PHYS 1050 Tutorial 1

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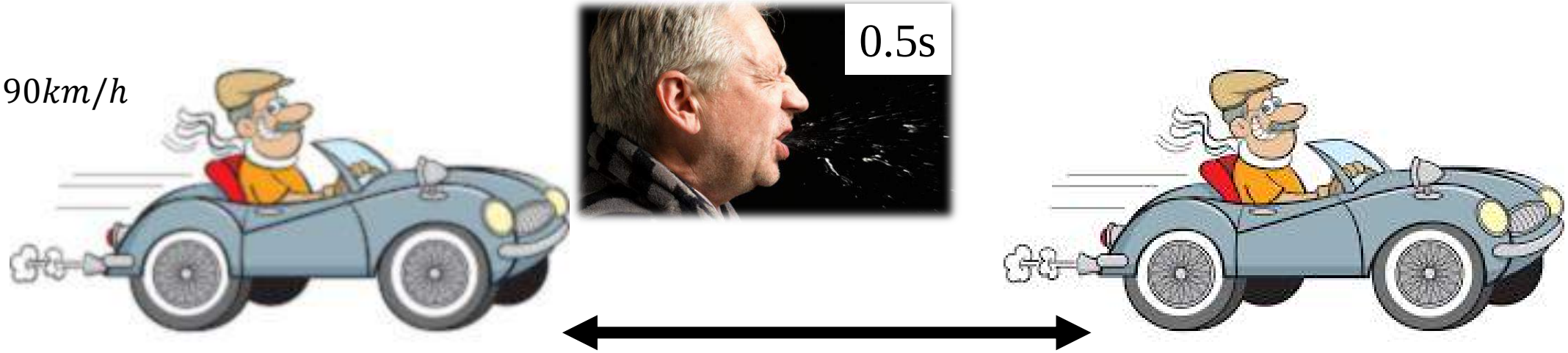
1) During a hard sneeze, your eyes might shut for 0.50 s. If you are driving a car at 90 km/h during such a sneeze, how far does the car move during that time?

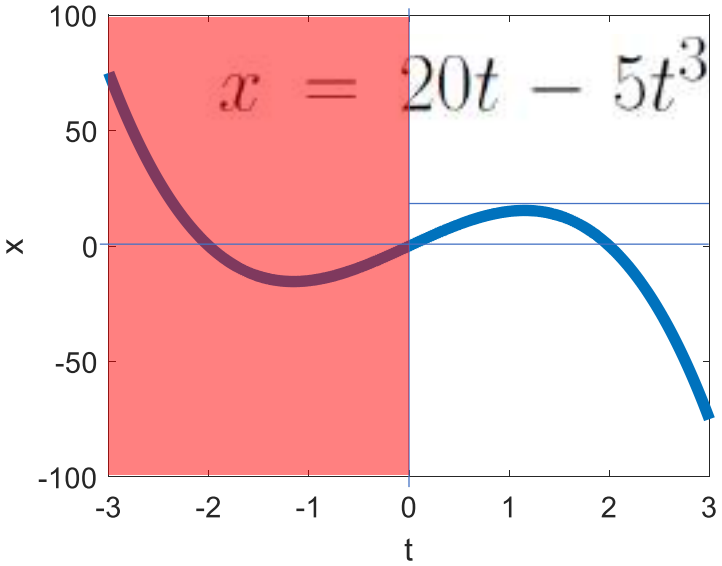
$v = 90km/h$



$1\ h = 60\ \text{min} \times 60s/min = 3600s$

$$Length\ = Vt = \frac{90{,}000m}{3600s} \times 0.5s = 12.5m$$

2) (a) If the position of a particle is given by $x = 20t - 5t^3$, where x is in meters and t in seconds, when, if ever, is the particle's velocity zero? (b) When is the acceleration a zero? (c) For what time range (positive or negative) is a negative? (d) Positive?



(a) $$V = \frac{dx}{dt} = 20 - 15t^2 = 0 \qquad t_1 = \sqrt{\frac{20}{15}} = 1.1547$$

(b) $$a = \frac{d^2x}{dt^2} = -30t = 0 \qquad t_2 = 0$$

(c) $t > 0$ → a negative

(d) $t < 0$ → a positive

3) When startled, an armadillo will leap upward. Suppose it rises 0.544 m in the first 0.200 s. (a) What is its initial speed as it leaves the ground? (b) What is its speed at the height of 0.544 m? (c) How much higher does it go?

Neglecting air resistance and $g = 9.8\,m/s^2$

(a) $d = v_0 t - \frac{1}{2} g t^2$ $\qquad v_0 = \frac{\left(d + \frac{1}{2} g t^2\right)}{t} = \frac{\left(0.544m + \frac{1}{2} \times 9.8m/s^2 \times (0.2s)^2\right)}{0.2s}$

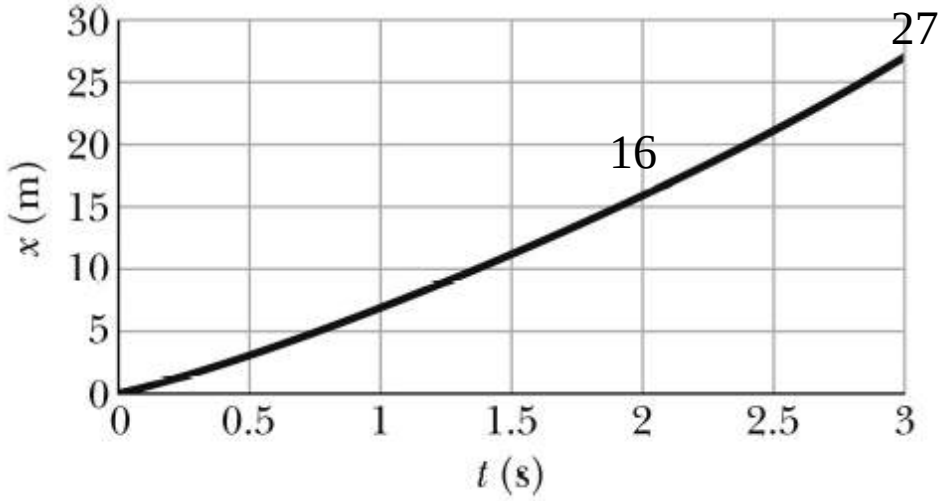
$$v_0 = 3.70\,m/s$$

(b) $v = v_0 - gt = 3.70m/s - 9.8 \times 0.2s = 1.74\,m/s$

(c) $v^2 - v_0^2 = 2gh$ $\qquad h = \frac{v_0^2}{2g} = \frac{3.70^2}{2 \times 9.8} = 0.698\,m$

$$\Delta h = 0.698 - 0.544 = 0.154m$$

4) An iceboat has a constant velocity toward the east when a sudden gust of wind causes the iceboat to have a constant acceleration towards the east for a period of 3.0 s. A plot of x versus t is shown below, where $t = 0$ is taken to be the instant the wind starts to blow and the positive x axis is toward the east. (a) What is the acceleration of the iceboat during the 3.0 s interval? (b) What is the velocity of the iceboat at the end of the 3.0 s interval? (c) If the acceleration remains constant for an additional 3.0 s, how far does the iceboat travel during this second 3.0 s interval?



(a)

$$x - x_0 = v_0 t + \frac{1}{2} a t^2$$

$$16\,m - 0 = v_0 \times 2s + \frac{1}{2} a \cdot (2s)^2$$

$$27\,m - 0 = v_0 \times 3s + \frac{1}{2} a \cdot (3s)^2$$

$$48 = 6\,v_0 + 6a$$

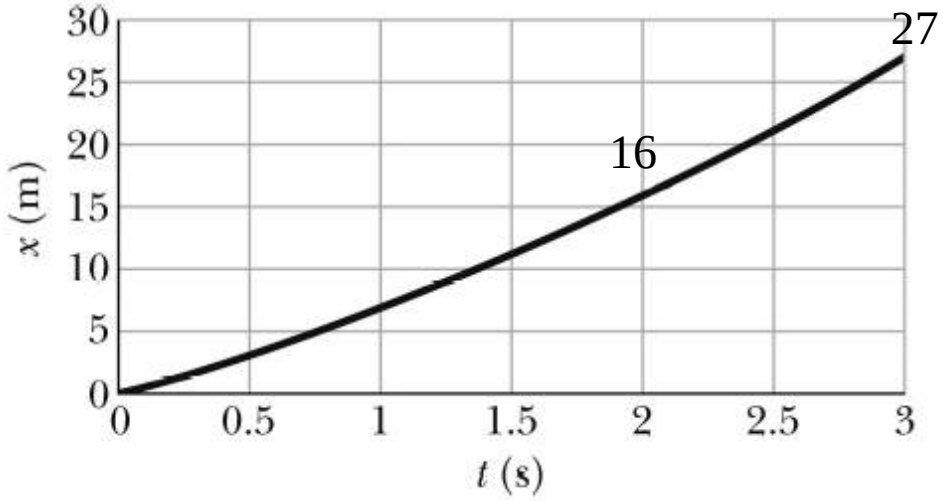
$$54 = 6\,v_0 + 9a$$

$$3a = 6$$

$$a = 2.0 m/s^2$$

$$v_0 = 6.0 m/s$$

4) An iceboat has a constant velocity toward the east when a sudden gust of wind causes the iceboat to have a constant acceleration towards the east for a period of 3.0 s. A plot of x versus t is shown below, where $t = 0$ is taken to be the instant the wind starts to blow and the positive x axis is toward the east. (a) What is the acceleration of the iceboat during the 3.0 s interval? (b) What is the velocity of the iceboat at the end of the 3.0 s interval? (c) If the acceleration remains constant for an additional 3.0 s, how far does the iceboat travel during this second 3.0 s interval?



(a)

$$a = 2.0 m/s^2$$

$$v_0 = 6.0 m/s$$

(b)

$$v = v_0 + at = 6 + 2 \times 3 = 12\, m/s$$

(c)

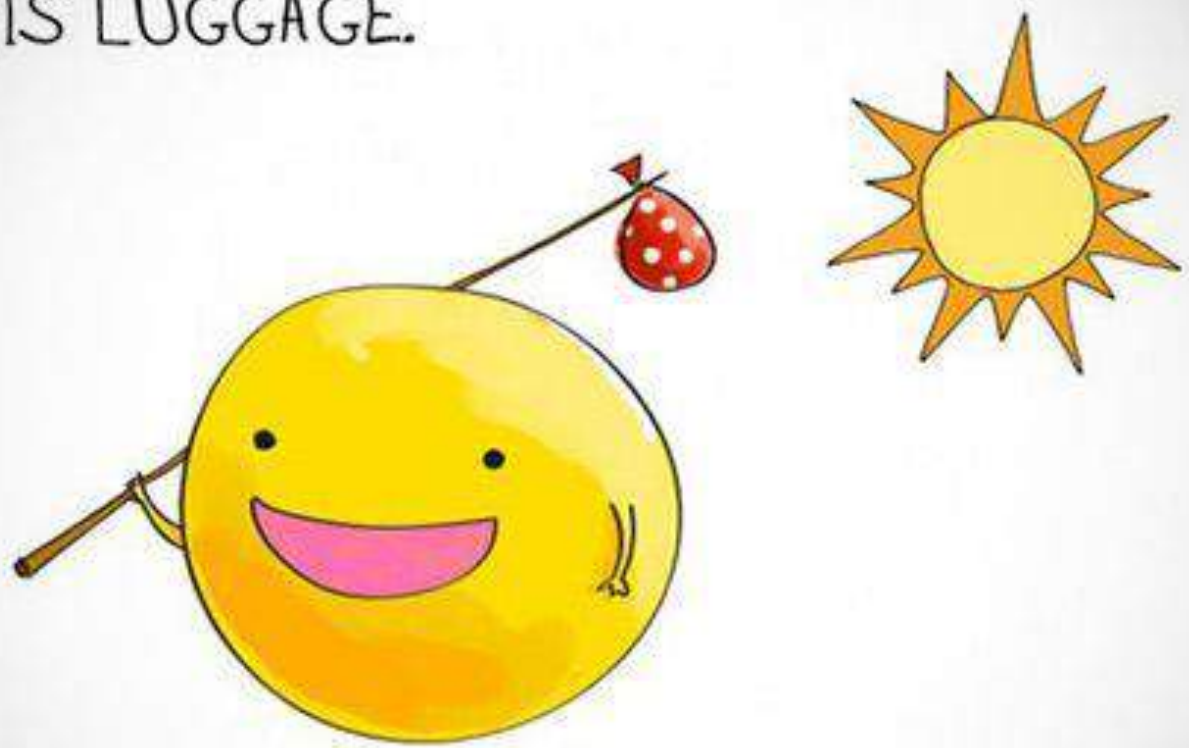
$$x - x_0 = v_0 t + \frac{1}{2} a t^2$$

$$x = 12 \times 3 + \frac{1}{2} \cdot 2(3)^2$$

$$x = 36 + 9$$

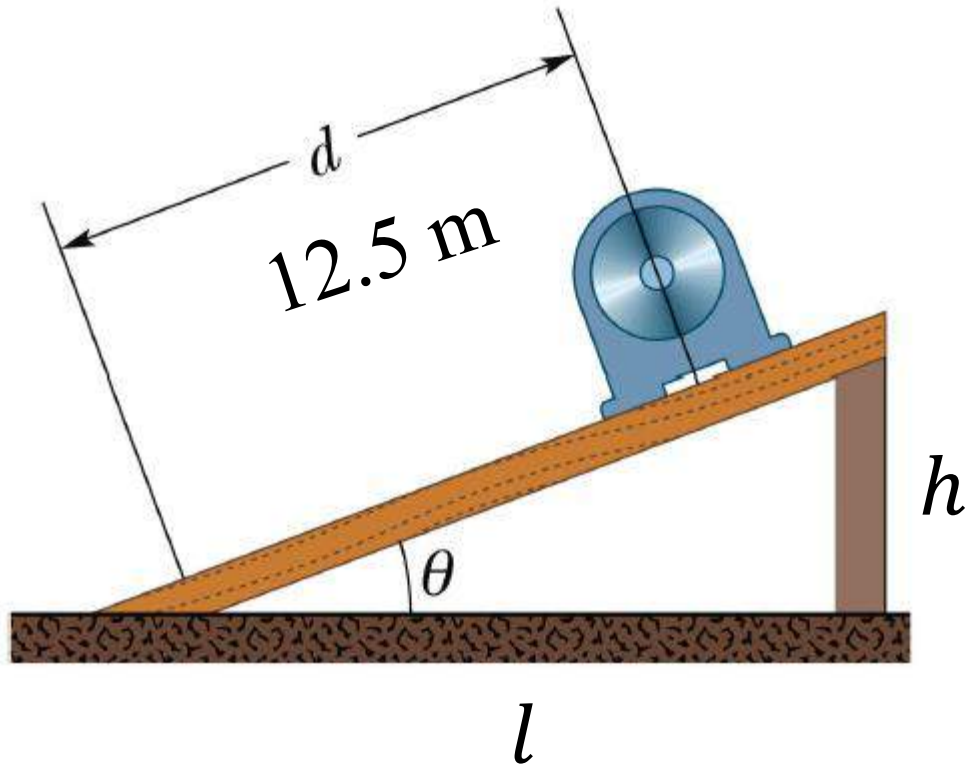
$$x = 45m$$

A PHOTON CHECKS INTO A HOTEL AND IS ASKED IF HE NEEDS ANY HELP WITH HIS LUGGAGE.



"NO, I'M TRAVELLING LIGHT."

5) In the figure below, a heavy piece of machinery is raised by sliding it a distance $d = 12.5$ m along a plank oriented at angle $\theta = 20.0°$ to the horizontal. How far is it moved (a) vertically, and (b) horizontally?



$$h = d \times \sin\theta$$
$$= 12.5m \times \sin 20°$$
$$= 9.28m$$

$$l = d \times \cos\theta$$
$$= 12.5m \times \cos 20°$$
$$= 11.75m$$

6) Two vectors are given by $\vec{a} = (4.0\ \text{m})\hat{i} - (3.0\ \text{m})\hat{j} + (1.0\ \text{m})\hat{k}$ and $\vec{b} = (-1.0\ \text{m})\hat{i} + (1.0\ \text{m})\hat{j} + (4.0\ \text{m})\hat{k}$. In unit-vector notation, find (a) $\vec{a} + \vec{b}$, (b) $\vec{a} - \vec{b}$, (c) a third vector $\vec{c}$ such that $\vec{a} - \vec{b} + \vec{c} = 0$.

(i, j, k)

$$\vec{a} + \vec{b} = (4, -3, 1) + (-1, 1, 4) = (3, -2, 5) \qquad = 3\hat{\imath} - 2\hat{\jmath} + 5\hat{k}$$

$$\vec{a} - \vec{b} = (4, -3, 1) - (-1, 1, 4) = (5, -4, -3) \qquad = 5\hat{\imath} - 4\hat{\jmath} - 3\hat{k}$$

$$\vec{a} - \vec{b} = -\vec{c}$$

$$\vec{c} = (-5, 4, 3) \qquad = -5\hat{\imath} + 4\hat{\jmath} + 3\hat{k}$$