



EXAM PAPERS PRACTICE

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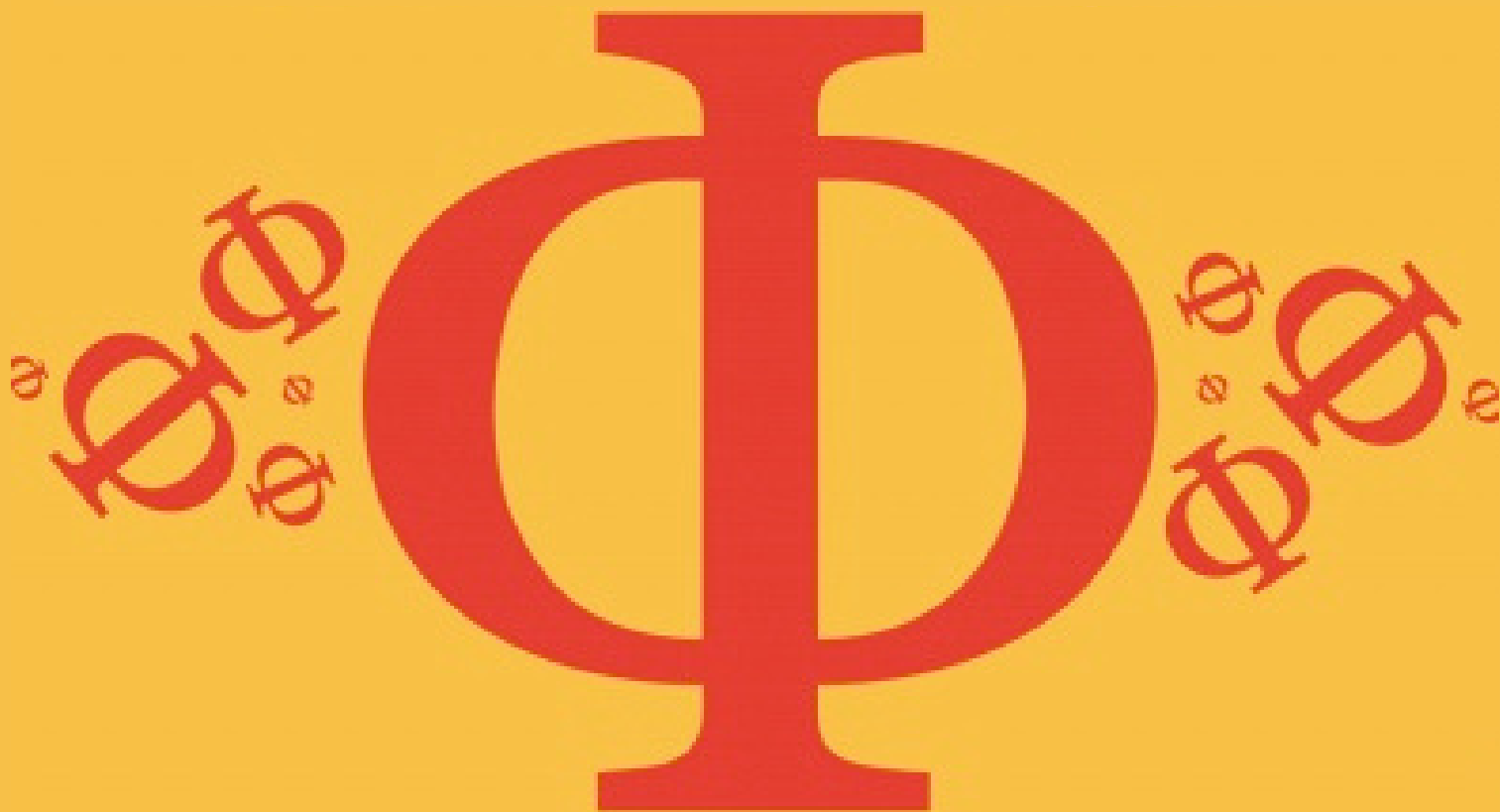
Detailed mark scheme

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thoroughly prepare you

7.3 The Structure of Matter

Hard



PHYSICS

IB HL

7.3 The Structure of Matter

Question Paper

| | |
|------------|---------------------------------------|
| Course | DPIB Physics |
| Section | 7. Atomic, Nuclear & Particle Physics |
| Topic | 7.3 The Structure of Matter |
| Difficulty | Hard |

EXAM PAPERS PRACTICE

Time allowed: 20
Score: /10
Percentage: /100

Question 1

The Σ^0 baryon has strangeness of -1 and is produced through the strong interaction between a π^+ meson and a neutron.



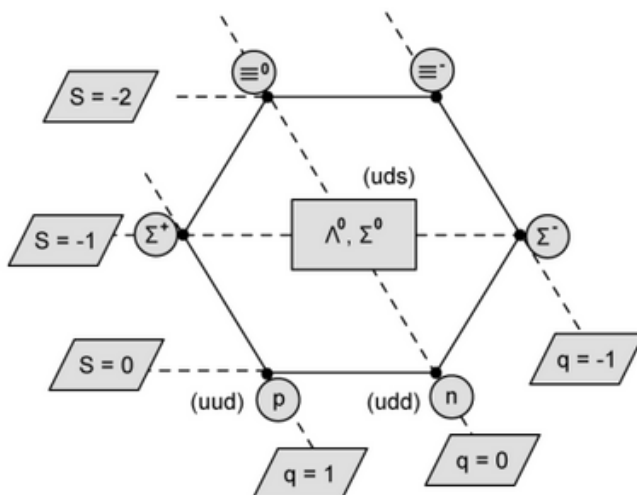
What is the quark composition of particle X?

- A. $u\bar{s}$
- B. uud
- C. $u\bar{d}$
- D. uus

[1 mark]

Question 2

Particles can be organised in a plot known as the 'eightfold way', as shown in the diagram below.

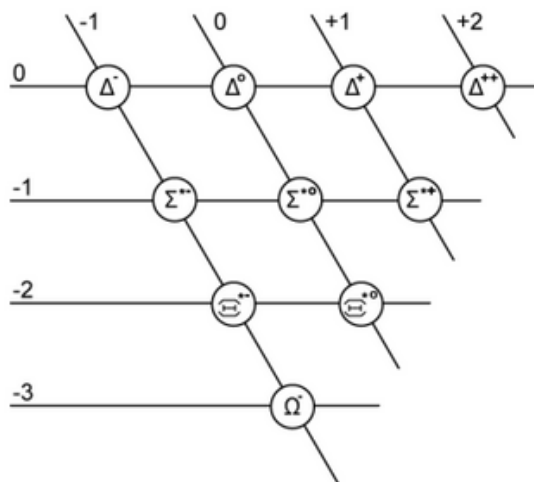


What are the quark compositions of Σ^+ , Σ^- , Ξ^0 and Ξ^- ?

| | Σ^+ | Σ^- | Ξ^0 | Ξ^- |
|---|------------|------------|---------|---------|
| A | uus | dds | uds | dss |
| B | uud | dss | udd | ddd |
| C | uus | dds | uss | dss |
| D | uud | ddd | uss | dds |

Question 3

The diagram is an example of a 'baryon decuplet'. Baryons are organised along horizontal and diagonal axes, as shown in the diagram below.



What is the quark structure of the Ξ^{*-} baryon?

- A. $\bar{u}s$
- B. uss
- C. dss
- D. uds

[1 mark]

Question 4

A collision between particles creates 4 mesons:

$$s\bar{u} + d\bar{s} + X + Y$$

The overall charge and strangeness of the 4 mesons is zero.

What are possible quark combinations for X and Y?

| | X | Y |
|---|------------|------------|
| A | $d\bar{u}$ | $s\bar{d}$ |
| B | $u\bar{s}$ | $u\bar{d}$ |
| C | $s\bar{s}$ | $u\bar{d}$ |
| D | $u\bar{s}$ | $s\bar{s}$ |

Question 5

The K^- is an example of a meson with strangeness -1 .

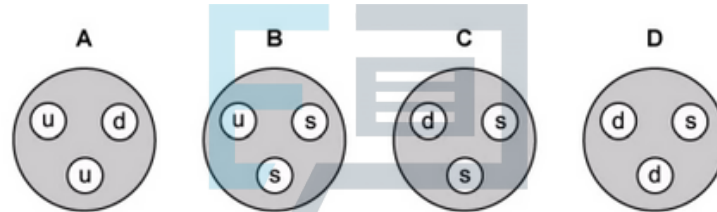
Which of the following combinations of particles could the K^- particle decay to?

- A. $\pi^+ + \pi^- + e^-$
- B. $\pi^0 + \pi^- + n$
- C. $\pi^- + e^- + \bar{\nu}_e$
- D. $\pi^0 + \mu^- + \bar{\nu}_\mu$

[1 mark]

Question 6

Which of the four hadrons shown could be Ξ^0 ?



[1 mark]

**Question 7**

None of the following decay equations for baryons are permitted.

Equation 1: $n \rightarrow p + e^- + \nu_e$

Equation 2: $\Delta^+ \rightarrow \pi^+ + \pi^0$

Equation 3: $p \rightarrow n + e^- + \nu_e$

Equation 4: $\Xi^0 \rightarrow p + \bar{\nu} + \pi^0$

Which property is not conserved in each equation?

| | Equation 1 | Equation 2 | Equation 3 | Equation 4 |
|----------|---------------|---------------|--------------------------|---------------------------------|
| A | charge | baryon number | charge and lepton number | baryon number |
| B | lepton number | baryon number | charge and lepton number | charge and lepton number |
| C | baryon number | lepton number | baryon number | lepton number and baryon number |
| D | lepton number | charge | charge | charge |

[1 mark]

Question 8

The charmed sigma particle, Σ_c^{++} decays through the following equation:

$$\Sigma_c^{++} \rightarrow \Lambda_c^+ + \pi^+$$

Both Σ_c^{++} and Λ_c^+ contain one charm quark and have strangeness of 0.

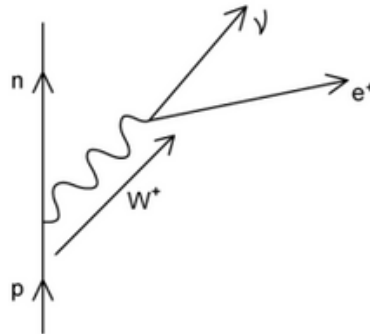
Which of the following could be the quark structure of the Σ_c^{++} and the Λ_c^+ ?

| | Σ_c^{++} | Λ_c^+ |
|----------|-----------------|---------------|
| A | ddc | $\bar{u}c$ |
| B | udc | dsc |
| C | uuc | udc |
| D | udc | uuc |

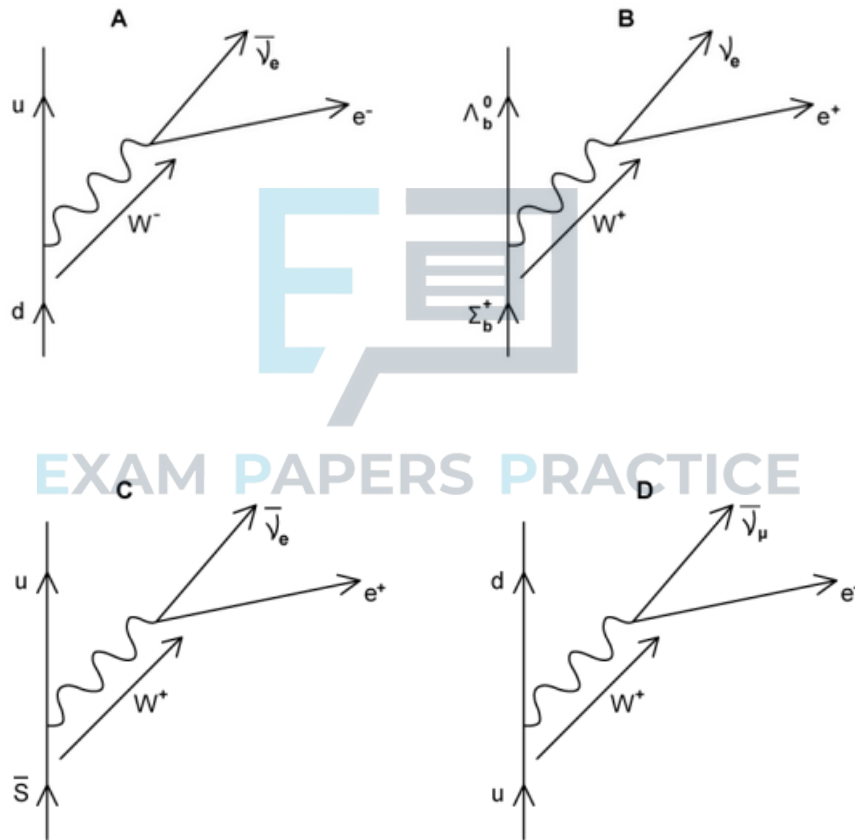


Question 9

The following Feynman diagram shows the baryons and leptons in a nuclear decay



Which of the four Feynman diagrams, **A** to **D**, is physically equivalent to the diagram given for this decay?



[1 mark]

Question 10

The Higgs Boson was discovered at CERN in 2012. It is not stable and decays into other particles.

Which of the following could not be a possible decay pathway for the Higgs Boson?

- A. $W^+ + W^-$
- B. $p + e^- + \nu_e$
- C. $\gamma\gamma$
- D. $b\bar{b}$

[1 mark]