Cambridge Assessment International Education

Cambridge International AS & A Level

6: Particle physics – Topic questions

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
7	2017	June	21
7	2017	March	22
8	2017	June	22

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

7 **(a)** Use the quark model to show that

(i) the charge on a proton is $+e$,

.....[1]

(ii) the charge on a neutron is zero.

.....[1]

(b) A nucleus of $^{90}_{38}Sr$ decays by the emission of a β^- particle. A nucleus of $^{64}_{29}Cu$ decays by the emission of a β^+ particle.

(i) In Fig. 7.1, state the nucleon number and proton number for the nucleus produced in each of these decay processes.

	nucleus formed by β^- decay	nucleus formed by β^+ decay
nucleon number		
proton number		

Fig. 7.1 [1]

(ii) State the name of the force responsible for β decay.

.....[1]

(iii) State the names of the leptons produced in each of the decay processes.

β^- decay: .....

β^+ decay: .....
[1]

[Total: 5]

7 A nucleus of bismuth-212 ($^{212}_{83}Bi$) decays by the emission of an α-particle and γ-radiation.

(a) State the number of protons and the number of neutrons in the nucleus of bismuth-212.

number of protons = ...

number of neutrons = ...

[1]

(b) The γ-radiation emitted from the nucleus has a wavelength of 3.8 pm.

Calculate the frequency of this radiation.

frequency = ... Hz [3]

(c) Explain how a single beam of α-particles and γ-radiation may be separated into a beam of α-particles and a beam of γ-radiation.

.....

.....

.....

.....[2]

(d) The α-particle emitted from the bismuth nucleus has an initial kinetic energy of 9.3×10^{-13} J. As the α-particle moves through air it causes the removal of electrons from atoms. The α-particle loses energy and is stopped after removing 1.8×10^{5} electrons as it moved through the air.

Determine the energy, in eV, needed to remove one electron.

energy = ... eV [2]

[Total: 8]

8 **(a)** Describe **two** differences between the decay of a nucleus that emits a β^- particle and the decay of a nucleus that emits a β^+ particle.

1. .....

.....

2. .....

.....

[2]

(b) In a simple quark model there are three types of quark. State the composition of the proton and of the neutron in terms of these three quarks.

proton: .....

neutron: .....

[1]

[Total: 3]

<table>
<tr><th>Question</th><th>Answer</th><th>Marks</th></tr>
<tr><td>7 (a) (i)</td><td>(proton is uud so) $(2 / 3)e + (2 / 3)e – (1 / 3)e = e$</td><td>1</td></tr>
<tr><td>7 (a) (ii)</td><td>(neutron is udd so) $(2 / 3)e – (1 / 3)e –(1 / 3)e = 0$</td><td>1</td></tr>
<tr><td>7 (b) (i)</td><td><table><tr><td></td><td>β^-</td><td>β^+</td></tr><tr><td>nucleon number</td><td>90</td><td>64</td></tr><tr><td>proton number</td><td>39</td><td>28</td></tr></table>all correct</td><td>1</td></tr>
<tr><td>7 (b) (ii)</td><td>weak (nuclear force/interaction)</td><td>1</td></tr>
<tr><td>7 (b) (iii)</td><td>β^- decay: electron and (electron) antineutrino
β^+ decay: positron and (electron) neutrino
all correct</td><td>1</td></tr>
<tr><td colspan="3">Total: 5</td></tr>
<tr><td>7 (a)</td><td>number of protons = 83 and number of neutrons = 129</td><td>1</td></tr>
<tr><td rowspan="3">7 (b)</td><td>$\lambda = 3.8 \times 10^{-12}$</td><td>1</td></tr>
<tr><td>$f = 3.0 \times 10^{8} / 3.8 \times 10^{-12}$</td><td>1</td></tr>
<tr><td>$f = 7.9 \times 10^{19}$ (7.89×10^{19}) Hz</td><td>1</td></tr>
<tr><td rowspan="2">7 (c)</td><td>use an electric field (at an angle to the beam)</td><td>1</td></tr>
<tr><td>α is deflected and γ is undeflected</td><td>1</td></tr>
<tr><td rowspan="6">7 (d)</td><td>either</td><td></td></tr>
<tr><td>energy $= 9.3 \times 10^{-13} / 1.8 \times 10^{5}$ ($= 5.17 \times 10^{-18}$ J)</td><td>1</td></tr>
<tr><td>$= 5.17 \times 10^{-18} / 1.6 \times 10^{-19}$
= 32 (32.3) eV</td><td>1</td></tr>
<tr><td>or</td><td></td></tr>
<tr><td>energy $= 9.3 \times 10^{-13} / 1.6 \times 10^{-19}$ ($= 5.81 \times 10^{6}$ eV)</td><td>(1)</td></tr>
<tr><td>$= 5.81 \times 10^{6} / 1.8 \times 10^{5}$
= 32 (32.3) eV</td><td>(1)</td></tr>
<tr><td colspan="3">Total: 8</td></tr>
<tr><td rowspan="2">8 (a)</td><td>β^- emission: neutron changes to proton (+ beta–/electron)
and
β^+ emission: proton changes to neutron (+ beta+/positron)</td><td>1</td></tr>
<tr><td>β^- emission: (electron) antineutrino also emitted
and
β^+ emission: (electron) neutrino also emitted</td><td>1</td></tr>
<tr><td>8 (b)</td><td>proton: up up down (and zero strange)
neutron: up down down (and zero strange)</td><td>1</td></tr>
<tr><td colspan="3">Total: 3</td></tr>
</table>

Notes about the mark scheme are available separately.