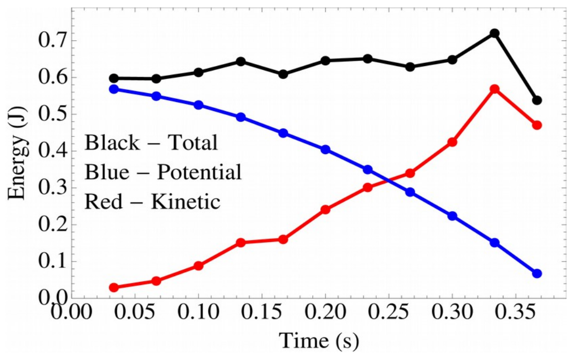
Name:

IQS Physics S1 Test

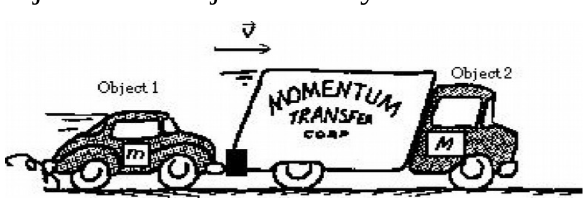
Physics Questions (5 pts. apiece) Answer in complete, well-written sentences ONLY WITHIN the spaces provided.

1. Consider an ideal gas. If the collisions of the particles with the wall perpendicular to the x direction are elastic, show the average force on that wall for each collision is $F_x = 2mv_x/\Delta t_x$ where m is the mass of each particle and Δt_x the mean interval between collisions with the wall. Start from Newton's Second Law. Clearly show all steps.

2. Consider the result below for a measurement of the kinetic, potential, and total energy of a falling ball. Does the mechanical energy appear to be conserved within experimental uncertainties? How would you quantitatively estimate the value of the experimental uncertainty? Once you establish the method apply it to your data. The average value of the total energy in the figure is 0.63 ± 0.05 J.



3. Suppose the mass of object 1 in the figure is much less that that of object 2 and that object 1 is pushing object 2 that has a dead motor so that both objects move in the same direction at speed v ($m_1 << m_2$ and $v_1=v_2$). What are the relative magnitudes of the forces between object 1 and object 2? Why?



4. Concrete has a higher specific heat than soil. Use this fact to partially explain why cities have a higher night-time temperature than the surrounding countryside.

Name:

Problems (4). Clearly show all reasoning for full credit. Show all work on the page below each problem.

1. 7 pts. The stratosphere of Venus has a temperature of $T_s = 190\ K$. The lapse rate in the Venutian atmosphere is $l_V = -9.0\ K/km$. The measured surface temperature of Venus is $T_{surf} = 730$ K. What is the altitude of the Venutian tropopause?

See next page.

Name:

2. 8 pts. A bullet of mass $m_1=0.01\ kg$ is fired horizontally into a wooden block of mass $m_2=0.4\ kg$ initially at rest on a horizontal surface and becomes embedded in it. The coefficient of friction between block and surface is $\mu=0.60$. The combined system slides a distance $x=4.0m$ before stopping. With what speed did the bullet strike the block?

See next page.

Name:

3. 10 pts. A room with a volume $V_0=90\ m^3$ is filled with an ideal gas (air) at a temperature $T_0=285\ K$ and pressure $P_0=10^5\ N/m^2$. For now treat the air as if it is monatomic. The air in the room is heated to a new temperature with the pressure remaining at P_0 since the room is not airtight.

   What is the initial internal energy of the air in the room?

   What is the change in the internal energy of the air in the room? Does this result make sense? Explain. Notice the room is not airtight so air can move freely in and out of it.

Name:

Physics 191 S1 Study Sheet

$$x(t) = \frac{1}{2}at^2 + v_0t + y_0 \quad v = at + v_0 \quad a_g = -g \quad a_c = \frac{v^2}{r} \quad (\vec{v} \perp \vec{r} \quad \vec{v} \perp \vec{a}_c)$$

$$\vec{F}_{net} = \sum_i \vec{F}_i = m\vec{a} = \frac{d\vec{p}}{dt} \qquad \vec{F}_{AB} = -\vec{F}_{BA} \quad \overline{\vec{F}} = \frac{\Delta\vec{p}}{\Delta t}$$

$$|\vec{F}_f| = \mu N \quad |\vec{F}_c| = m\frac{v^2}{r} \quad \vec{F}_s(x) = -kx\hat{i} \quad \vec{F}_g(y) = -mg\hat{j}$$

$$W = \int \vec{F} \cdot d\vec{s} = \int |\vec{F}||d\vec{s}|\cos\theta = \Delta KE = -\Delta PE \quad KE = \frac{1}{2}mv^2$$

$$PE_g = mgh \quad PE_s = \frac{1}{2}kx^2 \quad ME_0 = ME_1 \qquad \vec{p} = m\vec{v} \qquad \vec{p}_0 = \vec{p}_1$$

$$Q = mc\Delta T = nC_v\Delta T \qquad Q_{f,v} = mL_{f,v} \quad \Delta E_{int} = Q + W \qquad W = \text{force} \times \text{distance} \rightarrow P\Delta V$$

$$P = \frac{|\vec{F}|}{A} \qquad PV = Nk_BT = nRT$$

$$\vec{I} = \int \vec{F}dt = \overline{\vec{F}}\Delta t = \Delta\vec{p} \qquad \overline{KE} = \overline{E}_{kin} = \frac{1}{2}m\overline{v^2} \qquad \overline{E}_{kin} = \frac{3}{2}k_BT \qquad E_{int} = N\,\overline{E}_{kin} = \frac{3}{2}Nk_BT$$

$$C_V = \frac{3}{2}N_Ak_B \quad \mathscr{P} = e\sigma AT^4 \quad \text{lapse rate} = l_t = \frac{\Delta T}{\Delta y} = -6.5\ K/km$$

$$\langle x \rangle = \frac{1}{N}\sum_i x_i \qquad \sigma = \sqrt{\frac{\sum_i (x_i - \langle x \rangle)^2}{N-1}} \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \quad A = 4\pi r^2 \quad V = Ah \quad V = \frac{4}{3}\pi r^3$$

$$\frac{df(x)}{dx} = \lim_{\Delta x \to 0} \frac{f(x + \Delta x) - f(x)}{\Delta x} \qquad \int_a^b f(x)dx = \lim_{\Delta x \to 0} \sum_{n=1}^{N} f(x)\Delta x \quad \frac{dy}{dx} = \frac{dy}{du}\frac{du}{dx}$$

Speed of Light (c)	$2.9979 \times 10^8\ m/s$	proton/neutron mass	$1.67 \times 10^{-27}\ kg$
R	$8.31 J/K - mole$	g	$9.8\ m/s^2$
Gravitation constant	$6.67 \times 10^{-11}\ N - m^2/kg^2$	Earth's radius	$6.37 \times 10^6\ m$
Earth-Moon distance	$3.84 \times 10^8\ m$	Electron mass	$9.11 \times 10^{-31}\ kg$
σ	$5.67 \times 10^{-8}\ J/s - m^2 - K^4$	k_B	$1.38 \times 10^{-23}\ J/K$