

Q1.(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.

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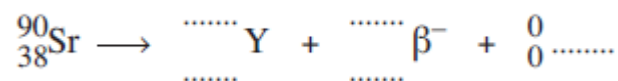
(6)

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

(3)

(Total 9 marks)

Q2.(a) Complete the following equation for beta minus (β^-) decay of strontium-90 (${}^{90}_{38}\text{Sr}$) into an isotope of yttrium (Y).



(3)

- (b) During β^- decay of a nucleus both the nucleon composition and the quark composition change.
State the change in quark composition.

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(1)

- (c) A positive kaon consists of an up quark and an antistrange quark ($u\bar{s}$). This kaon decays by strong and weak interactions into three pions. Two of the pions have quark compositions of ($u\bar{d}$). The third pion has a different quark composition.

- (i) Name the unique family of particles to which the kaon and pions belong.

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(1)

- (ii) Tick the box corresponding to the charge of the third pion.

positive negative neutral

(1)

- (iii) Positive kaons have unusually long lifetimes.
Give a reason why you would expect this to be the case.

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(1)

- (iv) Name the exchange particles which are involved in the strong and weak interactions of the kaon.

strong interaction

weak interaction

(1)

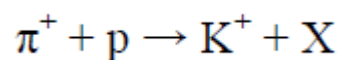
(Total 8 marks)

- Q3.(a)** Complete the table comparing some of the properties of the positive pion, π^+ , and the proton.

Name	π^+	Proton
Relative charge	+1	
Baryon number		
Quark composition		

(5)

- (b) When a positive pion interacts with a proton, a kaon can be produced, along with another strange particle, as shown in this equation



Circle the type of interaction shown in this equation.

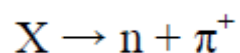
Electromagnetic Gravitational Strong Nuclear Weak Nuclear

(1)

- (c) Deduce the relative charge, baryon number and strangeness of particle X.

(3)

- (d) Particle X can decay to produce a neutron and positive pion as shown in this equation



Circle the type of interaction shown in this equation.

Electromagnetic Gravitational Strong Nuclear Weak Nuclear

(1)

(e) Explain your answer.

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(2)

(f) The neutron and positive pion will then decay. The positive pion can decay into a positron and an electron neutrino.

Write down the equation for the decay of the neutron.

(2)



(g) Explain why no further decays occur.

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(2)

(Total 16 marks)

Q4.What are the numbers of hadrons, baryons and mesons in an atom of ${}^7_3\text{Li}$?

	hadrons	baryons	mesons	
A	7	3	3	
B	7	4	4	

C	7	7	0	<input type="checkbox"/>
D	10	7	0	<input type="checkbox"/>

(Total 1 mark)

Q5. Which of the following is **not** true?

- A** Each meson consists of a single quark and a single antiquark.
- B** Each baryon consists of three quarks.
- C** The magnitude of the charge on every quark is $\frac{1}{3}$
- D** A particle consisting of a single quark has not been observed.

(Total 1 mark)

Q6. Mesons that contain a strange (or antistrange) quark are known as K-mesons or kaons. Mesons are a sub-group of a larger group of particles.

- (a) (i) State the name of this larger group of particles.

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(1)

- (ii) Determine the charge on a kaon with a quark structure of us .

.....

(1)

- (b) A proposed decay for this kaon is



- (i) Apply the law of conservation of strangeness to the proposed decay.

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(1)

(ii) Comment on whether or not this decay is possible.

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(1)

(Total 4 marks)

Q7. (a) The table gives information about some fundamental particles.

Complete the table by filling in the missing information.

particle	quark structure	charge	strangene	baryon number
	uud		0	
Sigma ⁺	uus	+ 1		
	ud		0	0

(7)

(b) Each of the particles in the table has an antiparticle.

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

particle

antiparticle

(1)

(ii) State the quark structure of an antibaryon.

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(1)

- (iii) Give **one** property of an antiparticle that is the same for its corresponding particle and **one** property that is different.

Same

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Different

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(2)

(Total 11 marks)