

Instructor(s): *N. Sullivan*PHYSICS DEPARTMENT
Midterm Exam 2

PHY 2004

March 11, 2015

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

1. (5 points) A 10 gram bullet is fired into a block of wood that has a mass of 1 kg. If the velocity of the block of wood is 10 m/s after the impact, what was the original velocity of the bullet?
 (1) 100 m/s (2) 52 m/s (3) 25 m/s (4) 15 m/s (5) 5.2 m/s

2. (5 points) A rocket ship of mass 10,000 kg is moving with a velocity of 30 m/s through space. The crew fire their engines and burn 60 kg of fuel that is ejected with a speed of 15,000 m/s (opposite to the motion of the ship). What is the final velocity of the rocket?
 (1) 120 m/s (2) 75 m/s (3) 1000 m/s (4) 510 m/s (5) 0.25 m/s

3. (5 points) A ramp inclined at 25 degrees to the horizontal is used to haul a load of 150 kg up the slope. What is the ideal mechanical advantage of this simple machine?
 (1) 2.37 (2) 3.86 (3) 1.00 (4) 5.62 (5) 0.25

4. (5 points) An orange billiard ball of mass 4 grams and traveling with a velocity of 4 m/s collides with a stationary blue billiard ball of mass 5 gm. What is the speed of the blue ball after the collision, assuming the collision is elastic?
 (1) 3.6 m/s (2) 1.3 m/s (3) 2.0 m/s (4) 0.44 m/s (5) 7.2 m/s

5. (5 points) A mosquito sits on a compact disc that is rotating at 1000 rpm. If the disc has a radius of 10 cm, what is the tangential speed of the mosquito at the edge of the disc?
 (1) 10.5 m/s (2) 105 m/s (3) 0 m/s (4) 21 m/s (5) 52.5 m/s

6. (5 points) A wheel rotating at 2000 rpm is braked and comes to rest in 30 seconds. How many revolutions did the wheel rotate through before coming to rest?
 (1) 500 (2) 333 (3) 210 (4) 51.0 (5) 33.3

Instructor(s): *N. Sullivan*PHYSICS DEPARTMENT
Mid-Term Exam 3

April 9, 2014

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

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$$g = 9.80 \text{ m/s}^2 \qquad R = 8314 \text{ J kmole}^{-1} \text{ K}^{-1}$$

1. (4 points) A volume of a gas mixture initially at 27°C is heated to a temperature of 227°C. At the same time the gas is compressed by a factor of 20 ($V_{\text{Final}} = 1/20V_{\text{Initial}}$). If the initial pressure is 1 atmosphere, what is the final pressure?
 - (1) 33 atmos.
 - (2) 27 atmos.
 - (3) 2.0 atmos.
 - (4) 17 atmos.
 - (5) 140 atmos.

2. (5 points) A log of wood floats in a pond with 15% of its volume above water. If the density of water is 1000 kg/m³, what is the density of the wood?
 - (1) 850 kg/m³
 - (2) 1150 kg/m³
 - (3) 95 kg/m³
 - (4) 15 kg/m³
 - (5) 150 g/m³

3. (3 points) A 1 m length of a bungee cord has a circular cross-sectional area of 1 cm². If a force of 10 N is applied to the cord, it stretches 10 cm. What is the Young's modulus of the cord?
 - (1) 10⁶ Pa
 - (2) 1 GPa
 - (3) 150 GPa
 - (4) 0.15 GPa
 - (5) 10 MPa

4. (5 points) A 5m³ tank of compressed natural gas has an absolute pressure of 4 kPa at a temperature of 27°C. What is the mass of the gas in the tank? 1 kmole of the gas weighs 16 kg.
 - (1) 0.13 kg
 - (2) 36.5 kg
 - (3) 1.61 kg
 - (4) 128 kg
 - (5) 6.42 kg

5. (4 points) A 10 meter length of steel changes temperature by 20°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) 4.8 cm
 - (3) 28.4 mm
 - (4) 1.8 m
 - (5) 0.82 mm

Instructor(s): *N. Sullivan*PHYSICS DEPARTMENT
Final Exam

December 13, 2011

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$$g = 9.80 \text{ m/s}^2 \qquad R = 8314 \text{ J/kmole K}$$

1. (5 points) A cubic block of wood floats in water with 11% of its volume below water. If the density of water is $1,000 \text{ kg/m}^3$, what is the density of the wood?
 - (1) 890 kg/m^3
 - (2) 1100 kg/m^3
 - (3) 990 kg/m^3
 - (4) 2200 kg/m^3
 - (5) 110 kg/m^3

2. (3 points) A stone dropped from a bridge that is 15 meters above the water. How long does the stone take to hit the water?
 - (1) 1.75 s
 - (2) 0.67 s
 - (3) 27.5 s
 - (4) 6.7 s
 - (5) 0.18 s

3. (5 points) A wheel rotating with an angular speed of 3 rev/s is brought to rest in 3 seconds. If a torque of 15 kg·m is used to bring the wheel to rest, what is the moment of inertia of the wheel?
 - (1) $2.39 \text{ kg}\cdot\text{m}^2$
 - (2) $15 \text{ kg}\cdot\text{m}^2$
 - (3) $1.55 \text{ kg}\cdot\text{m}^2$
 - (4) $155 \text{ kg}\cdot\text{m}^2$
 - (5) $243 \text{ kg}\cdot\text{m}^2$

4. (4 points) A steel beam has a length of 1.0 m and a cross-sectional area of 1 cm^2 . If the length of the beam changes by 0.50 mm with an applied force of 10,000 N, what is the Young's modulus of steel?
 - (1) 200 GPa
 - (2) 112 GPa
 - (3) 15 GPa
 - (4) 1500 GPa
 - (5) 7200 GPa

5. (4 points) A 2 m^3 steel gas cylinder contains natural gas at a pressure of 200 kPa at a temperature of 27°C . If the gas is compressed to 300 kPa, what is the final temperature?
 - (1) 177°C
 - (2) 300°C
 - (3) 57°C
 - (4) 200°C
 - (5) 420°C

6. (4 points) A 15 m^3 volume of ideal gas is compressed adiabatically. If the work done by the outside force is 2700 J, what is the change in internal energy of the gas?
 - (1) 2700 J
 - (2) -2700 J
 - (3) 1350 J
 - (4) -1350 J
 - (5) 0 J

7. (3 points) An astronaut with all her gear can jump 18 inches on the Earth'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 Moon's surface using the same energy?
 - (1) 108 inches
 - (2) 6 feet
 - (3) 3 inches
 - (4) 3 feet
 - (5) 1.1 inches

8. (3 points) A 2 meter length of steel changes length by 2.4 mm during the course of a day. If the coefficient of thermal expansion of steel is 12 parts per million per $^{\circ}\text{C}$, what is the change in temperature of the steel?
- (1) 100° (2) 24° (3) 12° (4) 373° (5) 273°
9. (5 points) A cylinder of radius b has a moment of inertia $I = (1/2)mb^2$. The cylinder is rolled along a flat horizontal surface at speed v so that when it hits a ramp it will travel to a height of 50 cm and then stop. What is the initial speed v of the cylinder?
- (1) 2.6 m/s (2) 5.2 m/s (3) 12.2 m/s (4) 9.2 m/s (5) 52.5 m/s
10. (4 points) An organ pipe open at one end has a length of 60 cm. If the speed of sound in air is 340 m/s, what is the lowest frequency produced by the organ pipe?
- (1) 141.5 Hz (2) 283 Hz (3) 70.8 Hz (4) 610 Hz (5) 305 Hz

Instructor(s): *N. Sullivan*PHYSICS DEPARTMENT
Final Exam

April 23, 2011

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

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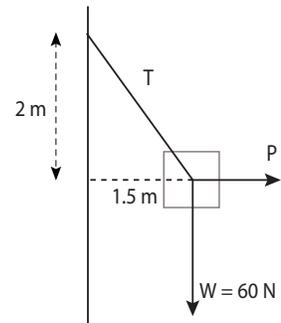
 $g = 9.80 \text{ m/s}^2$

$R = 8314 \text{ J/kmole/K}$

1. (3 points) A rock of mass 150 g is thrown vertically up into the air with a speed of 15 m/s. How high will it travel?
(1) 11.5 m (2) 1.56 m (3) 7.6 m (4) 23 m (5) 2.9 m
2. (3 points) A wheel rotating with an angular speed of 3 rev/s is brought to rest in 1.5 seconds. If the moment of inertia of the wheel is 1.0 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
3. (4 points) An aluminum beam has a length of 10 m and a cross-sectional area of 1 cm^2 . If the beam stretches by 2.01 mm with the application of a force of 1,000 N what is the value of the Young's modulus of aluminum in GPa. $1 \text{ GPa} = 10^9 \text{ Pa}$.
(1) 50 (2) 150 (3) 200 (4) 15 (5) 1.5
4. (3 points) Helium gas is stored in a 250 m^3 strong steel gas cylinder. If the temperature is raised from 27°C to 127°C and the initial absolute pressure was 50 kPa, calculate the final pressure.
(1) 66.7 kPa (2) 200 kPa (3) 4500 kPa (4) 110 kPa (5) 42 kPa
5. (3 points) A 12 m^3 volume of ideal gas is expanded adiabatically. If the work done by the gas is 900 J what is the change in internal energy of the gas?
(1) -900 J (2) 900 J (3) 600 J (4) -600 J (5) 0 J
6. (3 points) An astronaut with all his gear can jump 8 inches on the Earth's surface. He finds that with the same gear he can jump 4 feet on the moon's surface. What is the ratio of the acceleration due to gravity on the Moon compared to that on Earth?
(1) 0.16 (2) 6 (3) 1.0 (4) 2.0 (5) 1.6
7. (3 points) A 2 meter length of steel changes temperature by 100°C during the course of a day. If the length of the steel changes by 4.8 mm, what is the coefficient of thermal expansion of steel in parts per million per $^\circ\text{C}$?
(1) 24 (2) 48 (3) 12 (4) 5.2 (5) 0.56

8. (4 points) A disc is rotating about its center. A mosquito sits on the disc at a distance of 20 cm from the center and has a linear speed tangential to the circular motion of 32 cm/s. What is the speed of rotation of the disc?
- (1) 15.3 rpm (2) 6.8 rpm (3) 1.72 rpm (4) 32 rpm (5) 166 rpm
9. (3 points) A copper rod is 30 cm long and has a cross-sectional area of 1 cm^2 . The coefficient of thermal conductivity is $100 \text{ W/m}\cdot\text{K}$. 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) 0.67 W (2) 4.3 W (3) 2.5 W (4) 0.023 W (5) 10 W
10. (3 points) An automobile starts from rest and maintains a constant acceleration of $a = 5 \text{ m/s}^2$ for 5 s. The car then stops accelerating suddenly ($a = 0$) and maintains a constant velocity for 5 s. How far does the automobile travel during the 10 s?
- (1) 187 m (2) 111 m (3) 90 m (4) 78 m (5) 22 m
11. (3 points) The space shuttle makes 1 revolution around the Earth in 1.5 hours when it is in an orbit 200 km above the Earth's surface. The radius of the Earth R_e is $6.5 \times 10^6 \text{ m}$. If the shuttle moves to a new orbit such that it makes 1 revolution per day (24 hours), what is the radius of the new orbit?
- (1) $6.2R_e$ (2) $12R_e$ (3) $24.8R_e$ (4) $16R_e$ (5) $0.38R_e$
12. (4 points) A force P holds an object weighing 60 N a distance 1.5 m. from the wall as shown in the figure. The tie rope T is tied 2 m above the horizontal line of action P. Calculate P.

- (1) 45 N
 (2) 60 N
 (3) 11.2 N
 (4) 4.5 N
 (5) 33.7 N



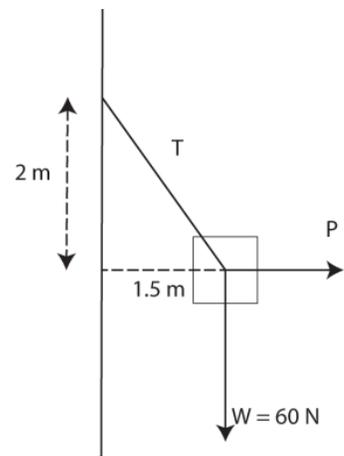
Example

$g=9.8 \text{ m/s}^2$, $R=8314 \text{ J/kmole K}$

- (3 points) A rock of mass 75 g is thrown vertically up into the air with a speed of 15 m/s. How high will it travel?
(A) 11.5 m (B) 1.56 m (C) 7.6 m (D) 23 m (E) 2.9 m
- (3 points) A wheel rotating with an angular speed of 3 rev/s is brought to rest in 1.5 seconds. If the moment of inertia of the wheel is 2.0 kg/m^2 , what torque was applied to bring the wheel to rest?
(A) 25.2 kg m (B) 2.0 kg m (C) 0.32 kg m (D) 12.6 kg m (E) 5.2 kg m
- (4 points) An aluminum beam has a length of 10 m and a cross-sectional area of 1 cm^2 . If the beam stretches by 2.01 mm with the application of a force of 1,000 N what is the value of the Young's modulus of aluminum in GPa. $1 \text{ GPa} = 10^9 \text{ Pa}$.
(A) 50 (B) 150 (C) 200 (D) 15 (E) 1.5
- (3 points) Helium gas is stored in a 250 m^3 strong steel gas cylinder. If the temperature is raised from 27°C to 127°C and the initial absolute pressure was 25 kPa, calculate the final pressure.
(A) 33.3 kPa (B) 200 kPa (C) 4500 Pa (D) 110 Pa (E) 66.7 kPa
- (3 points) A 12 m^3 volume of ideal gas is expanded adiabatically. If the work done by the gas is 600 J what is the change in internal energy of the gas?
(A) -600 J (B) -900 J (C) 600 J (D) -900 J (E) 100 J
- (3 points) An astronaut with all his gear can jump 8 inches on the Earth's surface. He finds that with the same gear he can jump 4 feet on the moon's surface. What is the ratio of the acceleration due to gravity on the Moon compared to that on Earth?
(A) 0.16 (B) 6 (C) 1.0 (D) 2.0 (E) 1.6

7. (3 points) A 2 meter length of steel changes temperature by 100°C during the course of a day. If the length of the steel changes by 4.8 mm what is the coefficient of thermal expansion of steel in parts per million per $^{\circ}\text{C}$?
- (A) 24 (B) 12 (C) 12 (D) 5.2 (E) 0.56
8. (4 points) A disc is rotating about its center. A mosquito sits on the disc at a distance of 20 cm from the center and has a linear speed tangential to the circular motion of 32 cm/s. What is the speed of rotation of the disc?
- (A) 15.3 rpm (B) 6.8 rpm (C) 1.72 rpm (D) 32 rpm (E) 166 rpm
9. (3 points) A copper rod is 30 cm long and has a cross-sectional area of 3 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?
- (A) 2.0 W (B) 4.3 W (C) 0.67 W (D) 0.023 W (E) 10 W
10. (3 points) An automobile starts from rest and maintains a constant acceleration of $a=5\text{ m/s}^2$ for 5 s. The car then stops accelerating suddenly ($a=0$) and maintains a constant velocity for 5 s. How far does the automobile travel during the 10s. ?
- (A) 187 m (B) 111 m (C) 90 m (D) 78 m (E) 22 m
11. (3 points) The space shuttle makes 1 revolution around the Earth in 1.5 hours when it is in an orbit 200 km above the Earth's surface. The radius of the Earth R_e is $6.5 \times 10^6\text{ m}$. If the shuttle moves to a new orbit such that it makes 1 revolution per day (24 hours) what is the radius of the new orbit?
- (A) $6.2 R_e$ (B) $12 R_e$ (C) $24.8 R_e$ (D) $16 R_e$ (E) $0.31 R_e$
12. (4 points) A force P holds an object weighing 30 N a distance 1.5 m. from the wall as shown as in the figure. The tie rope T is tied 2 m. above the horizontal line of action P. Calculate P.

- (A) 22.5 N (B) 50 N (C) 11.2 N (D) 45 N (E) 33.7 N



Instructor(s): *N. Sullivan*PHYSICS DEPARTMENT
Final Exam

December 13, 2010

PHY 2004

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

$R = 8314 \text{ J/kmole/K}$

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/m², 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 1.0 m and a cross-sectional area of 1 cm². 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 m³ 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 m³ 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 $^{\circ}\text{C}$, 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) 0.17 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 $100\text{ W/m}\cdot\text{K}$. 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

Instructor(s): *J. Ipser*

PHYSICS DEPARTMENT

PHY 2004

Final Exam

April 25, 2005

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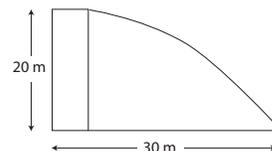
$$g = 9.80 \text{ m/s}^2$$

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 $M_1 = 1\text{kg}$, $M_2 = 2\text{kg}$, and $M_3 = 3\text{kg}$ are glued together and move above the ground. A force $F = 200\text{ N}$ 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

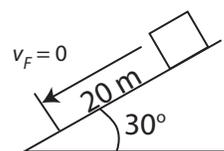
7. An elevator of mass 10^3 kg starts from rest at the 4th floor and is raised and lowered by its motor. After 15 s the elevator is 15 m below the 4th floor and is moving down at 10 m/s. How much work has been done by the motor during this process?

(1) -10^5 J (2) -10^3 J (3) -10 J (4) $+10\text{ J}$ (5) $+10^4\text{ J}$

8. A trunk of mass $m = 50\text{ kg}$ 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 ?

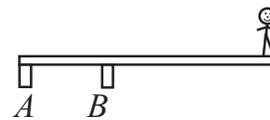
(1) 335 N (2) 300 N (3) 260 N (4) 225 N (5) 165 N

9. * A block of mass $M = 100\text{kg}$ 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 $x = 20\text{ m}$ down along the incline before it is brought to rest by friction. How much work is done by friction during this process?



(1) $-2.1 \times 10^4\text{J}$ (2) $-1.1 \times 10^4\text{J}$ (3) $-3.3 \times 10^4\text{J}$ (4) $-8.9 \times 10^4\text{J}$ (5) 10^8J

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

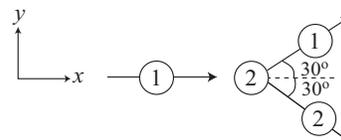


(1) not enough information (2) $9.8 \times 10^3\text{ N}$ (3) $1.96 \times 10^4\text{ N}$ (4) $5 \times 10^4\text{ N}$ (5) $6.8 \times 10^5\text{ N}$

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 ?

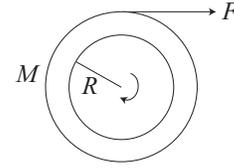


(1) 29 m/s (2) 22 m/s (3) 36 m/s (4) 43 m/s (5) 49 m/s

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) $3.22R_A$

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/m³ and floats in sea water that has density 1040 kg/m³. 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
Final Exam

December 12, 2006

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.**

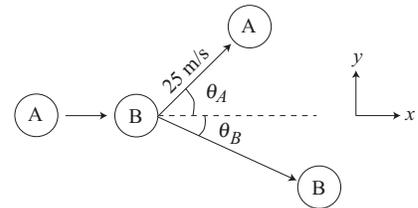
- (1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number).** Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY.** Code your UFID number on your answer sheet.
- (2) Print your name on this sheet and sign it also.
- (3) Do all scratch 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.
- (4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink.** Do not make any stray marks or some answers may be counted as incorrect.
- (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.**

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

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 $+20 \text{ m/s}$, and B is at rest. What is the velocity of A after the collision, in m/s ?

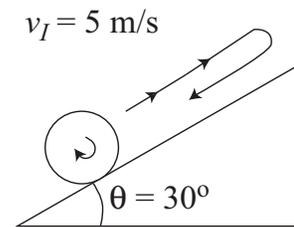
- (1) 6.67 (2) 9.34 (3) 4.23 (4) 2.21 (5) 11.3

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 $M = 2 \text{ kg}$ and radius $R = 0.5 \text{ m}$ 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.)

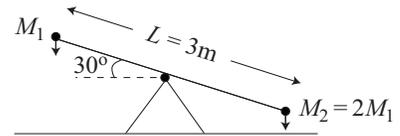


- (1) 4 s (2) 6 s (3) 8 s (4) 10 s (5) 12 s

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 $\omega = 2 \times 10^{-6} \text{ rad/s}$ (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.

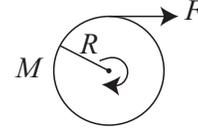
- (1) $2 \times 10^4 \text{ rad/s}$ (2) $4 \times 10^6 \text{ rad/s}$ (3) $2 \times 10^{-1} \text{ rad/s}$ (4) $2 \times 10^{-6} \text{ rad/s}$ (5) $2 \times 10^{-12} \text{ rad/s}$

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

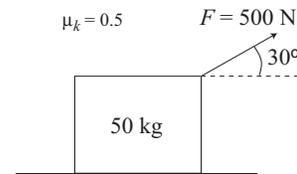
7. A 10^3 kg auto's engine puts out an average power of 100 hp for 10 s (1 hp = 746 W). Neglect frictional energy losses. During this time, the auto climbs up a hill through a height of 30 m, starting from rest. What is the auto's final kinetic energy after it has climbed the 30 m during this interval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

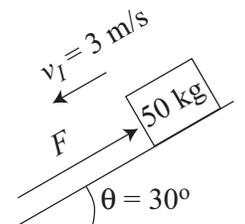
- (1) 3 m/s (2) 0 (3) 5 m/s (4) 8 m/s (5) 1.5 m/s

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 $\theta = 30^\circ$ 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

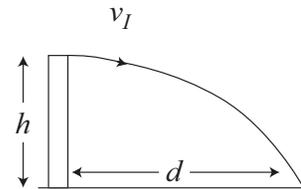
13. * A hiker walks at a constant speed of 2 m/s. All angles are measured counterclockwise with respect to the positive x -axis. The hiker first walks a distance of 300 m at an angle of 30° , and then 500 m at an angle of 120° . Finally, the hiker returns to her initial starting point. How much time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

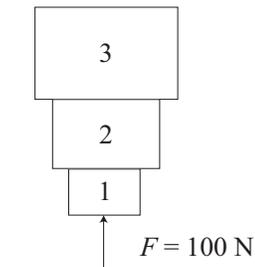
- (1) 19.6 m/s (2) 39.2 m/s (3) 0 (4) 14.3 m/s (5) 4 m/s

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?



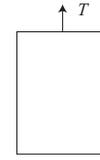
- (1) 19.6 m (2) 24.9 m (3) 31.3 m (4) 43.4 m (5) 56.2 m

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

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?



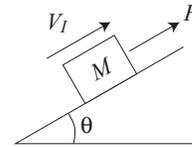
- (1) 0.3 (2) 0.45 (3) 0.6 (4) 0.75 (5) 0.9

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 $\theta = 30^\circ$ 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?

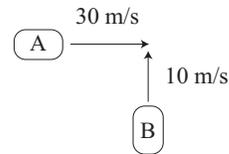


- (1) 8.3 m (2) 6.7 m (3) 3.2 m (4) 1.3 m (5) 13.8 m

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 tractor/trailer's velocity after the collision? (Hint: Think in terms of gap closing and opening.)

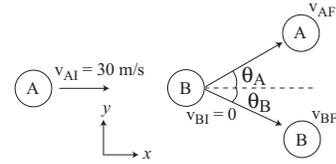
- (1) 40 m/s (2) -20 m/s (3) 20 m/s (4) 30 m/s (5) 50 m/s

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

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) $5 \times 10^3 \text{m/s}$ (2) $6 \times 10^4 \text{m/s}$ (3) $2.5 \times 10^3 \text{m/s}$ (4) 10^3m/s (5) 10^5m/s