Explanation of the Formulas
F = f / V and F = ρ a

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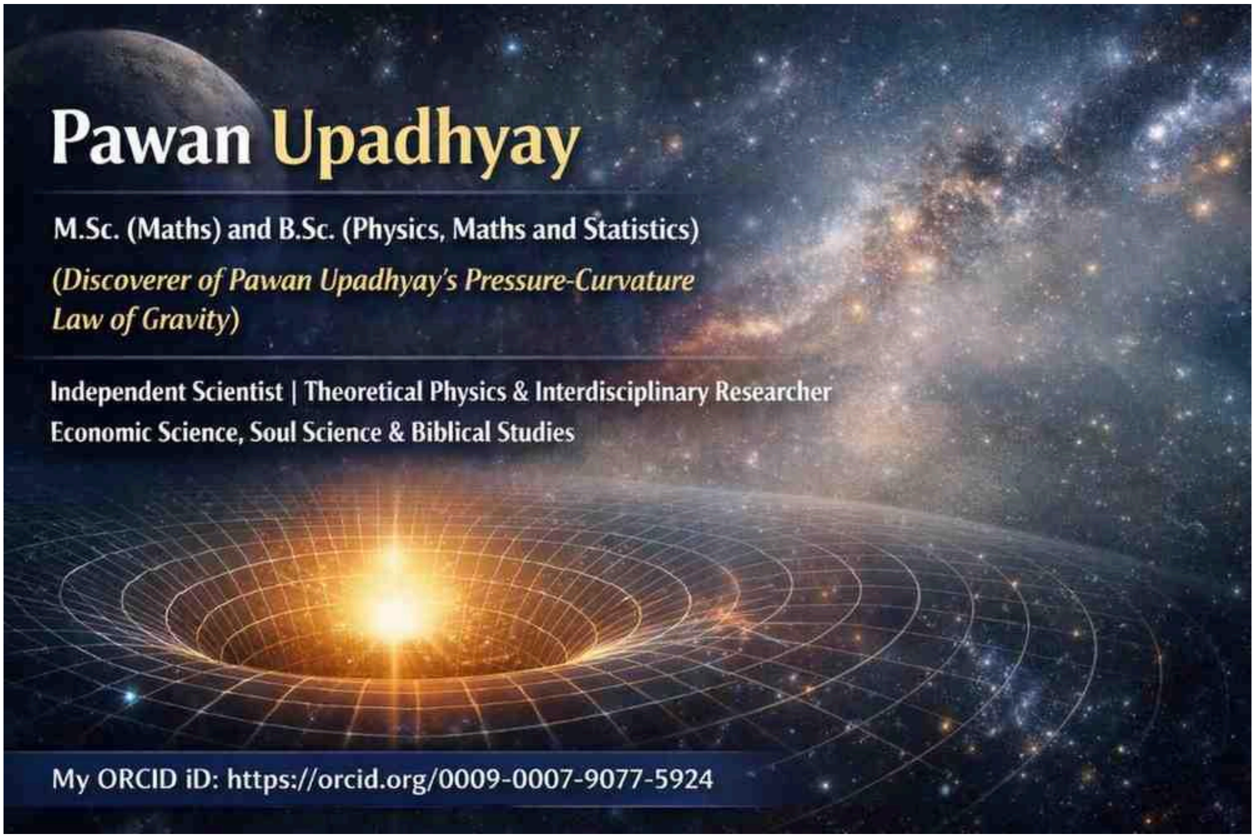

Force Density Definition
The field force density is defined as:
F = f / V

where
f = total force
V = volume
F = force per unit volume (force density)

This expression converts a total force acting on a body into a distributed field quantity.

Unit Check

Force (f):
Unit = Newton (N)

$1\ N = kg \cdot m \cdot s^{-2}$

Volume (V):
Unit = m^3
Therefore,
$F = N / m^3$

Substitute Newton:
$F = (kg \cdot m \cdot s^{-2}) / m^3$
$F = kg \cdot m^{-2} \cdot s^{-2}$

Thus, the unit of force density is:
N/m^3
or
$kg \cdot m^{-2} \cdot s^{-2}$

Dimensional Check

Force dimension:
$[f] = M\ L\ T^{-2}$

Volume dimension:
$[V] = L^3$

So,
$[F] = (M\ L\ T^{-2}) / L^3$
$[F] = M\ L^{-2}\ T^{-2}$
This is the correct dimension for force density.

Force Density from Mass Density

Starting from Newton's second law:
$f = m\ a$
Divide both sides by volume V:
$f / V = (m / V)\ a$
But mass density is defined as:
$\rho = m / V$
Therefore,
$F = \rho\ a$

Unit Check

Mass density (ρ):
Unit = kg/m^3

Acceleration (a):
Unit = m/s^2
Multiply:
$(kg/m^3) \times (m/s^2)$
$= kg \cdot m^{-2} \cdot s^{-2}$
$= N/m^3$
This matches the unit of force density.

Dimensional Check
Mass density dimension:
$[\rho] = M\ L^{-3}$
Acceleration dimension:
$[a] = L\ T^{-2}$
Multiply:
$(M\ L^{-3})(L\ T^{-2})$
$= M\ L^{-2}\ T^{-2}$
This exactly matches the dimension of force density.

Final Conclusion

$F = f / V = \rho\ a$
Unit: N/m^3
Dimension: $M\ L^{-2}\ T^{-2}$
Both expressions are dimensionally consistent and physically correct when ρ represents mass density.