AQA 1 Questions – Particles (set 2)

June 12 Q1

1 (a) The K^- meson has strangeness –1.

1 (a) (i) State the quark composition of a meson.

.....

(1 mark)

1 (a) (ii) State the baryon number of the K^- meson.

.....

(1 mark)

1 (a) (iii) What is the quark composition of the K^- meson?

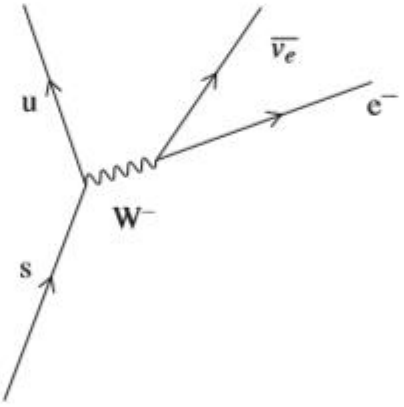
.....

.....

(1 mark)

1 (b) **Figure 1** shows a Feynman diagram for a possible decay of the strange quark.

Figure 1



1 (b) (i) Which interaction is responsible for this decay?

.....

(1 mark)

1 (b) (ii) Energy and momentum are conserved when the W^- particle is produced. State **two** other quantities that are also conserved and **one** that is not.

conserved .....

conserved .....

not conserved .....

(3 marks)

AQA 1 Questions – Particles (set 2)

1 (b) (iii) Complete this equation for the decay of a K^- meson.

$K^- \rightarrow$ ..... + ... + ...

(2 marks)

June 12 Q3

3 (a) Protons can interact with electrons by gravity and by two other fundamental interactions. In the following table identify these interactions and name the exchange particle involved.

interaction	exchange particle

(2 marks)

3 (b) State the quark composition of a proton.

.....

(1 mark)

3 (c) A change in quark identity is involved in *electron capture*.

3 (c) (i) Explain what is meant by electron capture.

.....

.....

.....

.....

.....

.....

(3 marks)

3 (c) (ii) In the space below draw a Feynman diagram representing electron capture.

(3 marks)

Jan 13 Q2

2 Under certain circumstances it is possible for a photon to be converted into an electron and a positron.

2 (a) State what this process is called.

.....

(1 mark)

2 (b) A photon must have a minimum energy in order to create an electron and a positron.

Calculate the minimum energy of the photon in joules. Give your answer to an appropriate number of significant figures.

minimum energy = ... J

(3 marks)

2 (c) A photon of slightly higher energy than that calculated in part (b) is converted into an electron and a positron.

State what happens to the excess energy.

.....

.....

(1 mark)

2 (d) Describe what is likely to happen to the positron shortly after its creation.

.....

.....

.....

.....

(2 marks)

AQA 1 Questions – Particles (set 2)

Jan 13 Q3

3 (a) (i) State how many quarks there are in a baryon.

.....

(1 mark)

3 (a) (ii) Hadrons fall into two groups, baryons being one of them.

State the name that is given to the other group of hadrons.

.....

(1 mark)

3 (a) (iii) Give **two** properties of hadrons that distinguish them from leptons.

property 1 .....

.....

property 2 .....

.....

(2 marks)

3 (b) The forces between particles can be explained in terms of exchange particles.

Complete the following table by identifying an exchange particle involved in the interaction.

interaction	exchange particle
electromagnetic	.....
weak	.....

(2 marks)

3 (c) The following equation shows electron capture.

$$p + e^- \rightarrow n + \nu_e$$

3 (c) (i) Draw a Feynman diagram that represents this interaction.

(3 marks)

3 (c) (ii) Explain why, when electron capture occurs, a neutrino rather than an antineutrino is produced.

.....

.....

.....

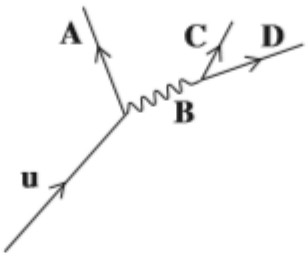
(1 mark)

AQA 1 Questions – Particles (set 2)

June 13 Q2

2 A positron is emitted from a nucleus when a proton changes to a neutron in the nucleus. The Feynman diagram for the quark interaction is shown in **Figure 1**.

Figure 1



2 (a) Identify the particles labelled **A**, **B**, **C** and **D** in the diagram.

A .....

B .....

C .....

D .....

(3 marks)

2 (b) (i) State the interaction responsible for this process.

.....

(1 mark)

2 (b) (ii) State which letter in **Figure 1** represents an exchange particle.

.....

(1 mark)

2 (b) (iii) State **one** difference between this exchange particle and a photon.

.....

(1 mark)

2 (c) Energy and momentum have to be conserved in this process. State **two** other quantities that need to be conserved and show that they are conserved in the process.

quantity 1 .....

.....

.....

quantity 2 .....

.....

.....

(4 marks)

June 13 Q3

3 (a) Hadrons and leptons are two groups of particles.
Write an account of how particles are placed into one or other of these two groups.
Your account should include the following:

- how the type of interaction is used to classify the particles
- examples of each type of particle
- details of any similarities between the two groups
- details of how **one** group may be further sub-divided.

The quality of your written communication will be assessed in your answer.

(6 marks)

AQA 1 Questions – Particles (set 2)

3 (b) Every type of particle has a corresponding antiparticle.

3 (b) (i) Give **one** example of a particle and its corresponding antiparticle.

particle .....

antiparticle .....

(1 mark)

3 (b) (ii) State **one** difference between this particle and its antiparticle.

.....

.....

(1 mark)

AQA 1 Questions – Particles (set 2)

June 14 Q1

1 (a) The positive kaon, K^+, has a strangeness of $+1$.

1 (a) (i) What is the quark structure of the K^+?

[1 mark]

.....

1 (a) (ii) What is the baryon number of the K^+?

[1 mark]

.....

1 (a) (iii) What is the antiparticle of the K^+?

[1 mark]

.....

1 (b) The K^+ may decay into a neutrino and an antimuon in the following way.

$$K^+ \rightarrow \nu_\mu + \mu^+$$

1 (b) (i) Complete **Table 1** using ticks and crosses as indicated in the first row.

[3 marks]

Table 1

Classification	**K^+**	**ν_μ**	**μ^+**
lepton	×	✓	✓
charged particle			
hadron			
meson			

1 (b) (ii) In this decay, charge, energy and momentum are conserved.
Give another quantity that is conserved in this decay and one that is not conserved.

[2 marks]

Conserved .....

Not conserved .....

AQA 1 Questions – Particles (set 2)

1 (c) Another possible decay of the K^+ is shown in the following equation,

$$K^+ \rightarrow \pi^+ + X$$

1 (c) (i) Identify X by ticking **one** box from the following list.

[1 mark]

electron	
muon	
negative pion	
neutral pion	
neutrino	
neutron	
positron	

1 (c) (ii) Give **one** reason for your choice in part (c)(i).

[1 mark]

.....

.....

.....

.....

AQA 1 Questions – Particles (set 2)

June 15 Q2

2 The equation shows an interaction between a proton and a negative kaon that results in the formation of particle, X.

$$K^- + p \rightarrow K^+ + K^0 + X$$

2 (a) (i) State and explain whether X is a charged particle.

[2 marks]

.....

.....

2 (a) (ii) State and explain whether X is a lepton, baryon or meson.

[2 marks]

.....

.....

2 (a) (iii) State the quark structure of the K^-, K^+ and the K^0.

[3 marks]

K^-.....

K^+.....

K^0.....

2 (a) (iv) Strangeness is conserved in the interaction.

Determine, explaining your answer, the quark structure of X.

[3 marks]

.....

.....

.....

.....

June 15 Q3

3 (a) Baryons, mesons and leptons are affected by particle interactions.

Write an account of these interactions. Your account should:

- include the names of the interactions
- identify the groups of particles that are affected by the interaction
- identify the exchange particles involved in the interaction
- give examples of **two** of the interactions you mention.

The quality of your written communication will be assessed in your answer.

[6 marks]

.....

.....

.....

.....

.....

.....

3 (b) Draw a labelled Feynman diagram that represents a particle interaction.

[3 marks]

AQA 1 Questions – Particles (set 2)

June 16 Q2

2 The positive kaon (K^+) has a strangeness of +1.

2 (a) Which of the following is the quark composition of the positive kaon?
Tick (✓) the correct answer.

[1 mark]

	✓ if correct
$\bar{u}s$	
$uu\bar{s}$	
$u\bar{s}$	
$\bar{d}\bar{d}s$	

2 (b) The equation shows a possible decay of the positive kaon.

$$K^+ \longrightarrow \mu^+ + \nu_\mu$$

2 (b) (i) Show that lepton number is conserved in this decay.

[1 mark]

2 (b) (ii) State a quantity that is not conserved in this decay.

[1 mark]

2 (b) (iii) Complete the following table using ticks to indicate correct classifications for each particle. The first column has been completed for you.

[3 marks]

	Charged	Hadron	Meson	Baryon	Lepton
K^+	✓				
μ^+	✓				
ν_μ					

2 (c) The positive kaon can also decay to form a π^+ and one other particle X.

Deduce the identity of X.

[3 marks]

June 16 Q3

3 Under certain conditions a photon may be converted into an electron and a positron.

3 (a) State the name of this process.

[1 mark]

_____

3 (b) For the conversion to take place the photon has to have an energy equal to or greater than a certain minimum energy.

3 (b) (i) Explain why there is a minimum energy.

[2 marks]

_____

_____

3 (b) (ii) Show that this minimum energy is about 1 MeV.
Use values from the Data and Formulae Booklet.

[1 mark]

3 (b) (iii) Explain what happens to the excess energy when the photon energy is greater than the minimum energy.

[1 mark]

_____

_____

3 (b) (iv) A photon has an energy of $1.0\ \text{MeV}$.

Calculate the frequency associated with this photon energy.
State an appropriate unit in your answer.

[4 marks]

frequency = _____ unit = _____