1 (a) Describe the interaction that is responsible for keeping protons and neutrons together in a stable nucleus.
You should include details of the properties of the interaction in your answer.

Called the strong force
Is a short range force beginning to act around 3-5fm
Attractive from about 3-5fm to about 1fm
Closer than 1fm it becomes replusive quickly
Acts on hardrons (ie baryons and mesons)
Mediated by (gluons) called pions

(3)

(b) Nuclei can decay by alpha decay and by beta decay.

In alpha decay only one particle is emitted but in beta decay there are two emitted particles.

Explain how baryon number is conserved in alpha and beta decay.

In alpha the total number of protons and neutrons remains the same there baryon number is conserved

In beta decay a neutron -> proton - so overall baryon number from hardons doesn't change. The electron emitted has a baryon number =0. So overall no change

(3)

(c) Kaons are mesons that can be produced by the strong interaction between pions and protons.

The equation shows a reaction in which a kaon and a lambda particle are produced.

$$\pi^- + p \rightarrow K^0 + \Lambda^0$$

quarks don't alter via strong so same no of each

Deduce the quark structure of the Λ^0

$\pi + p \rightarrow K^0 + \Lambda^0$

$d\bar{u} + uud \rightarrow d\bar{s} \quad uds$

$d\bar{u}uud$ ie ddu

$d\bar{s}uds \Rightarrow dud$

quark structure = _____

so uds

(2)

(d) The kaon decays by the weak interaction.

The equation shows an example of kaon decay.

$$K^0 \rightarrow \pi^+ + \pi^-$$

$d\bar{s} \rightarrow d\bar{d} + \bar{u}\,d$

State **one** feature of this decay that shows it is an example of the weak interaction.

✓ Strangeness not conserved (which is true in weak)

(1)

(e) There have been considerable advances in our understanding of particle physics over the past 100 years.

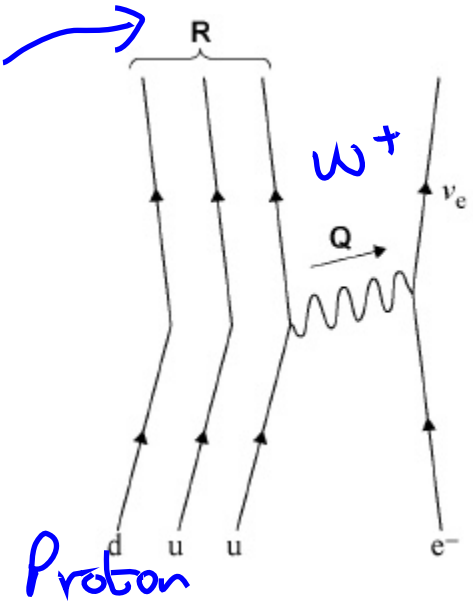
Explain why it is necessary for many teams of scientists and engineers to collaborate in order for these advances to be made.

- V. expensive particles
- check results
- huge skill sets required

(2)

(Total 11 marks)

5 The partially completed diagram represents electron capture.



Which row identifies the exchange particle **Q** and the quark structure of particle **R**?

	Particle Q	Quark structure of particle R	
A	W^-	uuu	○
B	W^+	dud	●
C	W^+	uuu	○
D	W^-	dud	○

(Total 1 mark)

6 The decay of a neutral kaon K^0 is given by the equation

$$K^0 \rightarrow X + Y + \bar{\nu}_e$$

What are X and Y?

do via lepton numbers (in this case L_e)

	X and Y	
A	e^+ and e^-	○
B	μ^+ and e^-	○
C	π^+ and e^-	●
D	π^- and e^+	○

(Total 1 mark)

11 When a nucleus of the radioactive isotope $^{65}_{28}Ni$ decays, a β^- particle and an electron antineutrino are emitted.

How many protons and neutrons are there in the resulting daughter nucleus?

	Number of protons	Number of neutons	
A	28	65	⬭
B	29	65	⬭
C	29	36	⬭
D	30	35	⬭

(Total 1 mark)

12 What interactions are involved in the production of a strange particle and its decay into non-strange particles?

	Production	Decay	
A	strong	weak	⬭
B	strong	strong	⬭
C	weak	strong	⬭
D	weak	weak	⬭

Strangeness rules are:
created via strong
decay via weak

(Total 1 mark)

16 An atom of $^{16}_{7}N$ gains 3 electrons.

What is the specific charge of the ion?

A 1.80×10^{7} C kg^{-1} ⬭

B -1.80×10^{7} C kg^{-1} ⬭

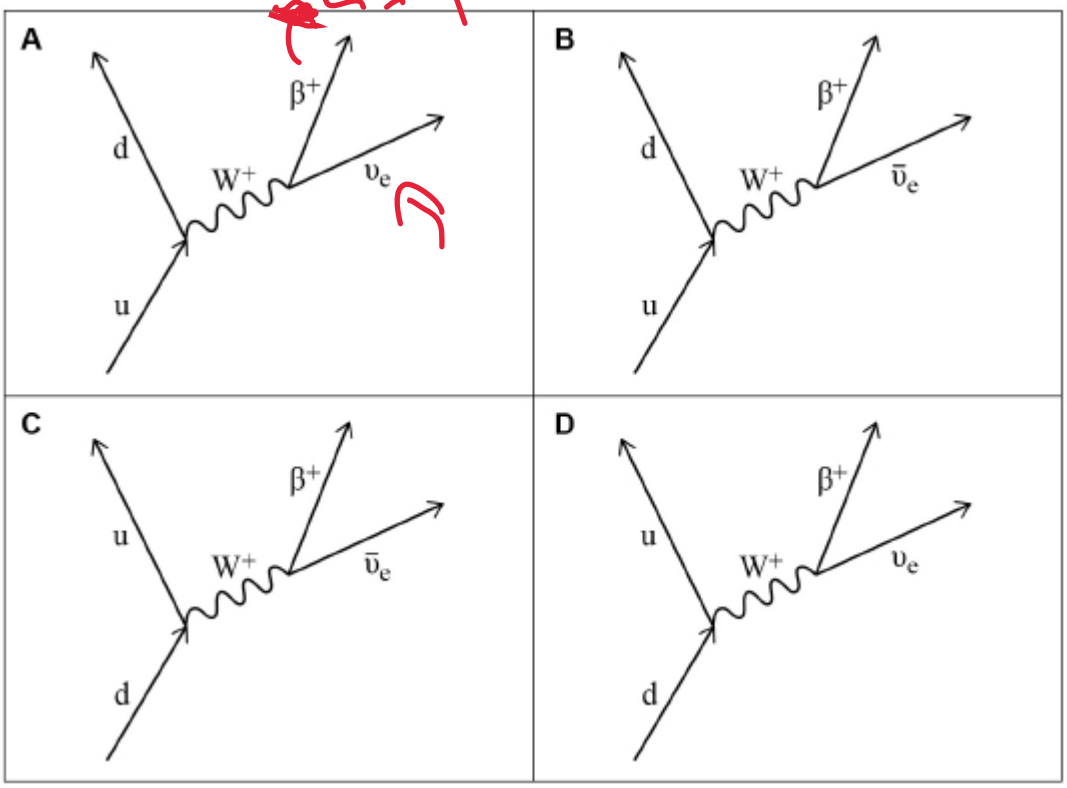
C 4.19×10^{7} C kg^{-1} ⬭

D -4.19×10^{7} C kg^{-1} ⬭

$p \rightarrow N + \beta^{+} + \nu_e$

(Total 1 mark)

17 Which diagram represents the process of beta-plus decay?



$u \rightarrow d$ is $p \rightarrow N$

A ⬭

B ⬭

C ⬭

D ⬭

β^{+} has $L_e = -1$

∴ need a $\bar{\nu}$ (not a $\bar{\upsilon}$)

(Total 1 mark)