**Year 12 Physics TEST # 6 – Standard Model 2022**

NAME:

*Total Marks: 35 Time Allowed: 45 minutes*

(Formula sheet and scientific calculator permitted)

**Question 1 (3 marks)**

Calculate in joules the energy lost when a top quark decays to a charm quark.

**Question 2 (4 marks)**

State Y (yes) or N (no) to indicate which of the four fundamental forces affect(s) anti-neutrinos:

|  |  |
| --- | --- |
| **Force** | **YES/NO** |
| Electromagnetism  Gravity  Weak nuclear  Strong nuclear |  |

**Question 3 (7 marks)**

The meson is called a *kaon* (or *K*+) particle. This particle decays according to the following partially complete equation:

……

where (pion positive) is the meson .

1. Determine the charge and baryon number of the missing particle. [2]
2. Complete the table below to classify the kaon positive particle. Answer Y (yes) or  
   N (no) in each case: [4]

|  |  |
| --- | --- |
| **Category** | **YES/NO** |
| Baryon  Hadron  Fermion  Boson |  |

1. Write down the quark code for the antiparticle (*K*-) of the kaon particle. [1]

**Question 4 (5 marks)**

The *Compton wavelength* of a particle is given by and the *Compton frequency* is given by , where is Planck’s constant and is the speed of light.

If gravitons have mass, it is believed that their Compton wavelength is at least 1.60 light-years.

Use the above information to determine

1. the maximum mass of a graviton in kg, [3]
2. the maximum Compton frequency of a graviton in Hz. [2]

**Question 5 (4 marks)**

Show that the following equation obeys lepton number conservation for all the appropriate lepton number types:

.

**Question 6 (4 marks)**

With reference to dark energy and dark matter, explain why the Big Crunch theory of the universe’s fate is now thought unlikely.

**Question 7 (8 marks)**

1. Explain the observed phenomenon of red shift, using the current scientific thinking that space itself is expanding. [3]
2. Use Hubble’s Law to determine the recessional speed of the galaxy GN-z11, which was discovered in the Ursa Major constellation in 2015 at a distance of 9.80 billion parsecs. Use *H*o = 67.4 km s-1 MPc-1 and give your answer in terms of *c*, the speed of light. [3]
3. Does your answer in part (b) conflict with Einstein’s universal speed limit? (Hint: refer to part (a).) [2]

*- End of Questions -*