

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

Final Examination

2011 May 9

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 it.
- Answer all the questions on all 15 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.
- **Multiple-choice 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]	15. _____ [20]

Total _____ [300]

2. Nuclear physics and nuclear materials – II [20]

- (a) Define the following materials in terms of the percentage of U-235 they contain: **[6]**
- i. low-enriched-uranium (LEU) —

 - ii. highly-enriched uranium (HEU) —

 - iii. weapon-grade uranium —
- (b) Define the following materials in terms of the percentage of Pu-239 they contain: **[4]**
- i. reactor-grade plutonium —

 - ii. weapon-grade plutonium —
- (c) What is the currently preferred technology for producing weapon-grade uranium? **[1]**
- (d) What is the currently preferred technology for producing weapon-grade plutonium? **[1]**
- (e) 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
- (f) List three of the physical factors that determine the critical mass of an assembly of nuclear explosive material. **[6]**
- i.

 - ii.

 - iii.

3. Nuclear explosions and their effects [20]

- (a) The explosive power of a given mass of nuclear-explosive material is about how many times greater than the power of an equal mass of conventional high explosives? (Circle the right answer.) [2]

100 times 1,000 times 10,000 times 100,000 times 1 million times

- (b) The fundamental limit to the yield of a modern, two-stage nuclear weapon is about [2]

100 kilotons 500 kilotons 1 Megaton 10 Megatons there is none

- (c) List two properties of reactor-grade plutonium that complicate its use as a nuclear-explosive material. [4]

i.

ii.

- (d) Which of the following are *nuclear* radiations? (Circle the right answers.) [4]

Radio Beta Gamma X-ray

- (e) Which produces more fallout, an airburst or a surface burst? (Circle the right answer.) [2]

Airburst Surface burst

- (f) The biological effect of a physical dose of radiation depends on four factors. Name two. [2]

i.

i.

- (g) A nuclear explosion in any city would likely cause the people in all cities to do what? [2]

- (h) Name one important negative consequence of this likely activity. [2]

4. Nuclear terrorism – I [20]

(a) Give one-sentence definitions of each of the following terms: **[6]**

i. State terrorism —

ii. State-sponsored terrorism —

iii. War terrorism —

(b) Richardson argues that a “lethal cocktail” of three factors fosters terrorism. List them. **[3]**

i.

ii.

iii.

(c) Richardson argues that although the long-term goals of terrorists differ, almost all terrorists share three short-term goals. List them. **[3]**

i.

ii.

iii.

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

i.

ii.

iii.

(e) What is the Nunn-Lugar Program? **[2]**

5. Nuclear terrorism – II [20]

- (a) What type of nuclear weapon design might be feasible for a terrorist group to construct? [2]
- (b) What type of nuclear explosive material would the group need to make this design work? [2]
- (c) State in one sentence the most effective way to prevent nuclear terrorism. [2]
- (d) A difficulty in screening for nuclear bombs is that some common innocuous substances are radioactive and cause false alarms. Name two such substances. [2]
- i.
 - ii.
- (e) In his book *Nuclear Terrorism*, Graham Allison lists three “No’s” that he argues must be accomplished to prevent nuclear terrorism. List them. [6]
- i.
 - ii.
 - iii.
- (g) In *Nuclear Terrorism*, Allison lists seven “Yes’s” that he argues must be accomplished to achieve his three “No’s”. List any three of his “Yes’s”. [6]
- i.
 - ii.
 - iii.

6. Nuclear arsenals – I [20]

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.

<i>Country</i>	<i>Year of first explosion</i>	<i>Approximate number of weapons</i>
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How many weapons were in the global nuclear arsenal when it reached its maximum?

7. Nuclear arsenals – II [20]

(a) For each category of nuclear delivery system listed below, name the NPT nuclear weapon states that employ it. [12]

i. Bombers —

ii. ICBMs —

iii. SLBMs —

(b) How many *operational tactical* nuclear weapons does Russia currently have? [2]

(c) How many *operational tactical* nuclear weapons does the United States currently have? [2]

(d) During the next decade, U.S. spending on nuclear weapons and nuclear weapon delivery systems is planned to (circle one) [2]

decrease substantially

remain about the same

increase substantially

(e) During the next decade, Pakistan's nuclear arsenal is expected to (circle one) [2]

decrease substantially

remain about the same

increase substantially

8. India's and Pakistan's nuclear weapon programs [20]

- (a) What fissile material is used in most of India's nuclear weapons? [2]
- (b) Which NPT Nuclear Weapon State has recently begun supplying fissile material and nuclear technology to India, despite the fact that this is not permitted by the NPT? [2]
- (c) What nuclear delivery method would India most likely use if it attacked Pakistan? [2]
- (d) What fissile material is used in most of Pakistan's nuclear weapons? [2]
- (e) What is the name of the Pakistani scientist who stole fissile material production technology from the Netherlands, used it to produce Pakistan's nuclear arsenal, and then sold nuclear weapon designs and fissile material production technology to a vast black market? [2]
- (f) Name three countries of concern to which Pakistan sold blueprints for nuclear weapons and technology for producing nuclear explosive material. [6]
- i.
 - ii.
 - iii.
- (g) From which country did Pakistan mainly obtain ballistic missiles and missile technology? [2]
- (h) What nuclear delivery method would Pakistan most likely use if it attacked India? [2]

9. North Korea's nuclear and missile programs [20]

- (a) In 2001, North Korea was thought to have enough plutonium to make about how many nuclear weapons? (Circle the right answer.) [2]

1 or 2 5 or 6 6–12 15–20 30–40

- (b) North Korea was observing a moratorium on long-range missile tests and its plutonium was under IAEA safeguards and unavailable for use in nuclear weapons in 2001. By 2002, the Bush administration had canceled ongoing nuclear and missile negotiations with North Korea, labeled North Korea part of “an axis of evil”, and terminated the 1994 Agreed Framework with North Korea. List three of the many important unilateral actions North Korea took in response. [6]

i.

ii.

iii.

- (c) North Korea is now thought to have enough plutonium to make about how many nuclear weapons? (Circle the right answer.) [2]

1 or 2 5 or 6 6–12 15–20 30–40

- (d) How many nuclear tests has North Korea conducted to date? [2]

- (e) In 2010, several U.S. scientists (including Siegfried Hecker) were allowed to tour nuclear installations in North Korea. What two new facilities were shown to these scientists? [4]

i.

ii.

- (f) What is the range in km of the longest-range missile North Korea has successfully tested? [2]

- (g) Could this missile reach any part of the United States? [2]

Yes

No

11. U.S. missile defense efforts – I [20]

(a) List the three major components any functioning anti-ballistic missile system must have. [6]

i.

ii.

iii.

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

i.

ii.

iii.

(c) About how much, in 2010 dollars, has the United States spent so far on missile defenses? [2]

(d) When did the United States first declare a missile defense system “operational”? [2]

(e) About how long did that system operate before it was shut down forever? [2]

(f) Have any of the systems the U.S. has tested or deployed been shown to be effective under battlefield conditions? [2]

Yes

No

12. U.S. missile defense efforts – II [20]

- (a) In 1983, President Reagan announced his “Strategic Defense Initiative” (SDI) to “render nuclear weapons _____ and _____”. State one reason why this goal was then, and still is, unachievable in the foreseeable future. [4]
- (b) List two “far-out” weapon concepts that caused Reagan’s SDI to be called “Star Wars”. [4]
- i.
 - ii.
- (c) List three important lessons of the Star Wars missile defense program. [6]
- i.
 - ii.
 - iii.
- (d) Name two of the many important negative consequences of Reagan’s Star Wars missile-defense program. [4]
- i.
 - ii.
- (e) Initial reports that the Patriot defense system was highly successful in defending against Iraqi short-range missiles during the 1991 Gulf War played a key role in the decision to restart a U.S. program to defend against ICBMs. In the end, how many intercepts of Iraqi short-range missiles were well-documented? (Circle the correct answer.) [2]

0

1

3

12

73

13. U.S. missile defense efforts – III [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 an adversary could use to defeat this system. [4]
- -
- (d) Roughly speaking, Obama’s U.S.-based midcourse defense program (circle one) [2]
- Cancels the Bush administration’s program
- Continues the Bush administration’s program
- Accelerates the Bush administration’s program
- (e) Obama has replaced the Bush administration’s European-based midcourse defense program with a “phased, adaptive approach” to missile defenses in Europe. [4]
- i. In what way is it “phased”?
- ii. In what way is it “adaptive”?
- (f) Obama’s proposed European missile defense system will initially rely primarily on (circle all that are correct) [4]
- Large ground-based interceptor rockets
- Small ship-based interceptor rockets
- Ship-based lasers
- Airborne lasers
- (g) The first phase of Obama’s proposed European missile defense system is supposed to become operational in what year? [2]

14. Nuclear arms control – I [20]

(a) List any three of the six motivations for nuclear arms control that were discussed in class. [3]

-
-
-

(b) List the two countries that have waged preventive wars because of their concern about another country's supposed nuclear weapons program and name the countries attacked. [3]

-
-

(c) According to International Law, a state that has signed a treaty must comply with it even if the state has not ratified the treaty. (Circle the correct answer.) [1]

Yes

No

(d) What year was the Limited Test Ban Treaty first signed? [1]

(e) What was the main accomplishment of the Limited Test Ban Treaty? [1]

(f) Horizontal proliferation is defined as [1]

(g) Vertical proliferation is defined as [1]

(h) What year was the nuclear Non-Proliferation Treaty (NPT) opened for signature? [1]

(i) What were the two main provisions of the NPT to which the nuclear-weapon state-parties agreed? [2]

i.

ii.

(j) What were the two main provisions of the NPT to which the non-nuclear-weapon state-parties agreed? [2]

i.

ii.

(k) List all the states that are *not* currently parties to the NPT. [4]

