MeV Conversion Questions

Q1.

The SI unit for mass is the kilogram. However, particle physicists often use the alternative unit

- **A** MeV
- **B** MeV/c
- **C** MeV/c^2
- **D** MeV^2/c^2

(Total for question = 1 mark)

Q2.

Pions are the lightest mesons. A negative pion (π^-) has a mass of 2.48×10^{-28} kg.

Which of the following is the mass of the π^- in in MeV/c^2?

- **A** 1.4×10^{8}
- **B** 1.4×10^{2}
- **C** 4.7×10^{-7}
- **D** 3.6×10^{-24}

(Total for question = 1 mark)

Q3.

A muon has a mass of 106 MeV/c^2.

The mass of a muon, to two significant figures, is

- **A** 1.7×10^{-11} kg
- **B** 5.7×10^{-20} kg
- **C** 1.9×10^{-28} kg
- **D** 1.9×10^{-34} kg

(Total for Question = 1 mark)

Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

A proton has a mass of 1.67×10^{-27} kg.

Which of the following shows the conversion of this mass to GeV/c^2 ?

☐ **A** $\dfrac{1.67 \times 10^{-27} \times 1.60 \times 10^{-10}}{(3.00 \times 10^{8})^2}$

☐ **B** $\dfrac{1.67 \times 10^{-27} \times 1.60 \times 10^{-19}}{(3.00 \times 10^{8})^2}$

☐ **C** $\dfrac{1.67 \times 10^{-27} \times (3.00 \times 10^{8})^2}{1.60 \times 10^{-10}}$

☐ **D** $\dfrac{1.67 \times 10^{-27}}{1.60 \times 10^{-10} \times (3.00 \times 10^{8})^2}$

(Total for question = 1 mark)

Q5.

The neutral lambda Λ^0 particle is a baryon of mass 1116 MeV/c^2 and contains one strange quark.

Calculate the mass of the Λ^0 particle in kg.

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Mass of Λ^0 particle = ... kg

(Total for question = 3 marks)

Q6.

Pions belong to a group of particles called mesons. Pions can be used in a form of radiotherapy to treat brain tumours.

The mass of a pion is 140 MeV/c^2.

Calculate the mass of a pion in kg.

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Mass = ...

(Total for question = 3 marks)

Q7.

Beams of antiprotons are often used in particle physics experiments.

Show that the rest mass of an antiproton is about 900 MeV / c^2.

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(Total for question = 4 marks)

Q8.

A muon (μ) is a lepton with a mass of 106 MeV/c^2.

Calculate the mass of a muon in kg.

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Mass of muon = ... kg

(Total for question = 3 marks)

Q9.

Subatomic particles such as pions are produced after collisions between protons that have been accelerated in a cyclotron.

The mass of a pion is 2.5×10^{-28} kg.

Calculate the mass of a pion in GeV/c^2.

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Mass = ... GeV/c^2

(Total for question = 3 marks)

Q10.

In 2011 physicists at the Relativistic Heavy Ion Collider (RHIC) announced the creation of nuclei of anti-helium-4 which consists of anti-protons and anti-neutrons instead of protons and neutrons.

'Ordinary' helium-4 is written as $^{4}_{2}\mathrm{He}$

Show that the mass of a stationary anti-helium nucleus is about 4 GeV/c^2.

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(Total for question = 4 marks)

Q11.

The discovery of the Higgs particle was an important contribution to our understanding of particle physics.

The mass of the Higgs particle is 2.2×10^{-25} kg.

Calculate this mass in GeV/c^2.

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Mass = ... GeV/c^2

(Total for question = 3 marks)

Q12.

A cosmic ray, consisting of a fast-moving proton, collides with a proton within the nucleus of an atom in the upper atmosphere. Three particles, a proton, a neutron and a pion result from the collision.

The mass of a pion is 140 MeV / c^2 .

Calculate the mass of the pion in kg.

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Mass = ... kg

(Total for question = 3 marks)

Q13.

A delta particle decays into a proton and a pion.

The mass of the delta particle is 1232 MeV/c^2.

(i) Calculate the mass of the delta particle in kg.

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Mass = ... kg

(ii) The mass of the proton is 939 MeV/c^2 and the mass of the pion is 139 MeV/c^2.

Explain why the sum of the masses of the two particles after the decay is not equal to the mass of the delta particle.

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(Total for question = 6 marks)

Q14.

A muon (μ) is a lepton with a mass of 106 MeV/c^2.

Muons are produced from the decay of pions in the upper atmosphere.

An example of this decay is given by the equation

$$\pi^- \rightarrow \mu^- + \bar{\nu}_\mu$$

The masses of these three particles, in MeV/c^2, are given below.

π^-	μ^-	$\bar{\nu}_\mu$
140	106	≈0

Explain why the total kinetic energy of the products of this decay is approximately 34 MeV. Assume the π^- is stationary.

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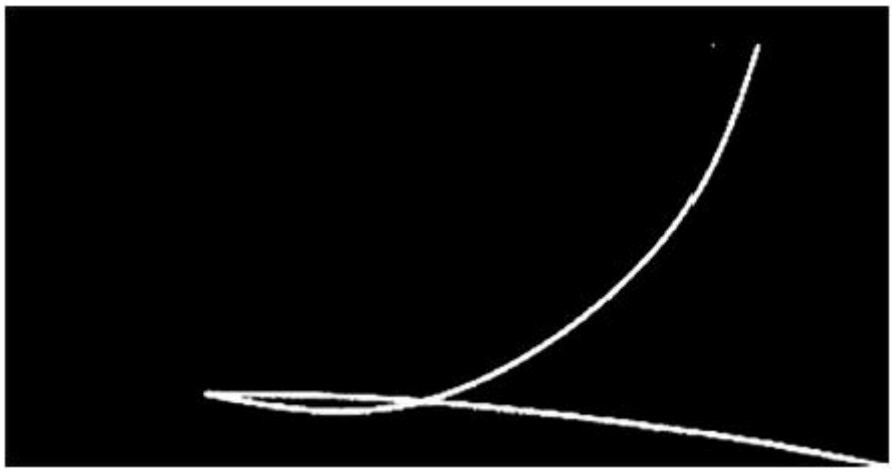
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(Total for question = 2 marks)

Q15.

The bubble chamber photograph shows tracks made by a proton and a pion. The proton and pion were both created by the decay of a lambda particle. No other particles were produced.



The rest mass of the lambda particle is 1115 MeV / c^2.

(i) Calculate this mass in kg.

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Mass = ... kg

(ii) The rest mass of a proton is 940 MeV / c^2. The rest mass of a pion is 140 MeV / c^2.

The kinetic energy of the lambda particle just before decay is 4.95 GeV.
Calculate the total kinetic energy of the proton and pion in MeV.

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Total kinetic energy = ... MeV

(Total for question = 6 marks)

Q16.

Hadrons are a group of particles composed of quarks. Hadrons can be either baryons or mesons.

The rest mass of the K^+ is 494 MeV/c^2.

Calculate, in joules, how much energy is released if a K^+ meets and annihilates a K^-.

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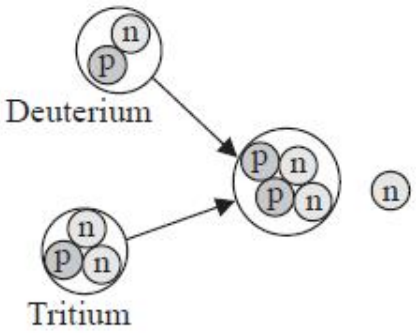
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Energy = ... J

(Total for Question = 3 marks)

Q17.

The latest proposed fusion reactor will fuse deuterium and tritium, which are isotopes of hydrogen. This fusion reaction is illustrated below.



(i) Complete the nuclear equation below to represent this fusion reaction.

(2)

$$\text{.....}^{\text{.....}}\text{H} + \text{.....}^{\text{.....}}\text{H} \rightarrow \text{.....}^{\text{.....}}\text{He} + \text{.....}^{\text{.....}}\text{n}$$

(ii) Calculate the energy released in the fusion of one deuterium nucleus with one tritium nucleus.

Particle	Mass / GeV/c^2
Proton	0.938272
Neutron	0.939566
Deuterium	1.875600
Tritium	2.808900
Helium	3.727400

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Energy released = ...

(Total for question = 4 marks)