Name of the Student:_____
Max. Marks : 26 Marks **Time : 26 Minutes**

Mark Schemes

Q1.

Question Number	Acceptable Answer	Additional guidance	Mark
(i)	charge not conserved		**(1)**

Question Number	Acceptable Answer	Additional guidance	Mark
(ii)	• both radial fields OR (1) the magnitude of the fields is the same (at a given distance) • different directions (1)		**(2)**

Q2.

Question Number	Acceptable answers	Additional guidance	Mark
	$\Lambda^0 \rightarrow e^+ + e^-$ (no 2) (1) baryon number not conserved (1) $\Lambda^0 \rightarrow$ n only (no 4) momentum **or** energy cannot be conserved (1) (1) $\Lambda^0 \rightarrow$ p and π^0 (no 5) (1) charge not conserved (1)	More than 3 decays identified as not possible max 2 marks for the decays.	**6**

Q3.

Question Number	Answer	Mark
	$\bar{u}d$ (1)	**1**

Q4.

Question Number	Answer		Mark
(a)	4 is the number of nucleons **Or** number of neutrons and protons **Or** mass number **Or** nucleon number 2 is the number of protons **Or** proton number **Or** atomic number	**(1)** **(1)**	**2**
(b)(i)	(The particles are moving) close to the speed of light	**(1)**	**1**
(b)(ii)	To create particle /antimatter **Or** To allow (large) repulsive forces to be overcome **Or** To break the particles (into their constituents)	**(1)**	**1**
(b)(iii)	Mass = 4u (accept use of $4m_p$) Use of $E = mc^2$ Division by e Mass = 3.74 (GeV/c^2) (use of mass of proton instead of u → 3.76 GeV/c^2) Example of calculation mass = $4 \times 1.66 \times 10^{-27}$ kg = 6.64×10^{-27} kg $mc^2 = 6.64 \times 10^{-27}$ kg × $(3 \times 10^8$ m s$^{-1})^2 = 6.0 \times 10^{-10}$ J 6.0×10^{-10} J / 1.6×10^{-19} Mass = 3.74 GeV/c^2	**(1)** **(1)** **(1)** **(1)**	**4**
(b)(iv)	They meet matter (helium nuclei) and annihilate	**(1)**	**1**
(b)(v)	Use of $E = hf$ ecf E from (iii) Frequency = 9.02×10^{23} Hz (using 3.74 GeV/c^2) (3.76 GeV/c^2 → 9.07×10^{23} Hz 4 GeV/c^2 → 9.65×10^{23} Hz) (half or double these values, due to a stray 2 can score 1st mark) (use of $\lambda = h/p$ scores 0) Example of calculation $f = 3.74 \times 10^9 \times 1.6 \times 10^{-19}$ J / 6.63×10^{-34} Js $f = 9.02 \times 10^{23}$ Hz	**(1)** **(1)**	**2**
(c)(i)	Quark and antiquark	**(1)**	**1**
(c)(ii)	$\bar{p}$ consists of $\bar{u}\,\bar{u}\,\bar{d}$ $-\frac{2}{3}e - \frac{2}{3}e + \frac{1}{3}e = -e$ must be consistent with structure of $\bar{p}$ $\bar{n}$ consists of $\bar{d}\,\bar{d}\,\bar{u}$ $+\frac{1}{3}e + \frac{1}{3}e - \frac{2}{3}e = 0$ must be consistent with structure of $\bar{n}$ (The sum must be clearly shown for marks 2 & 4)	**(1)** **(1)** **(1)** **(1)**	**4**