Solutions

Midterm Exam 02 (PHYS-203A-002) Fall 2018

Problem 1

$$\frac{g_J}{g_E} = \frac{\left(\frac{G M_J}{R_J^2}\right)}{\left(\frac{G M_E}{R_E^2}\right)}$$

$$\frac{g_J}{g_E} = \frac{M_J}{M_E} \frac{1}{\left(\frac{R_J}{R_E}\right)^2}$$

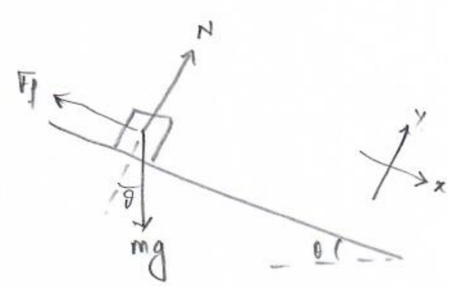
$$2.4 = 320 \frac{1}{\left(\frac{R_J}{R_E}\right)^2}$$

$$\left(\frac{R_J}{R_E}\right)^2 = \frac{320}{2.4}$$

$$\frac{R_J}{R_E} = \sqrt{\frac{320}{2.4}} = 11.6$$

$$\Rightarrow \quad R_J = 11.6 \, R_E = (11.6)(6.4\times10^6 \, m) = 7.4\times10^7 \, m$$

Problem 2



$$m\vec{a} = m\vec{g} + \vec{N} + \vec{F_f}$$

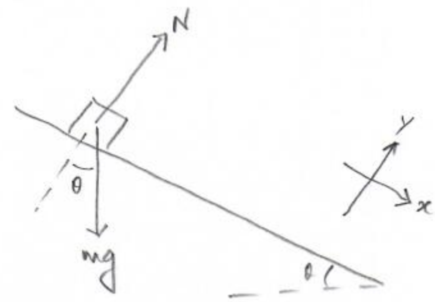
y dir: $0 = -mg\cos\theta + N + 0$

$$\Rightarrow \quad N = mg\cos\theta$$

$$= (740)\cos(30)$$

$$= 640 \text{ Newtons}$$

Problem 3



$$m\vec{a} = m\vec{g} + \vec{N}$$

x-dir

$$ma = mg\sin\theta + 0$$

$$\Rightarrow \quad a = g\sin\theta$$

$$= (9.8)\sin 30$$

$$= 4.9\ m/s^2.$$

y-dir

$$0 = -mg\cos\theta + N$$

$$\Rightarrow \quad N = mg\cos\theta.$$

$\Delta x = 3.00\,m$

$\Delta t = ?$

$V_i = 0$

$V_f =$

$a = 4.9\ \frac{m}{s^2}$

$$\Delta x = V_i\,\Delta t + \tfrac{1}{2} a\,\Delta t^2$$

$$3.00 = 0 + \tfrac{1}{2}(4.9)\,\Delta t^2.$$

$$\Delta t = \sqrt{\frac{(3.00)\,2}{4.9}} = 1.1\ \text{sec.}$$

Problem 4

$$\vec{F}_{12} = \frac{G m_1 m_2}{r_{12}^2}\,\hat{i}$$

$$= \frac{(6.7\times 10^{-11})(300)(500)}{(50)^2}\,\hat{i}$$

$$= 40.2\times 10^{-10}\ N\ \hat{i}$$

$$\vec{F}_{13} = \frac{G m_1 m_3}{r_{13}^2}\,\hat{i}$$

$$= \frac{(6.7\times 10^{-11})(300)(200)}{(75)^2}\,\hat{i}$$

$$= 7.2\times 10^{-10}\ N\ \hat{i}.$$

$$\vec{F}_{tot} = \vec{F}_{12} + \vec{F}_{13}$$

$$= (40.2 + 7.2)\times 10^{-10}\ N\ \hat{i}$$

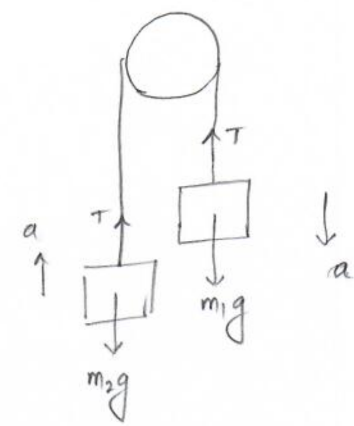
$$= 4.7\times 10^{-9}\ N\ \hat{i}$$

magnitude: $4.7\times 10^{-9}\,N$

direction: towards 2.

Problem 5

$m_1 = 50\ kg$
$m_2 = 20\ kg$

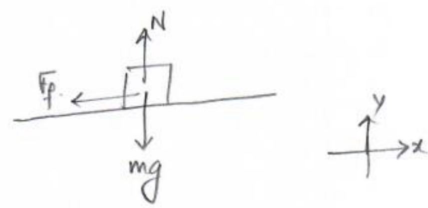


(a) gravity, tension.

(b)
$$-m_1 a = T - m_1 g \qquad\Rightarrow\qquad -50a = T - 50g$$
$$m_2 a = T - m_2 g \qquad\qquad\qquad 20a = T - 20g$$
$$0 = 7T - 200g$$

$$T = \frac{(200)(9.8)}{7} = 280 \text{ Newton}$$

Problem 6



$$m\vec{a} = m\vec{g} + \vec{N} + \vec{F_f}$$

$\mu_k = 0.50$
$\mu_s = 0.95$

x-dir

$$ma = 0 + 0 - F_f$$
$$\Rightarrow\quad ma = -F_f$$
$$= -\mu_k N$$
$$= -\mu_k mg$$
$$\Rightarrow\quad a = -\mu_k g = -(0.50)(9.8)$$
$$= -4.9\ \frac{m}{s^2}$$

y-dir

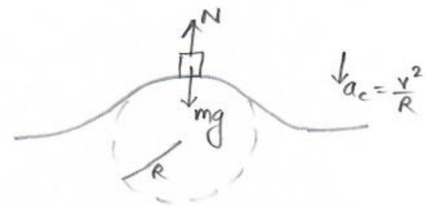
$$0 = -mg + N + 0$$
$$\Rightarrow\quad N = mg$$

$\Delta x = ?$ $\qquad V_i = 31.3\ \frac{m}{s}$ $\qquad a = -4.9\ \frac{m}{s^2}$

$\Delta t =$ $\qquad V_f = 0$

$$2a\Delta x = V_f^2 - V_i^2$$
$$2(-4.9)\ \Delta x = 0^2 - (31.3)^2$$
$$\Delta x = +\frac{(31.3)^2}{2(4.9)} = 100. \text{ meter.}$$

Problem 7



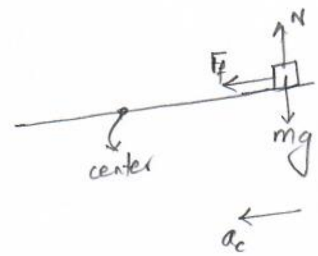
$$N - mg = -\frac{mv^2}{R}$$

$$N = mg - \frac{mv^2}{R}$$

$$= (330)(9.8) - (330)\frac{(20.0)^2}{120}$$

$$= -2100 \text{ Newtons}$$

Problem 8



$$m\vec{a} = m\vec{g} + \vec{N} + \vec{F_f}$$

x-dir

$$m a_c = 0 + 0 + F_f$$

$$\Rightarrow m\frac{v^2}{R} = F_f.$$

y-dir

$$0 = -mg + N + 0$$

$$\Rightarrow N = mg$$

(a) $F_f = m\frac{v^2}{R} = (85.0)\frac{(9.00)^2}{(25.0)} = 280$ Newtons (towards center of circle)

(b) $m\vec{g} + \vec{N} = 0$

Thus, $\vec{F}_{net} = \vec{F_f} = 280$ Newtons towards center of circle.