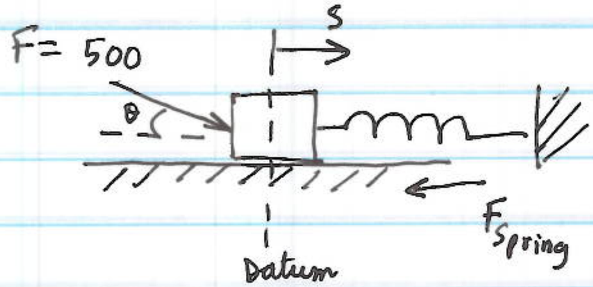
Principle of Work and Energy

F 14-1



Free-body diagram

so the applied force causes the motion which in turn compresses the spring. So the work of this force causes energy to be stored in the spring

By Principle of Work and Energy

$$\sum T_1 + \sum U_{1-2} = \sum T_2$$

$\cancel{\sum(\tfrac{1}{2}mv^2)_1 + \sum U_{1-2} = \sum}$

total energy of system original condition & + all work done = total energy of system at final condition

$$0 + F\cos\theta . s = \frac{1}{2}m_b v_b^2 + \frac{1}{2}k_s s^2$$

work of applied force — KE of block now in motion + potential energy stored in spring

$$500\left(\frac{4}{5}\right)(0.5) = \frac{1}{2}(10)v_b^2 + \frac{1}{2}(500)(0.5)^2$$

note that we have been told to neglect friction, also the weight of the block does not perform any work because there is no motion in the vertical plane.

so,

$$V_b = \sqrt{\frac{500\,(0.8)(0.5) - 0.5(500)(0.5)^2}{5}}$$

$$= 5.24 \quad m/s$$

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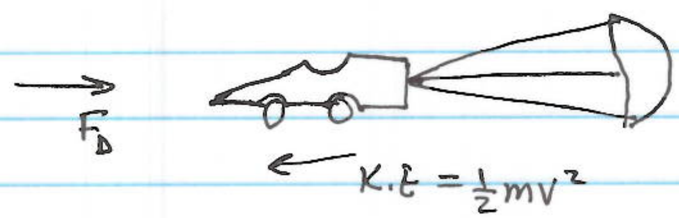

Once ~~brake~~ engine is shut off dragster moves by its inertia and only force acting on it is the drag for F_D.

Principle of Work and Energy

$$T_1 + U_{1-2} = T_2$$

so

Kinetic Energy at moment of eng shut off + work done by drag force over 400 m = Kinetic energy at 400 m from engine shutoff

Again note that weight of vehicle does not perform any work in this case.
so

$$T_1 = \frac{1}{2}(1800\,Kg)(125)^2 = 14{,}062{,}500$$

$$U_{1-2} = \text{area under graph}$$
$$= -\frac{1}{2}(50 + 20)(400) \times 10^3 = 14{,}000{,}000$$

(area of parallelogram)

$$T_2 = \frac{1}{2}(1800)\,V^2$$

$$14062500 \overset{-}{\cancel{+}} 1400000 = \frac{1}{2}(1800)\,V^2$$

$$V = \sqrt{\frac{14062500 \overset{-}{\cancel{+}} 1400000}{0.5(1800)}}$$

$V =$ m/s

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By Principle of Work and Energy to the block.

$$T_1 + U_{1-2} = T_2$$

$$T_1 = \tfrac{1}{2}(1.5)(4)^2 \cancel{4} = 12$$

$$U_{1-2} = F_s . s = ks^3 = 900(0.2)^3 = 7.2$$

so

$$12 - 7.2 = \tfrac{1}{2}(1.5)v^2$$

$$v = 2.53 \text{ m/s}$$

Oops! The force exerted by the spring various as the spring compresses or elongates, so we need integration.

$$U_{1-2} = \int_{s_1}^{s_2} F_s ds = \int_0^{0.2} 900 s^2 ds$$

$$= 900\left[\frac{s^3}{3}\right]_0^{0.2} = 2.4$$

so

$$12 - 2.4 = \tfrac{1}{2}(1.5)v^2$$

$$v = 3.58 \text{ m/s}^2$$

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when spring un-compresses back to original length the plug will move away from spring due to the kinetic energy it would have gained.

By Principle of Work and Energy

$$T_1 + U_{1-2} = T_2 \qquad —(1)$$

T_1 = original kinetic energy of plug = 0

T_2 = kinetic energy of plug at instant it moves away from spring

U_{1-2} = work done on plug, by spring.

Now spring force varies ~~day~~ as spring un-compresses.

$$U_{1-2} = \int_{s_1}^{s_2} +F_s \, ds = +\int_{0.05}^{\text{[illegible]}} 3s^{1/3} \, ds$$

$$= +3\left[\frac{s^{4/3}}{4/3}\right]_{0.05}^{\text{[illegible]}} = +\frac{9}{4}(0.05)^{4/3} = 0.0414$$

so from Eqn 1.

$$0 + 0.0414 = \frac{1}{2}mv^2$$

$$0.0414 = 0.5(20)v^2$$

$$v =$$

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During reaction time interval car keeps moving at V_1

$$\text{reaction time distance} = \frac{100 \times 10^3}{3600} \cdot 0.75\,s$$

$$= 20.83\ m$$

The car then skids till it stops.

so

$$U_{1-2,\,friction} = \int_{s_1}^{s_2} F_r\, ds$$

$$= \int_{s_1}^{s_2} \mu_k N\, ds = (0.25)(200{,}000)\int_0^s ds$$

$$= (0.25)(200{,}000)(9.81)\,s$$

From Principle of Work and Energy

$$T_1 + \Sigma U_{1-2} = T_2$$

$$\frac{1}{2}(200\,000)\left(\frac{100 \times 10^3}{3600}\right)^2 - 0.25(200\,000)(9.81)\,s = 0$$

$$s = \frac{0.5}{(9.81)\,0.25}\left(\frac{100 \times 10^3}{3600}\right)^2 = 157.22$$

Total distance to stop = 157.22 + 20.83

= 178.05 m.

You may rework this problem using Rectilinear Kinematics AND/OR Newton's 2nd Law. You should get the same result.