Essential Pre-Uni Physics J1.6

A Level

P P P

Complete the nuclear equation. Don't forget the neutrino / antineutrino if it is a beta decay! A periodic table is available here, however you shouldn't need it.

$^{90}_{38}\mathrm{Sr} \rightarrow \quad ...$ (Beta− decay)

- $^{89}_{38}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + {}^{1}_{1}\overline{\nu}$
- $^{90}_{39}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + {}^{0}_{0}\nu$
- $^{89}_{39}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + {}^{1}_{0}\overline{\nu}$
- $^{90}_{39}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + {}^{0}_{0}\overline{\nu}$
- $^{90}_{38}\mathrm{Y} + {}^{0}_{-1}\mathrm{e} + {}^{0}_{0}\overline{\nu}$

Essential Pre-Uni Physics J1.8

A Level

P P P

Complete the nuclear equation. Don't forget the neutrino / antineutrino if it is a beta decay! A periodic table is available here, however you shouldn't need it.

$^{235}_{92}\mathrm{U} \quad + \quad ^{1}_{0}\mathrm{n} \rightarrow \quad \ldots$ (Nuclear Fission)

- $^{147}_{57}\mathrm{La} \quad + \quad ^{87}_{35}\mathrm{Br} \quad + \quad 2^{1}_{0}\mathrm{n}$
- $^{147}_{57}\mathrm{La} \quad + \quad ^{87}_{35}\mathrm{Br} \quad + \quad ^{1}_{0}\mathrm{n}$
- $^{147}_{57}\mathrm{La} \quad + \quad ^{87}_{57}\mathrm{Br} \quad + \quad 2^{1}_{0}\mathrm{n}$

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics J2.2

A Level

A 'mole' of nuclei contains 6.02×10^{23} nuclei. The mass of one mole of nuclei (the 'molar mass') is approximately equal to $0.001\,\mathrm{kg}\times$ the mass number of the nucleus. Use this approximation wherever you have a question and are not given the molar mass explicitly.

Complete the questions in the table:

Half life	Decay constant / s^{-1}
(a)	3.2×10^{-10}
(b)	1.2×10^{-4}

Part A Decay constant of $3.2 \times 10^{-10}\,\mathrm{s}^{-1}$

a) What is the half life?

Part B Decay constant of $1.2 \times 10^{-4}\,\mathrm{s}^{-1}$

b) What is the half life?

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics J2.7

A Level P P P

A 'mole' of nuclei contains 6.02×10^{23} nuclei. The mass of one mole of nuclei (the 'molar mass') is approximately equal to $0.001\,\mathrm{kg}\times$ the mass number of the nucleus. Use this approximation wherever you have a question and are not given the molar mass explicitly.

Part A Number of nuclei

How many nuclei are there in $5.0\,\mathrm{mg}$ of $^{14}\mathrm{C}$? Give your answer to 2 significant figures (strictly the answer to this question should be given to 1 sig fig, but 2 sig figs allows us to check your method is correct)

Part B Activity

What is the activity of this sample if the half life is $5700\,\mathrm{years}$? Give your answer to 2 significant figures (strictly the answer to this question should be given to 1 sig fig, but 2 sig figs allows us to check your method is correct)

Physics. You work it out.

Essential Pre-Uni Physics J3.2

A Level

Complete the questions in the table.

Initial number of unstable nuclei	Initial activity / Bq	Half life	Decay constant / $\mathrm{s^{-1}}$	Number of unstable nuclei left after 6.0 hours	Activity after 6.0 hours / Bq
2.0×10^{21}	(a)	$3.0\,\mathrm{hours}$	(b)	(c)	(d)

Part A Initial activity

Initial number of unstable nuclei	Initial activity / Bq	Half life	Decay constant / $\mathrm{s^{-1}}$	Number of unstable nuclei left after 6.0 hours	Activity after 6.0 hours / Bq
2.0×10^{21}	(a)	$3.0\,\mathrm{hours}$	(b)	(c)	(d)

a) What is the initial activity?

Part B Decay constant

Initial number of unstable nuclei	Initial activity / Bq	Half life	Decay constant / s^{-1}	Number of unstable nuclei left after 6.0 hours	Activity after 6.0 hours / Bq
2.0×10^{21}	(a)	$3.0\,\mathrm{hours}$	(b)	(c)	(d)

b) What is the decay constant?

Part C Number of unstable nuclei after 6.0 hours

Initial number of unstable nuclei	Initial activity / Bq	Half life	Decay constant / s^{-1}	Number of unstable nuclei left after 6.0 hours	Activity after 6.0 hours / Bq
2.0×10^{21}	(a)	$3.0\,\mathrm{hours}$	(b)	(c)	(d)

c) What is the number of unstable nuclei remaining after $6.0\,\mathrm{hours}$? Give your answer to 2 significant figures.

Part D Activity after 6.0 hours

Initial number of unstable nuclei	Initial activity / Bq	Half life	Decay constant / s^{-1}	Number of unstable nuclei left after 6.0 hours	Activity after 6.0 hours / Bq
2.0×10^{21}	(a)	$3.0\,\mathrm{hours}$	(b)	(c)	(d)

d) What is the activity after $6.0\,\mathrm{hours}$? Give your answer to 2 significant figures.

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics J4.4

A Level

Mass defects, binding energies or energy yields in nuclear equations require high precision data as calculations involve subtracting two very similar numbers. Use the data here (and on page iv of the book) to all significant figures given. Take $c = 2.998 \times 10^{8}\,\mathrm{m\,s^{-1}}$, and the electronic charge as $1.602 \times 10^{-19}\,\mathrm{C}$.

Mass of neutron (m_n)	$1.67493 \times 10^{-27}\,\mathrm{kg}$
Mass of neutron (m_n)	$1.00867\,\mathrm{u}$
Mass of proton (m_p)	$1.67262 \times 10^{-27}\,\mathrm{kg}$
Mass of proton (m_p)	$1.00728\,\mathrm{u}$
Mass of electron (m_e)	$9.10938 \times 10^{-31}\,\mathrm{kg}$
Mass of electron (m_e)	$5.48580 \times 10^{-4}\,\mathrm{u}$
Atomic mass unit (u)	$1.66054 \times 10^{-27}\,\mathrm{kg}$

Calculate the binding energy per nucleon of $^{12}\mathrm{C}$ in MeV. Give your answer to 4 sig fig.

The mass of a $^{12}\mathrm{C}$ atom is $12.0000\,\mathrm{u}$.

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics J4.6

A Level

Mass defects, binding energies or energy yields in nuclear equations require high precision data as calculations involve subtracting two very similar numbers. Use the data here (and on page iv of the book) to all significant figures given. Take $c = 2.998 \times 10^8\,\mathrm{m\,s^{-1}}$, and the electronic charge as $1.602 \times 10^{-19}\,\mathrm{C}$.

Mass of neutron (m_n)	$1.67493 \times 10^{-27}\,\mathrm{kg}$
Mass of neutron (m_n)	$1.00867\,\mathrm{u}$
Mass of proton (m_p)	$1.67262 \times 10^{-27}\,\mathrm{kg}$
Mass of proton (m_p)	$1.00728\,\mathrm{u}$
Mass of electron (m_e)	$9.10938 \times 10^{-31}\,\mathrm{kg}$
Mass of electron (m_e)	$5.48580 \times 10^{-4}\,\mathrm{u}$
Atomic mass unit (u)	$1.66054 \times 10^{-27}\,\mathrm{kg}$

One nuclear fission reaction is ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{147}_{57}\mathrm{La} + {}^{87}_{35}\mathrm{Br} + 2{}^{1}_{0}\mathrm{n}$. The masses of the $\mathbf{atoms}$ are given in the table below.

${}^{235}_{92}\mathrm{U}$	$3.90300 \times 10^{-25}\,\mathrm{kg}$
${}^{147}_{57}\mathrm{La}$	$2.43981 \times 10^{-25}\,\mathrm{kg}$
${}^{87}_{35}\mathrm{Br}$	$1.44335 \times 10^{-25}\,\mathrm{kg}$

Calculate the energy released by this reaction in MeV. Give your answer to 4 sig fig.

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics L3.2

A Level

P P P

What is the function of a moderator?

- To speed up neutrons so they have more kinetic energy and are more likely to initiate other reactions
- To prevent a neutron from decaying
- To prevent the neutrons from escaping from the reactor core
- To slow down neutrons so they are more likely to initiate other fission reactions
- To ensure that the correct density of neutrons is maintained in the reactor core
- To remove excess neutrons

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Home Gameboard Physics Waves & Particles Nuclear Essential Pre-Uni Physics L3.9

Essential Pre-Uni Physics L3.9

A Level
P P P

Nuclear waste is very radioactive. Why?

- fission products are too light and therefore decay easily
- The neutrons from the reactor linger in the sample for a long time
- Fission products are neutron rich and therefore unstable
- Because the material is compacted and compressed before it is stored making the waste more concentrated
- Because it contains a lot of uranium fuel from the core

Gameboard:

STEM SMART Physics 48 - Revision - Nuclear Physics

Essential Pre-Uni Physics L3.10

A Level
P P P

Part A High temperature

Why is a high temperature needed to sustain a fusion reaction?

- To slow the reaction and prevent a runaway reaction
- So the thermal neutrons are hot and fast enough
- So that the nuclei move faster and collide with each other more frequently, causing more reactions per second
- So that nuclei have enough speed to get close enough and fuse
- Because chemical reactions go at a faster rate when the materials are heated

Part B Other conditions

Give one other condition needed for a sustained fusion reaction in a lab.

- Extra thermal neutrons to allow fusion
- An insulating container
- The correct pressure
- Two types of nuclear fuel
- A large volume of material to fuse

Part C Producing these conditions

Give one method of achieving these conditions in a lab.

- ◯ A fission reaction is used to initiate the fusion reaction
- ◯ It is heated in a very large lead container
- ◯ A very high voltage electric spark is used to maintain the high temperature
- ◯ High magnetic fields contain the fuel while it is heated