

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

**Midterm Examination**

**2011 March 17**

Full Name \_\_\_\_\_

UIUC ID 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 will have 90 minutes to complete it.
- Answer all the questions on all 10 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. _____	<b>[20]</b>	6. _____	<b>[20]</b>
2. _____	<b>[20]</b>	7. _____	<b>[20]</b>
3. _____	<b>[20]</b>	8. _____	<b>[20]</b>
4. _____	<b>[20]</b>	9. _____	<b>[20]</b>
5. _____	<b>[20]</b>	10. _____	<b>[20]</b>

Total \_\_\_\_\_ **[200]**

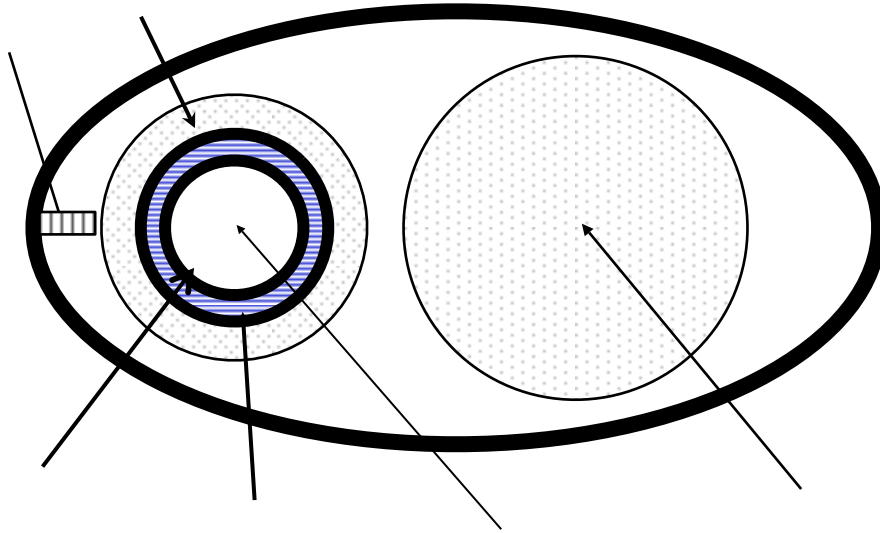


**2. Nuclear materials [20]**

- (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. True thermonuclear weapons [20]

- (a) Shown below is a simplified schematic diagram of a true thermonuclear weapon. Number the arrows in the diagram from 1 to 6 to indicate the locations of the following major weapon components: [1] the neutron-emitting initiator, [2] the high-explosive lens assembly, [3] the tamper/reflector, [4] the hollow shell (“pit”) made of nuclear-explosive material, [5] the boost gas (present when the weapon is detonated), and [6] the fusion packet. [6]



- (b) Circle and label the “primary”. [2]
- (c) Circle and label the “secondary”. [2]

Answer the following questions in a single sentence.

- (d) What is the function of the high-explosive lens assembly? [2]
- (e) What is the function of the tamper/reflector? [2]
- (f) What is the function of the initiator? [2]
- (g) What does the boost-gas do? [2]
- (h) What role does the bomb casing play if it is made of depleted uranium? [2]

**4. Nuclear explosions and their effects - I [20]**

(a) Which type or types of nuclear reactions occur in the *primary* of a modern two-stage nuclear weapon? [1]

(b) Which type or types of nuclear reactions occur in the *secondary* of a modern two-stage nuclear weapon? [1]

(c) 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 one. [1]

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

(d) The fundamental limit to the yield of a modern, two-stage nuclear weapon is about [1]

100 kilotons      500 kilotons      1 Megaton      10 Megatons      there is none

(e) Complete the following one-sentence definitions: [4]

i. An airburst is

ii. A surface burst is

(f) Which produces more fallout, an airburst or a surface burst? [2]

(g) List *five harmful physical phenomena* produced by a 1-Mt airburst in the order they are *produced* by the burst and give *the percentage of the total energy yield in each*. [10]

i.

ii.

iii.

iv.

v.

**5. Nuclear explosions and their effects – II [20]**

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

i.

i.

(b) List the *general* effect on the human body of the following whole-body radiation doses. [6]

i. 300 rem

ii. 450 rem

iii. 1,000 rem

(c) What is the expected change in global surface temperatures that would be produced if the weapons in the current strategic arsenals of the U.S. and Russia were exploded? [2]

-10 to -7 F    -6 to -3 F    -2 to 0 F    0 to +2 F    +3 to +6 F    +10 to +7 F

(d) Name three *indirect, long-term* consequences of a nuclear war other than fallout radiation and climate change that would be harmful to the people in a country that has been attacked. [6]

i.

ii.

iii.

(e) A nuclear attack on a country would likely cause a mass exodus from where to where? [2]

(f) Name one important negative consequence of this exodus. [2]

**6. Terrorism and its characteristics [20]**

(a) Terrorism is defined as \_\_\_\_\_ and \_\_\_\_\_ targeting \_\_\_\_\_ for \_\_\_\_\_ purposes. [4]

(b) Why is the phrase “war on terror” nonsensical? [4]

(c) Give a current or historical example of each of the following types of terrorism: [6]

i. State terrorism

ii. State-sponsored terrorism

ii. War terrorism

(b) Richardson argues that a “lethal cocktail” of three factors produces terrorism. List them. [6]

i.

ii.

iii.





**8. Nuclear weapon delivery methods [20]**

(a) Can a nuclear-armed cruise missile be recalled after it has been launched? [1]

Yes

No

(b) Can a nuclear-armed ballistic missile be recalled after it has been launched? [1]

Yes

No

(c) On U.S. submarines with nuclear-armed long-range ballistic missiles, who must give the order for them to be launched? [2]

Answer the following two questions in a phrase or a sentence, as appropriate.

(d) List two methods for delivering nuclear weapons that are among those the U.S. intelligence community assesses are most likely to be used to attack the territory of the U.S. [4]

i.

ii.

(e) The most recent U.S. National Intelligence Estimate of the ballistic missile threat to the United States gives several reasons why an attacker is likely to prefer one of the methods listed in part (d) over other methods. List two of these reasons. [4]

i.

ii.

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

i. ICBM

ii. SRBM

iii. MRBM

iv. IRBM

**9. Nuclear Proliferation [20]**

(a) List the year in which each of the following countries first created a nuclear explosion. [8]

United States:	China:	United Kingdom:	Pakistan:
Soviet Union:	France:	North Korea:	India:

(b) List three states that once had nuclear weapons but gave them up. [3]

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- 
- 

(c) Indicate which if any of the following actions are permissible under International Law by circling the sentence that describes the action. [3]

Attacking a country that is blockading your territory

Attacking a country to prevent it from launching an attack at some time in the future

Attacking a country to disrupt an attack on you that is already underway or is imminent

(d) Indicate which if any of the following are provisions of the Nuclear Nonproliferation Treaty by circling the provision. [4]

Nuclear weapon states must give up all their nuclear weapons.

Non-nuclear weapon states are guaranteed the right to enrich uranium and produce plutonium.

Non-nuclear weapon states must not accept or manufacture nuclear weapons.

Nuclear weapon states must not give nuclear weapons to non-nuclear weapon states or help them develop weapons.

(e) Is it possible to make a functioning nuclear weapon using reactor-grade plutonium? [2]

Yes

No

**10. Current events [20]**

- (a) What important nuclear arms control treaty entered into force this year? (Give its name.) [4]
- (b) List the states that are parties to this treaty. [4]
- (c) This treaty allows each party to deploy how many strategic nuclear warheads? [2]
- (d) This treaty allows each party to deploy how many strategic nuclear delivery vehicles, not counting vehicles held in reserve? [2]
- (e) Israel's intelligence chief recently stated that Iran is not thought capable of producing a nuclear weapon before what year? [2]
- (f) List two possible reasons for this delay. [4]
- i.
  - ii.
- (g) What unusual action is Iran planning to take at its Bushehr nuclear reactor? [2]