1 A radioactive nucleus emits either an $\alpha$-particle or a $\beta$-particle.

What are the products of these two types of radioactive emission?

| | product after $\alpha$-emission | product after $\beta$-emission |
|---|---|---|
| **A** | a nucleus of a different element | a nucleus of a different element |
| **B** | a nucleus of a different element | a nucleus of the same element |
| **C** | a nucleus of the same element | a nucleus of a different element |
| **D** | a nucleus of the same element | a nucleus of the same element |

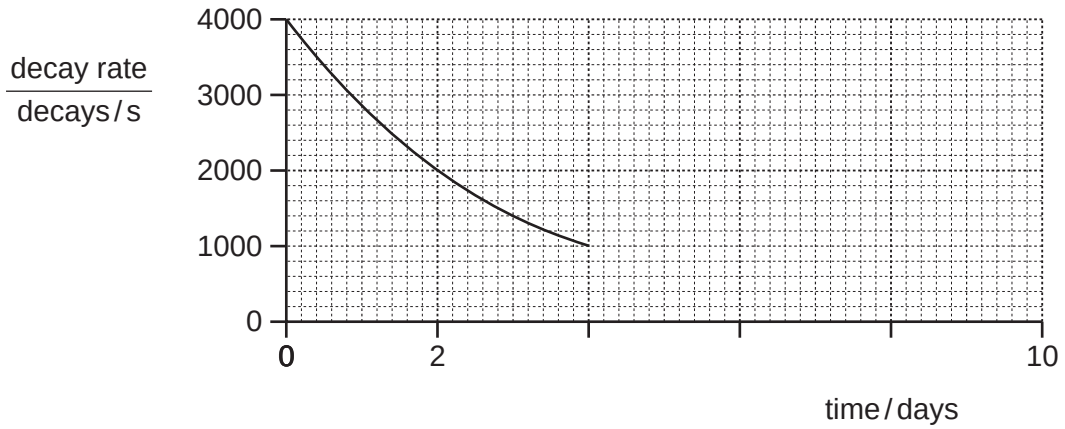
2 A reading is taken every 10 minutes of the number of emissions per second from a radioactive source. The table shows the readings.

| time / min | number of emissions per second |
|---|---|
| 0 | 800 |
| 10 | 560 |
| 20 | 400 |
| 30 | 280 |
| 40 | 200 |
| 50 | 140 |
| 60 | 100 |

What is the half-life of the source?

**A** 10 min **B** 20 min **C** 40 min **D** 60 min

3 The graph shows how the decay rate of a radioactive source changes with time.




What will be the activity at 8 days?

**A** 0 decays / s

**B** 125 decays / s

**C** 250 decays / s

**D** 500 decays / s

4 Radioactive materials should be handled carefully.

Which safety precaution does **not** reduce the risk to people using a radioactive material?

**A** keeping the material a long distance from people

**B** keeping the material at a low temperature

**C** using lead screening between the material and people

**D** using the material for only a short time

5 A sample of a radioactive isotope has an initial rate of emission of 128 counts per minute and a half-life of 4 days.

How long will it take for the rate of emission to fall to 32 counts per minute?

**A** 2 days **B** 4 days **C** 8 days **D** 12 days

6 A scientist carries out an experiment using a sealed source which emits β-particles. The range of the β-particles in the air is about 30 cm.

Which precaution is the most effective to protect the scientist from the radiation?

**A** handling the source with long tongs

**B** keeping the temperature of the source low

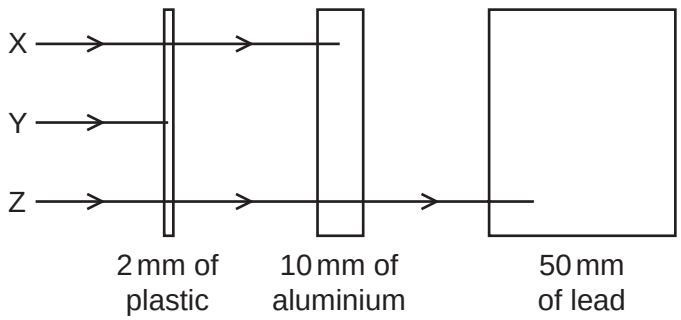
**C** opening all windows in the laboratory

**D** washing his hands before leaving the laboratory

7 Which row describes the nature of α-particles and of γ-rays?

| | α-particles | γ-rays |
|---|---|---|
| **A** | helium nuclei | electromagnetic radiation |
| **B** | helium nuclei | electrons |
| **C** | protons | electromagnetic radiation |
| **D** | protons | electrons |

8 The diagram shows the paths of three different types of radiation, X, Y and Z.




Which row in the table correctly identifies X, Y and Z?

| | X | Y | Z |
|---|---|---|---|
| **A** | α-particles | β-particles | γ-rays |
| **B** | β-particles | α-particles | γ-rays |
| **C** | β-particles | γ-rays | α-particles |
| **D** | γ-rays | α-particles | β-particles |

9 A powder contains 400 mg of a radioactive isotope that emits $\alpha$-particles.

The half-life of the isotope is 5 days.

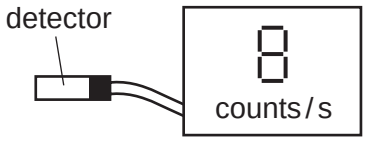
What mass of this isotope remains after 10 days?

**A** 0 mg **B** 40 mg **C** 100 mg **D** 200 mg

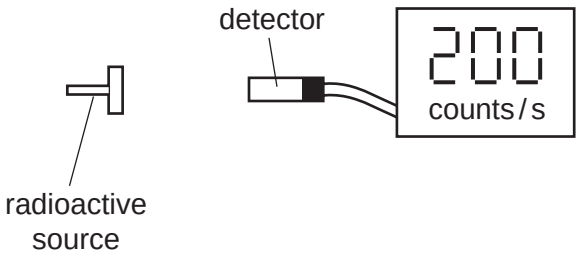
10 Which row gives the properties of the radiation from radioactive materials?

| | most penetrating radiation | most highly ionising radiation |
|---|---|---|
| **A** | $\alpha$ | $\beta$ |
| **B** | $\beta$ | $\gamma$ |
| **C** | $\gamma$ | $\alpha$ |
| **D** | $\gamma$ | $\gamma$ |

11 In a laboratory, a detector of ionising radiation records an average background count rate of 8 counts per second.




A radioactive source is now placed close to the detector. The count rate on the detector rises to 200 counts per second.




What is the count rate due to radiation from the radioactive source?

**A** 25 counts / s

**B** 192 counts / s

**C** 200 counts / s

**D** 208 counts / s

12 Which statement about $\alpha$-radiation is correct?

**A** It is a stream of fast-moving electrons.

**B** It is a form of electromagnetic radiation.

**C** It is more highly ionising than $\gamma$-radiation.

**D** It is more penetrating than $\beta$-radiation.

13 A radioactive source produces a count rate on a detector of 1600 counts / s.

After 32 hours the count rate has fallen to 100 counts / s.

Both count rates have been corrected for background radiation.

What is the half-life of the source?

**A** 2.0 hours **B** 6.4 hours **C** 8.0 hours **D** 16 hours

14 $\alpha$, $\beta$ and $\gamma$-radiations are emitted by radioactive substances.

Which statement is correct?

**A** $\alpha$-radiation consists of charged particles and is the most highly ionising radiation.

**B** $\beta$-radiation consists of charged particles and is the most penetrating radiation.

**C** $\beta$-radiation consists of uncharged particles and is the least highly ionising radiation.

**D** $\gamma$-radiation consists of uncharged particles and is the least penetrating radiation.

15 Which shows the nature and the penetrating ability of $\beta$-particles?

| | nature | most are stopped by |
|---|---|---|
| **A** | electron | a few mm of aluminium |
| **B** | electron | a thin sheet of paper |
| **C** | helium nucleus | a few mm of aluminium |
| **D** | helium nucleus | a thin sheet of paper |

16 A radioactive isotope is placed near a detector. The readings on the detector are corrected for background radiation and recorded every hour.

The table shows the corrected readings.

| time / hours | 0 | 1.0 | 2.0 | 3.0 | 4.0 |
|---|---|---|---|---|---|
| count rate / counts per second | 500 | 375 | 280 | 210 | 160 |

What is the half-life of the isotope?

**A** between 0 and 1 hour

**B** between 1 hour and 2 hours

**C** between 2 hours and 3 hours

**D** between 3 hours and 4 hours

17 A student investigates how the radiation from a radioactive source changes with time.

The table shows the results from the detector used by the student.

| time / minutes | count rate / counts per minute |
|---|---|
| 0 | 340 |
| 2.0 | 180 |
| 4.0 | 100 |
| 6.0 | 60 |
| 8.0 | 40 |

The experiment is repeated by many other students, who also measure the count rate every two minutes.

The half-life of the source is known to be exactly 2.0 minutes.

Why is the measured count rate **always greater** than half the previous value?

**A** Radioactive emissions occur randomly with time.

**B** The detector used is very close to the source.

**C** There is background radiation present.

**D** The radioactive source is decaying.

18 Which row shows the relative ionising effects and penetrating abilities of α-particles and β-particles?

| | ionising effect | penetrating ability |
|---|---|---|
| **A** | α greater than β | α greater than β |
| **B** | α greater than β | α less than β |
| **C** | α less than β | α greater than β |
| **D** | α less than β | α less than β |

19 A radioactive substance has a half-life of 2 weeks. At the beginning of an investigation, a sample of the substance emits 3000 β-particles per minute.

How many β-particles will it emit per minute after 6 weeks?

**A** 0 **B** 375 **C** 500 **D** 1500

20 The table shows the results of an experiment to find the half-life of a radioactive substance.

| time / s | count rate from substance / counts / second |
|---|---|
| 0 | 150 |
| 60 | 120 |
| 120 | 95 |
| 180 | 75 |
| 240 | 60 |

What is the half-life of the substance?

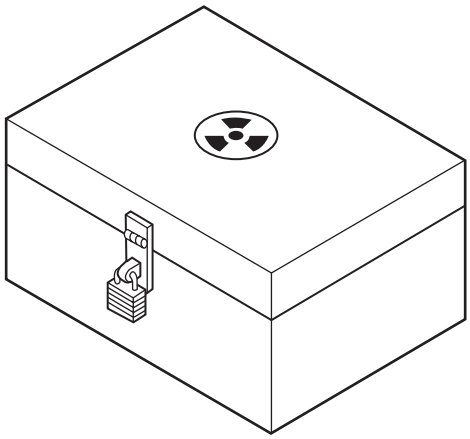
**A** 60 seconds

**B** 120 seconds

**C** 180 seconds

**D** 240 seconds

21 The diagram shows a box used for storing radioactive sources.



Which material is best for lining the box to prevent the escape of most radioactive emissions?

**A** aluminium

**B** copper

**C** lead

**D** steel

22 Compared with $\beta$-particles and $\gamma$-rays, $\alpha$-particles

**A** are the only type of radiation to carry a charge.

**B** have the greatest ionising effect.

**C** have the greatest penetrating effect.

**D** have the smallest mass.

23 In a cathode-ray tube, a hot tungsten cathode releases particles by thermionic emission.

What are these particles?

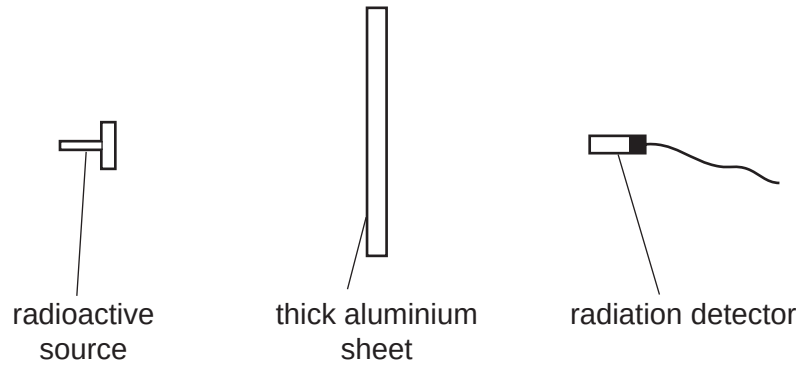
**A** $\alpha$-particles

**B** electrons

**C** protons

**D** tungsten atoms

24 The diagram shows a radioactive source, a thick aluminium sheet and a radiation detector.




The radiation detector shows a reading greater than the background reading.

Which type of radiation is being emitted by the source and detected by the detector?

**A** $\alpha$-radiation

**B** $\beta$-radiation

**C** $\gamma$-radiation

**D** infra-red radiation

25 The count rate from a radioactive isotope is recorded every hour. The count rate is corrected for background radiation.

The table shows the readings.

| time / hours | 0 | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|---|
| $\frac{\text{corrected count rate}}{\text{counts / s}}$ | 800 | 620 | 480 | 370 | 290 | 220 |

What estimate of the half-life of the isotope can be obtained from the readings in the table?

**A** between 1 and 2 hours

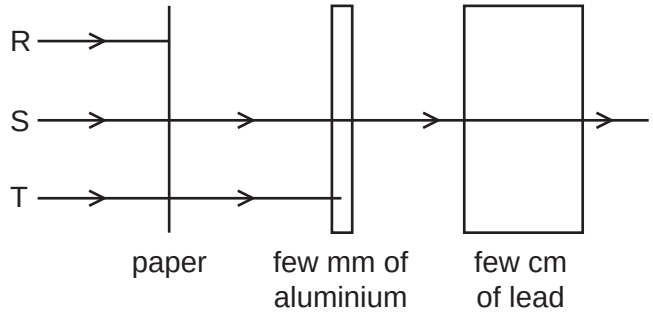
**B** between 2 and 3 hours

**C** between 3 and 4 hours

**D** between 4 and 5 hours

26 A radioactive source emits three types of radiation R, S and T.

The diagram shows an experiment set up to study the penetrating properties of R, S and T.




Which types of radiation are R, S and T?

| | R | S | T |
|---|---|---|---|
| **A** | $\alpha$-particles | $\beta$-particles | $\gamma$-rays |
| **B** | $\alpha$-particles | $\gamma$-rays | $\beta$-particles |
| **C** | $\beta$-particles | $\alpha$-particles | $\gamma$-rays |
| **D** | $\gamma$-rays | $\beta$-particles | $\alpha$-particles |

27 The half-life of a radioactive substance is 10 minutes. A sample of the radioactive substance contains 2000 nuclei.

How many radioactive nuclei were in the sample half an hour earlier?

**A** 250 **B** 4000 **C** 6000 **D** 16 000

28 In a cathode-ray tube, particles are fired at a screen.

What are these particles?

**A** $\alpha$-particles

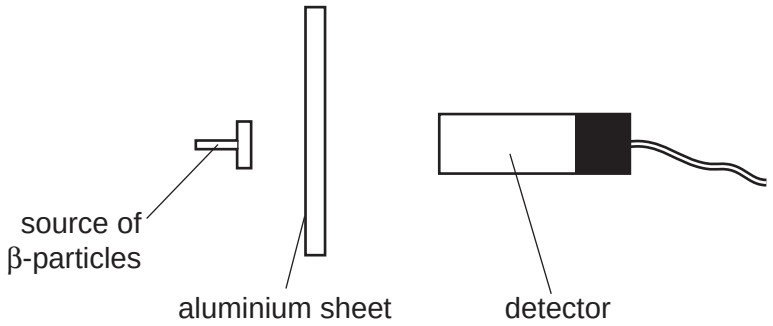
**B** electrons

**C** neutrons

**D** protons

29 A radiation detector is placed close to a source of β-particles.

Aluminium sheets of increasing thickness are placed between the source and the detector.




Eventually a sheet which is 2.0 cm thick is used. The reading on the detector decreases, but does not fall to zero.

Why does the reading not fall to zero?

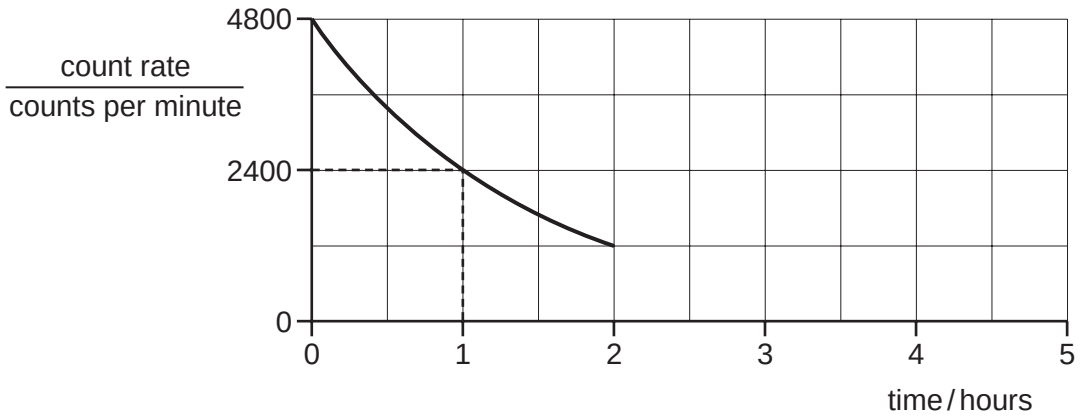
**A** Some of the β-particles go round the edges of the sheet.

**B** The detector is too close to the source.

**C** There is always some background radiation.

**D** The sheet can never be thick enough to absorb all the β-particles.

30 The graph shows how the count rate on a detector due to a radioactive source changes with time.




What is the count rate at 5.0 hours?

**A** 960 counts per minute

**B** 600 counts per minute

**C** 150 counts per minute

**D** 0 counts per minute

31 A radioactive substance emits a particle from the nucleus of one of its atoms. The particle consists of two protons and two neutrons.

What is the name of this process?

**A** $\alpha$-emission

**B** $\beta$-emission

**C** $\gamma$-emission

**D** nuclear fission

32 Why are some radioactive sources stored in boxes made from lead?

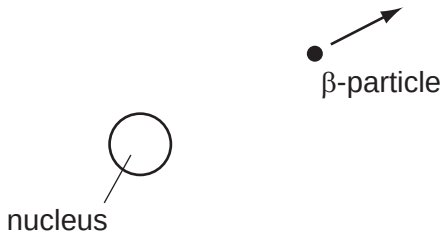
**A** Lead absorbs emissions from the radioactive sources.

**B** Lead decreases the half-life of radioactive sources.

**C** Lead increases the half-life of radioactive sources.

**D** Lead repels emissions from the radioactive sources.

33 A radioactive nucleus emits a $\beta$-particle.




What happens to the proton number (atomic number) of the nucleus?

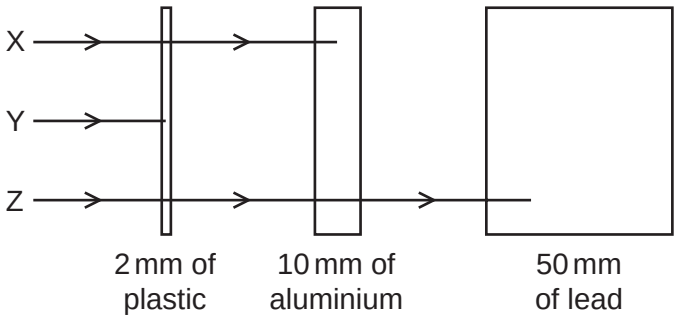
**A** It stays the same.

**B** It increases by 1.

**C** It decreases by 2.

**D** It decreases by 4.

34 The diagram shows the paths of three different types of radiation, X, Y and Z.




Which row in the table correctly identifies X, Y and Z?

| | X | Y | Z |
|---|---|---|---|
| **A** | $\alpha$-particles | $\beta$-particles | $\gamma$-rays |
| **B** | $\beta$-particles | $\alpha$-particles | $\gamma$-rays |
| **C** | $\beta$-particles | $\gamma$-rays | $\alpha$-particles |
| **D** | $\gamma$-rays | $\alpha$-particles | $\beta$-particles |

35 When measuring the emissions from a radioactive rock brought into the laboratory, a teacher mentions that background radiation must be taken into account.

What is this background radiation?

**A** infra-red radiation from warm objects in the laboratory

**B** infra-red radiation from the Sun

**C** ionising radiation from the radioactive rock brought into the laboratory

**D** ionising radiation in the laboratory when the radioactive rock is not present

36 Which row shows the relative ionising effects and penetrating abilities of $\alpha$-particles and $\beta$-particles?

| | ionising effect | penetrating ability |
|---|---|---|
| **A** | $\alpha$ greater than $\beta$ | $\alpha$ greater than $\beta$ |
| **B** | $\alpha$ greater than $\beta$ | $\alpha$ less than $\beta$ |
| **C** | $\alpha$ less than $\beta$ | $\alpha$ greater than $\beta$ |
| **D** | $\alpha$ less than $\beta$ | $\alpha$ less than $\beta$ |

37 A powder contains 400 mg of a radioactive material that emits $\alpha$-particles.

The half-life of the material is 5 days.

What mass of that material remains after 10 days?

**A** 0 mg **B** 40 mg **C** 100 mg **D** 200 mg

**38** A scientist needs to use a source of $\gamma$-rays as safely as possible.

Which action will **not** reduce the amount of radiation that reaches the scientist?

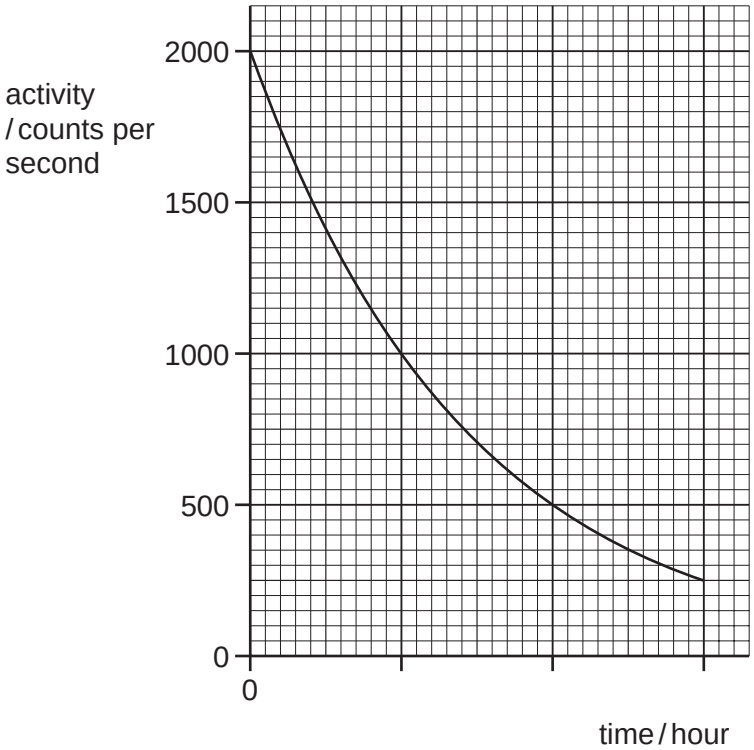
**A** keeping the distance between the source and the scientist as large as possible

**B** keeping the temperature of the source as low as possible

**C** keeping the time for which the scientist uses the source as small as possible

**D** placing a lead screen between the scientist and the source

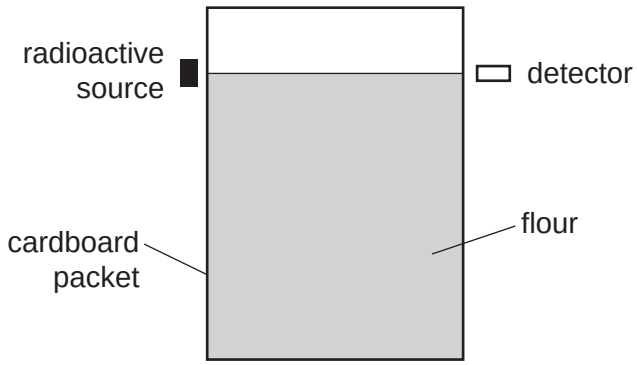
**39** The graph shows the activity of a radioactive source over a period of time.




What is the half-life of the source?

**A** $\frac{1}{2}$ hour **B** 1 hour **C** $1\frac{1}{2}$ hours **D** 3 hours

40 The arrangement shown is used to check whether the flour inside a cardboard packet is above a certain level. If it is above this level, the flour absorbs the radiation from the source so that it doesn't reach the detector.




Which type of radiation is suitable to use?

**A** $\alpha$-particles only

**B** $\beta$-particles only

**C** either $\alpha$-particles or $\beta$-particles

**D** $\gamma$-rays only

41 A reading is taken every 10 minutes of the number of emissions per second from a radioactive source. The table shows the readings.

| time / min | number of emissions per second |
|---|---|
| 0 | 800 |
| 10 | 560 |
| 20 | 400 |
| 30 | 280 |
| 40 | 200 |
| 50 | 140 |
| 60 | 100 |

What is the half-life of the source?

**A** 10 min **B** 20 min **C** 40 min **D** 60 min

42 A radioactive decay can be represented as shown.

$$^{233}_{91}\text{Pa} \rightarrow {}^{233}_{92}\text{U}$$

The equation is incomplete.

In this decay, the nucleus changes by

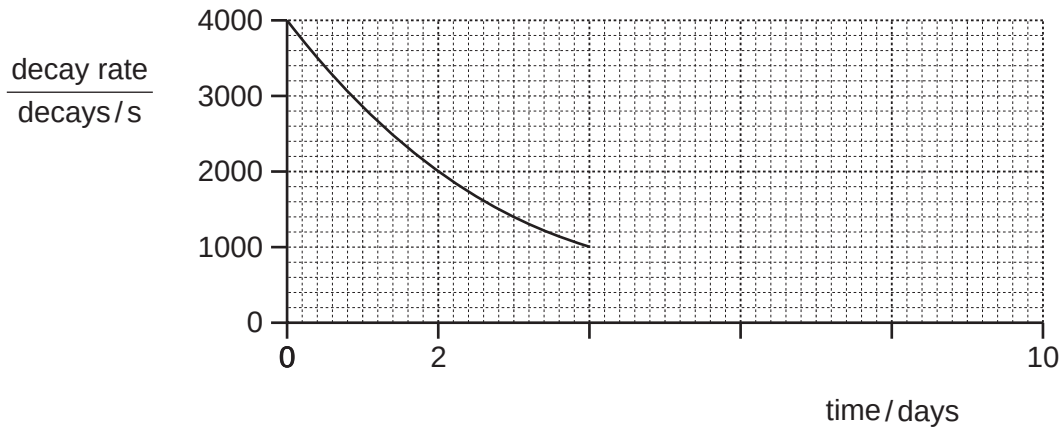
**A** absorbing a neutron.

**B** absorbing a proton.

**C** emitting an $\alpha$-particle.

**D** emitting a $\beta$-particle.

43 The graph shows how the decay rate of a radioactive source changes with time.




What will be the decay rate at 8 days?

**A** 0 decays / s

**B** 125 decays / s

**C** 250 decays / s

**D** 500 decays / s

44 Sodium-24 decays to magnesium-24 according to the following equation.

$$^{24}_{11}\text{Na} \rightarrow {}^{24}_{12}\text{Mg} + \text{emitted particle}$$

What is the emitted particle?

**A** $\alpha$-particle

**B** $\beta$-particle

**C** neutron

**D** proton

45 The reading on a detector placed near a radioactive material is 536 counts per second.

The background count rate is 44 counts per second.

The half-life of the radioactive material is 34 hours.

What is the reading on the detector after 68 hours?

**A** 44 counts per second

**B** 123 counts per second

**C** 134 counts per second

**D** 167 counts per second

46 A nucleus of a radioactive substance $^{218}_{84}\text{Po}$ undergoes an $\alpha$-decay followed by a $\beta$-decay.

What are the nucleon (mass) number and proton (atomic) number of the nuclide formed after both decays have happened?

| | nucleon number | proton number |
|---|---|---|
| **A** | 214 | 85 |
| **B** | 216 | 85 |
| **C** | 214 | 83 |
| **D** | 216 | 83 |

47 A scientist carries out an experiment using a sealed source which emits β-particles. The range of the β-particles in the air is about 30 cm.

Which precaution is the most effective to protect the scientist from the radiation?

**A** handling the source with long tongs

**B** keeping the temperature of the source low

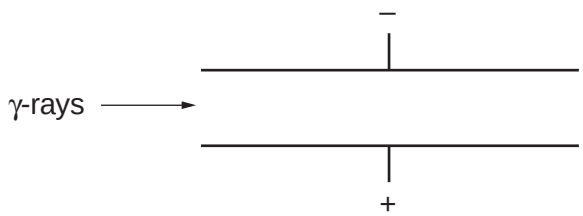
**C** opening all windows in the laboratory

**D** washing his hands before leaving the laboratory

48 Which row describes the nature of α-particles and of γ-rays?

| | α-particles | γ-rays |
|---|---|---|
| **A** | helium nuclei | electromagnetic radiation |
| **B** | helium nuclei | electrons |
| **C** | protons | electromagnetic radiation |
| **D** | protons | electrons |

49 A beam of γ-rays passes between two charged metal plates as shown in the diagram.




How do the γ-rays pass between the two charged plates?

**A** The rays are deflected in a direction perpendicular to the page

**B** The rays are deflected towards the negative plate.

**C** The rays are deflected towards the positive plate.

**D** The rays will continue in the same direction.

50 A powder contains 400 mg of a radioactive isotope that emits $\alpha$-particles.

The half-life of the isotope is 5 days.

What mass of this isotope remains after 10 days?

**A** 0 mg **B** 40 mg **C** 100 mg **D** 200 mg