

Summer Practice Test 2 (Ungraded) (7293503)

Question

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Description

This will not be graded, but it is in your interest to practice. The solutions will be placed on the class website, but I strongly encourage you to try the whole exam before looking at the solutions. The best way to practice is to mimic the environment of the exam as much as possible; I recommend giving yourself about an hour or so just to take this and then look over the solutions. Think carefully about what you got incorrect. If you still don't understand why after thinking about it, ask me to do that problem during the review day.

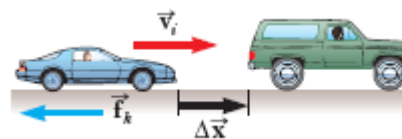
1. Question Details

sercp8 5.ae.03.nva [989171]

EXAMPLE 5.3 Collision Analysis

Goal Apply the work-energy theorem with a known force.

Problem The driver of a 1.00×10^3 kg car traveling on the interstate at 35.0 m/s (nearly 80.0 mph) slams on his brakes to avoid hitting a second vehicle in front of him, which had come to rest because of congestion ahead. After the brakes are applied, a constant friction force of 8.00×10^3 N acts on the car. Ignore air resistance. **(a)** At what minimum distance should the brakes be applied to avoid a collision with the other vehicle? **(b)** If the distance between the vehicles is initially only 30.0 m, at what speed would the collision occur?



A braking vehicle just prior to an accident

Strategy Compute the net work, which involves just the kinetic friction, because the normal and gravity forces are perpendicular to the motion. Then set the net work equal to the change in kinetic energy. To get the minimum distance in part (a), we take the final speed v_f to be zero just as the braking vehicle reaches the rear of the vehicle at rest. Solve for the unknown, Δx . For part (b) proceed similarly, except that the unknown is the final velocity v_f .

SOLUTION

(a) Find the minimum necessary stopping distance.

Apply the work-energy theorem to the car.

$$W_{\text{net}} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Substitute an expression for the frictional work and set $v_f = 0$.

$$-f_k\Delta x = 0 - \frac{1}{2}mv_i^2$$

Substitute $v_i = 35.0$ m/s, $f_k = 8.00 \times 10^3$ N, and $m = 1.00 \times 10^3$ kg. Solve for Δx .

$$\begin{aligned} -(8.00 \times 10^3 \text{ N})\Delta x &= -\frac{1}{2}(1.00 \times 10^3 \text{ kg})(35.0 \text{ m/s})^2 \\ \Delta x &= 76.6 \text{ m} \end{aligned}$$

(b) At the given distance of 30.0 m, the car is too close to the other vehicle. Find the speed at impact.

Write down the work-energy theorem.

$$W_{\text{net}} = W_{\text{fric}} = -f_k \Delta x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

Multiply by 2/m and rearrange terms, solving for the final velocity v_f .

$$v_f^2 = v_i^2 - (2/m)f_k \Delta x$$

$$v_f^2 = (35.0 \text{ m/s})^2 - (2 / 1.00 \times 10^3 \text{ kg})(8.00 \times 10^3 \text{ N})(30.0 \text{ m})$$




$$= 745 \text{ m}^2/\text{s}^2$$

$$v_f = 27.3 \text{ m/s}$$

LEARN MORE

Remarks This calculation illustrates how important it is to remain alert on the highway, allowing for an adequate stopping distance at all times. It takes about a second to react to the brake lights of the car in front of you. On a high-speed highway, your car may travel more than 30 meters before you can engage the brakes. Bumper-to-bumper traffic at high speed, as often exists on the highways near big cities, is extremely unsafe.

Question Qualitatively, how would the solution for the final velocity change in part (b) if it's raining during the incident? (Select all that apply.)

- The speed at collision would be smaller.
- The coefficient of kinetic friction would be higher.
-  The magnitude of the work done by friction would be smaller.
- The magnitude of the work done by friction would be greater.
-  The speed at collision would be greater.
-  The coefficient of kinetic friction would be lower.

PRACTICE IT

Use the worked example above to help you solve this problem. The driver of a 1.12×10^3 kg car traveling on the interstate at 35.0 m/s (nearly 80.0 mph) slams on his brakes to avoid hitting a second vehicle in front of him, which had come to rest because of congestion ahead. After the brakes are applied, a constant friction force of 7.90×10^3 N acts on the car. Ignore air resistance.

(a) At what minimum distance should the brakes be applied to avoid a collision with the other vehicle?

 86.8 m

(b) If the distance between the vehicles is initially only 30.0 m, at what speed would the collision occur?

 28.3 m/s

EXERCISE**HINTS: GETTING STARTED | I'M STUCK!**

Use the values from PRACTICE IT to help you work this exercise. A police investigator measures straight skid marks 34 m long in an accident investigation. Assuming friction force and car mass the same as in the problem above, what was the minimum speed of the car when the brakes locked?

 21.9 m/s

2. Question Details

sercp8 5.p.005.nva [824444]

Starting from rest, a 5.9-kg block slides 2.10 m down a rough 30.0° incline. The coefficient of kinetic friction between the block and the incline is $\mu_k = 0.436$.


(a) Determine the work done by the force of gravity.

  60.7 J

(b) Determine the work done by the friction force between block and incline.

  -45.8 J

(c) Determine the work done by the normal force.

  0 J

(d) Qualitatively, how would the answers change if a shorter ramp at steeper angle were used to span the same vertical height?

Key: If a shorter ramp is used to increase the angle of inclination while maintaining the same vertical displacement, the work done by gravity will not change, the work done by the friction force will decrease (because the normal force, and hence the friction force, will decrease and also because the ramp length L decreases), and the work done by the normal force remains zero (because the normal force remains perpendicular to the displacement).

3. Question Details

sercp8 5.p.016.nva [815674]

A **0.58 kg** particle has a speed of **8.0 m/s** at point *A* and kinetic energy of 7.5 J at point *B*.

(a) What is its kinetic energy at *A*?

  **18.6** J

(b) What is its speed at point *B*?

  **5.09** m/s


(c) What is the total work done on the particle as it moves from *A* to *B*?

  **-11.1** J

4. Question Details

sercp8 6.mc.003.nva [849929]

A car of mass m traveling at speed v crashes into the rear of a truck of mass $2m$ that is at rest and in neutral at an intersection. If the collision is perfectly inelastic, what is the speed of the combined car and truck after the collision?

- $2v$
-  $v/3$
- v
- none of these
- $v/2$

5. Question Details

sercp8 6.p.013.soln.nva [817510]

A car is stopped for a traffic signal. When the light turns green, the car accelerates, increasing its speed from 0 to 5.50 m/s in 0.810 s. What are the magnitudes of the linear impulse and the average total force experienced by a 66.0 kg passenger in the car during the time the car accelerates?

linear impulse

  363 kg·m/s

average force

  448 N

Solution or Explanation

We start with the following equation.

$$I = F_{\text{av}} (\Delta t) = \Delta p = m (\Delta v)$$

Using this, we can find the linear impulse.

$$|I| = m |\Delta v| = (66.0 \text{ kg}) (5.50 \text{ m/s} - 0) = \underline{363 \text{ kg} \cdot \text{m/s}}$$


From that, we can compute the average force.

$$F_{\text{av}} = \frac{I}{\Delta t} = \frac{363 \text{ kg} \cdot \text{m/s}}{0.810 \text{ s}} = \underline{448 \text{ N}} \text{ directed forward}$$

6. Question Details

sercp8 5.mc.005.nva [849996]


The work required to accelerate an object on a frictionless surface from a speed v to a speed $2v$ is

- twice the work required to accelerate the object from $v = 0$ to v .
- four times the work required to accelerate the object from $2v$ to $3v$.
- equal to the work required to accelerate the object from $v = 0$ to v .
-  three times the work required to accelerate the object from $v = 0$ to v .
- not known without knowledge of the acceleration.

7. Question Details

sercp8 5.mc.006.nva [849994]


Alex and John are loading identical cabinets onto a truck. Alex lifts his cabinet straight up from the ground to the bed of the truck, whereas John slides his cabinet up a rough ramp to the truck. Which statement is correct?

-  John does more work than Alex.
- None of these statements is necessary true because the angle of the incline is unknown.
- Alex does more work than John.
- None of these statements is necessary true because the force of friction is unknown.
- Alex and John do the same amount of work.

8. Question Details

sercp8 5.mc.007.nva [849924]


Mark and David are loading identical cement blocks onto David's pickup truck. Mark lifts his block straight up from the ground to the truck, whereas David slides his block up a ramp on massless, frictionless rollers. Which statement is true?

- None of these statements is necessary true because the mass of one block is not given.
- David does more work than Mark.
-  Mark and David do the same amount of work.
- None of these statements is necessary true because of the angle of the incline is unknown.
- Mark does more work than David.

9. Question Details

sercp8 5.mc.011.nva [849938]

If the net work done on a particle is zero, which of the following statements must be true?

-  The speed is unchanged.
- The velocity is decreased.
- The velocity is zero.
- More information is needed.
- The velocity is unchanged.

10. Question Details

sercp8 6.mc.004.nva [849978]

A small china bowl having kinetic energy E is sliding along a frictionless countertop when a server, with perfect timing, places a rice ball into the bowl as it passes him. If the bowl and rice ball have the same mass, what is the kinetic energy of the system thereafter?

- $E/4$
- $E/2$
- $E/8$
- $2E$
- E

11. Question Details

sercp8 6.mc.005.nva [849952]


In a game of billiards, a red billiard ball is traveling in the positive x -direction with speed v and the cue ball is traveling in the negative x -direction with speed $3v$ when the two balls collide head on. Which statement is true concerning their velocities subsequent to the collision? Neglect any effects of spin.

- red ball: $-v$; cue ball: $3v$
- red ball: v ; cue ball: $2v$
- red ball: v ; cue ball: $3v$
- red ball: $-3v$; cue ball: v
- The velocities can't be determined without knowing the mass of each ball.

12. Question Details

sercp8 6.mc.007.nva [849977]

A 0.10-kg object moving initially with a velocity of 0.20 m/s eastward makes an elastic head-on collision with a 0.15-kg object initially at rest. What is the final velocity of the 0.10-kg object after the collision?

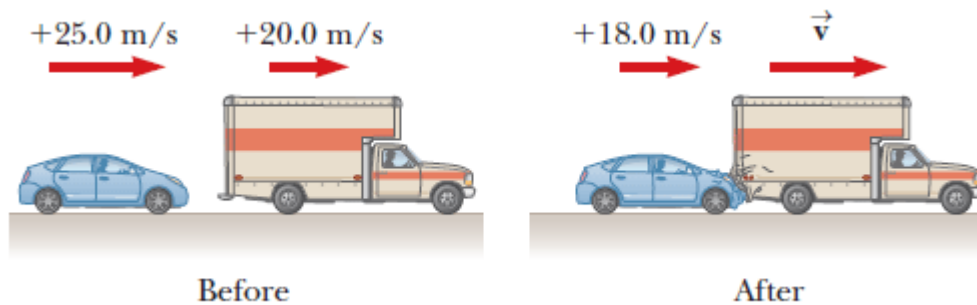
- 0.16 m/s eastward
-  0.040 m/s westward
- 0.040 m/s eastward
- 0.16 m/s westward
- none of these

13. Question Details

sercp8 6.p.042.nva [2611045]

Use the exact values you enter in previous answer(s) to make later calculation(s).

A **1,115**-kg car traveling initially with a speed of 25.0 m/s in an easterly direction crashes into the rear end of a **9,800**-kg truck moving in the same direction at 20.0 m/s (see figure below). The velocity of the car right after the collision is 18.0 m/s to the east.



(a) What is the velocity of the truck right after the collision?

20.8 m/s (east)

(b) How much mechanical energy is lost in the collision?

8600 J

Account for this loss in energy.

Key: The lost kinetic energy becomes internal energy.

14. Question Details

sercp10 4.cq.004.nva [2832879]

If you push on a heavy box that is at rest, you must exert some force to start its motion. Once the box is sliding, why does a smaller force to maintain its motion?

Key: The coefficient of static friction is larger than that of kinetic friction. To start the box moving, you must counterbalance the maximum static friction force. This exceeds the kinetic friction force that you must counterbalance to maintain constant velocity once it starts moving.

15. Question Details

sercp10 4.cq.008.nva [2832799]

If only one force acts on an object, can it be in equilibrium?

- Yes
- No


Explain.

Key: In order for an object to be in equilibrium, the resultant force acting on it must be zero. Thus, it is not possible for an object to be in equilibrium when a single force of non-zero magnitude acts on it.

16. Question Details

sercp10 4.cq.015.nva [2832623]

As a block slides down a frictionless incline, which of the following statements is true?


- Its speed increases and its acceleration decreases.
-  Its speed increases and its acceleration remains constant.
- Both its speed and acceleration increase.
- Its speed and acceleration remain constant.
- Both its speed and acceleration decrease.

17. Question Details

sercp10 4.cq.017.nva [2832975]

In the photo, a locomotive has broken through the wall of a train station. During the collision, what can be said about the force exerted by the locomotive on the wall?




-  The force exerted by the locomotive on the wall was the same in magnitude as the force exerted by the wall on the locomotive.
- The force exerted by the locomotive on the wall was larger than the force the wall could exert on the locomotive.
- The force exerted by the locomotive on the wall was less than the force exerted by the wall on the locomotive.
- The wall cannot be said to "exert" a force; after all, it broke.

18. Question Details

sercp10 4.cq.018.nva [2879008]

If an object is in equilibrium, which of the following statements is not true?

-  The object must be at rest.
- The acceleration of the object is zero.
- The net force acting on the object is zero.
- The velocity is constant.
- The speed of the object remains constant.

19. Question Details

sercp10 4.p.039.nva [2780377]

A dockworker loading crates on a ship finds that a 32-kg crate, initially at rest on a horizontal surface, requires a 73-N horizontal force to set it in motion. However, after the crate is in motion, a horizontal force of 54 N is required to keep it moving with a constant speed. Find the coefficients of static and kinetic friction between crate and floor.

static friction 0.233

kinetic friction 0.172

Solution or Explanation

When the block is on the verge of moving, the static friction force has a magnitude $f_s = (f_s)_{\max} = \mu_s n$.

Since equilibrium still exists and the applied force is 73 N, we have

$$\sum F_x = 73 \text{ N} - f_s = 0 \quad \text{or} \quad (f_s)_{\max} = 73 \text{ N}.$$

In this case, the normal force is just the weight of the crate, or $n = mg$. Thus, the coefficient of static friction is

$$\mu_s = \frac{(f_s)_{\max}}{n} = \frac{(f_s)_{\max}}{mg} = \frac{73 \text{ N}}{(32 \text{ kg})(9.80 \text{ m/s}^2)} = 0.233.$$

After motion exists, the friction force is that of kinetic friction, $f_k = \mu_k n$.

Since the crate moves with constant velocity when the applied force is 54 N, we find that $\sum F_x = 54 \text{ N} - f_k = 0$ or $f_k = 54 \text{ N}$. Therefore, the coefficient of kinetic friction is

$$\mu_k = \frac{f_k}{n} = \frac{f_k}{mg} = \frac{54 \text{ N}}{(32 \text{ kg})(9.80 \text{ m/s}^2)} = 0.172.$$

20. Question Details



sercp10 4.p.043.nva [2780425]

Consider a large truck carrying a heavy load, such as steel beams. A significant hazard for the driver is that the load may slide forward, crushing the cab, if the truck stops suddenly in an accident or even in braking. Assume, for example, a **13,000**-kg load sits on the flatbed of a 20,000-kg truck moving at **11.0** m/s. Assume the load is not tied down to the truck and has a coefficient of static friction of **0.400** with the truck bed.

(a) Calculate the minimum stopping distance for which the load will not slide forward relative to the truck.

 15.4 m

(b) Is any piece of data unnecessary for the solution? (Select all that apply.)

-  mass of the load
-  mass of the truck
- velocity
- coefficient of static friction

Solution or Explanation

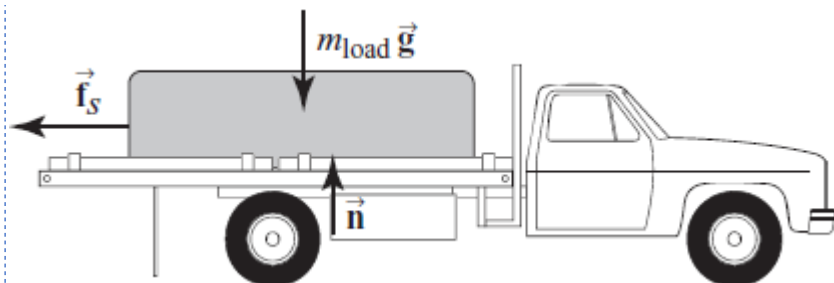
When the load is on the verge of sliding forward on the bed of the slowing truck, the rearward-directed static friction force has its maximum value

$$(f_s)_{\max} = \mu_s n = \mu_s m_{\text{load}} g.$$

Since slipping is not yet occurring, this single horizontal force must give the load an acceleration equal to that of the truck.

Thus,

$$\sum F_x = ma_x \Rightarrow -\mu_s m_{\text{load}} g = m_{\text{load}} (a_{\text{truck}})_{\max} \quad \text{or} \quad (a_{\text{truck}})_{\max} = -\mu_s g.$$



(a) If slipping is to be avoided, the maximum allowable rearward acceleration of the truck is seen to be $(a_{\text{truck}})_{\text{max}} = -\mu_s g$, and $v_x^2 = v_{0x}^2 + 2a_x(\Delta x)$ gives the minimum stopping distance as

$$(\Delta x)_{\text{min}} = \frac{0 - v_{0x}^2}{2(a_{\text{truck}})_{\text{max}}} = \frac{v_{0x}^2}{2\mu_s g}.$$

If $v_{0x} = 11.0$ m/s and $\mu_s = 0.400$, then

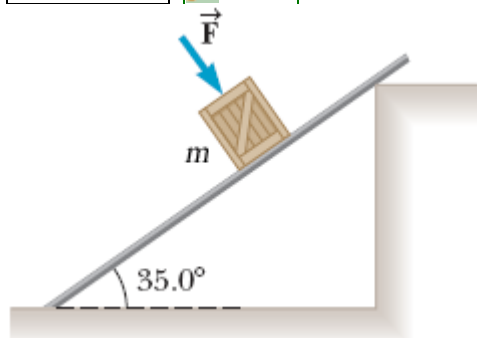
$$(\Delta x)_{\text{min}} = \frac{(11.0 \text{ m/s})^2}{2(0.400)(9.80 \text{ m/s}^2)} = 15.4 \text{ m}.$$

(b) Examining the calculation of part (a) shows that neither mass is necessary.

21. Question Details

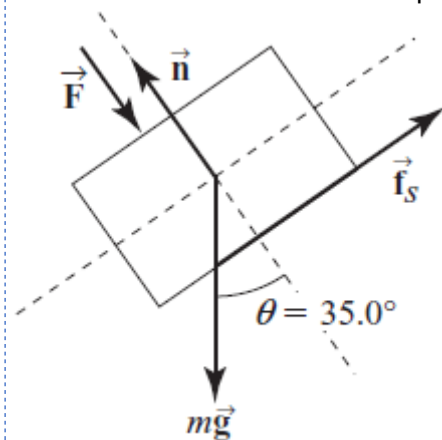
sercp10 4.p.047.wi.nva [2780409]

The coefficient of static friction between the $m = 3.45\text{-kg}$ crate and the 35.0° incline of the figure below is 0.265 . What minimum force \vec{F} must be applied to the crate perpendicular to the incline to prevent the crate from sliding down the incline?

  45.5 N


Solution or Explanation

The crate does not accelerate perpendicular to the incline.



Thus,

$$\sum F_{\perp} = ma_{\perp} = 0 \Rightarrow n = F + mg \cos \theta.$$

The net force tending to move the crate down the incline is $\sum F_{\parallel} = mg \sin \theta - f_s$, where f_s is the force of static friction

between the crate and the incline. If the crate is in equilibrium, then

$$mg \sin \theta - f_s = 0 \quad \text{so} \quad f_s = F_g \sin \theta.$$

But, we also know $f_s \leq \mu_s n = \mu_s(F + mg \cos \theta)$.

Therefore, we may write

$$mg \sin \theta \leq \mu_s(F + mg \cos \theta) \quad \text{or}$$

$$F \geq mg \left(\frac{\sin \theta}{\mu_s} - \cos \theta \right) = (3.45 \text{ kg})(9.80 \text{ m/s}^2) \left(\frac{\sin 35.0^\circ}{0.265} - \cos 35.0^\circ \right) = 45.5 \text{ N}.$$

22. Question Details

sercp10 4.p.019.nva [2780389]

A 122.4-N bird feeder is supported by three cables as shown in the figure below. Find the tension in each cable.

left cable 106 N
 right cable 61.2 N
 bottom cable 122 N



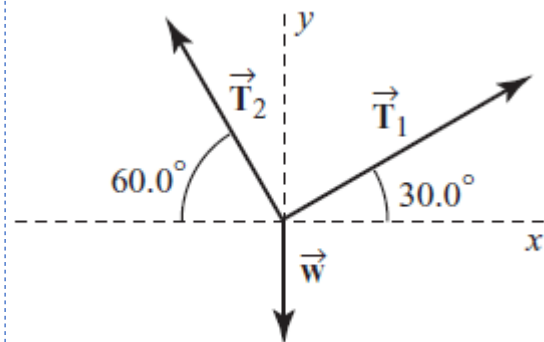
Solution or Explanation

From $\sum F_x = 0$,

$$T_1 \cos 30.0^\circ - T_2 \cos 60.0^\circ = 0$$

or

$$T_2 = (1.73)T_1. \quad \mathbf{[1]}$$



The tension in the vertical cable is the full weight of the feeder, or $T_{\text{vertical}} = 122.4 \text{ N}$.

Then $\sum F_y = 0$ becomes

$$T_1 \sin 30.0^\circ + (1.73T_1)\sin 60.0^\circ - 122.4 \text{ N} = 0$$

which gives $T_1 = 61.2 \text{ N}$ in the right side cable.

Finally, Equation [1] above gives $T_2 = 106 \text{ N}$ in the left side cable.

23. Question Details

sercp10 4.p.003.nva [2780381]

A **6.8 kg** object undergoes an acceleration of **2.5 m/s²**.

(a) What is the magnitude of the resultant force acting on it?

 17 N

(b) If this same force is applied to a **4.1 kg** object, what acceleration is produced?

 4.15 m/s²

Solution or Explanation

(a) $\sum F_x = ma_x = (6.8 \text{ kg})(2.5 \text{ m/s}^2) = 17.0 \text{ N}$

(b) $a_x = \frac{\sum F_x}{m} = \frac{17.0 \text{ N}}{4.1 \text{ kg}} = 4.15 \text{ m/s}^2$

Assignment Details

Name (AID): **Summer Practice Test 2 (Ungraded) (7293503)**

Submissions Allowed: **10**

Category: **Homework**

Code:

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