Exam Answers
Chapter 10·1 – Matter
Answer 1 2010:1:3

(3 marks)

Particles called *quarks* are the 'building blocks' of other sub-atomic particles. Table 1 lists the names of some quarks and two of their quantum numbers; charge q and strangeness S.

Table 1: Some properties of quarks

Quark	Charge, q	Strangeness, S
up	$+{}^{2}/_{3}$	0
down	$-{}^{1}/_{3}$	0
charm	$+{}^{2}/_{3}$	0
strange	$-{}^{1}/_{3}$	-1
top	$+{}^{2}/_{3}$	0
bottom	$-{}^{1}/_{3}$	0

When quarks combine their individual quantum numbers 'add'. For example, a fictitious particle, the Joton, made of two charm quarks and one top quark would have a charge of $+{}^{2}/_{3} + {}^{2}/_{3} + {}^{2}/_{3} = {}^{6}/_{3} = 2$ and a strangeness of 0+0+0 = 0.

Use Table 1 to determine the values of the charge and strangeness quantum numbers for the particles in Table 2.

Table 2: Properties of some sub-atomic particles

Particle	Quark composition	Charge, Q	Strangeness, S
Lambda	up, down, strange	**0**	**-1**
Xi	up, strange, strange	**0**	**-2**
Sigma minus	down , down strange	**-1**	**-1**

Description	Marks
Charge and strangeness correct for each particle	1
1 mark for each correct row.	
	Total 3

Answer 2 2013:1:4

(3 marks)

Table of quarks		
Name	**Symbol**	**Electrostatic charge**
Up	u	+ ⅔ e
Down	d	-⅓ e
Strange	s	-⅓ e
Charmed	c	+ ⅔ e
Bottom	b	-⅓ e
Top	t	+ ⅔ e

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Answer 2 continued

Table of baryons	
Particle	**Composition**
p^+	u u d
n	u d d
Σ^+	u u s
Σ^0	u d s
Σ^-	d d s
Ω^-	s s s

(a) Use the information in the above tables to explain why the electrostatic charge on the Σ^0 particle is neutral. (2 marks)

Description	Marks
Σ^0 = u d s	1
= + ⅔ e & -⅓ e & -⅓ e = 0	1
Total	**2**

(b) It is possible for another baryonic particle to exist in nature with a positive electrostatic charge equal to that of the proton. What would its quark composition be, given that this particle contains two up quarks and is **not** a proton? (1 mark)

Description	Marks
u u b **or** u u s	1
Total	**1**

Answer 3 2014:1:3

(2 marks)

An exotic hadron, initially seen over 40 years ago, has recently been confirmed at the European Organization for Nuclear Research (CERN). The Z(4430) particle consists of four quarks: a charm, an anti-charm, a down, and an anti-up.

Use the following table to show the calculation required to determine the charge of the Z (4430) particle.

Table of quarks		
Name	**Symbol**	**Electrostatic charge**
Up	u	+ ⅔ e
Down	d	-⅓ e
Strange	s	-⅓ e
Charm	c	+ ⅔ e
Bottom	b	-⅓ e
Top	t	+ ⅔ e

Description	Marks
a charm, an anti-charm, a down, and an anti-up $+\frac{2}{3}e + -\frac{2}{3}e + -\frac{1}{3}e + -\frac{2}{3}e$	1
= -1e (e optional)	1
If charges for antiparticles not reversed, zero marks	
Total	**2**