Student:_____
Max. Marks : 18 Marks **Time : 18 Minutes**

Q1.

A treatment for brain tumours involves firing a beam of pions at the tumour. Pions exist for a very short time. During treatment many pions hit the tumour just as they decay.

This causes the cells in the tumour to fragment, which kills them with no harmful effect to the surrounding tissue.

Pions belong to a group of sub-atomic particles called mesons. There are three types of pion: π^- π^+ π^0.

(a) The following table lists some quarks and their charge.

Quark	Charge/*e*
u	+2/3
d	−1/3
s	−1/3
c	+2/3

State a possible quark combination for a π^-

(1)

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(b) Pions are produced when protons, accelerated in a cyclotron, are aimed at a target of beryllium and interact with protons in the beryllium.

Identify the type of pion produced in the following interaction.

$$p + p \rightarrow p + p + \pi$$

(1)

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(c) The π^- mesons used for a treatment have a speed of 2.3×10^8 m s^{-1} and a range in air of 5.9 m.

Calculate the time for which these π^- mesons exist.

(2)

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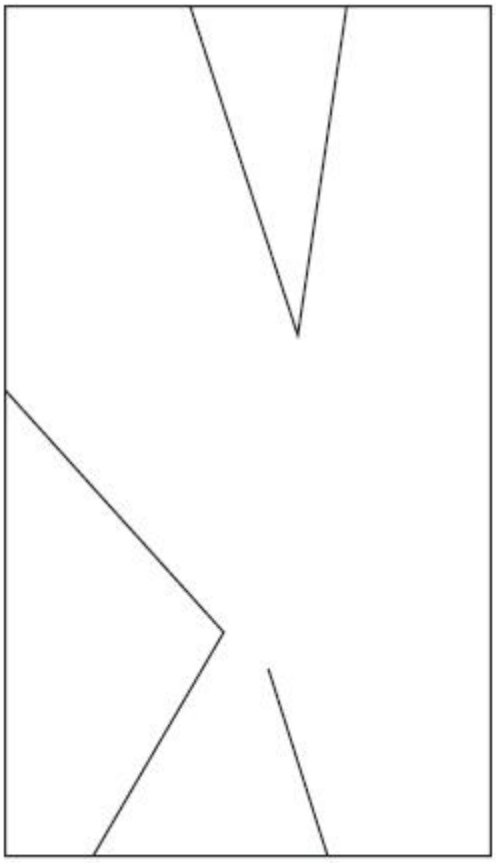
Time = ...

*(d) The photograph shows what happens in a Bubble Chamber when some pions enter at the bottom and travel upwards. One pion has been identified by X in the photograph and the simplified line diagram shows the visible tracks of the pion and subsequent decay products.



X

X

Explain what can be deduced about the sequence of the events shown in the line diagram.

(6)

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(e) If very high speed protons are fired at beryllium, the following interaction occurs

$$p + p = p + p + p + \bar{p}$$

(i) State the name of the particle $\bar{p}$ and give its properties.

(2)

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(ii) State what is likely to happen to the $\bar{p}$ particle.

(1)

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(Total for question = 13 marks)

Q2.

The table gives some of the properties of the up, down and strange quarks.

Type of quark	Charge/*e*	Strangeness
u	+2/3	0
d	−1/3	0
s	−1/3	−1

There are nine possible ways of combining u, d and s quarks and their antiquarks to make nine different mesons. These are listed below

$u\bar{u}$ $u\bar{d}$ $u\bar{s}$ $d\bar{d}$ $d\bar{u}$ $d\bar{s}$ $s\bar{s}$ $s\bar{u}$ $s\bar{d}$

(a) From the list select the four strange mesons and state the charge and strangeness of each of them.

(4)

Meson	Charge/*e*	Strangeness

(b) Some of the mesons in the list have zero charge and zero strangeness.

Suggest what might distinguish these mesons from each other.

(1)

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(Total for Question = 5 marks)