



Higher Standard Model Answers

1. A model for **classifying sub-nuclear particles** and their **interactions**.

2. Powers of ten are known as **orders of magnitude**.

3. a) The second particle is a **neutrino**.
b) A neutrino has a **very small mass** and **no charge**.

4. a) Matter and anti-matter.
b) Matter and anti-matter particles are the same in everything except they are **opposite in charge**.
c) If these two types of particle collided they would **annihilate each other**.

5. a) Protons and neutrons in the nucleus are known as **nucleons**.
b) The fundamental particles that make up protons and neutrons are **quarks**.

6. a) There are **three generations** of quarks.
b) There are **two types of quark** in each generation.
c) In each generation of quark there is an **increase in mass**.

7. a) 'Lepton' means **light**.
b) The mass of a **quark is much greater** than the mass of a lepton in each pair.
c) Lepton pairs consist of a **charged particle and a neutrino**.

8. a) A **proton** consists of **two up quarks and a down quark**.
b) A **neutron** consists of **one up quark and two down quarks**.
c) **Electrons** are made up of **leptons**.

9. Matter and anti-matter particles are the same in everything except they are **opposite in charge**.

10. a) i) 'Hadron' means **heavy**.

ii) **Neutrons** are not used in collision experiments at CERN as they have **no charge**.

b) i) A **pair of quarks** combined are called **mesons**.

ii) **Mesons** are **short-lived** particles.

c) i) A **triplet of quarks** combined are called **baryons**.

ii) **Baryons** are stable **long-lived** particles.

11. a) Strong nuclear force, electromagnetic force, weak nuclear force and gravitational force.

b) **Weak** nuclear force.

c) **Gravitational** force.

d) **Electromagnetic** force.

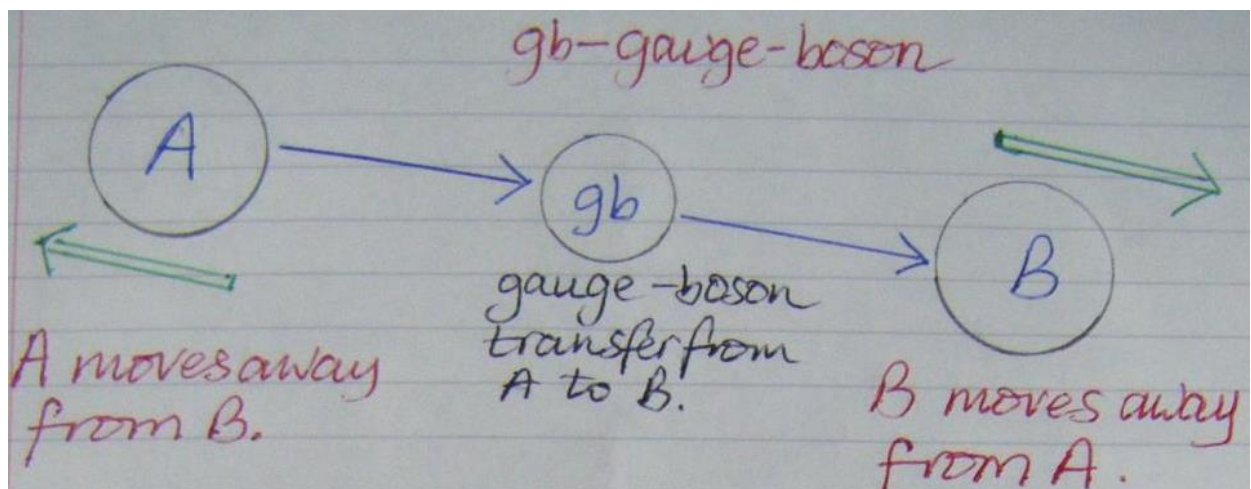
e) i) **Strong** nuclear force.

ii) $\times 10^{-14}\text{m}$.

12. a) Gauge-Bosons are **force mediating particles**.

b) Gauge-Bosons **carry momentum and energy** between massive particles.

c)



Particle **A emits** a gauge-boson.

Particle **A** then **recoils**.

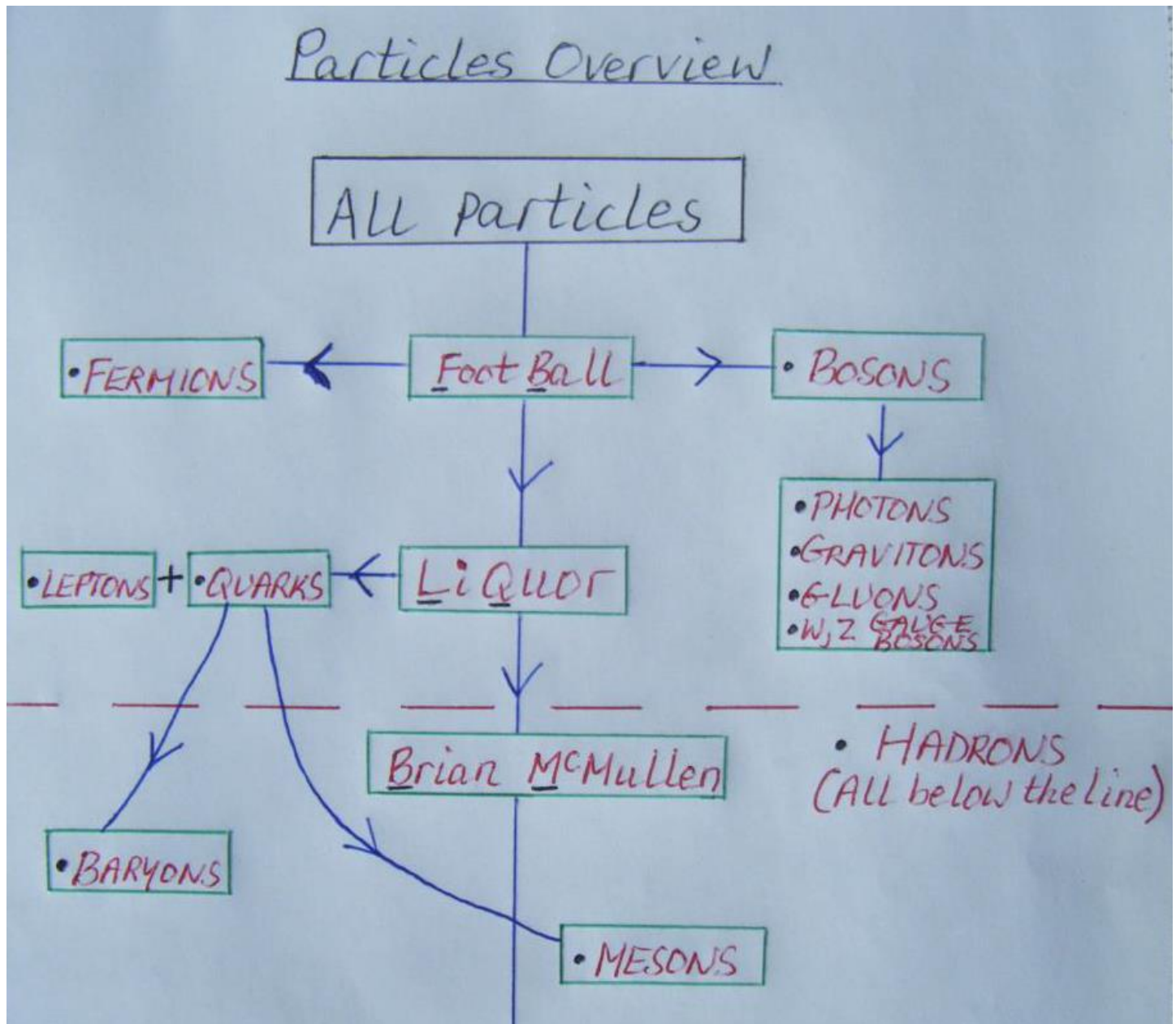
Particle **B** will **absorb** the gauge-boson.

Particle **B** will now **move away** from particle A.

13. Gluons.

14. Photons.

15. a)



b) All particles **below the horizontal line** are **hadrons**.

c) **Fermions include all quarks and leptons** as well as any composite particle made of an odd number of these.

A **fermion** can be an elementary particle such as an **electron** or it can be a composite particle such as a **proton**.