Physics 6A Practice Final Problems

1) A locomotive engine of mass M is attached to 5 train cars, each of mass M. The engine produces a constant force that moves the train forward at acceleration $a$. If 3 of the cars are removed, what will be the acceleration of the shorter train?
   a) 0.5a  
   b) 1.7a  
   c) 2.0a  
   d) 3.0a  

2) Two boxes are placed next to each other on a smooth flat surface. Box A has mass 1 kg and Box B has mass 3 kg. A constant horizontal force of 8 N is applied to Box A. Find the force exerted on Box B.
   a) 1 N  
   b) 2 N  
   c) 4 N  
   d) 6 N  

3) Two boxes are placed next to each other on a flat surface. Box A has mass 1 kg and Box B has mass 3 kg. The coefficients of friction are 0.3 and 0.4 for kinetic and static friction, respectively. A constant horizontal force of 8 N is applied. Find the acceleration of Box B.
   a) 0 m/s$^2$  
   b) 1 m/s$^2$  
   c) 2 m/s$^2$  
   d) 3 m/s$^2$  

4) A 0.2 kg piece of wood is being held in place against a vertical wall by a horizontal force of 5 N. Find the magnitude of the friction force acting on the wood.
   a) 1 N  
   b) 2 N  
   c) 5 N  
   d) 10 N  

5) A 4 kg block on a horizontal surface is attached to a spring with a force constant of 50 N/m. As the spring and block are pulled forward at constant speed, the spring stretches by 25 cm. Find the coefficient of kinetic friction between the block and the table.
   a) 0.25  
   b) 0.32  
   c) 0.42  
   d) 0.51  

6) A 90 kg man drives his car at a constant speed of 15 m/s over a small hill that has a circular cross section of radius 40 m. Find his apparent weight as he crests the top of the hill.
   a) 380 N  
   b) 500 N  
   c) 880 N  
   d) 1350 N

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Physics 6A Practice Final Problems

7) Planet X has a radius that is 3 times as large as Earth and a mass that is 6 times that of Earth. A NASA astronaut who weighs 550 N here on Earth is planning to embark on a manned mission to Planet X. What will be the astronaut’s weight when she lands there?
   a) 367 N  
   b) 550 N  
   c) 825 N  
   d) 1100 N

8) A car is traveling at a speed of 40 m/s. The brakes are applied, and a constant force brings the car to a complete stop in a time of 6.2 seconds. The tires on the car have a diameter of 70 cm. How many revolutions does each tire make while the car is braking?
   a) 12  
   b) 27  
   c) 56  
   d) 112

9) Two blocks of equal mass M are attached by a massless rope, with one block on a frictionless table, and the other block hanging down below, as shown. When the block on the table is moving in a circular path at 1 revolution per second, the hanging block is stationary. Find the radius of the circle.
   a) 10 cm  
   b) 25 cm  
   c) 50 cm  
   d) 150 cm

10) A merry-go-round is initially rotating at a rate of 1 revolution every 8 seconds. It can be treated as a uniform disk of radius 2 meters and mass 400 kg. A 50 kg child runs toward the merry-go-round at a speed of 5.0 m/s, jumping on to the rim (tangentially, as shown). Find the child’s linear speed after jumping onto the merry-go-round.
   a) 1.1 m/s  
   b) 2.3 m/s  
   c) 5.0 m/s  
   d) 7.2 m/s

11) A ballistic pendulum consists of a solid block of titanium with mass 5 kg, suspended from a light wire. A bullet of mass 5 g is launched toward the block at an unknown speed. The bullet bounces back at half its original speed, and the block rises to a height of 1.8 cm above its starting point. What was the initial speed of the bullet?
   a) 100 m/s  
   b) 200 m/s  
   c) 300 m/s  
   d) 400 m/s

12) Two cars are moving toward an intersection. Car A is traveling East at 20 m/s, and Car B is traveling North at 12 m/s. The mass of Car A is 1000 kg and the mass of Car B is 2000 kg. Driver A is applying mascara to her eyelashes, and driver B is reading a text message, so neither of them slows down as they approach the intersection. When the cars crash into each other, they stick together. Find the common velocity of the cars just after the collision.
   a) 32.0 m/s at an angle of 45° North of East  
   b) 12.0 m/s at an angle of 30° North of East  
   c) 23.3 m/s at an angle of 23° North of East  
   d) 10.4 m/s at an angle of 50° North of East

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Physics 6A Practice Final Problems

13) The Atwood’s machine system shown is comprised of a block of mass \( M \) attached by a massless rope to block of mass \( 2M \). The rope passes over a solid cylindrical pulley of mass \( M \) and radius \( R \), and the rope does not slip on the pulley.

Find the acceleration of the heavier block. Use \( g \) for gravitational acceleration.

\[
\begin{align*}
\text{a) } & \quad \frac{2}{7} g \\
\text{b) } & \quad \frac{2}{5} g \\
\text{c) } & \quad \frac{1}{2} g \\
\text{d) } & \quad \frac{2}{3} g \\
\end{align*}
\]

14) A light uniform ladder of length 5m is leaning against a wall so that the top of the ladder is 4m above the ground and the bottom of the ladder is 3m from the wall, as shown. How high can a person of mass 150 kg walk up the ladder before the ladder slips? Assume the coefficient of static friction between the ladder and the ground is 0.6 and that the wall is frictionless.

\[
\begin{align*}
\text{a) } & \quad 1.0 \text{ m} \\
\text{b) } & \quad 2.5 \text{ m} \\
\text{c) } & \quad 3.0 \text{ m} \\
\text{d) } & \quad 4.0 \text{ m} \\
\end{align*}
\]

15) A 50cm X 25 cm cafeteria tray with mass = 0.2 kg is loaded with the following items:
A carton of milk with mass = 0.5 kg is placed in the upper left corner.
An apple with mass = 0.3 kg is placed in the middle of the right hand side.
A plate with a uniform layer of mashed potatoes (mass = 2kg) is placed in the center.
A candy bar with mass = 0.05 kg is placed in the bottom right corner.

Find the location of the center of mass of the tray.

\[
\begin{align*}
\text{a) } & \quad x = -4.4 \text{ cm}, y = 2.3 \text{ cm} \\
\text{b) } & \quad x = -1.2 \text{ cm}, y = 1.8 \text{ cm} \\
\text{c) } & \quad x = -1.2 \text{ cm}, y = 2.3 \text{ cm} \\
\text{d) } & \quad x = 7.0 \text{ cm}, y = -1.8 \text{ cm} \\
\end{align*}
\]

16) Two balls are rolled down a hill. Ball A is a solid sphere with mass \( M \) and radius \( R \). Ball B is a hollow sphere with mass \( M \) and radius \( 2R \). Compare the speeds of the balls when they reach the bottom of the incline.

\[
\begin{align*}
\text{a) } & \quad V_A = 0.6 \ V_B \\
\text{b) } & \quad V_A = V_B \\
\text{c) } & \quad V_A = 1.1 \ V_B \\
\text{d) } & \quad V_A = 1.7 \ V_B \\
\end{align*}
\]
17) A box of mass M starts from rest at the top of a frictionless incline of height h. It slides down the hill and across a horizontal surface, which is also frictionless, except for a rough patch of length h, with coefficient of kinetic friction 0.25. The box comes into contact with a spring (spring constant = k), compressing it. The spring then unloads, sending the box back in the opposite direction.

Find the maximum height reached by the block as it slides back up the hill.

a) 0 (the block never gets back to the hill)
b) h/4
c) h/2
d) h

18) A diver tucks her body in mid-flight, reducing her moment of inertia by a factor of 2. What happens to her angular speed and kinetic energy?

a) Both angular speed and kinetic energy remain the same.
b) Angular speed is doubled, and kinetic energy remains the same.
c) Angular speed is doubled, and kinetic energy is increased by a factor of 4.
d) Both angular speed and kinetic energy are doubled.

19) A uniform marble rolls without slipping down the path shown, starting from rest. Find the minimum height required for the marble to make it across without falling into the pit.

a) 23m  
b) 14m  
c) 30m  
d) 35m

20) A school yard teeter-totter with a total length of 5.2 m and a mass of 36 kg is pivoted at its center. A child of mass 18-kg sits on one end. Where should the parent push downward with a force of 210 N to balance the teeter totter?

a) 0.5 m from the center  
b) 2.2 m from the center  
c) 1.3 m from the center  
d) 1.9 m from the center

Answers: 1)c  2)d  3)a  4)b  5)b  6)a  7)a  8)c  9)b  10)b  11)d  12)d  13)a  14)d  15)b  16)c  17)c  18)d  19)a  20)b