Name: _____

Class: _____

CHAPTER TEST

Chapter 4 Energy from the nucleus

Time permitted: 35 minutes

	Section	Number of questions	Marks available	Marks achieved
A	Multiple choice	15	15	
B	Short answer	3	15	
	Total		**30**	

Grade: _____

Scale:

| A+	29–30	A	26–28	B	23–25	C	19–22	D	15–18	E	9–14	UG	0–8

Comments:

Section A Multiple choice (15 marks)

Section A consists of 15 questions, each worth one mark. Each question has only one correct answer. Circle the correct answer. Attempt all questions. Marks will not be deducted for incorrect answers. You are advised to spend no more than 15 minutes on this section.

You will need a copy of the periodic table.

1 What holds a nuclide together?

   A The strong nuclear force

   B The weak nuclear force

   C The electromagnetic force

   D The gravitational force

2 What is the binding energy of a nucleus?

   A The energy released when the mass of the nucleus is totally converted to energy

   B The energy released when a nucleus decays

   C The energy needed to disassemble a nucleus into its individual nucleons

   D The energy needed to bind any two nucleons together

3 What is an electron-volt (eV)?

   A $10^{-19}\,\text{J}$

   B The potential difference between two energy states of an electron

   C The energy an electron gains when moving through a potential difference of $1\,\text{V}$

   D The charge on a single electron

4 When would a nuclide be the most stable?

   A When it has equal numbers of protons and neutrons

   B When it has more neutrons than protons

   C When the total nuclear binding energy is greatest

   D When the total nuclear binding energy per particle is greatest

5 Consider the stability curve for nuclides below. The black points all represent stable nuclides and the red point is an unstable nuclide.
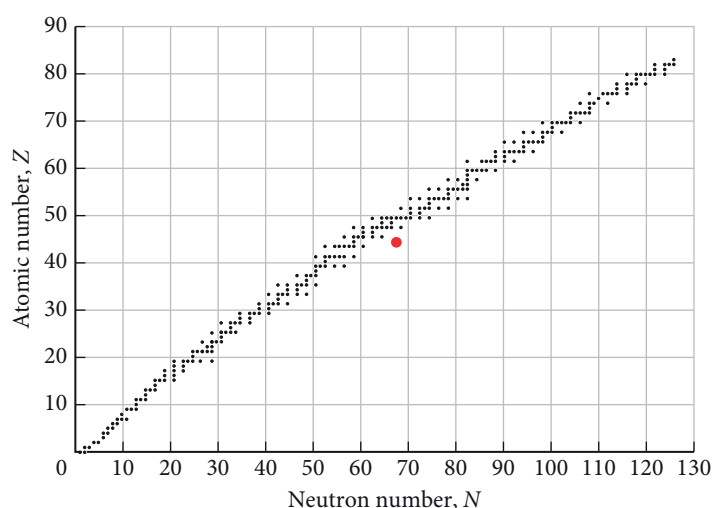
Which kind of radiation is the red nuclide most likely to release?

A Alpha radiation

B Beta positive radiation

C Beta negative radiation

D Either A or B

6 What happens when uranium-235 undergoes nuclear fission?

A A U-235 nuclide spontaneously splits into two smaller nuclides.

B A U-235 nuclide absorbs a neutron and then splits into two smaller nuclides.

C A U-235 nuclide joins with a small nuclide to create a larger nuclide.

D A U-235 nuclide absorbs a neutron and then beta decays to form neptunium-235.

7 What does a moderator do in a nuclear reactor?

A Absorbs free neutrons

B Cools down the reaction so the reactor doesn't overheat

C Slows down neutrons

D Absorbs toxic by-products of the reactions, known as 'neutron poisons'

8 What do control rods do in a nuclear reactor?

A Absorb free neutrons

B Cool down the reaction so the reactor doesn't overheat

C Slow down neutrons

D Absorb toxic by-products of the reactions, known as 'neutron poisons'

9 Which of the following would occur in an uncontrolled chain reaction?

  A An average of one neutron from each reaction produces another reaction.

  B An average of more than one neutron from each reaction produces another reaction.

  C An average of less than one neutron from each reaction produces another reaction.

  D All (two or three) neutrons from each reaction produce another reaction.

10 Which of the following is not a fusion reaction?

  A Two protons combine to form deuterium, releasing a positron

  B Three alpha particles combine to form a carbon nucleus

  C A neon-20 nucleus and a helium nucleus produce a magnesium-24 nucleus

  D Lithium-7 combines with a hydrogen nucleus to produce two helium nuclei

11 Which nuclear process would produce the most energy?

  A The fission of uranium-235

  B The fission of plutonium-239

  C Production of helium in stars from hydrogen by fusion

  D The fusion of two carbon-12 nuclei

12 Which of the following is not a reason why there are no nuclear fusion reactors?

  A Fusion occurs at very high temperatures ($100\,000\,000°C$).

  B Too much energy is produced.

  C Fusion reactions require the reactants to be at a high density.

  D The plasma state of matter required for fusion is very difficult to contain.

13 Which of the following is the most damaging form of radiation to the human body?

  A Alpha particles

  B Beta particles

  C Gamma particles

  D Slow (thermal) neutrons

14 The weighting factor for protons above $2\,MeV$ is 5. A person received a dose of $0.45\,Gy$ of proton radiation at $3\,MeV$. What is the equivalent dose, H, in sievert?

  A $0.09\,Sv$

  B $0.90\,Sv$

  C $2.25\,Sv$

  D $6.75\,Sv$

15 Which of the following effects of radiation exposure is classified as genetic?

    A NVD (nausea, vomiting and diarrhea)

    B Lowered bone marrow activity

    C Mutations of genes in reproductive cells

    D Shock and death

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Section B Short answer (15 marks)

Section B consists of three questions. Write your answers in the spaces provided. You are advised to spend 20 minutes on this section.

1 How much energy would be released if the mass of a neutron was converted to energy?

Mass of a neutron $= 1.67 \times 10^{-27}$ kg, speed of light $= 3.0 \times 10^{8}$ m s^{-1}. (2 marks)

2 A uranium-235 nuclide absorbs a neutron and splits into bromine-87 and lanthanum-146. (5 marks)

a How many neutrons are released? (1 mark)

b Write the equation for this nuclear reaction. (2 marks)

c Use the shape of the stability graph in section A question 5 to predict the kind of behaviour you would expect of the daughter products of nuclear fission. (2 marks)

3 In very hot stars, two carbon-12 nuclides combine to form neon-20 and helium-4. The mass of a neon-20 nucleus is 19.9924 u, and the mass of a helium nucleus is 4.0026 u. 1 u $\approx 1.661 \times 10^{-27}$ kg (8 marks)

a What is the unified mass unit for carbon-12 defined as? (1 mark)

b What is the mass defect in:

i unified mass units? (2 marks)

ii kilograms? (1 mark)

c How much energy is released by:

  i the fusion of two C-12 nuclides? (1 mark)

  ii the fusion of 1 kg of C-12? (3 marks)

End of test (30 marks)