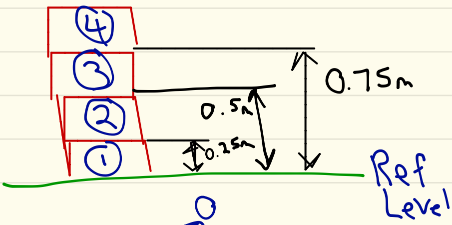
Types of energy and conservation of energy

SPH3U – Unit 3

25 cm = 0.25 m

2 kg



$E_{g①} = mgh^{0}$

$E_{g①} = 0\ J$

$E_{g②} = (2\,kg)(9.8\,\frac{m}{s^2})(0.25\,m)$

$E_{g②} = 4.9\ J$

$E_{g③} = (2\,kg)(9.8\,\frac{m}{s^2})(0.5)$

$E_{g③} = 9.8\ J$

$E_{g④} = (2\,kg)(9.8\,\frac{m}{s^2})(0.75)$

$= 14.7\ J$

$E_g = 0\,J + 4.9\,J + 9.8\,J + 14.7\,J$

Mechanical energy

- The sum of gravitational potential energy and kinetic energy

$$E_m = E_g + E_k$$

$$E_m = mgh + \frac{mv^2}{2}$$

Gravitational Potential Energy

$$E_g = mgh$$

Kinetic Energy

- scalar quantity
- Equation:

$$E_k = \frac{mv^2}{2}$$

- OR

$$E_k = \frac{1}{2}mv^2$$

Reason?

1. **Reason**. A friend proudly shows you the results of his calculation. Explain what errors he made and correct his solution.

$m = 250$ g
$v_1 = 5.0$ km/h
$y_1 = 3.4$ m

$E_{g1} = mgy_1 = (250\text{ g})(9.8\text{ N/kg})(3.4\text{ m}) = 8330\text{ J}$

$E_{k1} = \tfrac{1}{2}mv^2 = (0.5)(250\text{ g})(5.0\text{ km/h})^2 = 3125\text{ J}$

m/s

$1\text{ J} = 1\text{ N}\cdot\text{m}$

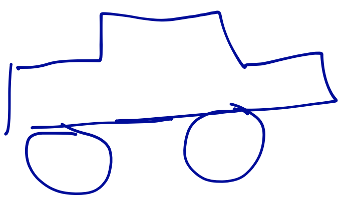
$= 1\text{ kg}\frac{\text{m}}{\text{s}^2}\cdot\text{m}$

$= 1\text{ kg}\frac{\text{m}^2}{\text{s}^2}$

More Reasoning !!

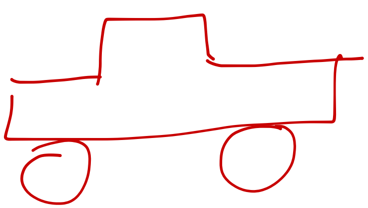
$$W = Fd$$

Reason. Two identical test cars are driving down a test track and hit their brakes at the same position. One car is travelling at twice the speed as the other. Compare the kinetic energies of the two cars. Use the idea of work to explain how much further the faster car travels while braking.



v

$$E_k = \frac{mv^2}{2} = \frac{1}{2}mv^2 \qquad W = W$$



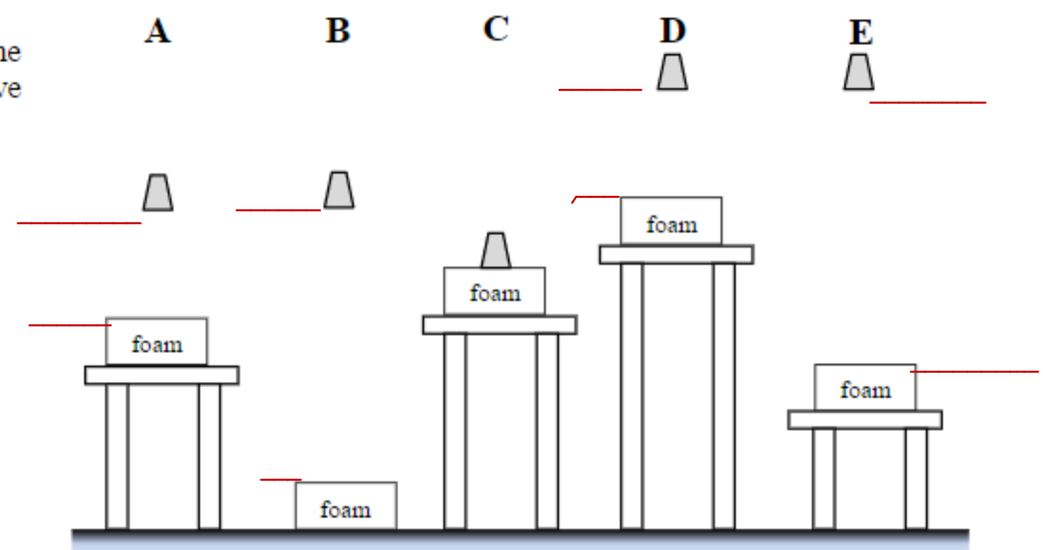
$2v$

$$E_k = \frac{m(2v)^2}{2} = \frac{m4v^2}{2} = 2mv^2$$

$$W = 4W$$

And Finally !!!!

Reason. A foam block is placed on different tables with different heights above the floor. The weight is released from different positions above the floor. Rank the size of the dent created in each foam block. Explain your ranking.

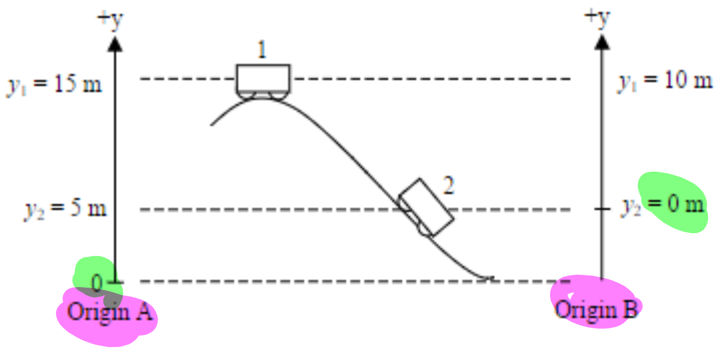


BE

AD

C

Comparing Origins



$E_m = E_g + E_k$ ($E_k \to 0$)

	E_{g1}	E_{g2}	E_{k2}	v_2
Origin A	$E_g = mgh = (100)(9.8)(15)$; $E_g = 14700\ J$	$E_g = mgh = (100)(9.8)(5)$; $E_g = 4900\ J$	$E_k = 14700 - 4900$; $E_k = 9800\ J$	$E_k = \frac{mv^2}{2}$; $9800\ kg\frac{m^2}{s^2} = \frac{100 kg\, v^2}{2}$; $9800\ kg\frac{m^2}{s^2} = 50\ kg\, v^2$
Origin B	$E_g = mgh = (100)(9.8)(10)$; $E_g = 9800\ J$	$E_g = (100)(9.8)(0)$; $E_g = 0\ J$	$E_k = 9800\ J$	$v = 14\ m/s$

$\frac{9800\ kg\frac{m^2}{s^2}}{50\ kg} = v^2$

$196\ \frac{m^2}{s^2} = v^2$

$v = 14\ m/s$

$E_m = E_g + E_k$ ($E_k \to 0$)

Explain:

- Use the calculations to explain why the choice of vertical origin did not affect the result of the calculation.

Solution:

Only *changes* in gravitational potential energy have a physical meaning. The exact value of the gravitational potential energy at one position **does not** have a physical meaning. That is why we can set any vertical position as the origin. The vertical displacement of the object does not depend on the choice of origin and therefore the *change* in gravitational potential energy does not depend on it either.

Homework

- Pg. 241 #1,2,4
- Read Section 5.4 – pages 242-249