

Physics/Global Studies 280
Nuclear Weapons, Nuclear War, and Arms Control

Final Examination

2013 May 10

Full Name _____

UIUC ID No. _____ Lab No. _____

- This is a closed book examination—you are not to consult any materials other than the exam itself, or any person. Giving or receiving unauthorized help is a violation of the University's rules on academic integrity.
- You have the full exam period (180 minutes) to complete this examination.
- Answer all the questions on all 14 topics. Each topic counts 20 points.
- The point value of each question within a topic is indicated by a boldface number in square brackets, e.g., [2].
- Write your answers in the spaces provided below each question. *Do not submit any additional pages.* If you need more room, write on the back of the preceding page.
- To receive full credit for definitions, give numbers where relevant.
- Questions with multiple possible answers will be scored using right minus wrong scoring.

Scores

1. _____ [20]	6. _____ [20]	11. _____ [20]
2. _____ [20]	7. _____ [20]	12. _____ [20]
3. _____ [20]	8. _____ [20]	13. _____ [20]
4. _____ [20]	9. _____ [20]	14. _____ [20]
5. _____ [20]	10. _____ [20]	

Total _____ [280]

1. Nuclear physics and nuclear weapons – I [20]

- (a) What type of nuclide can be fissioned by a neutron of any energy? [2]

- (b) What type of nuclide can be fissioned only by a neutron with an energy above a certain threshold energy? [2]

- (c) What type of nuclide captures a neutron to become fissile? [2]

- (c) List the two types of fission. [2]

- (c) Which fundamental forces of nature provide the energy for a nuclear weapon? [2]

- (d) Which fundamental force must be overcome in fusion but not in fission? [2]

- (e) Which element has the most stable nucleus? [2]

- (d) What isotope of uranium is most common in nature? [2]

- (e) Are all fissile nuclides nuclear-explosive nuclides? [2]

- (f) Are there any nuclear-explosive nuclides that are not fissile? [2]

2. Nuclear physics and nuclear weapons – I [20]

(a) Define the following materials in terms of the percentage of U-235 they contain: [6]

i. Weapons usable —

ii. Weapons grade —

iii. Preferred for use in weapons —

(b) What is the currently preferred technology for producing weapon-grade uranium? [1]

(c) Which type of separation is required to produce enriched plutonium from a reactor? [1]

Chemical

Nuclear

(d) The minimum amount of highly enriched uranium needed to make a nuclear bomb is about the same size as a [2]

pea

marble

softball

basketball

big beach ball

(e) The hardest part of making a nuclear weapon. [2]

(e) List two advantages of choosing to develop an uranium based weapon over a plutonium based weapon. [4]

(f) List two advantages of manufacturing a plutonium based weapon over a uranium based weapon. [4]

3. Current events [20]

- (a) With what level of confidence does the Pentagon's Defense Intelligence Agency believe that North Korea has developed nuclear weapons that could be delivered on a ballistic missile? [2]

Low confidence Medium confidence High confidence

- (b) Which country tested a nuclear weapon in February? [2]

- (c) What is happening in Iran in 2013 that caused Supreme Leader Ayatollah Ali Khamenei to decide to temporarily keep Iran's nuclear program within the limits demanded by Israel? [2]

- (d) Which former Soviet state signed an agreement with the U.S. in late April to counter nuclear smuggling? [2]

- (e) North Korea has threatened to attack U.S. military installations at which two islands? [4]

- (f) U.S. Defense Secretary Chuck Hagel announced that the U.S. will install \$1 billion worth of ground-based ballistic missile interceptors in which two states by 2017? [4]

- (g) Does the Boston Marathon bombing meet the four requirements of Richardson's definition of terrorism? [2]

Yes No

- (e) North Korea withdrew 50,000+ workers from what location? [2]

4. Delivery systems [20]

(a) Which of the following must operate within the atmosphere (endo-atmospheric)? [2]

Cruise missiles

Ballistic missiles

(b) What were the three legs of the Cold War nuclear “Triad”? Don’t use abbreviations. [6]

(c) Decode the following initializations and list the ranges that define these missile types. [8]

i. IRBM

ii. ICBM

iii. MRBM

iv. SRBM

(d) Give an example of natural features that cause gravitational field variations. [1]

(e) Give an example of atmospheric phenomena that cause drag variations. [1]

(f) Is there any physical barrier to prevent the crew of a U.S. submarine carrying nuclear-armed long-range ballistic missiles from launching them without Presidential authority? [2]

Yes

No

5. U.S. Anti-Ballistic Missile Efforts – I [20]

- (a) List the three main stages of missile flight. [3]

- (b) Give an example of a passive defense against nuclear missiles. [2]

- (c) List three ways to reduce the threat of nuclear-armed missiles. [6]

- (d) What are the three “Nitze Criteria” an anti-ballistic missile system must satisfy in order for deployment to make sense? [6]

- (e) About how much, in 2013 dollars, has the US spent on missile defense to date? [2]

- (f) True or False: Missile defense has the potential to render the US safe from all nuclear weapon attacks. [1]

6. U.S. Anti-Ballistic Missile Efforts – II [20]

- (a) The U.S.-based midcourse-intercept defense system that was declared operational by the second Bush administration is intended to defend against what type of missiles? [2]
- (b) Tests of the U.S.-based midcourse system have been highly scripted and unrealistic. Even so, the percentage of tests that have been declared successful is only (circle the right answer) [2]
- 0% 10% 50% 80% 90%
- (c) List two countermeasures that could be used to defeat midcourse-intercept systems. [4]
- (d) True or False: The Obama administration is continuing to develop the ground based midcourse defense (GMD) program of the second Bush administration? [2]
- (e) The first phase of Obama's European midcourse missile defense system became operational in what year? [2]
- (f) Boost-phase intercept systems would most likely have to be placed in what country to defend against a North Korean ICBM launch towards the continental US? [2]
- (g) An ICBM launch from North Korea targeting the continental US would be towards which cardinal direction (North, South, East, or West)? [2]
- (h) In what country would boost-phase intercept systems most likely need to be placed to defend against an ICBM missile launch by Iran? [2]
- (i) Money has been spent on many programs for boost-phase intercept. Have any of these programs been successful? [2]

Yes No

7. Nuclear Explosions [20]

- (a) List two properties of reactor-grade plutonium that complicate its use as a nuclear-explosive material. [4]
- (b) What is the definition of the neutron multiplication factor R in a configuration of nuclear material? [2]
- (c) What is the numerical value of the neutron multiplication factor R for [6]
- i. a sub-critical configuration of nuclear material
 - ii. a critical configuration of nuclear material
 - iii. a super-critical configuration of nuclear material
- (d) What type of radiation from a nuclear explosion would first reach someone standing 5 miles away? Circle one [2]
- electromagnetic neutrons alpha particles beta particles neutrinos
- (e) True or False: A nuclear weapon has never been detonated in space. [2]
- (f) Which nuclear weapon effect would be the primary cause for damage to satellites if a nuclear weapon were detonated in space? [2]
- (g) What method is the most prompt when detecting an underground nuclear explosion or nuclear weapons tests? [2]

8. Terrorism [20]

(a) Richardson argues that although the long-term goals of terrorists differ, almost all terrorists share three short-term goals. List them. **[6]**

i.

ii.

iii.

(b) List three of the six basic rules for countering sub-state terrorism according to Richardson. **[6]**

i.

ii.

iii.

(c) How does Richardson categorize the war on terror? **[2]**

(d) True or False: During war a missile accidentally veers off course and kills 10 civilians of the enemy's country. This incident does not fit the definition of war terrorism. **[2]**

(e) Would it be easy or difficult to activate a nuclear weapon stolen from the USA? **[2]**

(f) True or False: It would be difficult for a terrorist group to smuggle HEU into the country. **[2]**

9. Arsenals I [20]

- (a) About how many nuclear weapons were there at the peak? [2]
- (b) About when did the total worldwide nuclear arsenal peak? [2]
- (c) About how many nuclear weapons are in the global inventory today? [2]
- (d) How many tactical nuclear weapons based in Europe (in form of aerial bombs) does the US have? [2]
- (e) Which states abandoned their nuclear program in 1996? [6]
- (f) Name countries that possess land or sea-based intercontinental ballistic missiles. [4]
- (g) Name two countries that keep nuclear weapons under alert and are able to launch nuclear weapon delivery systems within minutes. [2]

10. Arsenals II [20]

- (a) List (i) all countries that are currently thought to have nuclear weapons,
(ii) the year each first created a nuclear explosion (if it is publicly known),
and (iii) the total number of weapons each country now has. **[18]**

Country	Year	Total Number of Weapons
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- (b) Are Pakistan's nuclear weapons thought to use uranium or plutonium? **[2]**

11. Arsenals – III [20]

- (a) About how many tons of highly enriched uranium (HEU) are there in the world? [3]
- (b) This quantity of HEU is enough to make about how many nuclear weapons? [3]
- (c) How many *operational strategic* nuclear weapons does Russia currently have? [3]
- (d) How many *tactical* nuclear weapons does Russia currently have in its arsenal? [3]
- (e) Is it possible to make a functioning nuclear weapon using reactor-grade plutonium? [2]
- Yes No
- (f) Which country gave Pakistan detailed plans for a nuclear weapon? [3]
- (g) Which country gave ballistic missiles and ballistic missile technology to Pakistan in return for Pakistan's assistance in developing nuclear weapons? [3]

12. Arms Control I [20]

(a) List the five States that are recognized as nuclear-weapon States by the NPT. [10]

(b) What is the 1971 Seabed Treaty? [4]

(c) What is the exception to the 1971 Seabed Treaty? [2]

(d) Name 2 of the Nuclear Weapons Free Zones *Regional* Treaties. [4]

13. Arms Control II [20]

- (a) Define horizontal proliferation. [2]

- (b) Define vertical proliferation. [2]

- (c) List the four States that are thought to have nuclear weapons but either never signed the Nuclear Nonproliferation Treaty or later withdrew from it. [4]

- (d) Name 3 motivations for controlling nuclear arms as mentioned in class. [6]

- (e) How does the New START Treaty affect the deployed strategic warheads of its members? [2]

- (f) Which countries signed the New Start Treaty? [2]

- (g) In which year did the New START Treaty come into effect? [2]

14. Arms Control – III [20]

- (a) What year was the Limited Test Ban Treaty opened for signature? [3]
- (b) What was banned by the Limited Test Ban Treaty? [3]
- (c) What threat did the Limited Test Ban Treaty eliminate? [3]
- (d) Did the Limited Test Ban Treaty have any significant impact on the nuclear arms race? [3]
- (e) What year was the CTBT opened for signature? [3]
- (f) Has the United States signed the CTBT? [2] Yes No
- (g) Has the United States ratified the CTBT? [2] Yes No
- (h) Is the United States currently bound by the CTBT? [1] Yes No