Answer on Question#56497 - Physics - Other

3/ A $m = 60.0$ kg skier starts from rest at the top of a ski slope $h = 65.0$ m high.

(a) A frictional forces do $W_f = 10.5$ kJ of work on her as she descends. How fast is she going at the bottom of the slope?

(b) Now moving horizontally, the skier crosses a patch of soft snow. where $\mu_k = 0.20$. The patch is $L = 82.0$ m wide and the average force of air resistance on the skier is $F_r = 160$ N. How fast is she going after crossing the patch?

(c) The skier hits a snowdrift and penetrates $l = 2.5$ m into it before coming to a stop. What is the average force exerted on her by the snowdrift as it stops her?

Solution:

(a) According to the law of conservation of energy

$$mgh = W_f + \frac{mv^2}{2},$$

Where v – is the speed of the skier at the bottom of the slope.

Therefore

$$v = \sqrt{2gh - \frac{2W_f}{m}} = \sqrt{2 \cdot 9.8\frac{\text{m}}{\text{s}^2} \cdot 65.0\text{m} - \frac{2 \cdot 10.5\text{ kJ}}{60.0\text{kg}}} = 30.4\frac{\text{m}}{\text{s}}$$

(b) Force of kinetic friction is given by

$$F_k = mg\mu_k$$

The total force is

$$F_t = F_k + F_r = mg\mu_k + F_r = 60\text{kg} \cdot 9.8\frac{\text{m}}{\text{s}^2} \cdot 0.2 + 160\text{ N} = 277.6\text{N}$$

The initial v and final v_f speed of skier are related by

$$v^2 - v_f^2 = 2\frac{F_t}{m}L$$

Therefore

$$v_f = \sqrt{v^2 - 2\frac{F_t}{m}L} = \sqrt{924\frac{\text{m}^2}{\text{s}^2} - 2 \cdot \frac{277.6\text{N}}{60\text{kg}}82.0\text{m}} = 12.85\frac{\text{m}}{\text{s}}$$

(c) As in the previous part the initial speed of skier (just before the hit) v_f and the average force F_{avg} are related by

$$v_f^2 = 2\frac{F_{avg}}{m}l$$

Thus

$$F_{avg} = \frac{mv_f^2}{2l} = \frac{60\text{kg} \cdot 165.2\frac{\text{m}^2}{\text{s}^2}}{2 \cdot 2.5\text{m}} = 1983\text{N}$$

Answer:

(a) $30.4\,\frac{\mathrm{m}}{\mathrm{s}}$

(b) $12.85\,\frac{\mathrm{m}}{\mathrm{s}}$

(c) $1983\mathrm{N}$