Practice Exam, Physics 111 Common Exam 1

Name (Print): _______________________________       4 Digit ID:________  Section: ______

Honors Code Pledge: For ethical and fairness reasons all students are pledged to comply with the provisions of the NJIT Academic Honor Code. You must answer the quiz questions entirely by yourself. Turn off all cell phones, pagers, or other communication devices.

Instructions:
▪ First, write your name and section number on both the Scantron card and this exam sheet.
▪ Use the formula sheet (last exam booklet page) and no other materials.
▪ Budget your time. There are 16 multiple choice problems (1 pt each).
▪ Answer each question on the Scantron card using #2 pencil. Also circle your answers on question papers.
▪ Do not hesitate to ask for clarification of any exam question, if needed, from your proctor or Professor.

1. 2 mm$^3$ is equivalent to:
   A) $2 \cdot 10^{-3}$ m$^3$
   B) $2 \cdot 10^{-6}$ m$^3$
   C) $2 \cdot 10^{-9}$ m$^3$
   D) $2 \cdot 10^{-12}$ m$^3$
   E) $2 \cdot 10^{-15}$ m$^3$

For the following 3 problems use the vectors:
$\vec{A} = 1\hat{i} + 2\hat{j} + 0\hat{k}$ and $\vec{B} = 2\hat{i} + 2\hat{j} + 0\hat{k}$

2. Find the magnitude of $\vec{A} + \vec{B}$. Select the closest answer.
   
   A) 1
   B) 2
   C) 3
   D) 4
   E) 5

3. Find the dot product $\vec{A} \cdot \vec{B}$ and the angle between vectors:
   A) 4, $33^0$
   B) 12, $38^0$
   C) 6, $48^0$
   D) 3, $48^0$
   E) 9, $23^0$

4. Find the vector (cross) product $\vec{A} \times \vec{B}$:
   
   A) 0
   B) $2\hat{j}$
   C) $-2\hat{j}$
   D) $-2\hat{k}$
   E) $2\hat{k}$
5. A body is projected vertically upward from the surface of the earth with a speed of 10.0 m/s. What is its speed (in m/s) when it is at \( \frac{1}{2} \) of its maximum height?

A) 0
B) 2.5
C) 5.0
D) 7.0
E) 10.0

6. A body moves from A to B along a straight line a distance of 100 m in 10 sec. Stops at B for 20 sec. and then returns to A at an average speed of 5 m/s. The average speed (in m/s) from A to B is:

A) 0
B) -2
C) 3
D) 4
E) 5

7. An Apache helicopter during vertical takeoff releases a package when it is at 39.2 m high and its speed is 9.80 m/s. How long (in seconds) does it take the package to read the ground?

A) 1
B) 2.8
C) 3
D) 4
E) 5.2

8. The displacement of a body \( x(t) = 10 \text{ (m)} + 20 \left( \frac{m}{s} \right) t - 5 \left( \frac{m}{s^2} \right) t^2 \). Find the average velocity for the period between \( t=0 \) and \( t=5s \).

A) 0
B) -1
C) 1
D) -2
E) -5

9. A ball is thrown off a 100 meters high cliff with an initial horizontal velocity of 20 m/s. How long does it take for it to hit the ground?

A) 4.5 s
B) 20.0
C) 2.0 s
D) 3.2 s
E) 12 s
10. A particle starts from the origin with velocity $5\hat{i}$ m/s and $t=0$ and moves in the xy plane with a constant acceleration of $6\hat{j}$. Determine the position of the particle after 5 s:
A) $\vec{r} = 25\hat{i} + 75\hat{j}$
B) $\vec{r} = 5\hat{i} + 25\hat{j}$
C) $\vec{r} = 30\hat{i} + 15\hat{j}$
D) $\vec{r} = 20\hat{i} + 30\hat{j}$
E) $\vec{r} = 5\hat{i} + 25\hat{j}$

11. Vectors $\vec{A}$ and $\vec{B}$ are shown. What is the magnitude of a vector $\vec{C} = \vec{A} - \vec{B}$?

![Diagram of vectors A and B]

a. 46
b. 10
c. 30
d. 78
e. 90

12. A marathon is 26.2188 miles long. An expert marathon runner finishes the race in 2 hours. What was her average speed in SI units?
A) 3.17 m/s
B) 10.1 m/s
C) 4.92 m/s
D) 5.86 m/s
E) 7.44 m/s

13. At $t = 0$, a particle leaves the origin with a velocity of 8 m/s in the positive y direction and moves in the xy plane with a constant acceleration of $(-2.0\hat{i} + 4.0\hat{j})$ m/s$^2$. How far from the origin is the particle 10 sec later?
 a. 100 m
 b. 210 m
 c. 297 m
d. 424 m
e. 345 m
14. The position of an object is given by \( x = (24t - 2.0t^3) \) where \( t \) is in seconds. At \( t = 2.0 \) s, what is the magnitude of the particle’s acceleration?
   a. 0 m/s²
   b. 2.0 m/s²
   c. 17 m/s²
   d. 36 m/s²
   e. 24 m/s²

15. The initial speed of a cannon ball is 200 m/s. If the ball is to strike a target that is at a horizontal distance of 3.0 km from the cannon, what is the minimum time of flight for the ball?
   a. 16 s
   b. 21 s
   c. 24 s
   d. 14 s
   e. 19 s

16. A bird, accelerating from rest at a constant rate, experiences a displacement of 28 m in 17 s. What is the final velocity after 11 s?
   a. 0.19 m/s
   b. 1.6 m/s
   c. 3.3 m/s
   d. 2.1 m/s
   e. 5.1 m/s
Formulas - exams 1 and 2

**Constants and units:** $g = 9.8 \text{ m/s}^2$, $1 \text{ mm} = 10^{-3} \text{ m}$, $1 \text{ cm} = 10^{-2} \text{ m}$, $1 \text{ km} = 10^3 \text{ m}$, $1 \text{ in} = 2.54 \text{ cm}$, $1 \text{ N (newton)} = \text{ kg} \cdot \text{ m/s}^2$, $1 \text{ J (joule)} = \text{ N} \cdot \text{ m} = \text{ kg} \cdot \text{ m}^2/\text{s}^2$, $1 \text{ W (watt)} = \text{ J/s}$.

**Volumes.** Cylinder: $\pi R^2 h$, sphere: $\frac{4}{3} \pi R^3$, cone: $\frac{1}{3} \pi R^2 h$.

**Quadratic equation.** $ax^2 + bx + c = 0$, $x = \left( -b \pm \sqrt{b^2 - 4ac} \right) / (2a)$.

**Derivatives/integrals.** $\frac{d}{dt} t^n = nt^{n-1}$, $\int r^n \, dr = \frac{1}{n+1} r^{n+1}$.

**Vectors.** If $e = \vec{a} + \vec{b}$, then $c_x = a_x + b_x$, $c_y = a_y + b_y$, $c_z = a_z + b_z$. and $c = \sqrt{c_x^2 + c_y^2 + c_z^2}$. Dot product: $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z = ab \cos \alpha$. Cross product: $\vec{i} \times \vec{j} = \vec{k}$, $\vec{j} \times \vec{k} = \vec{i}$, $\vec{k} \times \vec{i} = \vec{j}$.

**Kinematics:** $v = dx/dt$, $a = dv/dt = \dot{d}^2 x/dt^2$. Constant $a$: $v - v_0 = at$, $x - x_0 = \frac{v_0 + v}{2} t = v_0 t + \frac{1}{2} a t^2 = \frac{v^2 - v_0^2}{2a}$. Projectile: $v_x = \text{const}$, $x - x_0 = v_x t$, $v_y = v_0 y - gt$, $y - y_0 = v_0 y - \frac{1}{2} g t^2 = (v^2_0 - v_0^2)/(2g)$. Range: $(v^2_0/g) \sin(2\theta)$.

Circular motion with constant speed: $\omega = v/R$, $a_c = v^2/R = \omega^2 R$, towards center.

**The three Laws of motion:** (1) If $\vec{F}_{\text{net}} = 0$ then $\vec{v} = \text{const}$; (2) $\vec{F}_{\text{net}} = m \vec{a}$; (3) $\vec{F}_{21} = -\vec{F}_{12}$.

**Specific forces.** Gravity: $m \vec{g}$ (down). Normal $\vec{N}$ - perpendicular to surface; tension $T$ - constant along the string. Spring force: $F = -kx$ ($k$ is spring constant).

Friction - parallel to surface: kinetic: $f_k = \mu_k N$; static: $f_s \leq \mu_s N$ with $N = mg$ (horizontal plane) or $N = mg \cos \theta$ (inclined plane).

Inclined plane. Components of gravity: $mg \sin \theta$ (parallel to plane, downhill) and $mg \cos \theta$ (perpendicular to plane). Kinetic friction: $\mu_k mg \cos \theta$ (parallel to plane, opposite to direction of motion).

Centripetal motion: $F_{\text{net}} = mv^2/R$; direction of $\vec{F}_{\text{net}}$ - towards center of revolution.

**Work and power.** Constant force $W = \vec{F} \cdot (\vec{r}_2 - \vec{r}_1) = F_x \Delta x + F_y \Delta y + F_z \Delta z$ (or, $W = F \Delta r \cos \alpha$); general: $W_{AB} = \int_A^B \vec{F} \cdot d\vec{r}$. Power: $P = W/\Delta t = \vec{F} \cdot \vec{v}$. Work by specific forces: gravity: $W_g = -mg \Delta y$ (and $\Delta x$ does not matter); normal: $W_N = 0$; kinetic friction: $W_f = -fL$; spring $W_s = (1/2k) \left( x_1^2 - x_2^2 \right)$.

**Kinetic energy and work-energy theorem:** $K = \frac{1}{2}mv^2$, $\Delta K = W$ where $W$ is the net work (i.e. work by all forces).

**Potential energy.** For conservative forces (with path-independent work) introduce $U (\vec{r})$ so that $W_{AB} = U_A - U_B = -\Delta U$. For specific forces: gravity: $U_g = mgh$; spring: $U_s = (1/2k) x^2$. If only conservative forces, then energy conservation: $K + U = \text{const}$. If also non-conservative forces (e.g., friction) with work $W_{\text{non-cons}}$, then $\Delta (K + U) = W_{\text{non-cons}}$.