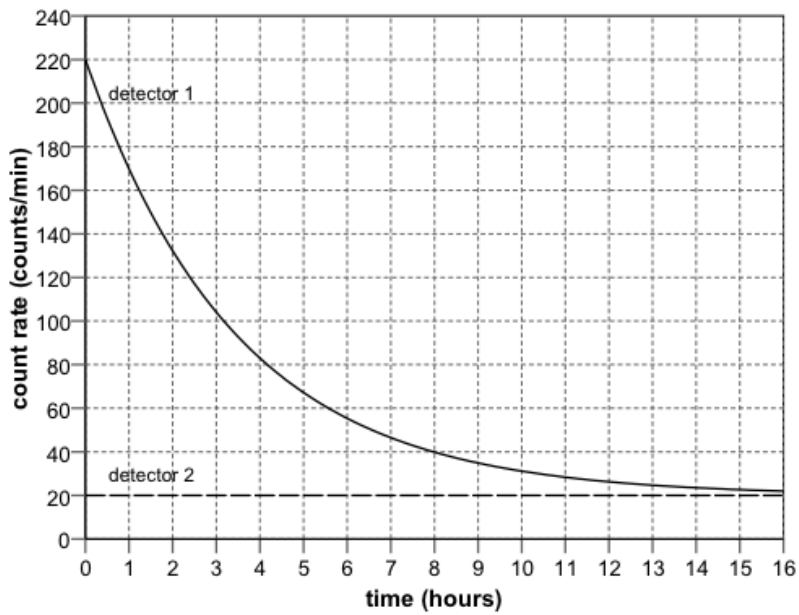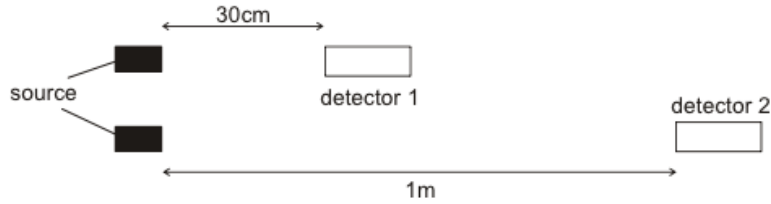# 2009

11 It is known that a radioactive source emits a single type of radiation. Detectors are placed in the two positions shown. The graph shows how the readings change over time.

Which type of radiation does the source emit, and what is its half-life?

	type of radiation	half-life (hours)
A	alpha	2.40
B	alpha	2.76
C	beta	2.40
D	beta	2.76
E	gamma	2.40
F	gamma	2.76

2010

3   In a laboratory experiment, protactinium-234 undergoes radioactive decay by β-emission into uranium-234.

The table below describes how the mass of uranium-234 present in the sample varies with time from the start of the experiment:

time / min	mass of u-234 / mg
0.0	0.0
1.2	8.0
2.4	12.0
3.6	14.0
4.8	15.0
6.0	15.5
7.2	15.7
8.4	15.9
9.6	15.9
10.8	16.0
12.0	16.0

Using the information in the table, approximately what is the half-life of protactinium-234?

A   1.2 minutes

B   2.4 minutes

C   6.0 minutes

D   9.6 minutes

E   10.8 minutes

F   12.0 minutes

11 When radioactive isotopes decay, they sometimes have to go through a succession of disintegrations to reach a stable isotope. These are called decay chains, and involve the successive emission of numerous α and/or β particles.

One such isotope is radon-219 ($^{219}_{86}$ Rn), which goes through a chain in which three α particles and two β particles are emitted before reaching a stable isotope.

What are the atomic and mass numbers of the resulting stable isotope?

|	atomic number	mass number
A	80	207
B	80	211
C	82	207
D	82	215
E	85	211
F	85	219
G	86	215
H	86	219

2011

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7 Which one of the following statements about nuclear physics is true?

A   The process of emission of a gamma ray from a nucleus is called nuclear fission.

B   The half life of a radioactive substance is half the time taken for its nuclei to decay.

C   The number of neutrons in a nucleus is its atomic number (proton number) minus its mass number.

D   The process used in nuclear power stations is nuclear fusion.

E   When a nucleus emits a beta particle, there is no change in the number of particles it contains.

F   When a nucleus emits an alpha particle, one of its neutrons becomes a proton plus an electron.

2012

3 Nuclide $_{R}^{N}X$ is an unstable isotope which decays in two stages into nuclide Z as shown:

$$_{R}^{N}X \rightarrow _{R-2}^{P}Y \rightarrow _{Q}^{P}Z$$
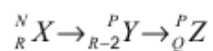
What are the values of P and Q?

	P	Q
A	N - 4	R + 1
B	N - 4	R - 1
C	N - 4	R - 2
D	N	R - 1
E	N	R - 2
F	N	R - 4

22 Tritium, symbol T, is hydrogen with a mass number of 3. It is radioactive and undergoes β decay.

Which of the following could be the only product(s) after a quantity of HTO undergoes decay?

    1   HeOH

    2 H_2O, O_2 and He

    3 H_2O, H_2 and He

A   1 only

B   2 only

C   3 only

D   1 and 2 only

E   1 and 3 only

F   2 and 3 only

7   Students investigate a radioactive source. They place a detector close to a radioactive source and take 5 readings over 5 minutes. They then place a thin sheet of paper between the detector and the source, and again observe the counts over 5 minutes. Lastly they replace the paper sheet with an aluminium one and observe the counts over 5 minutes. Their results are shown below:

	Nothing	Paper	Aluminium
Reading 1	100	101	30
Reading 2	98	102	31
Reading 3	99	96	28
Reading 4	103	101	33
Reading 5	101	103	27

What type(s) of radiation is being given off by the source?

A   α only

B   β only

C   γ only

D   α and β

E   α and γ

F   β and γ

2013

15 Two radioactive sources X and Y have half-lives of 4.8 hours and 8.0 hours respectively. Both decay directly to form only stable isotopes.

The activity of a sample of the source X was measured by a detector as 320 counts per minute, and simultaneously the radioactivity of a sample of the source Y was measured as 480 counts per minute. Immediately after the measurements, the two samples were combined.

What was the count rate when the activity of the combination of X and Y was measured 24 hours later?

[Assume that all readings in this question have been corrected for background radiation.]

A 25 counts per minute

B 50 counts per minute

C 55 counts per minute

D 70 counts per minute

E 100 counts per minute

F 140 counts per minute

2014

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23 When a particular nucleus of uranium-235 undergoes the process of nuclear fission, it absorbs a neutron and then splits into a nucleus of barium and a nucleus of krypton, as well as releasing further neutrons.

Which one of the rows of the table below gives the correct number of neutrons released and the isotopes of barium and krypton produced by this nuclear reaction?

	Number of neutrons released	Mass number of barium isotope produced	Mass number of krypton isotope produced
A	2	141	92
B	2	142	94
C	3	140	92
D	3	140	94
E	3	141	92
F	3	142	94

2015

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11 Below are three statements about radioactivity or nuclear energy.

    1   Neutrons emitted in nuclear fission can cause further fission.

    2   The half-life of a radioactive substance is half the time taken for all its nuclei to decay.

   **3**   The process that produces heat and light in the Sun is called nuclear fission.

Which of these statements is/are correct?

A   1 only

B   2 only

C   3 only

D   1 and 2 only

E   1 and 3 only

F   2 and 3 only

G   1, 2 and 3

H   None of them

19 Part of a radioactivity decay series is represented below. It involves the change of a nucleus M into a nucleus N by the emission of a beta-particle, followed by a further change into a nucleus Q by the emission of an alpha particle. Four quantities V, W, X and Y are shown.

$$^V_W M \xrightarrow{\beta^-} {}_X N \xrightarrow{\alpha} {}^Y Q$$
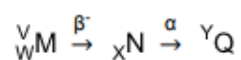
What are the expressions for X and Y?

	X	Y
A	W − 2	V − 4
B	W − 2	V − 2
C	W − 2	V
D	W	V − 3
E	W	V − 2
F	W + 1	V − 3
G	W + 1	V − 4
H	W + 1	V