Quiz #3 Ch.#6 T121 Phys101.37-39-v1

Student ID:......... ...... Student Name:........... Section # ....

Q#1 A 2.0 kg block is released from rest the top of a ramp (point A) as shown in Fig 8. The coefficient of kinetic friction between the block and the inclined surface is 0.20. The speed by which the block hits the bottom (point B) is : (Ans: 6.6 m/s)

$$\Delta K = W_g + W_f = mgy - f_k d$$

$$K_f = mgy - \mu_k mg\cos\theta \cdot d$$

$$\frac{1}{2} m v_f^2 = m(gy - \mu_k g\cos\theta d)$$

$$= g(y - \mu_k \cos\theta d)$$

$$\frac{v_f^2}{2} = 9.8(3 - 0.2\times\cos 36.9\times 5)$$

$$v_f = \sqrt{2\times 9.8(2.20)} = 6.6 \text{ m/s}$$

$$\theta = \tan^{-1}\left(\frac{3}{4}\right) = 36.9^\circ$$

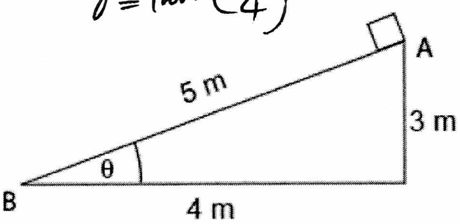


Figure 8

Q#2 A pilot of mass 75.0 kg in a jet aircraft executes a loop-the-loop, as shown in Figure 10. In this maneuver, the aircraft moves in a vertical circle of radius R = 3.00 km at a constant speed of 250 m/s. Determine the magnitude of the force exerted by the seat on the pilot at the bottom of the loop. (A) 2.30 ×103 N)

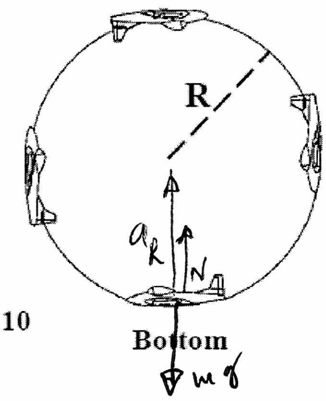
$$N - mg = ma_R = \frac{mv^2}{R}$$

$$N = mg + \frac{mv^2}{R} = m\left(g + \frac{v^2}{R}\right)$$

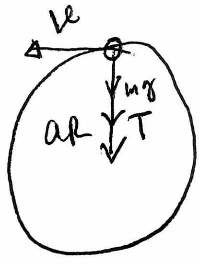
$$= 75\left(9.8 + \frac{(250)^2}{3000}\right)$$

$$N = 2.297\times 10^3 \text{ N}$$

Figure 10



Q#3: One end of a 1.0-m string is fixed, the other end is attached to a 2.0-kg stone. The stone swings in a vertical circle, and has a speed of 4.0 m/s at the top of the circle. The tension in the string at this point is approximately: (A1 12 N)



$$T + mg = \frac{mv^2}{R}$$

$$T = \frac{mv^2}{R} - mg = \frac{2\times 16}{1} - 2\times 9.8$$

$$= 12.2 \text{ N}$$

Quiz #3 Ch.#6 T121 Phys101.37-39-v2

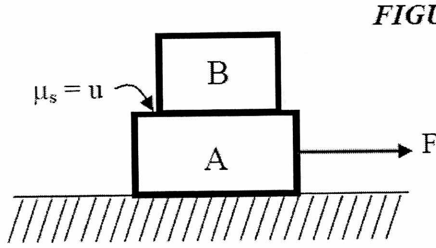
Student ID:……… …… Student Name:………… Section # ……….

Q#1, Block A, with mass mA, is initially at rest on a frictionless horizontal floor. Block B, with mass mB, is initially at rest on the top surface of A (Fig.5). The coefficient of static friction between the two blocks is (u). Block A is pulled with a force such that it begins to slide out from under B when its acceleration reaches: (A1 u . g)

$\vec{f}_s + \vec{F} = 0$; $f_s = -F = m_A a$

$f_s = \mu_s m_B g$

FIGURE-5



Q#2, A roller-coaster car has a mass of 500 kg when fully loaded with passengers. The car passes over a hill of radius 15 m (Fig 4). At the top of the hill, the car has a speed of 8 m/s. What is the force of the track on the car at the top of the hill? (A1 2800 N up)

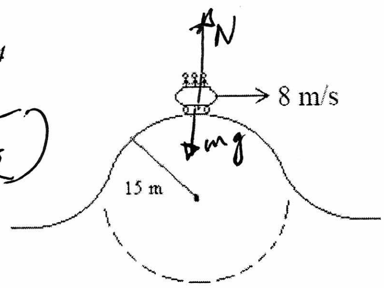
$N - mg = -\frac{mv^2}{R}$

$N = mg - \frac{mv^2}{R} = m\left(g - \frac{v^2}{R}\right)$

$= 500\left(9.8 - \frac{64}{15}\right)$

$N = 2767\ N$

FIGURE-4



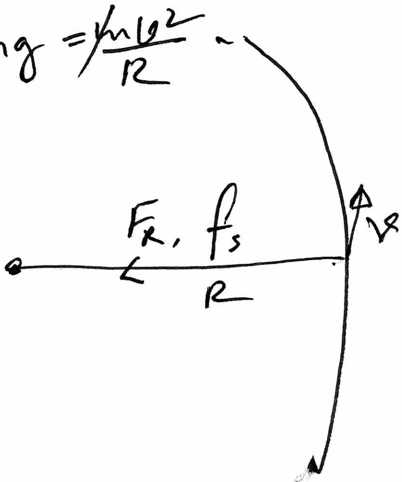
Q#3: On a rainy day the coefficient of friction between the tires of a car and a level circular track is reduced to half its usual value. The ratio of the maximum safe speed on a rainy day for rounding the circular track to its usual value (when it is not raining) is (A1 0.71*m*)

$|f_s| = \frac{mv^2}{R}$; $\mu_s mg = \frac{mv^2}{R}$

$\mu_{s\text{-rain}} = \frac{\mu_s}{2}$;

$v_{rain}^2 = \mu_{s\text{-rain}} \cdot R$

$v_{max}^2 = \mu_s \cdot R$



$\frac{v_{rain}^2}{v_{max}^2} = \frac{\mu_{s\text{-rain}}}{\mu_s} = \frac{1}{2}$

$\frac{v_{rain}}{v_{max}} = \sqrt{\frac{1}{2}} = 0.701$

Quiz #3 Ch.#6 T121 Phys101.37-39-v3

Student ID:……… …… Student Name:……….. Section # ……….

Q#1: A box with a weight of 50 N rests on a horizontal surface. A person pulls horizontally on it with a force of F1=10 N and it does not move. To start it moving, a second person pulls vertically upward on the box (Fig. 6) with a force F2. If the coefficient of static friction is 0.4, what is the smallest F2 for which the box moves? (A1 25 N)

$|f_s| = |F_1| = 10N$ but $\vec{f_s} = \mu_s \vec{N}$

along y-axis $\vec{N} + \vec{F_2} = 50N$

The $\vec{N} = 50 - \vec{F_2}$

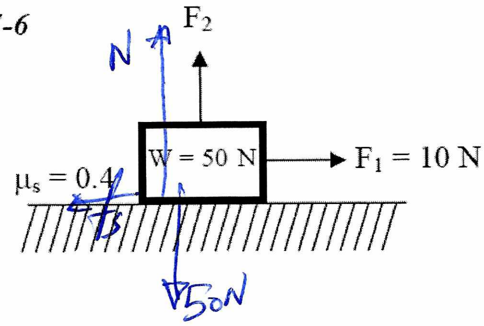
$|f_s| = \mu_s N = 0.4 \times (50 - F_2) = 10$

$20 - 0.4F_2 = 10$

$-0.4F_2 = 10 - 20 = -10$

$F_2 = \frac{10}{0.4} = 25N$

FIGURE-6



Q#2: Two masses $m_1 = 2$kg, $m_2 = 4$ kg are connected by a light string that passes over a frictionless and massless pulley (see Fig. 5). Find the magnitude of the acceleration of the masses. (A1 3.27 m/s**2)

For 2 kg object $T - 2\times9.8 = 2a$ —(1)

$T = 2a + 2\times9.8 = 2a + 19.6$ —(2)

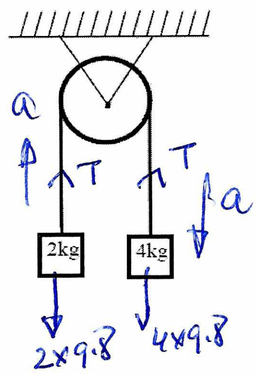
For 4 kg object $T - 4\times9.8 = -4a$

$T = 4\times9.8 - 4a = 39.2 - 4a$ —(3)

Solving (2) & (3) for T

$T = 39.2 - 4a = 2a + 19.6$

$6a = 19.6$, $a = \frac{19.6}{6} = 3.27\ m/s^2$



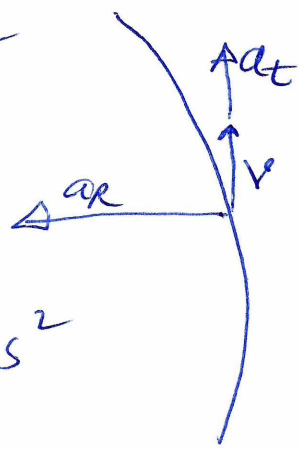
Q#3: A racing car, moving on a horizontal circular track of radius 500 m, accelerates at a uniform rate from 0.0 m/s to a speed of 35 m/s in 11 s. Find the magnitude of the total acceleration of the car when its speed is 30 m/s. (A1 3.7 m/s**2)

$|a_{tot}| = \sqrt{a_t^2 + a_R^2}$

$a_t = \frac{V_f - V_i}{t} = \frac{35 - 0}{11} = 3.18\ m/s^2$

$a_R = \frac{v^2}{R} = \frac{(30)^2}{500} = 1.8\ m/s$

$|a_{tot}| = \sqrt{3.2^2 + 1.8^2} = 3.7\ m/s^2$



Quiz #3 Ch.#6 T121 Phys101.37-39-v4

Student ID:......... ...... Student Name:........... Section # ....

Q#1: A block (m1= 3.0 kg) on a rough horizontal plane is connected to a second block (m2=5.0 kg) by a cord over a massless pulley. Calculate the coefficient of kinetic friction between the block m1 and the table if the acceleration of the descending block m2 is 4.3 m/s**2 (see Fig 7. (A1 0.50)

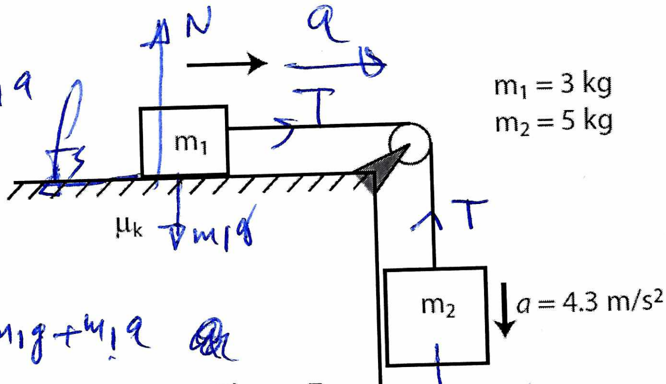


Figure 7

For m_1

$T - f_s = T - \mu_s N = T - \mu_s m_1 g = m_1 a$

$T = \mu_s m_1 g + m_1 a$

For m_2

$T - m_2 g = -m_2 a$

$T = m_2 g - m_2 a = \mu_s m_1 g + m_1 a$

$\mu_s = \dfrac{m_2 g - m_2 a - m_1 a}{m_1 g} = \dfrac{5\times 9.8 - 5\times 4.3 - 3\times 4.3}{3\times 9.8} = 0.50$

Q#2: A 500 *kg* car moves in a vertical roller coaster of radius 10.0 *m* at a constant speed of 18.0 *m/s* (see Fig. 2). The magnitude of the force exerted by the track on the car at the bottom of the circle is: (A) 2.11 x 10^4 *N*)

$N - Mg = \dfrac{Mv^2}{R}$

$N = Mg + \dfrac{Mv^2}{R} = M\left(g + \dfrac{v^2}{R}\right)$

$= 500\left(9.8 + \dfrac{18^2}{10}\right)$

$= 21100\,N = 2.11\times 10^4\,N$

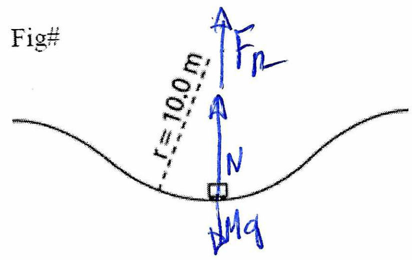


Figure 2

Q#3: Find the minimum coefficient of static friction between the tyres of a car and a level road if the car is to make a circular turn of radius 90 m at a speed of 60 km/h. (A1 0.315)

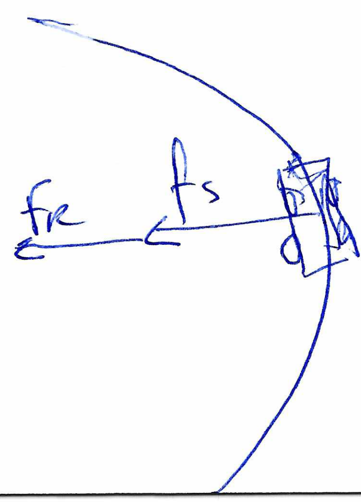
$v = 60\ km/h = 16.67\ m/s$

$f_s = F = \dfrac{mv^2}{R}$

$\mu_s mg = \dfrac{mv^2}{R}$

$\mu_s = \dfrac{v^2}{Rg} = \dfrac{(16.67)^2}{90\times 9.8}$

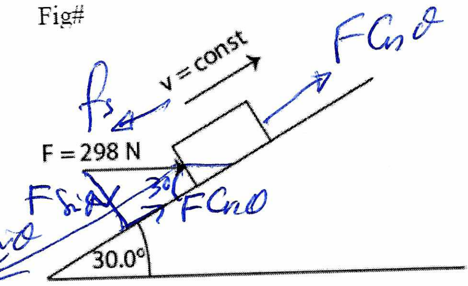
$= 0.315$



Quiz #3 Ch.#6 T121 Phys101.37-39-v5

Student ID:……… …… Student Name:………… Section # ……….

Q1: A 10.0 kg box is pushed up an incline (θ = 30.0°) by a horizontal force of 298 N. The box then moves at a constant velocity as shown in Fig. 7. What is the frictional force on the box? (A) 209 N)



along the incline forces are

$mg\sin\theta + f_s = F\cos\theta$

$f_s = F\cos\theta - mg\sin\theta$

$= 298\times\cos30 - 10\times9.8\times\sin30$

$= 258 - 49 = 209\ N$

Q2: 17. A 0.20-kg stone is attached to a string and whirled in a circle of radius r = 0.60 m on a horizontal frictionless surface as shown in Fig. 7. If the stone makes 150 revolutions per minute, the tension (T) in the string is: (A) 30 N)

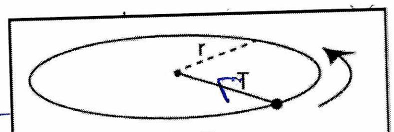


Fig. 7

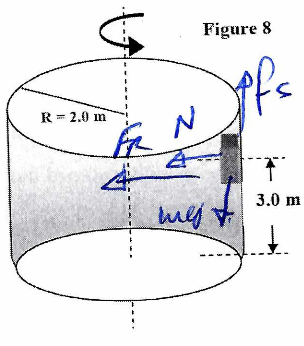
tension $T = \frac{mv^2}{R}$ but time period $T = \frac{2\pi R}{v}$

time period $T = \frac{60}{150} = 0.4\ sec$, $v = \frac{2\pi R}{T}$

then tension $T = \frac{mv^2}{R} = \frac{0.2\times\left(\frac{2\pi\times0.6}{0.4}\right)^2}{0.6}$

$= 29.6\ N$

Q#3: A block is 3.0 m up above the ground and is in contact with the inner side of a rotating cylinder of 2.0 m radius as shown in Figure 8. If the coefficient of static friction between the block and the cylinder is 0.50, what is the minimum speed the cylinder must have in order for the block not to fall down?(Ans: 6.3m/s)



For balancing the weight

$f_s = mg = \mu_s N \Rightarrow N = \frac{mg}{\mu_s}$

but for radial motion

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

$v = \sqrt{\frac{Rg}{\mu_s}} = \sqrt{\frac{2\times9.8}{0.5}}$

$= 6.26\ m/s$

Quiz #3 Ch.#6 T121 Phys101.37-39-v6

Student ID:......... ...... Student Name:............ Section # ....

Q#1 A block of mass 3.0 kg is pushed against a rough wall (coefficient of kinetic friction is 0.20) by a force P = 30 N that makes an angle of 50° with the horizontal as shown in Figure 9. Assuming the block is sliding down, find the magnitude of its acceleration.(Ans: 0.85 m/s2)

along x-axis, $N = P\cos\theta$

$f_s + P\sin\theta - mg = -ma$

$\mu_s N + P\sin\theta - mg = -ma$

$a = g - \frac{\mu_s N}{m} - \frac{P\sin\theta}{m} = g - \frac{\mu_s P\cos\theta}{m} - \frac{P\sin\theta}{m}$

$= 9.8 - \frac{0.2 \times 30 \times \cos 50}{3} - \frac{30 \times \sin 30}{3} = 0.86\ m/s^2$

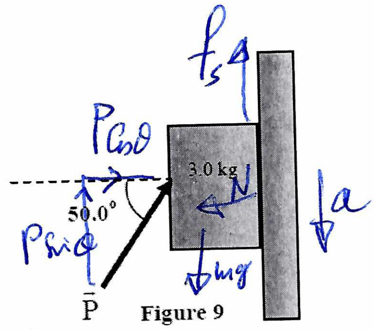


Figure 9

Q#2: . . A 2.3-N weight is suspended by a string from a ceiling and held at an angle θ from the vertical by 4.0-N horizontal force F as shown in Fig 6. The tension in the string is : (Ans: 4.6 N)

$T\sin\theta = 4.0N$; $T\cos\theta = 2.3\ N$

$\tan\theta = 4/2.3$; $\theta = \tan^{-1}\left(\frac{4}{2.3}\right) = 60.1^\circ$

The $T\sin\theta = 4.0N$

$T = \frac{4}{\sin\theta} = \frac{4}{\sin(60.1)} = 4.6N$

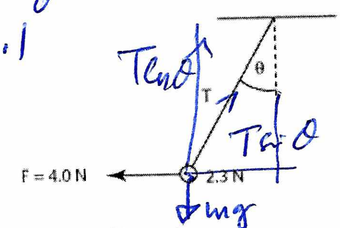


Figure 6

Q3: A car is rounding a flat curve of radius R=220 m with speed v = 94 km/h. What is the magnitude of the force exerted by the seat on the passenger whose mass m is 85 kg. (A1 263 N)

$|F_{seat}| = \frac{mv^2}{R}$

$\vec{v} = 94\ km/h$

$= \frac{94 \times 1000}{3600} = 26.1\ m/s$

$R = 220\ m$.

$|F_{seat}| = \frac{85 \times (26.1)^2}{220} = 263.2N$.