Physics 123 - Analytical Physics
FIRST COMMON HOUR EXAM
Monday, October 4, 2010
Professor R.A. Bartynski

⇒ Answers ⇐

Your name sticker with **exam code. SIGN HERE:**

1. The exam will last from 9:40 - 11:00 p.m. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts..
2. In the section labeled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit RUID Number.
4. Enter 123 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and one 8.5 x 11 inch sheet (both sides) with formulas and notes.
7. There are 15 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. **At the end of the exam, hand in the answer sheet and the cover page.** Retain this question paper for future reference and study.
8. When you are asked to open the exam, make sure that your copy contains all 15 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.
10. If needed, the acceleration due to gravity on earth may be take as g = 9.81 m/s^2.

1. A commercial jet plane such as the Boeing 747 can cruise at a speed of 575 miles/hour. Express that speed in m/s assuming that 1 ft = 0.300 m and there are 5280 ft in a mile.

- a) 30.6 m/s
- b) 172 m/s
- [✓ c)] 253 m/s
- d) 392 m/s
- e) 2800 m/s

$575 \frac{mi}{hr} \cdot \frac{5280 ft}{1 mi} \cdot \frac{0.300 m}{1 ft} \cdot \frac{1 hr}{3600 s}$

$= 253 \frac{m}{s}$

2. If all the people in your ~~Wednesday~~ ~~morning~~ Friday afternoon ~ 250 students physics lecture held hands with their arms outstretched, estimate the length of the line?

- [✓ a)] 1200 ft ~ 360m
- b) 50 m
- c) 0.6 miles ~ 960 m
- d) 1.2×10^5 inches ~ 3×10^3 m
- e) 3.0×10^6 microns ~ 3 m

out streched arm ~ 1.5 m

$1.5_m \times 250 = 375$ m

3. From the fact that the average density of the earth is 5.5 g/cm^3 and its mean radius is 6.4×10^6 m, the mass of the earth is closest to:

- a) 6.0×10^{22} kg
- b) 6.0×10^{21} kg
- c) 6.0×10^{17} kg
- d) 6.0×10^{12} kg
- [✓ e)] 6.0×10^{24} kg

$m = \rho V = 5.5 \frac{g}{cm^3} \cdot \frac{4}{3}\pi(6.4\times10^6 m)^3 \sim 6\times10^{24}$ kg

4. At time t = 0 a car traveling along a straight line has a velocity of 16 m/s. It slows down with an acceleration given by -0.50 m/s^2. At the end of 4.0 s it has traveled: $x = 16t - \frac{0.5}{2}t^2$

- a) 0 m
- b) 12 m
- c) 56 m
- d) 25 m
- [✓ e)] 60 m

at $t = 4 s$, $x = 16\times4 - \frac{0.5}{2}4^2 = 60$ m

5. A car starts from rest and accelerates at a constant rate in a straight line. In the first second the car covers a distance of 2.0 meters. How fast will the car be moving at the end of the second second?

- a) 2.0 m/s
- b) 4.0 m/s
- [✓ c)] 8.0 m/s
- d) 16 m/s
- e) 32 m/s

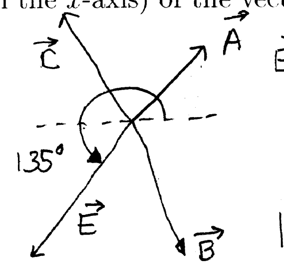
$x = \underset{0}{x_0} + \underset{0}{v_0}t + \frac{1}{2}at^2$

$2.0 = \frac{1}{2}a\cdot(1.0)^2 \Rightarrow a = 4.0 \frac{m}{s^2}$

$v = a\underset{2.0 s}{t} = 4.0 \times 2.0 = 8.0 \frac{m}{s}$

6. Consider the displacement vectors $\vec{A} = 3.00\hat{\imath} + 3.00\hat{\jmath}$, $\vec{B} = \hat{\imath} - 4.00\hat{\jmath}$, and $\vec{C} = -2.00\hat{\imath} + 5.00\hat{\jmath}$. Find the magnitude and direction (the angle counterclockwise from the x-axis) of the vector $\vec{E} = -\vec{A} - \vec{B} + \vec{C}$.

- [✓ a)] 8.49; 135°
- b) 5.24; 45°
- c) 2.12; −60°
- d) 18.0; 90.0°
- e) 4.47; 63.4°



$\vec{E} = -3\hat{i} - 3\hat{j}$

$-1\hat{i} + 4\hat{j}$

$-2\hat{i} + 5\hat{j}$

$= -6\hat{i} + 6\hat{j}$

$|\vec{E}| = \sqrt{36+36} = 8.49$

7. The initial velocity of an electron is 2.0×10^5 m/s. If its acceleration is -4.2×10^{14} m/s^2, how far does it travel before momentarily coming to rest?

- a) 4.8×10^{-10} m
- b) 2.1×10^9 m
- [✓ c)] 4.8×10^{-5} m
- d) 8.4×10^{19} m
- e) 2.1×10^4 m

$v = v_0 + at = 2.0\times10^5 - 4.2\times10^{14}t$

$v = 0$ at $t = 4.8\times10^{-10}$

$x = v_0t + \frac{1}{2}\underset{-4.2\times10^{14}\frac{m}{s^2}}{a}t^2$

$= 4.8\times10^{-5}$ m

8. Which of the following is true? $v = v_0 + at = v_0$, if $a = 0$

- a) The velocity of a particle must be zero if the acceleration is zero.
- b) The speed of a particle being accelerated must change. if $\vec{a}$ is ⊥ to $\vec{v}$, only direction of $\vec{v}$ changes.
- [✓ c)] The average acceleration of an airplane during a flight starting from the gate at Newark to the gate at San Francisco is zero.
- d) The instantaneous velocity of an airplane during a flight is never equal to its average velocity averaged over that flight. ? if $\vec{v}$ = const, $\vec{v}_{av} = \frac{d\vec{x}}{dt}$
- e) None of the other statements is true.

$a_{av} = \frac{v_2 - v_1}{t_2 - t_1} = \frac{0}{t_2 - t_1}$

9. A particle with velocity $\vec{v}_o = 5.0\hat{\imath}$ m/s and acceleration $\vec{a} = 3.0\hat{\jmath}$ m/s^2 is at the origin at t = 0.0 s. Find the position and speed of the particle at t = 2.0 s.

- a) (5.0, 3.0); 5.8 m/s
- [✓ b)] (10, 6.0); 7.8 m/s
- c) (-5.0, 6.0); 4.0 m/s
- d) (10, 1.5); 6.3 m/s
- e) (7.5, 4.5); 4.4 m/s

$\vec{v} = \vec{v}_0 + \vec{a}t$ $t = 2.0 s$

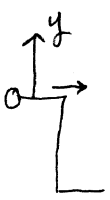
$\vec{x} = \vec{v}_0t + \frac{1}{2}\vec{a}t^2$

$\vec{v} = 5.0\hat{i} + 3.0\times2.0\hat{j} = 5.0\hat{i} + 6.0\hat{j}$

$|\vec{v}| = \sqrt{25+36} = 7.8 \frac{m}{s}$

10. An empty beer mug slides horizontally off a table 0.86 m high and strikes the floor 1.4 m from the base. With what speed did the mug leave the table?

- [✓ a)] 3.3 m/s
- b) 1.9 m/s
- c) 2.3 m/s
- d) 5.1 m/s
- e) 1.6 m/s



v_x = constant

$y = v_{oy} t - \frac{1}{2} g t^2 \Rightarrow -0.86 = \frac{-1}{2} g t^2$

$\hookrightarrow 0$

$t = 0.42\ s$

$\leftarrow y = -0.86$

$v_x t = 1.4\ m$

$v_x = 3.3\ \frac{m}{s}$

11. The position of a particle moving along the x-axis is given by $x = (21 + 22t - 6.0t^2)$ m, where t is time in s. What is the average velocity during the time interval $t = 1.0$ s to $t = 3.0$ s?

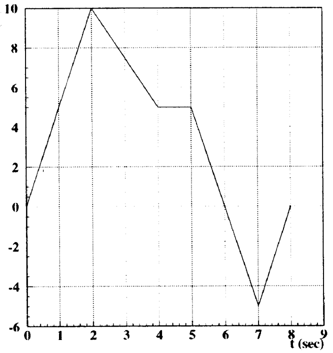
- a) −6.0 m/s
- b) −4.0 m/s
- [✓ c)] −2.0 m/s
- d) −8.0 m/s
- e) 8.0 m/s

$$v_{av} = \frac{x_2 - x_1}{t_2 - t_1} = \frac{33 - 37}{3 - 1} = \frac{-4}{2} \frac{m}{s}$$

$$= -2.0\ \frac{m}{s}$$

12. The plot below shows the **position** x versus time for a ball. Which of the following statements is true?

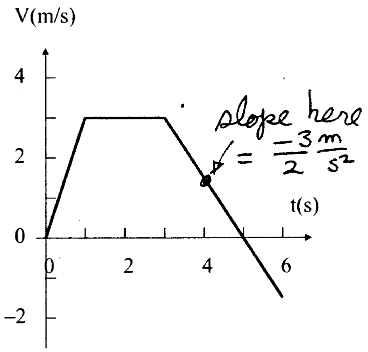
- a) At $t = 6$ s, the ball is at rest. – no, $v \sim -4.5$ m/s
- b) From $t = 0$ to $t = 6$ s, the velocity of the ball is always positive. no $v < 0$, $2 < t < 4\ s$.
- c) The acceleration of the ball is non-zero and negative at $t = 6$ s. $a = 0$, v = constant
- d) The velocity of the ball is the same at $t = 1$ s and $t = 6$ s.
- [✓ e)] The speed of the ball is the same at $t = 1$ s, $t = 5.5$ s, and $t = 7.5$ s. yes. |slope| is same.



$v_x > 0$ at $t = 1\ s$, $v_x <$ at $t = 6\ s$

13. The **velocity** V of a particle as a function of time is shown in the figure. Determine the instantaneous acceleration of the particle at $t = 4$ s.

- a) +0.37 m/s^2
- b) −0.37 m/s^2
- c) 0 m/s^2
- d) +1.5 m/s^2
- [✓ e)] −1.5 m/s^2



slope here $= \frac{-3}{2} \frac{m}{s^2}$

14. A ball thrown directly upwards collides with a falling ball. The collision occurs 10.0 m above the thrower and 20.0 m below where the falling ball was dropped from rest. How fast was the upwards ball thrown (in m/s)? For the ball dropped, $y = \frac{1}{2} g t^2$, $20 = \frac{1}{2} g t^2 \Rightarrow t \approx 2\ s$

a) 9.90 b) 12.1 c) 14.0 [✓ d)] 14.9 e) 17.2

For the ball thrown upwards, $y = v_0 t - \frac{1}{2} g t^2 \Rightarrow 10 = v_0 \cdot 2 - 20$

$\Downarrow$

$v_0 = 15 \frac{m}{s}$

15. A stone is thrown from the top of a building with an initial velocity of 20 m/s downward. The top of the building is 60 m above the ground. How much time elapses between the instant of release and the instant of impact with the ground?

[✓ a)] 2.0 s b) 4.0 s c) 3.5 s d) 1.6 s e) 1.0 s

$$y_2 - y_1 = \frac{v_2^2 - v_1^2}{2g}$$

$$60 = \frac{v_2^2 - (20)^2}{2 \times 9.8} \Rightarrow v_2 = 40 \frac{m}{s}$$

$$v = v_0 + at$$

$$40 = 20 + 9.8 t \Rightarrow t = 2.0\ s$$