Instructor(s): *N. Sullivan*

PHYSICS DEPARTMENT

PHY 2004 Final Exam December 17, 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*.*81 m/s2 *R* = 8314 J/kmole K

1. A 20 m3 volume of ideal gas is compressed adiabatically. If the work done by the outside force is 3800 J, hat is the change in internal energy of the gas?

(1) 3800 J (2) −3800 J (3) 0 J (4) 1900 J (5) −1900 J

Adiabatic, thus DQ=0 and DU= - DW=-(-3800) J

1. A 4-meter length of steel changes length by 2.4 mm as it is warmed from 27◦C. If the thermal expansion coefficient of the steel is 12 ppm, what is the final temperature?

(1) 77◦C (2) 127◦C (3) 57◦C (4) 37◦C (5) 92◦C

Use DL=aLDT where a is the coefft of thermal expansion to find DT

1. A ball is thrown up vertically with a speed of 12 m/s. How high will the ball rise?

(1) 7.3 m (2) 10.5 m (3) 21 m (4) 17.5 m (5) 3.9 m

V^2 = 2gH

1. An automobile starts from rest and maintains a constant acceleration of 2 m/s2 for 5 s. The automobile then stops accelerating and moves at constant speed for 3 s. How far does the automobile move?

(1) 55 m (2) 187 m (3) 77 m (4) 27 m (5) 35 m

X(phase 1) = (1/2)at^2 for t= 5 V(After phase 1) = at X(phase 2) = V(after)\*t for t=3

1. Oxygen is stored in a very strong steel gas cylinder. If the temperature is raised from 37◦C to 137◦C and the initial pressure was 100 kPa, calculate the final pressure.

(1) 132 kPa (2) 267 kPa (3) 100 kPa (4) 212 kPa (5) 167 kPa

Use PV=nRT T in kelvin

1. A sapphire rod is 10 cm long and has a cross-sectional area of 1 cm2. The coefficient of thermal conductivity is 100 W/cm 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) 200 W (2) 4.3 W (3) 0.23 W (4) 10 W (5) 20 W

Q/t = kA\*DT/L where k is the coefft of thermal conductivity, A is area and L is length

1. Jane, whose mass is 50 kg, stands on a scale in an elevator. As the elevator descends it is slowing at a rate of 3m/s2. What is the reading on the scale for Jane’s apparent weight?

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

W = m(g+a)

1. Joe leaves the center of town and walks 5 km west. He then walks 12 km due north. How far is he from his starting point? Use Pythagoras

(1) 13 km (2) 17 km (3) 5 km (4) 23 km (5) 1.3 km

PHY 2004 Final Exam December, 2014

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*g* = 9*.*80 m/s2 *R* = 8314 J/kmole K

1. (4 points) Elizabeth walks 12 km due East and then walks 5 km due North. How far is she from her starting point? (1) 13 km (2) 17 km (3) 7 km (4) 3 km (5) 21 km

Use Pythagoras

1. (4 points) Car A is traveling with a constant speed of 6 m/s. A drives past car B which is at rest. At the moment A passes B, B accelerates with a constant acceleration of 3 m/s2. How long does it take Be to catch up with A?

(1) 4.0 s (2) 2.0 s (3) 0.5 s (4) 10 s (5) 7.5 s

Calculate the distance X for each car. X(A) = 6t X(B) = (1/2)\*3\*t^2 Use X(A) =X(B) to solve for t.

1. (4 points) A horse pulls a limestone block of weight 150 kg up an inclined plane. If the plane is inclined at an angle of 15◦ to the horizontal, what is the ideal mechanical advantage of this system?

(1) 3.9 (2) 0.67 (3) 2.4 (4) 11.0 (5) 0.26

MA =1/sintheta

1. (4 points) A volume of gas initially at 27◦C is contained in a solid steel container with an internal pressure of 150 kPa. If the gas is compressed by a factor of 15 (*V*Final = 1*/*15 *V*Initial) and the temperature rises to 327◦C, what is the final pressure?

(1) 4500 kPa (2) 175 kPa (3) 1715 kPa (4) 30.0 kPa (5) 2500 kPa

Use PV=nRT P(final) = P(initial)\*[V(init)/V(final)]\* T(final)/T(initial) T in kelvin

1. (4 points) An engine is operated as an ideal Carnot cycle between a hot source at 180◦C and a cold source of 40◦C. What is the efficiency of the engine?

(1) 30.9% (2) 100% (3) 46.7% (4) 83.3% (5) 15%

Efficiency n = 1-T(cold)/T(hot)

1. (4 points) Albert is standing on a log that has a mass of 40 kg. The log is at rest on the surface of a smooth lake. Albert jumps off the log with a speed of 3 m/s. If Albert has a mass of 100 kg, what is the speed of recoil of the log after he jumps?

(1) 7.5 m/s (2) 15 m/s (3) 0 (4) 3 m/s (5) 10.5 m/s

Momentum P(before) = P(after)

1. (4 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

Calculate angular deceleration a=w(initial)/t. Use torque tau= I\*a to solve

1. (4 points) An astronaut can jump 2 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. 4 inches (2) 12 feet (3) 2 inches (4) 2 feet (5) 12 inches

H=v^2/g v^2 is constant thus H(Earth) =H(moon)\*g(moon)/g(earth)

1. (4 points) A disc is rotating at 16.6 rpm (revolutions per minute). A seed is placed on the disc at a distance of 20 cm from the center. How fast is the seed moving?

(1) 0.32 m/s (2) 0.64 m/s (3) 4.5 m/s (4) 1.5 m/s (5) 9.3 m/s

Use speed v =r\*w

1. (4 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

The change DL for length L is given by DL/L = (F/A)\* (1/Y)

PHY 2004 Final Exam December 12, 2012

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*g* = 9*.*80 m/s2 *R* = 8314 J/kmole K

## Circle the correct answer.

1. (3 points) In the U-tube shown at the right, the left hand side is filled with water to a height of 30 cm and the right hand side is filled with oil to a height of 45 cm. If the density of water is 1000 kg/m3, what is the density of the oil?

(1) 667 kg/m3 (2) 1500 kg/m3 (3) 1000 kg/m3 (4) 550 kg/m3 (5) 1750 kg/m3

Use pressure P=rho\*g\*h for both sides and rho(oil) = (30/45)\* rho(water)

1. (4 points) In the figure to the right, a force of 17 N pulls two boxes of equal mass that are joined by a rope. What is the tension in the rope?

17 N

(1) 8.5 N (2) 17 N (3) 0 N (4) 25.5 N (5) 35 N

If m is each mass the acceleration a= 17/2m. For the last mass T=ma =17/2

1. (4 points) In an adiabatic compression of an ideal gas, the external force does work of 700 J on the gas. Calculate the change in internal energy.

(1) 700 J (2) *−*700 J (3) 0 J (4) 350 J (5) 1400 J

DQ=0 thus DU=- (DW) = - (-700)

1. (5 points) A 120 N horizontal force holds a block of weight 100 N at rest on an inclined plane that makes an angle of 37*◦* to the horizontal. Calculate the coefficient of friction.

120 N

37o

100 N

(1) 0.23

(2) 0.37

(3) 0.11

(4) 0.55

(5) 0.41

Force up the plane = 120 cos37 – 100sin37 and this must equal friction f= mu\*(120sin37+100 cos37) Solve for mu

1. (4 points) A 2 kg ball is dropped from a tower and hits the ground in 2 seconds. How high is the tower? (1) 19.6 m (2) 9.8 m (3) 5.2 m (4) 12.6 m (5) 29.4 m

Use x=(1/2)gt^2

1. (3 points) An alligator floats in water with 9.0% of its volume above the water. If the density of water is 1000 kg/m3, what is the density of the alligator?

(1) 910 kg/m3 (2) 1009 kg/m3 (3) 91 kg/m3 (4) 790 kg/m3 (5) 1910 kg/m3

Use upthrust= wt of water displaced =weight of alligator

1. (4 points) On planet X the acceleration due to gravity is 6.5 m/s2. If an astronaut can jump a height of 26 cm on planet X, how high can she jump using the same energy on earth where *g* = 9*.*8 m/s2?

(1) 17.2 cm (2) 12.5 cm (3) 26.0 cn (4) 5.6 cm (5) 39.1 cm

Height H = V^2/g. V^2 is a constant thus H(earth)=H(moon)\*g(moon)/g(earth)

1. (3 points) An organ pipe is 75 cm long and is closed at one end only. If the velocity of sound in air is 331 m/s, what is the fundamental frequency of the pipe?

(1) 110 Hz (2) 220 Hz (3) 330 Hz (4) 55 Hz (5) 275 Hz

For fundamental lambda= 4L =300cm =3 m. f=v/Lambda = 110

1. (5 points) A car traveling at 6 m/s passes a truck traveling at 4 m/s. The truck starts to accelerate at 1 m/s2 just as the car passes it. In what distance will the truck catch up with the car?

(1) 24 m (2) 32 m (3) 48 m (4) 6.5 m (5) 13.0 m

Use X(car) = 6t X(truck) = (1/2)at^2 [a=1m/s2] Solve for t using X(car)=X(truck)

1. (5 points) A rocket ship whose mass is 20,000 kg is traveling at 100 m/s in space. The ship fires its engines burning 4000 kg of fuel that is ejected at 1000 m/s. What is the final velocity of the ship?

(1) 375 m/s (2) 172 m/s (3) 250 m/s (4) 107 m/s (5) 457 m/s

Use conservation of momentum

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First answers given are correct answers

Instructor(s): *N. Sullivan*

PHYSICS DEPARTMENT

PHY 2004 Final Exam December 13, 2011

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1. Hand in the answer sheet separately.

*g* = 9*.*80 m/s2 *R* = 8314 J/kmole K

1. (5 points) A cubic block of wood floats in water with 11% of its volume above water. If the density of water is 1,000 kg/m3, what is the density of the wood?

(1) 890 kg/m3 (2) 1100 kg/m3 (3) 990 kg/m3 (4) 2200 kg/m3 (5) 110 kg/m3

Upthrust =wt of fluid displaced = 0.11V\*rho(water)\*g. This must = wt of log =V\*rho(wood)\*g

1. (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

Use x=(1/2)gT^2

1. (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 kg*·*m2 (2) 15 kg*·*m2 (3) 1.55 kg*·*m2 (4) 155 kg*·*m2 (5) 243 kg*·*m2

Use torque=I\*a where a is the angular acceleration

1. (4 points) A steel beam has a length of 1.0 m and a cross-sectional area of 1 cm2. 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

Y= (F/A)/[DL/L]

1. (4 points) A 2 m3 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

Use PV=nRT with T in kelvin. V is constant, thus T(final)=T(initial)\*P(final)/P(initial)

1. (4 points) A 15 m3 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

DQ=0, thus dU= - (DW). DW = - 2700

1. (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

H=V^2/2g. V^2 is constant thus H(moon)=H(earth)\*g(earth)/g(moon)

1. (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 *◦*C, what is the change in temperature of the steel?

(1) 100*◦* (2) 24*◦* (3) 12*◦* (4) 373*◦* (5) 273*◦*

Use DL=aLDT where a is the coefficient of thermal expansion

1. (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

Use initial KE = (1/2)mV^2 +(1/2)Iw^2 = final PE =mgh and use v-bw

1. (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

For standing sound waves the fundamental occurs for L = lambda/4 f = v/lambda

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Instructor(s): *N. Sullivan*

PHYSICS DEPARTMENT

PHY 2004 Final Exam April 23, 2011

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*g* = 9*.*80 m/s2 *R* = 8314 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

Use (1/2)V^2 =gH

1. (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/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

Calculate angular deceleration a = 3\*2pi/(1.5) and torque =Ia

1. (4 points) An aluminum beam has a length of 10 m and a cross-sectional area of 1 cm2. 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*GPA* = 109Pa.

(1) 50 (2) 150 (3) 200 (4) 15 (5) 1.5

Y={(F/A)]/DL/L]

1. (3 points) Helium gas is stored in a 250 m3 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

Use PV=nRT V is constant thus P(final)=P(initial)\*T(final)/T(initial)

1. (3 points) A 12 m3 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

DQ=0, thus DU= -(DW)

1. (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

H=V^2/2g V is constant (constant energy). Thus g(moon)=g(earth)\* H(moon)/H(earth)

1. (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 *◦*C ?

(1) 24 (2) 48 (3) 12 (4) 5.2 (5) 0.56

Use DL=aLDT where a is the expansion coefficient and DL and DT are changes in length and temperature

1. (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

Use v=rw

1. (3 points) A copper rod is 30 cm long and has a cross-sectional area of 1 cm2. 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) 0.67 W (2) 4.3 W (3) 2.5 W (4) 0.023 W (5) 10 W

Q/t = kADT/L where k is the coefficient of thermal conductivity and DFT is temperature change

1. (3 points) An automobile starts from rest and maintains a constant acceleration of *a* = 5 m/s2 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

For first part X=(1/2)at^2 and V(After acceleration) =at. For second part X= VT

1. (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 *Re* is 6*.*5 *×* 106m. 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*.*2*Re* (2) 12*Re* (3) 24*.*8*Re* (4) 16*Re* (5) 0*.*38*Re*

Use centripetal acceleration a= V^2/R =Rw^2 where w = angular velocity =2pi/T

1. (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.

T

P

1.5 m

W = 60 N

2 m

(1) 45 N

(3) 11.2 N

(4) 4.5 N

(5) 33.7 N

Calculate the torques about the point where T is attached to the wall.

# PHYS 2004 FINAL EXAM April 28 2011

Example

g=9.8 m/s2, R=8314 J/kmole K

* 1. (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

H=V^2/2g

* 1. (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 m2, 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

Calculate the angular deceleration a = 3\*2pi/1.5. Use torque = Ia

* 1. (4 points) An aluminum beam has a length of 10 m and a cross-sectional area of 1 cm2. 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 GPA = 109 Pa.

(A) 50 (B) 150 (C) 200 (D) 15 (E) 1.5

Use Y =[F/A] \* [DL/L]

* 1. (3 points) Helium gas is stored in a 250 m3 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

V is constant. Use PV =nRT and P(final)=P(initial) \* T(final)/T(initial)

* 1. (3 points) A 12 m3 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

DQ =0, Thus DU = - (DW)

* 1. (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

H =V^2/g and V^2 is constant. Thus g(moon)/g(earth) = H(moon)/H(earth)

* 1. (3 points) A 2 meter length of steel changes temperature by 100⁰C 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 ⁰C ?

(A) 24 (B) 12 (C) 12 (D) 5.2 (E) 0.56

Use DL=aLDT where a is the coefficient of thermal expansion.

* 1. (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

Use v=rw

* 1. (3 points) A copper rod is 30 cm long and has a cross-sectional area of 3 cm2. 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

Use Q/t = kADT/L where k is the coefficient of thermal expansion

* 1. (3 points) An automobile starts from rest and maintains a constant acceleration of a=5 m/s2 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. ?

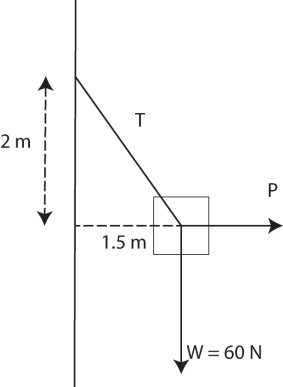
(A) 187 m (B) 111 m (C) 90 m (D) 78 m (E) 22 m

In first part X(I) = (1/2)at^2 and at end V=at. In second part V\*(II) =Vt

* 1. (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 Re is 6.5x10^6 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 Re (B) 12 Re (C) 24.8 Re (D) 16 Re (E) 0.31 Re

Use centripetal acceleration a =V^2/R = rw^2 where w=2pi/T is the angular velocity

* 1. (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

Calculate torques about the point where T is attached to the Wall.

77777 77777

Instructor(s): *N. Sullivan*

PHYSICS DEPARTMENT

PHY 2004 Final Exam December 13, 2010

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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.
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*g* = 9*.*80 m/s2 *R* = 8314 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

1. (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 × 109 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

1. (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 fi pressure.

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

1. (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

1. (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

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1. (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

1. (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

1. (3 points) A sapphire rod is 10 cm long and has a cross-sectional area of 1 cm2. The coefficient of thermal conductivity is 100 W/m·K. If there is a 20◦C diff in temperature from one end of the rod to the other, what is the heat fl w 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 Name (print, last fi Signature: *On my honor, I have neither given nor received unauthorized aid on this examination.*

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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/s2

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

1. \* 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?

20 m

30 m

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

1. 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/s2. 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

1. 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/s2?

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

1. \* A lady whose mass is 50 kg stands on a scale in an elevator. As the elevator approaches the ground fl or from above, it is slowing at a rate of 3 m/s2. 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

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1. Three masses *M*1 = 1kg, *M*2 = 2kg, and *M*3 = 3kg 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

1. An elevator of mass 103 kg starts from rest at the 4th fl or and is raised and lowered by its motor. After 15 s the elevator is 15 m below the 4th fl or and is moving down at 10 m/s. How much work has been done by the motor during this process?

(1) −105 J (2) −103 J (3) −10 J (4) +10 J (5) +104 J

1. A trunk of mass *m* = 50 kg is pulled across a horizontal fl or 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/s2, what is the value of *F* ?

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

1. \* A block of mass *M* = 100kg 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?

*vF* = 0

20 m

30o

(1) −2*.*1 × 104J (2) −1*.*1 × 104J (3) −3*.*3 × 104J (4) −8*.*9 × 104J (5) 108J

1. 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 *FB* exerted by support B?

*A B*

(1) not enough information (2) 9*.*8 × 103 N (3) 1*.*96 × 104 N (4) 5 × 104 N (5) 6*.*8 × 105 N

1. \* 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

1. Masses *M*1 and *M*2 (*M*1 = *M*2) undergo a collision in 2 dimensions. *y*

2

1

30o 30o

2

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

1

at an angle of 30◦ with respect to the x axis. What is the fi *x*

speed *v*2*F* of *M*2?

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

1. Satellites A and B are in orbits around the Earth. The periods *TA* and *TB* of the satellite orbits satisfy *TA* = 3*TB* . If

*RA* is the radius of orbit *A*, what is the radius of orbit *B*?

(1) 0*.*48*RA* (2) *RA* (3) 1*.*45*RA* (4) 2*.*16*RA* (5) 3*.*22*RA*

*F*

*R*

1. 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 *M*

to its rim. What is the kinetic energy of rotation of the tire after

10 s?

(1) 2*.*5 × 105 J (2) 0*.*95 × 107 J (3) 0*.*54 × 107 J (4) 4*.*7 × 107 J (5) 109 J

1. \* A bicycle tire of mass *M* = 2 kg and radius *R* = 0*.*5 m is initially rotating with angular velocity *ωI* = 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

1. \* An iceberg has a density 920 kg/m3 and fl 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

PHY 2004 Final Exam December 12, 2006

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6. Hand in the answer sheet separately.

Suggestion: Try \* problems first.

*g* = 9*.*80 m/s2

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

1. Autos A and B have the same mass and undergo a 2-dimensional

A

A

B

*A*

*B*

B

collision in which B is initially at rest, while A has initial velocity *y*

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

25 m/s

is the *y* component of the final velocity of B? *x*

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

1. 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.)

*vI* = 5 m/s

= 30o

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

1. \* Idealize the sun as a thin bicycle tire of mass 1033 kg and radius 109 m. The sun is currently rotating with an angular velocity *w* = 2 × 10−6 rad/s (about 1 revolution every month). If the sun suddenly were to shrink to a radius of 104 m, what would be the value of its angular velocity? Assume angular momentum is conserved.

(1) 2 × 104 rad/s (2) 4 × 106 rad/s (3) 2 × 10−1 rad/s (4) 2 × 10−6 rad/s (5) 2 × 10−12 rad/s

1. 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 = 2*M*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 = 3*M*1 be placed so that the seesaw is in equilibrium?

*M*1

30o

*M*2 = 2*M*1

*L = 3m*

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

1. A thin bicycle tire of mass *M* = 2 kg is spun up from rest by a *F*

*R*

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: *M*

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

1. A 103 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 × 105 J (2) 3*.*1 × 105 J (3) 1*.*3 × 105 J (4) 8*.*5 × 104 J (5) 5*.*3 × 104 J

1. A 103 kg elevator is initially moving downwards at 5 m/s. The cable of the elevator motor exerts a constant upward force of 104 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

1. A 50 kg trunk is pulled across a horizontal surface by a force *F* =

50 kg

*k* = 0.5

*F* = 500 N

30o

shown. The coefficient of kinetic friction is *µ*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

1. A 50 kg trunk is initially sliding with speed 3 m/s down a fric- tionless incline that makes an angle *θ* = 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* ?

= 30o

*v*

*I*

= 3 m/s

*F*

50 kg

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

1. \* 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

1. \* 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

1. \* 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

1. \* 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

1. A rock is thrown out horizontally with speed 20 m/s from a tower *vI*

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?

*h*

*d*

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

1. 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?

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 3 | | | | | |  |
|  | 2 | | | |  |
|  | | 1 | |  | | |
|  | | | *F* = 1 | | | |

00 N

(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

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*g* = 9*.*80 m/s2

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?

y

θ

x

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

1. A ball is thrown straight down with speed 20 m/s from the top of 20

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 *h*

the same height 2 s later. What is the height *h* of the tower?

30

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

1. 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

1. 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?

M1 M2 M3

F = 100 N

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | 2 |  | |
|  | 4 | | |  |
| 6 | | | | |

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

1. An auto accelerates from rest with acceleration *a* = 5 m/s2 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

1. 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?

*T*

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

1. 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
2. A 15 kg block accelerates from rest at a rate of 2 m/s2 across a *F*

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

1. A 15 kg block accelerates from rest at a rate of 2 m/s2 across a *F*

horizontal surface, due to a horizontal applied force *F* = 75 N.

How much work is done by friction during the fi 10 s of motion?

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

1. A block of mass *M* = 50 kg is initially moving with speed 10 m/s up along an incline that makes an angle *θ* = 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?

*VI*

*F*

θ

*M*

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

1. 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

1. 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?

30 m/s

A

B

10 m/s

(1) 4*.*5 × 105J (2) 1*.*6 × 104J (3) 2*.*4 × 103J (4) 6*.*3 × 105J (5) 8*.*8 × 104J

1. 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 fi velocity of A with respect to the x axis?

vAI = 30 m/s θ

A

A B θ

*y*

vBI = 0 B

*x*

vAF

A

vBF

B

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

1. A wheel spins up from rest to 300 rpm in 10 s. What is its angular acceleration in rad/s2?

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

1. 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

1. A satellite is in a circular orbit around planet X. The radius of its orbit is *RI* and the satellite’s speed is 104m/s. The satellite is then moved to a new orbit of radius 4*RI* . What is the satellite’s speed in its new orbit?

(1) 5 × 103m/s (2) 6 × 104m/s (3) 2*.*5 × 103m/s (4) 103m/s (5) 105m/s