Physics 101	Hour Exam 1	October 7, 2013

Last Name: _______________ **First Name** ________________ **ID**_________________

Discussion Section:____________________ **Discussion TA Name**:___________________

Instructions—Turn off your cell phone and put it away.
Calculators cannot be shared. Please keep yours on your own desk.

This is a closed book exam. You have 90 minutes to complete it.
This is a multiple choice exam. Use the bubble sheet to record your answers.

1. Use a #2 pencil; do **not** use a mechanical pencil or a pen. Fill in completely (until there is no white space visible) the circle for each intended input – both on the identification side of your answer sheet and on the side on which you mark your answers. If you decide to change an answer, erase vigorously; the scanner sometimes registers incompletely erased marks as intended answers; this can adversely affect your grade. Light marks or marks extending outside the circle may be read improperly by the scanner.

2. Print your last name in the **YOUR LAST NAME** boxes on your answer sheet and print the first letter of your first name in the **FIRST NAME INI** box. Mark (as described above) the corresponding circle below each of these letters.

3. Print your NetID in the **NETWORK ID** boxes, and then mark the corresponding circle below each of the letters or numerals. Note that there are different circles for the letter "I" and the numeral "1" and for the letter "O" and the numeral "0". **Do not** mark the hyphen circle at the bottom of any of these columns.

4. You may find the version of **this Exam Booklet at the top of page 2**. Mark the version circle in the **TEST FORM** box in the bottom right on the front side of your answer sheet. **DO THIS NOW!**

5. Stop **now** and double-check that you have bubbled-in all the information requested in 2 through 4 above and that your marks meet the criteria in 1 above. Check that you do not have more than one circle marked in any of the columns.

6. Print your UIN# in the **STUDENT NUMBER** designated spaces and mark the corresponding circles. You need not write in or mark the circles in the SECTION box.

7. Write in your course on the **COURSE LINE** and on the **SECTION** *line*, print your **DISCUSSION SECTION**. (You need not fill in the INSTRUCTOR line.)

8. Sign **(DO NOT PRINT)** your name on the **STUDENT SIGNATURE** *line*.

*Before starting work, check to make sure that your test booklet is complete. After these instructions, you should have **8** **numbered pages** plus 2 Formula Sheets.*

On the test booklet:
Write your **NAME**, your **Discussion TA's NAME**, your **DISCUSSION SECTION** and your **NETWORK-ID**. Also, write your **EXAM ROOM** and **SEAT NUMBER**.

When you are finished, you must hand in BOTH the exam booklet AND the answer sheet. Your exam will not be graded unless both are present.

Academic Integrity—**Giving assistance to or receiving assistance from another student or using unauthorized materials during a University Examination can be grounds for disciplinary action, up to and including expulsion.**

This Exam Booklet is Version A. Mark the **A** circle in the **TEST FORM** box in the bottom right on the front side of your answer sheet. **DO THIS NOW!**

Exam Format & Instructions:

This exam is a mixture of
* Two-Answer Multiple Choice (2 points each)
* Three-Answer Multiple Choice (3 points each)
* Five-Answer Multiple Choice (6 points each)

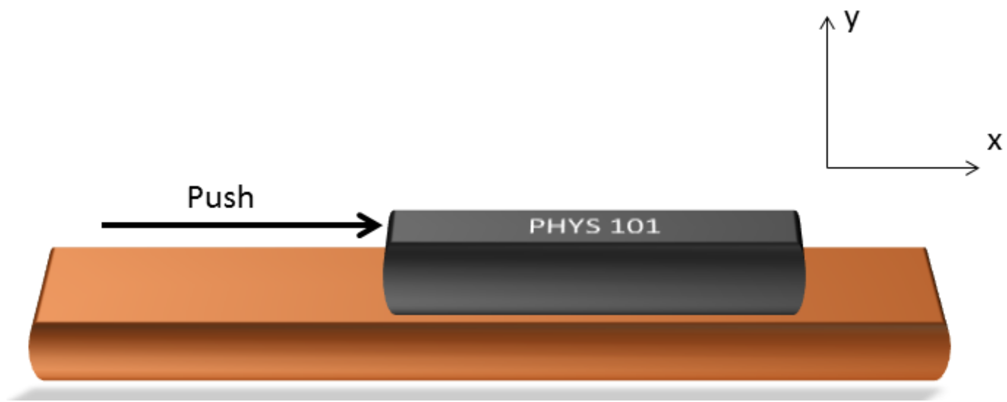
There are 25 problems for a maximum possible raw score of 110 points.

Instructions for Two-Answer Multiple Choice Problems:
Indicate on the answer sheet the correct answer to the question (*a* or *b*).
Each question is worth 2 points. If you mark the wrong answer, or mark more than one answer, you receive 0 points.

Instructions for Three-Answer Multiple Choice Problems:
Indicate on the answer sheet the correct answer to the question (*a*, *b* or *c*).
Each question is worth 3 points. If you mark the wrong answer, or mark more than one answer, you receive 0 points.

Instructions for Five-Answer Multiple Choice Problems:
Indicate on the answer sheet the correct answer to each question (*a*, *b*, *c*, *d* or *e*).
Credit is awarded in the following way:
- If you mark one answer and it is correct, you will receive 6 points;
- If you mark two answers, and one of them is correct, you will receive 3 points;
- If you mark three answers and one of them is correct, you will receive 2 points.
- If you mark no answer or more than three answers, you will receive 0 points.

The next three questions pertain to the situation described below.



Your Physics 101 textbook has a mass $M = 5\ kg$. It rests on a level library table. Let $g = -9.81\ m/s^2$.

1) If you do not push the book, which forces are present?

a. $W = Mg$
b. $N = -Mg$
c. $W = -Mg$
d. $W = -Mg$ and $N = -Mg$
e. $N = -Mg$ and $W = Mg$

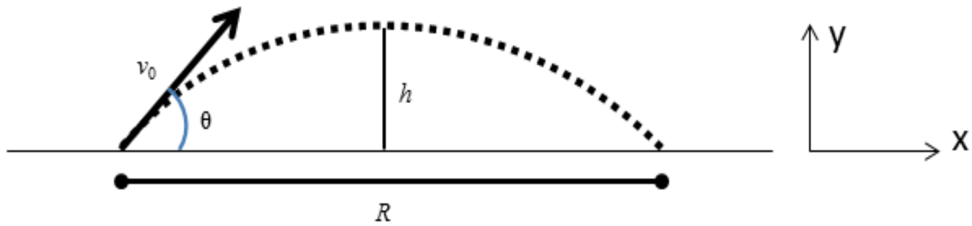
2) If the coefficient of static friction between the table and the book is $\mu_s = 0.37$, how much force must you apply to start the book moving?

a. $F = 18$ N
b. $F = 49$ N
c. $F = 7.8$ N

3) You push the book until it starts moving at a constant velocity. You want the book to continue to travel with this constant velocity. You must continue pushing the book ($\mu_k = 0.16$):

a. True
b. False

The next four questions pertain to the situation described below.



A projectile is launched as shown in the diagram. It has an initial velocity v_0 with angle θ from the horizontal. It travels a distance R and reaches a maximum height h. The total flight takes a time t. Ignore air resistance

4) The initial horizontal velocity of the projectile is

a. v_0
b. $v_0 \cos \theta$
c. $v_0 \sin \theta$

5) The initial vertical velocity of the projectile is

a. $v_0 \sin \theta$
b. $v_0 \cos \theta$
c. v_0

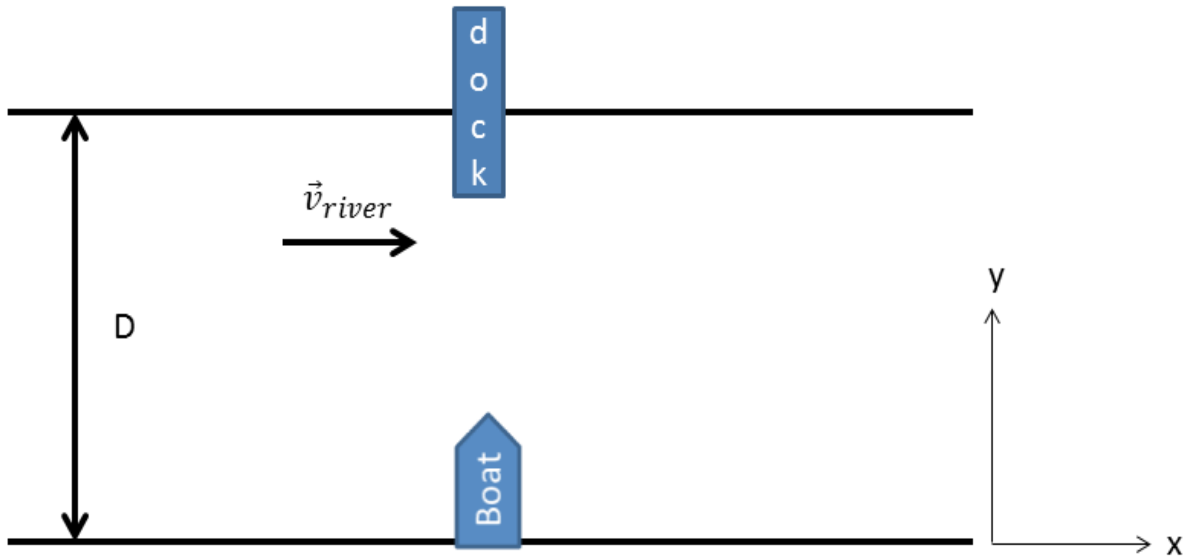
6) Which of the following represents the range R of the projectile?

a. ht
b. $v_0 t$
c. $v_0\, t \sin \theta$
d. $ht \sin \theta$
e. $v_0\, t \cos \theta$

7) Which of the following represents the maximum height h reached by the projectile?

a. $gt^2/8$
b. $v_0 t$
c. $v_0\, t \sin \theta$
d. $v_0^2 \sin \theta^2/2g$
e. $v_0\, t \cos \theta$

The next three questions pertain to the situation described below.



You wish to pilot a small boat across a rapidly flowing river as shown in the diagram. The river flows in the +*x*-direction with a velocity of $v_{river} = 2\ m/s$ and is $D = 51\ m$ across.

8) The dock is directly opposite your current position as shown. How do you stear your boat to reach the dock?

a. Upstream
b. Straight Across
c. Downstream

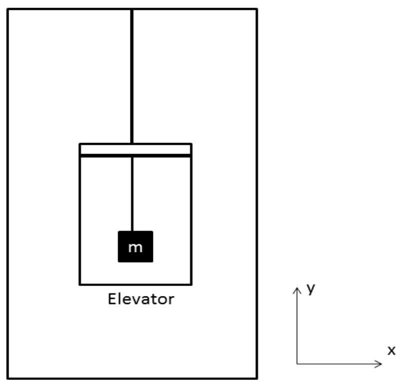
9) You choose to stear your boat straight across the river in the +y-direction. You notice that the boat's speedometer reads $8\ m/s$. How long does it take to get across the river?

a. $t = 100\ s$
b. $t = 26\ s$
c. $t = 6\ s$

10) If you stear your boat straight across the river (your boat's speedometer still reads $8\ m/s$) where will you make landfall?

a. *L = 0 m, straight across from the starting point*
b. *L = 12 m, upstream*
c. *L = 48 m, downstream*
d. *L = 48 m, upstream*
e. *L = 12 m, downstream*

The next two questions pertain to the situation described below.



A 2 *kg* mass hangs by a string from the ceiling of an elevator. The elevator is moving *down* with a constant velocity of 25 *m/s*.

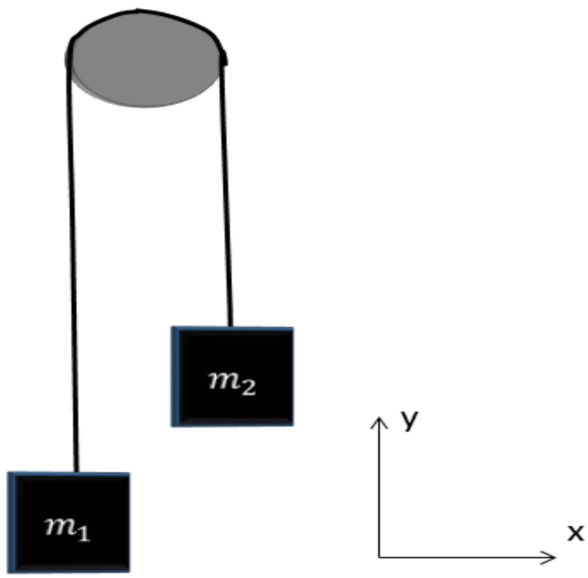
11) Find the tension, *T*, in the string:

a. $T = 20\ N$
b. $T = 70\ N$
c. $T = -30\ N$

12) The elevator begins to decelerate at 2 m/s^2. Find the tension during the deceleration.

a. $T = 550\ N$
b. $T = 16\ N$
c. $T = 24\ N$

The next four questions pertain to the situation described below.



Consider two masses, connected by a massless, flexible rope over a massless, frictionless pulley as shown in the diagram.

13) The masses are at rest if the m_1 and m_2 are *unequal*.

a. True
b. False

14) If $m_1 = 8\ kg$ and $m_2 = 2\ kg$ do the blocks experience the same net force?

a. Yes
b. No

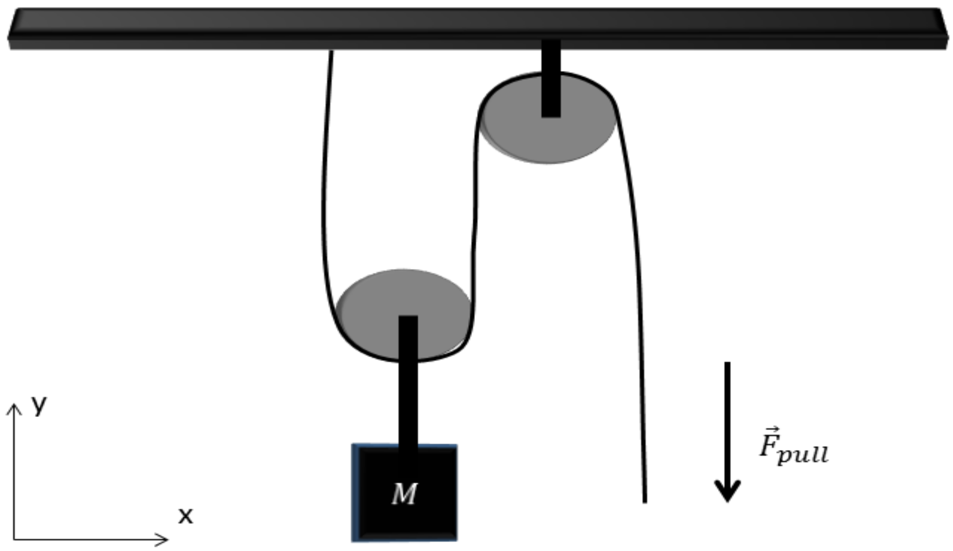
15) If $m_1 = 8\ kg$ and $m_2 = 2\ kg$ do the blocks experience the same acceleration?

a. No
b. Yes

16) Calculate the magnitued of the acceleration of the blocks.

a. $a = 5.9\ m/s^2$
b. $a = 16\ m/s^2$
c. $a = 150\ m/s^2$

The next three questions pertain to the situation described below.



You need to lift a heavy crate of mass $M = 218\ kg$ onto a flat-bed truck.

17) Consider the system in the figure. When you pull on the rope it is easier to lift the crate because

a. the weight of the crate is reduced.
b. the weight of the crate is distributed across the tension in each segment of the rope.
c. the pulleys roll making moving the rope easier.

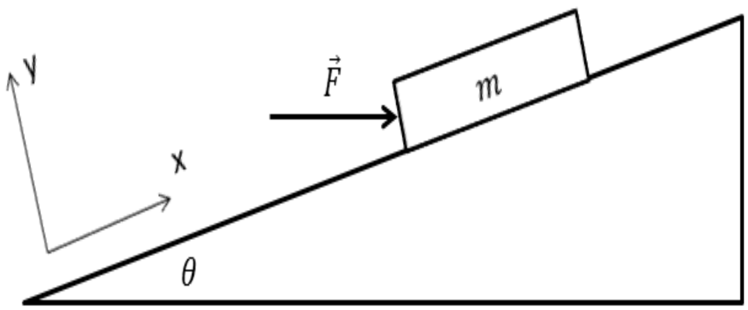
18) The tension in each segment of the rope is the same.

a. True
b. False

19) With how much force must you pull to lift the crate *at constant velocity* with a two pulley system as shown in the figure?

a. $F_{pull} = 1100\ N$
b. $F_{pull} = 6400\ N$
c. $F_{pull} = 710\ N$

The next three questions pertain to the situation described below.



An inclined plane with $\theta = 30^{o}$ to the horizontal has a wooden box, $m = 20\ kg$, is placed on the plane. A horizontal force, $F = 275\ N$, is exerted on the box. The coefficient of kinetic friction is $\mu_k = 0.1$.

20) The force of kinetic friction F_k is:

a. $F_k = -65\ m$
b. $F_k = -9.8\ m$
c. $F_k = -31\ m$
d. $F_k = -680\ m$
e. $F_k = -17\ m$

21) As a result of this external force the box will move:

a. *up*
b. *down*

22) Determine the acceleration a of the box:

a. $a = 10\ m/s^2$
b. $a = 140\ m/s^2$
c. $a = 5\ m/s^2$
d. $a = 93\ m/s^2$
e. $a = 0.2\ m/s^2$

23) The centripetal force acting on an object is doubled. The radius of the object's motion is also doubled. The speed of the object:

a. increases by a factor of 4.
b. decreases by a factor of 4.
c. does not change.
d. decreases by a factor of 2.
e. increases by a factor of 2.

The next two questions pertain to the situation described below.

A compact disc accelerates from rest to 21 revolutions per second in 2 seconds.

24) What is the angular acceleration of the disc?

a. $\alpha = 66\ rad/s^2$
b. $\alpha = 10\ rad/s^2$
c. $\alpha = 16\ rad/s^2$

25) What is the angular displacement of the disc over these 2 seconds?

a. *s = 130 revolutions*
b. *s = 10 revolutions*
c. *s = 21 revolutions*

Physics 101 Formulas

Kinematics

$\mathbf{v}_{ave} = \Delta\mathbf{x}/\Delta t$ $\mathbf{a}_{ave} = \Delta\mathbf{v}/\Delta t$

$v = v_0 + at$ $x = x_0 + v_0t + {}^1/_2at^2$ $v^2 = v_0^2 + 2a\Delta x$

$g = 9.8\ m/s^2 = 32.2\ ft/s^2$ (near Earth's surface)

Dynamics

$\Sigma\mathbf{F} = m\mathbf{a}$ $F_g = Gm_1m_2 / R^2$ $F_g = mg$ (near Earth's surface)

$f_{s,max} = \mu_sF_N$ Gravitational constant, $G = 6.7 \times 10^{-11}\ N{\cdot}m^2/kg^2$

$f_k = \mu_kF_N$ $a_c = v^2 / R = \omega^2R$

Work & Energy

$W_F = FD\cos(\theta)$ $K = {}^1/_2mv^2 = p^2/2m$ $W_{NET} = \Delta K = K_f - K_i$ $E = K + U$

$W_{nc} = \Delta E = E_f - E_i = (K_f + U_f) - (K_i + U_i)$

$U_{grav} = mgy$

Impulse & Momentum

Impulse $\mathbf{I} = \mathbf{F}_{ave}\Delta t = \Delta\mathbf{p}$ $\mathbf{F}_{ave}\Delta t = \Delta\mathbf{p} = m\mathbf{v}_f - m\mathbf{v}_i$ $\mathbf{F}_{ave} = \Delta\mathbf{p}/\Delta t$

$\Sigma\mathbf{F}_{ext}\Delta t = \Delta\mathbf{P}_{total} = \mathbf{P}_{total,final} - \mathbf{P}_{total,initial}$ (momentum conserved if $\Sigma\mathbf{F}_{ext} = 0$)

$\mathbf{x}_{cm} = (m_1\mathbf{x}_1 + m_2\mathbf{x}_2)/(m_1 + m_2)$

Rotational Kinematics

$\omega = \omega_0 + \alpha t$ $\theta = \theta_0 + \omega_0t + {}^1/_2\alpha t^2$ $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$

$\Delta x_T = R\Delta\theta$ $v_T = R\omega$ $a_T = R\alpha$ (rolling without slipping: $\Delta x = R\Delta\theta$ $v = R\omega$ $a = R\alpha$)

1 revolution = 2π radians

Rotational Statics & Dynamics

$\tau = Fr\sin\theta$

$\Sigma\tau = 0$ and $\Sigma F=0$ (static equilibrium)

$\Sigma\tau = I\alpha$

$I = \Sigma mr^2$ (for a collection of point particles)

$I = {}^1/_2MR^2$ (solid disk or cylinder) $I = {}^2/_5MR^2$ (solid ball) $I = {}^2/_3MR^2$ (hollow sphere)

$I = MR^2$ (hoop or hollow cylinder) $I = {}^1/_{12}ML^2$ (uniform rod about center)

$W = \tau\theta$ (work done by a torque)

$\mathbf{L} = I\omega$ $\Sigma\tau_{ext}\Delta t = \Delta\mathbf{L}$ (angular momentum conserved if $\Sigma\tau_{ext} = 0$)

$K_{rot} = {}^1/_2I\omega^2 = L^2/2I$ $K_{total} = K_{trans} + K_{rot} = {}^1/_2mv^2 + {}^1/_2I\omega^2$

Simple Harmonic Motion

Hooke's Law: $F_s = -kx$

$U_{spring} = {}^1/_2kx^2$

$x(t) = A\cos(\omega t)$ or $x(t) = A\sin(\omega t)$

$v(t) = -A\omega\sin(\omega t)$ or $v(t) = A\omega\cos(\omega t)$

$a(t) = -A\omega^2\cos(\omega t)$ or $a(t) = -A\omega^2\sin(\omega t)$

$\omega^2 = k/m$ $T = 2\pi/\omega = 2\pi\sqrt{m/k}$ $f = 1/T$

$x_{max} = A$ $v_{max} = \omega A$ $a_{max} = \omega^2A$ $\omega = 2\pi f$

For a simple pendulum $\omega^2 = g/L$, $T = 2\pi\sqrt{L/g}$

Fluids

$P = F/A$, $P(d) = P(0) + \rho gd$ change in pressure with depth d

Buoyant force $F_B = \rho gV_{dis}$ = weight of displaced fluid

Flow rate $Q = v_1A_1 = v_2A_2$ continuity equation (area of circle $A = \pi r^2$)

$P_1 + {}^1/_2\rho v_1^2 + \rho gy_1 = P_2 + {}^1/_2\rho v_2^2 + \rho gy_2$ Bernoulli equation

$\rho_{water} = 1000\ kg/m^3$ $1m^3 = 1000$ liters

$\rho = M/V$ 1 atmos. = 1.01×10^5 Pa 1 Pa = 1 N/m^2

Temperature and Heat

Temperature: Celsius (T_C) to Fahrenheit (T_F) conversion: $T_C = (5/9)(T_F - 32)$

Celsius (T_C) to Kelvin (T_K) conversion: $T_K = T_C + 273$

$\Delta L = \alpha L_0\Delta T$ $\Delta V = \beta V_0\Delta T$ thermal expansion

$Q = cM\Delta T$ specific heat capacity

$Q = L_fM$ latent heat of fusion (solid to liquid) $Q = L_vM$ latent heat of vaporization

$Q = \kappa A\Delta Tt/L$ conduction

$Q = e\sigma T^4At$ radiation ($\sigma = 5.67 \times 10^{-8}$ J/(s·m²·K⁴))

$P_{net} = e\sigma A(T^4 - T_0^4)$ (surface area of a sphere $A = 4\pi r^2$)

Ideal Gas & Kinetic Theory

$N_A = 6.022 \times 10^{23}$ molecules/mole Mass of carbon-12 = 12.000 u

$PV = nRT = Nk_BT$ $R = 8.31$ J/(mol·K) $k_B = R/N_A = 1.38 \times 10^{-23}$ J/K

$KE_{ave} = {}^3/_2k_BT = {}^1/_2mv_{rms}^2$ $U = {}^3/_2Nk_BT$ (internal energy of a monatomic ideal gas)

$v_{rms}^2 = 3k_BT/m = 3RT/M$ (M = molar mass = kg/mole)

Thermodynamics

$\Delta U = Q + W$ (1'st law)

$U = ({}^3/_2)nRT$ (internal energy of a monatomic ideal gas for fixed n)

$C_V = ({}^3/_2)R = 12.5$ J/(mol·K) (specific heat at constant volume for a monatomic ideal gas)

$Q_H + Q_C + W = 0$ (heat engine or refrigerator)

$e = -W/Q_H = 1 + Q_C/Q_H$ $e_{max} = 1 - T_C/T_H$ (Carnot engine)

$-Q_C/Q_H = T_C/T_H$ at maximum efficiency (2'nd law)

$W = -P\Delta V$ (work done by expanding gas)

Harmonic Waves

$v = \lambda / T = \lambda f$

$v^2 = F/(m/L)$ for wave on a string

$v = c = 3 \times 10^8$ m/s for electromagnetic waves (light, microwaves, etc.)

$I = P/(4\pi r^2)$ (sound intensity)

Sound Waves

Loudness: $\beta = 10 \log_{10}(I/I_0)$ (in dB), where $I_0 = 10^{-12}\ W/m^2$

$$f_{observer} = f_{source}\frac{v_{wave} - v_{observer}}{v_{wave} - v_{source}}$$ (Doppler effect)