Radioactivity – 2021 IGCSE 0625

1. Nov/2021/QPaper_11,12&13/No.37

A very important experiment improved scientists' understanding of the structure of matter.

The experiment involved α-particles being fired at a thin, gold foil.

What happened?

A All the α-particles were absorbed by the nuclei of the gold atoms.

B All the α-particles were unaffected by the gold atoms.

C Some of the α-particles were attracted by the neutrons in the nuclei of the gold atoms.

D Some of the α-particles were repelled by the protons in the nuclei of the gold atoms.

2. Nov/2021/QPaper_11/No.38

Some sources of background radiation are natural and others are due to human activity.

Which source is natural?

A medical X-rays

B nuclear weapons testing

C radioactive waste from power stations

D radon gas from rocks

3. Nov/2021/QPaper_12/No.38

A sample contains 0.0016 g of a radioactive isotope.

After 4.0 hours the mass of the radioactive isotope in the sample falls to 0.00080 g.

What is the half-life of the radioactive isotope?

A 2.0 hours **B** 4.0 hours **C** 8.0 hours **D** 16 hours

4. Nov/2021/QPaper_11/No.39

A radioactive material is placed near a detector.

The detector shows a count rate of 28 000 counts / min.

When a piece of card is put between the material and the counter, the reading decreases to 25 000 counts / min.

When an aluminium sheet is put between the material and the counter, the reading remains at 25 000 counts / min.

When a sheet of lead is put between the material and the counter, the reading decreases to 19 000 counts / min.

What is being emitted by the radioactive material?

A α, β and γ-radiation

B α and β-radiation only

C α and γ-radiation only

D β and γ-radiation only

5. Nov/2021/QPaper_11/No.40

A radioactive isotope has a half-life of 3 years.

A sample gives a count rate of 100 counts / min on a detector.

Which calculation is used to predict the count rate after 12 years?

A $100 \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$

B $100 \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2}$

C $100 \times \frac{3}{12}$

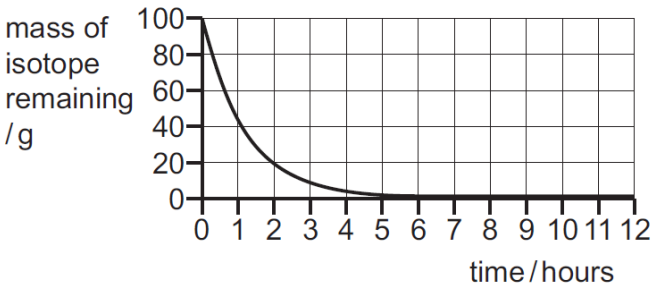
D $100 \times \frac{12}{3} \times \frac{1}{2}$

6. Nov/2021/QPaper_12/No.39

A sample of a radioactive isotope has a mass of 100 g. The half-life of the radioactive isotope is 6.0 hours.

Which graph shows the decay for this isotope?

A



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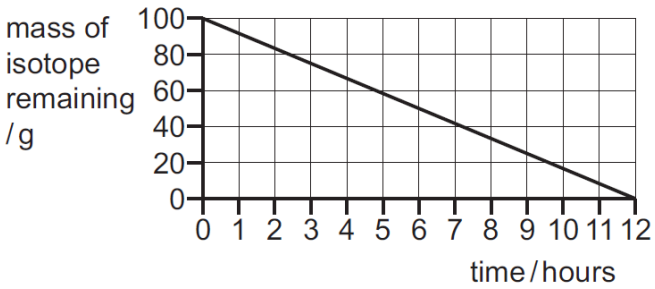

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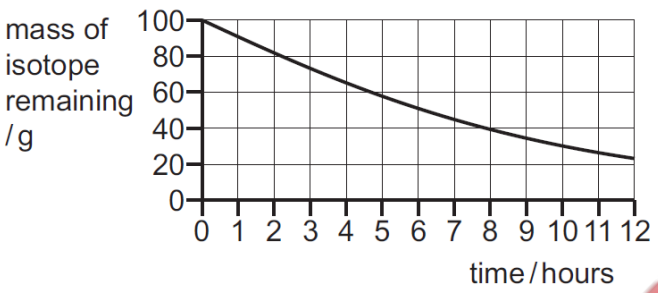

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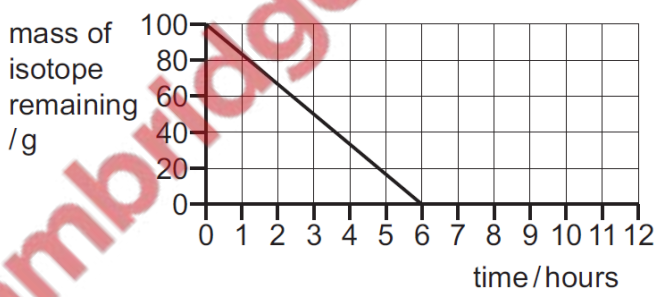


7. Nov/2021/QPaper_12/No.40

Which statement best describes background radiation?

A any harmful level of radiation

B radiation that is only found in space

C radiation from natural sources

D radiation that is absorbed by rocks

8. Nov/2021/QPaper_13/No.38

A nuclide has the symbol $^{23}_{11}Na$.

Which statement about all atoms of this nuclide is correct?

A There are 11 protons in the nucleus.

B There are 23 neutrons in the nucleus.

C There are 11 electrons in the nucleus.

D There are 34 nucleons in the nucleus.

9. Nov/2021/QPaper_13/No.39

The half-life for lead-202 is 52 500 years.

A sample of lead-202 produces 800 counts / s.

How long will it take for the count rate to drop to 100 counts / s?

A 105 000 years

B 157 500 years

C 210 000 years

D 420 000 years

10. Nov/2021/QPaper_13/No.40

Why is a thick shield made of lead needed to protect people from a source of γ-rays?

A Gamma radiation is strongly ionising and so is not very penetrating.

B Gamma radiation is strongly ionising and so is very penetrating.

C Gamma radiation is weakly ionising and so is not very penetrating.

D Gamma radiation is weakly ionising and so is very penetrating.

11. Nov/2021/QPaper_21,22&23/No.37

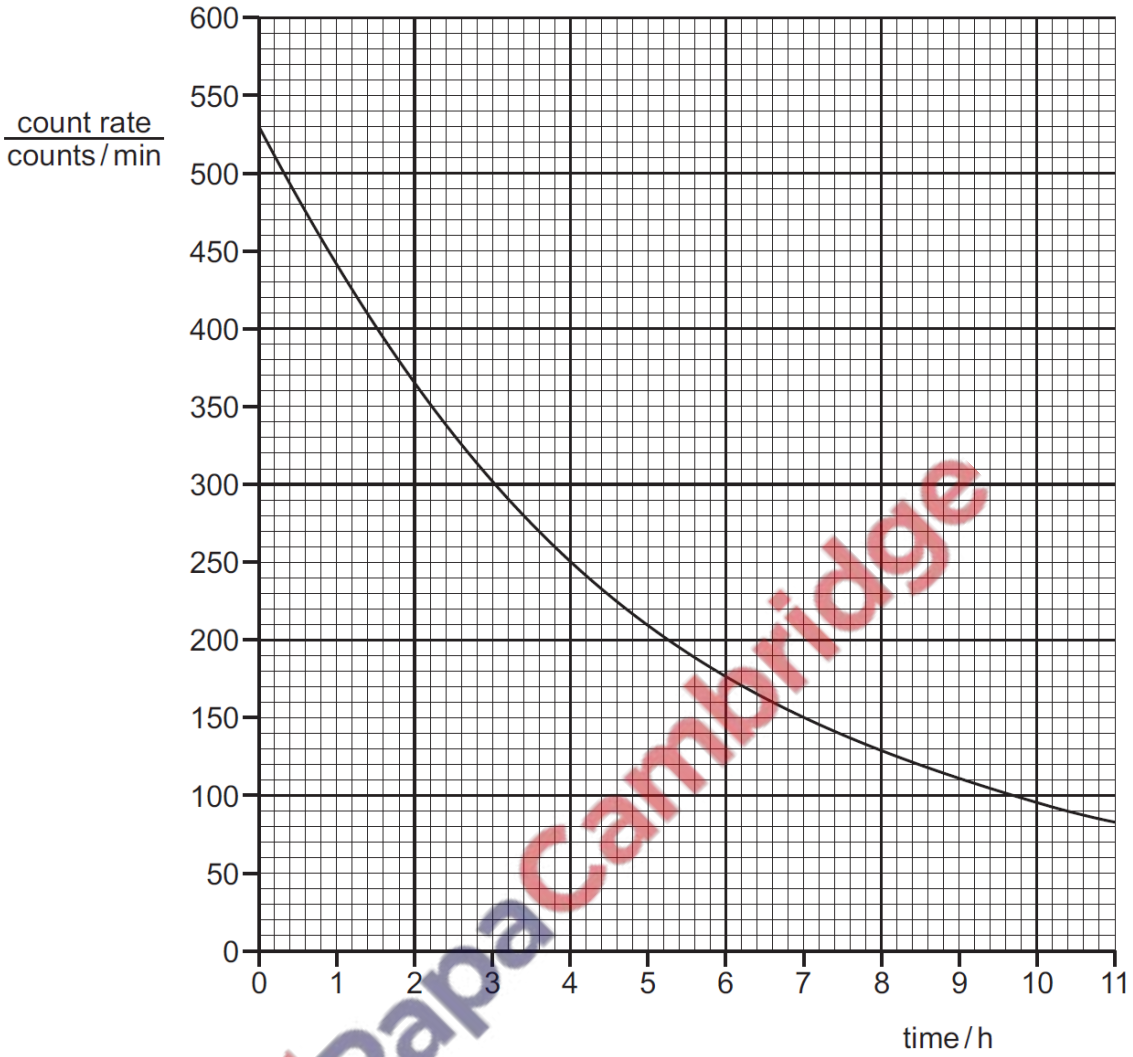
The nucleus of an americium atom contains 146 neutrons and 95 protons. It decays by emitting an α-particle.

How many neutrons and how many protons remain in the nucleus when this form of americium decays?

	number of neutrons remaining	number of protons remaining
A	142	93
B	142	95
C	144	93
D	144	95

12. Nov/2021/QPaper_21/No.38

The graph shows how the count rate measured by a radioactivity detector placed near a radioactive sample changed with time.



Given that the background count rate is 30 counts / min, what is the half-life of this sample?

A 3.4 h **B** 3.6 h **C** 4.0 h **D** 5.5 h

13. Nov/2021/QPaper_21/No.40

Which statement is **not** correct?

A α-particles are used to detect cracks in metallic structures.

B β-particles are used in the measurement of the thickness of paper.

C γ-rays may be used to treat cancer patients.

D Smoke alarms contain a weak source of α-particles.

14. Nov/2021/QPaper_21/No.39

A teacher holds a radioactive source near a detector.

The reading on the detector is 320 counts / min.

The detector is switched on again after the source has been removed and it shows a reading of 20 counts / min.

What is the counts / min solely due to the source and why is there a reading on the detector when there is no radioactive source present?

	counts / min due to the source	reason for reading with no source
A	300	zero error on detector
B	300	background radiation
C	340	zero error on detector
D	340	background radiation

15. Nov/2021/QPaper_22/No.38

A sample of americium decays and changes into neptunium. The half-life of americium is 432 years.

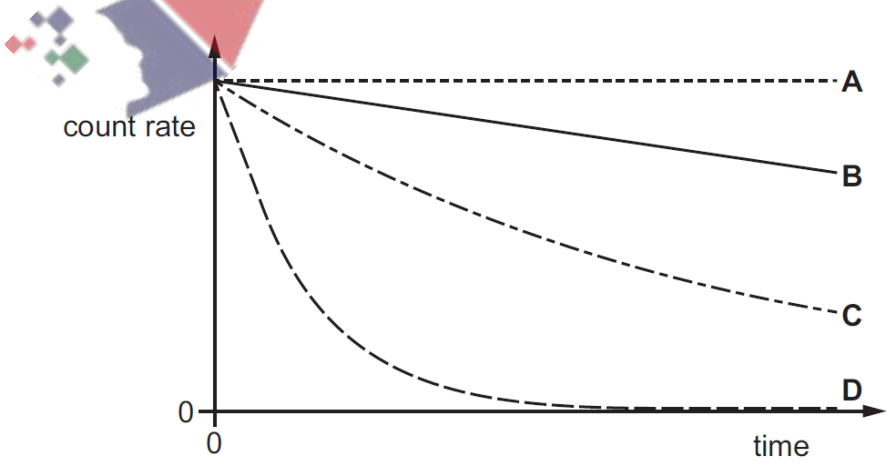
Which fraction of the americium will remain after 1728 years?

A 0 **B** $\frac{1}{16}$ **C** $\frac{1}{8}$ **D** $\frac{1}{4}$

16. Nov/2021/QPaper_22/No.39

The graph shows the decay curves of four different radioactive isotopes.

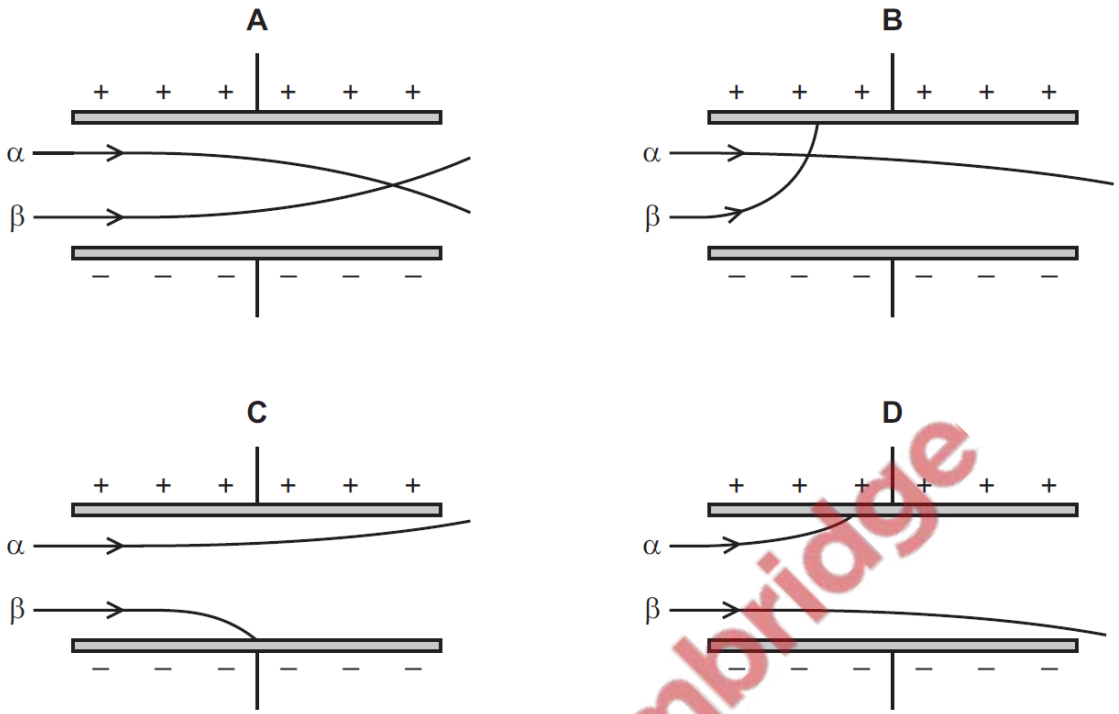
Which isotope has the largest half-life?



17. Nov/2021/QPaper_22/No.40

The diagrams show α-particles and β-particles passing through an electric field.

Which diagram shows the correct paths of the α-particles and β-particles?



18. Nov/2021/QPaper_23/No.38

The half-life for lead-202 is 52 500 years.

A sample of lead-202 produces 800 counts / s.

How long will it take for the count rate to drop to 100 counts / s?

A 105 000 years

B 157 500 years

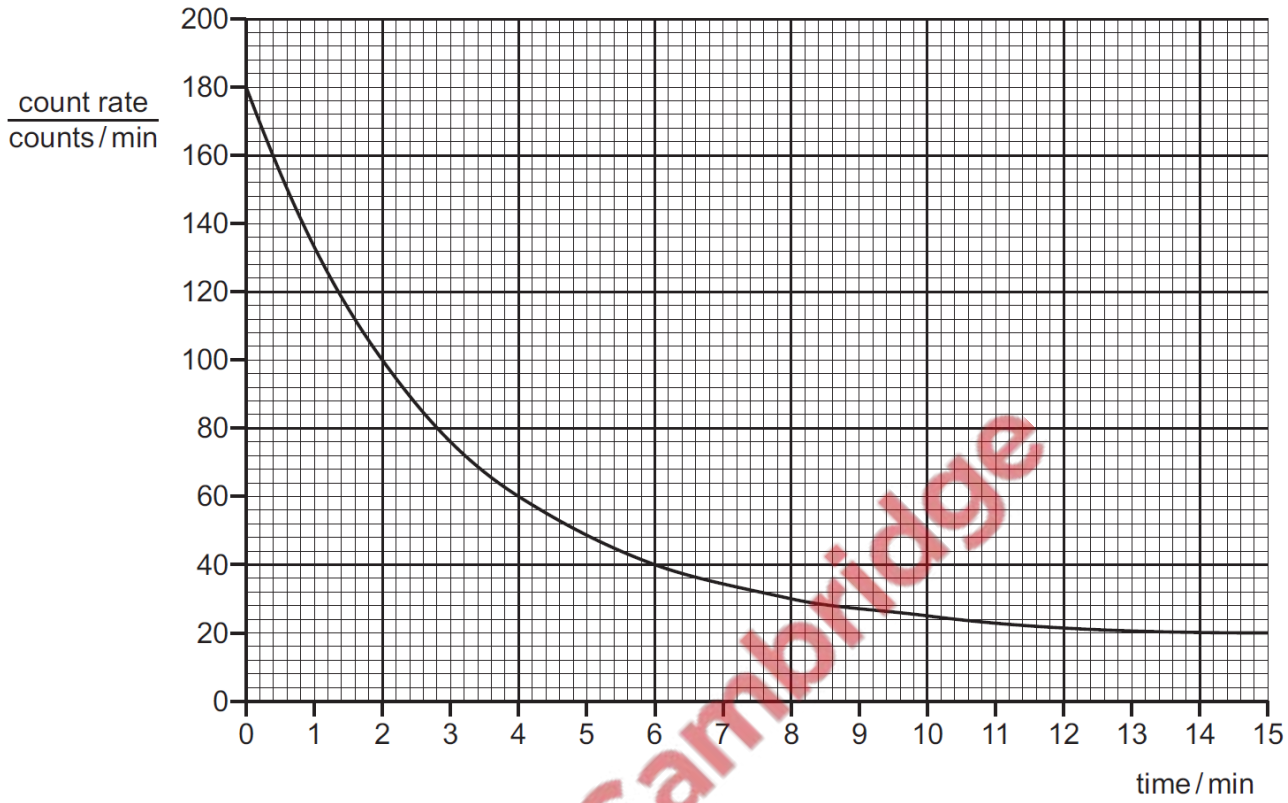
C 210 000 years

D 420 000 years

19. Nov/2021/QPaper_23/No.39

Oxygen-15 is used in hospitals.

The count rate from a detector placed close to a sample of oxygen-15 was recorded over a period of 15 min. The background count rate is 20 counts / min.



What is the half-life of this sample of oxygen-15?

A 2.0 min **B** 2.4 min **C** 2.8 min **D** 7.5 min

20. Nov/2021/QPaper_23/No.40

Of the three types of ionising radiation, α, β and γ, why does α-emission cause the most ionisation?

A α-particles have the smallest mass.

B α-particles have the greatest mass.

C α-particles move with the greatest speed.

D α-particles travel the greatest distance in matter.

21. Nov/2021/QPaper_31/No.11

(a) α (alpha)-particles, β (beta)-particles and γ (gamma)-rays have different characteristics.

Complete Table 11.1 by indicating the correct type of radiation for each characteristic. The first one is done for you.

Table 11.1

characteristic	type of radiation		
	α-particles (alpha-particles)	β-particles (beta-particles)	γ-rays (gamma-rays)
largest mass	✓		
most ionising			
most penetrating			
negatively charged			
greatest speed			

[3]

(b) A sample of radioactive material contains 80 mg of sodium-24.
The half-life of sodium-24 is 15 hours.

Calculate the mass of sodium-24 remaining in the sample after 45 hours.

mass remaining = ... mg [3]

[Total: 6]

22. Nov/2021/QPaper_32/No.12

(a) State which radioactive emission is:

(i) the most penetrating ..... [1]

(ii) the most ionising. ..... [1]

(b) Explain the meaning of the term *isotope*.

.....

..... [2]

(c) The isotope iodine-131 is used in hospitals. A sample of iodine-131 is prepared for use.

The half-life of iodine-131 is 8 days.

Determine the fraction of iodine-131 remaining in the sample after 16 days.

fraction remaining = ... [2]

[Total: 6]

23. Nov/2021/QPaper_33/No.11

(a) Table 11.1 gives information about the nature and charge of three types of radioactive emission. The table is incomplete.

Table 11.1

type of radioactive emission	nature	charge
α (alpha)	helium nucleus	
β (beta)		negative
γ (gamma)		

Complete Table 11.1. [4]

(b) **(i)** State which radioactive emission is the most ionising.

..... [1]

(ii) State which radioactive emission is the most penetrating.

..... [1]

(c) Californium-241 is a radioactive isotope. A scientist measures the count rate from a sample of californium-241 as it decays. Table 11.2 shows the results.

Table 11.2

time / min	count rate / counts / s
0	800
2	560
4	400
6	280
8	200
10	140
12	100
14	

(i) Determine the half-life of californium-241.

half-life of californium-241 = ... min [2]

(ii) Predict the count rate of this sample of californium-241 at time = 14 min.

count rate = ...counts / s [1]

[Total: 9]

24. Nov/2021/QPaper_41/No.9

Uranium-235 ($^{235}_{92}U$) is a radioactive isotope of uranium that occurs naturally on Earth.

(a) Describe the composition and structure of a neutral atom of uranium-235.

.....

.....

.....

.....

..... [4]

(b) Another isotope of uranium is uranium-238.

Describe how an atom of uranium-238 differs from an atom of uranium-235.

.....

..... [1]

(c) In the reactor in a nuclear power station, a nucleus of uranium-235 absorbs a slow-moving neutron and then undergoes nuclear fission.

Two neutrons, a nucleus of xenon-140 ($^{140}_{54}Xe$) and a nucleus of an element represented by E are produced.

Complete the equation for this fission reaction.

$$n + {}^{235}_{92}U \rightarrow {}^{140}_{54}Xe + {}^{\ldots\ldots}_{\ldots\ldots}E + 2n$$

[2]

(d) Xenon-140 ($^{140}_{54}Xe$) is radioactive. It decays by β-emission to isotope Q.

Determine:

(i) the proton number of Q ..... [1]

(ii) the nucleon number of Q. ..... [1]

[Total: 9]

25. Nov/2021/QPaper_42/No.11

(a) Describe the composition and structure of a neutral atom of beryllium-8, which has a proton number of 4 and a nucleon number of 8.

.....

.....

.....

..... [4]

(b) A radioactive isotope decays by β-emission to form an isotope of barium with nucleon number 135.

Table 11.1

element	symbol	proton number
iodine	I	53
xenon	Xe	54
caesium	Cs	55
barium	Ba	56
lanthanum	La	57
cerium	Ce	58
praseodymium	Pr	59

Use data from Table 11.1 to write down the nuclide equation for this decay.

[4]

[Total: 8]

26. Nov/2021/QPaper_43/No.11

(a) A detector of radioactivity is placed in a laboratory where there are no radioactive samples. A student notices that the detector shows a count rate that varies between 20 counts / min and 24 counts / min.

(i) Suggest a source of these readings.

..... [1]

(ii) Explain why these readings are **not** constant.

..... [1]

(b) A nucleus of uranium (U) contains 92 protons and 146 neutrons. It decays by emitting an α-particle to become a nucleus of thorium (Th).

Complete the nuclide equation for this radioactive decay.

$$^{\cdots\cdots}_{\cdots\cdots}\mathrm{U} \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{Th} + {}^{\cdots\cdots}_{\cdots\cdots}\alpha$$

[3]

(c) An isotope of radon has a half-life of 3.8 days. It decays by emitting α-radiation.

Calculate the time taken for 16 mg of this isotope to decay to 2 mg of this isotope.

time = ... days [2]

[Total: 7]