

Nuclear and particle physics

Question Paper 3

Level	A Level
Subject	Physics
Exam Board	OCR
Topic	Particles and medical physics
Sub-Topic	Nuclear and particle physics
Booklet	Question Paper 3

Time Allowed: 56 minutes

Score: / 46

Percentage: /100

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

(c) In the nuclear reactor of a power station, each fission reaction of uranium produces 3.2×10^{-11} J of energy. The electrical power output of the power station is 3.0 GW. The efficiency of the system that transforms nuclear energy into electrical energy is 22%. Calculate

(i) the total power output of the reactor core

power output = W [1]

(ii) the total energy output of the reactor core in one day

1 day = 8.64×10^4 s

energy output = J [1]

(iii) the mass of uranium-235 converted in one day. The mass of a uranium-235 nucleus is 3.9×10^{-25} kg.

mass = kg [2]

(d) Discuss the physical properties of nuclear waste that makes it dangerous.

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..... [2]

(c) The radius of a ${}_{92}^{235}\text{U}$ nucleus is $8.8 \times 10^{-15}\text{ m}$. The average mass of a nucleon is $1.7 \times 10^{-27}\text{ kg}$.

(i) Estimate the average density of this nucleus.

density = kg m^{-3} [3]

(ii) State one assumption made in your calculation.

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..... [1]

[Total: 14]

3 (a) Describe the process of induced nuclear fission.

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..... [2]

(b) Explain how nuclear fission can provide energy.

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..... [2]

(c) Suggest a suitable material which can be used as a moderator in a fission reactor and explain its role.

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..... [3]

[Total: 7]

4 (a) A sample of a radioactive isotope contains 4.5×10^{23} active undecayed nuclei. The half-life of the isotope is 12 hours. Calculate

(i) the initial activity of the sample

activity = s^{-1} [2]

(ii) the number of active nuclei of the isotope remaining after 36 hours

number = [1]

(iii) the number of active nuclei of the isotope remaining after 50 hours.

number = [2]

(b) Explain why the activity of a radioactive material is a major factor when considering the safety precautions in the disposal of nuclear waste.

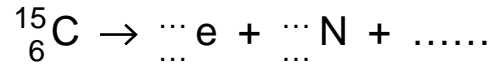
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[Total: 7]

5 There are two types of beta decay, beta-plus and beta-minus. An isotope of carbon $^{15}_6\text{C}$ decays by beta emission into an isotope of nitrogen $^{15}_7\text{N}$. An isotope of phosphorus $^{30}_{15}\text{P}$ decays by beta emission into an isotope of silicon $^{30}_{14}\text{Si}$.

(a) Complete the following decay equations for the carbon and phosphorus isotopes.

(i) carbon decay



(ii) phosphorus decay



[3]

(b) State the two beta decays in terms of a quark model of the nucleons.

(i) beta-plus decay

(ii) beta-minus decay

[2]

(c) Name the force responsible for beta decay.

..... [1]

[Total: 6]