Atomic Structure & Decay Equation

TOPIC QUESTIONS

Level	A Level
Subject	Physics
Exam Board	AQA
Paper Type	Multiple Choice

Time Allowed : 30min

1. An atom of oxygen-15 $\left(^{15}_{8}\mathrm{O}\right)$ gains two electrons to form an ion.

What is the specific charge of the ion?

A $-1.3 \times 10^{7}\ \mathrm{C\ kg^{-1}}$

B $-2.4 \times 10^{7}\ \mathrm{C\ kg^{-1}}$

C $-5.1 \times 10^{7}\ \mathrm{C\ kg^{-1}}$

D $-6.4 \times 10^{7}\ \mathrm{C\ kg^{-1}}$

2. Which is an exchange particle for the weak interaction?

A lepton

B photon

C pion

D W^{+}

3. A particular baryon has a quark structure dss and decays by the weak interaction.What are possible decay products of this baryon?

The quark structure of Λ^0 is uds.

A $\Lambda^0 + \pi^-$

B $n + \pi^-$

C $\Lambda^0 + e^-$

D $K^+ + K^0$

4. A muon and an electron are travelling at the same speed.

Which row gives the particle with the greater kinetic energy and the particle with the longer deBroglie wavelength?

	Greater kinetic energy	Longer de Broglie wavelength
A	muon	muon
B	muon	electron
C	electron	muon
D	electron	electron

5. A particle has a kinetic energy of E_k and a de Broglie wavelength of λ.

What is the de Broglie wavelength when the particle has a kinetic energy of $4E_k$?

A $\frac{\lambda}{2}$ **B** $\frac{\lambda}{\sqrt{2}}$

C $\sqrt{2}\lambda$

D 2λ

6. A photon has energy of 1×10^{18} eV.
An object of mass 0.03 kg has kinetic energy equal to the energy of the

photon.What is the speed of the object?

A $1\ m\ s^{-1}$

B $3\ m\ s^{-1}$

C $10\ m\ s^{-1}$

D $30\ m\ s^{-1}$

7. The nucleus of $^{9}_{4}Be$ captures a proton and emits an α particle. What is the product nucleus?

A $^{10}_{6}C$

B $^{7}_{3}Li$

C $^{6}_{3}Li$

D $^{6}_{2}He$

8.When comparing X-rays with UV radiation, which statement is correct?

A X-rays have a lower frequency.

B X-rays travel faster in a vacuum.

C X-rays do not show diffraction and interference effects.

D Using the same element, photoelectrons emitted usingX-rays have the greater maximum kinetic energy.

9. Monochromatic light of wavelength 490 nm falls normally on a diffraction grating that has 6×10^5 lines per metre. Which one of the following is correct?

A The first order is observed at angle of diffraction of 17°.

B The second order is observed at angle of diffraction of 34°.

C The third and higher orders are not produced.

D A grating with more lines per metre could produce more orders.

10. Astatine is a radioactive substance; it has a nucleon number of 218 and a proton number of 85. When it decays, itforms a polonium nucleus, emitting a β^- particle and an α-particle.

What are the nucleon number and the proton number of the polonium nucleus?

	nucleon number	proton number
A	214	84
B	214	83
C	216	83
D	215	82

11. An atom of $^{19}_{9}\mathrm{F}$ gains 2 electrons.

What is the specific charge of the ion?

A. 1.01×10^{7} C kg^{-1}

B. -1.01×10^{7} C kg^{-1}

C. 2.13×10^{7} C kg^{-1}

D. -2.13×10^{7} C kg^{-1}

12. Antimatter is a particle that is an antiparticle to the corresponding particle. A positron is the antiparticle of anelectron.

What is the difference between a positron and an electron?

A. Mass

B. Magnitude of charge

C. Charge

D. Spin

13. An element with an unstable nucleus decays by emitting an alpha particle to become the nucleus of a differentelement.

The nucleus of the new element is unstable and will emit either an α-particle or a β^- particle. This processcontinues until an isotope of the original element is formed.

What is the minimum possible number of the particles emitted?

A. 5

B. 4

C. 3

D. 2

14. Specific charge is used to describe the charge-mass ratio of certain particles.Which statement is **not correct**?

A. ions have a non-zero value for specific charge, and we include their electrons when calculating it

B. neutral atoms have a non-zero value for specific charge, and we include their electrons when calculating it

C. all nuclei have a non-zero value for specific charge, calculated using their proton and neutron numbers

D. the specific charge on isotopes of the same substance will always be different

15. In β- decay a neutron decays to form three products.

Which row correctly identifies the three missing particles in the decay equation?

$$n \rightarrow \square + \square + \square$$

A	anti-proton	electron	anti-neutrino
B	proton	electron	anti-neutrino
C	proton	positron	neutrino
D	anti-proton	positron	neutrino

16. A substance undergoes first alpha decay and then β-plus decay.

Initially the substance has a mass number of 235 and a proton number of 92.What are the correct values after the two decays are complete?

	nucleons	protons	neutrons
A	231	89	142
B	231	91	140
C	231	90	141
D	235	93	142

17. Radioactive isotopes are used in medical imaging.

For example, two isotopes of iodine, 123-*I* and 131-*I* are both used by radiographers, who give them to patientsin the form of iodide before taking scans.

The possible decay equations for these isotopes are:

1. $^{123}_{53}\mathrm{I} \rightarrow {}^{123}_{52}\mathrm{Te} + \_\_\_\_\_$
2. $^{131}_{53}\mathrm{I} \rightarrow {}^{131}_{54}\mathrm{Xe} + \_\_\_\_\_$

Which is a correct difference between these two decays?

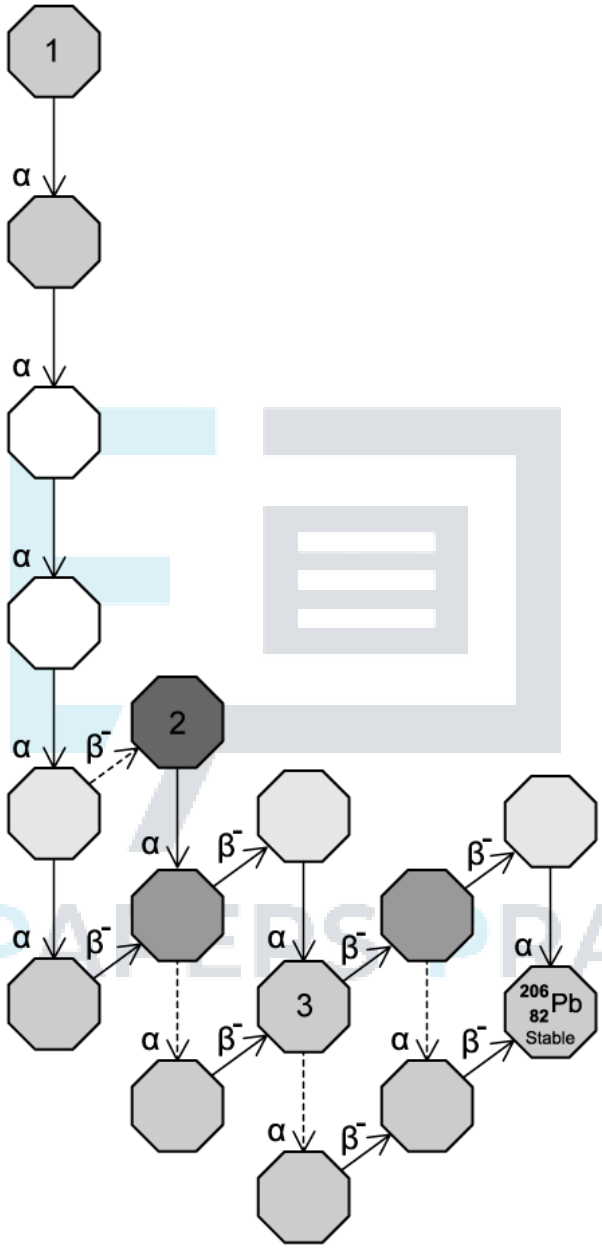
A. in 1, an electron neutrino is emitted, but in 2 an anti-electron neutrino is emitted

B. in 1, an electron has been absorbed but in 2 a neutron has been absorbed

C. in 1, an anti-electron neutrino is emitted, but in 2 an electron neutrino is emitted

D. in 1, a neutron became a proton but in 2 a proton became a neutron

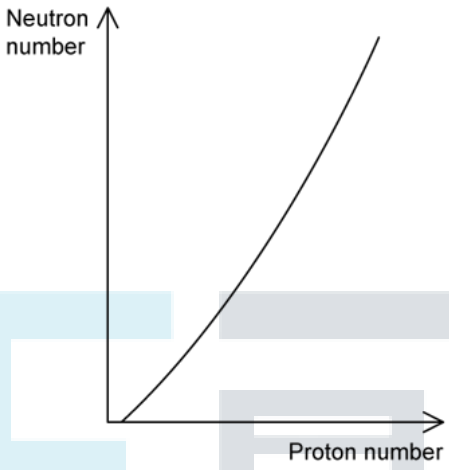
18. The diagram shows the decay chain for a particular isotope.What are the isotopes labelled 1, 2 and 3?



	1	2	3
A	$^{230}_{90}Th$	$^{218}_{85}At$	$^{210}_{82}Pb$
B	$^{234}_{92}U$	$^{218}_{85}At$	$^{210}_{82}Pb$
C	$^{234}_{92}U$	$^{218}_{84}Po$	$^{210}_{81}Tl$

D	$^{230}_{90}Th$	$^{218}_{84}Po$	$^{210}_{82}Pb$

19. The graph shows the how the neutron-proton ratio of stable nuclei changes as proton number increases. What other changes with increasing proton number are suggested by the graph?



1. the charge-mass ratio increases
2. the charge-mass ratio decreases
3. the likelihood of α-decay increases
4. the likelihood of β-plus decay increases
5. protons outnumber neutrons in large nuclei, with a rapidly increasing ratio

A. 1 and 3

B. 2 and 3

C. 2, 4 and 5

D. 2, 3 and 5

20. Nuclear power stations use a fission reactor to create a nuclear reaction. A nucleus absorbs one neutron, leadingto a reaction where more than one neutron is released. These neutrons in turn will set off more reactions.

This process is called a chain reaction.

Which one of these decay processes would be suitable to create a chain reaction?

A. $^{10}_{5}B + {}^{1}_{0}n \rightarrow {}^{7}_{3}Li + \_\_\_\_$

B. $^{27}_{13}Al + {}^{4}_{2}a \rightarrow {}^{30}_{15}P + \_\_\_\_$

C. $^{30}_{15}P \rightarrow {}^{30}_{14}Si + \_\_\_\_$

D. $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{138}_{55}Cs + {}^{95}_{37}Rb + \_\_\_\_$