Name:

General Physics I-A
Final Exam Version 1

May 5, 2006

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
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12.	A	B	C	D
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14.	A	B	C	D
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16.	A	B	C	D
17.	A	B	C	D
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19.	A	B	C	D
20.	A	B	C	D
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23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D
26.	A	B	C	D
27.	A	B	C	D
28.	A	B	C	D
29.	A	B	C	D
30.	A	B	C	D

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Acceleration of Gravity: $g = 9.8\,\mathrm{m/s^2}$
Gravitational Force Constant: $G = 6.67 \times 10^{-11}\,\mathrm{N{\cdot}m/^2/kg^2}$
1 liter = 1000 $\mathrm{cm^3} = 1 \times 10^{-3}\,\mathrm{m^3}$
1 atm = $1.013 \times 10^5\,\mathrm{N/m^2}$
Density of water: 1.00 $\mathrm{g/cm^3} = 1000\ \mathrm{kg/m^3}$
Density of air: 1.25 $\mathrm{kg/m^3}$
Speed of sound in air: 343 m/s (at 20°C)
1 cal = 4.186 J
Specific heat of water: 1.00 cal/g
Heat of fusion of water: 79.7 cal/g
Heat of vaporization of water: 539 cal/g
Avogadro's number: $N_A = 6.02 \times 10^{23}\ \mathrm{mol^{-1}}$
Absolute zero: 0 K = -273.15°C
Boltzmann's Constant: $k = 1.38 \times 10^{-23}$ J/K
Ideal Gas Constant: $R = N_A k = 8.315$ J/(mol K)
Stefan-Boltzmann Constant: $\sigma = 5.67 \times 10^{-8}\,\mathrm{W/m^2{\cdot}K^4}$
Moments of Inertia about CM:

Thin Hoop: MR^2, Solid Cylinder: $\frac{1}{2}MR^2$,
Solid Sphere: $2MR^2/5$, Rod: $ML^2/12$.

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1. [1pt] You are throwing a ball straight up in the air. At the highest point, the ball's

A) acceleration is nonzero, but its velocity is zero.
B) velocity and acceleration are zero.
C) velocity is nonzero but its acceleration is zero.
D) velocity and acceleration are both nonzero.

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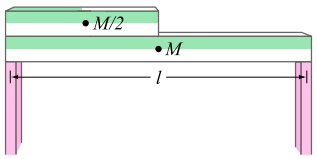
2. [1pt] A uniform steel beam has a mass of 888 kg. On it is resting half of an identical beam, as shown in the figure below.



What is the vertical support force at each end?

A) 8.7 kN on the left and 4.4kN on the right.
B) 10.9 kN on the left and 2.2kN on the right.
C) 7.6 kN on the left and 5.4kN on the right.
D) 9.8 kN on the left and 3.3kN on the right.

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3. [1pt] The left end of a see-saw accelerates downward, as you view it. By the right-hand rule, the torque vector acting on the see-saw points (Select one)

A) toward you.
B) down.
C) away from you.
D) counterclockwise.

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4. [1pt] The following expression gives the resistive force on a sphere of radius r moving with speed v through air:

$$R(v) = 3.1 \times 10^{-4} rv + 0.87 r^2 v^2,$$

where R is in Newtons, r is in meters, and v is in m/s. Estimate the terminal speed of fall (in air) of an air-filled toy balloon, with a diameter of 50 cm and a mass (not counting the air inside) of 0.59 g.

A) 0.46 m/s
B) 75 m/s
C) 0.33 m/s
D) 37 m/s

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5. [1pt] The springs of a car of mass 1780 kg give it a period when empty of 0.77 s for small vertical oscillations. How much further does the car sink down when the driver and three passengers, each of mass 84 kg, get into the car?

A) 1.4 cm
B) 2.1 cm
C) 2.8 cm
D) 0.7 cm

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6. [1pt] What mass of steam at 100°C must be added to 1.10 kg of ice at 0°C to yield liquid water at 35.0°C?

A) 5.79 kg
B) 3.00 kg
C) 0.21 kg
D) 0.52 kg

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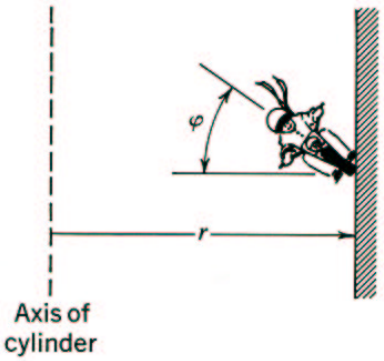
7. [1pt] How much work would be required to move a satellite of mass 4990 kg from a circular orbit of radius $r_1 = 4r_E$ about the Earth to another circular orbit of radius $r_2 = 8r_E$? (r_E is the radius of the Earth, 6380 km.)

A) $1.95{\times}10^{10}$ J
B) $1.73{\times}10^{10}$ J
C) $3.90{\times}10^{10}$ J
D) $3.47{\times}10^{10}$ J

8. [1pt] A trick cyclist rides his bike around a "wall of death" in the form of a vertical cylinder (see the figure). The maximum frictional force parallel to the surface of the cylinder is equal to a fraction μ of the normal force exerted on the bike by the wall.



If $\mu = 0.54$ and the radius of the cylinder is 6.3 m, what minimum speed must the cyclist ride to avoid slipping down?

A) 10.7 m/s
B) 15.1 m/s
C) 5.3 m/s
D) 7.6 m/s

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9. [1pt] A train traveling east at 64 mph collides a baseball thrown at it head-on with a speed of 87 mph. If the collision is elastic, how fast will the ball be moving after it bounces off the front of the moving train? (All speeds are relative to the ground.)

A) 238 mph
B) 192 mph
C) 215 mph
D) 261 mph

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10. [1pt] A fire hose delivers 12 liters per second with a speed of 23 m/s. If the hose is aimed directly at a wall, what is the force of water on the wall? (Assume it all runs down the wall without splashing.)

A) 221 N
B) 331 N
C) 386 N
D) 276 N

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11. [1pt] The temperature of 1.55 mol of an ideal diatomic gas goes from 26.7°C to 43.5°C at a constant volume. What is the change in entropy?

A) 15.7 J/K
B) -1.76 J/K
C) 1.76 J/K
D) -15.7 J/K

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12. [1pt] You are given two carts, A and B. They look identical, and you are told that they are made of the same material. You place A at rest on an air track and give B a constant velocity directed to the right so that it collides elastically with A. After the collision, both carts move to the right, the velocity of B being smaller than what it was before the collision. What do you conclude?

A) The two carts are identical.
B) need more information
C) Cart A is hollow.
D) Cart B is hollow.

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13. [1pt] Starting from a point that can be taken as the origin, a ship travels 47.2 miles northeast in a straight line, and then 24.8 miles on a course that heads in a direction making a counterclockwise angle of 66.0° with a reference line drawn eastward. Find the x and y coordinates of its final position (x eastward, y northward).

A) $x = 23.3$ mi, $y = 43.5$ mi
B) $x = 43.5$ mi, $y = 56.0$ mi
C) $x = 23.3$ mi, $y = 56.0$ mi
D) $x = 43.5$ mi, $y = -10.7$ mi

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14. [1pt] A heat pump is used to keep a house warm at 22.5°C. How much work is required of the pump to deliver 2760 J of heat into the house if the outdoor temperature is 0°C. Assume ideal (Carnot) behavior.

A) 227 J
B) 2760 J
C) 210 J
D) 195 J

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15. [1pt] You open the refrigerator in your room and put in a case of room-temperature root beer. After an hour, the root beer is ice cold. If your room air did not exchange any heat with the outdoor air during that time, the room air will be (Select one)

A) colder because the refrigerator reverses natural heating, so that things get colder rather than hotter.

B) warmer because some of the heat from the root beer inevitably leaks out into the room as the result of imperfect insulation.

C) warmer because the refrigerator will have pumped heat out of the root beer and into the room air.

D) colder because as the refrigerator struggles to cool the root beer, some of the cold it produces inevitably leaks out into the room as the result of imperfect insulation.

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16. [1pt] Consider two identical glasses. Glass 1 contains only water. Glass 2 is filled to the same level with water, but also contains a large floating ice cube. Which glass is heavier?

A) Glass 1.

B) It is impossible to say without more information.

C) Glass 2.

D) They have the same weight.

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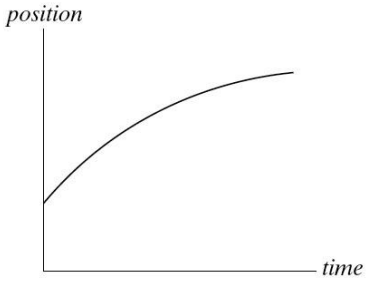
17. [1pt] A train car moves along a long straight track. The graph shows the position as a function of time for this train.



The graph shows that the train:

A) moves at a constant velocity.

B) slows down all the time.

C) speeds up all the time.

D) speeds up part of the time and slows down part of the time.

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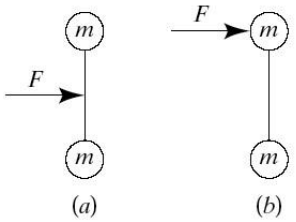
18. [1pt] A force F is applied to a dumbbell for a time interval Δt, first as in (a) and then as in (b).



Which statement is true?

A) Dumbbell a moves faster but b has more energy.

B) The speeds are the same but dumbbell a has more energy.

C) The speeds are the same but dumbbell b has more energy.

D) Dumbbell a moves faster and has more energy than b.

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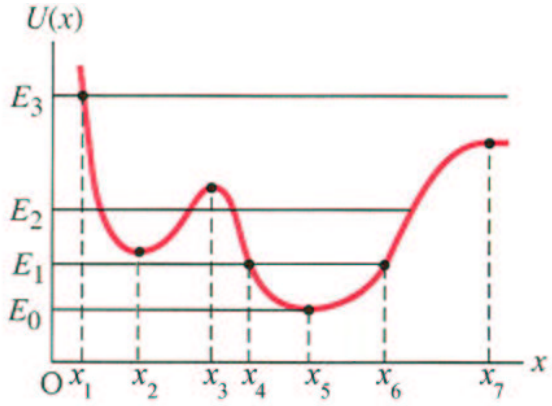
19. [1pt] A particle moves in one dimension under the influence of a force with potential energy $U(x)$ as shown in the graph.



A particle with total energy E_2

A) must oscillate about point x_2.

B) may oscillate about point x_2 or x_5.

C) may oscillate about any of the points x_2, x_3 or x_5.

D) must oscillate about point x_5.

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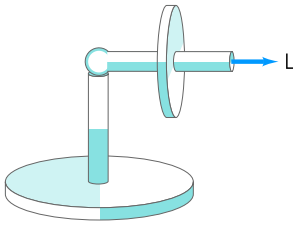
20. [1pt] A toy gyroscope consists of a disk mounted at the center of an axle as shown. One end of the axle is attached to a pivot which is free to turn. The angular momentum vector of the spinning disk is as shown in the figure.

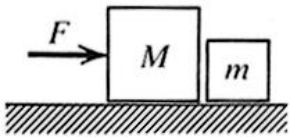


Seen from above, the gyroscope will precess about the pivot

A) in a clockwise direction with a period inversely proportional to L
B) in a counterclockwise direction with a period proportional to L
C) in a clockwise direction with a period proportional to L
D) in a counterclockwise direction with a period inversely proportional to L

---

21. [1pt] Two blocks, of masses $M = 4.50\,\text{kg}$ and $m = 1.16\,\text{kg}$, are in contact on a horizontal table. A constant horizontal force $F = 6.31\,\text{N}$ is applied to block M as shown). There is a *constant* frictional force of 1.66 N between the table and the block m, but *no* frictional force between the table and the first block M.



Calculate the acceleration of the two blocks.

A) $0.82\,\text{m/s}^2$
B) $1.11\,\text{m/s}^2$
C) $1.41\,\text{m/s}^2$
D) $4.01\,\text{m/s}^2$

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22. [1pt] If you double the absolute temperature of a light bulb filament, its power output increases by a factor of (Select one)

A) 8
B) 16
C) 2
D) 4

---

23. [1pt] A particular organ pipe can resonate at 216 Hz, 360 Hz, and 504 Hz, but not at any other intermediate frequencies. The organ pipe is

A) open on both ends with fundamental frequency 72 Hz.
B) open on one end with fundamental frequency 72 Hz.
C) open on both ends with fundamental frequency 216 Hz.
D) open on one end with fundamental frequency 216 Hz.

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24. [1pt] If one drum has a loudness of 95 dB, how loud would 100 identical drums be?

A) 195 dB
B) 115 dB
C) 125 dB
D) 105 dB

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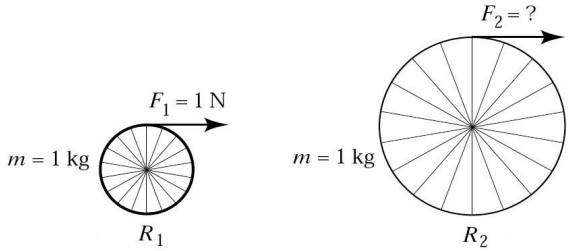
25. [1pt] Two wheels with fixed hubs, each having a mass of 1 kg, start from rest, and forces are applied as shown. The first wheel has radius $R_1 = 0.5$ m, and the second wheel has radius $R_2 = 1.0\,\text{m}$.



Assume the hubs and spokes are massless, so that the rotational inertia is $I = mR^2$. In order to impart identical angular accelerations, how large must F_2 be?

A) 0.5 N
B) 1 N
C) 4 N
D) 2 N

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26. [1pt] Which of the following statements is **not** explained by Bernoulli's principle?

A) A narrow horizontal pipe of constant cross-section will have a greater pressure difference between the ends than a wide one, assuming the same volume rate of flow.
B) If a pipe becomes narrower, the pressure drops in the narrow part.
C) If holes are punched in a can full of water, the water will flow faster from holes near the bottom than holes near the top.
D) A fast wind can lift the roof off a house.

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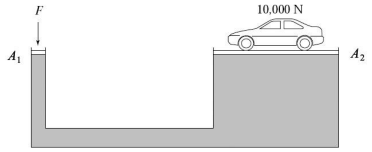
27. [1pt]



A container is filled with oil and fitted on both ends

with pistons. The area of the left piston is 23.0 mm^2; that of the right piston 27600 mm^2. What force must be exerted on the left piston to keep the 10,000- N car on the right at the same height?

A) 10000 N
B) 6.94×10^{-3} N
C) 8.33 N
D) 289 N

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28. [1pt] You are in the kitchen with three mixing bowls in front of you. One bowl is metal, the second is glass, and the third is plastic. All three are at exactly the same temperature: the 68° F (20° C) temperature of the room. If you touch the three bowls together, (Select one)

A) heat will flow from the metal bowl to the glass bowl, and from the glass bowl to the plastic bowl.
B) no heat will flow between the bowls.
C) heat will flow from the glass bowl to both the plastic bowl and the metal bowl.
D) heat will flow from the plastic bowl to the glass bowl, and from the glass bowl to the metal bowl.

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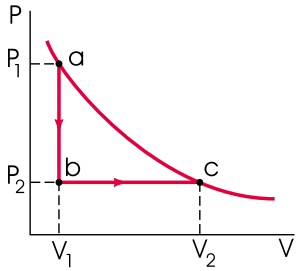
29. [1pt] Consider the following cyclic process. An ideal gas enclosed in a piston starts at point a and is cooled at constant volume so that its pressure drops from P_1 to P_2 at point b. Then the gas expands at constant pressure, from a volume of V_1 to V_2, where the temperature reaches its original value at point c. Then the gas is compressed at constant temperature back to its original pressure P_1 and volume P_2, returning to point a.



Which of these statements is true for the complete cycle *abca*?

A) The net work done by the gas is zero.
B) The net work done by the gas is positive.
C) The sign of the net work cannot be determined without more information about the heat added to the system.
D) The net work done by the gas is negative.

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30. [1pt] Suppose that in the diagram for the previous problem, $P_1 = 2.27$ atm, $P_2 = 1.41$ atm, $V_1 = 7.03$ L, and $V_2 = 12.9$ L. How much work is done by the gas in going from point a to b and then to c?

A) 511 J
B) 226 J
C) 1350 J
D) 838 J