Exercises in Physics
Assignment # 9

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P1.

$$N_A = mg - \frac{m{v_A}^2}{\rho}$$
$$N_B = mg + \frac{m{v_B}^2}{\rho}$$
$$N_B = 2N_A$$

$$mg + \frac{m{v_B}^2}{\rho} = 2\left(mg - \frac{m{v_A}^2}{\rho}\right)$$
$$mg + \frac{m{v_B}^2}{\rho} = 2mg - 2\frac{m{v_A}^2}{\rho}$$
$$\frac{m{v_B}^2}{\rho} + 2\frac{m{v_A}^2}{\rho} = mg$$
$$\frac{{v_B}^2}{\rho} + 2\frac{{v_A}^2}{\rho} = g$$
$$\frac{{v_B}^2}{99} + 2\frac{16.67^2}{101} = 9.81$$
$$v_B = 74.34km/h$$

P2.

$$G_\theta = mg\cos 30 = 1.2 \times 9.81\cos 30 = 10.19N$$
$$F_\theta = ma_\theta + G_\theta = m\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right) + G_\theta$$
$$= 1.2\left(1.25 \times \frac{2\pi}{3} + 2 \times 0.5 \times \frac{\pi}{3}\right) + 10.19$$
$$= 4.40 + 10.19$$
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$$= 14.59N$$

$$G_r = mg\sin 30 = 1.2 \times 9.81\sin 30 = 5.89N$$
$$F_r = ma_r + G_r = m\left(\ddot{r} + r\dot{\theta}^2\right) + G_r$$
$$= 1.2\left(-0.5 + 1.25 \times \frac{\pi^2}{9}\right) + 5.89$$

$= 6.93N$

P3.

$r = 200mm = 0.2m$

$\dot{r} = \frac{10mm}{s} = -0.1m/s$

$\dot{r} = cosntant\ \ddot{r} = 0$

$\dot{\theta} = 3\ rad/s$

$\ddot{\theta} = 1\ rad/s$

$ma_\theta = N$

$ma_t = T$

$ma_\theta = m\left(r\ddot{\theta} + 2\dot{r}\dot{\theta}\right)$

$= 1(0.2 \times 1 + 2 \times -0.1 \times 3)$

$= -0.4N$

$ma_t = m\left(\ddot{r} + r\dot{\theta}^2\right)$

$= 1(0 + 0.2 \times 3^2)$

$= 1.8N$

$ma_\theta = N = -0.4N < 0$

Normal force N exerted on the slider is form surface B

P4.

$r = 2.5m$

$m = 35kg$

$\theta = 20°$

(a)

$F_t = ma_t = mg\cos 30$

$a_t = g\cos 30 = 8.50m/s^2$

$Fds = mvdv$

$\frac{Fds}{m} = vdv$

$rg\cos 30\, d\theta = vdv$

$$rg\int_{20}^{30}\cos\theta\,d\theta = \int_0^v v^2 dv$$
$$2.5\times 9.81\times[\sin\theta]_{20}^{30} = [\frac{v^2}{2}]_0^v$$
$$2.5\times 9.81\times\sin 30 - 2.5\times 9.81\times\sin 20 = \frac{v^2}{2}$$
$$v = 2.78m/s$$
$$N - mg\sin 30 = \frac{mv^2}{r}$$
$$N = mg\sin 30 + \frac{mv^2}{r}$$
$$= 35\times 9.81\sin 30 + \frac{35\times 2.78^2}{2.5}$$
$$= 278.87N$$

(b)

$$a_t = g\cos 90 = 0$$
$$rg\int_{20}^{90}\cos\theta\,d\theta = \int_0^v v^2 dv$$
$$2.5\times 9.81\times[\sin\theta]_{20}^{90} = [\frac{v^2}{2}]_0^v$$
$$2.5\times 9.81\times\sin 90 - 2.5\times 9.81\times\sin 20 = \frac{v^2}{2}$$
$$16.13 = \frac{v^2}{2}$$
$$v = 5.68m/s$$

$$N - mg\sin 90 = \frac{mv^2}{r}$$
$$N = mg\sin 90 + \frac{mv^2}{r}$$
$$= 35\times 9.81\sin 90 + \frac{35\times 5.68^2}{2.5}$$
$$= 795.02N$$