Midterm Exam No. 02 (2014 Summer)

PHYS 203A: College Physics

Date: 2014 Jul 3

Solutions

(Name) (Signature)

1. (**10 points.**) Two skaters, a man and a woman, are standing on ice. Neglect friction. The mass of the man is 81 kg, and the mass of the woman is 62 kg. The woman pushes on the man with a force of 65 N due East. Determine the acceleration (magnitude and direction) of the woman.

2. (**10 points.**) The radius of planet A is only one-third of planet B. The ratio m_B/m_A of the mass of the planets is 5. Find the ratio w_B/w_A of the weights of an object on these planets.

3. (**10 points.**) Three particles have their positions on a straight line, far away from any other objects. See Fig. 1. The masses of these particles are $m_1 = 100\,\text{kg}$, $m_2 = 200\,\text{kg}$, and $m_3 = 300\,\text{kg}$. The distances are $r_{12} = 150\,\text{m}$ and $r_{23} = 75\,\text{m}$. Find the magnitude and direction of the net gravitational force acting on particle 2.

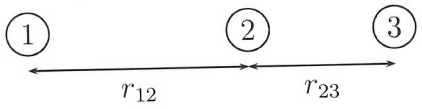


Figure 1: Problem 3

4. (**10 points.**) Your mass is 95 kg, which corresponds to a weight of 931 N. How much will you weigh on a bathroom scale inside an elevator that is

   (a) slowing down at $2\,\text{m/s}^2$ while moving upward?

   (b) speeding up at $2\,\text{m/s}^2$ while moving downward?

   (c) moving upward at constant speed?

5. (**10 points.**) A student is skateboarding down a ramp that is 9.5 m long and inclined at 17° with respect to the horizontal. Neglect friction.

   (a) What is the acceleration of the student while coming down the ramp?

MTE-02, Prob. 1

$F = ma$ $\quad a = \frac{F}{m} = \frac{65}{62} = 1.05 \frac{m}{s^2}$ towards West.

MTE-02, Prob. 2

$$\frac{w_B}{w_A} = \frac{\left(\frac{G m_B m}{R_B^2}\right)}{\left(\frac{G m_A m}{R_A^2}\right)} = \frac{m_B}{m_A}\left(\frac{R_A}{R_B}\right)^2 = 5 \times \left(\frac{1}{3}\right)^2 = 0.56$$

MTE-02, Prob. 3

① $F_{21} \longleftarrow$ ② $\longrightarrow F_{23}$ ③

$$F_{tot} = F_{23} - F_{21} = \frac{6.67\times10^{-11}\times 200\times 300}{(75)^2} - \frac{6.67\times10^{-11}\times 200\times 100}{(150)^2}$$

$$= 7.12 \times 10^{-10} - 0.59 \times 10^{-10}$$

$$= 6.53 \times 10^{-10}\ N \quad \text{(towards mass 3)}$$

MTE-02, Prob. 4

(a) ↑N ↓a ↓mg

(b) ↑N ↓a ↓mg

(c) $a = 0$

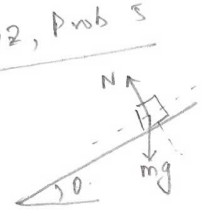
$\Rightarrow N = 931\ N.$

$N = mg + ma = 931 + (95\times 2) = 1121\ N.$

$N = mg + ma = 1121\ N$

see corrected version at the end.

MTE-02, Prob 5



(a) $mg\sin\theta = ma_x \Rightarrow a_x = g\sin\theta = 9.8\times\sin 17 = 2.87\ m/s^2$

(b) $\Delta x = v_f \Delta t - \frac{1}{2} a \Delta t^2$

$9.5 = v_f\, 2.5 - \frac{1}{2}\, 2.87 \times (2.5)^2 \Rightarrow v_f = 7.39\ \frac{m}{s}$

MTE-02, Prob. 6

$$a_A = a_B$$

$$\frac{V_A^2}{R_A} = \frac{V_B^2}{R_B} \Rightarrow \frac{R_A}{R_B} = \left(\frac{V_A}{V_B}\right)^2 = 2^2 = 4.$$

MTE-02, Prob. 7

(a) 90°

(b) $a = \frac{V^2}{R} = \frac{3^2}{1} = 9 \frac{m}{s^2}$

MTE-02, Prob. 8

(a) $$\frac{G M_E m}{R^2} = m \frac{4\pi^2}{T^2} R$$

$$R^3 = \frac{G M_E T^2}{4\pi^2} = \frac{6.67\times10^{-11} \times 5.98\times10^{24} \times (24\times60\times60)^2}{4\pi^2} = 75.42 \times 10^{21} \ m^3$$

$$R = 4.23 \times 10^7 \ m$$

(b) $$V = \frac{2\pi}{T} R = \frac{2\pi \times 4.23\times10^7}{24\times60\times60} = 3.08 \times 10^3 \ \frac{m}{s}.$$

MTE-02, Prob. 4 (corrected)

(a) motion ↑, a ↓

$$N - mg = -ma$$
$$N = mg - ma = 95(9.8-2) = 741 \ N$$

(b) motion ↓, a ↓

$$N - mg = -ma$$
$$N = mg - ma = 95(9.8-2) = 741 \ N$$

(c) $a = 0 \Rightarrow N = mg = 931 \ N.$