

Physics 2414  
Midterm #2 – Fall 2012

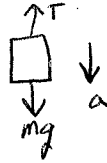
Version A

Multiple choice (6 points each)

- 1) Two objects, one having three times the mass of the other, are dropped from the same height. Ignoring air resistance, at the end of their fall, their velocities are equal because:
- Anything falling has constant velocity if air resistance is ignored
  - The acceleration of the larger object is three times greater than that of the smaller object
  - The force of gravity is the same for both objects
  - The ratio of the objects masses is 3
  - ☒ None of the above

- 2) A 5-kg block is suspended by a rope from the ceiling of an elevator as the elevator descends downward at  $3.0 \text{ m/s}^2$ . The tension of the rope is:

- 15 N up
- ☒ 34 N up
- 34 N down
- 64 N up
- 64 N, down



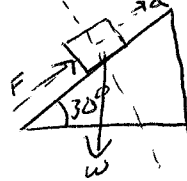
$$T - mg = -ma$$

$$T = mg - ma = m(g - a)$$

$$T = 5(6.8) = 34 \text{ N}$$

- 3) A sled is on an icy (frictionless) slope that is  $30^\circ$  above the horizontal. When a 40 N force parallel to the incline and directed up the incline, is applied to the sled, the acceleration of the sled is  $2.0 \text{ m/s}^2$ , up the incline. The mass of the sled is:

- 3.8 kg
- 4.1 kg
- ☒ 5.8 kg
- 6.2 kg
- 10 kg



$$F - mg \sin \theta = ma$$

$$F = ma + mg \sin \theta$$

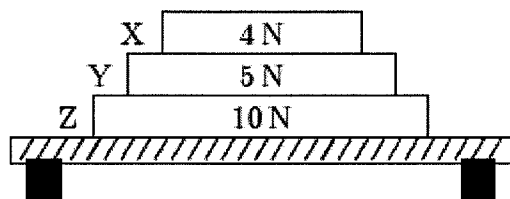
$$F = m(a + g \sin \theta)$$

$$m = \frac{F}{a + g \sin \theta} = \frac{40}{2 + 9.8 \sin 30^\circ} = 5.8 \text{ kg}$$

- 4) An "action" force is applied to an object and the object does not move. A person states that this is because the "reaction" force cancels out the "action" force. This is an incorrect statement. The "reaction" force does not cancel out the "action" force because:

- The action force is greater than the reaction force
- ☒ They are on the different objects
- They are in the same direction
- The reaction force exists only after the action force is removed
- None of the above

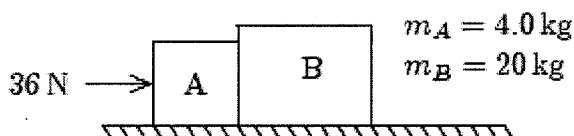
- 5) Three books (X, Y, and Z) rest on a table. The weight of each book is indicated. The net force on book Y is:



- a. 4N down
- b. 5N up
- c. 9N down
- ☒ d. Zero
- e. None of the above

since  $a = 0$   
Net Force = 0

- 6) Two blocks (A and B) are in contact on a horizontal frictionless surface. A 36 N constant force is applied to A as shown. The magnitude of the force of A on B is:



- a. 1.5 N
- b. 6.0 N
- c. 29 N
- ☒ d. 30 N
- e. 36 N

$$36 \text{ N} = 24 \text{ kg} \cdot a$$

$$a = 1.5 \text{ m/s}^2$$

so

$$F = 20 \text{ kg} \cdot 1.5 \text{ m/s}^2 = 30 \text{ N}$$

- 7) A box rests on a rough horizontal surface ( $\mu_s = 0.50$ ,  $\mu_k = 0.40$ ). A constant horizontal force, just sufficient to start the box to move, is then applied. The acceleration of the box in  $\text{m/s}^2$  is:

- a. 0.56
- ☒ b. 0.98
- c. 3.3
- d. 4.5
- e. Cannot be determined since the mass is not known

$$F = \mu_s F_N$$

$$F_f = \mu_k F_N$$

$$F_N = mg$$

$$\mu_s F_N - \mu_k F_N = ma$$

$$\mu_s mg - \mu_k mg = ma$$

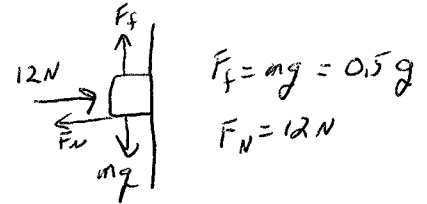
$$a = g(\mu_s - \mu_k) = 0.1g = 0.98$$

- 8) An object moving in a circle at constant speed:

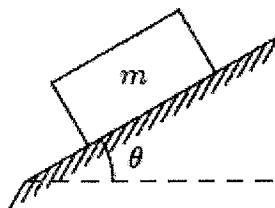
- a. Must have only one force acting on it
- b. Is not accelerating
- c. Has a constant acceleration
- ☒ d. Has an acceleration of constant magnitude
- e. Has an acceleration that is tangent to the circle

- 9) A horizontal force of 12 N pushes a 0.5 kg book against a vertical wall. The book is initially at rest. If the coefficients of friction are  $\mu_s=0.6$  and  $\mu_k=0.58$ , which of the following is true?

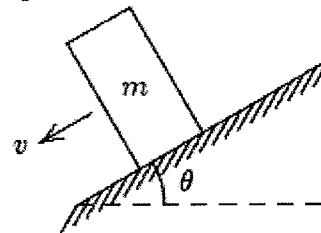
- (a) The magnitude of the frictional force is 4.9 N  
 b. The magnitude of the frictional force is 7.2 N  
 c. The normal force is 4.9 N  
 d. The book will start moving and accelerate  
 e. None of the above



- 10) A block is first placed on its long side and then on its short side on the same inclined plane as shown. The block slides down the plane on its short side but remains at rest on the long side. A possible explanation is:



(i)

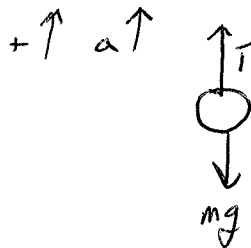


(ii)

- (a) The short side is smoother  
 b. The friction force is less because the contact area is less  
 c. The normal force is less for the second case  
 d. The force of gravity is more nearly down the plane in the second case  
 e. None of the above answers

- 11) One end of a 3.0 m long string is fixed and the other end is attached to a 2.0 kg stone. The stone swings in a vertical circle, passing the bottom point at 4.0 m/s. The tension of the string at the bottom point is:

- a. 0  
 b. 12 N  
 c. 20 N  
 (d) 30 N  
 e. 52 N

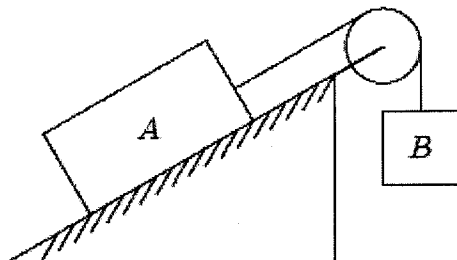


$$T - mg = \frac{mv^2}{r}$$

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

$$T = \frac{2 \cdot (4)^2}{3} + 2 \cdot 9.8 \text{ m/s}^2 = 30 \text{ N}$$

- 12) Block A, with a mass of 10 kg, rests on a  $30^\circ$  incline. The coefficient of kinetic friction is 0.20. The attached string is parallel to the incline and passes through a massless frictionless pulley at the top. Block B, with a mass of 8.0 kg, is attached to the dangling end of the string. The acceleration of Block A is:



see last page

- a.  $0.69 \text{ m/s}^2$  up the plane
- b.  $0.45 \text{ m/s}^2$  up the plane
- c.  $0.82 \text{ m/s}^2$  up the plane
- d.  $1.3 \text{ m/s}^2$  up the plane
- e.  $0.35 \text{ m/s}^2$  up the plane

- 13) A person riding a Ferris wheel is strapped into her seat by a seatbelt. The wheel is spun such that the centripetal acceleration is  $g$ . Select the correct combination of forces that act on her when she is at the top.  $F_g$  = Force of gravity,  $F_b$  = force of seatbelt,  $F_s$  = seat force

- a.  $F_g=0$     $F_b=mg$     $F_s=0$
- b.  $F_g=mg$     $F_b=0$     $F_s=0$
- c.  $F_g=0$     $F_b=0$     $F_s=mg$
- d.  $F_g=mg$     $F_b=mg$     $F_s=0$
- e.  $F_g=mg$     $F_b=0$     $F_s=mg$

Since centripetal acceleration is  $g$   
 net force = 0  
 $F_g = F_s = 0$   
 $w = mg$   
 $mg = ma_c = mg$

- 14) The mass of a hypothetical planet is  $1/100^{\text{th}}$  that of Earth and its radius is  $1/4$  that of Earth. If a person weighs 600 N on Earth, what would he weigh on this planet?

- a. 24 N
- b. 48 N
- c. 96 N
- d. 192 N
- e. 600 N

$$F = \frac{G m_1 m_2}{r^2}$$

$$\frac{F_{\text{new}}}{F} = \frac{16}{100} = .16$$

$$F_{\text{new}} = \frac{6 m_1 m_2}{100 \left(\frac{r}{4}\right)^2}$$

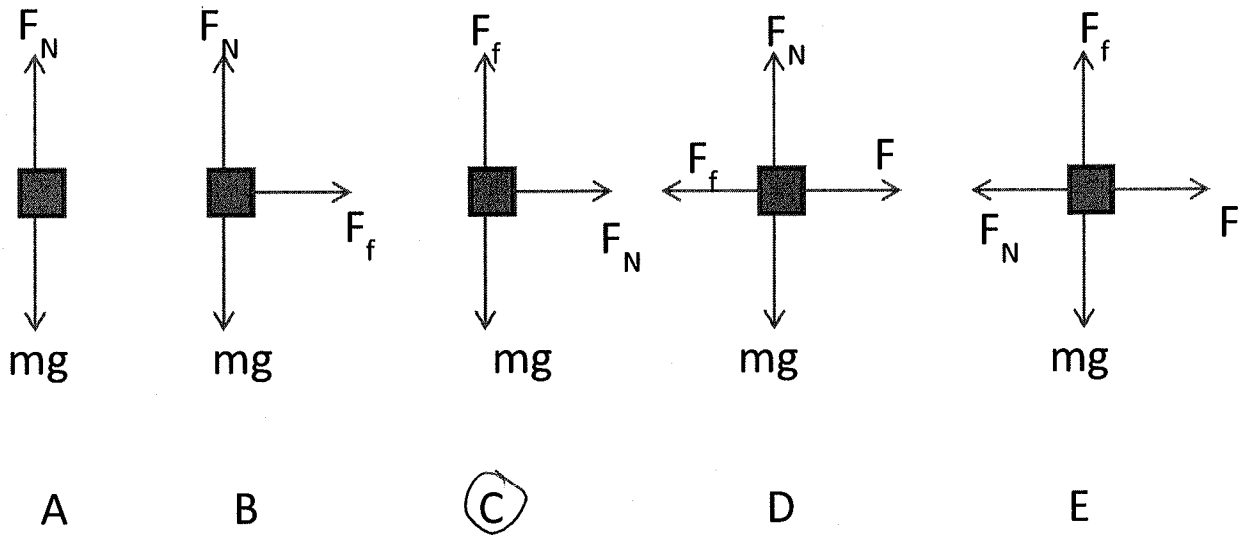
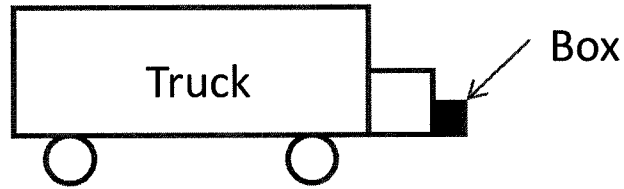
$$F_{\text{new}} = .16 \cdot 600 = 96 \text{ N}$$

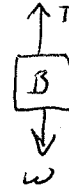
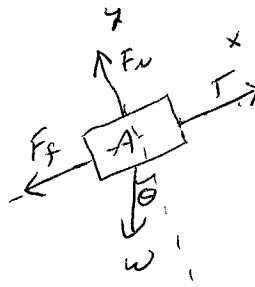
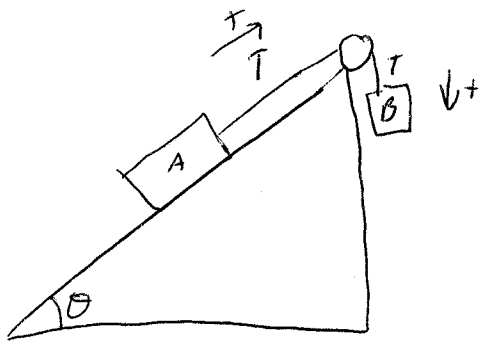
- 15) Circular freeway entrances and exit ramps are commonly banked to handle a car moving at 13 m/s. To design a similar ramp for 26 m/s one should:

- a. Increase radius by a factor of 2
- b. Decrease radius by a factor of 2
- c. Increase radius by a factor of 4
- d. Decrease radius by a factor of 4
- e. Increase radius by a factor of  $\sqrt{2}$

$$\tan \theta = \frac{v^2}{gr} \quad \text{if } v \rightarrow 2v \quad r \rightarrow 4r$$

- 16) A truck accelerates so quickly that a box of mass  $m$  sitting in front of the truck does not fall. What is the correct free body diagram for the box?  $F_N$ =Normal Force,  $F_f$ =Force of friction,  $F$  = Net Force acting on the box





$$y: F_N - m_a g \cos \theta = 0$$

$$-T + m_b g = m_b a$$

$$x: T - F_f - m_a g \sin \theta = m_a a$$

$$T = m_a a + F_f + m_a g \sin \theta$$

$$T = m_b g - m_b a$$

$$m_a a + \mu_k F_N + m_a g \sin \theta = m_b g - m_b a$$

$$m_a a + \mu_k m_a g \cos \theta + m_a g \sin \theta = m_b g - m_b a$$

$$m_a a + m_b a = m_b g - \mu_k m_a g \cos \theta + m_a g \sin \theta$$

$$a = \frac{m_b g - \mu_k m_a g \cos \theta - m_a g \sin \theta}{m_a + m_b}$$

$$a = \frac{(8 \text{ kg} \times 9.8 \text{ m/s}^2) - (0.2 \times 10 \text{ kg} \times 9.8 \text{ m/s}^2 \times \cos 30^\circ) - (10 \text{ kg} \times 9.8 \text{ m/s}^2 \times \sin 30^\circ)}{18 \text{ kg}}$$

$$a = \frac{78.4 - 16.97 - 49}{18} = \boxed{.69 \text{ m/s}^2}$$