Instructor(s): *N. Sullivan*

First answers are the correct answers

YSICS DEPARTMENT

PHY 2004 Final Exam December 13, 2010

Name (print, last first): _____ Signature: _____

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

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(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
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(5) **The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, leave the form blank.**
(6) Hand in the answer sheet separately.

$g = 9.80$ m/s^2 $R = 8314$ J/kmole/K

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1. (4 points) A stone dropped from a tall building hits the ground in 2 seconds. How tall is the building?

   (1) 19.6 m (2) 9.8 m (3) 4.1 m (4) 12.4 m (5) 1.1 m

2. (4 points) A tennis ball of mass 5 g is thrown vertically up into the air with a speed of 5 m/s. How high will it travel?

   (1) 1.28 m (2) 2.56 m (3) 5.2 m (4) 15 m (5) 8.4 m/s

3. (5 points) A wheel rotating with an angular speed of 3 rev/s is brought to rest in 3 seconds. If the moment of inertia of the wheel is 2 kg/m^2, what torque was applied to bring the wheel to rest?

   (1) 12.6 kg m (2) 2.0 kg m (3) 0.32 kg m (4) 20 kg m (5) 5.2 kg m

4. (5 points) An iron beam has a length of 10 m and a cross-sectional area of 1 cm^2. If the Young's modulus of iron is 150×10^9 Pa, what is the change in the length of the beam for an applied force of 10,000 N?

   (1) 0.67 mm (2) 1.5 mm (3) 5.6 cm (4) 12 mm (5) 7.4 mm

5. (4 points) Oxygen is stored in a 2 m^3 strong steel gas cylinder. If the temperature is raised from 27°C to 127°C and the initial absolute pressure was 200 kPa, calculate the final pressure.

   (1) 267 kPa (2) 410 kPa (3) 4500 Pa (4) 110 Pa (5) 42 kPa

6. (4 points) A 2 m^3 volume of ideal gas is compressed adiabatically. If the work done by the outside force is 1200 J, what is the change in internal energy of the gas?

   (1) 1200 J (2) −1200 J (3) 600 J (4) −600 J (5) 0 J

7. (4 points) An astronaut can jump 3 feet on the moon's surface. If the acceleration due to gravity on the moon's surface is one sixth that of the value at the Earth's surface, how high can the astronaut jump on the Earth's surface using the same energy?

   (1) 6 inches (2) 6 feet (3) 3 inches (4) 3 feet (5) 2 inches

8. (3 points) A 2 meter length of steel changes temperature by 100°C during the course of a day. If the coefficient of thermal expansion of steel is 12 parts per million per °C, what is the change in length of the steel?

   (1) 2.4 mm (2) 5.6 cm (3) 12.4 mm (4) 1.2 m (5) 0.56 mm

9. (4 points) A disc is rotating at 16.6 rpm (revolutions per minute). A seed is placed on the disc at a distance of 10 cm from the center. How fast is the seed moving?

   (1) 0.16 m/s (2) 0.50 m/s (3) 4.5 m/s (4) 1.5 m/s (5) 0.33 m/s

10. (3 points) A sapphire rod is 10 cm long and has a cross-sectional area of 1 cm^2. The coefficient of thermal conductivity is 100 W/m·K. If there is a 20°C difference in temperature from one end of the rod to the other, what is the heat flow along the rod?

    (1) 2.0 W (2) 4.3 W (3) 0.25 W (4) 0.02 W (5) 10 W

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Instructor(s): The first answer given is the correct answer

PHYSICS DEPARTMENT

PHY 2004 Final Exam April 25, 2005

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$g = 9.80$ m/s^2

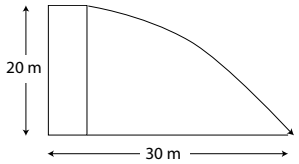
Hint: Try * problems first.

---

1. A rock is thrown straight down with speed 10 m/s from a height of 20 m above the ground. At the same moment, another rock is thrown straight up with speed 15 m/s. What is the height of the rocks when they cross each other?

   (1) 8.9 m (2) 4.3 m (3) 18.4 m (4) 12.6 m (5) 0

2. * A rock is thrown out horizontally from a tower of height 20 m. The rock hits the ground at a horizontal distance of 30 m from the base of the tower. What is the initial speed of the rock in m/s?



   (1) 15 (2) 10 (3) 20 (4) 25 (5) 30

3. Autos A and B have a head-on collision in 1 dimension. At time $t = 0$ the distance between the autos is 100 m. Each auto is initially traveling at 30 m/s. Auto A maintains constant velocity, while auto B decelerates at a constant rate of 10 m/s^2. At what time t do the autos collide?

   (1) 2 s (2) 0.5 s (3) 3 s (4) 4.5 s (5) 9 s

4. On Earth a cannon can shoot a cannonball a distance of 1000 m if it is aimed at an angle of 45° above the horizontal. On planet X, the same cannon can shoot a cannonball a distance of 500 m if it is aimed at an angle of 60° above the horizontal. What is the acceleration of gravity on planet X in m/s^2?

   (1) 17 (2) 21 (3) 24 (4) 27 (5) 30

5. * A lady whose mass is 50 kg stands on a scale in an elevator. As the elevator approaches the ground floor from above, it is slowing at a rate of 3 m/s^2. What is the reading on the scale for the lady's apparent weight?

   (1) 640 N (2) 350 N (3) 120 N (4) 200 N (5) 75 N

6. Three masses $M_1 = 1$kg, $M_2 = 2$kg, and $M_3 = 3$kg are glued together and move above the ground. A force $F = 200$ N is applied in the downward direction to M_3 as shown. What is the magnitude of the force that M_2 exerts on M_3?

(1) 100 N (2) 99.3 N (3) 113.4 N (4) 126.3 N (5) 200 N

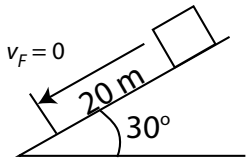
7. An elevator of mass 10^3 kg starts from rest at the 4th floor and is raised and lowered by its motor. After 15 s the elevator is 15 m below the 4th floor and is moving down at 10 m/s. How much work has been done by the motor during this process?

(1) -10^5 J (2) -10^3 J (3) -10 J (4) $+10$ J (5) $+10^4$ J

8. A trunk of mass $m = 50$ kg is pulled across a horizontal floor by a force F that acts at an angle of 30° above the horizontal. The coefficient of kinetic friction is 0.75. If the trunk accelerates at 1 m/s^2, what is the value of F?

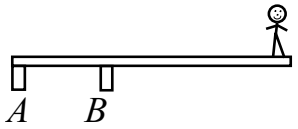
(1) 335 N (2) 300 N (3) 260 N (4) 225 N (5) 165 N

9. * A block of mass $M = 100$kg is moving down an incline that makes an angle of 30° relative to the horizontal. The block is initially moving at a speed of 15 m/s. The block moves a distance $x = 20$ m down along the incline before it is brought to rest by friction. How much work is done by friction during this process?



(1) -2.1×10^4J (2) -1.1×10^4J (3) -3.3×10^4J (4) -8.9×10^4J (5) 10^8J

10. A diver stands in equilibrium at the end of a uniform diving board of length $L = 5$ m and mass 100 kg. The diver's mass is 75 kg. What is the force F_B exerted by support B?

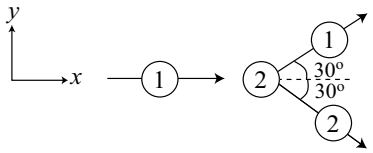


(1) not enough information (2) 9.8×10^3 N (3) 1.96×10^4 N (4) 5×10^4 N (5) 6.8×10^5 N

11. * An auto goes from 0 to 30 m/s in 5 s, at a uniform rate of acceleration. The radius of the auto's tires is 0.33 m. How many revolutions per second are the tires making after the auto has traveled for 2.5 s? Assume that the tires don't slip.

(1) 7.2 (2) 6.1 (3) 5 (4) 8.3 (5) 9.5

12. Masses M_1 and M_2 ($M_1 = M_2$) undergo a collision in 2 dimensions. Before the collision, M_1 is moving in the positive x direction at 50 m/s and M_2 is at rest. After the collision, each mass is moving at an angle of 30° with respect to the x axis. What is the final speed v_{2F} of M_2?



(1) 29 m/s (2) 22 m/s (3) 36 m/s (4) 43 m/s (5) 49 m/s

13. Satellites A and B are in orbits around the Earth. The periods T_A and T_B of the satellite orbits satisfy $T_A = 3T_B$. If R_A is the radius of orbit A, what is the radius of orbit B?

(1) $0.48R_A$ (2) R_A (3) $1.45R_A$ (4) $2.16R_A$ (5) $3.22R_A$

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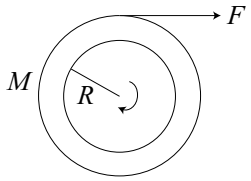
14. A bicycle tire of mass $M = 2$ kg and radius $R = 0.5$ m is spun up from rest by a force $F = 100$ N that acts in a direction parallel to its rim. What is the kinetic energy of rotation of the tire after 10 s?



(1) 2.5×10^5 J (2) 0.95×10^7 J (3) 0.54×10^7 J (4) 4.7×10^7 J (5) 10^9 J

15. * A bicycle tire of mass $M = 2$ kg and radius $R = 0.5$ m is initially rotating with angular velocity $\omega_I = 20$ rad/s. The mass of the tire is suddenly increased to 4 kg without changing its radius. After the mass is increased in this way, how many revolutions does the tire make in 1 s?

(1) 1.6 (2) 2 (3) 3 (4) 4.2 (5) 5.6

16. * An iceberg has a density 920 kg/m^3 and floats in sea water that has density 1040 kg/m^3. What fraction of the iceberg's volume is under the water?

(1) 0.88 (2) 0.98 (3) 0.51 (4) 0.33 (5) 0.66

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Final Exam December 12, 2006

Name (print, last first): _____ Signature: _____

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Suggestion: Try * problems first.
$g = 9.80$ m/s^2

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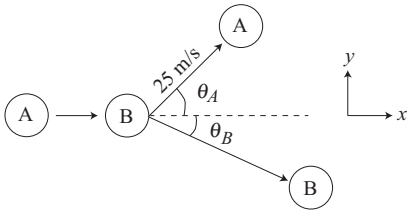
1. Auto A undergoes a 1-dimensional elastic collision with auto B along the x axis. The mass of A is twice that of B. Before the collision, the x component of the velocity of A is +20 m/s, and B is at rest. What is the velocity of A after the collision, in m/s?

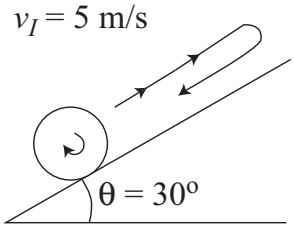
   (1) 6.67 (2) 9.34 (3) 4.23 (4) 2.21 (5) 11.3

2. Autos A and B have the same mass and undergo a 2-dimensional collision in which B is initially at rest, while A has initial velocity 30 m/s in the positive x direction. After the collision, A has speed 25 m/s, and the x component of the velocity of B is 10 m/s. What is the y component of the final velocity of B?



   (1) −15 m/s (2) −25 m/s (3) 0 (4) 10 m/s (5) 35 m/s

3. At time $t = 0$ a thin bicycle tire of mass $M = 2$ kg and radius $R = 0.5$ m is rolling up an incline with initial speed 5 m/s. The tire rolls without slipping, and the incline makes an angle of 30° with respect to the horizontal. How much time transpires before the tire returns to its initial position? (Hint: use the work-energy theorem for a rolling object.)



   (1) 4 s (2) 6 s (3) 8 s (4) 10 s (5) 12 s

4. * Idealize the sun as a thin bicycle tire of mass 10^{33} kg and radius 10^9 m. The sun is currently rotating with an angular velocity $w = 2 \times 10^{-6}$ rad/s (about 1 revolution every month). If the sun suddenly were to shrink to a radius of 10^4 m, what would be the value of its angular velocity? Assume angular momentum is conserved.

   (1) 2×10^4 rad/s (2) 4×10^6 rad/s (3) 2×10^{-1} rad/s (4) 2×10^{-6} rad/s (5) 2×10^{-12} rad/s

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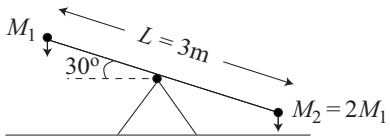
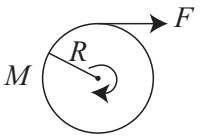
5. A uniform seesaw of length of 3 m rotates about a fulcrum at its midpoint and makes an angle of 30° with respect to the horizontal. Masses M_1 and $M_2 = 2M_1$ sit at opposite ends of the seesaw. How far along the seesaw from its midpoint (distance measured along seesaw) must a mass $M_3 = 3M_1$ be placed so that the seesaw is in equilibrium?



(1) 0.5 m (2) 0.25 m (3) 0 (4) 1 m (5) 1.5 m

6. A thin bicycle tire of mass $M = 2$ kg is spun up from rest by a constant force $F = 10$ N applied parallel to its rim. After 2 s the tire has made 3 revolutions. What is the radius of the tire? (Hint: use the analog of Newton's 2nd Law for rotational motion.)



(1) 0.53 m (2) 0.24 m (3) 0.11 m (4) 0.38 m (5) 0.67 m

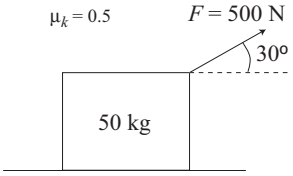
7. A 10^3 kg auto's engine puts out an average power of 100 hp for 10 s (1 hp = 746 W). Neglect frictional energy losses. During this time, the auto climbs up a hill through a height of 30 m, starting from rest. What is the auto's final kinetic energy after it has climbed the 30 m during this interval of 10 s? (Hint: use the work-energy theorem.)

(1) 4.5×10^5 J (2) 3.1×10^5 J (3) 1.3×10^5 J (4) 8.5×10^4 J (5) 5.3×10^4 J

8. A 10^3 kg elevator is initially moving downwards at 5 m/s. The cable of the elevator motor exerts a constant upward force of 10^4 N on the elevator. Ten seconds later, what is the elevator's speed?

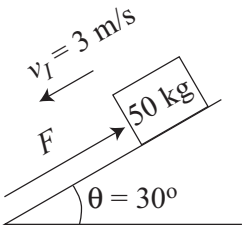
(1) 3 m/s (2) 0 (3) 5 m/s (4) 8 m/s (5) 1.5 m/s

9. A 50 kg trunk is pulled across a horizontal surface by a force $F =$ 500 N that makes an angle of 30° with respect to the horizontal as shown. The coefficient of kinetic friction is $\mu_k = 0.5$. The trunk starts from rest. How much time is required to pull it across the floor through a distance of 10 m?



(1) 1.8 s (2) 0.5 s (3) 2.9 s (4) 3.7 s (5) 0.2 s

10. A 50 kg trunk is initially sliding with speed 3 m/s down a frictionless incline that makes an angle $\theta = 30°$ with respect to the horizontal. A force F directed up along the incline is applied to the trunk in order to bring it to rest. After the force is applied for 2 s, the trunk is brought to rest. What is the value of F?



(1) 320 N (2) 115 N (3) 55 N (4) 185 N (5) 235 N

11. * A 50 kg lady stands on a scale in an elevator that exhibits a steady reading of 75 kg for the lady's apparent mass. At time $t = 0$ the elevator is moving down with speed 5 m/s. What is the elevator's speed at $t = 2$ s?

(1) 4.8 m/s (2) 2.4 m/s (3) 1.2 m/s (4) 9.6 m/s (5) 13.4 m/s

12. * An auto accelerates at a constant rate from 0 to 30 m/s in 6 s. The auto's wheels roll without slipping, and their radius is 0.5 m. How many revolutions do the wheels make during the 6 s interval?

(1) 29 (2) 14 (3) 7 (4) 21 (5) 4

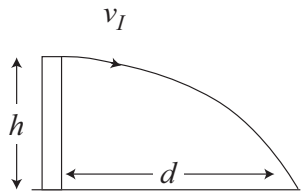
13. * A hiker walks at a constant speed of 2 m/s. All angles are measured counterclockwise with respect to the positive x-axis. The hiker first walks a distance of 300 m at an angle of 30°, and then 500 m at an angle of 120°. Finally, the hiker returns to her initial starting point. How much time is required to complete the trip?

(1) 690 s (2) 100 s (3) 50 s (4) 250 s (5) 400 s

14. * A ball is shot straight up from the ground and reaches its maximum height at time $t = 4$ s. What is its speed at time $t = 6$ s?

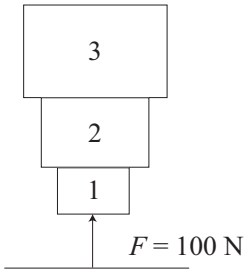
(1) 19.6 m/s (2) 39.2 m/s (3) 0 (4) 14.3 m/s (5) 4 m/s

15. A rock is thrown out horizontally with speed 20 m/s from a tower of height h. The rock hits the ground at a distance $d = 40$ m from the base of the tower. What is the height h of the tower?



(1) 19.6 m (2) 24.9 m (3) 31.3 m (4) 43.4 m (5) 56.2 m

16. Three blocks, $M_1 = 2$ kg, $M_2 = 4$ kg, and $M_3 = 6$ kg are glued together and move above the earth. A force $F = 100$ N is applied vertically upwards to the bottom of M_1. What is the magnitude of the force of M_2 on M_1?



(1) 83 N (2) 98 N (3) 116 N (4) 129 N (5) 156 N

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Final Exam December 14, 2007

Name (print, last first): _____ Signature: _____

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$g = 9.80$ m/s^2

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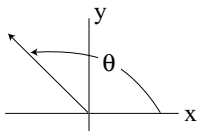
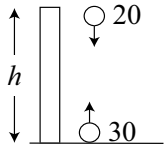
1. In this problem, all angles θ are measured counterclockwise with respect to the positive x axis. A hiker walks 100 m at 180° and then 300 m at 45°. What is the angle of the net displacement?



(1) 60° (2) 280° (3) 40° (4) 20° (5) 80°

2. A ball is thrown straight down with speed 20 m/s from the top of a tower of height h. At the same moment another ball is thrown straight up from the ground with speed 30 m/s. The balls are at the same height 2 s later. What is the height h of the tower?

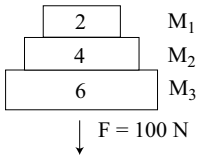


(1) 100 m (2) 20 m (3) 40 m (4) 60 m (5) 80 m

3. The acceleration of gravity on the Moon is 1/6 that on Earth. On Earth a cannon shoots a cannonball a horizontal distance of 500 m when it is aimed at 45° above the horizontal. How far does the cannon shoot a cannonball on the Moon if it is aimed at 30° above the horizontal?

(1) 2600 m (2) 3000 m (3) 2200 m (4) 1800 m (5) 300 m

4. Three masses, $M_1 = 2$ kg, $M_2 = 4$ kg and $M_3 = 6$ kg, are glued together and move above Earth. A downward force $F = 100$ N is applied to M_3. What is the magnitude of the force of M_3 on M_2?

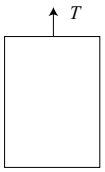


(1) 50 N (2) 25 N (3) 75 N (4) 100 N (5) 125 N

5. An auto accelerates from rest with acceleration $a = 5$ m/s^2 for 10 s. It then maintains constant velocity for a period of time. Finally, in phase 3, it accelerates uniformly to rest over a period of 20 s. It travels a total distance of 1000 m. How much time does it spend traveling at constant speed?

(1) 5 s (2) 10 s (3) 2.5 s (4) 15 s (5) 20 s

6. A 3000 kg elevator is initially moving up at 10 m/s. The tension in the elevator cable is $T = 15,000$ N. If the initial height of the elevator is 100 m, what is its height 3 s later?



(1) 108 m (2) 127 m (3) 93 m (4) 82 m (5) 62 m

7. In the previous problem, a 50 kg lady stands on a scale in the elevator. What is the reading on the scale, in N?

(1) 250 (2) 350 (3) 450 (4) 550 (5) 650

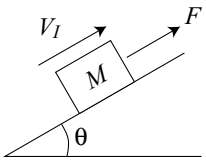
8. A 15 kg block accelerates from rest at a rate of 2 m/s^2 across a horizontal surface, due to a horizontal applied force $F = 75$ N. What is the value of the coefficient of kinetic friction?

(1) 0.3 (2) 0.45 (3) 0.6 (4) 0.75 (5) 0.9

9. A 15 kg block accelerates from rest at a rate of 2 m/s^2 across a horizontal surface, due to a horizontal applied force $F = 75$ N. How much work is done by friction during the first 10 s of motion?

(1) -4500 J (2) -3500 J (3) $+4000$ J (4) -2000 J (5) -1000 J

10. A block of mass $M = 50$ kg is initially moving with speed 10 m/s up along an incline that makes an angle $\theta = 30°$ with respect to the horizontal. An applied force $F = 200$ N acts on the block in the upward direction along the incline. The coefficient of kinetic friction is 0.6. How far along the incline does the block move before its speed drops to zero?

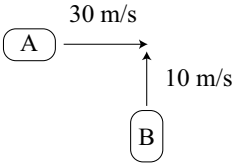


(1) 8.3 m (2) 6.7 m (3) 3.2 m (4) 1.3 m (5) 13.8 m

11. A massive tractor/trailer and a small auto undergo an elastic collision. The tractor/trailer's mass is 50 times greater than that of the auto. Before the collision the tractor/trailer's velocity in the x direction is +30 m/s. After the collision the auto's velocity is +20 m/s. What is the auto's velocity before the collision? (Hint: Think in terms of gap closing and opening.)

(1) 40 m/s (2) -20 m/s (3) 20 m/s (4) 30 m/s (5) 50 m/s

12. A 2000 kg auto is initially moving with velocity 30 m/s in the positive x direction. A 3000 kg auto is initially moving with velocity 10 m/s in the positive y direction. The autos undergo a completely inelastic sticking collision. What is the kinetic energy of the two autos after the collision?



(1) 4.5×10^5J (2) 1.6×10^4J (3) 2.4×10^3J (4) 6.3×10^5J (5) 8.8×10^4J

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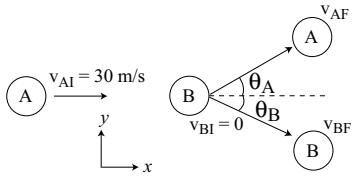
13. Two equal-mass autos A and B undergo a 2-dimensional collision. Before the collision, B is at rest and A is moving along the x axis with velocity 30 m/s. After the collision, the y-component of the velocity of A is 10 m/s, and the x-component of the velocity of B is 20 m/s. What is the value of the angle θ of the final velocity of A with respect to the x axis?



(1) 45° (2) 30° (3) 15° (4) 60° (5) 75°

14. A wheel spins up from rest to 300 rpm in 10 s. What is its angular acceleration in rad/s^2?

(1) 3.14 (2) 1.21 (3) 8.39 (4) 0.64 (5) 12.42

15. A auto accelerates from rest to 30 m/s in 6 s. During this time its tires rotate through a total angle of 270 radians (no slipping). What is the radius of the tires? (Hint: consider the distance that the auto travels.)

(1) 0.33 m (2) 0.28 m (3) 0.46 m (4) 0.21 m (5) 0.14 m

16. A satellite is in a circular orbit around planet X. The radius of its orbit is R_I and the satellite's speed is 10^4m/s. The satellite is then moved to a new orbit of radius $4R_I$. What is the satellite's speed in its new orbit?

(1) 5×10^3m/s (2) 6×10^4m/s (3) 2.5×10^3m/s (4) 10^3m/s (5) 10^5m/s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 3 April 28, 2008

Name (print, last first): _____ Signature: _____

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$g = 9.80$ m/s^2

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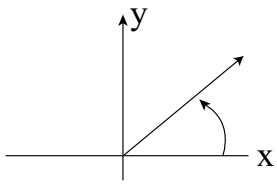
1. In this problem all angles are measured counterclockwise with respect to the positive x-axis. A hiker travels at angle 30° for 10 s at a speed of 2 m/s. In the second leg of her trip, the hiker travels at angle 225° for 20 s at 1.5 m/s. At the end of the third leg of her trip, the hiker finds that for the whole trip of three legs her net displacement has magnitude 25 m and is directed at angle 180°. What is the angle of the third leg?

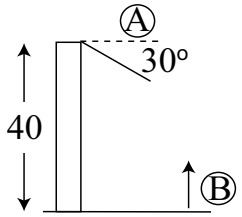


(1) 152° (2) 36° (3) 238° (4) 302° (5) 180°

2. An auto travels along the x-axis. At time $t = 0$ the auto is moving in the positive x direction with speed 20 m/s. At this moment, the auto begins to accelerate at a constant rate. Twenty seconds later, the auto's net displacement is $\Delta x = -20$ m. What is the auto's constant acceleration, in m/s^2?

(1) −2.1 (2) +2.4 (3) −1.2 (4) −3.8 (5) +1.1

3. At time $t = 0$ ball A is thrown out with speed 30 m/s from a tower of height 40 m, and at an angle of 30° below the horizontal. At the same moment ball B is thrown straight up from the ground with speed 40 m/s. At a later time, the balls are at the same height h. What is the value of h, in m?

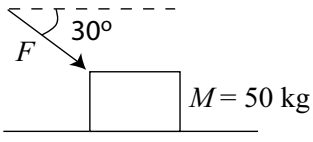


(1) 26.5 (2) 18.5 (3) 9.5 (4) 38.5 (5) 5.5

4. On Earth a cannon shoots a cannonball a distance of 500 m when it is aimed at 60° above the horizontal. On the moon, the same cannon shoots a cannonball a distance of 1000 m when it is aimed at angle θ_m above the horizontal. What is the value of θ_m? The acceleration of gravity on the moon is 1/6 that on Earth.

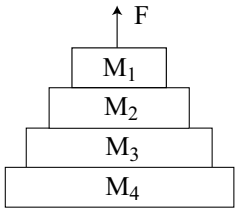
(1) 8° (2) 23° (3) 31° (4) 44° (5) 62°

5. A student pushes a 50 kg trunk across a horizontal floor at constant acceleration. Starting from rest, the trunk travels 3 m in 5 s. The student pushes on the trunk at an angle of 30° below the horizontal. If the floor is frictionless, how much work does the student do during the process?



(1) 36 J (2) 12 J (3) 21 J (4) 48 J (5) 62 J

6. Four blocks of masses $M_1 = 2$ kg, $M_2 = 4$ kg, $M_3 = 6$ kg, $M_4 = 8$ kg are glued together and move above the Earth. An upward vertical force F acts on the top of M_1 as shown. Starting from rest, the system rises through a vertical distance of 20 m in 5 s under the action of the upward force F. During the process, what is the magnitude of the force that M_4 exerts on M_3?

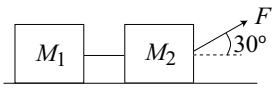


(1) 91 N (2) 34 N (3) 16 N (4) 48 N (5) 69 N

7. A 2000 kg elevator is moving down with constant acceleration vector. As it passes the 5th floor the elevator's downward speed is 30 m/s. When it reaches the 2nd floor, which is 20 m below the 5th floor, its downward speed is 5 m/s. What is the magnitude of the acceleration, in m/s^2?

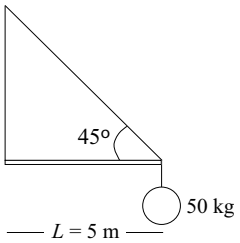
(1) 22 (2) 5 (3) 12 (4) 2 (5) 0

8. Two blocks, with masses $M_1 = 10$ kg and $M_2 = 5$ kg, are connected together by a horizontal rope, and are pulled across a horizontal floor by a force F that makes an angle of 30° with the horizontal as shown. The force $F = 50$ N. Starting from rest, the speed of the blocks is 5 m/s after 4 s. The work done by friction on M_2 during this time is -200 J. What is the coefficient of kinetic friction for M_1?



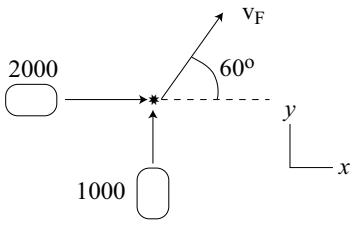
(1) 0.05 (2) 0.25 (3) 0.4 (4) 0.65 (5) 0.9

9. A uniform horizontal crane sticks out from a wall in equilibrium as shown. The crane's length is 5 m and the supporting cable makes an angle of 45° with respect to the horizontal as shown. The crane's mass is 100 kg and a 50 kg mass hangs from its end. What is the vertical component of the force of the wall on the crane?



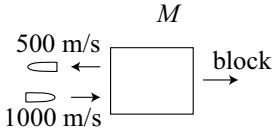
(1) 490 N (2) 220 N (3) 725 N (4) 1030 N (5) 1655 N

10. A 2000 kg auto is traveling in the positive x direction at 10 m/s and a 1000 kg auto is traveling in the positive y direction. The autos collide and stick together. The final velocity vector makes an angle of 60° with respect to the x direction. What is the initial speed of the 1000 kg auto in m/s?



(1) 35 (2) 10 (3) 65 (4) 20 (5) 5

11. A block of mass 5 kg sits on a horizontal table. A 0.05 kg bullet moving horizontally with initial speed 1000 m/s strikes the block and bounces off of it with speed 500 m/s in the direction opposite to the incoming direction. As a result, the block slides along the table. How far along the table does the block slide if the coefficient of kinetic friction is 0.8?



(1) 14.3 m (2) 5.6 m (3) 2.1 m (4) 9.2 m (5) 0.5 m

12. An auto's crankshaft is initially spinning at 4000 rpm (revolutions per minute). The crankshaft spins down uniformly and comes to rest after 10 s. How many revolutions does the crankshaft make during this process?

(1) 330 (2) 490 (3) 680 (4) 920 (5) 1050

13. An automobile decelerates uniformly from 40 m/s to rest in 10 s. The radius of the auto's tires is 0.5 m. Through what angle do the tires rotate during this process?

(1) 400 rad (2) 200 rad (3) 500 rad (4) 600 rad (5) 300 rad

14. The space shuttle, in its orbit approximately 200 km above the Earth's surface, makes 1 revolution around the Earth in approximately 1.5 hours. The radius of the Earth is $R_E = 6.5 \times 10^6$m. If the shuttle is placed in a new orbit such that it makes 1 revolution per day (24 hours) what is the radius of the new orbit?

(1) $6.5R_E$ (2) $11R_E$ (3) $24.5R_E$ (4) $16R_E$ (5) $38R_E$

15. An automobile travels around a circular horizontal track. The radius of the track is 300 m and the coefficient of static friction between the track and the auto's tires is 0.75. What is the maximum speed at which the auto can travel around the track without beginning to slide out?

(1) 47 m/s (2) 31 m/s (3) 14 m/s (4) 38 m/s (5) 65 m/s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 3rd Exam November 29, 2006

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$g = 9.80$ m/s^2

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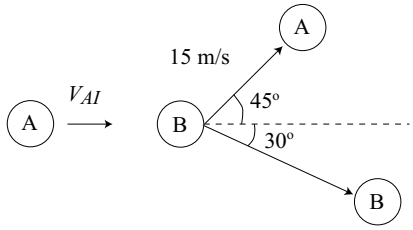
1. A 0.02 kg bullet is shot from a 10 kg rifle. The rifleman stops the recoil of the rifle by exerting a force of 250 N on it for 0.1 s. What is the bullet's initial speed in m/s?

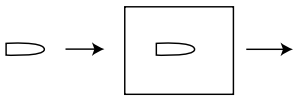
(1) 1250 (2) 1700 (3) 2500 (4) 3200 (5) 4800

2. Billiard ball A, moving in the positive x direction, strikes stationary ball B. The balls have the same mass. After the collision, ball A is traveling at an angle of 45° with respect to the x-axis, with speed 15 m/s; and ball B is traveling at an angle of 30° with respect to the x-axis. What is the speed of A before the collision?



(1) 29 m/s (2) 25 m/s (3) 19 m/s (4) 14 m/s (5) 9 m/s

3. A 0.02 kg bullet initially traveling at 500 m/s imbeds itself in a 2 kg block. What is the kinetic energy of the block immediately after the collision?

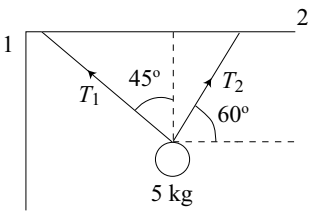


(1) 24.5 J (2) 19.8 J (3) 15.6 J (4) 33.4 J (5) 8.3 J

4. Two masses, M_1 and M_2, undergo a 1-dimensional elastic collision. At 2 s before the collision, the distance between the objects is 200 m. At 1 s before the collision, the distance between the objects is 100 m. Before the collision, M_1 is moving in the positive x direction and M_2 is at rest. After the collision, M_2 is traveling in the positive x direction with speed 75 m/s. What is the velocity of M_1 after the collision, in m/s?

(1) −25 m/s (2) −75 m/s (3) +25 m/s (4) +75 m/s (5) +175 m/s

5. A 5-kg mass is held in equilibrium by 2 ropes as shown. What is the value of T_2, the tension in rope 2?



(1) 36 N (2) 43 N (3) 52 N (4) 65 N (5) 79 N

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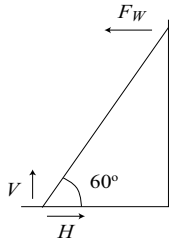
6. A uniform ladder of length 6 m and mass 75 kg leans precariously in equilibrium against a wall. The force F_W of the wall on the ladder is horizontal. Let H denote the horizontal component of the floor's force on the ladder, and let V denote the vertical component. These two components satisfy the equation $H = \mu_s V$, where μ_s is the coefficient of static friction. What is the value of μ_s?



(1) 0.29 (2) 0.17 (3) 0.38 (4) 0.47 (5) 0.56

7. The crankshaft of an auto is initially rotating at 3000 rpm. The rotation of the crankshaft begins to decrease at a constant rate, and it stops rotating 15 s later. What is the magnitude of the angular acceleration of the crankshaft, in rad/s^2?

(1) 21 (2) 5 (3) 36 (4) 12 (5) 43

8. The radius of an auto's tires is 0.5 m. The tires rotate without slipping. The auto starts from rest and accelerates uniformly to 30 m/s in 6 s. The auto then decelerates uniformly for 10 s and comes to rest. Through what angle do the auto's tires rotate during the 16 s time interval?

(1) 480 rad (2) 240 rad (3) 120 rad (4) 960 rad (5) 60 rad

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 1 September 24, 2007

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$g = 9.80$ m/s^2

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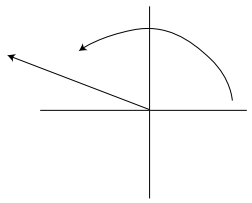
1. A trip consists of three legs. All angles are measured counterclockwise with respect to the positive x axis as shown. The following information is given:
   Leg 1: 5 m at 30° Leg 2: 5 m at 150°
   Net displacement: 10 m at 270°
   What is the angle associated with Leg 3?



(1) 270° (2) 180° (3) 90° (4) 137° (5) 55°

2. An automobile is initially traveling backwards at 3 m/s at $t = 0$. At this moment, the driver places the transmission into first gear and immediately establishes a constant acceleration of 2 m/s^2 in the forward direction. What is the net displacement after 4 s?

(1) 4 m (2) 8 m (3) 16 m (4) 24 m (5) 12 m

3. An auto passes a parked police cruiser at a constant velocity of 15 m/s. When the auto is 30 m past the cruiser's position, the cruiser takes off after the auto, maintaining a constant acceleration of 4 m/s^2. How much time is required for the cruiser to catch up to the auto?

(1) 9 s (2) 4 s (3) 60 s (4) 15 s (5) 23 s

4. An auto starts from rest and maintains a constant acceleration of 4 m/s^2 for 10 s. It then immediately begins to decelerate (brake) at a constant rate. It travels a total distance of 300 m (including both phases). What is the magnitude of the auto's acceleration while it is slowing down, in m/s^2?

(1) 8 (2) 4 (3) 2 (4) 24 (5) not enough information

5. Ball A is thrown up from the ground at time $t = 0$ with initial speed 40 m/s. At the same moment, ball B is thrown up from a tower of height 40 m with a speed of 10 m/s. At what time are the balls at the same height?

(1) 1.3 s (2) 2.2 s (3) 0.5 s (4) 3.6 s (5) 4.7 s

6. Ball A is thrown straight up from the ground with initial speed $v*$ and reaches height h. Ball B is thrown straight up from the ground and reaches a height of $16h$. What is the initial speed of ball B?

(1) $4v*$ (2) $2v*$ (3) $3v*$ (4) $9v*$ (5) $6v*$

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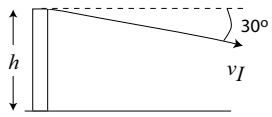
7. A rock is thrown out from a tower of height 20 m at an angle of 30° below the horizontal, with speed 30 m/s. What is the magnitude of its final velocity vector, in m/s, when it reaches the ground?



(1) 36 (2) 24 (3) 47 (4) 53 (5) 18

8. An astronaut wants to measure the acceleration of gravity on Planet X. On Earth his powerful dart gun will shoot a dart a maximum horizontal distance of 30 m before the dart returns to the same height from which it was shot. He performs the same experiment on Planet X and finds that the dart gun shoots the dart a maximum distance of 45 m. What is the value of the acceleration of gravity on Planet X, in m/s^2?

(1) 6.5 (2) 3.8 (3) 9.8 (4) 12.4 (5) 15.9

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 1 February 7, 2005

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$g = 9.80\ \text{m/s}^2$

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1. Ball A is dropped from a height of 4 m. At the same time, ball B is dropped from 12 m. Ball A hits the ground at time t_A, and ball B at t_B. What is the value of $t_B - t_A$?

   (1) 0.66 s (2) 0.33 s (3) 0.99 s (4) 0.15 s (5) 1.21 s

2. A rock is dropped (zero speed) from a height of 30 m above the ground. At the same moment, another rock is thrown straight up with speed v from the ground. The rocks cross each other at a height of 15 m. What is the value of v in m/s?

   (1) 17 (2) 12 (3) 8 (4) 4 (5) 26

3. A baseball is batted into the air with an initial speed of 39 m/s, at an angle of 60° above the horizontal. Assume that the baseball is hit from ground level. What is its height after 3 s (neglecting air resistance, of course)?

   (1) 57 m (2) 49 m (3) 38 m (4) 27 m (5) 16 m

4. Autos A and B have a head-on collision in 1 dimension. At time $t = 0$, A is at rest and B is heading at A with a speed of 40 m/s. A accelerates at a constant rate of 5 m/s^2, while B maintains constant velocity. The autos collide at $t = 6$ s. How far apart are the autos at $t = 0$?

   (1) 330 m (2) 110 m (3) 220 m (4) 430 m (5) 550 m

5. An auto starts from rest and maintains a constant acceleration $a = 5\ \text{m/s}^2$ for 5 s. It then stops accelerating suddenly ($a = 0$) and maintains constant velocity for 5 s. How far does the auto travel during this 10 s trip?

   (1) 187 m (2) 111 m (3) 95 m (4) 84 m (5) 27 m

6. On Earth a cannon can shoot a cannonball a distance of 800 m if it is aimed at an angle of 45° above the horizontal. How far can the same cannon shoot a cannonball on the Moon if it is aimed at an angle of 15° above the horizontal? The acceleration of gravity on the Moon is 1/6 that on Earth.

   (1) 2400 m (2) 1000 m (3) 3300 m (4) 5400 m (5) 9800 m

7. A hiker walks for 60 s at 1 m/s in the positive x direction (East), and then for 90 s at 1.5 m/s in the negative y direction (South). At what angle θ, measured counterclockwise from the positive x direction, must the hiker walk in order to return directly to the starting point?

   (1) 114° (2) 211° (3) 165° (4) 84° (5) 302°

8. An auto of mass 2×10^3 kg is initially traveling at 40 m/s brakes at a constant rate of acceleration and requires a distance of 100 m to come to rest along a horizontal surface. What is the magnitude of the horizontal force that the auto exerts on the surface?

   (1) 1.6×10^4 N (2) 3.1×10^3 N (3) 8.6×10^4 N (4) 7.5×10^3 N (5) 5.2×10^3 N

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 1st Exam February 6, 2006

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$g = 9.80\ \text{m/s}^2$

---

1. A hiker walks 20 s at a speed of 2 m/s at an angle of 150° measured counterclockwise with respect to the positive x axis, then for 10 s at 2.5 m/s at an angle of 270° measured counterclockwise with respect to the positive x axis, and then for 15 s at 1.5 m/s at an angle of 45° measured counterclockwise with respect to the positive x axis. What is the magnitude of the average velocity for this trip?

   (1) 0.48 m/s (2) 0.23 m/s (3) 0.11 m/s (4) 0.34 m/s (5) 0.59 m/s

2. In the previous problem, after the hiker finishes her trip, at what angle measured counterclockwise with respect to the positive x axis must she walk in order to return to her starting position?

   (1) 330° (2) 140° (3) 40° (4) 214° (5) 8°

3. An auto travels in 1 dimension at constant acceleration. The auto travels a net displacement of 200 m in 10 s and its final velocity is +50 m/s. What is its initial velocity, in m/s?

   (1) −10 (2) −20 (3) −30 (4) 0 (5) +10

4. An auto starts from rest, accelerates at a constant rate of 5 m/s^2 for 10 s and then at a constant rate such that it comes to rest at a distance of 400 m from its standing point (1-dimensional motion). What is the total time associated with this trip?

   (1) 16 s (2) 12 s (3) 20 s (4) 24 s (5) 28 s

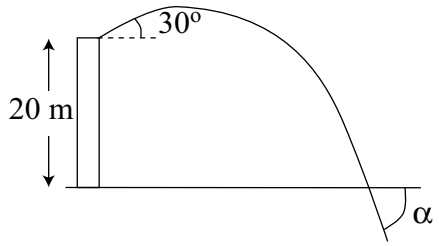
5. A police cruiser traveling at 20 m/s is passed by an auto traveling at 40 m/s. The cruiser immediately begins to chase the auto and accelerates at 4 m/s^2. The auto itself accelerates at 2 m/s^2. How far does the cruiser travel before it catches up to the auto?

   (1) 1200 m (2) 1030 m (3) 920 m (4) 815 m (5) 745 m

6. A ball is thrown straight up from the ground with initial speed 15 m/s. At the same moment, a rock is dropped (initial speed 0) from height h. The ball and the rock hit the ground at the same time. What is the value of h?

   (1) 46 m (2) 15 m (3) 24 m (4) 35 m (5) 96 m

7. A rock is thrown out from a tower of height 20 m at an angle of 30° above the horizontal. The initial speed of the rock is 20 m/s. What is the angle that the rock's velocity makes with respect to the ground just before it hits the ground?



(1) 52° (2) 89° (3) 64° (4) 32° (5) 43°

8. Golfer A hits golf ball A at an angle of 60° above the horizontal on the Moon, and the golf ball travels 500 m before it hits the Moon's surface. Just before hitting the surface, its speed is v_A. Golfer B hits golf ball B at an angle of 15° above the horizontal on Earth, and the gold ball travels 100 m before it hits the Earth's surface. Just before hitting the surface, its speed is v_B. What is the value of $\frac{v_B}{v_A}$. The acceleration of gravity on the Moon is 1/6 that on Earth.

(1) 1.44 (2) 1.65 (3) 0.96 (4) 0.73 (5) 0.21

THE FOLLOWING QUESTIONS, NUMBERED IN THE ORDER OF THEIR APPEARANCE ON THE ABOVE LIST, HAVE BEEN FLAGGED AS CONTINUATION QUESTIONS: 2

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 1 February 4, 2008

Name (print, last first): _____ Signature: _____

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$g = 9.80$ m/s^2

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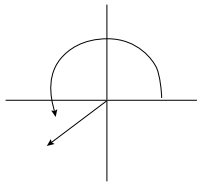
1. A trip consists of 2 legs. All angles are measured counterclockwise with respect to the positive x axis as shown. Leg 2 is a displacement of magnitude 10 m at 120°. The net displacement has magnitude 5 m and its angle is 30°. What is the magnitude of the initial leg 1?



(1) 11 m (2) 5 m (3) 25 m (4) 2 m (5) 18 m

2. An auto is initially backing up at a speed of 5 m/s. At time $t = 0$ the auto begins accelerating in the forward direction at 4 m/s^2. What is its net displacement after 4 s of acceleration? (In other words, if $x_I = 0$, what is the value of X_F at $t = 4$ s?)

(1) 12 m (2) 9 m (3) 6 m (4) 3 m (5) 0

3. An auto accelerates from rest in the positive x direction at a rate of 4 m/s^2 for 10 s. It then brakes at a constant rate until it comes to rest. The auto travels a total distance of 500 m. What is the magnitude of its acceleration in m/s^2 while it is braking?

(1) 2.7 (2) 4.7 (3) 6.5 (4) 8.9 (5) 12.1

4. A police cruiser is travling at 20 m/s. An auto traveling in the same direction at 30 m/s passes the cruiser. At this moment the auto begins to accelerate in the forward direction at a rate of 2 m/s^2, and the cruiser begins to accelerate in the forward direction at 4 m/s^2. How far does the cruiser travel until it catches up to the auto?

(1) 400 m (2) 300 m (3) 200 m (4) 100 m (5) 500 m

5. A ball is thrown straight up from the ground. After 5 s, the ball is at a height of 30 m. What is the y component of the ball's final velocity in m/s? The positive y direction is up.

(1) −18.5 (2) +12.3 (3) +5.2 (4) −36.2 (5) +22.4

6. Ball A is thrown straight up from the ground with speed v^* and reaches height h. Ball B is thrown straight up from the ground and reaches height $16h$. What is the initial speed of ball B in terms of v^*?

(1) $4v^*$ (2) $2v^*$ (3) $6v^*$ (4) $8v^*$ (5) $16v^*$

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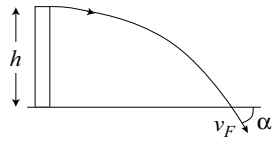
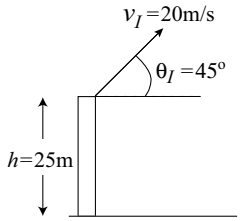
7. A rock is thrown out horizontally from a tower of height h. The rock is in the air for 5 s before it reaches the ground. When the rock reaches the ground, its final velocity vector $\vec{v}_F$ makes an angle α with the ground as shown. If $\alpha = 60°$, what is the rock's initial speed in m/s?



(1) 28 (2) 20 (3) 12 (4) 49 (5) 68

8. A rock is thrown out from a tower of height $h = 25$ m at an angle $\theta_I = 45°$ above the horizontal as shown. How long is the rock in the air before it hits the ground if its initial velocity has magnitude $v_I = 20$ m/s?



(1) 4 s (2) 7 s (3) 2 s (4) 12 s (5) 18.s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 2nd Exam October 30, 2006

Name (print, last first): _____ Signature: _____

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$g = 9.80$ m/s^2

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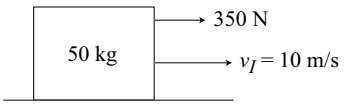
1. A lady stands on a scale in an elevator. The lady's mass is 50 kg. The elevator is moving downward toward the ground floor and its speed is decreasing at a rate of 3 m/s^2. What is the reading on the scale?

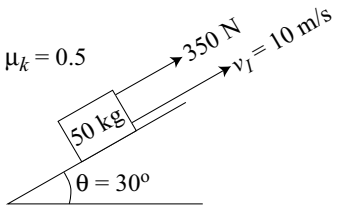
   (1) 640 N (2) 225 N (3) 860 N (4) 125 N (5) 500 N

2. A 50 kg block is moving across a horizontal surface. The coefficient of kinetic friction is $\mu_k = 0.5$. A horizontal force of 350 N is applied to the block in the direction in which the block is moving. At time $t = 0$ the block's velocity is 5 m/s. How far along the surface does the block move in the next 5 s?



   (1) 51 m (2) 42 m (3) 33 m (4) 22 m (5) 15 m

3. A 50 kg block is moving up an incline that makes an angle of 30° with the horizontal. A force of 350 N is applied to the block as shown. The coefficient of kinetic friction is $\mu_k = 0.5$. At time $t = 0$ the block's velocity is $v_I = 10$ m/s. At what time does the block's speed decrease to 0?



   (1) 4.7 s (2) 3.6 s (3) 2.4 s (4) 6.9 s (5) 7.9 s

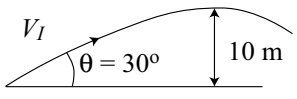
4. A 2000 kg auto accelerates at a constant rate from 0 to 30 m/s in 8 s, without "spinning" its wheels (i.e., no slipping of wheels). What is the minimum value of the coefficient of static friction?

   (1) 0.38 (2) 0.49 (3) 0.57 (4) 0.66 (5) 0.74

5. A 2000 kg elevator starts from rest and is lifted at constant acceleration $a = 1$ m/s^2. What is the instantaneous power output of the elevator motor after the elevator has been lifted for 5 s?

   (1) 10^5 W (2) 4.5×10^5 W (3) 7×10^4 W (4) 2.5×10^3 W (5) 8×10^5 W

6. A rock is thrown up from the ground at an angle $\theta_I = 30°$ and reaches a maximum height of 10 m. What is the rock's initial speed when it is thrown up, in m/s?



   (1) 28 (2) 21 (3) 14 (4) 8 (5) 39

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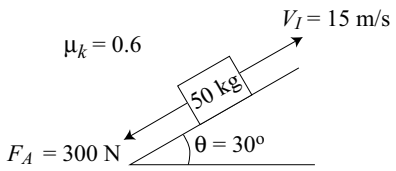
7. A 50 kg block is moving up an incline that makes an angle of 30° with respect to the horizontal. The block's initial speed is 15 m/s. The coefficient of kinetic friction is 0.6. An applied force $F_A = 300$ N acts on the block in the downward direction along the incline. How far up along the incline does the block travel until its velocity drops to 0?



(1) 7 m (2) 5 m (3) 3 m (4) 10 m (5) 12 m

8. A baseball of mass 0.1 kg is traveling horizontally with speed 40 m/s and is struck by the batter. The impulse of the bat on the baseball is directed straight up vertically and has magnitude $I = 10$ Ns. What is the baseball's speed immediately after it is struck by the bat?

(1) 108 m/s (2) 330 m/s (3) 87 m/s (4) 65 m/s (5) 146 m/s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 2 October 22, 2007

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$g = 9.80$ m/s^2

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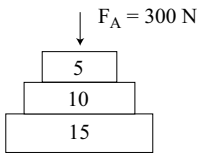
1. An automobile of mass 2000 kg accelerates from 0 to 40 m/s in 10 s along a horizontal surface. What is the total force exerted by the road on the auto? (Remember to include both horizontal and normal forces.)

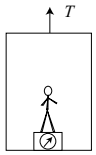
(1) 2×10^4N (2) 8×10^3N (3) 6×10^3N (4) 3×10^3N (5) 10^3N

2. Three blocks of masses 5, 10, and 15 kg, respectively, are glued together and move above the Earth. A downward force $F_A = 300$ N is applied to the 5 kg block as shown. What is the magnitude of the force that the 15 kg block exerts on the 10 kg block?



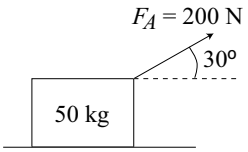
(1) 150 N (2) 200 N (3) 280 N (4) 300 N (5) 350 N

3. A lady stands on a scale in an elevator. The total mass of the elevator system is 2000 kg. The lady's weight is 600 N, and the reading on the scale is 300 N. What is the tension T in the elevator cable?



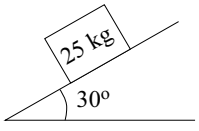
(1) 10^4 N (2) 10^3 N (3) 5×10^3 N (4) 10^5 N (5) 10^6 N

4. A 50 kg trunk is pulled at constant speed across a horizontal floor by a force F_A of magnitude 200 N directed at an angle of 30° above the horizontal as shown. What is the value of the coefficient of kinetic friction?



(1) 0.45 (2) 0.25 (3) 0.6 (4) 0.75 (5) not enough information

5. A block of mass 25 kg sits at rest on an incline that makes an angle of 30° with respect to the horizontal as shown. The block does not move. What is the force of friction on the block?



(1) 123 N (2) 65 N (3) 79 N (4) 89 N (5) 101 N

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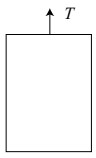
6. The mass of an elevator system is 2000 kg. The elevator starts from rest at the ground floor. Ten seconds later it is 10 m above the ground floor and its speed is 5 m/s. How much work is done by the tension in the elevator cable during this 10 second interval?

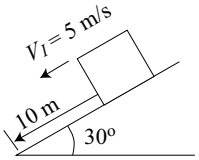


(1) 2.2×10^5J (2) 1.2×10^4J (3) 35.6×10^4J (4) 6.3×10^5J (5) 9.8×10^5J

7. A 2000 kg auto accelerates uniformly from rest to 40 m/s in 10 s. What is the power output of the auto's engine when the auto reaches speed 40 m/s? (1 hp = 746 W)

(1) 430 hp (2) 375 hp (3) 255 hp (4) 525 hp (5) 305 hp

8. A 20 kg block is initially moving at 5 m/s down along an incline that makes an angle of 30° with respect to the horizontal. The block comes to rest after traveling 10 m down along the incline. How much work is done by friction during this process?



(1) −1230 J (2) −560 J (3) 290 J (4) −920 J (5) −1560 J

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 2 March 14, 2005

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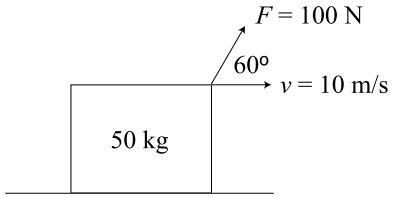
$g = 9.80 \text{ m/s}^2$

---

1. A lady whose mass is 50 kg stands on a scale in an elevator. The elevator is moving down at a constant speed of 5 m/s. What is the reading on the scale for the lady's weight?

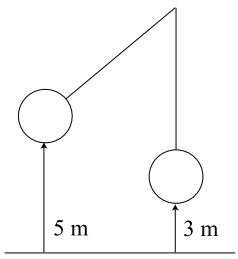
(1) 490 N (2) 620 N (3) 0 (4) 745 N (5) 980 N

2. A block of mass 50 kg is moving at a constant velocity of 10 m/s in the positive x direction. A force $F = 100$ N acts on the block at an angle of 60° relative to the x-axis as shown. How much work is done by the force F in 2 s?



(1) 1000 J (2) 450 J (3) −320 J (4) −250 J (5) 250 J

3. A pendulum ball is at a height of 5 m above the ground and is moving at a speed of 5 m/s. When the ball reaches 3 m, what is its speed in m/s?



(1) 8 (2) 5 (3) 2 (4) 13 (5) 19

4. A 5 kg rifle shoots a 0.05 kg bullet at a speed of 10^3 m/s. The recoil of the rifle is stopped by a force F that acts for 0.01 s. What is the value of F in N?

(1) 5×10^3 (2) 2×10^2 (3) 6×10^4 (4) 2×10^4 (5) 1.5×10^3

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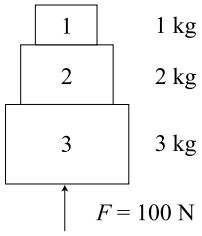
5. Three masses $M_1 = 1$kg, $M_2 = 2$kg, $M_3 = 3$kg are glued together and move above the ground as shown. A force $F = 100$N is applied in the upward direction to the bottom of mass M_3. What is the magnitude of the force that M_1 exerts on M_2?

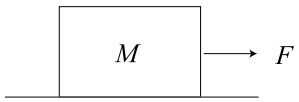


(1) 16.7 N (2) 13.1 N (3) 11.2 N (4) 9.4 N (5) 7.1 N

6. An elevator of mass 10^3kg starts from rest at the ground floor and is raised and lowered by its motor. After 10 s, the elevator is 10 m above the ground floor, and its speed is 10 m/s. How much work has been done by the motor during this process?

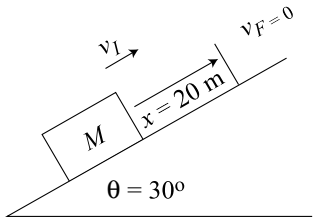
(1) 1.5×10^5J (2) not enough information (3) -3×10^5J (4) -4×10^4J (5) 6.5×10^4J

7. A trunk of mass $M = 50$ kg is pulled across a horizontal floor by a horizontal force F of magnitude 300 N. The trunk moves at constant velocity. What is the value of the coefficient of kinetic friction?



(1) 0.6 (2) 0.5 (3) 0.4 (4) 0.7 (5) 1.1

8. A block of mass $M = 50$ kg is moving up an incline that makes an angle of 30° relative to the horizontal. The block comes to rest after having moved a distance $x = 20$ m up along the incline. The only forces acting are gravity and friction. The coefficient of kinetic friction is $\mu_k = 0.6$. What is the initial speed of the block in m/s?



(1) 20 (2) 11 (3) 31 (4) 50 (5) 5

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 2nd Exam March 6, 2006

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(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
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$g = 9.80$ m/s^2

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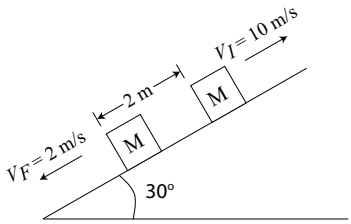
1. A 10 kg block is accelerated across a horizontal floor from rest to 5 m/s in 3 s. The magnitude of the work done by friction on the block is 75 J. How much work is done by the applied force that causes the block to accelerate?

   (1) 200 J (2) 50 J (3) 100 J (4) 150 J (5) 300 J

2. At time $t = 0$ a 2000 kg elevator is moving down with speed 7 m/s as it passes the third floor of a building. Twenty seconds later the elevator is moving up with speed 4 m/s as it passes the fifth floor, which is 15 m above the third floor. How much work is done by the elevator motor during this 20 s time interval?

   (1) 2.6×10^5J (2) 10^5J (3) 4.8×10^4J (4) -4×10^4J (5) -8×10^5J

3. At time $t = 0$ a 5 kg block is moving up a 30° incline with speed 10 m/s. Only the force of friction and of gravity have components parallel to the incline. 5 s later the block is moving down the incline with speed 2 m/s, at a distance of 2 m down along the incline from its original position. How much work is done by friction during this 5 s interval?

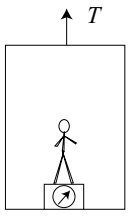


   (1) −290 J (2) −125 J (3) −200 J (4) +360 J (5) +25 J

4. A 2000 kg elevator is accelerated upward from rest at a constant rate for 5 s and achieves a final speed of 10 m/s. What is the power output of the elevator motor at this point in time?

   (1) 2.4×10^5W (2) 3.9×10^5W (3) 7.5×10^5W (4) 1.2×10^5W (5) 6.9×10^6W

5. A 50 kg lady (her mass is 50 kg) stands on a scale in an elevator. The scale reads 40 kg. The mass of the elevator system is 2,500 kg. What is the tension in the elevator cable?



   (1) 2×10^4J (2) 10^4J (3) 4×10^4J (4) 6×10^4J (5) 5×10^8J

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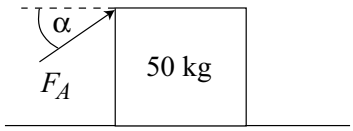
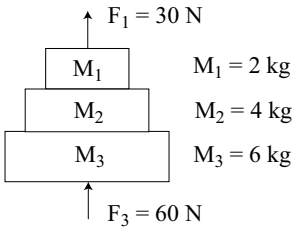
6. A force F_A is applied as shown to a 50 kg trunk in order to move it across a horizontal floor. The angle α is 45°. If the coefficient of kinetic friction is $\mu_k = 0.5$, what value of F_A is needed to keep the trunk moving at constant velocity?



(1) 231 N (2) 53 N (3) 106 N (4) 403 N (5) 326 N

7. Three blocks are glued together and move above the Earth. The vertical force $F_1 = 30$N and the vertical force $F_3 = 60$N. The system starts from rest. What is the force of M_1 on M_2 5 s later?



(1) 15 N (2) 20 N (3) 25 N (4) 30 N (5) 35 N

8. A 2×10^3 kg auto accelerates along a horizontal track from 0 to 30 m/s in 6 s. What is the <u>total</u> force of the auto on the track? Be sure to consider vertical as well as horizontal forces.

(1) 2.2×10^4N (2) 1.1×10^4N (3) 3.3×10^4N (4) 4.3×10^4N (5) 6.4×10^4N

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 2 March 3, 2008

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(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
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$g = 9.80$ m/s^2

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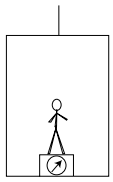
1. Two blocks, with masses $M_1 = M_2 = 5$ kg, are connected together by a horizontal rope, and are pulled across a horizontal floor by a horizontal force F as shown. The force F has magnitude 35 N. The block M_2 is frictionless but M_1 is not. Starting from rest, the speed of the blocks is 10 m/s after 5 s. What is the value of the coefficient of kinetic friction for M_1?

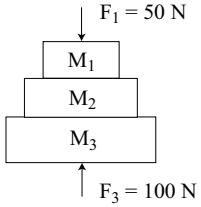
(1) 0.3 (2) 0.1 (3) 0.2 (4) 0.4 (5) 0.6

2. A 50 kg lady stands on a scale in an elevator. Initially, the elevator is moving down at 15 m/s. Three seconds later it is moving down at 5 m/s. Assume that the acceleration of the elevator is constant. What is the reading on the scale for the lady's apparent weight?



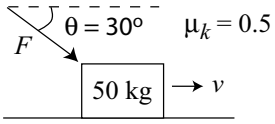
(1) 655 N (2) 325 N (3) 545 N (4) 435 N (5) 210 N

3. Three masses, $M_1 = 2$ kg, $M_2 = 4$ kg, and $M_3 = 6$ kg, are glued together and move above the earth. A force $F_1 = 50$ N acts down on M_1, and a force $F_3 = 100$ N acts up on M_3. What is the magnitude of the force that M_2 exerts on M_1?



(1) 59 N (2) 31 N (3) 27 N (4) 18 N (5) 7 N

4. A 50 kg trunk is pushed across a horizontal floor by a force F that acts at an angle $\theta = 30°$ below the horizontal, and whose magnitude is 450 N. The block starts from rest. The coefficient of kinetic friction is $\mu_k = 0.5$. How far does the block move in 3 seconds?



(1) 2.9 m (2) 3.7 m (3) 4.9 m (4) 6.1 m (5) 8.8 m

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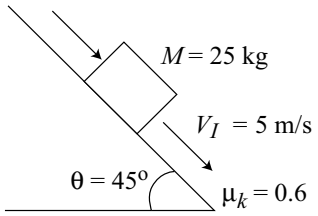
5. A 25 kg block is pushed down a 45° incline by a force $F = 250$ N parallel to the incline in the downward direction. The coefficient of kinetic friction $\mu_k = 0.6$. The block's initial velocity is 5 m/s in the downward direction along the incline. How much time is required for the block to achieve a speed of 15 m/s?

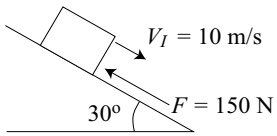


(1) 0.78 s (2) 1.24 s (3) 5.68 s (4) 0.32 s (5) 16.98 s

6. A 2000 kg elevator initially is moving with speed 2 m/s as it passes the 5th floor. Ten seconds later it is traveling up at 8 m/s as it passes the 3rd floor. The 3rd floor is 10 m below the 5th floor. How much work is done by nonconservative forces during the 10 second interval?

(1) -1.4×10^5 J (2) $+1.7 \times 10^5$ J (3) -4.7×10^5 J (4) $+5.9 \times 10^5$ J (5) 0

7. A 25 kg block is sliding down a 30° incline with an initial velocity of 10 m/s. A force $F = 150$ N is applied to the block in the upward direction along the incline. The coefficient of kinetic friction $\mu_k = 0.7$. How far down along the incline does the block travel before coming to rest?



(1) 7 m (2) 3 m (3) 1.5 m (4) 14 m (5) 23 m

8. A projectile is shot from the ground at an angle of 60° above the horizontal. At a later point in time it is traveling horizontally at a height of 10 m above the ground. What is the projectile's initial speed?

(1) 16 m/s (2) 33 m/s (3) 9 m/s (4) 4 m/s (5) 2 m/s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 1st Exam September 25, 2006

Name (print, last first): _____ Signature: _____

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$g = 9.80\ \text{m/s}^2$

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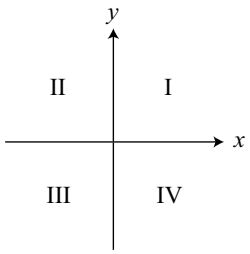
1. A vector A of magnitude 20 m lies in quadrant IV and makes an angle of 60° with the x-axis in that quadrant. Vector B, of magnitude 30 m, lies in quadrant III and makes an angle of 30° with respect to the x-axis in that quadrant. What is the magnitude of the vector A–B?



(1) 36.1 m (2) 10.3 m (3) 5.6 m (4) 19.8 m (5) 26.3 m

2. An auto accelerates from rest at a constant rate for 10 s. The auto then immediately begins to brake with deceleration of 7 m/s^2 and comes to rest after braking for 5 s. What was the rate of acceleration of the auto from rest?

(1) 3.5 m/s (2) 5 m/s (3) 6.5 m/s (4) 9.5 m/s (5) 12 m/s

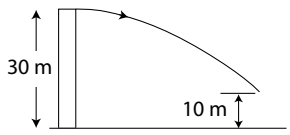
3. An auto passes a parked police cruiser. The auto maintains a constant velocity of 40 m/s in the x-direction. The cruiser is traveling at 10 m/s in the x-direction when the auto passes, and the cruiser immediately begins to chase the auto with an acceleration of 3 m/s^2. How much time passes before the cruiser catches up to the auto?

(1) 20 s (2) 15 s (3) 10 s (4) 25 s (5) 30 s

4. A rock is thrown up from the ground with speed 30 m/s. When the rock is coming back down, what is the time interval between the moment the rock's downward speed is 10 m/s and the moment it reaches the ground?

(1) 2 s (2) 1 s (3) 3 s (4) 6 s (5) not enough information

5. A rock is thrown out horizontally from a tower of height 30 m with a speed of 20 m/s. What is the rock's speed (magnitude of its velocity vector) when it is at a height of 10 m?

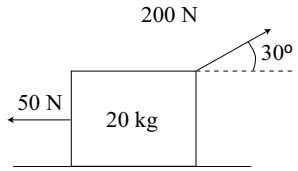


(1) 28 m/s (2) 36 m/s (3) 23 m/s (4) 18 m/s (5) 13 m/s

6. A cannon shoots a cannonball a distance of 10^3m on Earth when it is aimed 20° above the horizontal. How far does the same cannon shoot a cannonball on the Moon if it is aimed at 45° above the horizontal? The acceleration of gravity on the Moon is $\frac{1}{6}$ that on Earth.

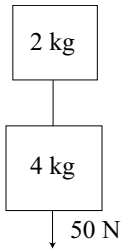
(1) 9300 m (2) 6500 m (3) 280 m (4) 4600 m (5) 1875 m

7. A block of mass 20 kg is pulled across a horizontal floor by an applied force of 200 N acting at an angle of 30° above the horizontal as shown. The floor exerts a retarding horizontal friction force of 50 N. If the block starts from rest, how much time is required for it to travel a horizontal distance of 5 m?



(1) 1.25 s (2) 2.5 s (3) 0.5 s (4) 4 s (5) 6.5 s

8. A 4 kg block is connected to a 2 kg block by a rope as shown. A 50 N downward vertical force is applied to the 4-kg block. What is the magnitude of the force with which the 2 kg block pulls on the rope?



(1) 16.6 N (2) 8.3 N (3) 4.2 N (4) 2.3 N (5) 34.7 N

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 3 November 19, 2007

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$g = 9.80$ m/s^2

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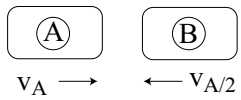
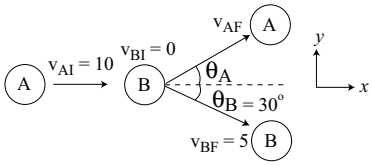
1. Two vehicles of equal mass M undergo a one-dimensional head-on collision. Vehicle A's initial speed is $v_A = 4$ m/s. Vehicle B's initial speed is $v_a/2$. The vehicles stick together after the collision. What is the kinetic energy of the 2-vehicle system immediately after the collision?



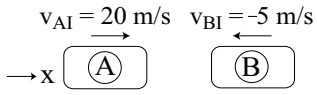
(1) $Mv_A^2/16$ (2) $Mv_A^2/2$ (3) $Mv_A^2/4$ (4) $Mv_A^2/8$ (5) $Mv_A^2/100$

2. Two objects A and B undergo a collision in 2 dimensions. Both objects have mass M. Object B is initially at rest. Choose X and Y axes as shown (x axis is parallel to the initial velocity of A). The initial incoming velocity v_{AI} of A is 10 m/s. The final speed v_{BF} of B is 5 m/s and the angle θ_B that it makes with respect ot the x axis is 30°. What is the x component v_{AFx} of the final velocity of A?



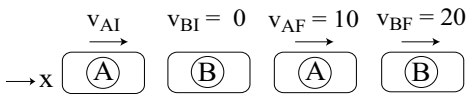
(1) 5.7 m/s (2) 6.8 m/s (3) 4.3 m/s (4) 2.3 m/s (5) 18 m/s

3. Two autos of masses $M_A = 10^3$kg and $M_B = 4 \times 10^3$kg undergo a one-dimensional sticking collision (same final velocity v_F). The autos travel along the x axis. The initial velocity v_{AI} of A is 20 m/s, and the initial velocity of B is -5 m/s. What is the common final velocity v_F?



(1) 0 (2) +5 m/s (3) -5 m/s (4) -10 m/s (5) +2.5 m/s

4. Two vehicles A and B with masses $M_A = 10^3$kg and M_B unknown undergo a one-dimensional collision along the x-axis. Vehicle B is initially at rest. Measurements reveal that the final velocities are given by $v_{AF} = 10$ m/s and $v_{BF} = 20$ m/s. If the collision is elastic, what is the initial velocity of vehicle A, in m/s?



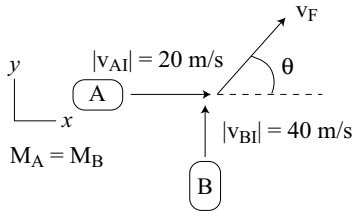
(1) 10 (2) 5 (3) -5 (4) -10 (5) 20

5. A 5 kg rifle shoots a 0.05 kg bullet at 10^3 m/s. The rifleman'a shoulder stops the rifle's recoil by exerting a force F for time 10^{-2}s on the rifle. What is the value of F?

(1) 5×10^3N (2) 10^3N (3) 2×10^2N (4) 6×10^4N (5) 10^5N

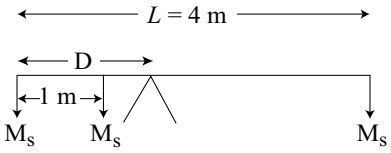
77777

6. Two autos of the same mass undergo a two-dimensional perpendicular T-bone sticking collision as shown. The autos move together after the collision with common final velocity v_F that makes an angle θ with respect to the x-axis. What is the value of θ?



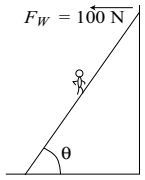
(1) 65° (2) 5° (3) 15° (4) 20° (5) 25°

7. Three children of equal weight sit on a uniform seesaw of length 4 m. One child sits at each end, and the third child sits 1 m from the left end as shown. What is the value of D, the distance of the fulcrum (the support point about which the seesaw rotates) from the left end of the seesaw? Neglect the weight of the seesaw itself.



(1) 5/3 m (2) 1/3 m (3) 2 m (4) 4 m (5) 3 m

8. A uniform ladder leans against a vertical wall at an angle of $\theta = 60°$ with respect to the horizontal as shown. A climber stands at the middle of the ladder, and the combined weight of the ladder and climber is 2000 N. The length of the ladder is 4 m. The force F_W of the wall on the ladder is hroizontal and has magnitude 100 N. What is the magnitude of the horizontal force (force of friction) of the floor on the ladder?



(1) 100 N (2) 50 N (3) 25 N (4) 150 N (5) 250 N

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 3 April 11, 2005

Name (print, last first): _____ Signature: _____

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(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.
(6) **Hand in the answer sheet separately.**

$g = 9.80$ m/s^2

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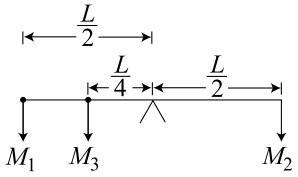
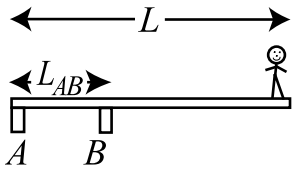
1. As shown, three children sit on a uniform seesaw that is in equilibrium. If $M_1 = M_3 = 50$kg, what is the value of M_2 in kg?



(1) 75 (2) 50 (3) 25 (4) 100 (5) 125

2. A 100 kg diver stands in equilibrium on the end of a diving board of length $L = 5$ m. Neglect the weight of the diving board. The magnitudes of the forces exerted by supports A and B are F_A and F_B, respectively. If $F_B = 1.5F_A$, what is the distance L_{AB} between supports A and B?



(1) 1.67 m (2) 1.5 m (3) 1.33 m (4) 1 m (5) 0.75 m

3. A dragster starts from rest, accelerates uniformly, and travels 400 m in 4 s. The radius of the dragster's tires is 0.5 m. What is the angular velocity of the tires after the dragster has traveled for 2 s? Assume that the tires don't slip.

(1) 200 s^{-1} (2) 400 s^{-1} (3) 600 s^{-1} (4) 800 s^{-1} (5) 100 s^{-1}

4. Masses M_1 and M_2 undergo an elastic collision in one dimension. M_2 is initially at rest, and the initial velocity of M_1 is 20 m/s in the positive x direction. After the collision, M_1 is moving at 10 m/s in the negative x direction. What is the final speed of M_2 in m/s?

(1) 10 (2) not enough information (3) 0 (4) 20 (5) 25

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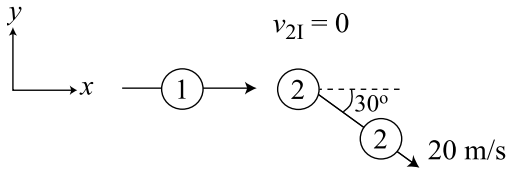
5. Masses $M_1 = 0.1$ kg and $M_2 = 0.2$ kg undergo a collision in 2 dimensions. Before the collision, M_2 is at rest and M_1 is moving in the positive x direction. After the collision, M_2 is moving with speed 20 m/s at an angle of 30° with respect to the x axis, and M_1 is also moving at an angle of 30° with repsect to the x axis. What is the initial speed v_{1I} of M_1 in m/s?



(1) 69 (2) 43 (3) 56 (4) 92 (5) 105

6. Masses M_1 and M_2 undergo a head-on sticking collision. Before the collision, M_1 is moving in the $+x$ direction with speed 20 m/s, and M_2 is moving in the $-x$ direction with the same speed. If $M_1 = 2M_2$, what is the speed of the masses, in m/s, after the collision?

(1) 6.67 (2) 5.33 (3) 7.5 (4) 4.0 (5) 30

7. A satellite is in an orbit of radius $R = 2 \times 10^7$ m around the Earth. The speed of the satellite is V. The satellite is then moved to a new orbit in which its speed is $V/2$. What is the radius of the new orbit?

(1) 8×10^7 m (2) 5×10^6 m (3) 10^7 (4) 3×10^7 m (5) 4×10^8 m

8. An auto of mass 2×10^3kg travels around a racetrack that is a circle of radius 300 m. The coefficient of static friction is $\mu_s = 0.85$. What is the smallest amount of time required for the auto to make one complete revolution without slipping?

(1) 38 s (2) 48 s (3) 58 s (4) 10 s (5) 69 s

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 3rd Exam April 10, 2006

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$g = 9.80$ m/s^2

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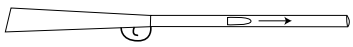
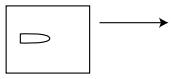
1. A bullet of mass 0.02 kg is fired by a rifle. As it travels down the rifle barrel, the ignited gunpowder gases exert an average force of 200 N on the bullet, and as a result, the bullet leaves the barrel at a speed of 500 m/s. How much time does the bullet spend traveling through the barrel? (Hint: think about the bullet's momentum.)



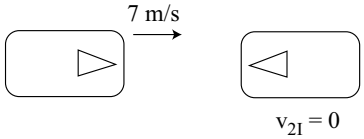
(1) 0.05 s (2) 0.1 s (3) 0.01 s (4) 3 s (5) 0.2 s

2. A 0.02 kg bullet traveling at 500 m/s imbeds itself in an initially stationary 2 kg block. What is the subsequent speed of the block/bullet system?



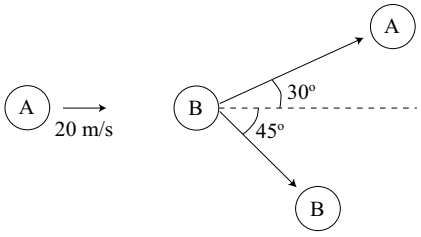
(1) 5 m/s (2) 1 m/s (3) 10 m/s (4) 20 m/s (5) 30 m/s

3. Two bumper cars undergo an elastic collision. Each bumper car has a mass of 200 kg. Before the collision, bumper car 1 is moving in the positive x direction at 7 m/s, and bumper car 2 is at rest. What is the velocity of bumper car 1 after the collision?



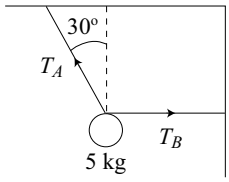
(1) 0 (2) 7 m/s (3) 5 m/s (4) 3 m/s (5) 10 m/s

4. (Save for last.) Two balls undergo a 2-dimensional collision. Ball A has a mass of 0.2 kg, and ball B has a mass of 0.1 kg. Before the collision, ball A is traveling in the positive x direction at 20 m/s, and ball B is at rest. After the collision, ball A is moving at angle $\theta_1 = 30°$ with respect to the x axis, and ball B is moving at angle $\theta_2 = 45°$ with respect to the x axis. What is the final speed of ball B?



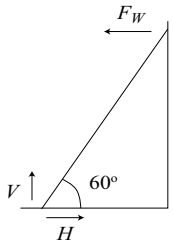
(1) 21 mph (2) 5 mph (3) 11 mph (4) 16 mph (5) 0

5. A 5 kg weight is suspended in equilibrium via 2 wires. Wire A makes an angle of 30° with respect to the vertical, while wire B is horizontal as shown. What is the tension in wire B?



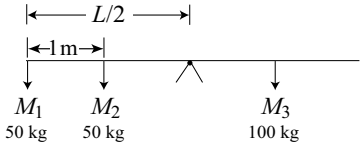
(1) 28 N (2) 64 N (3) 34 N (4) 41 N (5) 53 N

6. A uniform ladder of mass 50 kg and length 4 m leans against a wall in equilibrium. The ladder makes an angle of 60° with respect to the horizontal. The force of the wall on the ladder is horizontal. The (vertical) normal force of the floor on the ladder is denoted by V, and the (horizontal) friction force of the floor on the ladder is denoted by H. What is the minimum value of the coefficient of static friction?



(1) 0.3 (2) 0.4 (3) 0.5 (4) 0.6 (5) 0.7

7. A uniform seesaw of length 4 m is supported in equilibrium by a fulcrum at its midpoint. A mass $M_1 = 50$ kg sits at one end of the seesaw and a mass $M_2 = 50$ kg sits on the seesaw at a distance of 1 m from M_1. How far from the fulcrum must mass $M_3 = 100$ kg be located if the seesaw is in equilibrium?



(1) 1.5 m (2) 1 m (3) 0.5 m (4) 2 m (5) 0

8. An automobile accelerates at constant acceleration from 0 to 30 m/s in 6 s. The radius of the auto's tires is 0.33 m. How many revolutions does each of the auto's tires make during this 6 s interval? Assume that the tires do not slip.

(1) 43 (2) 64 (3) 93 (4) 13 (5) 28

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004 Exam 3 April 7, 2008

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$g = 9.80$ m/s^2

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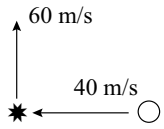
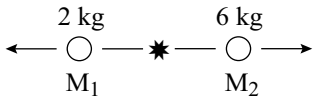
1. A ball of mass 0.1 kg is pitched horizontally at 40 m/s towards the batter. The batter pops the ball straight up. The speed of the ball as it leaves the bat is 60 m/s. The bas is in contact with the ball for 10^{-2} s. What is the magnitude of the bat's average force on the ball, in N?



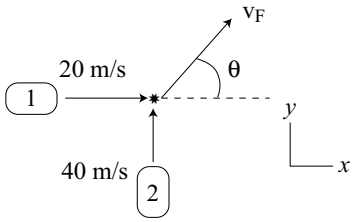
(1) 720 (2) 0 (3) 100 (4) 4900 (5) 1530

2. An object at rest explodes and breaks into 2 pieces of masses $M_1 = 2$ kg and $M_2 = 6$ kg. The kinetic energy of M_2 immediately after the explosion is 300 J. What is the speed of M_1 immediately after the collision, in m/s?



(1) 30 (2) 10 (3) 50 (4) 60 (5) 20

3. Two autos of equal mass $M_1 = M_2$ undergo a T-bone sticking collision. The autos are initially traveling perpendicular to each other, with M_1 moving along the x-axis and M_2 along the y-axis. The initial speed of M_1 is 20 m/s, and that of M_2 is 40 m/s. What is the angle between the final velocity vector $\vec{v}_F$ and the x-axis?



(1) 63° (2) 51° (3) 45° (4) 30° (5) 18°

4. Two vehicles of masses M_1 and M_2 undergo a 1-dimensional elastic collision. Before the collision, M_1 is traveling in the positive-x direction at 20 m/s and M_2 is traveling in the negative-x direction at 10 m/s. After the collision, M_2 is traveling in the positive-x direction at 40 m/s. What is the speed of M_1 after the collision, in m/s?

(1) 10 (2) 20 (3) 30 (4) 40 (5) 50

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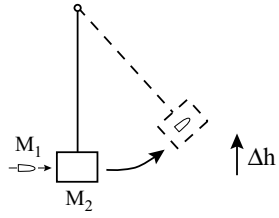
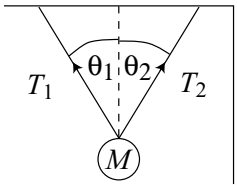
5. A bullet of mass $M_1 = 0.05$ kg strikes and imbeds itself in a pendulum block of mass $M_2 = 5$ kg as shown. After the collision, the block rises through a vertical distance Δh before its speed drops to zero. The bullet's incoming speed is 10^3 m/s. What is the value of Δh?



(1) 5 m (2) 10 m (3) 2.5 m (4) 1 m (5) 20 m

6. A mass M is suspended in equilibrium from two ropes as shown. The angles $\theta_1 = \theta_2 = 30°$. The value of the tension in rope 1 is $T_1 = 50$ N. What is the weight of the mass M, in N?

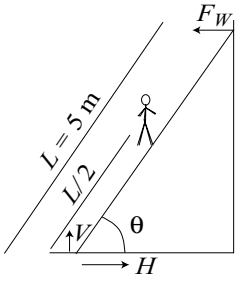


(1) 87 (2) 56 (3) 233 (4) 24 (5) 153

7. A uniform seesaw of length 5 m is in equilibrium. A child of weight 500 N sits at one end, and a child of weight 1000 N sits at the other end. The fulcrum is positioned at a point that is 2 m away from the 1000 N child. What is the weight of the seesaw, in N?

(1) 1000 (2) 1500 (3) 500 (4) 2000 (5) 0

8. A uniform ladder of length $L = 5$ m and weight 1000 N leans against a wall at an angle θ with respect to the horizontal. A climber of weight 1500 N stands at the midpoint of the ladder. The horizontal component H of the floor's force on the ladder is equal to the vertical (normal) component V. Assume that the force F_W of the wall on the ladder is horizontal. What is the value of the angle θ?



(1) 27° (2) 55° (3) 15° (4) 5° (5) 45°