Physics 211, Fall 2008
Quiz 3, Form: A

Name: Key

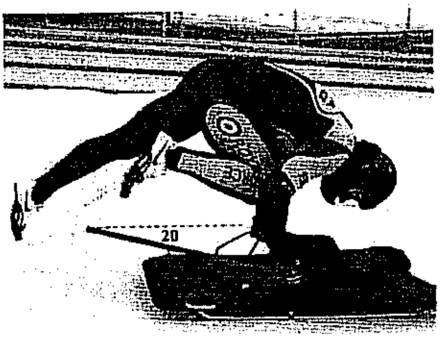
Date:

Section 1. Multiple Choice

1. If a force produces a torque on a body so that it tends to make the body rotate *clockwise*, then the torque is

   [✓ (a)] negative
   (b) positive
   (c) zero

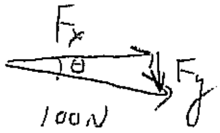
Questions 2–4: At a certain instant while pushing a 5.0-kg sled on level ice, a man exerts a force on the sled of 100 N at an angle 20° below the horizontal as shown below.



Define the +x direction to be parallel to the ice and to the right. Define the +y axis to be perpendicular to the ice and upward. Neglect friction.

2. What is the x-component of the force on the sled by the man?

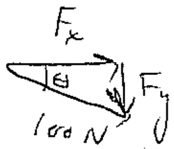
   (a) zero
   (b) 100 N
   (c) 66 N
   (d) 34 N
   [✓ (e)] 94 N



$F_x = 100\cos(20) = 94\ N$

3. What is the y-component of the force on the sled by the man?

   (a) zero
   (b) -100 N
   (c) -66 N
   [✓ (d)] -34 N
   (e) -94 N



$F_y = 100\sin(20) = -34\ N$

4. What is the normal component of the force on the sled by the ice?

   (a) 15 N
   (b) 17 N
   (c) 46 N
   (d) 49 N
   [✓ (e)] 83 N

$\Sigma F_y = ma_y$ and $a_y = 0$

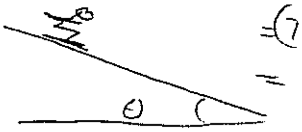
so $F_{N_{ice}} - mg - 34 = 0$

$F_{N_{ice}} = (5kg)(9.8) + 34 = 83\ N$

Questions 5–7: A ski jumper of mass 70 kg is skiing down a hill of angle 36° before the takeoff. The +x axis points parallel to the hill and down the hill and the +y axis is perpendicular to the hill.

5. What is the weight of the skier?

   (a) 5.76 N
   [✓ (b)] 686 N
   (c) 283 N
   (d) 555 N
   (e) 403 N



$\theta = 36°$

$W = mg = (70)(9.8) = 686\ N$

6. What is the x-component of the weight of the skier?

   (a) 5.76 N
   (b) 686 N
   (c) 283 N
   (d) 555 N
   [✓ (e)] 403 N

$W_x = mg\sin(36°) = 686\sin(36) = 403\ N$

7. What is the y-component of the weight of the skier?

   (a) -5.76 N
   (b) -686 N
   (c) -283 N
   [✓ (d)] -555 N
   (e) -403 N

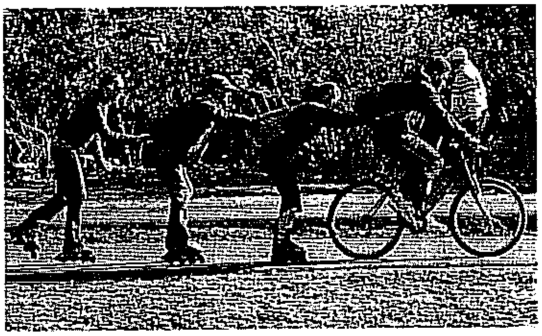
$W_y = mg\cos(36°) = 686\cos(36) = -555\ N$

8. Suppose that you stand vertically on a scale that is in equilibrium on a hill. What will the scale read?

   (a) your weight
   [✓ (b)] less than your weight
   (c) greater than your weight

$W_y = mg\cos(\theta)$ on a hill.

9. In the "people train," shown below, suppose that the guy with the hat is slowing down as he travels to the right. *Neglect friction.*



Which force on the man with the hat has a larger magnitude?

(a) The force on the man with the hat by the woman with the backpack (on the right).

[✓ (b)] The force on the man with the hat by the woman on the left.

(c) Neither, because the woman on the left and the woman with the backpack are exerting equal magnitude forces on him.

Net force on his is to the left.

10. If the normal component of a contact force is doubled, by what factor does the frictional force change?

$f = \mu F_N$

(a) 1/2

[✓ (b)] 2

(c) 4

(d) 8

(e) None of the above, because it stays the same. The frictional force does not depend on the normal force.

11. If the normal component of a contact force is doubled, by what factor does the coefficient of friction for the surfaces in contact change?

(a) 2

(b) 4

(c) 1/2

(d) 8

[✓ (e)] None of the above, because it stays the same. The coefficient of friction does not depend on the normal force but only on the types of surfaces in contact.

μ depends on surfaces in contact, not F_N

12. A cart accelerates down an inclined ramp in lab. When fitting a curve to the data, you find the best fit function to be: $x = 1.2t^2 + 0.08t + 0.41$, where x is in meters and t is in seconds. What is the acceleration of the cart?

(a) 1.2 m/s^2

(b) 0.6 m/s^2

(c) 0.41 m/s^2

[✓ (d)] 2.4 m/s^2

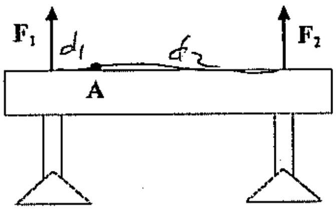
(e) 0.08 m/s^2

$$x - x_0 = v_{0x} t + \frac{1}{2} a_x t^2$$

$$\frac{1}{2} a_x = 1.2$$

$$a_x = 2(1.2) = 2.4 \frac{m}{s^2}$$

13. A balance beam apparatus is shown below. The two forces F_1 and F_2 are the upward forces of the support stands on the balance beam. The beam is in equilibrium.



If a gymnast stands on the balance beam at point A, which force is larger?

[✓ (a)] $\vec{F_1}$ because $F_1 d_1 = F_2 d_2$

(b) $\vec{F_2}$

(c) neither, because they are equal.

14. For the balance beam in the previous question, the net torque on the balance beam is

[✓ (a)] zero.

(b) positive.

(c) negative.

15. Suppose that you push horizontally with a force F in the +x direction on a bobsled during a training exercise. There is also a frictional force f on the bobsled in the $-x$ direction. If the bobsled moves in the +x direction and is slowing down,

$f \longleftarrow \circ \longrightarrow F$

(a) $f = F$

(b) $f < F$

[✓ (c)] $f > F$

$\overset{\longleftarrow}{a}$

so $f > F$

16. A 30-kg child sits 1.5-m from the fulcrum of a seesaw. If the child's dad of mass 90-kg wants to balance the child so that they are in equilibrium, how far from the fulcrum should he sit (on the opposite side of the seesaw).

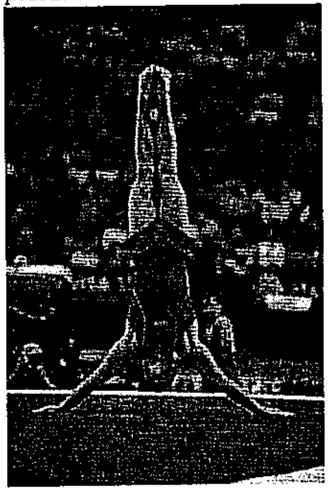
(a) 3.0 m
(b) 1.0 m
(c) 1.5 m
[✓ (d)] 0.5 m
(e) 0.25 m

$F_1 d_1 = F_2 d_2$

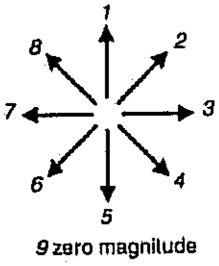
$(30)(9.8)(1.5) = (90)(9.8) d_2$

$d_2 = \frac{30(1.5)}{90} = 0.5 m$

17. A gymnast is in equilibrium, as shown in the picture below.



Which arrow below points in the direction of the frictional force on *his right hand* by the floor. (Note: his right hand is on the left side of the picture.)



(a) 1
(b) 2
[✓ (c)] 3
(d) 7
(e) 8

f is always parallel to the surfaces in contact

18. A basketball player bends her knees and then jumps vertically. During the jump, while her feet are in contact with the floor and while she is speeding up, the force on her by the floor is

(a) equal to her weight.
(b) less than her weight.
[✓ (c)] greater than her weight.

$\uparrow F_N$ $\downarrow mg$ $\uparrow a_y$

19. Which is larger for two surfaces in contact (like rubber and concrete, for example), the coefficient of static friction or the coefficient of kinetic friction?

$f_{s_{max}} > f_k$

[✓ (a)] coefficient of static friction
(b) coefficient of kinetic friction
(c) neither, because they are usually equal.
(d) it depends on the surfaces in contact.

20. The following forces act in the x-direction on a cyclist: $F_{1x} = -200$ N and $F_{2x} = 150$ N. The x-acceleration of the cyclist at this instant is

(a) zero
(b) positive.
[✓ (c)] negative.

$\xleftarrow{200N} \cdot \xrightarrow{} 150 N$

$F_{net_x} = -200 + 150$
$= -50 N$

So a_x is negative

+30 total

Section 2. Problem Solving

21. A 2.1 kg sled is dragged across snow by a rope exerting a 10.0 N tension force at an angle of 30°. The sled moves with a constant velocity.

(a) What is the force of kinetic friction on the sled? (Hint: use Newton's second law in the x-direction)

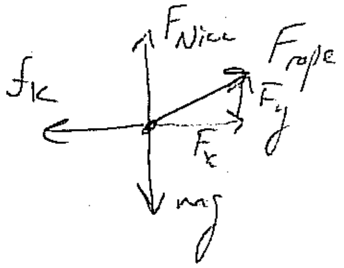
object = sled!

$\theta = 30°$

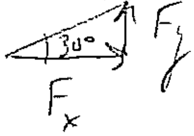
$T = 10N$

a_x and $a_y = 0$

$f_k = ?$



$F_{rope} = 10N$



$\Sigma F_x = ma_x$

$\Sigma F_y = ma_y$

$8.66 - f_k = 0$

$\boxed{f_k = 8.66N}$

$F_{rope\,x} = 10\cos(30)$
$= 8.66\ N$

$F_{rope\,y} = 10\sin(30) = 5N$

+15

(b) What is the normal component of the force of the snow on the sled? (Hint: use Newton's second law in the y-direction)

$\Sigma F_y = ma_y$

$F_{rope\,y} + F_{N\,ice} - mg = 0$

$F_{Nice} = -F_{rope\,y} + mg$

$= -5 + (2.1)(9.8)$

$= -5 + 20.58N$

$\boxed{F_{Nice} = 15.58\ N}$

+10

(c) What is the coefficient of kinetic friction for the sled/snow surface?

$f_k = \mu_k F_N$

so $\mu_k = \frac{f_k}{F_N} = \frac{8.66N}{15.58N} = \boxed{0.56}$

pretty high! must be "rough" snow

+5