Solutions

Physics 2414
Midterm #2 – Spring 2012

Version A

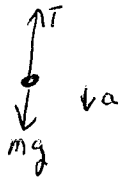
Multiple choice (6 points each)

1) Tarzan has a mass of 100 kg and is 200 m above the ground and wants to slide down a nearby vine. The vine can only hold 400 N without breaking. Assuming Tarzan starts from rest and moves with constant acceleration, what is the longest time it can take for Tarzan to reach the ground?

A) 4.5 s
B) 5.8 s
C) 8.3 s
D) 9.4 s
E) Infinite as he can hang on the vine

$y = \frac{1}{2}at^2$

$t = \sqrt{\frac{2y}{a}} = \sqrt{\frac{400m}{5.8 m/s^2}} = 8.3s$



$T - mg = -ma$

$T = m(g-a)$

$400N = 100kg \cdot g - 100kg$

$a = 5.8 m/s^2$

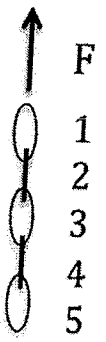
2) A chain consisting of 5 links, each of mass 0.10 kg, is lifted vertically with a force F and has a constant acceleration of 2.5 m/s^2. What is the force that link 2 exerts on link 3?

A) 0.25 N
B) 1.25 N
C) 2.30 N
D) 3.70 N
E) 6.20 N

$\Sigma \vec{F} = m\vec{a}$

$F = (m_3 + m_4 + m_5)(g + a)$

$= (.3)(9.8 m/s^2 + 2.5 m/s^2) = 3.7N$



3) A piece of ice slides down a 45° incline in twice the time (i.e ¼ the acceleration of the frictionless incline) it takes to slide down a frictionless 45° incline. What is the coefficient of kinetic friction between the ice and the incline? Assume that the inclines have the same length and that in both cases the initial speed of the ice is zero.

$a_f = \frac{1}{4}a$

A) 0.34
B) 0.55
C) 0.62
D) 0.75
E) 0.82

$mg\sin\theta = ma$

$a = g\sin\theta$

$-F_f + mg\sin\theta = ma_f$

$-\mu_k F_N + mg\sin\theta = m\frac{1}{4}a$

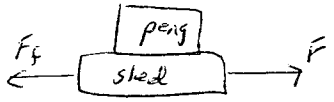
$-\mu_k mg\cos\theta + mg\sin\theta = \frac{m}{4}g\sin\theta$

$-\mu_k \cos\theta = -\frac{3}{4}\sin\theta$

$\mu_k = \frac{3}{4}\frac{\sin\theta}{\cos\theta} = .75$

4) A sled weighing 60.0 N is pulled horizontally across snow so that the coefficient of kinetic friction between the sled and the snow is 0.10. A penguin weighing 70N rides on the sled. If the coefficient of static friction between the penguin and the sled is 0.70, find the maximum horizontal force that can be exerted on the sled before the penguin begins to slide off.

A) 89 N
B) 51 N
C) 75 N
D) 104 N
E) 128 N



maximum a $\quad F_{f_{max}} = ma \quad \mu_s mg = ma$

$a = \mu_s g$

$F - F_f = ma \quad m = m_s + m_p$

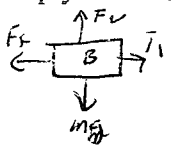
$F = ma + F_f = ma + \mu_k mg$

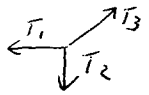
$F = m\mu_s g + \mu_k mg = mg(\mu_s + \mu_k) = (130N)(.8)$

$= 104$

5) Block B weighs 710 N. The coefficient of static friction between the block and the table is 0.25 and $\theta = 20°$. Find the maximum weight of block A for which the system will be in equilibrium (i.e a=0)? (The tensions in the ropes, T1, T2 and T3 are indicated to help you with your 3 free body diagrams you need to draw)

A) 65 N
B) 100 N
C) 145 N
D) 230 N
E) 345 N

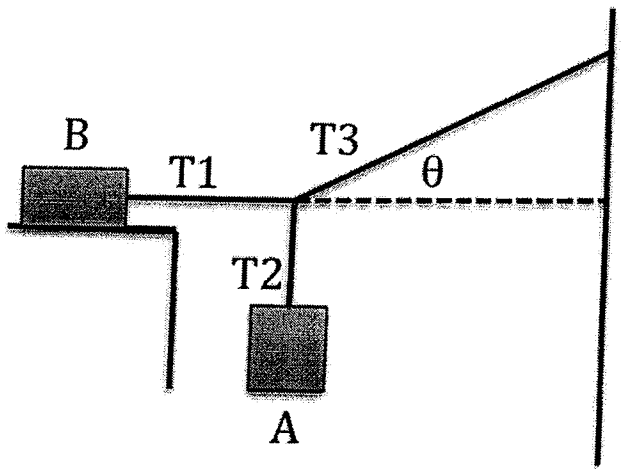




$T_1 - F_f = 0 \quad T_1 = \mu_s F_N$

$T_1 = \mu_s m_b g$

$T_2 - m_A g = 0 \quad T_2 = m_A g$



$T_3 \cos 20° = T_1 = \mu_s m_b g$

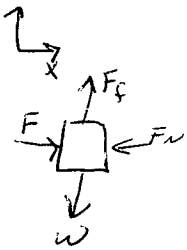
$T_3 = \frac{\mu_s m_b g}{\cos 20°} \quad T_3 = 188.89\ N$

$T_3 \sin 20° = T_2$

$T_2 = 188.89 \sin 20° = 65N$

6) A professor holds an eraser against a vertical chalkboard by pushing horizontally on it. He pushes with a force that is much greater than is required to hold the eraser. The force of friction exerted by the board on the eraser increases if he:

A) Pushes with slightly greater force $\quad F_f = w$
B) Pushes with slightly less force $\quad F_f = w$
C) Stops pushing $\quad F_f = 0$
D) Raises his elbow so the force he exerts is slightly downward but has the same magnitude $\quad F_f = w + F_y$
E) Lowers his elbow so the force he exerts is slightly upward but has the same magnitude $\quad F_f = w - F_y$



7) A planet has a mass half that of the earth and a radius twice that of the earth. What is the acceleration due to gravity on the planet in terms of g, the acceleration due to gravity on the earth?

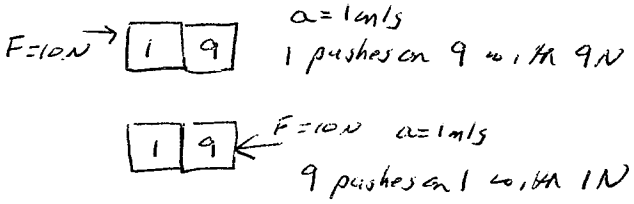
A) g
B) 2g
C) g/2
D) g/4
E) g/8

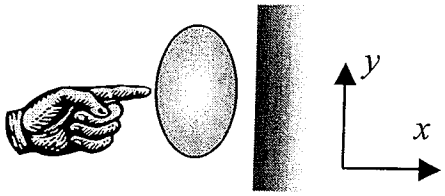
$F = \frac{GM_1 m}{r^2} = mg \qquad g = \frac{GM_1}{r^2}$

$a_{new} = \frac{G\left(\frac{M}{2}\right)}{(2r)^2} = \frac{1}{8}\frac{GM}{r^2} = \frac{1}{8}g$

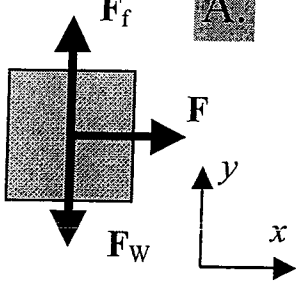
8) Two boxes rest next to each other on a frictionless flat surface. One is heavy and the other is light. A force is either applied to the light box or the heavy box. In these two cases, the force between the two boxes is:

A) The same in either case
B) larger when you push on the heavier box
C) larger when you push on the lighter box
D) Cannot be determined





9) You hold a ball against a vertical wall with your finger as shown in the diagram. Your finger exerts a force **F** on the ball. Which free-body diagram for the ball describes this situation? F_f=Force of friction, F_N= Normal force, F_w=weight.

A.


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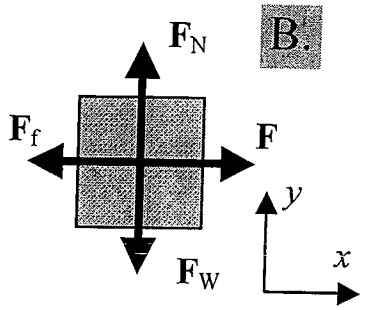

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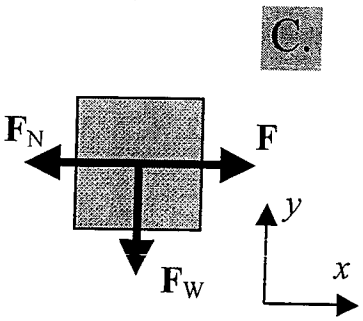
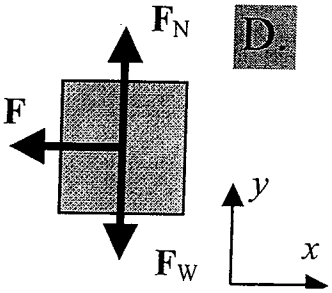


D.


E.
None of these are correct.

no friction

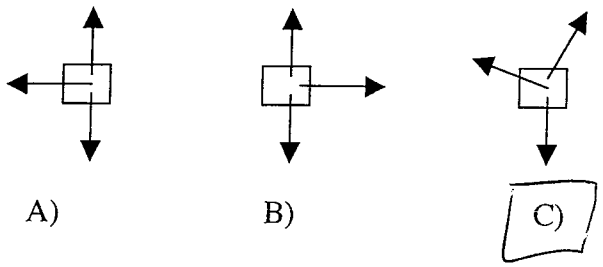
$v^2 = \tan\theta\, gr$

$v = 9.068$

to make turn

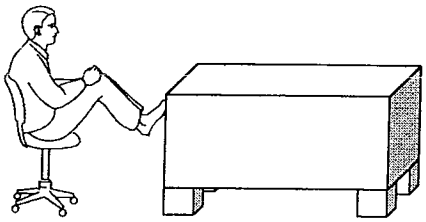
since car velocity < 9.068 it will slide down with no friction so friction up slope

10) A car is turning on a banked corner of radius 10 m and angle $\theta=40^\circ$ as shown in the diagram to the right. The speed of the car is 8 m/s. The curve of the road has its center to the right of the car. Which diagram below shows the correct free body diagram for this car?



A) B) C) D) E)

11) 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



a) both you and the desk exert forces of each other with the same magnitude.

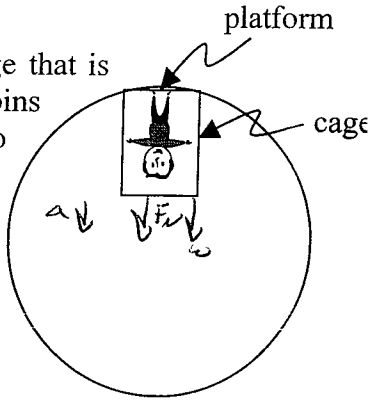
b) neither you nor the desk are exerting any force on the other.

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 forces on each other, and the magnitude of the force you exert is greater.

e) both you and the desk exert a force on each other, but the magnitude of force the desk exerts is greater

12) In a carnival ride, a man with mass *m* stands on a platform in a cage that is attached to a giant wheel that spins in the vertical direction. The wheel spins so fast that the man in the cage exerts a force on the platform that is equal to his own weight when the cage is at the top of the wheel and the man is upside down. At this point, the *net force* on the man is



A) zero

B) *mg*, down

C) *mg*, up

D) 2*mg*, down

E) 2*mg*, up

$F_N + w = ma$

$w + w = \text{net force}$

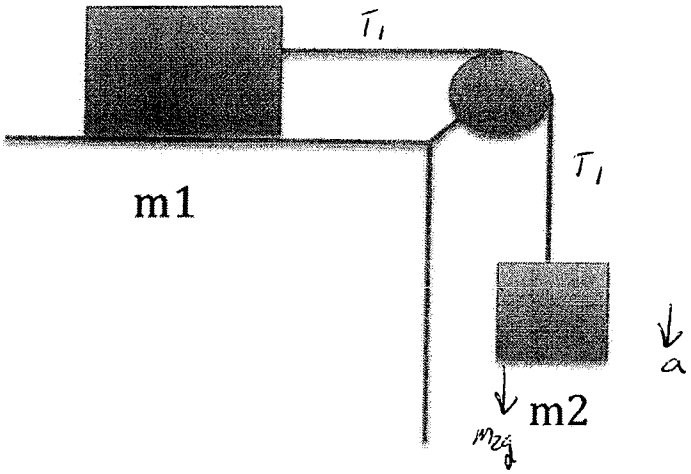
$mg + mg = \text{net force}$

$2mg$ downward

13) Two blocks are connected by a light string passing over a pulley. The mass with mass m1 slides on a frictionless horizontal surface, while m2 hangs vertically. If m1>m2, the tension in the string is:

A) less than m2g
B) equal to m2g
C) greater than m2g, but less than m1g
D) equal to m1g
E) greater than m1g

$T_1 = m_1 a$



$m_2 g - T_1 = m_2 a$

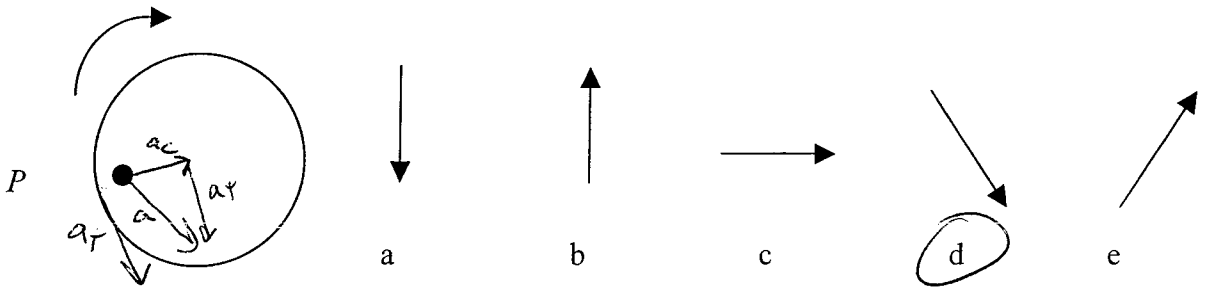
$T_1 = m_2 g - m_2 a$

$T_1 = m_2 (g - a)$ so $< m_2 g$

$m_1 a = m_2 g - m_2 a$

$a = \frac{m_2 g}{m_1 + m_2}$ $a < g$

14) Before CD's were invented, we used to listen to music on thin pieces of plastic with groves in them called records. Suppose you put a penny on a record and let it spin clockwise on the turntable. After turning the turntable off, it is still spinning, but is slowing down. Which arrow shows the direction of the acceleration of the penny at point *P* during this time when the turntable is spinning but slowing down.



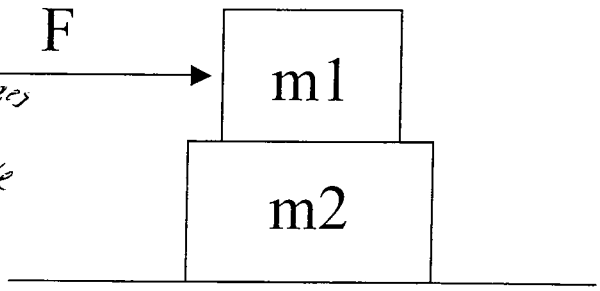
m1) $F_{f_{max}} = \mu_s m_1 g = (10kg)(9.8 m/s^2)(.7) = 68.6\ N$

so friction cannot hold m_1 and it accelerates

m2) $F_f = (m_1 + m_2)\mu_s g = (30kg)(9.8 m/s^2)(0.4) = 117.6$

so F cannot overcome friction of m_2

it does not move



15) Two blocks m1 and m2 are initially at rest. m1 sits on top of m2. m1=10 kg and m2=20 kg. The coefficient of static friction between the floor and m2=0.4 and the coefficient of kinetic friction between the floor and m2=0.2. The coefficient of static friction between m2 and m1 is 0.7 and the coefficient of kinetic friction between m1 and m2=0.6. A force of 70 Newtons is applied horizontally on block m1. What happens?

a) Block m1 moves at a constant velocity, Block m2 stationary
b) Both Block m2 and Block m1 move at a constant velocity
c) Block m1 accelerates, Block m2 accelerates
d) Block m1 accelerates, Block m2 stationary
e) Block m1 stationary, Block m2 stationary

16) Which statement is true of the normal force, $\mathbf{F}_N$?

A) The normal force always acts perpendicular to the surface of contact.
B. The normal force is always equal and opposite to the force of weight, $\mathbf{F}_W$.
C. The normal force always acts in the upward vertical direction.
D. The normal force is the reaction force to the weight, $\mathbf{F}_W$.
E. More than one of the above statements is true.