Physics 2010 Exam 1

Constants and Formulae Sheet

Useful Constants

u	=	1.661×10^{-27} kg	N_A	=	6.022×10^{23} mol^{-1}
k_B	=	$R/N_A = 1.381 \times 10^{-23}$ J/K	R	=	8.314 J/K/mol
k	=	$1/4\pi\varepsilon_\circ = 9.00 \times 10^9$ N m^2 / C^2	m_e	=	9.109×10^{-31} kg
G	=	6.672×10^{-11} N m^2 / kg^2	e	=	1.602×10^{-19} C
$\varepsilon_\circ$	=	$1/(\mu_\circ c^2) = 8.854 \times 10^{-12}$ F/m	$\mu_\circ$	=	$4\pi \times 10^{-7}$ H/m
h	=	6.626×10^{-34} J s	m_p	=	1.672×10^{-27} kg
c	=	3.00×10^8 m/s	$M_\odot$	=	1.99×10^{30} kg
$R_\odot$	=	6.96×10^8 m	g	=	9.80 m/s^2
$M_\oplus$	=	5.98×10^{24} kg	$R_\oplus$	=	6.37×10^6 m
1 mm	=	10^{-3} m	1 cm	=	10^{-2} m
1 km	=	10^3 m	1 mi	=	5280 ft
1 mi	=	1.609 km	1 ly	=	9.461×10^{15} m
1 inch	=	2.54 cm	1 pc	=	3.262 ly
1 min	=	60 s	1 hr	=	3600 s
1 day	=	8.64×10^4 s	1 yr	=	365.242 days
1 kg	=	10^3 grams	1 μg	=	10^{-6} grams

Useful Formulae

$\sin\theta = (\text{opposite})/(\text{hypotenuse})$ | $\cos\theta = (\text{adjacent})/(\text{hypotenuse})$

$\tan\theta = (\text{opposite})/(\text{adjacent})$ | $a^2 = b^2 + c^2 - 2bc\cos A$

$1 = \cos^2\theta + \sin^2\theta$ | $c^2 = a^2 + b^2$

$(\sin A)/(a) = (\sin B)/(b) = (\sin C)/(c)$ | $v_{\rm f} = v_{\rm i} + a(t_{\rm f} - t_{\rm i})$

$x_{\rm f} = x_{\rm i} + v_\circ(t_{\rm f} - t_{\rm i}) + \frac{1}{2}a(t_{\rm f} - t_{\rm i})^2$ | $v_{\rm f}^2 = v_{\rm i}^2 + 2a(x_{\rm f} - x_{\rm i})$

$E = mc^2$ | $R = |\vec{R}| = \sqrt{R_x^2 + R_y^2}$

$R_x = R\,\cos\theta$ | $R_y = R\,\sin\theta$

$\tan\theta = R_y/R_x$ | $x = x_\circ + v_{\circ x}(t - t_\circ)$

$y = y_\circ + v_{\circ y}(t - t_\circ) - \frac{1}{2}g(t - t_\circ)^2$ | $v_x = v_{\circ x}$

$v_y = v_{\circ y} - g(t - t_\circ)$ | $v_y^2 = v_{\circ y}^2 - 2g(y - y_\circ)$

$v = \sqrt{v_x^2 + v_y^2}$ | $\theta = \tan^{-1}\left(\frac{v_y}{v_x}\right)$

$\vec{r} = \vec{r}' + \vec{u}t$ | $\vec{v} = \vec{v}' + \vec{u}$

$\sum \vec{F} = m\vec{a}$ | $F_g = \vec{w} = m\vec{g}$

$f_s \le \mu_s n$ | $f_k = \mu_k n$

$W = (F\cos\theta)s$ | $\text{KE} \equiv \frac{1}{2}mv^2$

$\text{PE}_g = mgy$ | $\text{PE}_s = \frac{1}{2}kx^2$

$W_{net} = \text{KE}_f$ - $\text{KE}_i = \frac{1}{2}m(v^2 - v_\circ^2)$ | $W_c = \text{PE}_i$ - PE_f

$\text{KE}_i + \text{PE}_i = \text{KE}_f + \text{PE}_f$ | $\vec{p} \equiv m\vec{v}$

$\frac{1}{2}mv_i^2 + mgy_i = \frac{1}{2}mv_f^2 + mgy_f$ | $m_1v_{1i} + m_2v_{2i} = m_1v_{1f} + m_2v_{2f}$

$W_{nc} = (\text{KE}_f$ - $\text{KE}_i) + (\text{PE}_f$ - $\text{PE}_i)$ | $m_1v_{1i} + m_2v_{2i} = (m_1 + m_2)\vec{v}_f$

$\overline{P} = (W)/(\Delta t) = (F\Delta s)/(\Delta t) = F\overline{v}$ | θ (rad) $= (\pi/180^\circ)\theta$ (deg)

$\Delta\vec{p} = \vec{F}\Delta t = m\vec{v}_f - m\vec{v}_i$ | $s = \theta r$

$\omega = \omega_\circ + \alpha t$ | 1 rev $= 2\pi$ radians $= 360^\circ$

$\theta = \omega_\circ t + \frac{1}{2}\alpha t^2$ | $\omega^2 = \omega_\circ^2 + 2\alpha\theta$

$v_t = r\omega$ | $a_t = r\alpha$

$F_c = ma_c = (mv_t^2)/r = mr\omega^2$ | $a_c = v^2/r$

$\vec{a} = \vec{a}_t + \vec{a}_c$ | $a = \sqrt{a_t^2 + a_c^2}$

$\vec{F}_g = (Gm_1m_2/r^2)\,\hat{r}$ | $v = 2\pi r/T$

$g = GM_\oplus/r^2 = GM_\oplus/R_\oplus^2$ (at surface) | $F_c = Mv^2/r$

$T^2 = (4\pi^2/GM_\odot)\,r^3 = K_\odot r^3$ | T^2 (yr) $= r^3$ (AU)

Note: In the trigonometric equations above, $a \equiv$ opposite side, $b \equiv$ adjacent side, and $c \equiv$ hypotenuse where the angle is θ. Capital letters A, B, and C are the angles opposite the sides a, b, and c, respectively.

Physics 2010-004 Name: _____

Exam 1A – 28 September 2009 .

Part A: Hard Multiple Choice (10 points total, 2 points each). (Circle the best answer.)

1. Let $\vec{A} = 2\hat{x} - 2\hat{y}$ and $\vec{B} = 2\hat{x} + 2\hat{y}$. What is the value of the angle that lies between these two vectors?

a) 120° b) 90° c) 30° d) 0° e) −45°

2. Let $\vec{A} = 36\hat{x} - 12\hat{y}$ and $\vec{B} = -12\hat{x} - 8\hat{y}$. If $\vec{R} = \vec{A} + \vec{B}$, what is vector $\vec{R}$ equal to?

a) 31.2 b) 48.2 c) 0 d) $48\hat{x} - 4\hat{y}$ e) $24\hat{x} - 20\hat{y}$

3. A ball is hit with a force of 322 N which causes it to accelerate at 429 m/s^2 just after it is struck. What is the mass of the ball?

a) –429 kg b) 1.33 kg c) 1.38×10^5 kg d) 322 grams e) 751 grams

4. Suppose your professor discovers Luttermoser's Law which states $v = B\,r^2/at^2$, what are the SI units of the B parameter if r, v, a, and t are displacement, velocity, acceleration, and time, respectively?

a) N m b) m/s c) kg m d) s^{-1} e) unitless

5. One Astronomical Unit (A.U.) is the average distance that the Earth orbits the Sun and is equal to 1.4960×10^{11} m. The Earth moves 2π A.U. in one year, what is this speed in SI units?

a) 2.98×10^4 m/s b) 3.14×10^6 m/s c) 166.1 km/s

d) 10.72 m/s e) 17.6 km/s

Part B: Easy Multiple Choice (10 points total, 1 point each). (Circle the best answer.)

6. A body is moving with uniform motion, which of the following must be true?

a) A non-zero contact force must be acting on it.

b) A non-zero field force must be acting on it.

c) The body is accelerating.

d) The body is decelerating.

e) The summation of all forces acting on the body is zero.

7. Who discovered the laws of motion in classical physics?

a) Galileo b) Kepler c) Einstein d) Newton e) Ptolomy

8. Which of the following describes the positions and motions of objects in space as a function of time without regard to its causes?

a) kinematics b) mass c) relativity d) volume e) dynamics

9. In the cgs system, inertia is measured in what units?

a) $\mathrm{N} \cdot \mathrm{m}$ b) $\mathrm{dyne} \cdot \mathrm{cm}$ c) gram d) seconds e) m/s

10. The orthogonal coordinate system also goes by the name of which coordinate system?

a) Galilean b) polar c) Cartesian d) hyperbolic e) elliptical

11. In physics, *displacement over a time interval* is called

a) inertia b) velocity c) force d) energy e) acceleration

12. If a body is in free-fall, which of the following forces (if any) are acting on the body?

a) contact b) weak c) gravity d) friction e) none of these

13. The *study of motion* is called what in physics?

a) democracy b) optics c) mechanics d) relativity e) electromagnetism

14. Which of the following is a valid statement about the word **theory** in science?

a) If a hypothesis is confirmed by repeated experiments and/or observations, it becomes a theory.

b) A theory is developed from every day experiences or from an instant of insight.

c) An authority figure is speculating about an idea in science.

d) Theory is just a matter of opinion.

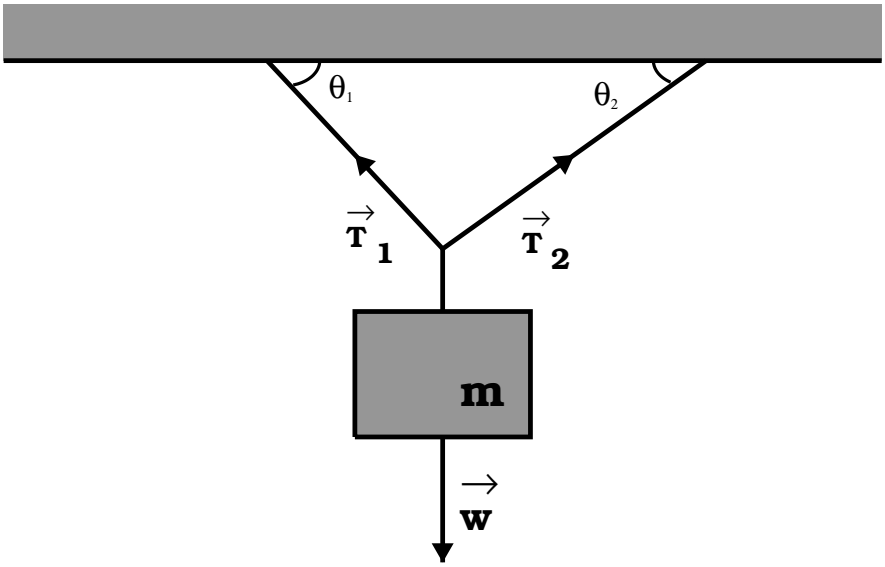
e) Someone is guessing as to how a process works in science.

15. Who is considered to be the father of experimental physics?

a) Newton b) De Cartes c) Franklin d) Kepler e) none of these

Part D: Problems (20 points total, 10 points each).

16. In the figure below, $\theta_1 = 51.7°$ and $\theta_2 = 34.6°$. If the tension on cable '1' of the diagram below is 57.6 N, (a) what is the tension on cable '2' and (b) what is the <u>mass</u> of the object hanging from the cables? (*Hint:* The mass can be considered to be located at the junction point connecting cable 1 and cable 2. **Show <u>all</u> work including free-body diagram!**)



17. A ball is thrown directly off a building in the horizontal direction with a velocity of 32.2 m/s. When thrown, the ball is at height of 38.2 m above the ground. (a) How much time elapses before the ball hits the ground? (b) How far in the horizontal direction does the ball travel before it hits the ground? (*Hint:* The initial velocity of the ball in the vertical direction is zero. **Show all work, including drawing a picture!**)

Extra Credit Problem (5 points, do this only if you have time).

18. A river flows due north at 2.66 m/s. A boat crosses the river traveling initially from west to east at 6.66 m/s in 10 minutes and 33 seconds. Assuming the river has banks that are parallel to each other, how far does the boat travel before it reaches the opposite shore (in km)? (**Show all work including figures!**)