

1 How many neutrons are in a nucleus of the nuclide  $^{37}_{17}\text{Cl}$ ?

- A** 17                      **B** 20                      **C** 37                      **D** 54

2 A certain element has several isotopes.

Which statement about these isotopes is correct?

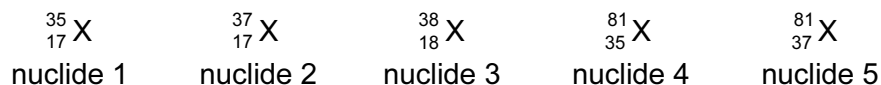
- A** They must have different numbers of electrons orbiting their nuclei.  
**B** They must have the same number of neutrons in their nuclei.  
**C** They must have the same number of nucleons in their nuclei.  
**D** They must have the same number of protons in their nuclei.

3 A neutral atom consists of electrons orbiting a nucleus. The nucleus contains protons and neutrons.

Which statement about the atom **must** be correct?

- A** The number of electrons is equal to the number of neutrons.  
**B** The number of electrons is equal to the number of protons.  
**C** The number of neutrons is equal to the number of protons.  
**D** The number of electrons, neutrons and protons are all different.

4 Below are the symbols for five different nuclides.



Which two nuclides are isotopes of the same element?

- A** nuclide 1 and nuclide 2  
**B** nuclide 2 and nuclide 3  
**C** nuclide 2 and nuclide 5  
**D** nuclide 4 and nuclide 5

- 5 A proton and a neutron are each close to a positive nucleus.



How does the charge on the nucleus affect the proton and the neutron, if at all?

- A** The neutron is attracted; the proton is repelled.  
**B** The neutron is not affected; the proton is repelled.  
**C** The proton is attracted; the neutron is repelled.  
**D** The proton is not affected; the neutron is repelled.
- 6 Below are four statements about isotopes of a certain element.

Which statement about the isotopes **must** be correct?

- A** They are radioactive.  
**B** They are unstable.  
**C** They have the same number of neutrons.  
**D** They have the same number of protons.

- 7 A nucleus of element X is represented as  ${}^{56}_{26}\text{X}$ .

Which is an isotope of element X?

- A**  ${}^{26}_{56}\text{X}$                       **B**  ${}^{54}_{26}\text{X}$                       **C**  ${}^{56}_{24}\text{X}$                       **D**  ${}^{54}_{28}\text{X}$

- 8 The charge on a proton is  $e$ .

What is the charge on an electron and what is the charge on a neutron?

	electron	neutron
<b>A</b>	$e$	$e$
<b>B</b>	$e$	0
<b>C</b>	$-e$	$-e$
<b>D</b>	$-e$	0

- 9 A particular nuclide has the symbol  ${}^{37}_{17}\text{Cl}$ .

What is true for atoms of this nuclide?

- A** There are 17 nucleons in the nucleus.
- B** There are 17 protons in the nucleus.
- C** There are 37 electrons in the nucleus.
- D** There are 37 neutrons in the nucleus.

- 10  ${}^{14}_6\text{C}$  is a nuclide of carbon.

What is the composition of one nucleus of this nuclide?

	neutrons	protons
<b>A</b>	6	8
<b>B</b>	6	14
<b>C</b>	8	6
<b>D</b>	14	6

- 11 A nuclide has the symbol  ${}^{42}_{18}\text{Ne}$ .

What is the proton number of a nucleus of this nuclide?

- A** 10                      **B** 12                      **C** 22                      **D** 32

- 12 The nucleus of an americium atom contains 146 neutrons and 95 protons. It decays by emitting an  $\alpha$ -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
<b>A</b>	142	93
<b>B</b>	142	95
<b>C</b>	144	93
<b>D</b>	144	95

- 13 Which statement is correct for the nucleus of **any** atom?

- A** The nucleus contains electrons, neutrons and protons.
- B** The nucleus contains the same number of protons as neutrons.
- C** The nucleus has a total charge of zero.
- D** The nucleus is very small compared with the size of the atom.

14 Which particles are emitted during thermionic emission?

- A** atoms
- B** electrons
- C** neutrons
- D** protons

15 A uranium  ${}_{92}^{238}\text{U}$  nucleus emits an  $\alpha$ -particle.

What are the new nucleon and proton numbers?

	nucleon number	proton number
<b>A</b>	238	88
<b>B</b>	236	90
<b>C</b>	234	92
<b>D</b>	234	90

16 The nuclide symbol for radioactive polonium is  ${}_{84}^{210}\text{Po}$ .

A nucleus of this type of polonium emits an  $\alpha$ -particle.

What is the proton number (atomic number) of the nucleus after it has emitted the  $\alpha$ -particle?

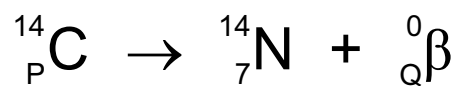
- A** 82                      **B** 83                      **C** 84                      **D** 85

17 The nuclide notation for radium-226 is  ${}_{88}^{226}\text{Ra}$ .

How many electrons orbit the nucleus of a neutral atom of radium-226?

- A** 0                      **B** 88                      **C** 138                      **D** 226

- 18 Radioactive carbon-14 decays into nitrogen by emitting a  $\beta$ -particle. The equation below represents the decay.



What are the values of P and Q?

	P	Q
<b>A</b>	6	1
<b>B</b>	6	–
<b>C</b>	8	1
<b>D</b>	8	–

19 A radioactive nucleus contains 128 nucleons. It emits a  $\beta$ -particle.

How many nucleons are now in the nucleus?

- A** 124                      **B** 127                      **C** 128                      **D** 129

20 The nuclide notation for radium-226 is  $^{226}_{88}\text{Ra}$ .

How many electrons orbit the nucleus of a neutral atom of radium-226?

- A** 0                      **B** 88                      **C** 138                      **D** 226

21 A nuclide has the symbol  $^{14}_6\text{C}$ .

How many protons are there in one nucleus of this nuclide?

- A** 6                      **B** 8                      **C** 14                      **D** 20

22 A lithium nucleus contains 3 protons and 4 neutrons.

What is its nuclide notation?

- A**  $^3_4\text{Li}$                       **B**  $^4_3\text{Li}$                       **C**  $^7_3\text{Li}$                       **D**  $^7_4\text{Li}$

23 A particular nuclide of chlorine can be represented by the symbol shown.



How many electrons are there in a neutral atom of this nuclide?

- A** 17                      **B** 20                      **C** 37                      **D** 54

- 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
<b>A</b>	a nucleus of a different element	a nucleus of a different element
<b>B</b>	a nucleus of a different element	a nucleus of the same element
<b>C</b>	a nucleus of the same element	a nucleus of a different element
<b>D</b>	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.

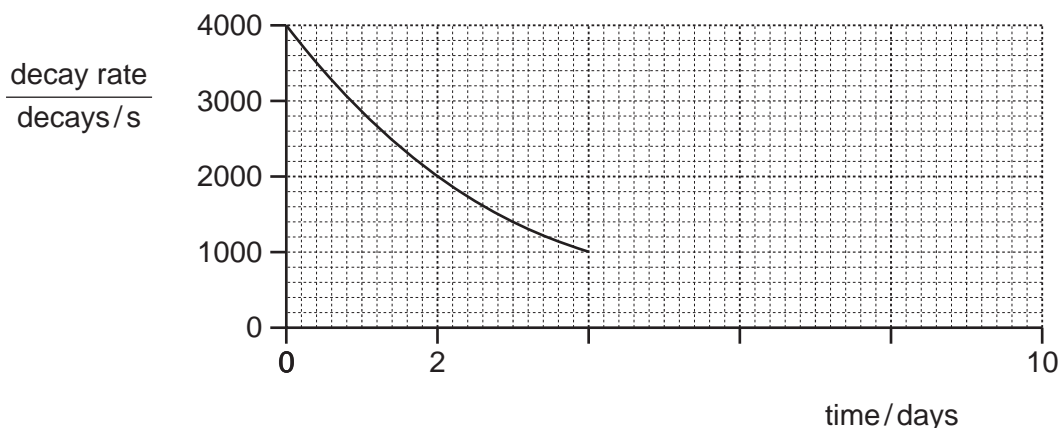
time / min	number of emissions per second
0	800
10	560
20	400
30	280
40	200
50	140
60	100

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  $\beta$ -particles. The range of the  $\beta$ -particles in the air is about 30 cm.

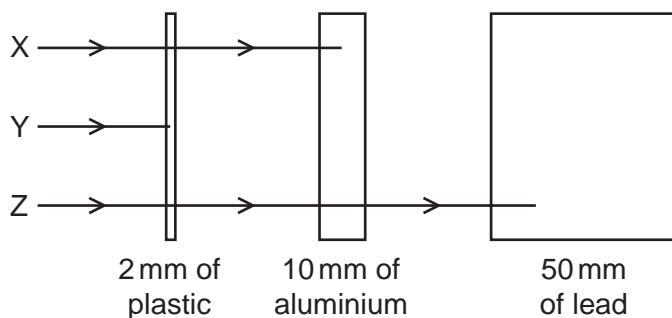
Which precaution is the most effective to protect the scientist from the radiation?

- 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  $\alpha$ -particles and of  $\gamma$ -rays?

	$\alpha$ -particles	$\gamma$ -rays
<b>A</b>	helium nuclei	electromagnetic radiation
<b>B</b>	helium nuclei	electrons
<b>C</b>	protons	electromagnetic radiation
<b>D</b>	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
<b>A</b>	$\alpha$ -particles	$\beta$ -particles	$\gamma$ -rays
<b>B</b>	$\beta$ -particles	$\alpha$ -particles	$\gamma$ -rays
<b>C</b>	$\beta$ -particles	$\gamma$ -rays	$\alpha$ -particles
<b>D</b>	$\gamma$ -rays	$\alpha$ -particles	$\beta$ -particles

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

The half-life of the isotope is 5 days.

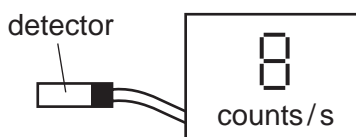
What mass of this isotope remains after 10 days?

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

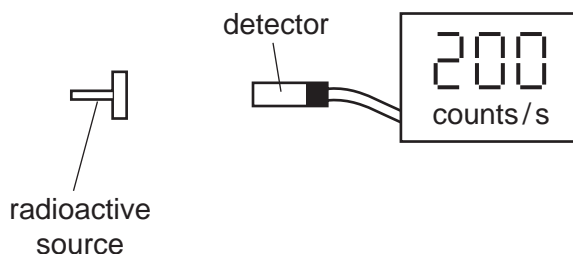
10 Which row gives the properties of the radiation from radioactive materials?

	most penetrating radiation	most highly ionising radiation
<b>A</b>	$\alpha$	$\beta$
<b>B</b>	$\beta$	$\gamma$
<b>C</b>	$\gamma$	$\alpha$
<b>D</b>	$\gamma$	$\gamma$

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
<b>A</b>	electron	a few mm of aluminium
<b>B</b>	electron	a thin sheet of paper
<b>C</b>	helium nucleus	a few mm of aluminium
<b>D</b>	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  $\alpha$ -particles and  $\beta$ -particles?

	ionising effect	penetrating ability
<b>A</b>	$\alpha$ greater than $\beta$	$\alpha$ greater than $\beta$
<b>B</b>	$\alpha$ greater than $\beta$	$\alpha$ less than $\beta$
<b>C</b>	$\alpha$ less than $\beta$	$\alpha$ greater than $\beta$
<b>D</b>	$\alpha$ less than $\beta$	$\alpha$ less than $\beta$

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

How many  $\beta$ -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