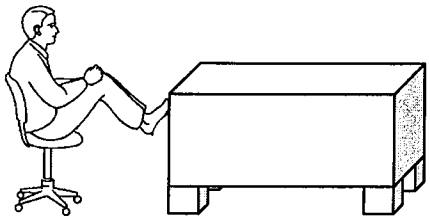
Solutions

Physics 2414
Midterm #2 – Spring 2008

Version A

Multiple choice (6 pts each)

1. You sit at a desk and push against it with your feet so that you slide across the floor. The desk does not move. During the push and while you are still touching the desk



Newton's 3rd Law

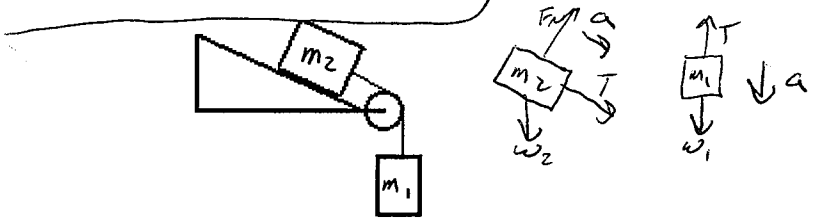
a) both you and the desk exert the same force on each other.
b) neither you nor the desk are exerting any force on the each other.
c) you exert a force on the desk, but the desk does not exert any force on you.
d) both you and the desk exert a force on each other, but the force you exert is greater.
e) both you and the desk exert a force on each other, but the force the desk exerts is greater.

2. You tie a stone to a string and twirl it in a horizontal circle above your head at a constant speed. If you double the speed of the stone without changing the length of the string what happens to the magnitude of the stone's centripetal acceleration?

a) it is half as much
b) it is two times greater
c) it is one-fourth as much
d) it is four times greater
e) it is the same

$T = \frac{mV^2}{r}$ $\quad V_{new} = 2V$

$T_{new} = \frac{m(2V)^2}{r} = 4\frac{mV^2}{r} = 4T$



$m_1 g - T = m_1 a \Rightarrow T = m_1 g - m_1 a$

$T + m_2 g \sin\theta = m_2 a \Rightarrow T = m_2 a - m_2 g \sin\theta$

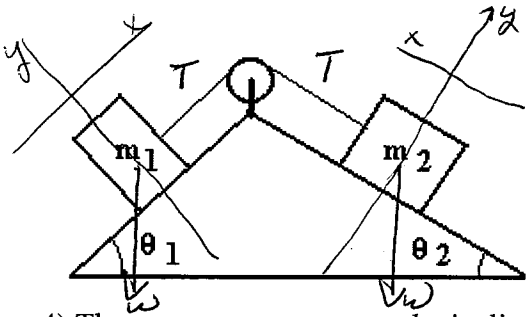
$m_1 g - m_1 a = m_2 a - m_2 g \sin\theta$

$m_1 g + m_2 g \sin\theta = m_2 a + m_1 a$

3) Two masses are connected by a string which passes over a frictionless, mass less pulley. One mass hangs vertically and one mass slides on a 30 degrees incline. The vertically hanging mass is 4.0 kg and the mass on the incline is 6.0 kg. The acceleration of the 4.0 kg mass is,

a) 0.98 m/s^2
b) 3.92 m/s^2
c) 5.75 m/s^2
d) 6.86 m/s^2
e) 7.84 m/s^2

$a = \frac{g(m_1 + m_2 \sin\theta)}{m_1 + m_2} = 6.86\ m/s^2$



$T - w_1 \sin\theta_1 = 0$

$T - w_2 \sin\theta_2 = 0$

$w_1 \sin\theta_1 = w_2 \sin\theta_2$

$m_1 \sin\theta_1 = m_2 \sin\theta_2$

4) The masses are at rest on the inclines that are frictionless. What is the relationship between the masses and the angles?

a) $m_1 = m_2$

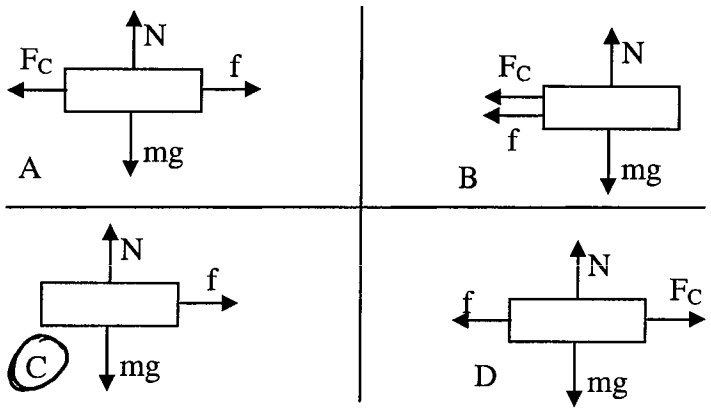
b) $m_1 = m_2 \sin\theta_2$

c) $m_1 \tan\theta_1 = m_1 \tan\theta_1$

(d) $m_1 \sin\theta_1 = m_2 \sin\theta_2$

e) $m_1 \cos\theta_1 = m_2 \cos\theta_2$

5) Which free body diagram below correctly displays the forces acting on a car going around an unbanked curve (*the center of the curve is on the right*) on a road surface with a frictional force between the tires of the car and the road surface? (N=Normal, Fc=centripetal Force, f=force of friction)



Note you DO NOT draw centripetal Force on Free body diagrams

E) None of the above.

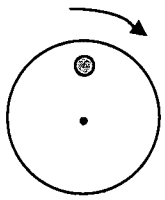
6) A truck weighs twice as much as a car and is traveling at twice the speed of the car. What is the ratio of the truck's kinetic energy to the car's kinetic energy?

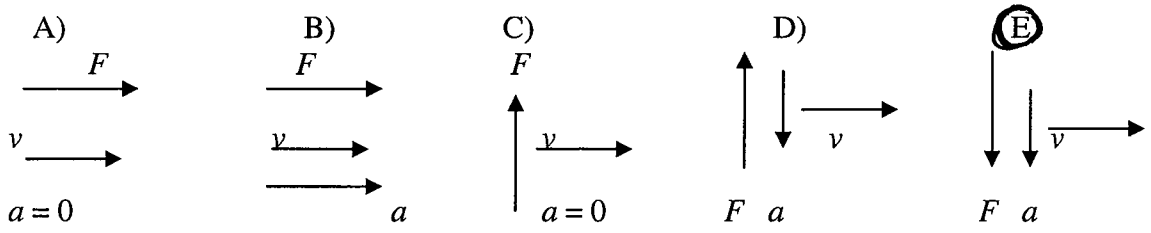
a) 1 b) 2 c) 4

(d) 8 e) 16

$K_C = \frac{1}{2} m v^2$ $K_T = \frac{1}{2}(2m)(2v)^2 = \frac{1}{2} 8 \cdot \frac{1}{2} m v^2 = 8 K_C$

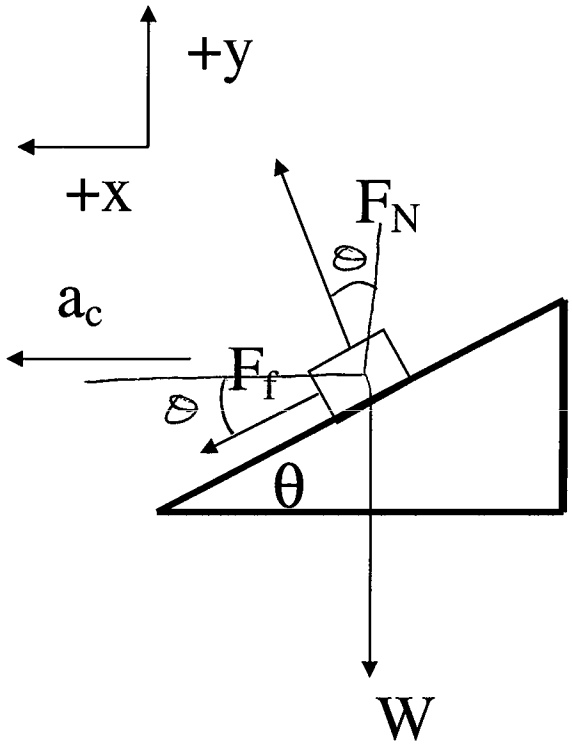
7) You put a penny on a circular turntable, and watch it rotate at a constant speed as illustrated in the diagram. While it is rotating you think about all of the various vectors associated with this motion. Which of the sets of vectors below best describes the velocity, acceleration, and net force acting on the cylinder at the point indicated in the diagram?





8) A car of mass m drives around a banked curve with friction of angle θ as shown. According to Newton's second Law, what equations are correct?

A) $F_N\cos\theta+F_f\cos\theta=ma_c$; $F_N\sin\theta-F_f\sin\theta=W$
B) $F_N\sin\theta+F_f\sin\theta=ma_c$; $F_N\cos\theta-F_f\cos\theta=W$
C) $F_N\cos\theta+F_f\sin\theta=ma_c$; $F_N\cos\theta-F_f\sin\theta=W$
(D) $F_N\sin\theta+F_f\cos\theta=ma_c$; $F_N\cos\theta-F_f\sin\theta=W$
E) $F_N\cos\theta+F_f\cos\theta=ma_c$; $F_N\sin\theta+F_f\sin\theta=W$

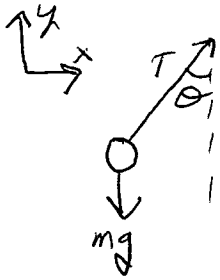


$X: F_f\cos\theta + F_N\sin\theta = \frac{mv^2}{r} = ma_c$

$y: -F_f\sin\theta + F_N\cos\theta - w = 0$

9) A car driver builds an "accelerometer" by hanging a mass of 3 kg from the roof of his car. The mass makes an angle of 10 degrees as shown when the car is accelerating to the right. What is the acceleration of the car in m/s^2?

A) 3.41
B) 1.73
C) 1.94
D) 2.14
E) 1.41



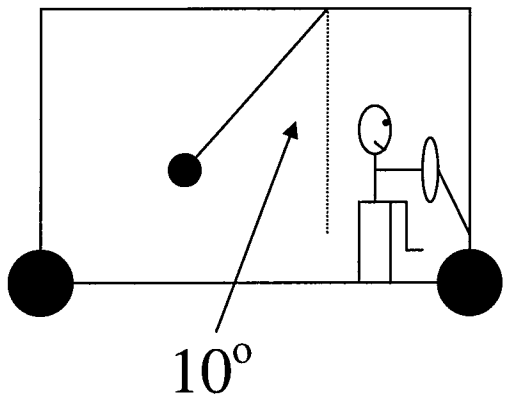
$x: T\sin\theta = ma$

$y: T\cos\theta - mg = 0$

$\tan\theta = a/g$

$a = g\tan\theta$

$a = 1.73\ m/s^2$



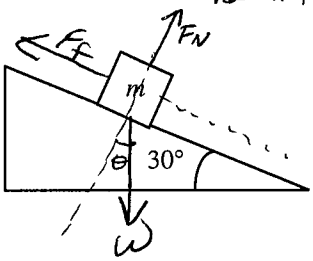
10) A 5,000 kg satellite is orbiting the earth in a circular path. The height of the satellite above the surface of the earth is 800 km. The time is takes for the satellite to travel around the earth is, ($Me = 5.98 \times 10^{24}$ kg, $Re = 6.37 \times 10^{6}$ m, $G = 6.67 \times 10^{-11}\ Nm^2/kg^2$)

a) 0.75 hours
b) 0.95 hours
c) 1.25 hours
d) 1.68 hours
e) 2.01 hours

$F = \frac{GmeM_S}{r^2} = \frac{M_S v^2}{r}$ $\quad v = \sqrt{\frac{GM_E}{r_e + 8\times10^5 m}} = 7459\ m/s$

$T = \frac{2\pi r}{v}$ $\quad T = \frac{2\pi (r_e + 8\times10^5 m)}{7459\ m/s} = 6040\ s$ $\quad \frac{6040\ s}{3600\ s/h} = 1.68\ h$

11) A block of mass m is at rest on an inclined plane that makes an angle of 30° with the horizontal, as shown in the figure. The coefficient of static friction between the block and the plane is less than one and given by μ_s. Which of the following statements about the force of static friction (F_s) is necessarily true?



a) $F_s = \mu_s mg$
b) $F_s = \mu_s mg \cos 30°$
c) $F_s = \mu_s mg \tan 30°$
d) $F_s = \mu_s mg \sin 30°$
e) More than one of these statements is true.

$F_f = \mu_s F_N$ $\quad F_N - w\cos\theta = 0$

$F_N = w\cos\theta$

$F_f = \mu_s mg\cos\theta$

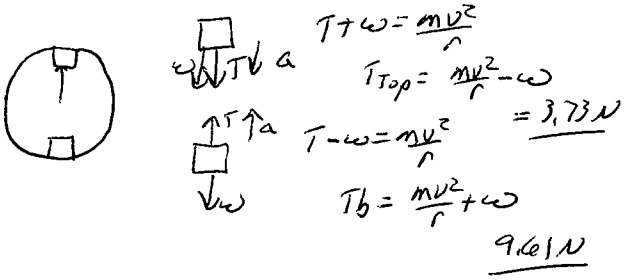
12) A steel cable is attached to an elevator and is pulling the elevator up at a constant velocity of v_0. If the tension in the cable is doubled, the elevator

a) moves up at a constant velocity of $2v_0$.
b) moves up at velocity greater than v_0, but not necessarily $2v_0$.
c) speeds up for a while, but eventually reaches a constant speed.
d) moves up at a continually faster speed.
e) moves up at a constant velocity of v_0 but with a greater tension.

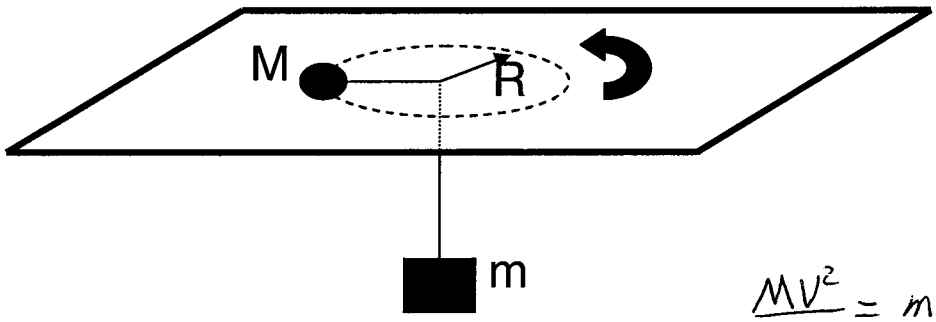
Since I have a net Force when Tension doubled, I have an acceleration so it speeds up continually

13) A ball at the end of string is moving with a constant speed in a vertical circle of radius 72.0 cm. If is speed is 4.00 m/s and its mass is 0.300 kg, what is the tension in the string when the ball is at the top and at the bottom?

a) Top: T=3.73 N Bottom: T=9.61 N
b) Top: T=2.94 N Bottom: T=2.94 N
c) Top: T=6.67 N Bottom: T=6.67 N
d) Top: T=9.61 N Bottom: T=3.73 N
e) Top: T=2.94 N Bottom: T=6.67 N



14) A ball of mass M is rotated in a circle of radius R on a frictionless table and is held in this orbit by a light cord connecting to a hanging block of mass m. What is the relationship between the constant speed (v) and M, R, m, and g.

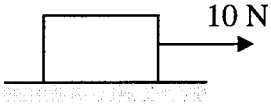


$\frac{MV^2}{r} = mg$

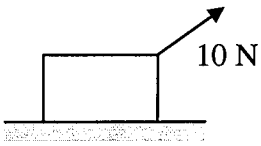
$V^2 = \frac{mgr}{M}$

a) $v^2=gR$
b) $v^2=mgR/M$
c) $v^2=Mgr/m$
d) $v^2=Mgr/(m+M)$
e) $v^2=gR/2$

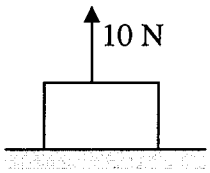
15) A crate moves to the right on a horizontal surface as a woman pulls on it with a 10 N force. Rank the situations below according to the work done by the 10 N force, least to greatest. The displacement is the same for all cases.



A



B



C

a) A, B, C
b) B, A, C
c) C, A, B
d) A, C, B
e) C, B, A

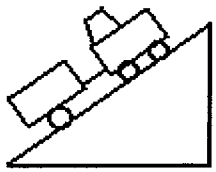
$W = F d \cos\theta$

$d = \text{same}$

C) $\cos\theta = 0$ minimum

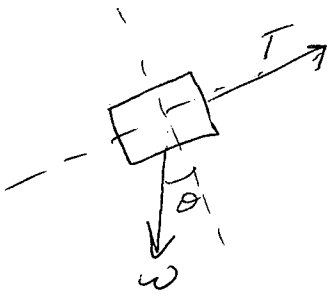
B) $0 < \cos\theta < 1$

A) $\cos\theta = 1$ maximum



16) A car is pulling a trailer up an incline of 30 degrees at a constant velocity. The car has a mass of 2,000 kg and the trailer has a mass of 500 kg. The tension in the trailer hitch between the car and the trailer is,

a) 12,300 N
b) 9,840 N
c) 6,520 N
d) 5,980 N
e) 2,450 N



$T - W\sin\theta = 0$

$T = W\sin\theta$

$T = mg\sin\theta = (500kg)(9.8 m/s^2)(\sin 30^\circ)$

$= 2450 N$