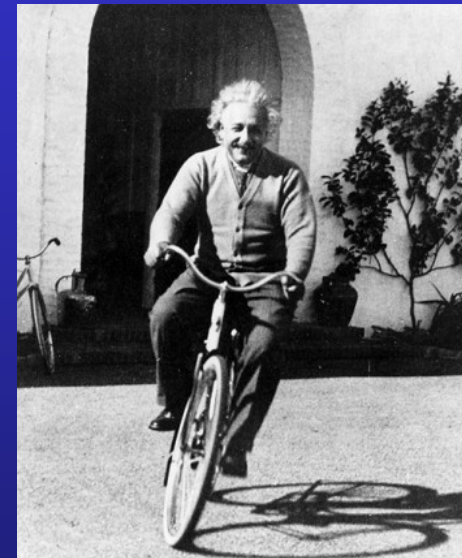


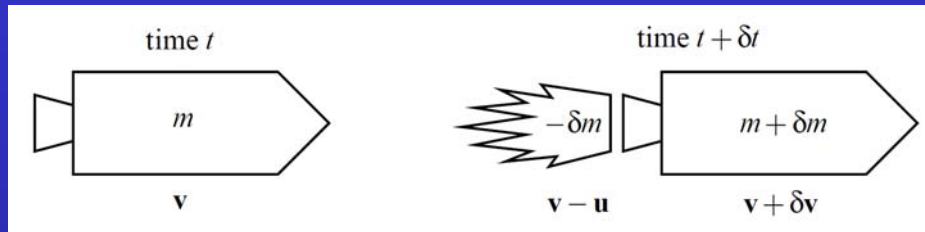
Classical Mechanics

PHYS 2006

Tim Freegarde



Rocket acceleration



- Momentum conserved; air resistance neglected

$$m\mathbf{v} = (m + \delta m)(\mathbf{v} + \delta \mathbf{v}) - \delta m(\mathbf{v} - \mathbf{u})$$

$$\Rightarrow \mathbf{u} \frac{dm}{m} = -d\mathbf{v}$$

$$\Rightarrow \mathbf{v}_f = \mathbf{v}_i + \mathbf{u} \ln \left(\frac{m_i}{m_f} \right)$$



Ariane 6



- Momentum conserved; air resistance neglected

$$m\mathbf{v} = (m + \delta m)(\mathbf{v} + \delta \mathbf{v}) - \delta m(\mathbf{v} - \mathbf{u})$$

$$\Rightarrow \mathbf{u} \frac{dm}{m} = -d\mathbf{v}$$

$$\Rightarrow \mathbf{v}_f = \mathbf{v}_i + \mathbf{u} \ln \left(\frac{m_i}{m_f} \right)$$

ARIANE 6.4

- launch mass: 800 tonnes
- payload: 10 tonnes

1st stage

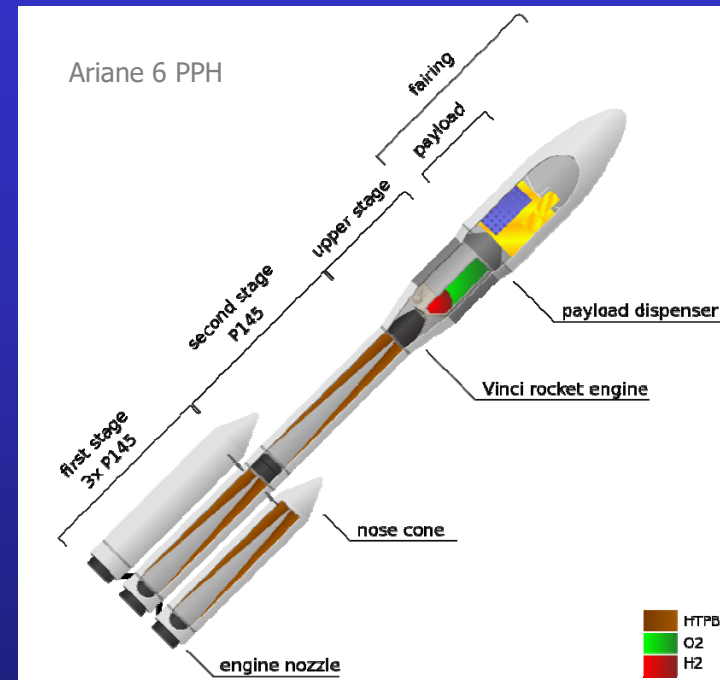
120 tonnes
solid fuel

2nd stage

150 tonnes
H₂/O₂

upper stage

30 tonnes
H₂/O₂



Falling rope

- A rope falls under gravity onto a set of scales...
- How does the weight indicated vary with time?



Falling Slinky

- A Slinky spring is suspended under gravity...
- ...and released from rest.
- What happens next?



Veritasium

Falling Slinky

- A Slinky spring is suspended under gravity...
- ...and released from rest.
- What happens next?



Veritasium

1. Martin Gardner, "A Slinky problem," *Phys. Teach.* **38**, 78 (2000)
2. W G Unruh, "The falling Slinky," [arXiv.org/abs/1110.4368](https://arxiv.org/abs/1110.4368) (2011)
3. R C Cross & M S Wheatland, "Modeling a falling Slinky," *Am J Phys* **80**, 1057 (2012)