Version A

Name (print neatly):____________________________Section #:_____

Physics 111 Exam 1

First, write your name on this sheet and on the Scantron Card.

The Physics faculty would like to help you do well:

1. Budget your time: 80 minutes/14 questions=4.4 min each.
2. Questions vary in difficulty. Look for ones you can do first.
3. If you get stuck on a question, move on.
4. All answers are in standard units of m, s, kg and J.
5. If you show your work on the exam sheet, you will do better and the work will improve your ability to study the exam afterward.
6. If any question is unclear, ask a tutor to clarify it immediately.
7. Use a calculator.
8. Answers are approximate. Select the closest one.

Since the NJIT Student Council asks for scrupulous fairness in exams, we remind you that you have pledged to comply with the provisions of the NJIT Academic Honor Code. The tutors will help by allowing no devices with internet access.

Signature: ____

1. A student is driving a car at 60.0 miles/hr. What is its speed in m/s? There are 3.28 feet in a meter and 5280 feet in a mile.
   a. 2.24
   b. 27
   c. 134
   d. 45
   e. 23

2. How many million gallons of blood does a human heart pump in an average lifetime? The average number of beats in a lifetime is about 3000 million and the volume pumped with each beat is about 50 cm^3. A gallon is 3800 cm^3.
   a. 39
   b. 228,000
   c. 150,000
   d. 0.79
   e. 47

3. Car A starts 10 meters ahead of car B. Car A moves at $\mathbf{v}_A$=(3.0 **i** +0 **j**) m/s and Car B moves forward at $\mathbf{v}_B$=(7.0 **i** + 0 **j**) m/s. How many seconds does it take car B to catch up?
   a. 2.5
   b. 3.3
   c. 1.4
   d. 10
   e. 7

4. An airplane accelerates with (7.33 **i**+ 0 **j**) m/s^2 from an initial velocity (200 **i** + 0 **j**) m/s for a distance of (1.20 **i** + 0 **j**)km. What is the final velocity in m/s?
    a. (440 **i** + 200 **j**)
    b. (500 **i** + 0 **j**)
    c. (240 i + 0 j)
    d. (240 i + 200 j)
    e. (200 i + 240 j)

5. A car drives carrying a flag of width w=0.5m. When the flag goes through a photogate, it blocks and unblocks a light. If the average speed of the car is 20m/s, what is the photogate time interval in seconds?
    a. 40
    b. 4
    c. 0.25
    d. 0.025
    e. 0.01

6. A jet test pilot can accelerate at "5g" (5x9.8 m/s^2). At that acceleration she will black out in 5 s. She plans to start from rest and to speed up to Mach 3 (3x331m/s). How long (in s) would this part of her planned flight take, if she can do it?
    a. 20
    b. 15
    c. 200
    d. 4
    e. 1

7. A military jet first flies in one direction, turns sharply and then flies in another, as described by the vectors: **A**=2**i**+4**j**; **B**=5**i**-3**j**. Take the x-axis as east and find the angle in degrees of the sum of these motions relative to east.
   a. 4
   b. 8
   c. 10
   d. 82
   e. 352

8. A car slows down because of traffic and has an acceleration of -1.0 m/s^2. After moving for 6.0 m, it has a velocity of 4.0 m/s. What was its initial velocity?
   a. 2
   b. 16
   c. 5.3
   d. 15
   e. 3.8

9. A car drives off a cliff next to a river at a speed of 30 m/s and lands on the bank on the other side. The road above the cliff is horizontal and 8.3 m above the other shore where the car lands. The tires on the car all hit at once and the air resistance is insignificant. How long is the car in the air?
   a. 1.3
   b. 0.92
   c. 0.76
   d. 0.45
   e. 2.2

10. The launch angle of a projectile is 30 degrees and its velocity in the x direction is 1.7 m/s after 2s. Neglecting friction, what is the initial magnitude of the projectile's velocity along its firing direction?
    a. 0
    b. 1.7
    c. 0.6
    d. 2
    e. 3.4

11. A rocket-launching vehicle is moving forward at a constant velocity of 5 m/s. A cannon on the vehicle shoots a shell straight up with a velocity of 20 m/s. The shell moves without friction, (no air resistance). How high does the shell go, in m?
    a. 1
    b. 10
    c. 40
    d. 2.0
    e. **20**.

12. A second launching vehicle is moving forward at 5m/s and its cannon shoots a shell straight up. The shell moves through the air without friction for 2s. How far, in m, in front of the cannon does the shell land?
    a. 10.
    b. 40.
    c. -10.
    d. 0
    e. 20.

13. A quarterback throws a football at a speed of 32.1 m/s at an angle 41.2 degrees. What horizontal distance in m can he throw it down field is if wind and air resistance are insignificant?
    a. 52
    b. 104
    c. 77.3
    d. 42.2
    e. 25.7

14. A plane in level flight at 98 m/s at an altitude of 935 m drops a package. Find the speed in m/s with which the package lands.
    a. 940
    b. 167
    c. 336
    d. 98
    e. 233

15. A bean fills a volume of 3.0 mm^3 . To compare the size of a bean with a large container, what is the volume of the bean in units of m^3 ?
    a. 0.003 m^3
    b. 0.027 m^3
    c. 3 x 10^{-6} m^3
    d. 3 x 10^{-9} m^3
    e. 3 x 10^{9} m^3

16. A speeding car moving at constant speed of 60 m/s passes a policeman who immediately starts his motorcycle (from rest) and accelerates at 2 m/s^2. How long, in seconds, will it take the policeman to catch up with the car?
    a. 20
    b. 30
    c. 60
    d. 80
    e. 120

17. Another car moving at a constant speed of 60m/s passes a policeman who starts his motorcycle (from rest) in 10 seconds and then accelerates at 2 m/s^2. How far, in meters, from the original point will it catch up with the car?
    a. 1700
    b. 2700
    c. 3700
    d. 4700
    e. 5700

18. A drone is in level flight at a speed of 201 m/s and an altitude of 802 m. At what horizontal distance, in m, from the target should the remote pilot drop an aid package so it lands on target?
    a. 257
    b. 375
    c. 890
    d. 1560
    e. 2570

Constants: 1 inch = 2.54 cm; 1 mi =1.61 km; 1 cm=10^{-2}m; 1 mm= 10^{-3} m; 1 gram=10^{-3} kg;
$g = 9.8$ m/s^2 ; $G = 6.674\times10^{-11}$ N m^2/kg^2 ; $M_{Earth} = 5.97\times10^{24}$ kg ; $R_{Earth} = 6.37\times10^{6}$ m

1D and 2D motion: $x=x_i+vt$ (constant v);
$x = x_i + v_i t + \frac{1}{2}at^2$; $v = v_i + at$; $v^2 = v_i^2 + 2a(x - x_i)$; $\vec{r} = \vec{r}_i + \vec{v}_i t + \frac{1}{2}\vec{a}t^2$; $\vec{v} = \vec{v}_i + \vec{a}t$

Circular motion: $T = 2\pi R / v$; $T = 2\pi / \omega$; $a_c = v^2 / R$

Force: $\sum \vec{F} = m\vec{a}$; $\vec{F}_{12} = -\vec{F}_{21}$; **Friction:** $f_s \le \mu_s N$; $f_k = \mu_k N$

Energies: $K = \frac{1}{2}mv^2$; $U_g = mgy$; $U_s = \frac{1}{2}kx^2$; $W = -\int \vec{F}\cdot d\vec{r} = -\vec{F}\cdot\Delta\vec{r}$
$E_{total} = K + U_g + U_S$; $\Delta E_{mech} = \Delta K + \Delta U_g + \Delta U_s = -f_s d$; $P = dW/dt = \vec{F}\cdot\vec{v}$; $\Delta K = W$

Momentum and Impulse: $\vec{p} = m\vec{v}$; $\vec{I} = \int \vec{F}dt = \Delta\vec{p}$

Center of mass: $\vec{r}_{cm} = \sum_i m_i \vec{r}_i / \sum_i m_i$; $\vec{v}_{cm} = \sum_i m_i \vec{v}_i / \sum_i m_i$

Collisions: $\vec{p}$ = const and E≠ const (inelastic) or $\vec{p}$ = const and E= const (elastic)

Rotational motion: $\omega = 2\pi / T$; $\omega = d\theta / dt$; $\alpha = d\omega / dt$; $v_t = r\omega$; $a_t = r\alpha$
$a_c = a_r = v_t^2 / r = \omega^2 r$; $a_{tot}^2 = a_r^2 + a_t^2$; $v_{cm} = r\omega$ (rolling, no slipping) ; $a_{cm} = r\alpha$
$\omega = \omega_o + \alpha t$; $\theta_f = \theta_i + \omega_o t + \alpha t^2 / 2$; $\omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i)$
$I_{point} = MR^2$; $I_{hoop} = MR^2$; $I_{disk} = MR^2 / 2$; $I_{sphere} = 2MR^2 / 5$; $I_{shell} = 2MR^2 / 3$;
$I_{rod\,(center)} = \langle ML^2 / 12 \rangle$
$I_{rod\,(end)} = ML^2 / 3$; $I = \sum_i m_i r_i^2$; $I = I_{cm} + Mh^2$; $\vec{\tau} = \vec{r} \times \vec{F}$; $\sum \tau = I\alpha$; $\vec{L} = \vec{r} \times \vec{p}$; $\vec{L} = I\vec{\omega}$

Energy: $K_{rot} = I\omega^2 / 2$; $K = K_{rot} + K_{cm}$; $\Delta K + \Delta U = 0$; $W = \tau\,\Delta\theta$; $P_{inst} = \tau\omega$

Fluid: $\rho = \frac{M}{V}$; $P = P_o + \rho g h$; $A_1 v_1 = A_2 v_2$; $P_1 + \rho g y_1 + \frac{1}{2}\rho v_1 = P_2 + \rho g y_2 + \frac{1}{2}\rho v_2$; $B = \rho_{fluid} V^{object} g$

Gravitation: $\vec{F}_g = -\frac{G m_1 m_2}{r^2}\hat{r}_{12}$; $g(r) = GM / r^2$; $U = -G m_1 m_2 / r$; $T^2 = \frac{4\pi^2}{GM}a^3$

Math: 360° = 2π rad = 1 rev; Arc: $s = r\theta$; $V_{sphere} = 4\pi R^3 / 3$; $A_{sphere} = 4\pi R^2$; $A_{circle} = \pi R^2$

quadratic formula to solve $ax^2 + bx + c = 0$: $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Vectors: $\vec{A} = A_x\hat{i} + A_y\hat{j}$; $A_x = |\vec{A}|\cos(\theta)$; $A_y = |\vec{A}|\sin(\theta)$; $|\vec{A}| = \sqrt{A_x^2 + A_y^2}$; $\tan\theta = \frac{A_y}{A_x}$
$\vec{C} = \vec{A} + \vec{B}$ => $C_x = A_x + B_x$; $C_y = A_y + B_y$;
$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|\cos\theta = A_x B_x + A_y B_y + A_z B_z$; $\hat{\imath}\cdot\hat{\imath} = \hat{\jmath}\cdot\hat{\jmath} = \hat{k}\cdot\hat{k} = 1$; $\hat{\imath}\cdot\hat{\jmath} = \hat{\imath}\cdot\hat{k} = \hat{\jmath}\cdot\hat{k} = 0$
$|\vec{A}\times\vec{B}| = |\vec{A}||\vec{B}|\sin\theta$; $\vec{A}\times\vec{B} = \hat{\imath}(A_y B_z - A_z B_y) + \hat{\jmath}(A_z B_x - A_x B_z) + \hat{k}(A_x B_y - A_y B_x)$
$\hat{\imath}\times\hat{\imath} = \hat{\jmath}\times\hat{\jmath} = \hat{k}\times\hat{k} = 0$; $\hat{\imath}\times\hat{\jmath} = \hat{k}$; $\hat{\jmath}\times\hat{k} = \hat{\imath}$; $\hat{k}\times\hat{\imath} = \hat{\jmath}$