Cambridge Assessment International Education

Cambridge IGCSE™

10: Atomic physics – Topic questions

Paper 4

The questions in this document have been compiled from a number of past papers, as indicated in the table below.

Use these questions to formatively assess your learners' understanding of this topic.

Question	Year	Series	Paper number
11	2016	June	41
10	2016	March	42
12	2016	November	41

The mark scheme for each question is provided at the end of the document.

You can find the complete question papers and the complete mark schemes (with additional notes where available) on the School Support Hub at www.cambridgeinternational.org/support

11 Bismuth-214 is radioactive. It has a half-life of 20 minutes.

(a) The nuclide notation for bismuth-214 is $^{214}_{83}\text{Bi}$.

State the composition of the nucleus of bismuth-214.

....

.... [2]

(b) Bismuth-214 decays by β-decay to an isotope of polonium, Po.

Complete the equation for the decay of bismuth-214.

$$^{214}_{83}\text{Bi} \rightarrow \,^{\cdots\cdots}_{\cdots\cdots}\beta + \,^{\cdots\cdots}_{\cdots\cdots}\text{Po}$$

[3]

(c) The count rate from a sample of bismuth-214 is 360 counts / s.

Predict the count rate from the sample after 60 minutes.

count rate = ... [2]

(d) State **two** of the social, economic or environmental issues involved in the storage of radioactive materials with very long half-lives.

....

....

....

.... [2]

[Total: 9]

10 (a) An iodine isotope $^{131}_{53}\text{I}$ decays by β-emission to an isotope of xenon (Xe).

(i) State the number of each type of particle in a neutral atom of $^{131}_{53}\text{I}$.

protons .... neutrons .... electrons .... [2]

(ii) State the symbol, in nuclide notation, for the xenon nucleus.

....[2]

(b) The background count rate of radioactivity in a laboratory is 30 counts / min.

A radioactive sample has a half-life of 50 minutes. The sample is placed at a fixed distance from a detector. The detector measures an initial count rate from the sample, including background, of 310 counts / min.

On Fig. 10.1, plot suitable points and draw a graph of the count rate from the sample, **corrected for background**, as it changes with time.

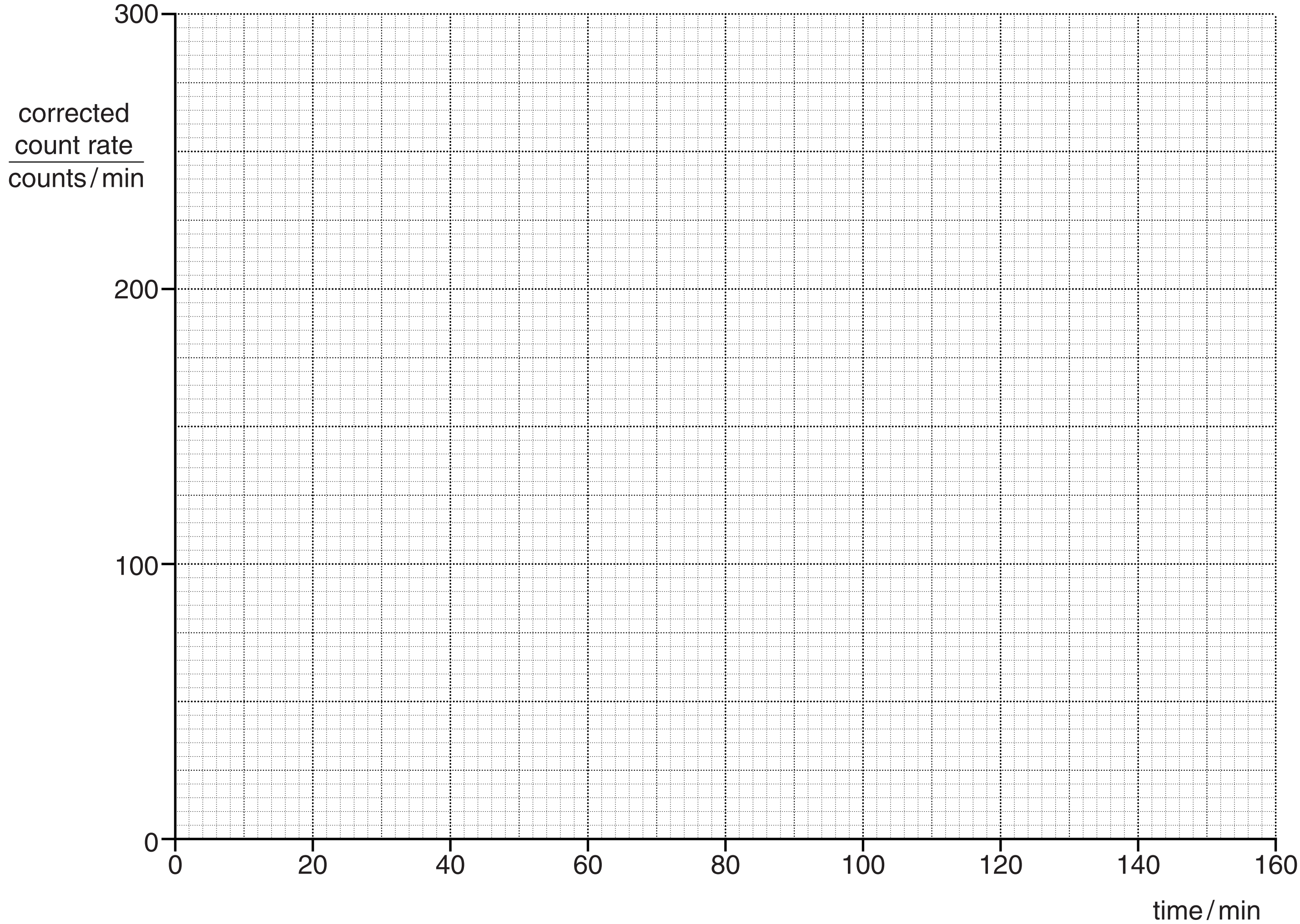

Fig. 10.1

[3]

[Total: 7]

12 The nuclear equation below shows the decay of a plutonium (Pu) nucleus to an americium (Am) nucleus and a β-particle.

$$^{241}_{Z}\text{Pu} \rightarrow\ ^{241}_{95}\text{Am} + \beta$$

(a) **(i)** State the quantity that is represented by the letter Z in this equation.

....[1]

(ii) State the numerical value of Z.

Z = ...[1]

(b) The americium nucleus decays by the emission of an α-particle into a neptunium (Np) nucleus.

Complete the nuclear equation for this decay.

$$^{241}_{95}\text{Am} \rightarrow$$

[2]

(c) The half-life of this americium nuclide is 470 years. A sample of this nuclide contains 8.0×10^{14} atoms.

After some time, 6.0×10^{14} americium atoms have decayed.

Calculate the time required for this decay.

time = ...[3]

[Total: 7]

Question	Answer	Mark
11 (a)	83 protons 131 neutrons	B2
11 (b)	$^{0}_{-1}\beta$ Superscript 0 Subscript –1 $^{214}_{84}Po$	B1 B1 B1
11 (c)	(After 20 min count rate is) 360 / 2 or 180 (count / s) (After 40 min count rate is) 180 / 2 or 90 (counts / s) (After 60 min count rate is) 90 / 2 **OR** new count-rate = 360/(2 × 2 × 2) or 360 / 8 or 3 half-lives 45 (counts / s)	C1 A1
11 (d)	Any two points chosen from the lists below: (economic): high cost of storage / shielding / guarding / need to store for a long time **OR** reduction in tourism **OR** loss of farming produce / land **OR** reduction of land / property values (social): fear of cancer / causes cancer / genetic mutations / radiation sickness in people / animals **OR** local objections **OR** cause people to move away (environmental): crop mutations **OR** leakage into water supplies **OR** pollution of atmosphere / water supply	B2
		Total: 9
10 (a) (i)	53 protons 78 neutrons 53 electrons	B2
10 (a) (ii)	$^{131}_{54}Xe$	B1 B1
10 (b)	Points plotted at 3 of: 0 s, 50 s, 100 s, 150 s B1 3 corrected counts/minute plotted at any from : (0, 280) (50, 140) (100, 70) (150, 35) Graph drawn as curve through correct points	B1 M1 A1
		Total: 7

Question	Answer	Mark
12 (a) (i)	atomic number **OR** number of protons **OR** proton number	B1
12 (a) (ii)	94	B1
12 (b)	$^{237}_{93}Np$ **+** $^{4}_{2}\alpha$	B1 B1
12 (c)	(No of Am atoms remaining = 8 × 10^{14} – 6 × 10^{14}) = 2 × 10^{14} 4 × 10^{14} (Am atoms remain after) 470 yrs or 1 half-life (2 × 10^{14} Am atoms remain after) 940 yrs or 2 half-lives	C1 C1 A1
		Total: 7

Notes about the mark scheme are available separately.