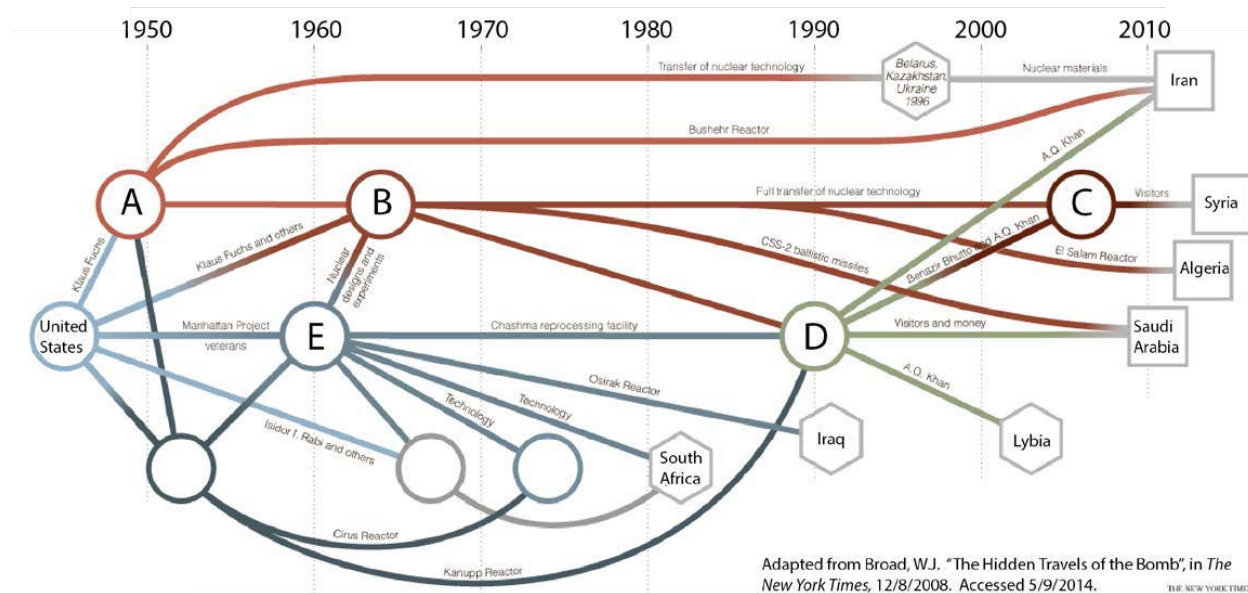
57) Is it possible to make a functioning nuclear weapon using reactor-grade plutonium?

- A. Yes
- B. No

58) 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.

Use the graphic below and your knowledge to answer questions 59 and 60. 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.



Adapted from Broad, W.J. "The Hidden Travels of the Bomb", in *The New York Times*, 12/8/2008. Accessed 5/9/2014.

59) Which country is represented by circle “A”?

- A. North Korea
- B. USSR
- C. China
- D. Pakistan

60) 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 many other countries.
- D. It shared ballistic missile technology with many other countries.
- E. It is an NPT weapons state.

61) Which nations currently maintain a nuclear triad?

- A. Only the United States.
- B. The United States and Russia.
- C. The United States, China, and Russia.
- D. The United States, China, India, and Russia.
- E. The United States, China, India, France, and Russia.

62) What is the main reason why Pakistan has not invested significantly in ICBM technology?

- A. All of Pakistan’s targets are close enough so that ICBMs are not necessary.
- B. The Pakistani government cannot afford to research, build, and maintain ICBMs.
- C. Pakistani fear of a first strike from India should they discover the ICBM program.

63) Why does the Russian nuclear arsenal rely heavily on mobile ballistic missile launchers?

- A. Russia is unable to build missile silos deep underground due to the annual soil freezing and defreezing cycle of the region.
- B. Russian geography allows mobile launchers to move about vast areas of land, making them harder to locate and destroy in a first strike.
- C. Russian ICBMs have a much shorter range than American ICBMs, and must be able to move closer to their target to be within striking range.

64) Which non-NPT state is thought to maintain the largest nuclear arsenal?

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

- 65) Which of the following was **not** a proposed deployment method for the MX missile?
- A. Densely packing many silos together so incoming warheads would destroy one another.
 - B. Mobile basing on railroad cars that would move throughout the US to avoid destruction in a first strike.
 - C. Retrofitting existing missile silos to accept the new MX missile.
 - D. A racetrack model where the missiles would be moved about from silo to silo so that it would be impossible to know which silo actually contained a missile.
 - E. All of the above were proposed deployment methods.
- 66) In exchange for dismantling nuclear facilities and allowing IAEA inspections, the 1994 Agreed Framework promised what to North Korea? **[Mark all correct answers.]**
- A. Heavy fuel oil to meet North Korean energy needs.
 - B. Food relief in the form of 20 tons of grain.
 - C. The construction of two new light-water reactors in North Korea.
 - D. Removal of US armored divisions from the demilitarized zone.
 - E. Removal of all US sanctions against North Korea.
- 67) Israel's Negev Nuclear Research center operates an IRR-2 research reactor, as well as a uranium purification and fuel fabrication facility. No activities at the site are subject to IAEA inspections. Which of the following statements is the most likely role this facility has in Israel's weapons complex?
- A. The site is for peaceful research applications only.
 - B. The on-site uranium facilities are used to create fuel which is then used to breed weapons-usable plutonium in the reactor.
 - C. The uranium enrichment facilities are used to enrich natural uranium to HEU usable for nuclear arms, with the process being run by power from the research reactor.
 - D. The research reactor's spent fuel is used in the creation of radiological weapons.
- 68) Does the US continue to have nuclear weapons forward-deployed in Europe?
- A. Yes
 - B. No
- 69) 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

H. Current Events

70) 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.

71) Recent improvements in US ballistic missile systems have led some to argue that the US is increasing its ability to launch a successful first strike that has a higher chance of neutralizing Russia's second-strike capability. Why have US chances increased?

[Mark all correct answers.]

- A. Russia's nuclear arsenal is smaller than in previous years due to treaty-mandated reductions, and thus the US could strike all Russian silos with a smaller number of warheads.
- B. The new "super-fuze" device allows US missiles to penetrate hardened silos more effectively.
- C. The new "super-fuze" device allows US missiles to more reliably destroy hardened silos by detonating above a target when previous missiles would have overflown the target.
- D. Russia has moved away from mobile launchers to a higher number of stationary launch platforms, making US targeting easier.

72) In March of this year, a UN conference was held to push for a legally binding resolution to prohibit nuclear weapons. Which of the following **was not** a stated reason for pessimism regarding this resolution?

- A. A loss of interest in the public overall concerning nuclear issues
- B. Defeatism among international leaders regarding the likelihood of this resolution to have any effect.
- C. Concern that progress in nuclear energy development will stop if nuclear weapons development is prohibited.
- D. The refusal of 40 countries (including the US, Britain, and France) to attend the conference.

73) North Korean authorities usually avoid visible activity at nuclear facilities when commercial satellites pass overhead. On March 30, 2017, activity was detected at a facility which possibly pointed toward a nuclear test. According to reports, why might satellites have detected this activity?

- A. Changes in satellite flight patterns confused North Korean authorities.
- B. Recent purges in North Korean military leadership have left the country less able to effectively track satellites.
- C. The regime occasionally uses visible activity to send a political message.

74) Both President Trump and Rex Tillerson (Secretary of State) have stated that the US is willing to act unilaterally to stop North Korea if China decides not to help. What is China's proposed international approach to dealing with North Korea?

- A. Increased economic "smart" sanctions on North Korean elites.
- B. Support for opposition military leaders to stage a coup.
- C. An agreement where North Korea would stop nuclear testing and US/South Korea would stop joint military drills.
- D. Direct military intervention when/if North Korea successfully tests a ballistic missile capable of delivering a nuclear warhead.

75) The Ground-based Midcourse Defense system (GMD) is designed to stop a nuclear strike from Iran or North Korea by shooting down incoming warheads. Why doesn't the US rely on similar systems to stop an attack from Russia or China?

- A. A strike from Russia or China would likely consist of too many warheads for GMD to successfully intercept.
- B. Chinese and Russian missile technology is too advanced for GMD to track and intercept.
- C. The US has bilateral treaties with both China and Russia that completely prohibit the use of missile defense systems against each country.

76) Even in staged tests, the GMD system (see question above) fails to intercept its target more than half of the time. Which of the following **is not** a factor that makes success even less likely in the event of an actual attack?

- A. GMD operators know the time of the test in advance, while an attack would be unlikely to come with advance warning.
- B. Attackers are unlikely to fire only a single warhead, as has been the case in the tests.
- C. In an attack, operators would be unlikely to know the size, speed, and approximate trajectory of the warhead.
- D. An attacking country is likely to launch a cyber attack that disables the system before launching the attack.

77) Under the JCPOA, Iran will **not** possess uranium over ___ % U-235

- A. 5.5%
- B. 15%
- C. 2.1%
- D. 3.7%

78) Iran sold dozens of metric tons of 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.

79) Israel's multi-tiered missile defense system consists of four layers of defense: Iron Dome (short-range), David's Sling (low to mid-range), Arrow II (upper-atmospheric), and Arrow III (exo-atmospheric). Which of the following types of attacks is Iron Dome designed to stop?

- A. Rockets and slow-moving cruise missiles fired from 40km to 300km away. Medium-range ballistic missiles.
- B. Improvised explosive devices (IEDs)
- C. Short-range rockets which pose a threat to protected areas like population centers.

80) In recent years, US ability to gather intelligence from North Korea has increased. Why has this been the case? **[Mark all correct answers.]**

- A. High-quality satellite imagery is becoming publicly available.
- B. Foreigners in North Korea can now use mobile phones to access the internet and make international calls (though these are monitored)
- C. Kim Jong-un has initiated several summits and bilateral talks with Western leaders.
- D. The Associated Press opened a bureau in North Korea in 2011.

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

82) 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.

83) Put the following treaties in order of their entry into force

- A. LTBT-SALT-START-New START
- B. LTBT-START-SALT-New START
- C. SALT-LTBT-START-New START
- D. SALT-START-LTBT-New START

- 84) Which of the following arms control agreements is not yet in force?
- D. Limited Test Ban Treaty
 - E. Nuclear Nonproliferation Treaty
 - F. Intermediate-Range Nuclear Forces Treaty
 - G. Comprehensive Test Ban Treaty
- 85) What is the default requirement for a treaty to enter into force?
- F. Signature by all negotiating states
 - G. Ratification by all negotiating states
 - H. Signature of 2/3 of negotiating states
 - I. Ratification by 2/3 of negotiating states
- 86) Define horizontal proliferation
- A. The spread of nuclear weapons to additional states or non-state actors.
 - B. The increase in range of ballistic missiles.
 - C. The increased likelihood of proliferation through the black market or stealing.
 - D. Strategic positioning of nuclear weapons throughout large states, such as Russia.
- 87) Define vertical proliferation.
- A. More powerful nuclear weapons.
 - B. Increase in the number and/or capability of the NWs of states that already have them.
 - C. The sharing of nuclear weapons technology with developing countries.
 - D. The existence of two clear leaders in the arms race, Russia and the U.S. .
- 88) What convention sets the rules for treaties in international law?
- A. UN Protocol on International Treaties
 - B. Geneva Protocol on International Treaties
 - C. Vienna Convention on the Law of Treaties
 - D. Berlin Convention on the Law of Treaties
- 89) 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.

- 90) Which of the following titles would *not* be considered a treaty under international law?
- A. Protocol
 - B. Convention
 - C. Executive Agreement
 - D. All of the above
- 91) What is the duration of the current Chemical Weapons Convention (CWC)?
- A. 15 years
 - B. Indefinite
 - C. 20 years
 - D. 5 years
- 92) Which of the following is not a provision of the Limited Test Ban Treaty?
- A. Bans nuclear explosions in the atmosphere.
 - B. Bans nuclear explosions that cause radioactive debris to travel out of territorial limits of the state.
 - C. Has a verification provision.
 - D. Bans underwater nuclear explosions.
- 93) 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
- 94) How many countries are covered by nuclear-weapon-free zones?
- A. 50
 - B. 70
 - C. 100
 - D. 110
 - E. 140
- 95) From the date it went into force, the New Start Treaty is in force for...
- A. Ten years
 - B. Fifty years
 - C. Indefinitely

96) START limited the US and Soviet Union to 6,000 accountable war heads (AWHs). The treaty limited:

- A. The number of nuclear weapons that can be verified by the IAEA.
- B. The maximum number of warheads that could be placed on ICBMs and SLBMs.
- C. The number of deployed nuclear weapons.
- D. The number of missile delivery systems.

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

Please answer the prompt based on the Congressional Research Service (CRS) report on North Korea's nuclear program 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 current situation in North Korea and the state of diplomacy regarding the nuclear program there. The target audience for your essay is a group of Physics 280 students.

- i. Discuss North Korea's relationship with China.
 - 1. Why has it changed in the past 5-10 years?
 - 2. How do variations in China's relationship with North Korea affect US diplomacy with both countries?
- ii. Discuss changes in diplomacy after the six-party talks and after Obama's presidency.
 - 1. How did President Obama change the US approach to diplomacy with North Korea? Why?
 - 2. How have North Korea's neighbors (particularly South Korea and Japan) responded to recent nuclear tests and aggressive posturing?
- iii. Explain the internal and external factors driving diplomacy.
 - 1. Which conditions or phenomena inside North Korea tend to encourage/drive North Korean leaders to reach out or offer concessions?
 - 2. What effect (if any) has external pressure had on North Korea's willingness to engage in diplomacy over its nuclear program?
- iv. Offer a reasoned opinion (no wrong answers as long as you logically support your claim)
 - 1. Will increasing economic prosperity in North Korea (if it continues) have a stabilizing or destabilizing effect on nuclear negotiations? Why?

<p style="text-align: center;">Check to make sure you bubbled in all your answers. Did you bubble in your name, exam version and network-ID?</p>
