

**40** Which particle is a lepton?

- A** meson
- B** positron
- C** proton
- D** quark

**38** An up quark in a hadron changes to a down quark.

The elementary charge is  $e$ .

What is the magnitude of the change in the charge of the hadron?

- A**  $\frac{1}{3}e$
- B**  $\frac{2}{3}e$
- C**  $e$
- D** zero

**40** Which combination of three quarks has no overall charge?

- A** down, strange, strange
- B** up, charm, strange
- C** up, charm, top
- D** up, down, strange

6 (a) State what is meant by a fundamental particle.

.....  
..... [1]

(b) (i) Particle Q is a meson with a charge of 0.

Determine a possible quark composition for Q.

..... [2]

(ii) Particle Q has a mass of 0.67 u and a kinetic energy of  $2.1 \times 10^{-16}$  J.

Calculate the speed of particle Q.

speed = .....  $\text{ms}^{-1}$  [3]

(c) Radium-228 ( $^{228}_{88}\text{Ra}$ ) is a radioactive nuclide.

(i) State the number of electrons in a neutral atom of radium-228.

number of electrons = ..... [1]

(ii) A nucleus of radium-228 undergoes a series of decays to form nucleus X.  
During the process, 5  $\alpha$ -particles and 4  $\beta^-$  particles are emitted.

Determine the number of protons and the number of neutrons in nucleus X.

number of protons = .....

number of neutrons = .....

[2]

[Total: 9]

**38** Which list contains only fundamental particles?

- A** antineutrinos, baryons, neutrons, electrons
- B** mesons, electrons, neutrinos, protons
- C** positrons, quarks, hadrons, protons
- D** quarks, positrons, neutrinos, leptons

**40** A hadron consists of antiquarks that are all identical.

What is a possible value, in terms of the elementary charge  $e$ , for the charge on the hadron?

- A**  $0e$
- B**  $+1e$
- C**  $+2e$
- D**  $+3e$

**39** What is the composition of a meson?

- A** 1 quark and 1 antiquark
- B** 1 quark and 2 antiquarks
- C** 2 quarks and 1 antiquark
- D** 3 quarks

**40** A nucleus of carbon-11 contains 6 protons and 5 neutrons.

The nucleus of carbon-11 decays by  $\beta^+$  emission.

What is the total number of up and down quarks in the product of the decay of this nucleus?

|          | up quarks | down quarks |
|----------|-----------|-------------|
| <b>A</b> | 15        | 18          |
| <b>B</b> | 16        | 17          |
| <b>C</b> | 17        | 16          |
| <b>D</b> | 18        | 15          |

**33** What **cannot** be the charge on a charge carrier?

- A**  $-4.8 \times 10^{-19} \text{ C}$
- B**  $-3.2 \times 10^{-19} \text{ C}$
- C**  $-2.4 \times 10^{-19} \text{ C}$
- D**  $+3.2 \times 10^{-19} \text{ C}$

**38** A nucleus decays by emitting a  $\beta^+$  particle.

Which particle **must** also be emitted from the nucleus?

- A** antineutrino
- B**  $\beta^-$  particle
- C**  $\alpha$ -particle
- D** neutrino

**39** What are the charges on an antidown quark and on an antistrange quark?

|          | antidown quark  | antistrange quark |
|----------|-----------------|-------------------|
| <b>A</b> | $+\frac{1}{3}e$ | $+\frac{1}{3}e$   |
| <b>B</b> | $+\frac{1}{3}e$ | $-\frac{1}{3}e$   |
| <b>C</b> | $-\frac{1}{3}e$ | $+\frac{1}{3}e$   |
| <b>D</b> | $-\frac{1}{3}e$ | $-\frac{1}{3}e$   |