Keep This Page Attached to the Exam

Physics 7B Winter 2007 Final Exam Cover Sheet

INSTRUCTIONS:

Right now, as soon as you get this part of the exam:

1. Fill in this cover sheet **completely**.
2. Put your **name** and your DL section on **each page** of the exam. **This is important!! The pages are separated for grading!**
3. Count the pages of the final exam. There should be **10 pages total** with problems and questions on pages 2 - 9. If you find this is not the case, inform the proctor IMMEDIATELY. It is **your** responsibility to have a complete exam.

Remember:

* You may not know the answer or immediately know what to do when you first read a question. You are being tested on your ability to think. So think about how you can apply the general models and methods you have learned to the particular situations discussed in the questions. *

Don't Cheat!

We automatically report anyone suspected of cheating to Student Judicial Affairs.

I certify by my signature below that I have read the above instructions and that I will abide by the UC Davis Code of Academic Conduct. This includes

- not copying from anyone else's final
- not letting any other student copy from my final
- not discussing this final exam with any student who has not yet taken it, nor providing any information, written or oral, that might get to a student who has not yet taken it

Name (Print Clearly): ______________________________ ________________________

Last first

7B Lecture (A, B, C, or D) _______ DL Section Number:______ (This is a number between 1 and 11)

Signature:______________________________________

You may begin the final as soon as you have completed this and the following: put your name, DL section number, and first three letters of your last name **on each of the following eight pages (pp. 2-9)**.

Tear off the formula page stapled to the back of the exam (page 10); remove it from the exam in order to use it (you do not have to return the formula sheet).

Last name ______ First name ______ DL Sec ______ First three initials of last name ______ grade (for office use only)

1. Two ice-skaters glide together on frictionless ice at 3.0 m/s in the $+x$ direction. (The x-y plane is parallel to the ground.) Skater 1 has an 80 kg mass and skater 2 has a 40 kg mass. Now they push off from one another. Afterward, skater 1 is moving at 3.0 m/s in the $+y$ direction.

a. (3.0 pts) Make a properly labeled and scaled momentum chart for skater 1, skater 2 and the two-skater system. On the side, show clearly any vector addition/subtraction needed to clarify your chart. (No calculations are expected here. The magnitudes of your vectors should be reasonably correct, but they don't have to be perfect.)

b. (1.5 pts) The push lasted for 0.50 s. Determine the magnitude and direction of the average force that skater 1 exerted on skater 2. (Include proper units.)

Last name | First name | DL Sec | First three initials of last name | grade (for office use only)

2. A diver leaves a high diving board with her body relatively outstretched and rotating clockwise (when viewed from the side) with an angular velocity of ω_0.

a. (2.0 pts) She then goes into a tuck, curling up in a ball. Qualitatively, what happens to her motion, and why? Use the proper terms.

b. (2.5 pts) She stretches out again just before reaching the water, at which point she is essentially vertical with her arms straight down. Her rotation rate decreases greatly once her arms enter the water. Representing the diver as just a vertical line, make an extended force diagram, properly labeled, for a point in time when just her arms are in the water and use it to help explain the change in her rotation rate. Here again, use the proper terms to explain the effect.

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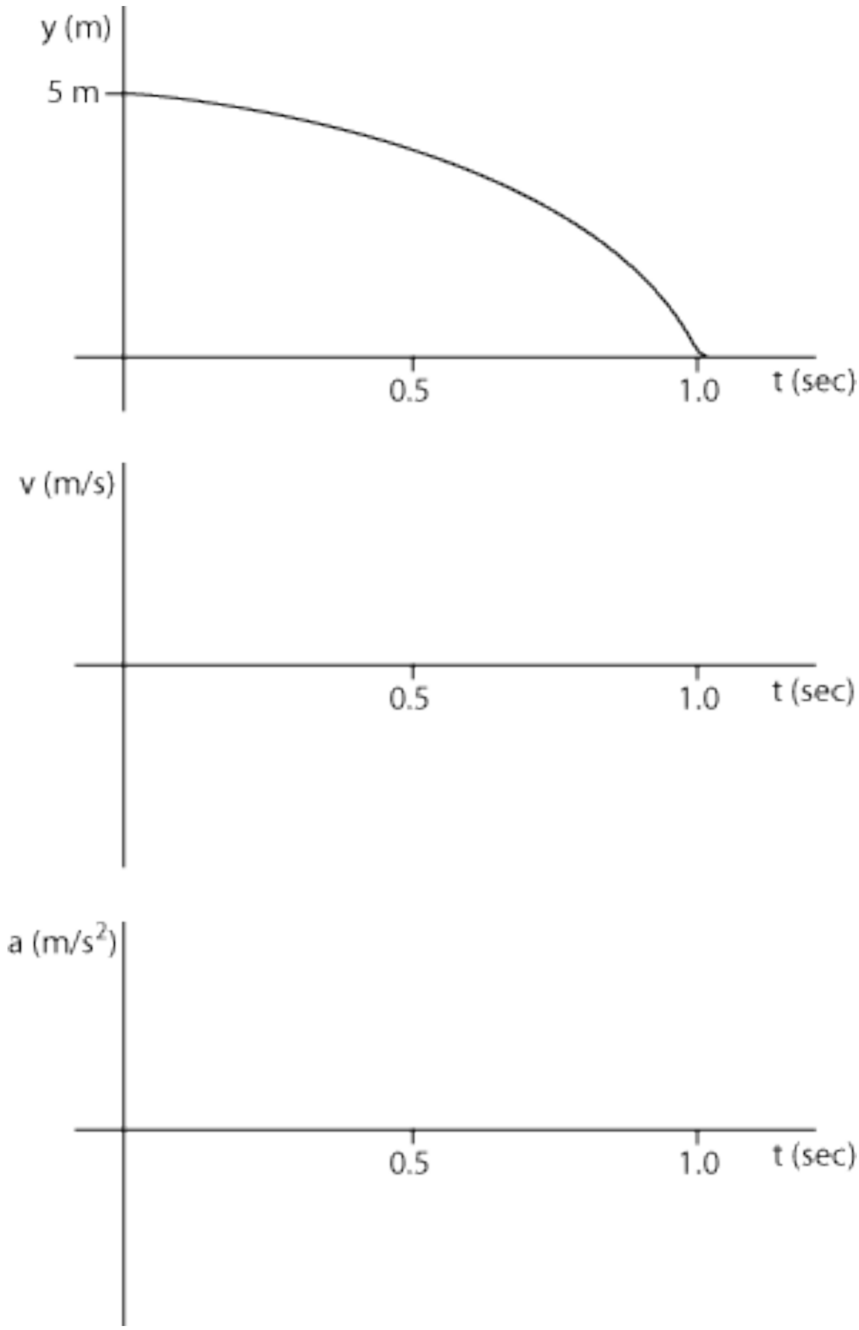
3. The position versus time graph below shows the height of the center of mass of a blob of putty which falls form rest from a height of y=5 m to the floor, where it sticks. (Assume g = 10 m/s^2.)

a. (3.0 pts) Draw on the graphs, for all times shown, the velocity and acceleration of the putty blob.

b. (1.5 pts) On the vertical axes provide an accurate scale. (Use tick marks with numbers.)



Last name | First name | DL Sec | First three initials of last name | grade (for office use only)

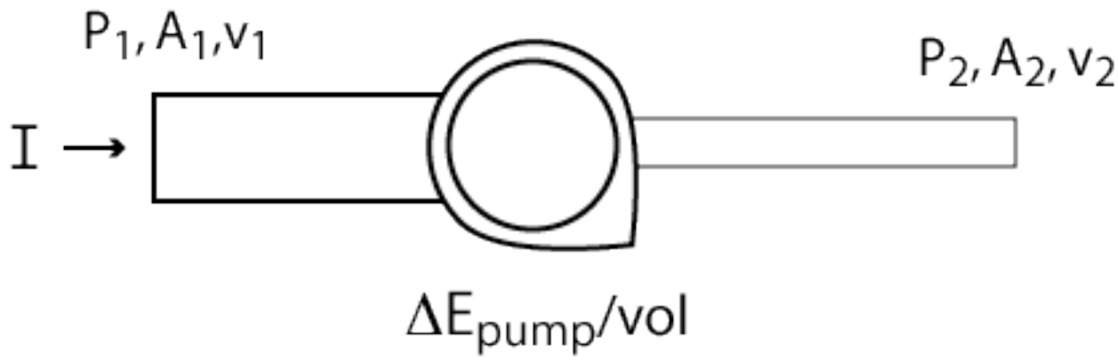
4. A pendulum has a massless string of length *r* with a ball of mass *m* attached to the end. The bob is pulled to an angle θ from the vertical and released from rest. It then it swings in a vertical plane. Assume there is no air resistance.

a. (3.0 pts) Draw a force diagram indicating all the forces on the pendulum bob at the moment it passes though its lowest point. Label the forces clearly, and give them relative magnitudes that are reasonable.

b. (1.5 pts) Derive an algebraic expression in terms of *r*, *m*, *g*, and θ for the tension T in the string at the moment the bob passes through its lowest point. (Hint: find the velocity v at the bottom first.)

Last name | First name | DL Sec | First three initials of last name | grade (for office use only)

5. Consider this horizontal portion of a fluid circuit:



Assume that P_1 is known, and the pipe cross sectional areas are such that $A_1 > A_2$. Assume there is no resistance in the tubing or pump.

a. (1.5 pts) Which is greater, v_2 or v_1 ? Explain, very briefly.

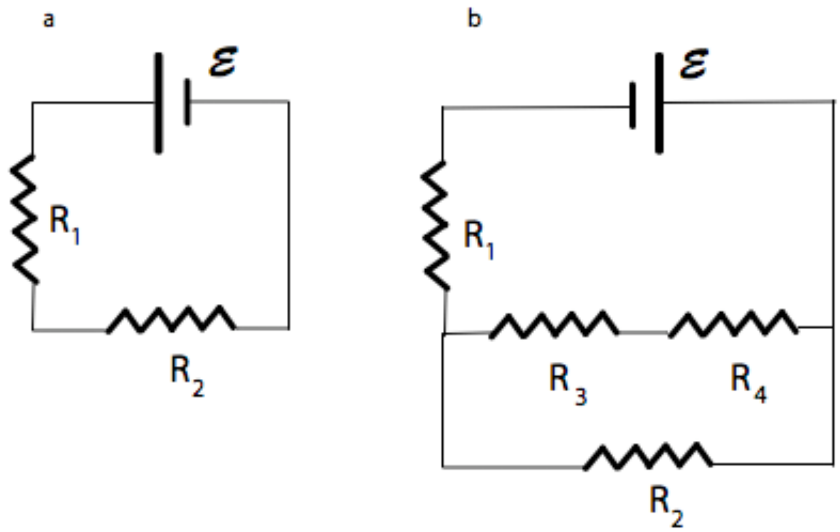
b. (1.5 pts) Write an algebraic expression for P_2 in terms of the other algebraic quantities in the diagram.

c. (1.5 pts) Which is greater, P_2 or P_1 (or does it depend on the details)? Explain using the fully extended Bernoulli equation.

Last name First name DL Sec First three initials of last name

grade (for office use only)

6. Consider the two circuits below.



a) (0.5 pts) How does the reversal of the battery polarity affect the current through resistor 1?

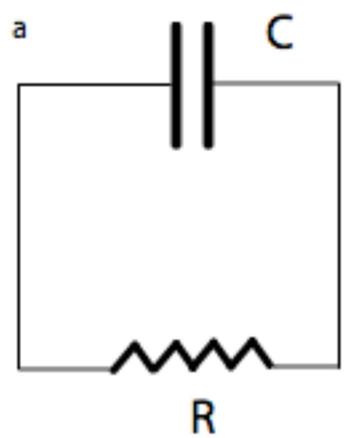
b) (1.5 pts) In which circuit is the current through resistor 1 larger?

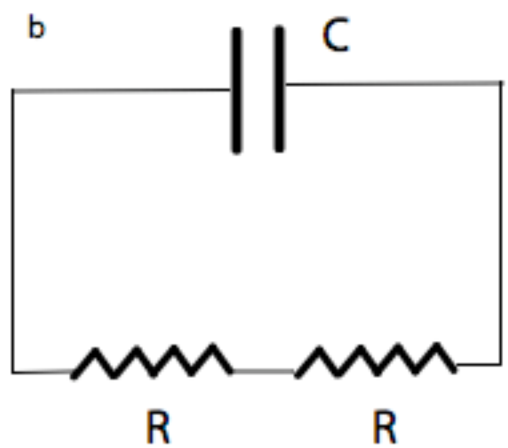
c) (1.5 pts) In which circuit is the voltage drop across resistor 2 larger?

d) (1.0 pts) If $\mathcal{E}$=1.5 V, R_1= 100 Ω, R_2= 200 Ω, R_3= 300 Ω, and R_4= 100 Ω, then what is the power dissipated by resistor 2 in each case?

7. Two identical capacitors are charged up with a battery with a voltage $\mathcal{E}$. They are then connected to the circuits shown below. Each of the resistors has the same resistance R.

a) (1.5 pts) Once the circuits are connected, what is the maximum current that flows through each of the resistors?
b) (3.0 pts) Draw on a single graph as accurately as possible the current I as a function of time, where t=0 corresponds to the moment the circuits are completed.





8. You have a mass on an essentially frictionless surface connected to a horizontal spring. The period of oscillation of this system is 2.0 s. You pull the mass 0.30 m to the positive side of its equilibrium position and let it go.

a. (2.0 pts) Write an expression describing the position of the mass as a function of time. Put numerical values in where appropriate.

b. (2.0 pts) What will be the acceleration of the mass 1.8 s after you release it?

c. (0.5 pts) Given the location where the mass should be at 1.8 s, does the sign/direction of the acceleration make sense? Explain.

Physics 7B Final Exam Formula Sheet

(Separate this sheet from the test packet. Do not turn it in.)

Category	Concept	Translation	*Rotation*	Relation
kinematic variables	**position**	**x**	θ	θ = arclength /r
	velocity	$\mathbf{v} = d\mathbf{x}/dt$	$\omega = d\theta/dt$	$\omega = v/r$
	acceleration	$\mathbf{a} = d\mathbf{v}/dt$	$\alpha = d\omega/dt$	$\alpha = a/r$
fundamental dynamic variables	**force/torque**	**F**	$\boldsymbol{\tau}$	$\tau = r_\perp F$
	inertia	m	I	$I = \Sigma\, mr^2$
	momentum	$\mathbf{p} = m\mathbf{v}$	$\mathbf{L} = I\boldsymbol{\omega}$	$L = r_\perp p$
Energy	**Kinetic Energy**	$\frac{1}{2}mv^2$	$\frac{1}{2}I\omega^2$	
	Work	$W = \int F_{\parallel} dx = F_{\parallel}\Delta x$	$W = \int \tau_{\parallel} d\theta = \tau_{\parallel}\Delta\theta$	
	Energy Conservation	$\Delta E_{system} = W_{all} + Q$		
	Power	$P = dE/dt = F_{\parallel}v$	$P = dE/dt = \tau_{\parallel}\omega$	
Momentum	**Momentum**	$\mathbf{p} = m\mathbf{v}$	$\mathbf{L} = I\boldsymbol{\omega}$	$L = r_\perp p$
	Impulse	$\mathbf{J} = \int \mathbf{F} dt = \mathbf{F}_{avg}\Delta t$	$\mathbf{AngJ} = \int \boldsymbol{\tau} dt = \boldsymbol{\tau}_{avg}\Delta t$	
	Momentum Conserv.	$\Delta \mathbf{p}_{system} = \mathbf{J}_{net}$	$\Delta \mathbf{L}_{system} = \mathbf{AngJ}_{net}$	
Newton's Laws	**Newton's 1st law**	if $\Sigma\mathbf{F} = 0$, then $\Delta\mathbf{v} = \Delta\mathbf{p} = 0$	if $\Sigma\boldsymbol{\tau} = 0$, then $\Delta\boldsymbol{\omega} = \Delta\mathbf{L} = 0$	
	Newton's 2nd law	$\Sigma\mathbf{F} = m\mathbf{a}$ or, $\Sigma\mathbf{F} = d\mathbf{p}/dt$	$\Sigma\boldsymbol{\tau} = I\boldsymbol{\alpha}$ or, $\Sigma\boldsymbol{\tau} = d\mathbf{L}/dt$	
	Newton's 3rd law	$\mathbf{F}_{1\text{ on }2} = -\mathbf{F}_{2\text{ on }1}$	$\boldsymbol{\tau}_{1\text{ on }2} = -\boldsymbol{\tau}_{2\text{ on }1}$	

Other Useful Relations:

$a_r = v^2/r = \omega^2 r$; $F_{restoring} = -ky$; $\frac{d^2}{dt^2}y(t) = -\left(\frac{2\pi}{T}\right)^2 y(t)$;

$y(t) = A\sin\left(\frac{2\pi t}{T} + \phi\right)$; $T = 2\pi\sqrt{\frac{m}{k}}$; $T = 2\pi\sqrt{\frac{L}{g}}$; $f = \frac{1}{T}$; $E_{total} = PE + KE = \frac{1}{2}ky^2 + \frac{1}{2}mv^2$;

For constant acceleration along the y direction; $y(t) = y_0 + v_{y0}\,t + \frac{1}{2}a_y t^2$ and $v_y(t) = v_{y0} + a_y t$

$\Delta V_{1to2} = \varepsilon_{1to2} - IR_{1to2}$; $Power = I(\Delta V_R) = I^2 R = \frac{(\Delta V_R)^2}{R}$; $R_{series} = R_1 + R_2$; $\frac{1}{R_{parallel}} = \frac{1}{R_1} + \frac{1}{R_2}$

$\sum I_{in} = \sum I_{out}$; Δ(Total Head) = E_{pump}/vol – IR; $\Delta(TotalHead) = \Delta P + \frac{1}{2}\rho_d \Delta v^2 + \rho_d g\Delta y$

$A_1 v_1 = A_2 v_2$; $j = -k\, d\phi/dt$; $N(t) = N_0 e^{-\lambda t}$; $\frac{\Delta N}{\Delta t} = -\lambda N$; $t_{1/2} = \frac{\ln(2)}{\lambda}$