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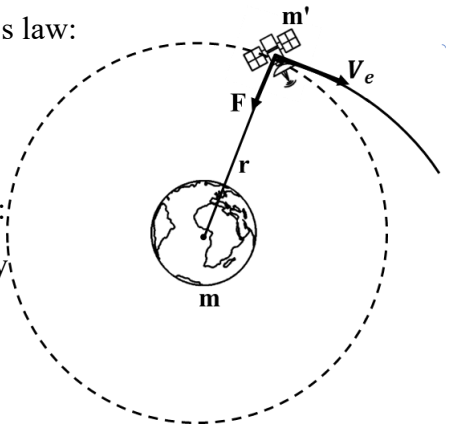
First name :
Last name :
Group :

Physics – 01
Academic year: 2025 – 2026
Duration : 30 min

Micro Interrogation No. 01 (groupe 3 and 6)

The force of attraction (F) acting between the earth of mass (m) and the satellite of mass (m'), separated by a distance (r), is given, in magnitude by Newton's law:

$$\boldsymbol{F = G\frac{mm'}{r^2}}$$



1- Determine the dimensional equations of the following quantities: velocity (V), acceleration (γ), force (F), work (W), kinetic energy (E_c), Period (T) and the universal gravitational constant (G).

2- Check that: $[\boldsymbol{2\pi r/V}] = [\boldsymbol{r^3/Gm}]^{\frac{1}{2}} = [\boldsymbol{T}] = \boldsymbol{T}$.

3- Find the expression of the velocity $(\boldsymbol{V_e})$ of a satellite freed from the gravitational influence (G) of the earth of radius (R) and mass (m), which takes the form:

$$\boldsymbol{V_e = k\, G^{\alpha} R^{\beta} m^{\gamma}}$$

(**k**: is a constant without dimension).

5 pts

Standard correction of Micro – Interrogation No 1, PHYSICS-1 (Section 1/2)

1°/ Dimensional equations

- Velocity: $[V] = \frac{[dx]}{[dt]} = LT^{-1}$ 0.25
- Acceleration: $[\gamma] = \frac{[dV]}{[dt]} = \frac{[V]}{[t]} = LT^{-2}$ 0.25
- Force: $[F] = [m][\gamma] = MLT^{-2}$ 0.25
- Work: $[W] = [\int F.dl] = ML^2T^{-2}$ 0.25
- Kinetic energy: $[E_c] = \left[\frac{1}{2}mV^2\right] = ML^2T^{-2}$ 0.25
- Period: [T]=T 0.25
- Gravitational constant G: $[G] = \left[\frac{F\,r^2}{m\,m'}\right] = M^{-1}L^3T^{-2}$ 0.5

2°/ Show that: $[2\pi r/V\,] = [r^3/Gm]^{\frac{1}{2}} = [T] = T$

$$\rightarrow \begin{cases} \left[\frac{2\pi r}{V}\right] = \frac{[r]}{[V]} = T & 0.5 \\ \left[\frac{r^3}{G\,m}\right]^{\frac{1}{2}} = \left(\frac{[r]^3}{[G][m]}\right)^{\frac{1}{2}} = T & 0.5 \\ [T] = T \end{cases}$$

So the relationship is verified

3°/ Expression of the escape velocity (Ve) of a satellite

We have: $V_e = k\,G^{\alpha}R^{\beta}m^{\gamma}$

Using dimensional homogeneity, it is necessary that: $[V_e] = \left[k\,G^{\alpha}R^{\beta}m^{\gamma}\right]$

$$\Rightarrow [V_e\,] = [k]\,[G]^{\alpha}[R]^{\beta}[m]^{\gamma}$$

$$\Longrightarrow LT^{-1} = M^{-\alpha+\gamma}\,L^{3\alpha+\beta}\,T^{-2\alpha}$$

$$\begin{cases} -\alpha+\gamma = 0 \\ 3\alpha+\beta = 1 \\ -2\alpha = -1 \end{cases} \Rightarrow \begin{cases} \alpha = \frac{1}{2} & 0.5 \\ \beta = -\frac{1}{2} & 0.5 \\ \delta = \frac{1}{2} & 0.5 \end{cases} \qquad \Rightarrow \text{Expression: } V_e = k\sqrt{\frac{G\,m}{R}} \quad 0.5$$