## Nuclear

### May 02

1. Which set of radioactive emissions corresponds to the descriptions given in the table headings?

-	1 0				
	high-speed electrons	high-speed helium nuclei	high-frequency photons		
Α	α	β	Ŷ		
в	α	Y	β		
С	β	CZ.	γ		
D	β	Y	α		

2. The nucleus of one of the isotopes of nickel is represented by  ${}_{28}$  Ni ${}^{60}$ . Which line in the table correctly describes a neutral atom of this isotope?

	number of protons	number of neutrons	number of orbital electrons
A	28	32	28
в	28	60	28
С	60	28	28
D	60	32	32

3. A nucleus of bohrium <sup>x</sup><sub>y</sub>Bh decays to mendelevium <sup>255</sup><sub>101</sub>Md

by a sequence of three  $\alpha$ -particle emissions. bohrium  ${}^{x}_{a}Bh \longrightarrow dubnium + \alpha$ 

 $\rightarrow$  lawrencium +  $\alpha$ 

 $\longrightarrow$  mendelevium <sup>255</sup><sub>101</sub> Md +  $\alpha$ 

**D** 154

How many neutrons are there in a nucleus of Bh?A 267B 261C 160

## Nov 02

4. The numbers of protons, neutrons and nucleons in three nuclei are shown.

nucleus	number of protons	number of neutrons	number of nucleons
х	15	16	31
Y	15	17	32
Z	16	16	32

Which nuclei are isotopes of the same element? **A** X and Y **B** X and Z **C** Y and Z **D** none of them

5. In an experiment to investigate the nature of the atom, a very thin gold film was bombarded with  $\alpha$ -particles.

What pattern of deflection of the  $\alpha$ -particles was observed?

**A** A few  $\alpha$ -particles were deflected through angles greater than a right angle.

 ${\boldsymbol{\mathsf{B}}}$  All  $\alpha\text{-particles}$  were deflected from their original path.

 $\boldsymbol{\mathsf{C}}$  Most  $\alpha\text{-particles}$  were deflected through angles greater than a right angle.

**D** No  $\alpha$ -particle was deflected through an angle greater than a right angle.

6. When a nucleus of 30 absorbs a slow neutron it

subsequently emits two  $\alpha$ -particles. What is the resulting nucleus?

A 240 Np B 240 Pa C 239 Pu D 239 Th

# June 03

7. In what way do the atoms of the isotopes <sup>12</sup>C, <sup>13</sup>C and <sup>14</sup>C differ?

- A different charge
- B different numbers of electrons
- C different numbers of neutrons

D different numbers of protons

**8.** Strontium- 90 ( $_{38}$ Sr  $^{90}$ ) is radioactive and emits  $\alpha$ -particles. Which equation could represent this nuclear decay?

Α	$^{90}_{38}\text{Sr} \to ^{90}_{39}\text{Sr} + ^{0}_{-1}\beta$	В	$^{90}_{38}\text{Sr} \rightarrow ^{90}_{39}\text{Y} + ^{0}_{-1}\beta$
С	$^{90}_{38}$ Sr $\rightarrow ^{90}_{37}$ Rb + $^{0}_{1}\beta$	D	$^{90}_{38}$ Sr $\rightarrow ^{90}_{37}$ Sr + $^{0}_{1}$ $\beta$

**9.** Protons and neutrons are thought to consist of smaller particles called quarks.

The 'up' quark has a charge of 2/3 e: a 'down' quark has a charge of -1/3 e, where e is the elementary charge (+1.6 x  $10^{-19}$  C). How many up quarks and down quarks must a proton contain?

Indi	up quarks	down quarks
Α	0	3
в	1	1
С	1	2
D	2	1

# Nov 03

10. Which are the correct descriptions of a  $\gamma$ -ray and a  $\alpha$ -particle?

	γ-ray	β-particle
A	high-speed electron	electromagnetic radiation
в	electromagnetic radiation	Helium-4 nucleus
С	electromagnetic radiation	high-speed electron
D	high-speed electron	Helium-4 nucleus

11. A certain nuclide, Uranium-235, has nucleon number 235, proton number 92 and neutron number 143. Data on four other nuclides are given below. Which is an isotope of Uranium-235?

	nucleon number	proton number	neutron number
Α	235	91	144
в	236	92	144
С	237	94	143
D	238	95	143

12. A nickel nucleus  $_{28}Ni^{59}$  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?

Α	58Ni 28	B	58Co	C	59Co	D	59Cu	

### June 04

13. A nucleus of the nuclide  ${}_{94}Pu^{241}$  decays by emission of a  $\beta$ -particle followed by the emission of an  $\alpha$ -particle. Which of the nuclides shown is formed?

A <sup>239</sup> <sub>93</sub> Np B <sup>239</sup> <sub>91</sub> Pa C <sup>237</sup> <sub>93</sub> Np D	237 92 U
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14. A thin gold foil is bombarded with  $\alpha$ -particles as shown.



The results of this experiment provide information about the A binding energy of a gold nucleus. B energy levels of electrons in gold atoms. C size of a gold nucleus.

D structure of a gold nucleus.

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 Ge represents a nuclide of

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

What is the symbol of this arsenic nuclide?

A 32As B 32As C 31As D 33As

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

	X	Y	z
charge	0	-1e	+2 e
mass	0	1 1840 u	4 <i>u</i>
speed	c	-0.9 c	-0.1c

What are the radiations X, Y and Z?

	x	Y	z
A	alpha	beta	X-rays
в	gamma	alpha	beta
С	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 <sup>12</sup><sub>6</sub>C and <sup>14</sup><sub>6</sub>C C <sup>23</sup><sub>11</sub>Na and <sup>24</sup><sub>12</sub>Mg

B <sup>16</sup><sub>7</sub>N and <sup>15</sup><sub>8</sub>O D <sup>32</sup><sub>14</sub>Si and <sup>32</sup><sub>15</sub>P

20. A student conducts an experiment using an  $\alpha\mbox{-particle}$  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.

$$\overset{247}{_{85}}\text{At} \xrightarrow{\alpha} V \xrightarrow{\alpha} W \xrightarrow{\beta} X$$
  
What is the nuclide X?

A 213 At B 215 Ir

### 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
в	0	-1
С	+1	-1
D	+1	0



23. Two α-particles with equal energies are fired towards the

### June 06.

25. What is a correct order of magnitude estimate for the diameter of a typical atomic nucleus?

A  $10^{-14}$ m B  $10^{-18}$ m C  $10^{-22}$ m D  $10^{-26}$ 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
в	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.

$$^{220}_{36}$$
Rn  $\rightarrow ^{216}_{84}$ Po +  $^{4}_{2}$ He

How many neutrons are in the radon and polonium nuclei?

=	Rn	Po
A	86	84
в	134	132
С	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
в	in the nucleus	orbiting the nucleus	in the nucleus
с	orbiting the nucleus	in the nucleus	orbiting the nucleus
D	orbiting the nucleus	in the nucleus	in the nucleus

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

	a-particles	β-particles
A	1	1
в	2	1
с	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 77 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 12 As B 12 As C 13 As D 17 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 H B 2He C Li D 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,  $100_{\text{Zr}}$ , is a  $\beta$ -emitter.

The product nucleus is also a  $\beta$ -emitter. What is the final resulting nucleus of these two decays?



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

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

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  $\overset{\checkmark}{\downarrow}$  Q . Which of the following is an isotope of Q?

 $\mathbf{A} \stackrel{y-1}{_{x}}\mathbf{Q} \quad \mathbf{B} \stackrel{y}{_{x-1}}\mathbf{Q} \quad \mathbf{C} \stackrel{y}{_{x+1}}\mathbf{Q} \quad \mathbf{D} \stackrel{y-1}{_{x+1}}\mathbf{Q}$ 

42. A 🕇	U nucleus decays in	two stages to a	<sup>231</sup> Pa nucleus.
What wa	as emitted in these two	stages?	
$A \alpha + \beta$	Βα+γ	C β + β	D β + γ

# June 09

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

234 -

	nucleon number	proton number
А	different	different
В	different	same
С	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	ranuom nature
А	no	no
В	no	yes

С	yes	no
	1/00	

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

- A 12 C and 14 C B 18 N and 15 O
- C 23 Na and 24 Mg D 32 Si and 32 P

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20 Ca is formed by beta decay. 46. The calcium nuclide

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
А	41	19
В	41	21
С	42	19
D	42	21

boron-11 (1B) is bombarded with 47. When

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

 ${}^{11}_{5}\mathsf{B} + {}^{1}_{1}\!\mathsf{He} \rightarrow {}^{11}_{6}\!\mathsf{C} + {}^{1}_{0}\!\mathsf{n} \qquad \mathbf{B} \quad {}^{11}_{5}\!\mathsf{B} + {}^{2}_{2}\!\mathsf{He} \rightarrow {}^{12}_{7}\mathsf{N} + {}^{1}_{0}\!\mathsf{n}$  ${}^{11}_{5}B + {}^{4}_{2}He \rightarrow {}^{14}_{6}C + {}^{1}_{1}n \qquad D \quad {}^{11}_{5}B + {}^{4}_{2}He \rightarrow {}^{14}_{7}N + {}^{1}_{0}n$ 

#### Nov 09.

185 79 Au 48. The gold nucleus undergoes alpha decay.

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

	nucleon number	proton numb
А	183	79
В	183	77
С	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	В L, P, Z	С М, Р, Z	D N, Q, X

## June 10

51. What are the correct descriptions of a  $\gamma$ -ray and a  $\beta$ -particle? β-particle γ-ray A high-speed electron electromagnetic radiation B electromagnetic radiation helium-4 nucleus C electromagnetic radiation high-speed electron helium-4 nucleus D high-speed electron

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  ${}_{3}\text{Li}^{8}$  decays by emitting a  $\beta$ -particle. What is the resulting nuclide?



53. What is not conserved in nuclear processes?

4

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.

$$\begin{array}{cccc} & & & & & & & \\ & & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & & \\ & & & \\ & & & & \\ & & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ & & & \\ &$$