Answer on Question#54175 - Physics - Other

A recovery vehicle is towing a broken down lorry, of mass $m = 42$ tons, up an incline of 1 in 10. Both vehicles start from rest and accelerate constantly up the incline at $0.1\frac{\text{m}}{\text{s}^2}$. If the resistance to motion (not the gravitational component) is: $F = 820 + 0.06 \cdot v^3$ where F is resistance in Newtons and v is velocity in $\frac{\text{m}}{\text{s}}$. What is power in kW transmitted through the tow hook to the lorry at a velocity of $10\frac{\text{m}}{\text{s}}$?

A. 462.82
B. 556.34
C. 67.65
D. 120.8
E. 1220.67

Solution:

The resistance to motion consists of 3 components: gravitational, inertial force and F. The gravitational force is given by

$$F_g = m \cdot g \cdot \sin\alpha,$$

where α – is the angle of inclination, and $g = 9.8\frac{\text{m}}{\text{s}^2}$ – is the acceleration due to gravity.

The inertial force is given by

$$F_i = m \cdot a,$$

where $a = 0.1\frac{\text{m}}{\text{s}^2}$.

therefore the total force of resistance is given by

$$F_r(v) = F + F_g + F_i = 820 + 0.06 \cdot v^3 + m(g \cdot \sin\alpha + a)$$

Since $\tan\alpha = \frac{1}{10}$, then $\sin\alpha = \frac{1}{\sqrt{101}}$. The power in transmitted through the tow hook is given by

$$W(v) = F_r \cdot v = [820 + 0.06 \cdot v^3 + m(g \cdot \sin\alpha + a)] \cdot v$$

Therefore, the power at a velocity of $10\frac{\text{m}}{\text{s}}$ is

$$W(10) = \left[820 + 0.06 \cdot \left(10\frac{\text{m}}{\text{s}}\right)^3 + 42000\ \text{kg}\left(9.8\frac{\text{m}}{\text{s}^2} \cdot \frac{1}{\sqrt{101}} + 0.1\frac{\text{m}}{\text{s}^2}\right)\right] \cdot 10\frac{\text{m}}{\text{s}} = 460\ \text{kW}$$

Therefore the correct answer is A.

Answer: A.