Review Problems Unit 2

1. The net force on a moving object suddenly becomes zero and remains zero. The object will
   a. stop abruptly
   b. reduce speed gradually
   c. continue at a constant velocity
   d. increase speed gradually

2. A cup of coffee is sitting on a table in an RV. The cup is seen to slide toward the rear of the vehicle. According to Newton's laws, which one or more of the following statements could describe the motion of the RV? *Check all that are possible.*
   ____the RV was originally at rest, and the driver suddenly accelerates forward.
   ____the RV is moving forward, and the driver suddenly accelerates forward.
   ____the RV is moving backward, and the driver suddenly hits the brakes.

3. Two cars go around the same unbanked curve on a day when icy conditions have made the frictional force between tires and road equal to zero. Can the heavier car take the turn safely at a higher speed than the lighter car? Justify your answer.

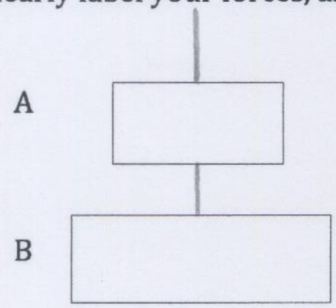
4. An object is floating in a zero gravity environment. Two ropes are attached to it and forces of 10 N and 30 N respectively are applied to the ropes. (These are the only forces acting on the object.) Which of the following could NOT be the magnitude of the net force on the object?
   a. 10 N
   b. 20 N
   c. 30 N
   d. 40 N

5. A person pushes a 10 kg crate exerting a 200 N force on it, but the crate's acceleration is only 5 m/s^2. Explain.
   a. The crate pushes back on the person, so the acceleration is lower than expected.
   b. There are other forces exerted on the crate.
   c. Not enough information is given to explain this.

6. The speedometer of your car shows that you are traveling at a constant speed of 23 m/s. Is it possible that your car is accelerating? Explain.

7. Air resistance, or Drag, is a force which always opposes the motion as an object moves through the air. A ball is dropped from a height to the ground. If Drag is present, is the net force on the ball greater, less, or equal to its actual weight? Justify your answer.

8. Two blocks are being accelerated upward by massless ropes 1 and 2, as shown. Block B is more massive than block A, and the tension in the rope 1 is T1. Draw separate free-body diagrams for each block. Clearly label your forces, and rank these forces from largest to smallest.

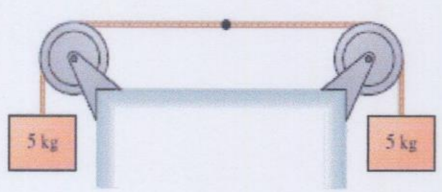


9. You are making a circular turn in your car when you hit a big patch of ice, causing the frictional force between your tires and the road to go to zero. While the car is on the ice, it

a. moves in a straight line
b. continues on a circular path but with a larger radius
c. follows the original circular path
d. follows a curved path that is non-circular

10. An object has only three forces acting on it. You started to draw the free-body diagram for this object, but became distracted after drawing the two forces shown. When you came back to the problem, you could not remember what the third force had been, but you remembered that the acceleration had been in the direction shown to the right. Make a reasonable drawing of the third force, and show how you found this force.

11. The system shown is at rest, and the ropes and pulleys are massless. The pulleys are frictionless. Find the tension at the marked point.



All mathematical problems on the exam will require that you:

1. Sketch the system.
2. Draw a free-body diagram, including your axes and each force clearly labeled.
3. Start your problem solving with Newton's 2nd law and show how your solution follows logically from the 2nd law and your free-body diagram.

11. A 20 kg sled is being pulled across a horizontal surface at a constant velocity of 0.50 m/s. The pulling force has a magnitude of 80 N and is directed at an angle of 30^0 above the horizontal. Find the coefficient of kinetic friction between sled and snow.

12. A 50 kg student gets into an elevator at rest. As the elevator begins to move, she has an apparent weight of 600 N for the first 3.0 s.

a. how far does the student travel in this 3.0 s?

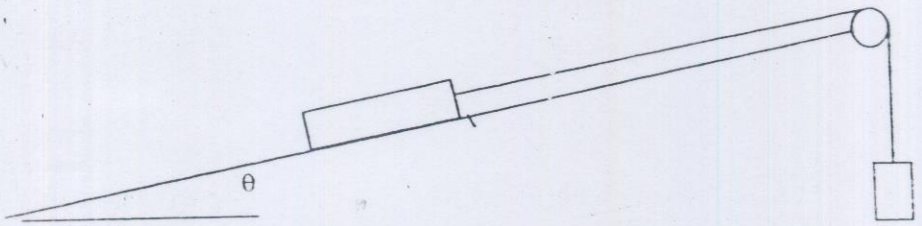
b. can you tell whether the student went upward or downward? Explain your reasoning.

13. A curve in the highway has a radius of 140 m and is banked at an angle θ above the horizontal. During an ice storm, when the frictional force between your tires and the road is essentially zero, the maximum speed at which you can take the curve is 24 m/s. Find θ.

14. A cart with a mass of 2.3 kg sits on an incline, as shown, and is attached by a string over a frictionless pulley to a hanging block. The coefficient of kinetic friction between cart and ramp is 0.12, and the angle $\theta = 50^0$. You observe that when you let go of the cart, it accelerates <u>down</u> the ramp with an acceleration of 0.80 m/s^2.

a. find the mass of the hanging block

b. find the tension in the string



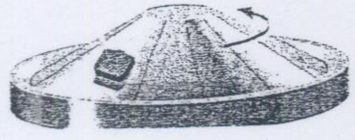
15. The drawing shows a baggage carousel at an airport. Your suitcase (m = 9.0 kg) is stuck partway down the slope and is going around in a circle of radius 11 m at a constant speed as the carousel turns. The coefficient of static friction between suitcase and carousel is 0.76, and the slope makes an angle $\theta = 36^0$ to the horizontal.

a. mark the center of the circle your suitcase is going around.

b. make a free body diagram for the suitcase. Include your coordinate system.

c. find the speed of your suitcase.

d. find the time it takes the suitcase to go around once.

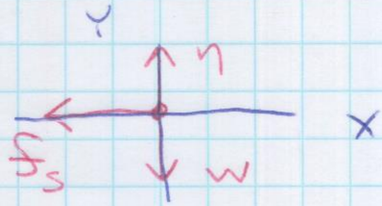


Rev Unit 2

1. 1st Law (+ 2nd Law). v = constant if net F = 0.
(C)

2. All. Cup continues vehicle's original motion, since static friction evidently could not provide enough force to accelerate cup as fast as RV is.

3.

$\Sigma F_x = ma_x$ $\qquad$ $\Sigma F_y = ma_y$

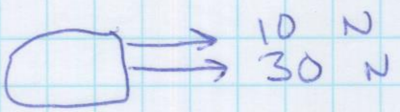
$f_s = ma_x$ $\qquad$ $n - w = 0$

$\mu_s n = ma_x$ $\qquad$ $n = mg$

$\mu_s (mg) = ma_x$

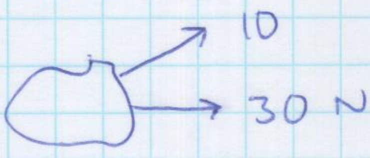
$a_x = \mu_s g$ $\quad$ Mass is irrelevant.

Both cars have same $a_c = v^2/r$ so same safe speed.

4.


$\Sigma F = 40 N$

$\Sigma F = 20 N$



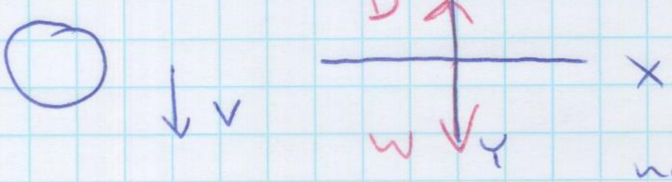
At some angle, will be 30 N.

(A) not possible.

5. (B). Must be other forces causing $\Sigma F < 200 N$.
Friction, another push / pull, tension in a rope...

6. Yes. Velocity is a Vector. If your direction is changing, you are accelerating.

7.

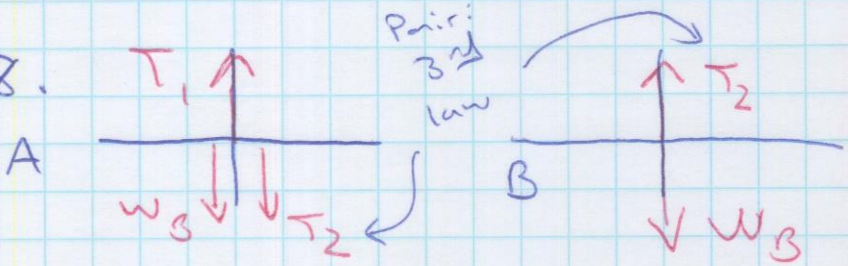


$\Sigma F = ma$

$\underbrace{W - D} = ma$

net Force less than W.

8.



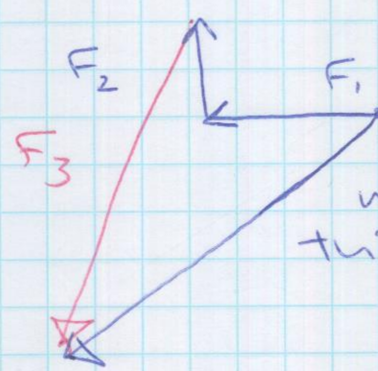
and a ↑ so ↑ ΣF

$T_1 > (T_{2\,ON\,A} = T_{2\,ON\,B}) > W_B > W_A$

9. A. 2nd + 1st Law: You have removed the force giving F_c. $\vec{v}$ stays constant.

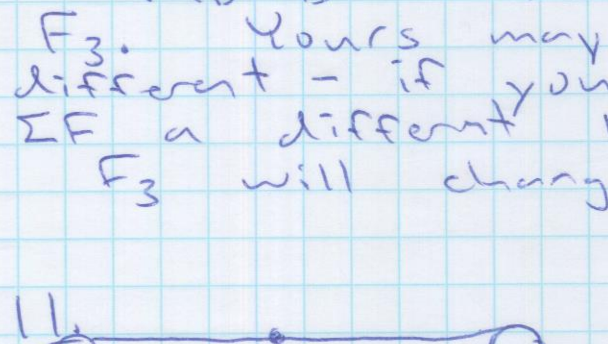
10. Add vectors head-to-tail. Resultant gives direction of net Force.

This is a reasonable F_3. Yours may be different - if you draw ΣF a different length, F_3 will change.



need this ΣF.

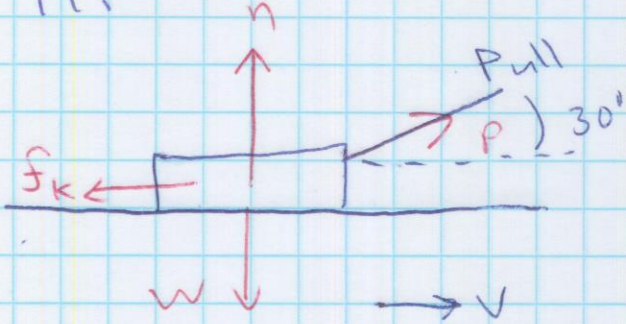
11.

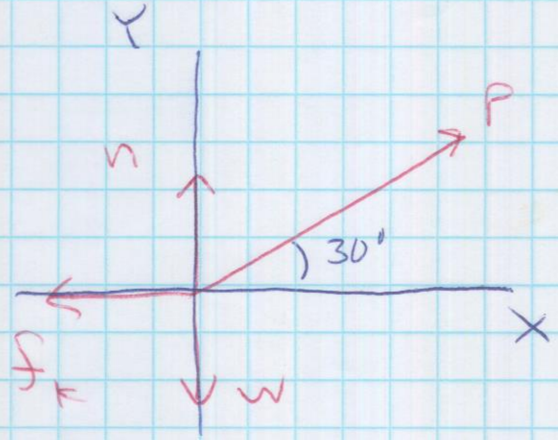


Marked point does not move. Same as if were attached to a wall.

$T = 49\ N.$

11.





v = const, so
a = 0

$\Sigma F_x = ma_x$

$P\cos 30^\circ - f_k = 0$

$P\cos 30^\circ = \mu_k n$

$n = \dfrac{P\cos 30^\circ}{\mu_k}$

$\Sigma F_y = ma_y$

$P\sin 30 + n - w = 0$

$P\sin 30 + n = mg$

$$P\sin 30 + \frac{P\cos 30}{\mu_k} = mg$$

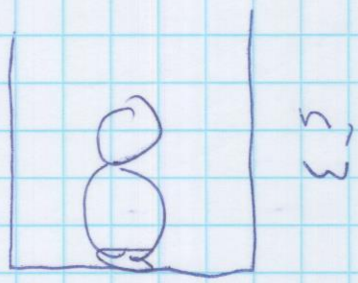
$$80\sin 30 + \frac{1}{\mu_k}(80\cos 30) = (20)(9.8)$$

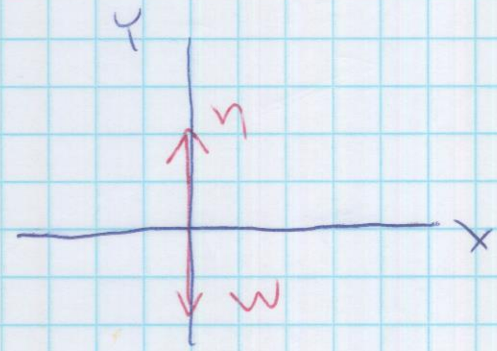
$$40 + \frac{1}{\mu_k}(69.23) = 196$$

$$\frac{1}{\mu_k}(69.23) = 156$$

$$\mu_k = 0.44$$

12.





a either up or down, but not Ø.

Pick either up = +Y or Down = +Y

$\Sigma F_y = m a_y$

$n - w = m a_y$

Scale reads normal force : $n = 600$ N.

$600_N - (50\text{ kg})(9.8\text{ m/s}^2) = (50\text{ kg})\, a$

$a = +2.2\text{ m/s}^2$

In my +Y direction, so accel. is UP

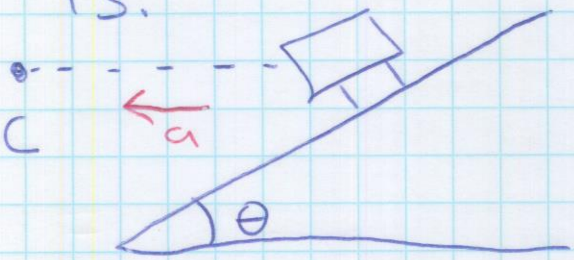
$v_0 = 0$ and a (+), so v is UP

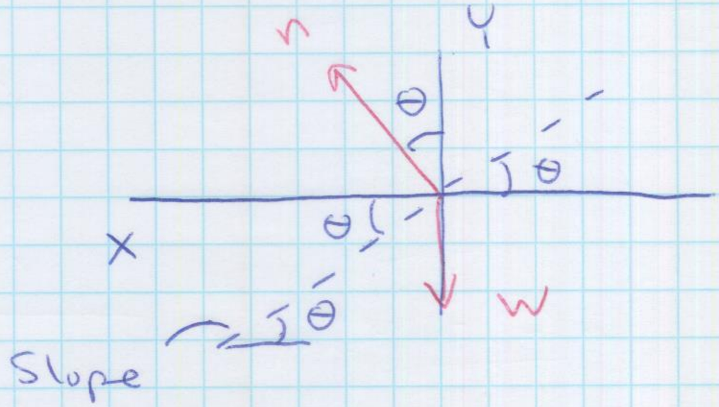
$\Delta Y = v_{0y}\Delta t + \frac{1}{2} a_y \Delta t^2$

$\Delta Y = 0 + \frac{1}{2}(2.2\text{ m/s}^2)(3.0\text{ s})^2$

$\Delta Y = 9.9$ m

13.





$$\Sigma F_x = ma_x$$

$$n\sin\theta = \frac{mv^2}{r}$$

$$\left(\frac{mg}{\cos\theta}\right)\sin\theta = \frac{mv^2}{r}$$

$$g\tan\theta = \frac{v^2}{r}$$

$$\tan\theta = \frac{v^2}{gr} = \frac{(24\ m/s)^2}{(9.8\ m/s^2)(140\ m)}$$

$$\tan\theta = 0.420$$

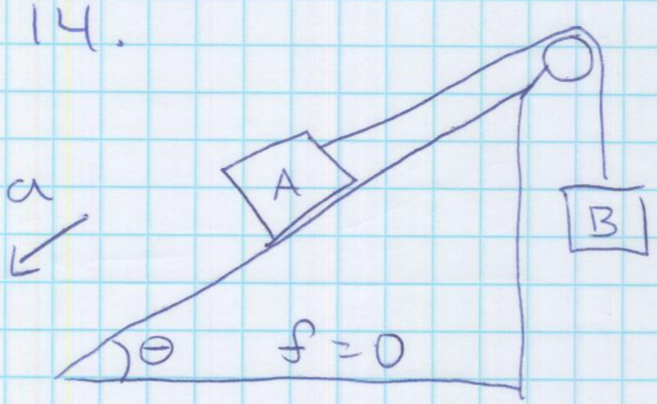
$$\theta = 23^\circ$$

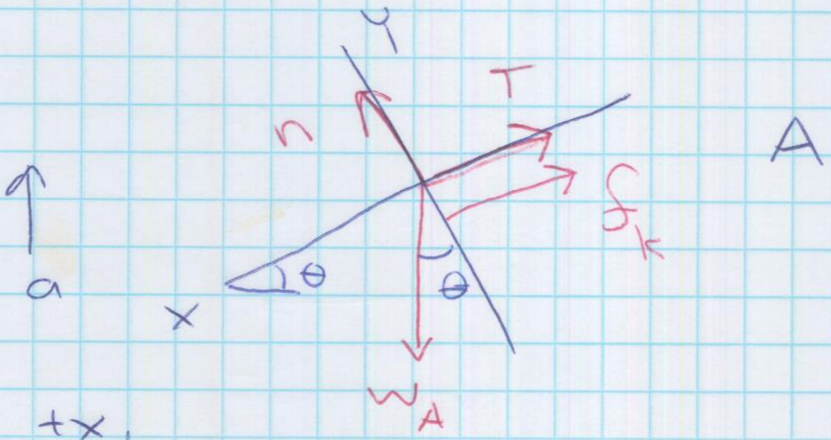
$$\Sigma F_y = ma_y$$

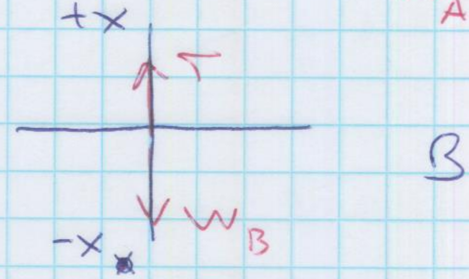
$$n\cos\theta - w = 0$$

$$n = \frac{mg}{\cos\theta}$$

14.







Hanging Mass:

$$\Sigma F_x = m a_x$$

$$T - w_B = m_B a$$

$$T = m_B a + m_B g$$

$$T = m_B (a + g)$$

Cart:

$$\Sigma F_x = m a_x \qquad \Sigma F_y = m a_y$$

$$w_A \sin\theta - T - f_k = m_A a \qquad n - w_A \cos\theta = 0$$

$$n = m_A g \cos\theta$$

$$n = (2.3)(9.8)\cos 50^\circ$$

$$n = 14.5 \text{ N}$$

$$m_A g \sin\theta - T - \mu_k n = m_A a$$

$$(2.3)(9.8)\sin 50 - T - 0.12(14.5) = 2.3(+0.80)$$

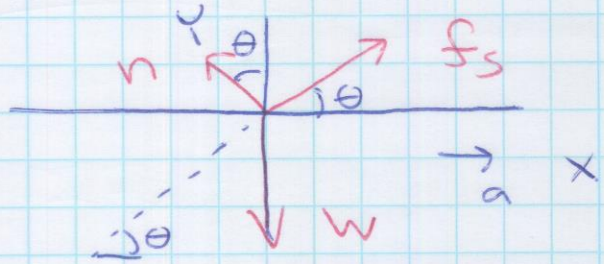
$$17.27 - T - 1.74 = 1.84$$

$$T = 13.7 \text{ N}$$

from Hanging Mass: $T = m_B(a + g)$

$$m_B = \frac{13.7}{(0.8 + 9.8)} = 1.29 \text{ kg}$$

level with suitcase.



Static friction helps keep suitcase from sliding down ramp.

$\Sigma F_x = m a_x$

$f_s \cos 36 - n \sin 36 = \frac{mv^2}{r}$

$\Sigma F_y = m a_y$

$n \cos 36 + f_s \sin 36 - mg = 0$

$n \cos 36 + \mu_s n \sin 36 = mg$

$n [\cos 36 + \mu_s \sin 36] = mg$

$n [\cos 36 + 0.76 \sin 36] = (9)(9.8)$

$n = 70.3$ N

$\mu_s n \cos 36 - n \sin 36 = \frac{mv^2}{r}$

$n [\mu_s \cos 36 - \sin 36] = mv^2/r$

$70.3 [0.76 \cos 36 - \sin 36] = (9)(v^2) / 11$

$v = 1.43$ m/s

$2\pi r = vT$

$T = \frac{2\pi (11 \text{ m})}{1.43 \text{ m/s}} = 48 \text{ s}$