Particle Physics Exam Qs

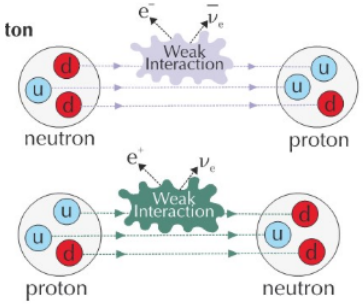
Q1.(a) State the combination of quarks that makes up a neutron.

..... udd .....

(1)

the eqn in part b is wrong - it is an e^- not an anti e (ie not an e^+)

(b) When a neutron decays, a down quark changes into an up quark as shown by the following reaction.



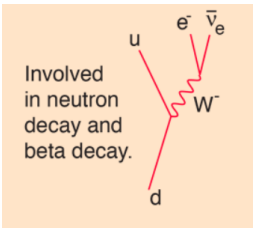
$$d \rightarrow u + \bar{e} + \bar{\nu}_e$$

Show, in terms of the conservation of charge, baryon number and lepton number, that this transformation is permitted.

assuming its an electron and not an anti electon...
charge: -1/3-> 2/3+-1
baryon: 1/3 ->1/3+0+0
Lepton: 0->0+1+-1

3)

(ii) State the products arising from the decay of an anti-down quark, $\bar{d}$.



$\bar{d} \rightarrow \bar{u} + e^+ + \nu_e$ ✓

$+\frac{1}{3} \rightarrow -\frac{2}{3} + 1 \quad +0$ ✓

Charge $-\frac{1}{3} \rightarrow -\frac{2}{3} + 0 \quad +0$

baryon $0 \rightarrow 0 \quad -1 \quad +1$

L_e

(1)
(Total 5 marks)

Q2. In a nuclear reaction $^{14}_{7}N$ is bombarded by neutrons. This results in the capture of one neutron and the emission of one proton by one nucleus of $^{14}_{7}N$. The resulting nucleus is

A $^{13}_{7}N$

B $^{14}_{6}C$

C $^{12}_{6}C$

D $^{14}_{8}O$

$^{14}_{7}N + {}^{1}_{0}n \Rightarrow {}^{15}_{7}N$

now lose $^{1}_{1}p$

so $^{14}_{6}C$

(Total 1 mark)

Q3. Leptons, mesons and baryons are three classes of sub-atomic particles.

(a) Some classes of particles are fundamental; others are not. Circle the correct category for each of these three classes.

leptons	fundamental/not fundamental
mesons	fundamental/not fundamental
baryons	fundamental/not fundamental

(1)

(b) Name the class of particles of which the proton is a member.

baryons

(1)

(c) By referring to the charges on up and down quarks explain how the proton has a charge of +1e.

u d u $u = +\frac{2}{3}e$

$2u + 1d = +1e$ $d = -\frac{1}{3}e$

(2)
(Total 4 marks)

Q4. A negative pion (π^-) is a meson with a charge of −1e.

$q\bar{q}$ pair

State and explain the structure of the π^- in terms of up and down quarks.

π^- : $\bar{u} = -\frac{2}{3}e$ $d = -\frac{1}{3}e$

(Total 3 marks)

Q5. A physicist, who is attempting to analyse a nuclear event, suggests that a π^- particle and a proton collided and were annihilated with the creation of a neutron, a π^+ particle, and a K^- particle.

π and K particles are mesons. The baryon and lepton numbers of both these mesons are zero.

(a) Write down the equation that represents this interaction.

$\pi^- + p \rightarrow n + \pi^+ + K^-$

(1)

(b) Show, in terms of the conservation of charge, baryon number and lepton number, that this transformation is permitted.

	π^-	+ p	$\rightarrow$ n	+ π^+	+ K^-	
charge	−1	+1	0	+1	−1	✓
baryon	0	+1	+1	0	0	✓
L_e	0	0	0	0	0	
L_μ	0	0	0	0	0	

All balance therefore this transformation is allowed

(4)

(Total 5 marks)

Q6. A radium-288 nuclide ($^{228}_{88}Ra$) is radioactive and decays by the emission of a β^- particle to form an isotope of actinium (Ac).

(a) Complete the equation for this decay.

$$^{228}_{88}Ra \rightarrow {}^{228}_{89}Ac + {}^{0}_{-1}\beta^- + \bar{\nu}_e$$

(3)

(b) β^- decay is the result of a neutron within a nucleus decaying into a proton. Describe the change in the quark sub-structure that occurs during the decay.

udu → udd

So a u → d

(1)

(Total 4 marks)