

Revision Sheet

A-Level Physics · Unit 11 Particle physics

12 vocabulary items · 37 marks of exam questions (9 questions)

Part 1 · Vocabulary review (12 items). The terms this unit is examined on most. Mark it yourself from the answer key.

Section A · Chinese to English

Write the English word.

1.

[1]
2.

[1]
3.

[1]
4.

[1]
5.

[1]
6.

[1]
7.

[1]
8.

[1]
9.

[1]
10.

[1]
11.

[1]
12.

[1]

Part 2 · Exam questions (37 marks, 9 questions) begins on the next page. They are ordered easy to difficult and none of them has been set before.

13 Which combination of three quarks has no overall charge?

- ☐

A down, strange, strange
- B up, charm, strange
- C up, charm, top
- D up, down, strange

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14 Which statement explains why alpha-particles have discrete energies, but beta-particles have a continuous range of energies?

- ☐

A Beta-particles have a much smaller mass than alpha-particles which means beta-particles can be emitted with a larger range of velocities.
- B Only alpha-particles experience repulsion from the nucleus which is dependent on the number of protons in the nucleus.
- C Only beta-particles are emitted with another lepton and some energy is transferred to the other lepton.
- D Only the energy of alpha-particles is discrete because the composition of alpha-particles is always the same.

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15 A magnesium nucleus $^{23}_{12}\text{Mg}$ decays by emitting two particles.

☐

 The resulting nucleus is sodium $^{23}_{11}\text{Na}$.

Which two particles are emitted?

- A α -particle, antineutrino
- B β^+ particle, antineutrino
- C β^- particle, neutrino
- D β^+ particle, neutrino

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16 Which statement about radioactive decay is correct?

- ☐

A Neutrinos are always emitted during α -decay.
- B The α -particles emitted from a radioactive sample have a continuous range of kinetic energies.
- C The β^- particles emitted from a radioactive sample have a continuous range of kinetic energies.
- D The proton number of a nucleus decreases by four when it undergoes α -decay.

17 (a) Table 7.1 shows incomplete data for three flavours (types) of quark. The elementary charge is e .

Table 7.1

flavour	quark		antiquark	
	symbol	charge/ e	symbol	charge/ e
up	u	$+\frac{2}{3}$	$\bar{u}$	
down	d		$\bar{d}$	
charm	c		$\bar{c}$	

Complete Table 7.1 by inserting the missing charges. [2]

(b) Using the symbols given in Table 7.1, state a possible quark combination for the following hadrons:

(i) a neutral baryon
..... [1]

(ii) a meson with a charge of $+e$.
..... [1]

(c) Quarks are fundamental particles.

Electrons are in another group (class) of fundamental particle.

(i) State the name of this group.
..... [1]

(ii) State the name of another particle in this group.
..... [1]

[Total: 6]

18 (a) The results of the α -particle scattering experiment provide evidence for the structure of the atom.

Result 1: The vast majority of the α -particles pass straight through the metal foil or are deviated by small angles.

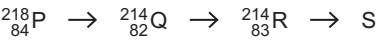
Result 2: A very small minority of α -particles is scattered through angles greater than 90° .

State what may be inferred (deduced) from:

(i) result 1
.....
..... [1]

(ii) result 2.
.....
.....
..... [2]

(b) A radioactive decay sequence contains four nuclei, P, Q, R and S, as shown.



Nucleus S is an isotope of nucleus P.

(i) Determine the proton number and the nucleon number of nucleus S.

proton number =
nucleon number = [2]

(ii) The quark composition of a nucleon in Q changes as Q decays to form R.

Describe this change to the quark composition of the nucleon.
.....
..... [1]

[Total: 6]

19 (a) Potassium-40 ($^{40}_{19}\text{K}$) undergoes β^- decay to form a nuclide of element X. Particle Z is emitted during the decay. The equation for the decay is shown.

$$^{40}_{19}\text{K} \rightarrow {}^P_Q\text{X} + {}^R_S\beta^- + \text{Z}$$

- (i) State the values of P , Q , R and S .
- $P =$ $R =$
 $Q =$ $S =$ [2]

(ii) State the name of particle Z.

..... [1]

(iii) State the name of the class of fundamental particle to which both the β^- particle and particle Z belong.

..... [1]

(b) Determine the quark composition of an alpha-particle.

quark composition [3]

[Total: 7]

20 (a) Fluorine-18 ($^{18}_9\text{F}$) is an isotope that decays to an isotope of oxygen (O) by the emission of a β^+ particle.

(i) Complete the nuclear equation for the decay, including all the particles involved.

$^{18}_9\text{F} \rightarrow$ [3]

(ii) A quark in the fluorine-18 nucleus changes flavour during the decay. State this change of flavour.

..... quark to quark. [1]

(b) A hadron has a charge of $-2e$, where e is the elementary charge.

(i) State and explain whether the hadron is a meson or a baryon.

.....
.....
..... [2]

(ii) State a possible quark composition for the hadron.

.....
..... [1]

[Total: 7]

21 (a) An unstable nucleus ${}^A_Z\text{X}$ decays by emitting a β^- particle.

(i) Determine quantitatively the changes, if any, in A and Z when X decays.

change in A =

change in Z =

[2]

(ii) In addition to the β^- particle, another lepton is emitted during the decay.

State the name of the other lepton that is emitted.

..... [1]

(b) A particle P is composed of an up quark (u) and a down antiquark ($\bar{d}$).

(i) Calculate the charge q of particle P in terms of e , where e is the elementary charge.

Show your working.

$q = \dots\dots\dots e$ [2]

(ii) Particle P belongs to **two** classes (groups) of particles.

State the names of these two classes.

1

2

[2]

[Total: 7]