

Particle Physics

(Past Year Topical Questions 2010-2015)

May/June 2010 (11)

- 38 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each.

A nucleus of the nuclide ${}^8_3\text{Li}$ decays by emitting a β -particle.

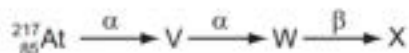
What is the resulting nuclide?

number of protons	4					A	B
	3				${}^6_3\text{Li}$	${}^7_3\text{Li}$	${}^8_3\text{Li}$
	2		${}^3_2\text{He}$	${}^4_2\text{He}$			C
	1	${}^1_1\text{H}$	${}^2_1\text{H}$				
		0	1	2	3	4	5
		number of neutrons					

- 39 What is **not** conserved in nuclear processes?

- A charge
- B momentum
- C the total number of neutrons
- D the total number of nucleons

- 40 The following represents a sequence of radioactive decays involving two α -particles and one β -particle.

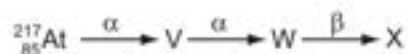


What is the nuclide X?

- A ${}^{213}_{85}\text{At}$
- B ${}^{215}_{77}\text{Ir}$
- C ${}^{209}_{82}\text{Pb}$
- D ${}^{217}_{81}\text{Tl}$

May/June 2010 (12)

- 38 The following represents a sequence of radioactive decays involving two α -particles and one β -particle.



What is the nuclide X?

- A ${}_{85}^{213}\text{At}$ B ${}_{77}^{215}\text{Ir}$ C ${}_{82}^{209}\text{Pb}$ D ${}_{81}^{217}\text{Tl}$

- 39 What are the correct descriptions of a γ -ray and a β -particle?

	γ -ray	β -particle
A	high-speed electron	electromagnetic radiation
B	electromagnetic radiation	helium-4 nucleus
C	electromagnetic radiation	high-speed electron
D	high-speed electron	helium-4 nucleus

October/November 2010 (11)

- 38 Uranium-235 may be represented by the symbol ${}_{92}^{235}\text{U}$.

Which row shows the numbers of nucleons, protons and neutrons in a ${}_{92}^{235}\text{U}$ nucleus?

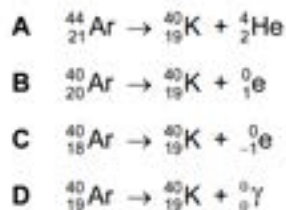
	nucleons	protons	neutrons
A	92	235	143
B	143	92	235
C	235	92	143
D	235	143	92

- 39 When a magnesium nucleus ${}_{12}^{25}\text{Mg}$ is hit by a gamma ray, a sodium nucleus ${}_{11}^{24}\text{Na}$ is formed and another particle is emitted.

What are the nucleon number (mass number) and proton number (atomic number) of the other particle produced in this nuclear reaction?

	nucleon number	proton number
A	0	-1
B	0	1
C	1	-1
D	1	1

- 40 Which nuclear equation shows the beta decay of a nucleus of argon (Ar) into potassium (K)?



October/November 2010 (12)

- 38 In the Rutherford scattering experiment, α -particles were fired at a thin gold foil. A small proportion of the α -particles were deflected through large angles.

Which statement gives the correct conclusion that could be drawn directly from these results?

- A** The atom is made up of electrons, protons and neutrons.
B The nucleus is at the centre of the atom.
C The nucleus is made up of protons and neutrons.
D The atom contains a very small, charged nucleus.

- 39 Which statement about the nuclei of the atoms of an element is correct?
- A Every nucleus of an element contains an equal number of neutrons and protons.
 - B Every nucleus of an element contains the same number of neutrons as all others of that element, but the number of protons may differ.
 - C Every nucleus of an element contains the same number of protons as all others of that element, but the number of neutrons may differ.
 - D The number of protons in a nucleus differs from isotope to isotope of an element, as do the number of neutrons.
- 40 A counter recording radioactive decays from a radioactive source gives the following counts in equal intervals of time.

time / min	counts
0–10	424
10–20	395
20–30	413
30–40	363
40–50	366
50–60	294
60–70	301
70–80	253
80–90	212

What can be deduced from these readings?

- A that radioactivity is random and that the half-life is 90 minutes
- B that radioactivity is random and that the half-life is uncertain
- C that radioactivity is spontaneous and that the half-life is 90 minutes
- D that radioactivity is spontaneous and that the half-life is uncertain

May/June 2011 (11)

- 38 The first artificial radioactive substance was made by bombarding aluminium, $^{27}_{13}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, $^{30}_{15}\text{P}$.

What was the by-product of this reaction?

- A an α -particle
 B a β -particle
 C a γ -ray
 D a neutron
- 39 Uranium-238, $^{238}_{92}\text{U}$, decays by α -emission into a daughter product which in turn decays by β -emission into a grand-daughter product.

What is the grand-daughter product?

- A $^{234}_{90}\text{Th}$ B $^{234}_{91}\text{Pa}$ C $^{234}_{92}\text{U}$ D $^{230}_{90}\text{Th}$
- 40 Which statement about nuclei is correct?
- A Different isotopic nuclei have different proton numbers.
 B For some nuclei, the nucleon number can be less than the proton number.
 C In some nuclear processes, mass-energy is not conserved.
 D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

May/June 2011 (12)

- 39 The uranium nucleus $^{238}_{92}\text{U}$ undergoes α -decay, producing nucleus X.

Nucleus X undergoes β -decay, producing nucleus Y.

For nucleus Y, what are the values of the proton number and nucleon number?

	proton number	nucleon number
A	89	234
B	89	236
C	91	234
D	91	236

- 40 Radon-220 is radioactive and decays to polonium-216 with the emission of an α -particle. The equation for the radioactive decay is shown.



How many neutrons are in the radon and polonium nuclei?

	Rn	Po
A	86	84
B	134	132
C	220	212
D	220	216

May/June 2011 (13)

- 38 Which statement about nuclei is correct?

- A Different isotopic nuclei have different proton numbers.
- B For some nuclei, the nucleon number can be less than the proton number.
- C In some nuclear processes, mass-energy is not conserved.
- D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

- 39 The first artificial radioactive substance was made by bombarding aluminium, ${}_{13}^{27}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, ${}_{15}^{30}\text{P}$.

What was the by-product of this reaction?

- A an α -particle
- B a β -particle
- C a γ -ray
- D a neutron

- 40 Uranium-238, ${}_{92}^{238}\text{U}$, decays by α -emission into a daughter product which in turn decays by β -emission into a grand-daughter product.

What is the grand-daughter product?

- A ${}_{90}^{234}\text{Th}$
- B ${}_{91}^{234}\text{Pa}$
- C ${}_{92}^{234}\text{U}$
- D ${}_{90}^{230}\text{Th}$

October/November 2011 (11)

40 An atomic nucleus emits a β -particle.

What change does this cause to the proton number and the nucleon number of the nucleus?

	proton number	nucleon number
A	-1	+1
B	0	-1
C	+1	-1
D	+1	0

October/November 2011 (12)

39 Which statement concerning α -particles is correct?

- A An α -particle has charge $+4e$.
- B An α -particle is a helium atom.
- C When α -particles travel through air, they cause ionisation.
- D When α -particles travel through a sheet of gold foil, they make the gold radioactive.

40 A nucleus of the nuclide ${}_{94}^{241}\text{Pu}$ decays by emission of a β -particle followed by the emission of an α -particle.

Which nucleus is formed?

- A ${}_{93}^{239}\text{Np}$ B ${}_{91}^{238}\text{Pa}$ C ${}_{93}^{237}\text{Np}$ D ${}_{92}^{237}\text{U}$

May/June 2012 (11) & May/June 2012 (13)

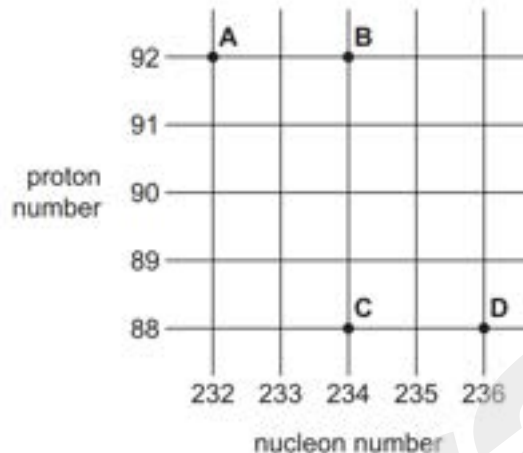
39 An experiment in which α -particles were deflected by a gold foil produced new insights into the structure of the atom.

Which conclusion can be drawn from the results of the experiment?

- A Atomic nuclei occupy a very small fraction of the volume of an atom.
- B Electrons orbit the atomic nucleus.
- C Some atoms of the same element contain different numbers of neutrons.
- D The atomic nucleus contains protons and neutrons.

- 40 Thorium-234 (${}_{90}^{234}\text{Th}$) decays by β -emission into a daughter product which in turn decays by further β -emission into a granddaughter product.

Which letter in the diagram represents the granddaughter product?



May/June 2012 (12)

- 39 Nuclear decay is both spontaneous and random in nature.

Which row gives the correct experimental evidence for these properties?

	spontaneous nature of decay	random nature of decay
A	the decay rate is not affected by pressure	the decay rate is not affected by temperature
B	the decay rate is not affected by pressure	the rate at which radiation is received at a counter fluctuates
C	the decay rate is not affected by temperature	the decay rate is not affected by pressure
D	the rate at which radiation is received at a counter fluctuates	the decay rate is not affected by pressure

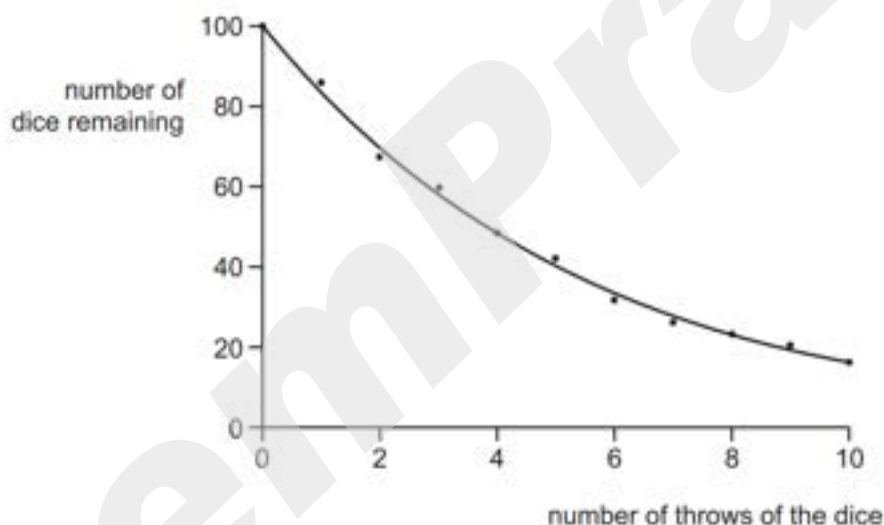
40 Radon $^{222}_{86}\text{Rn}$ is the start of a decay chain that forms bismuth $^{214}_{83}\text{Bi}$ by alpha and beta emission.

For the decay of each nucleus of radon, how many α -particles and β -particles are emitted?

	α -particles	β -particles
A	1	1
B	2	1
C	1	2
D	2	2

October/November 2012 (11)

38 A class of students used dice to simulate radioactive decay. After each throw, those dice showing a '6' were removed. The graph shows the results.



What could the scatter of points about the best-fit curve represent for actual radioactive decay?

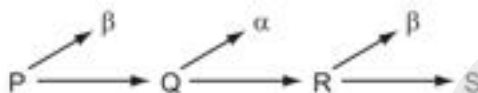
- A** background count not being taken into account
- B** more than one type of radiation being present
- C** the random nature of radioactive decay
- D** the spontaneous nature of radioactive decay

39 Which statement about alpha, beta and gamma radiation is correct?

- A Alpha radiation has the greatest ionising power.
- B Beta radiation has the greatest ionising power.
- C Gamma radiation has the greatest ionising power.
- D Alpha, beta and gamma radiation have nearly equal ionising powers.

40 In a radioactive decay series, three successive decays each result in a particle being emitted.

The first decay results in the emission of a β -particle. The second decay results in the emission of an α -particle. The third decay results in the emission of another β -particle.



Nuclides P and S are compared.

Which statement is correct?

- A P and S are identical in all respects.
- B P and S are isotopes of the same element.
- C S is a different element of lower atomic number.
- D S is a different element of reduced mass.

October/November 2012(12)

39 A material contains a radioactive isotope that disintegrates solely by the emission of α -particles at a rate of 100 s^{-1} .

Which statement about this material is correct?

- A The number of atoms in the material diminishes at a rate of 100 s^{-1} .
- B The number of neutrons in the material diminishes at a rate of 100 s^{-1} .
- C The number of nucleons in the material diminishes at a rate of 400 s^{-1} .
- D The number of protons in the material diminishes at a rate of 100 s^{-1} .

40 A different nucleus can be formed by bombarding a stable nucleus with an energetic α -particle.

${}_{11}^{25}\text{Na}$ is bombarded with an energetic α -particle.

What could be the products of this nuclear reaction?

- A ${}_{10}^{25}\text{Ne}$ + neutron
- B ${}_{11}^{25}\text{Na}$ + proton
- C ${}_{12}^{26}\text{Mg}$ + β
- D ${}_{13}^{27}\text{Al}$ + γ

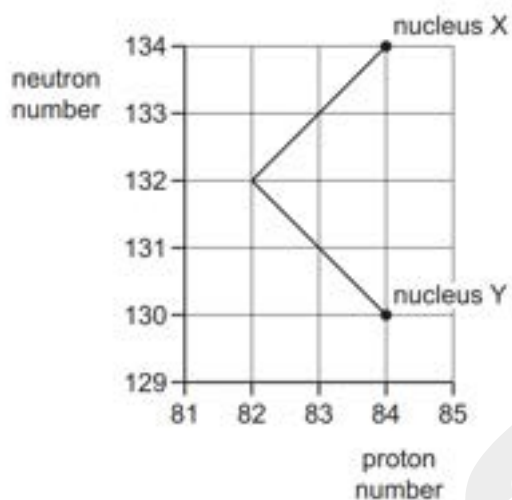
October/November 2012 (13)

38 A nuclear isotope emits radiation which is detected by a Geiger-Müller tube held at a distance of about 10 cm from the radioactive source. The radiation is stopped completely by a 2 mm thick sheet of lead.

What can be deduced from this information about the emission from the isotope?

- A It could be alpha and beta radiation, but not gamma radiation.
 - B It could be alpha and gamma radiation, but not beta radiation.
 - C It could be beta and gamma radiation, but not alpha radiation.
 - D It could be alpha, beta and gamma radiation.
- 39 What remains constant during β -emission from a number of identical nuclei in a substance?
- A energy of the β -particles
 - B neutron number of the nuclei
 - C nucleon number of the nuclei
 - D proton number of the nuclei

- 40 The graph of neutron number against proton number represents a sequence of radioactive decays.



Nucleus X is at the start of the sequence and, after the decays have occurred, nucleus Y is formed.

What is emitted during the sequence of decays?

- A one α -particle followed by one β -particle
- B one α -particle followed by two β -particles
- C two α -particles followed by two β -particles
- D two β -particles followed by one α -particle

May/June 2013 (11)

- 38 A nickel nucleus ${}_{28}^{59}\text{Ni}$ can be transformed by a process termed K-capture. In this process the nucleus absorbs an orbital electron.

If no other process is involved, what is the resulting nucleus?

- A ${}_{28}^{58}\text{Ni}$ B ${}_{27}^{58}\text{Co}$ C ${}_{27}^{59}\text{Co}$ D ${}_{29}^{59}\text{Cu}$

- 39 It was once thought that the mass of an atom is spread uniformly through the volume of the atom. When α -particles are directed at a piece of gold foil, the results led scientists to believe instead that nearly all the mass of the gold atom is concentrated at a point inside the atom.

Which effect is possible **only** if nearly all the mass of the gold atom is concentrated at a point?

- A a few α -particles bounce back
 B most α -particles are only slightly deflected
 C some α -particles pass through without any deflection
 D some α -particles are absorbed
- 40 Which pair of nuclei are isotopes of one another?

	nucleon number	number of neutrons
A	186	112
	180	118
B	186	112
	182	108
C	184	110
	187	110
D	186	110
	186	112

May/June 2013 (12)

- 39 What is the approximate mass of an alpha particle?

- A 10^{-28} kg
 B 10^{-26} kg
 C 10^{-24} kg
 D 10^{-22} kg

- 40 An actinium nucleus has a nucleon number of 227 and a proton number of 89. It decays to form a radium nucleus, emitting a beta particle and an alpha particle in the process.

What are the nucleon number and the proton number of this radium nucleus?

	nucleon number	proton number
A	223	87
B	223	88
C	224	87
D	225	86

May/June 2013 (13)

- 38 Scientists investigating the count rate from a radioactive source observed that the count rate fluctuates.

What do these fluctuations imply about the nature of radioactive decay?

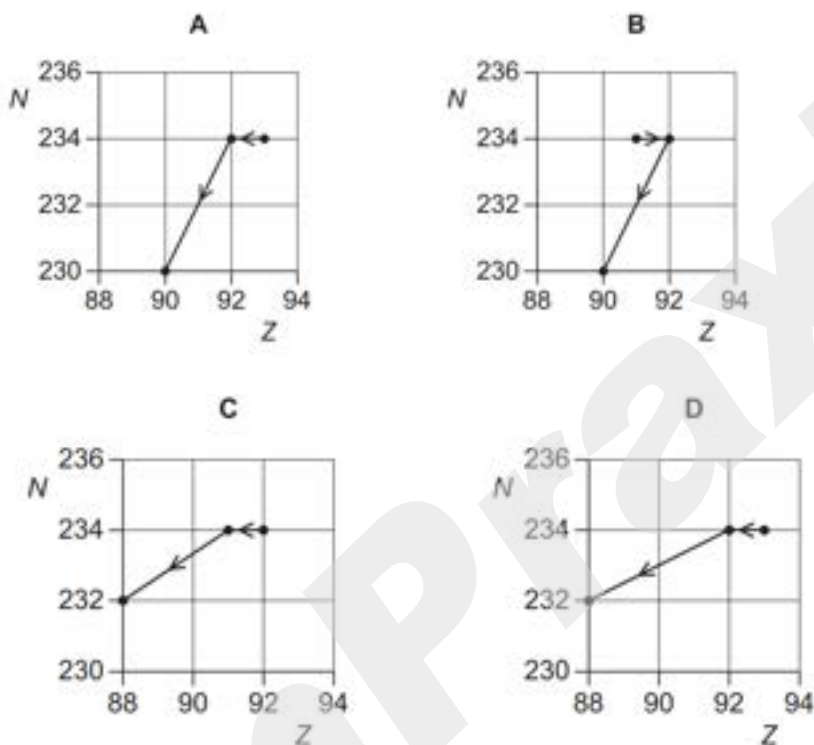
- A** It involves atomic nuclei.
 - B** It is predictable.
 - C** It is random.
 - D** It is spontaneous.
- 39 The decay of a nucleus of neptunium is accompanied by the emission of a β -particle and γ -radiation.

What effect (if any) does this decay have on the proton number and on the nucleon number of the nucleus?

	proton number	nucleon number
A	increases	decreases
B	decreases	increases
C	unchanged	decreases
D	increases	unchanged

40 A radioactive nucleus is formed by β -decay. This nucleus then decays by α -emission.

Which graph of nucleon number N plotted against proton number Z shows the β -decay followed by the α -emission?



October/November 2013 (11)

39 When α -particles are fired at a thin metal foil, most of the particles pass straight through but a few are deflected by a large angle.

Which change would increase the **proportion** of α -particles deflected by a large angle?

- A using α -particles with greater kinetic energy
- B using a foil made of a metal with fewer protons in its nuclei
- C using a double thickness foil
- D using an alpha source with a higher activity

40 Plutonium-239 (${}^{239}_{94}\text{Pu}$) decays by emitting α -radiation.

Which nuclide is formed from one of these decay reactions? (The product nuclides are represented by X.)

- A ${}^{235}_{92}\text{X}$
- B ${}^{237}_{92}\text{X}$
- C ${}^{239}_{93}\text{X}$
- D ${}^{239}_{95}\text{X}$

October/November 2013 (12)

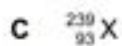
- 39 When α -particles are fired at a thin metal foil, most of the particles pass straight through but a few are deflected by a large angle.

Which change would increase the **proportion** of α -particles deflected by a large angle?

- A using α -particles with greater kinetic energy
- B using a foil made of a metal with fewer protons in its nuclei
- C using a double thickness foil
- D using an alpha source with a higher activity

- 40 Plutonium-239 ($^{239}_{94}\text{Pu}$) decays by emitting α -radiation.

Which nuclide is formed from one of these decay reactions? (The product nuclides are represented by X.)



October/November 2013 (13)

- 39 A nucleus of the nuclide $^{228}_{89}\text{Ac}$ decays by emitting a beta particle. The nuclear equation below represents this decay.

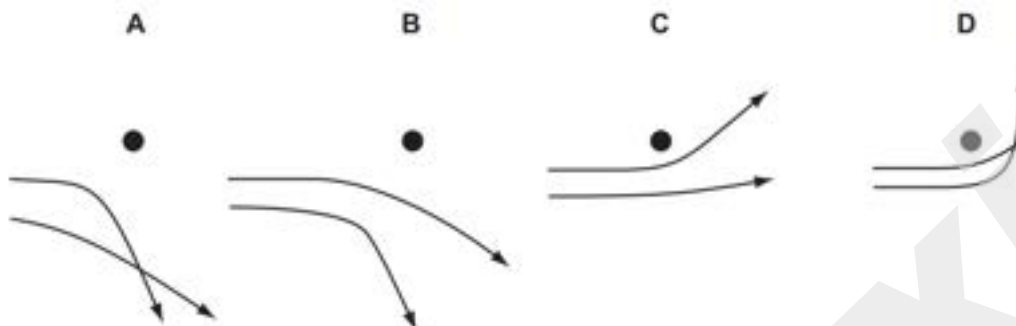


Which pair of values of X and Y is correct?

	X	Y
A	224	87
B	224	89
C	228	88
D	228	90

40 Two α -particles with equal energies are deflected by a large nucleus.

Which diagram best represents their paths?



May/June 2014 (11)

37 Alpha, beta and gamma radiations have various depths of penetration in matter and different charges.

Which row best summarises the penetration and charge of each radiation?

	alpha	beta	gamma
A	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium no charge	not fully absorbed by several cm of lead no charge
B	absorbed by a sheet of card negative charge	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead no charge
C	absorbed by a sheet of card positive charge	absorbed by several mm of aluminium negative charge	not fully absorbed by several cm of lead no charge
D	absorbed by several mm of aluminium positive charge	not fully absorbed by several cm of lead negative charge	absorbed by a sheet of card no charge

38 In 2002, two-proton radioactive decay of an isotope of iron, ${}^{45}_{26}\text{Fe}$, was observed.

What could be the resulting product?

- A ${}^{43}_{26}\text{Fe}$ B ${}^{43}_{24}\text{Cr}$ C ${}^{45}_{24}\text{Cr}$ D ${}^{47}_{28}\text{Ni}$

39 U^{2+} is a doubly-ionised uranium atom. The uranium atom has a nucleon number of 235 and a proton number of 92.

In a simple model of the atom, how many particles are in this ionised atom?

- A 235 B 325 C 327 D 329

40 The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each.

A nucleus of the nuclide ${}^8_3\text{Li}$ decays by emitting a β -particle.

What is the resulting nuclide?

number of protons	4				A	B		
	3			${}^6_3\text{Li}$	${}^7_3\text{Li}$	${}^8_3\text{Li}$		
	2		${}^3_2\text{He}$	${}^4_2\text{He}$		C	D	
	1	${}^1_1\text{H}$	${}^2_1\text{H}$					
		0	1	2	3	4	5	6
		number of neutrons						

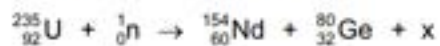
May/June 2014 (12)

38 A nucleus X decays into a nucleus Y by emitting an alpha particle followed by two beta particles.

Which statement about this nuclear decay is correct?

- A Beta particle decay occurs when a proton changes into a neutron.
 B Nucleus Y has the same nucleon number as nucleus X.
 C Nucleus Y is an isotope of nucleus X.
 D The total mass of the products is equal to the mass of the initial nucleus X.

- 39 A slow-moving neutron collides with a nucleus of uranium-235. This results in a nuclear reaction that is represented by the following nuclear equation



where x represents one or more particles.

What does x represent?

- A one neutron
 - B two electrons
 - C two neutrons
 - D two protons
- 40 The first artificial radioactive substance was made by bombarding aluminium, ${}_{13}^{27}\text{Al}$, with α -particles. This produced an unstable isotope of phosphorus, ${}_{15}^{30}\text{P}$.
- What was the by-product of this reaction?
- A an α -particle
 - B a β -particle
 - C a neutron
 - D a proton

May/June 2014 (13)

- 39 An isotope of thorium has a nucleon number of 232 and a proton number of 90. It decays to form another isotope of thorium with a nucleon number of 228.

How many alpha particles and beta particles are emitted by a nucleus of thorium during this decay?

	alpha particles	beta particles
A	0	4
B	1	0
C	1	2
D	2	1

40 Four nuclei are represented below.



Which statement about these nuclei is correct?

- A An uncharged atom of element Q has 24 orbital electrons.
- B Nucleus M could transform into Q by emitting a beta particle.
- C Nuclei G and M are isotopes of the same element.
- D When E absorbs a neutron and then emits an alpha particle, nucleus E transforms into M.

October/November 2014 (11)

38 Which statement about α -particles is correct?

- A α -particles emitted from a single radioactive isotope have a continuous distribution of energies.
- B α -particles have less ionising power than β -particles.
- C The charge of an α -particle is $+1.60 \times 10^{-19} \text{ C}$.
- D The speeds of α -particles can be as high as $1.5 \times 10^7 \text{ ms}^{-1}$.

39 The isotope ${}_{86}^{222}\text{Rn}$ decays in a sequence of emissions to form the isotope ${}_{82}^{206}\text{Pb}$. At each stage of the decay sequence, it emits either an α -particle or a β -particle.

What is the number of stages in the decay sequence?

- A 4 B 8 C 16 D 20

40 What is the approximate mass of a nucleus of uranium?

- A 10^{-15} kg B 10^{-20} kg C 10^{-25} kg D 10^{-30} kg

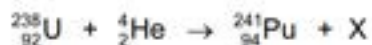
October/November 2014(12)

- 38 Which statement about α -particles is correct?
- A α -particles emitted from a single radioactive isotope have a continuous distribution of energies.
 - B α -particles have less ionising power than β -particles.
 - C The charge of an α -particle is $+1.60 \times 10^{-19} \text{ C}$.
 - D The speeds of α -particles can be as high as $1.5 \times 10^7 \text{ ms}^{-1}$.
- 39 The isotope ${}^{222}_{86}\text{Rn}$ decays in a sequence of emissions to form the isotope ${}^{206}_{82}\text{Pb}$. At each stage of the decay sequence, it emits either an α -particle or a β -particle.
- What is the number of stages in the decay sequence?
- A 4 B 8 C 16 D 20
- 40 What is the approximate mass of a nucleus of uranium?
- A 10^{-15} kg B 10^{-20} kg C 10^{-25} kg D 10^{-30} kg

October/November 2014 (13)

- 38 The nucleus of a radioactive isotope of an element emits an alpha particle. The daughter nucleus then emits a beta particle and then the daughter nucleus of that reaction emits another beta particle.
- Which statement describes the final nuclide that is formed?
- A It is a different isotope of the original element.
 - B It is a nuclide of a different element of higher proton number.
 - C It is a nuclide of the same element but with different proton number.
 - D It is identical to the original nuclide.

39 A nuclear reaction is shown.



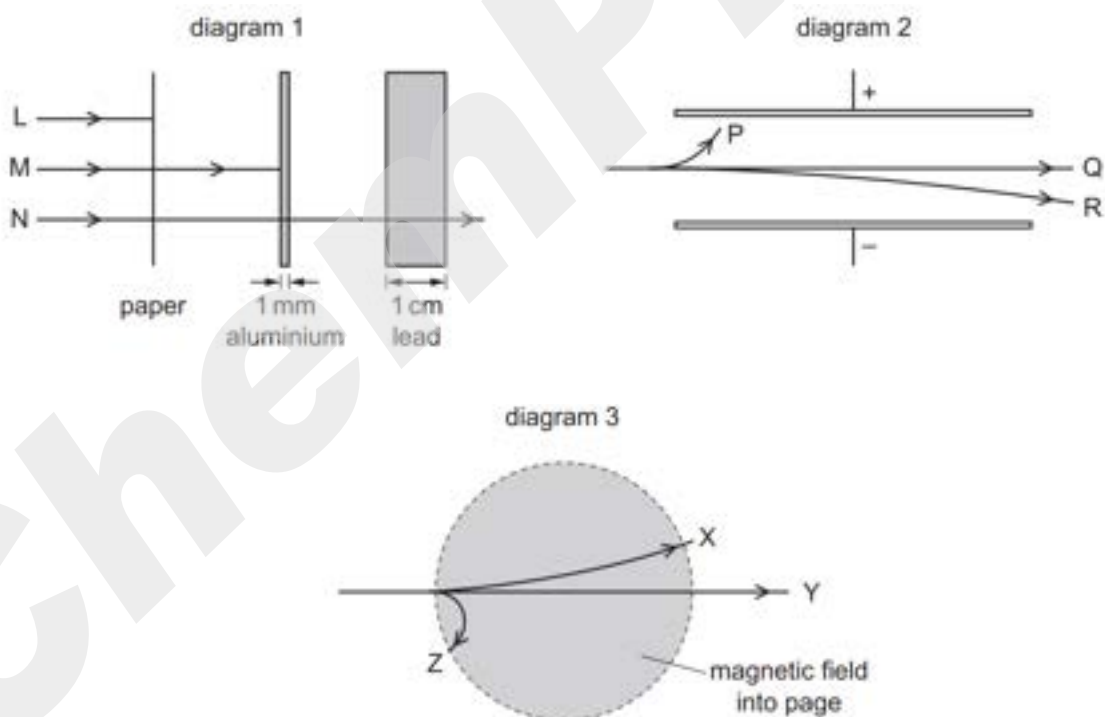
What is product X?

- A an alpha particle
- B an electron
- C a neutron
- D a proton

40 Alpha, beta and gamma radiations

- 1 are absorbed to different extents in solids,
- 2 behave differently in an electric field,
- 3 behave differently in a magnetic field.

The diagrams illustrate these behaviours.



Which three labels on these diagrams refer to the **same** kind of radiation?

- A L, P, X
- B L, P, Z
- C M, P, Z
- D N, Q, X

May/June 2015 (11)

 39 When α -particles are directed at gold leaf

- 1 almost all α -particles pass through without deflection,
- 2 a few α -particles are deviated through large angles.

What are the reasons for these effects?

	1	2
A	most α -particles have enough energy to pass right through the gold leaf	gold is very dense so a few low energy α -particles bounce back from the gold surface
B	most α -particles miss all gold atoms	a few α -particles bounce off gold atoms
C	the gold nucleus is very small so most α -particles miss all nuclei	occasionally the path of an α -particle is close to a nucleus
D	the positive charge in an atom is not concentrated enough to deflect an α -particle	occasionally an α -particle experiences many small deflections in the same direction

 40 The nuclide ${}_{86}^{222}\text{Rn}$ decays in a sequence of stages to form the nuclide ${}_{82}^{206}\text{Pb}$.

 Four of the nuclides formed in the sequence are α -particle emitters. The others are β -particle emitters.

 How many nuclides formed in the decay sequence are β -particle emitters?

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

May/June 2015 (12)

 38 An experiment in which α -particles were deflected by a gold foil produced new insights into the structure of the atom.

Which conclusion can be drawn from the results of the experiment?

- A** Atomic nuclei occupy a very small fraction of the volume of an atom.
- B** Electrons orbit the atomic nucleus.
- C** Some atoms of the same element contain different numbers of neutrons.
- D** The atomic nucleus contains protons and neutrons.

39 A radioactive substance contains a number of identical nuclei that emit β -particles.

Which property of these nuclei remains unaltered by the emission?

- A charge
- B neutron number
- C nucleon number
- D proton number

40 A uranium-238 nucleus, ${}_{92}^{238}\text{U}$, undergoes nuclear decays to form uranium-234, ${}_{92}^{234}\text{U}$.

Which series of decays could give this result?

- A emission of four β -particles
- B emission of four γ -rays
- C emission of one α -particle and two β -particles
- D emission of two α -particles and eight β -particles

May/June 2015 (13)

38 Nucleus P decays in two stages to produce nucleus Q.

Which decay sequence will result in the highest number of neutrons in nucleus Q?

- A an α -particle followed by a β -particle
- B an α -particle followed by a γ -ray
- C a β -particle followed by another β -particle
- D a β -particle followed by a γ -ray

39 A neutral atom has a nucleus given by the symbol ${}_{55}^{133}\text{Cs}$.

How many protons, neutrons and electrons are in this atom?

	protons	neutrons	electrons
A	55	78	55
B	55	133	55
C	78	55	78
D	133	55	133

40 The nuclear equation for a fission reaction is shown below.



What are the values of X and Y?

	X	Y
A	37	0
B	37	1
C	37	2
D	38	2

October/November 2015 (11)

37 Radioactive decay is random.

What is meant by the term *random*?

- A The decay of a nucleus can be predicted.
- B The decay of a nucleus is unaffected by pressure.
- C The decay of a nucleus is unaffected by temperature.
- D The nucleus has a constant probability of decay per unit time.

38 The nuclei of the isotopes of an element all contain the same number of a certain particle.

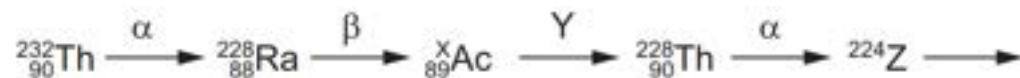
What is this particle?

- A electron
- B neutron
- C nucleon
- D proton

39 Which statement about nuclei is correct?

- A Different isotopic nuclei have different proton numbers.
- B For some nuclei, the nucleon number can be less than the proton number.
- C In some nuclear processes, mass-energy is not conserved.
- D Nucleon numbers of nuclei are unchanged by the emission of β -particles.

- 40 The diagram shows part of a radioactive decay chain in which the nuclide thorium-232 decays by α -emission into radium-228. This nuclide is also unstable and decays by β -emission into a nuclide of actinium. This process continues.



What are X, Y and Z?

	X	Y	Z
A	228	α	Th
B	228	β	Ra
C	232	α	Th
D	232	β	Ra

October/November 2015 (12)

- 39 A material contains a radioactive isotope that disintegrates solely by the emission of α -particles at a rate of 100 s^{-1} .

Which statement about this material is correct?

- A The number of atoms in the material diminishes at a rate of 100 s^{-1} .
- B The number of neutrons in the material diminishes at a rate of 100 s^{-1} .
- C The number of nucleons in the material diminishes at a rate of 400 s^{-1} .
- D The number of protons in the material diminishes at a rate of 100 s^{-1} .
- 40 A radioactive nucleus emits an α -particle or a β -particle, creating a product nucleus.

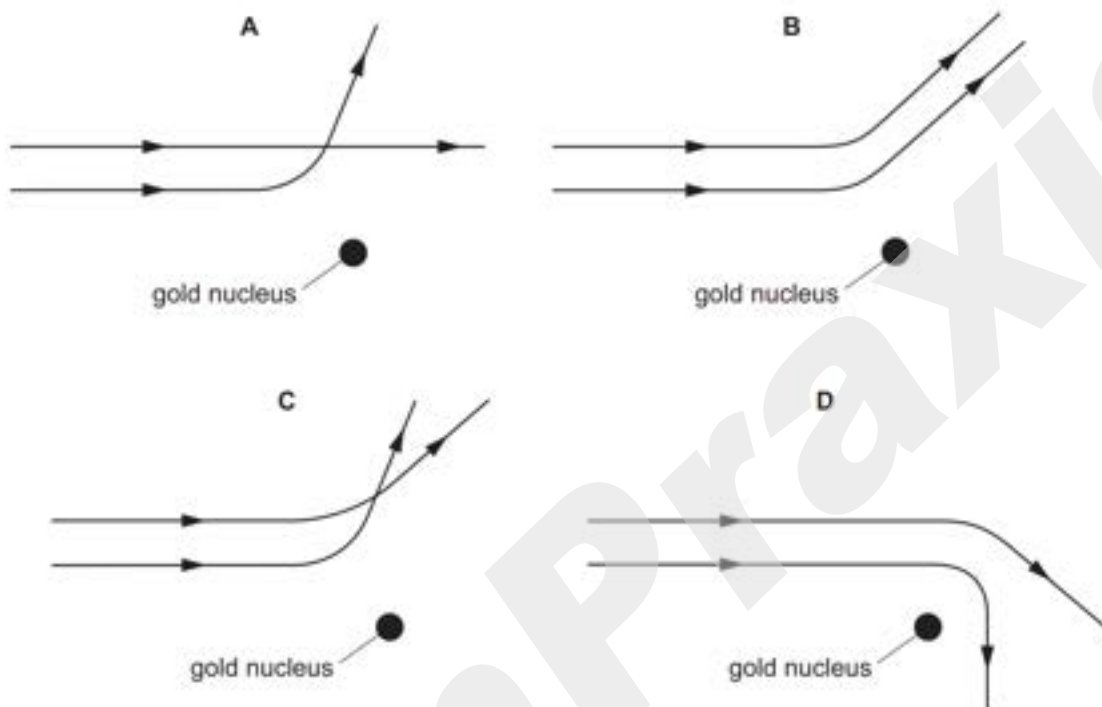
Which decay process could create the product nucleus stated?

	radioactive nucleus	decay	product nucleus
A	${}_{88}^{226}\text{Ra}$	α	${}_{86}^{224}\text{Rn}$
B	${}_{92}^{238}\text{U}$	α	${}_{94}^{242}\text{Pu}$
C	${}_{88}^{228}\text{Ra}$	β	${}_{87}^{228}\text{Fr}$
D	${}_{90}^{231}\text{Th}$	β	${}_{91}^{231}\text{Pa}$

October/November 2015 (13)

38 Two α -particles with equal energies are fired towards the nucleus of a gold atom.

Which diagram best represents their paths?



39 When a nucleus emits an α -particle, how do the proton number and the nucleon number of the original nucleus change?

	proton number	nucleon number
A	-4	-2
B	-2	-2
C	-2	-4
D	+1	no change

- 40 A simple theory of α -particle scattering by a thin metal foil uses the four assumptions given below.

Which assumption is exact and is **not** an approximation?

- A Each α -particle interacts with just one nucleus.
- B The α -particles lose no kinetic energy when they are deflected.
- C The metal nuclei do not recoil.
- D Total momentum is conserved.