



15. Isotopes of a given element all have the same  
 A charge / mass ratio.                      B neutron number.  
 C nucleon number.                            D proton number

**Nov 04.**

16. The symbol  ${}^{77}_{32}\text{Ge}$  represents a nuclide of

germanium that decays to a nuclide of arsenic (As) by emitting a  $\beta$ -particle.

What is the symbol of this arsenic nuclide?

- A  ${}^{76}_{32}\text{As}$     B  ${}^{78}_{32}\text{As}$     C  ${}^{78}_{31}\text{As}$     D  ${}^{77}_{33}\text{As}$

17. The table shows three properties of different types of ionising radiation.

	X	Y	Z
charge	0	-1 e	+2 e
mass	0	$\frac{1}{1840}u$	4 u
speed	c	-0.9 c	-0.1 c

What are the radiations X, Y and Z?

	X	Y	Z
A	alpha	beta	X-rays
B	gamma	alpha	beta
C	gamma	beta	alpha
D	X-rays	alpha	beta

18. Which conclusion can be drawn from the results of the experiment showing the scattering of  $\alpha$ -particles by gold foil?  
 A Electrons orbit the atomic nucleus in well-defined paths.  
 B Nuclei of different isotopes contain different numbers of neutrons.  
 C The atomic nucleus contains protons and neutrons.  
 D The nucleus is very small compared with the size of the atom.

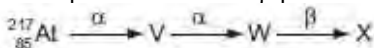
**June 05**

19. Which two nuclei contain the same number of neutrons?

- A  ${}^{12}_6\text{C}$  and  ${}^{14}_6\text{C}$                       C  ${}^{23}_{11}\text{Na}$  and  ${}^{24}_{12}\text{Mg}$   
 B  ${}^{16}_7\text{N}$  and  ${}^{15}_8\text{O}$                       D  ${}^{32}_{14}\text{Si}$  and  ${}^{32}_{15}\text{P}$

20. A student conducts an experiment using an  $\alpha$ -particle source.  
 When considering safety precautions, what can be assumed to be the maximum range of  $\alpha$ -particles in air?  
 A between 0 and 5 mm  
 B between 5 mm and 200 mm  
 C between 200 mm and 500 mm  
 D between 500 mm and 1000 mm

21. The following represents a sequence of radioactive decays involving two  $\alpha$ -particles and one  $\beta$ -particle.



What is the nuclide X?

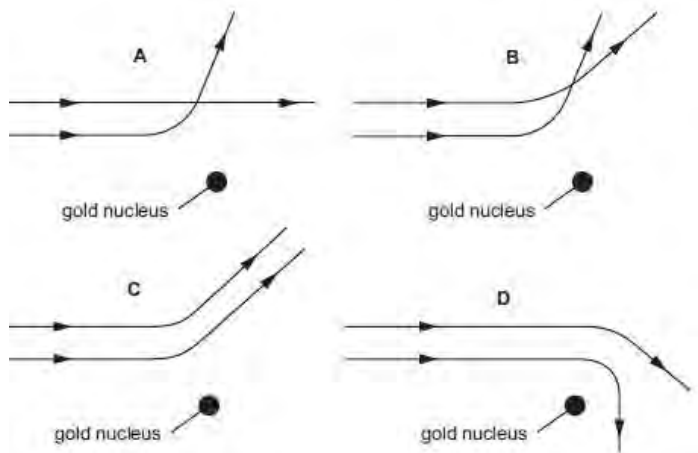
- A  ${}^{213}_{85}\text{At}$     B  ${}^{215}_{77}\text{Ir}$     C  ${}^{209}_{82}\text{Pb}$     D  ${}^{217}_{81}\text{Tl}$

**Nov 05**

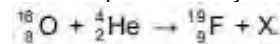
22. An atomic nucleus emits a  $\beta$ -particle.  
 What change does this cause to the proton and nucleon numbers of the nucleus?

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

23. Two  $\alpha$ -particles with equal energies are fired towards the nucleus of a gold atom.  
 Which diagram best represents their paths?



24. A nuclear reaction is represented by the equation



What is particle X?

- A an  $\alpha$ -particle    B a  $\beta$ -particle  
 C a neutron    D a proton

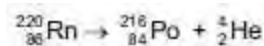
**June 06.**

25. What is a correct order of magnitude estimate for the diameter of a typical atomic nucleus?  
 A  $10^{-14}\text{m}$     B  $10^{-18}\text{m}$     C  $10^{-22}\text{m}$     D  $10^{-26}\text{m}$

26. The decay of a nucleus of neptunium is accompanied by the emission of a  $\beta$ -particle and  $\gamma$ -radiation.  
 What effect (if any) does this decay have on the proton number and the nucleon number of the nucleus?

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

27. Radon-220 is radioactive and decays to Polonium-216 with the emission of an  $\alpha$ -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

**Nov 06.**

28. Where are electrons, neutrons and protons found in an atom?

	electrons	neutrons	protons
A	in the nucleus	in the nucleus	orbiting the nucleus
B	in the nucleus	orbiting the nucleus	in the nucleus
C	orbiting the nucleus	in the nucleus	orbiting the nucleus
D	orbiting the nucleus	in the nucleus	in the nucleus

29. Radon  ${}_{86}\text{Rn}^{222}$  decays by  $\alpha$ - and  $\beta$ -emission to bismuth  ${}_{83}\text{Bi}^{214}$ . For the decay of each nucleus of radon, how many  $\alpha$ - and  $\beta$ -particles are emitted?

	$\alpha$ -particles	$\beta$ -particles
A	1	1
B	2	1
C	1	2
D	2	2

**June 07.**

30. A detector is exposed to a radioactive source. Fluctuations in the count-rate are observed.

What do these fluctuations indicate about radioactive decay?  
 A It is random. B It is spontaneous.  
 C It is exponential. D It is non-linear.

31. The symbol  ${}_{32}^{77}\text{Ge}$  represents a nucleus of

germanium that decays to a nucleus of arsenic by emitting a  $\beta$ -particle. What is the symbol of this arsenic nucleus?

- A  ${}_{32}^{76}\text{As}$  B  ${}_{32}^{78}\text{As}$  C  ${}_{31}^{78}\text{As}$  D  ${}_{33}^{77}\text{As}$

32. Each of the nuclei below is accelerated from rest through the same potential difference.

Which one completes the acceleration with the lowest speed?

- A  ${}^1_1\text{H}$  B  ${}^4_2\text{He}$  C  ${}^7_3\text{Li}$  D  ${}^9_4\text{Be}$

**Nov. 07**

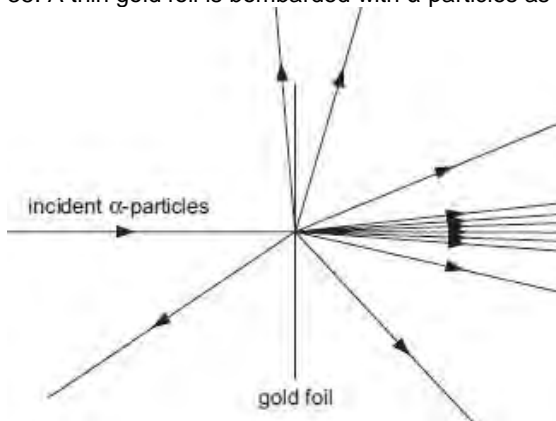
33. How is it possible to distinguish between the isotopes of uranium?

- A Their nuclei have different charge and different mass, and they emit different particles when they decay.  
 B Their nuclei have different charge but the same mass.  
 C Their nuclei have the same charge but different mass.  
 D Their nuclei have the same charge and mass, but they emit different particles when they decay.

34. What is not conserved in nuclear processes?

- A energy and mass together B nucleon number  
 C neutron number D charge

35. A thin gold foil is bombarded with  $\alpha$ -particles as shown.



What can be deduced from this experiment?

- A the binding energy of a gold nucleus  
 B the energy levels of electrons in gold atoms  
 C the small size of a gold nucleus  
 D the structure of a gold nucleus

36. A zirconium nucleus,  ${}_{40}^{100}\text{Zr}$ , is a  $\beta$ -emitter.

The product nucleus is also a  $\beta$ -emitter.

What is the final resulting nucleus of these two decays?

- A  ${}_{38}^{100}\text{Sr}$  B  ${}_{42}^{100}\text{Mo}$  C  ${}_{40}^{98}\text{Zr}$  D  ${}_{40}^{102}\text{Zr}$

37. The following particles are each accelerated from rest through the same potential difference.

Which one completes the acceleration with the greatest momentum?

- A  $\alpha$ -particle B electron  
 C neutron D proton

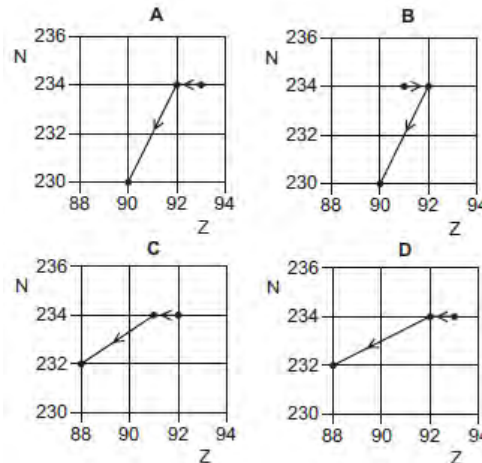
**June 08**

38. What is the approximate mass of a nucleus of uranium?

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

39. A radioactive nucleus is formed by  $\beta$ -decay. This nucleus then decays by  $\alpha$ -emission.

Which graph of proton number Z plotted against nucleon number N shows the  $\beta$ -decay followed by the  $\alpha$ -emission?



**Nov. 08**

40. Which conclusion can be drawn from the results of the experiment showing the scattering of  $\alpha$ -particles by gold foil?

- A Electrons orbit the atomic nucleus in well-defined paths.  
 B Nuclei of different isotopes contain different numbers of neutrons.  
 C The atomic nucleus contains protons and neutrons.  
 D The nucleus is very small compared with the size of the atom.

41. A nucleus Q has the notation  ${}^y_x\text{Q}$ . Which of the following is an isotope of Q?

- A  ${}^{y-1}_x\text{Q}$  B  ${}^y_{x-1}\text{Q}$  C  ${}^y_{x+1}\text{Q}$  D  ${}^{y+1}_{x+1}\text{Q}$

42. A  ${}_{92}^{238}\text{U}$  nucleus decays in two stages to a  ${}_{91}^{234}\text{Pa}$  nucleus. What was emitted in these two stages?

- A  $\alpha + \beta$  B  $\alpha + \gamma$  C  $\beta + \beta$  D  $\beta + \gamma$

**June 09**

43. How do the nucleon (mass) number and proton (atomic) number of two isotopes of an element compare?

- |   |                |               |
|---|----------------|---------------|
|   | nucleon number | proton number |
| A | different      | different     |
| B | different      | same          |
| C | same           | different     |
| D | same           | same          |

44. Nuclear decay is both spontaneous and random.

When the count rate of a radioactive isotope is measured, the readings fluctuate.

Which row describes what the fluctuations demonstrate?

- |   |                    |               |
|---|--------------------|---------------|
|   | spontaneous nature | random nature |
| A | no                 | no            |
| B | no                 | yes           |
| C | yes                | no            |
| D | yes                | yes           |

45. Which two nuclei contain the same number of neutrons?

- A  ${}_{6}^{12}\text{C}$  and  ${}_{8}^{14}\text{C}$  B  ${}_{7}^{16}\text{N}$  and  ${}_{8}^{15}\text{O}$   
 C  ${}_{11}^{23}\text{Na}$  and  ${}_{12}^{24}\text{Mg}$  D  ${}_{14}^{32}\text{Si}$  and  ${}_{15}^{32}\text{P}$

46. The calcium nuclide  $^{42}_{20}\text{Ca}$  is formed by beta decay.

What are the nucleon (mass) number and proton (atomic) number of the unstable nuclide that underwent beta decay to form the calcium nuclide?

	nucleon number	proton number
A	41	19
B	41	21
C	42	19
D	42	21

47. When boron-11 ( $^{11}_5\text{B}$ ) is bombarded with

$\alpha$ -particles, a new nucleus is formed and a neutron is released. Which nuclear equation could represent this reaction?

- A  $^{11}_5\text{B} + ^4_2\text{He} \rightarrow ^{11}_6\text{C} + ^1_0\text{n}$       B  $^{11}_5\text{B} + ^2_2\text{He} \rightarrow ^{12}_7\text{N} + ^1_0\text{n}$   
 C  $^{11}_5\text{B} + ^4_2\text{He} \rightarrow ^{14}_6\text{C} + ^1_1\text{n}$       D  $^{11}_5\text{B} + ^4_2\text{He} \rightarrow ^{14}_7\text{N} + ^1_0\text{n}$

**Nov 09.**

48. The gold nucleus  $^{185}_{79}\text{Au}$  undergoes alpha decay.

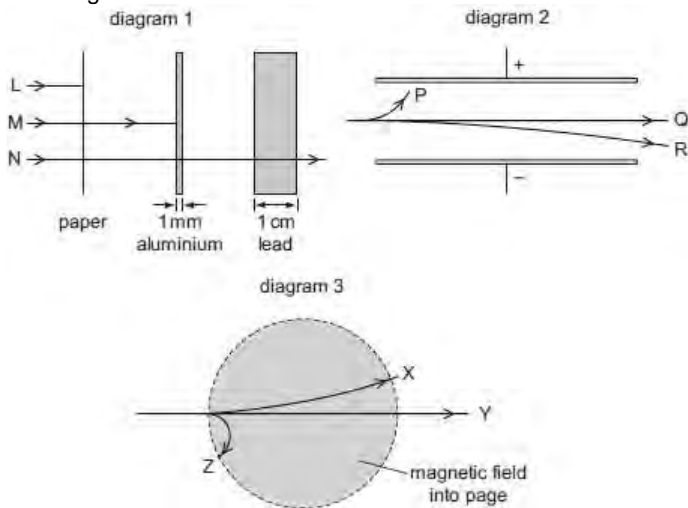
What are the nucleon (mass) number and proton (atomic) number of the nucleus formed by this decay?

	nucleon number	proton number
A	183	79
B	183	77
C	181	77
D	181	75

49. 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

50. 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

**June 10**

51. What are the correct descriptions of a  $\gamma$ -ray and a  $\beta$ -particle?

- |                             |                           |
|-----------------------------|---------------------------|
| $\gamma$ -ray               | $\beta$ -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          |

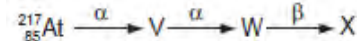
52. The grid shows a number of nuclides arranged according to the number of protons and the number of neutrons in each. A nucleus of the nuclide  $^8_3\text{Li}$  decays by emitting a  $\beta$ -particle. What is the resulting nuclide?

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

53. What is not conserved in nuclear processes?

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

54. The following represents a sequence of radioactive decays involving two  $\alpha$ -particles and one  $\beta$ -particle.



What is the nuclide X?

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