First Midterm Exam, Friday, Oct 2\textsuperscript{nd}

Name: ____________________________ Andrew ID: ____________________

Signature: ________________________ Recitation Session: ____________

Results:

<table>
<thead>
<tr>
<th>Question</th>
<th>max points</th>
<th>achieved points</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>100</td>
<td></td>
</tr>
</tbody>
</table>

Note:

- Read all questions carefully before answering them.
- If after 20 minutes you haven’t started with the essay, you probably should. You can come back to the other questions if you have time left in the end.
- If in question 2 you need to write more than you have space, you are probably thinking too complicated.
1: Multiple choice questions

1 Kinetic energy (the energy of motion) can be measured in...
   □ Watts
   □ Grams
   □ Calories
   □ Amperes
   □ Horsepower

2 Which of the following statements is false?
   □ Hydrogen has more energy per gram than TNT.
   □ Liquid hydrogen is less dense than water.
   □ Per gallon, liquid hydrogen is a less efficient source of energy than gasoline.
   □ Hydrogen cannot be easily produced, so it must be mined, and this is expensive.
   □ Burning hydrogen produces water.

3 If satellites fly too low, they will ultimately crash because of...
   □ Stronger gravity
   □ Weaker gravity
   □ Larger air resistance
   □ Interaction with the Earth’s magnetic field
   □ Angular momentum conservation

4 If you put a 60 watt light bulb into a lamp and plug it into a standard US outlet, how much current will approximately flow?
   □ 0.1 amp
   □ 0.5 amp
   □ 1 amp
   □ 2 amp
   □ 7.2 amp

5 The smallest container that could contain one critical mass of plutonium (*i.e.*, enough for a nuclear bomb explosion) is...
   □ A teaspoon
   □ A coffee mug
   □ The container for a gallon of milk
   □ A large suitcase
   □ The trunk of a car
6 Alcohol made from fossil fuels is not radioactive, because...
- The radioactivity has decayed away
- There is no carbon in such alcohol
- Ancient plants never were radioactive
- The half-life of the key element is too long
- Wrong, it’s just as radioactive as conventional alcohol

7 You put a glass of milk into a microwave oven and warm it up from room temperature to 50°C. Therefore, the thermal energy of the milk...
- Approximately doubles
- Approximately triples
- Increases, but just a little bit (maybe 10 to 20 percent)
- Decreases very slightly
- Doesn’t change, because microwave ovens only increase the temperature but not the thermal energy.

8 The C-14 method is...
- A way to create high-powered explosives
- One of several possibilities to get satellites into orbit
- A very efficient method to enrich uranium
- A technique to date organic materials
- A way to reduce carbon emissions from power plants that use coal, oil, or natural gas

9 The efficiency of a coal power plant for turning the energy contained in the coal into electric energy is closest to...
- 1%
- 5%
- 30%
- 70%
- 95%

10 Geostationary satellites orbit the Earth approximately in...
- 90 minutes
- 1 day
- 1 week
- 1 month
- Wrong, they don’t orbit; they are stationary.
2: Questions requiring short written answers

1. On the 23rd of November 2006 the Russian ex-KGB-officer Alexander Litvinenko died at the University College Hospital in London, UK. The case caused a huge press coverage because it was concluded that he was murdered in a very unusual way. How was he assassinated and what did he die from?

2. What is the main purpose of a “moderator” in a nuclear reactor?

3. Hydrogen is the most abundant element in the universe. Our sun consists of 90% hydrogen, and also the large planets Jupiter and Saturn consist largely of hydrogen gas (H₂). However, hydrogen gas can hardly be found on Earth. Specifically, it is virtually absent in our atmosphere. Why is that?

4. In order to make high resolution pictures, spy satellites orbit the Earth in a very low orbit. What disadvantage does this invariably have?

5. Name two properties of a metallic wire that affect its electric resistance!
3: A short calculation

A frequently quoted number for a nutritional diet is 2000 Cal/day. This is “energy per time”, so it measures power. We can also measure power in watt, which is joules per second, or J/s. How many watts, then, is a 2000 Cal/day diet? (Hint: 1 Cal ≈ 4000 J). It’s fine to calculate an approximate answer, you don’t need to do the necessary division very accurately.
On the 26th of April 1986 a reactor at the Chernobyl Nuclear Power Plant in the Ukraine had a worst-case-scenario nuclear accident. As a result, large amounts of radioactivity were leaked into the environment and spread over the Soviet Union, Eastern Europe, and Western Europe. It is estimated that this led to 24,000 additional cases of cancer worldwide. In the aftermath the Soviet Government decided to evacuate all regions in which a person would receive a lifetime radiation dose exceeding 35 rem.

Write a short essay about this accident, in which you should in particular address the following issues:

• Describe in broad strokes what happened.

• In what way was this accident similar to or different from a nuclear bomb?

• How “bad” is a radiation exposure of 35 rem, and what considerations might have gone into picking this number (rather than a larger or smaller value) as the evacuation cutoff point?

• Why is it hard for individual cancer victims to hold nuclear companies accountable for their disease?