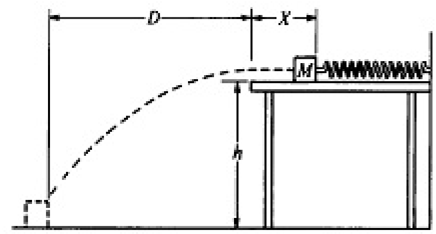
Fluids

WORKSHEET #5

Name: ______________________

1. One end of a spring is attached to a solid wall while the other end just reaches to the edge of a horizontal, frictionless tabletop, which is 1.25 m above the floor. A 2.15 kg block, ***M***, is placed against the end of the spring and pushed toward the wall until the spring has been compressed a distance ***X*** = 35.1 cm, as shown. The block is released, follows the trajectory shown, and strikes the floor a horizontal distance ***D*** from the edge of the table. Air resistance is negligible.



Find: (a) The time elapsed from the instant the block leaves the table to the instant it strikes the floor. (b) The horizontal component of the velocity of the block just before it hits the floor. (c) The work done on the block by the spring. (d) The spring constant.

a. $x = \frac{1}{2}at^2$

$t = (2x/a)^{\frac{1}{2}} = (2 \cdot 1.25\text{ m} / 9.8\text{ m/s}^2)^{\frac{1}{2}} = 0.5050762723\text{ s} = \boxed{0.505\text{ s}}$

b. $v = d/t = D/0.505\text{ s} = 1.979899 \cdot D\text{ m/s} = \boxed{1.98D\text{ m/s}}$

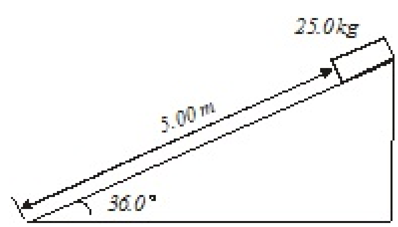
c. $W_{spr} \rightarrow KE_{block}$

$KE = \frac{1}{2}mv^2 = 0.5 \cdot 2.15\text{ kg} \cdot (1.98D\text{ m/s})^2 = 4.214D^2\text{ J} = \boxed{4.21D^2\text{ J}}$

d. $\frac{1}{2}kx^2 = \frac{1}{2}mv^2$

$k = mv^2/x^2 = 2.15\text{ kg}\,(1.98D\text{ m/s})^2 / (0.351\text{ m})^2 = 68.408536D^2\text{ N/m} = \boxed{68.4D^2\text{ N/m}}$

2. A 25.0 kg block slides down a ramp that is elevated at 36.0° a distance of 5.00 m. The coefficient of kinetic friction is 0.220. (a) What is the potential energy of the block before it begins to slide? (b) What is the work done by friction as the block slides down the ramp (said energy being converted into heat)? (c) What is the speed of the block when it reaches the bottom?



a. $PE = mgh$

$= 25.0\text{ kg} \cdot 9.8\text{ m/s}^2 \cdot 5.00\text{ m} \cdot \sin 36.0° = 720.03693\text{ J} = \boxed{720.\text{ J}}$

b. $W_{fric} = F_{fric} \cdot d = \mu \cdot F_N \cdot d = \mu \cdot w\cos 36° \cdot d$

$= 0.220 \cdot 25.0\text{ kg} \cdot 9.8\text{ m/s}^2 \cdot \cos 36° \cdot 5.00\text{ m} = 218.03008\text{ J} = \boxed{218\text{ J}}$

c. $KE = PE - W_{fric}$

$\frac{1}{2}mv^2 = 720\text{ J} - 218\text{ J}$

$\frac{1}{2}25.0\text{ kg} \cdot v^2 = 502\text{ J}$

$v = 6.3371918\text{ m/s} = \boxed{6.34\text{ m/s}}$

3. A 12.6 kg monkey sitting on a branch grabs a 25.0 m long vine and swings outward. Initially the vine made an angle of 28.0°. How fast will the monkey be traveling when she reaches the bottom of her swing?

$KE = \Delta PE$

$\frac{1}{2}mv^2 = mg\Delta h$

$v^2 = 2g\Delta h = 2 \cdot 9.8\ m/s^2 \cdot (25\ m - 25\ m \cdot \cos 28°) = 57.3557\ m^2/s^2$

$v = 7.573353\ m/s =$ $\boxed{7.57\ m/s}$

4. You weigh 625 N on earth. What would you weigh on Venus? Venus' mass is 4.88 x 10^{24} kg and it has a radius of 6.07 x 10^6 m.

$m = w/g = 625\ N / 9.8\ m/s^2 = 63.78\ kg$

$F = Gm_1m_2/r^2 = (6.67 \times 10^{-11}\ m^3/kg \cdot s^2) \cdot 63.78\ kg \cdot 4.88 \times 10^{24}\ kg / (6.07 \times 10^6\ m)^2$

$= 563.4466339\ N =$ $\boxed{563\ N}$

5. A porthole on a sub has an area of 0.380 m^2. It is at a depth of 9 562 m in the Pacific Ocean. So what is the force acting on the porthole?

$P = \rho gh = 1025\ kg/m^3 \cdot 9.8\ m/s^2 \cdot 9562\ m = 96{,}050{,}290\ Pa$

$F = P \cdot A = 96{,}050{,}290\ Pa/0.380\ m^2 = 36\ 499\ 110\ N =$ $\boxed{3.65 \times 10^7\ N}$

6. A copper sphere has a diameter of 4.6 cm. It is dipped in water. What is the apparent weight of the sphere. Figure copper has a density of 8.9 x 10^3 kg/m^3.

$w_{app} = w - F_b$

$= mg - \rho Vg$

$= \rho_{copper}Vg - \rho_{water}Vg = (\rho_{copper} - \rho_{water})Vg = (\rho_{copper} - \rho_{water})(4/3\ \pi r^3)g$

$= (8900\ kg/m^3 - 1000\ kg/m^3) \cdot (4/3)\pi \cdot (0.023\ m)^3 \cdot 9.8\ m/s^2 = 3.945711\ N =$ $\boxed{3.9\ N}$

7. Water flows through a rubber hose that is 2.85 cm in diameter. If the hose is coupled into a nozzle that has a diameter of 0.450 cm where its velocity is 135 m/s, what is its velocity in the hose?

$A_{hose}v_{hose} = A_{nozzle}v_{nozzle}$

$v_{hose} = A_{nozzle}v_{nozzle}/A_{hose}$

$= \pi(0.225\ cm)^2 \cdot 135\ m/s / \pi(1.425\ cm)^2 = 3.36565\ m/s =$ $\boxed{3.37\ m/s}$