

## O Level Physics

### Unit 4: Mass, Weight and Density

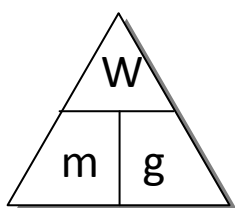
#### Mass and Weight

	Mass	Weight
1) Definition	Measure of the amount of matter in a body.	Amount of gravitational force acting on a body.
SI Unit	Kilogram (kg)	Newton (N)
Dependent on	Dependent on the number and composition of atoms making up the body.	Dependent on the mass of the object and the gravitational field strength.
Properties	Mass has only magnitude, and is constant (unaffected by gravitational field strength).	Weight has both magnitude and direction (towards the centre of Earth).
Measuring Instrument	Beam balance, electronic balance	Spring balance, compression balance
Relationship	Weight of an object is directly proportional to its mass. Weight = Mass x Gravitational field strength	

#### Gravitational field strength

- Gravitational field is the region surrounding the Earth where gravity is experienced.
- Gravitational field strength,  $g$ , is the gravitational force acting per unit mass on an object.  
SI unit= N/kg.
- The gravitational force pulls objects to the centre of the Earth and gets weaker with increasing altitude.
- A 1kg object will experience a 10N gravitational force due to Earth's gravitational pull (gravity).

11)



$$\text{Weight (N)} = \text{Mass (kg)} \times \text{Gravitational field strength (N/kg)}$$
$$W = mg$$

- An electronic balance measures the weight of an object but is calibrated to give readings in mass (kg). If used on the Moon, it will register a lower reading as it is not calibrated to the Moon's lower gravitational field strength.
- A calibrated electronic balance reads 70kg on Earth.
  - Given that the gravitational field strength on Earth and on the Moon is 10N/kg and 1.6N/kg respectively, calculate the mass the electronic balance will read on the Moon.
  - Explain why the electronic balance registered a different reading of the same mass on the Moon.
  - If the electronic balance was replaced with a beam balance, would it register the correct reading of 70kg? Why?

$$\begin{aligned} \text{(a) Weight on Moon} &= 70\text{kg} \times 1.6\text{N/kg} \\ &= 112\text{N} \end{aligned}$$

The balance is calibrated for use on Earth where  $g$  is  $10\text{N/kg}$ .

$$\begin{aligned} \therefore \text{mass (it will register)} &= \frac{\text{weight on moon}}{\text{calibrated } g} \\ &= \frac{112\text{N}}{10\text{N/kg}} \\ &= 11.2\text{kg (Ans)} \end{aligned}$$

*(b) The electronic balance is calibrated for use on Earth only. Since gravitational field strength on the Moon is lower than that of Earth, it will display a lower reading since the scale is not calibrated to the Moon's lower gravitational field strength.*

*(c) It will display the correct 70kg. A beam balance compares the gravitational force acting on an object with standard masses. Since both pans of the beam balance will experience the same gravitational field strength, the mass readings taken whether on Earth or on Moon would be the same.*

### Inertia

14) The inertia of an object is the reluctance of the object to change its state of motion or rest.

Note: Inertia is not a force.

15) The inertia of an object is directly proportional to its mass.

16) **Explain how seatbelts can prevent a driver from injury during a sudden stop.**

*Initially, the driver is in motion. During a sudden stop, the driver will continue to move forward due to his inertia. Without seatbelts, the driver will be thrown forward and crash into the windscreen. Seatbelts will pull the driver back onto his seat and stop him from moving forward, thus preventing him from crashing into the windscreen and injury.*

### Density

17) Density is the mass per unit volume of a substance. SI unit =  $\text{kg/m}^3$

The density of a substance is dependent on the composition and number of atoms making up

18) the substance (mass). Metals have high densities as the atoms are closely packed. The large number of atoms in 1kg the metal contributes to the higher mass and hence density, compared to gases where the molecules are spaced further apart.

19) **Use the kinetic particle theory to explain why solids have higher densities than gases.**

*Solids have higher densities than gases as their particles are packed closer together. The number of particles per unit mass in a solid is higher than in gases. Of the same mass, solids have a lower volume hence a higher density; while gases have higher volumes hence a lower density.*

Notes: