

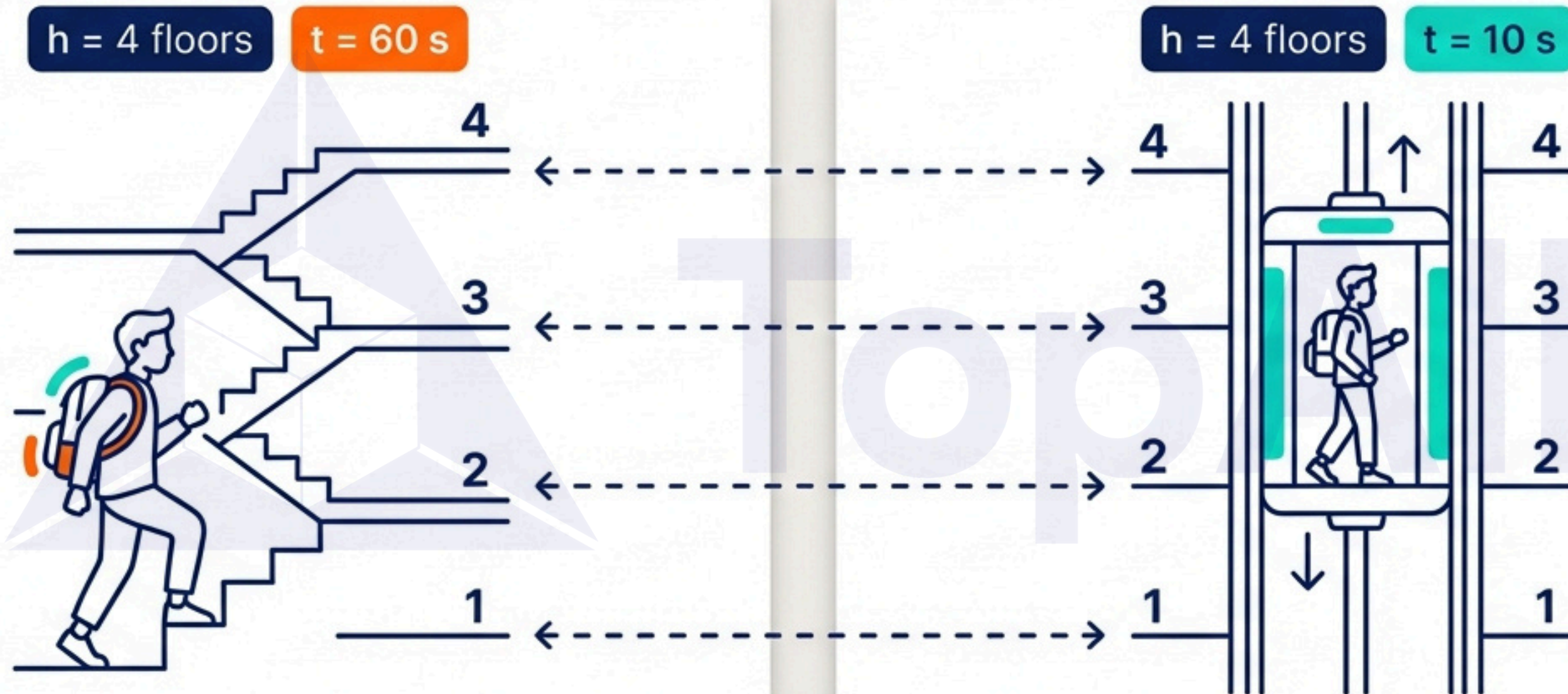
CLASS 11 PHYSICS • WORK, ENERGY & POWER

Power

The Time Rate of Doing Work and Energy Transfer.

Same Work, Different Time

Power tells us not just how much work is done, but how fast it is done.



Work Done (mgh) is IDENTICAL. Power is DIFFERENT.

Average Power

Average power is the ratio of total work done (W) to the total time taken (t).

QUANTITY

Scalar
(Directionless)

$$P_{av} = \frac{W}{t}$$

DIMENSIONS

$[M L^2 T^{-3}]$



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$$E=mc^2$$



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Key Highlights

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- » Get Clear Explanations, Not Just Marks
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Instantaneous Power

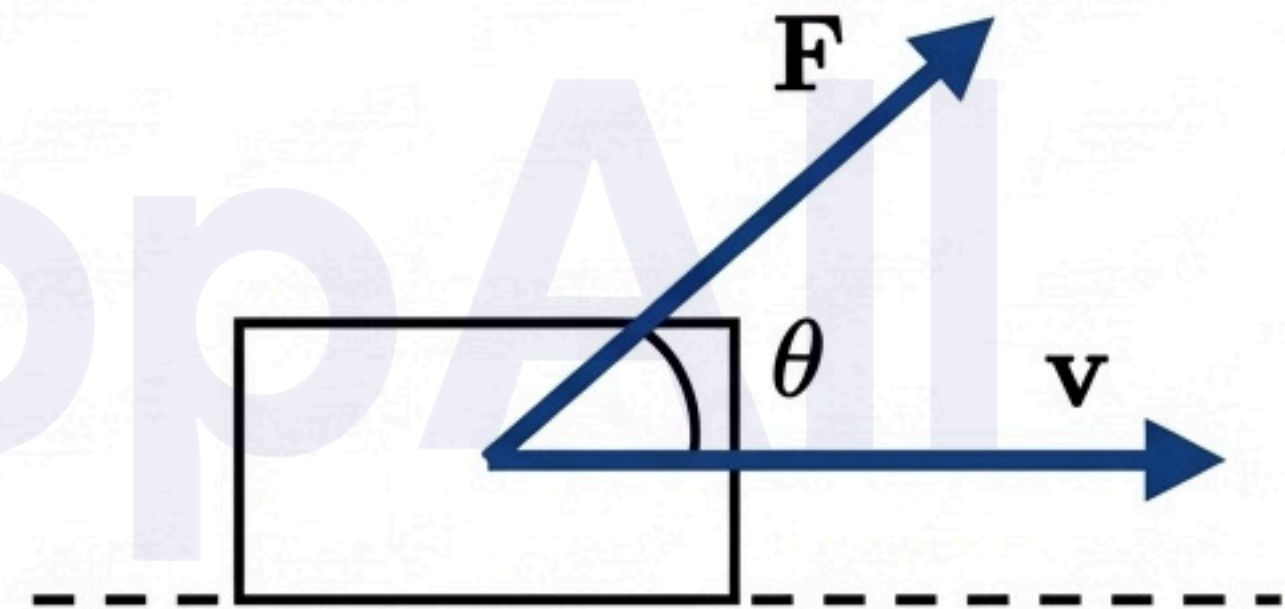
Power evaluated at a specific, limiting instant in time as the time interval approaches zero ($dt \rightarrow 0$).

$$P = \frac{dW}{dt}$$

Since $dW = \mathbf{F} \cdot d\mathbf{r}$

$$P = \mathbf{F} \cdot \frac{d\mathbf{r}}{dt}$$

$$P = \mathbf{F} \cdot \mathbf{v}$$



$$P = Fv \cos(\theta)$$

Units of Power & Energy

$$1 \text{ Watt (W)} = 1 \text{ J/s}$$

(SI Unit, named after James Watt)

$$1 \text{ Horsepower (hp)} \\ = 746 \text{ W}$$

(Common commercial unit for engines)

EXAM TRAP / MISCONCEPTION

Kilowatt-hour (kWh) is a unit of ENERGY, not Power.

Power $\times$ Time = Energy.

If a 1000 W device runs for **1 hour**, it consumes energy.

$$1 \text{ kWh} = 1000 \text{ W} \times 3600 \text{ s} \\ = 3.6 \times 10^6 \text{ Joules}$$

Key Takeaways



- ✓ Rate of Work: Power is the time rate at which work is done or energy is transferred ($P = W/t$).
- ✓ Vector to Scalar: Instantaneous power is the dot product of Force and Velocity ($F \cdot v$), making it a scalar quantity with dimensions $[M L^2 T^{-3}]$.
- ✓ kWh is Energy: Watt and Horsepower measure Power. Kilowatt-hour (kWh) measures Energy ($3.6 \times 10^6 \text{ J}$).



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