7 **(a)** Give one example of

a hadron: .....

a lepton: .....
[1]

(b) Describe, in terms of the simple quark model,

(i) a proton,

.....[1]

(ii) a neutron.

.....[1]

(c) Beta particles may be emitted during the decay of an unstable nucleus of an atom. The emission of a beta particle is due to the decay of a neutron.

(i) Complete the following word equation for the particles produced in this reaction.

neutron → ..... + ... + ... [1]

(ii) State the change in quark composition of the particles during this reaction.

.....[1]

[Total: 5]

6 A neutron decays by emitting a β^- particle.

(a) Complete the equation below for this decay.

$$ {}^{1}_{0}\mathrm{n} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\cdots\cdots + {}^{\cdots\cdots}_{\cdots\cdots}\beta^- + {}^{\cdots\cdots}_{\cdots\cdots}\bar{\nu} $$

[2]

(b) State the name of the particle represented by the symbol $\bar{\nu}$.

..... [1]

(c) State the name of the class (group) of particles that includes β^- and $\bar{\nu}$.

..... [1]

(d) State

(i) the quark structure of the neutron,

..... [1]

(ii) the change to the quark structure when the neutron decays.

.....

..... [1]

[Total: 6]

8 **(a)** State the quantities, other than momentum, that are conserved in a nuclear reaction.

.....

.....[2]

(b) A stationary nucleus of uranium-238 decays to a nucleus of thorium-234 by emitting an α-particle. The kinetic energy of the α-particle is 6.69×10^{-13} J.

(i) Show that the kinetic energy E_k of a mass m is related to its momentum p by the equation

$$E_k = \frac{p^2}{2m}.$$

[1]

(ii) Use the conservation of momentum to determine the kinetic energy, in keV, of the thorium nucleus.

kinetic energy = ... keV [3]