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PHYS 211X
HW 7, Due Friday, 3/10/2023 23:59; §9 Q: #7, 8 P: #11, 18, 20, 22, 40 §10 Q: #4, 8 P: #11, 15, 22

Chapter 9

Questions

7. While the particle is moving up, the work done by gravity is negative. While it's moving down, the work done is positive. While it's not moving in either direction, it's doing zero work.
8. Since work is $F \cdot d$, and the force of pulling the rope on a plane is reduced, proportionally to an increase in the distance you need to travel, the product of both cases will be the same.

Problems

11. a.

$$\begin{aligned}\vec{A}\cdot\vec{B} &= A_xB_x + A_yB_y \\ &= (4)(-2)+(-2)(-3) = -8+6 = \boxed{-2}\end{aligned}$$

b.

$$\vec{A}\cdot\vec{B} = (-4)(2)+(2)(4) = -8+8 = \boxed{0}$$

18.

$$\begin{aligned}W_{\vec{F}_G} &= (2500N)(-5.00m) \approx \boxed{-12{,}500J} \\ W_{\vec{T}_1} &= (1830N)(5.00m)(\sin(60^\circ)) \approx \boxed{7924J} \\ W_{\vec{T}_2} &= (1295N)(5.00m)(\sin(60^\circ)) \approx \boxed{4578J}\end{aligned}$$

20. 0-1: $4N \cdot 1m = 4J$

1-2: $4N \cdot 0.5m - 4N \cdot 0.5m = 0J$

2-3: $2N \cdot 1m = 2J$

22.

$$\begin{aligned}K_i &= \frac{1}{2}mv^2 = \frac{1}{2}0.5(2.0)^2 = 1J \\ W &= \int_0^2 F_x(x)dx = 50J \\ K_t &= K_i + W = 50+1 = 51J \\ v_{x=2} &= \sqrt{\frac{2K_t}{m}} = \sqrt{\frac{2(51)}{0.5}} = \boxed{204m/s} \\ v_{x=4} &= \sqrt{\frac{2(1)}{0.5}} = \boxed{2m/s}\end{aligned}$$

40. a.

$$\begin{aligned}v_f &= \frac{50m}{7.0s} = 7.1m/s \\ K_t &= \frac{1}{2}(50kg)(7.1m/s)^2 = 177.5J = W \\ F &= \frac{W}{d} = \frac{177.5J}{50m} = \boxed{3.55N}\end{aligned}$$

b.

$$P_{s=2} = P_{s=4} = P_{s=6} = \frac{W}{t} = \frac{177.5}{7.0} = \boxed{25.4W}$$

Chapter 10

Questions

4. v_a and v_b will be the same because with an initial velocity on ball b, the velocity of ball a when it returns to $y = 0$ will be equal to ball b. Ball c has no additional vertical velocity and thus will have a velocity lower than a and b.

8. a. $x = 6m$

   b. It has a turning point at $x = 8m$.

   c. Yes, if the E line is moved to the minima at $x = 6m$, then a stable equilibrium will exist where the particle has no kinetic energy, thus it will be at rest.

Problems

11.

$$y_0 = 10m, \quad yf = 15m, \quad v_0 = 15m/s$$
$$K_i + U_{Gi} = \frac{1}{2}mv_0^2 + mgy_0 = K_f + U_{Gf}$$
$$v_f = \sqrt{v_0^2 + 2g(y_0 - y_f)}$$

$$\begin{aligned} v_f &= \sqrt{(15m/s)^2 + 2(-9.8m/s^2)(-5m)} \\ &= \sqrt{225 + 98} \\ &= \boxed{18.0m/s} \end{aligned}$$

15.

$$\begin{aligned} 200J &= \frac{1}{2}(1000)(\Delta s)^2 \\ 0.4J &= (\Delta s)^2 \\ \Delta s &= \boxed{0.2m} \end{aligned}$$

22. Because we've added another spring, we've doubled the amount of energy being stored. Therefore, the amount of energy released is doubled, and thus the velocity the block leaves the springs is quadrupled to $\boxed{4v_0}$ because the velocity derived from kinetic energy is the square root of a factor of the kinetic energy, thus $2^2 = 4$.