Physics 2010
Summer Semester 2008
Richard Ingebretsen

# EXAM 3

**1**

Name: Justin                    unid: u _ _ _ _ _ _ _ _

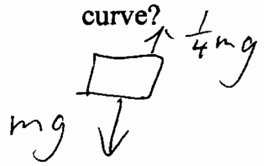
Discussion TA (circle): Brendan    Eric    Jacque    Justin

A. *[6 pts.]* A car is traveling at a constant speed around a circular track whose radius is 2.5 km. The car goes half-way around the track in 205 s. What is the magnitude of the centripetal acceleration of the car?

$$v = \frac{\frac{1}{2}(2\pi r)}{\Delta t} = \frac{\pi r}{\Delta t}$$

$$a_c = \frac{v^2}{r} = \frac{\pi^2 r}{(\Delta t)^2} = \frac{\pi^2(2500)}{(205)^2} = \boxed{0.587\ m/s^2}$$

B. *[7 pts.]* A roller coaster at an amusement park has a curve that tops out in a vertical circle of radius r = 22.0 m. A passenger feels the seat of the car pushing upward on her with a force equal to one quarter of her weight as she goes over the top. How fast is the roller coaster traveling at the top of the curve?




$$mg - \frac{1}{4}mg = \frac{mv^2}{r}$$

$$\sqrt{\frac{3}{4}gr} = v$$

$$v = \sqrt{\left(\frac{3}{4}\right)(9.8)(22)} = \boxed{12.7\ m/s}$$

C. *[6 pts.]* A projectile of mass 0.550 kg is shot straight up with an initial speed of 19.0 m/s. If the projectile rises to a maximum height of only 12.5 m, determine the magnitude of the average force due to air resistance.

$$E_f - E_0 = W_{nc}$$

$$mgh - \frac{1}{2}mv^2 = -F(h)$$

$$F = \frac{-(mgh - \frac{1}{2}mv^2)}{h} = \boxed{2.55\ N}$$

D. *[6 pts.]* A skier slides horizontally along the snow for a distance of 21 m before coming to rest. The coefficient of kinetic friction between the skier and the snow is $\mu_k = 0.059$. Initially how fast was the skier going?

$$W_f = -\frac{1}{2}mv^2$$

$$+\mu_k(21m)(F_N) = +\frac{1}{2}mv^2$$

$$+\mu_k(21m)(mg) = +\frac{1}{2}mv^2$$

$$v = \sqrt{2(21)(9.8)(0.059)} = \boxed{4.93\ m/s}$$

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# EXAM 3

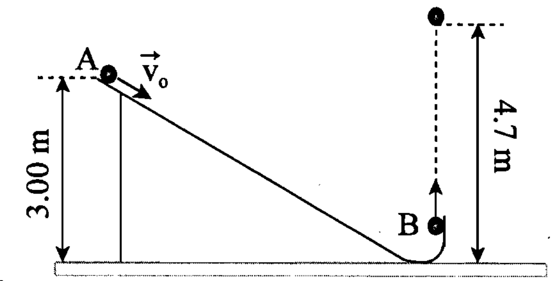
# 2

Name: Brendan

unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Brendan Eric Jacque Justin

A. *[13 pts.]* A particle of mass 3 kg, starting from point *A* in the drawing at a height $h_0 = 3.0$ m, is projected down the curved runway. Upon leaving the runway at point *B*, the particle is traveling straight upward and reaches a height $h_f = 4.7$ m above the floor before falling back down. If −45 J of work is done by friction on the particle, find the speed of the particle at point *A*.




$$W_{NC} = \Delta KE + \Delta PE = \frac{1}{2}m\overset{0}{v_f^2} - \frac{1}{2}mv_0^2 + mgh_f - mgh_0$$

$$\frac{1}{2}mv_0^2 = mg(h_f - h_0) - W_{NC}$$

$$v_0 = \sqrt{\frac{2}{m}\left(mg(h_f-h_0) - W_{NC}\right)}$$

$$v_0 = \sqrt{\frac{2}{3kg}\left((3kg)(9.81\tfrac{m}{s^2})(1.7m) + 45J\right)} = \underline{7.960 \tfrac{m}{s}}$$

B. *[6 pts.]* A 9.5 kg monkey is hanging by one arm from a branch and is swinging on a vertical circle. As an approximation, assume a radial distance of 90 cm between the branch and the point where the monkey's mass is located. As the monkey swings through the lowest point on the circle, it has a speed of 3.2 m/s. What is the magnitude of the tension in the monkey's arm?

$90cm = .9m$


$$\Sigma F = T - mg = ma_c$$

$$a_c = \frac{mv^2}{r} \Rightarrow T = m\left(g + \frac{v^2}{r}\right)$$

$$T = (9.5kg)\left(9.81\tfrac{m}{s^2} + \frac{(3.2\frac{m}{s})^2}{.9m}\right) = \underline{201N}$$

C. *[6 pts.]* You are trying to lose weight by working out on a rowing machine. Each time you pull the rowing bar (which simulates the "oars") toward you, it moves a distance of 1.3 m in a time of 1.6 s. The readout on the display indicates that the average power you are producing is 82 W. What is the magnitude of the force that you exert on the handle?

$$P = \frac{Work}{time} = \frac{Force \cdot distance}{time}$$

$$\Rightarrow Force = \frac{Power \cdot time}{distance} = \frac{(82W)(1.6s)}{1.3m} = \underline{101N}$$

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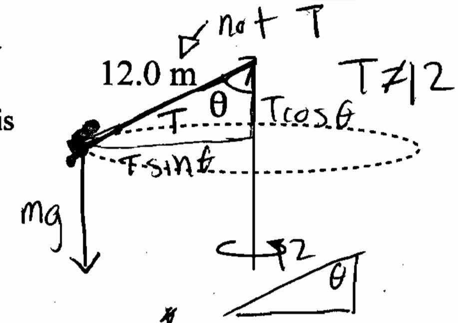
# EXAM 3

3

Name: Jacque　　　　　unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Brendan　　Eric　　Jacque　　Justin

A. A "swing" ride at a carnival consists of chairs that are swung in a circle by 12.0 m cables attached to a vertical rotating pole at an angle of θ = 63.5°, as the shown in the drawing. The total mass of the chair and its occupant is 248 kg.




1. *[10 pts.]* Find the speed of the chair.

$\Sigma F_x = T\sin\theta = \frac{mv^2}{r}$　　$T = \frac{mg}{\cos\theta}$　　$r = 12\sin\theta$

$\Sigma F_y = T\cos\theta - mg = 0$　　$\cancel{m}g\tan\theta = \frac{\cancel{m}v^2}{r}$

$T\cos\theta = mg$

$T\sin\theta = \frac{mv^2}{r}$　　$v = \sqrt{rg\tan\theta} = \sqrt{12\sin(63.5)(9.8)\tan(63.5)}$

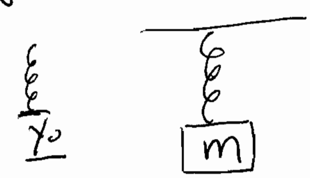
$= 14.5\ m/s$

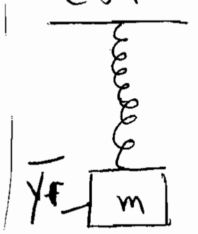
2. *[2 pts.]* How much work is done by the tension in ¼ of a revolution?

$T \perp s$　　$W = 0$

B. *[13 pts.]* A 1.8 kg object is suspended from a vertical spring whose spring constant is 135 N/m. The object is at rest. The object is then pulled straight down by an additional distance of 0.15 m and released from rest. Find the speed with which the object passes through its original position on the way up.　$y_1 = .15m$

unstretched　initial　　　after




conservation of energy
no nonconservative forces,
so $W_{nc} = 0$

$W_{nc} = \Delta KE + \Delta PE \rightarrow E_f = E_i$

$\Sigma F = -mg + ky_0 = 0$

$mg = ky_0$

$y_0 = \frac{mg}{k}$

$y_0 = .13m$

after pulled down　$E_i = \frac{1}{2}k(y_0 + y_1)^2$

returns to initial　$E_f = mgy_1 + \frac{1}{2}ky_0^2 + \frac{1}{2}mv^2$

$\frac{1}{2}k(y_0 + y_1)^2 = mgy_1 + \frac{1}{2}ky_0^2 + \frac{1}{2}mv^2$

$\frac{1}{2}mv^2 = \frac{1}{2}k(\cancel{y_0^2} + y_1^2 + 2y_0y_1) - mgy_1 - \cancel{\frac{1}{2}ky_0^2}$

$v = \sqrt{\frac{ky_1^2 + 2ky_0y_1 - 2mgy_1}{m}} = 1.293\ m/s$

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# EXAM 3

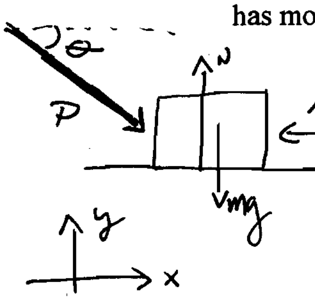
4

Name: Eric Jwards  unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Brendan  Eric  Jacque  Justin

A. *[15 pts.]* A $1.20 \times 10^2$ kg crate is being pushed across a horizontal floor by a force $\vec{P}$ that makes an angle of 30.0° below the horizontal. The coefficient of kinetic friction is 0.300. What should be the magnitude of $\vec{P}$, so that the net work done by it and the kinetic frictional force is 100 J when the block has moved 2 meters?

$\boxed{P \cong 562.5\ N}$



6

ⓐ $\Sigma F_x = P\cos\theta - \mu N = ma_x$

ⓑ $\Sigma F_y = N - mg - P\sin\theta = ma_y$

here block constrained to ground, so $a_y = 0$  $a_x = ?$

($\Sigma F$

$\Delta s \equiv 2m$

$\mu = 0.3$

$\theta = 30°$

$m = 120kg$

$\Sigma W_{NC} = 100J$

8

$W_{NC_P} = P\,\Delta s\,\cos\theta_{P\Delta s} = P\,\Delta s\,\cos\theta$

$W_{NC_f} = \mu N\,\Delta s\,\cos\theta_{\mu N\Delta s} = \mu N\,\Delta s\,\cos(180) = -\mu N\,\Delta s$

($\Sigma W_{NC}$

ⓒ $\Sigma W_{NC} = 100J = P\Delta s\cos\theta - \mu N\Delta s$

1

ⓑ $N - mg - P\sin\theta = 0 \rightarrow N = mg + P\sin\theta$

ⓒ $\Delta s(P\cos\theta - \mu N) = \Sigma W_{NC} \rightarrow P\cos\theta - \mu N = \frac{\Sigma W_{NC}}{\Delta s}$

ⓐ unnecessary equation

(algebra

solve ⓑ for N → ⓒ and get $P\cos\theta - \mu(mg + P\sin\theta) = \frac{\Sigma W_{NC}}{\Delta s}$

or $\boxed{P = (\Sigma W_{NC}/\Delta s + \mu mg)/(\cos\theta - \mu\sin\theta)}$ answer above

B. A 47.0 g golf ball is driven from the tee with an initial speed of 56.0 m/s and rises to a height of 24.0 m.

1. *[5 pts.]* Neglecting air resistance, determine the kinetic energy of the ball at its highest point.

$W_{NC} = \Delta KE + \Delta PE$ : here $W_{NC} = 0$ so Energy is conserved.

initial) $PE_0 = mg(h \equiv 0) = 0$  $KE_0 = \frac{1}{2}mv_0^2$

$v_0 = 56\ m/s$
$m = 0.047kg$
$h_{max} = 24m$

final) $PE_f = mg(h_{max})$  $KE_f = \frac{1}{2}mv_f^2$

$\boxed{62.64\ J \cong KE_{final}}$

$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2 + mgh_{max} - 0$  or  $\boxed{\frac{1}{2}mv_f^2 = \frac{1}{2}mv_0^2 - mgh_{max} = KE_{final}}$

2. *[5 pts.]* What is its speed when it is 8.0 m below its highest point?

again, Energy is conserved: $0 = \Delta KE + \Delta PE$

ini) $PE_0 \equiv 0$  $KE_0 = \frac{1}{2}mv_0^2$

final) $PE_f = mg(24 - 8\ m)$  $KE_f = \frac{1}{2}mv_f^2$

$0 = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2 + mg(16m) - 0$

$\frac{1}{2}mv_f^2 = \frac{1}{2}mv_0^2 - mg(16m)$

$\boxed{v_f = \left[\left(\frac{1}{2}mv_0^2 - mg(16m)\right)/\frac{1}{2}m\right]^{1/2}} \cong 53\ m/s$