Higher Gravitation Answers

1. **F** - Gravitational force of attraction -> **N**.

G – Universal constant of gravitation -> 6.67 x10^{-11} **Nm^2kg^{-2} or** $m^3kg^{-1}s^{-2}$.

m_1 – mass of object 1 -> **kg**

m_2 – mass of object 2 -> **kg**

r – distance between object 1 and object 2 -> **m**. (This is measured from the centre of each object!!)

$$F = G\frac{m_1 m_2}{r^2}$$

2. a) Strong nuclear force, weak nuclear force and the electromagnetic force.

b) Strong nuclear force, weak nuclear force, electromagnetic force and the gravitational force.

3. F = 8.0 x 10^{-8}N.

4. a) From

$$F = G\frac{m_1 m_2}{r^2}$$

$G = \frac{F r^2}{m_1 m_2}$ => $G = Nm^2kg^{-2}$

b) From F = ma -> 1N = $1kgms^{-2}$

=> **Nm^2kg^{-2}** = $(kgms^{-2})m^2kg^{-2}$ = **$m^3kg^{-1}s^{-2}$**.

5. F = 3.56 x 10^{26}N.

6. F = 1124N.

7. a) Weight = Gravitational force

$$\Rightarrow mg = \frac{GMm}{r^2}$$

$$\Rightarrow \mathbf{g = \frac{GM}{r^2}}$$

b) i) $g = 8.65 Nkg^{-1}$.

ii) T = 5549s.

8. a) Gravitational force is the force or weight acting on unit mass. **Nkg^{-1}**.

b) i) Weight = Gravitational force

$$\Rightarrow mg = \frac{GMm}{r^2}$$

$$\Rightarrow \mathbf{G = \frac{gr^2}{M}}$$

ii) $G = \frac{26.4 \times (70{,}000 \times 10^3)^2}{1.94 \times 10^{27}} = \mathbf{6.67 \times 10^{-11} Nm^2 kg^{-2}}$. => **QED**

9. Weight = Gravitational force

$$\Rightarrow mg = \frac{GMm}{r^2}$$

$$\Rightarrow \mathbf{g = \frac{GM}{r^2}}$$

$gr^2 = GM$ => a constant

a) $r_2 = 8.49 \times 10^5 m$.

b) $g = 18 Nkg^{-1}$.

10. $M = 1.09 \times 10^{26} kg$.