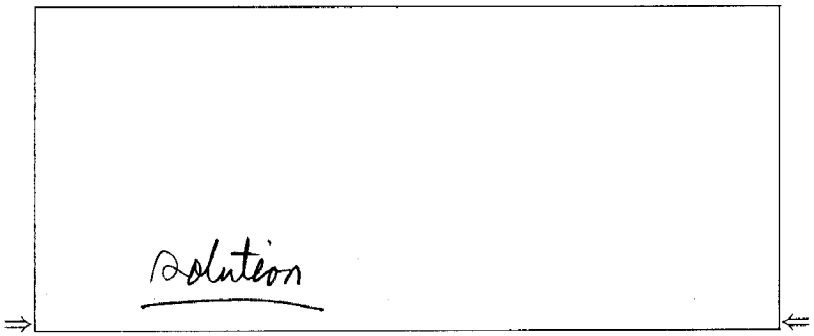
Physics 123 - Analytical Physics
FIRST COMMON HOUR EXAM
Monday, October 5, 2009
Professor R.A. Bartynski



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. The components of vectors $\vec{A}$ and $\vec{B}$ are given as follows:
$A_x = +5.7$ $A_y = -3.6$
$B_x = -9.8$ $B_y = -6.5$
The magnitude of the vector difference $\vec{B} - \vec{A}$, is closest to:

(a) 16
b) 5.0
c) 11
d) 250
e) -5.0

$B_x - A_x = -15.5$
$B_y - A_y = -2.9$
$\vec{B} - \vec{A} = -15.5\hat{i} - 2.9\hat{j}$
$|\vec{B} - \vec{A}| = \sqrt{15.5^2 + 2.9^2} = 15.8$

2. The following conversion equivalents are given: 1 kg = 1000 g, 1 liter = 1000 cm^3, 1 liter = 0.0353 ft^3. The density of a liquid is 0.30 g/cm^3. The density of the liquid, in kg/ft^3, is closest to:

a) 10
(b) 8.5
c) 9.3
d) 6.8
e) 7.6

$0.30 \frac{g}{cm^3} \cdot \frac{1000\,cm^3}{1\,\ell} \cdot \frac{1\,\ell}{0.0353\,ft^3} \cdot \frac{1\,kg}{1000\,g}$
$= 8.5 \frac{kg}{ft^3}$

3. A train starts from rest and accelerates uniformly, until it has traveled 5.4 km and acquired a velocity of 31 m/s. The train then moves at a constant velocity of 31 m/s for 400 s. The train then decelerates uniformly at 0.065 m/s^2, until it is brought to a halt. The distance traveled by the train during deceleration, in km, is closest to:

a) 6.0
(b) 7.4
c) 6.7
d) 7.0
e) 6.3

$v_0 = 31$ m/s
$v^2 = v_0^2 + 2a(\Delta x)$
$0 = 31^2 + 2x(-0.065)\Delta x$
$\Delta x = \frac{31^2}{0.13} = 7.4 \times 10^3$ m

4. A motorist makes a trip of 180 miles. For the first 90 miles she drives at a constant speed of 30 mph. At what constant speed must she drive the remaining distance if her average speed for the total trip is to be 40 mph?

a) 52.5 mph
b) 45 mph
c) 55 mph
(d) 60 mph
e) 50 mph

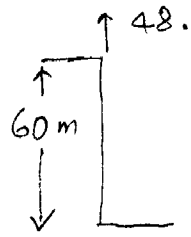
$\frac{180}{\Delta t} = 40$ mph $\quad \Delta t = 4.5$ h
$\frac{90}{30} = 3$ h $\quad 4.5 - 3 = 1.5$ h
to travel $(180 - 90) = 90$ m
$\Rightarrow v = \frac{90\,m}{1.5\,h} = 60$ mph

5. Which of the following situations is impossible?

   a) An object has constant nonzero velocity and changing acceleration.
   b) An object has zero velocity but nonzero acceleration.
   c) An object has velocity directed east and acceleration directed west.
   d) An object has velocity directed east and acceleration directed east.
   e) An object has constant nonzero acceleration and changing velocity.

6. A ball is projected upward at time $t = 0.0$ s, from a point on a roof 60 m above the ground. The ball rises, then falls and strikes the ground. The initial velocity of the ball is 48.2 m/s. Consider all quantities as positive in the upward direction. At time $t = 4.92$ s, the velocity of the ball is closest to:

   a) zero
   b) +119 m/s
   c) −12 m/s
   d) −119 m/s
   e) +12 m/s



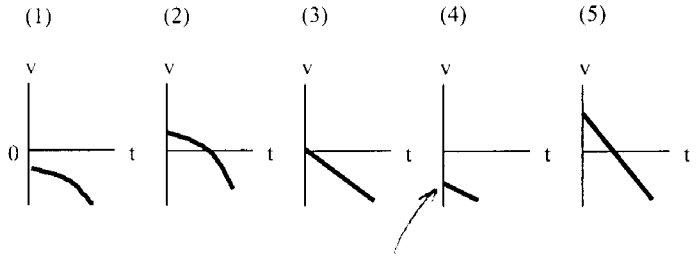
$v = v_0 + at$

$= 48.2 + (-9.8 \times 4.92)$

$= -0.016 \ \frac{m}{s}$

7. A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at $t = 0$. Which of the graphs shown here best represents the velocity of the stone as a function of time?

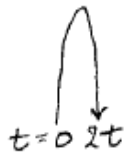
   a) 1
   b) 2
   c) 3
   d) 4
   e) 5



$v_0 < 0, \quad a < 0$

8. On the earth, when an astronaut throws a 0.250-kg stone vertically upward, it returns to his hand 8.00 s later. On planet X he finds that, under the same circumstances, the stone returns to his hand in 16.0 s. In both cases, he throws the stone with the same initial velocity and it feels negligible air resistance. The acceleration due to gravity on planet X (in terms of g) is closest to:

a) $2g$
b) $\frac{g}{\sqrt{2}}$
c) $g\sqrt{2}$
(d) $\frac{g}{2}$
e) $\frac{g}{4}$



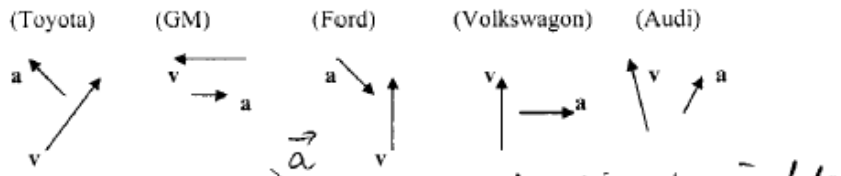
$2t = \frac{2v_0}{g} = 8$ (1) on earth

$\frac{2v_0}{a} = 16$ (2) on X planet

(1) ÷ (2) $\Rightarrow \frac{a}{g} = \frac{1}{2}$ or $a = \frac{g}{2}$

9. Shown here are the velocity and acceleration vectors for cars in several different types of motion. Which car is slowing down and turning to the right?

a) Toyota
b) GM
(c) Ford
d) Volkswagon
e) Audi



$\vec{a}$ ↘ + acceleration to right

− " forward

10. A toy cart starts on a straight track at position $x = 2.37$ m, travels to $x = 3.85$ m, then travels backward to $x = 1.22$ m. The travel time from $x = 2.37$ m to $x = 1.22$ m is measured to be 17.94 s. The correct way to state the magnitude of its average velocity is:

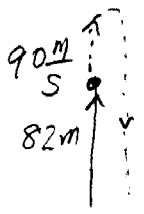
a) none of the others
(b) 6.41×10^{-2} m/s
c) 6.410×10^{-2} m/s
d) 6.4×10^{-2} m/s
e) 6×10^{-2} m/s

$\left| \frac{-1.15\ m}{17.94\ s} \right| = 6.41\times10^{-2}\ \frac{m}{s}$

3 significant figures

11. A toy rocket, initially at rest, is launched vertically from ground level (y = 0 m), at time t = 0.0 s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 82 m and acquired a velocity of 90 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground. Neglecting air resistance, the time interval, during which the rocket engine provides upward acceleration, is closest to:

a) 1.6 s
b) 1.3 s
c) 1.5 s
d) 2.0 s
e) 1.8 s



$v^2 = v_0^2 + 2a(x_2 - x_1)$

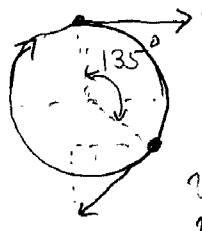
$90^2 = 0^2 + 2a\ 82$

$a = \frac{90^2}{2 \times 82} = 49.4 \frac{m}{s^2}$

$v = at \quad 90 = 49.4\ t \Rightarrow t = 1.8\ s$

12. A merry-go-round has a radius of 5.2 m and rotates clockwise in the xy plane around its axis at constant speed. The instantaneous velocity vector (v_x, v_y) at one position on the rim at t = 0 is (+0.58 m/s, 0). The instantaneous velocity at t = 21 s is closest to?

a) (−0.58 m/s, 0)
b) (0, −0.58 m/s)
c) (0.41 m/s, −0.41 m/s)
d) (−0.41 m/s, 0.41 m/s)
e) (−0.41 m/s, −0.41 m/s)



distance traveled = 12.18m

circumference = 32.65 m

$v_x = 0.58(-\cos 45°) = -0.41 \frac{m}{s}$

$v_y = 0.58(-\sin 45°) = -0.41 \frac{m}{s}$

13. The position of a particle moving along the x axis is given by $x = (35 + 16t - 5.0t^2)$ m,
where t is time in s. What is the closest time at which the velocity becomes 1/2 of the initial velocity at t = 0?

a) 1.0 s
b) 2.0 s
c) 0.80 s
d) 35 s
e) 5.0 s

$v = 16 - 10t$

$8.0 = 16 - 10t$

$t = \frac{8.0}{10} = 0.80\ s$

14. A cylindrical glass jar of radius 5 cm and height 10 cm is filled with approximately identical marbles. The radius of the marble is about 0.2 cm. The number of marbles in the jar is approximately: Note:

a) 10^2
b) 10^6
c) 10^8
d) 10^0
e) 10^4

V_c = vol. of cylinder $\approx 10 \times 10 \times 10 = 10^3\ cm^3$

V_m = " " marble $\pi(0.4)^3 = 64 \times 10^{-3}\ cm^3$

# of marbles $= \frac{V_c}{V_m} \approx 1.6 \times 10^4$

15. A car comes to the part of road where the driver sees a road sign indicating a sharp left turn and the speed limit sign of 25 mi/h. The driver obeys the speed limit sign and keeps the constant speed at 25 mi/h while driving on the curved road. Which of the following statement is correct?

a) The velocity vector of the car remains constant, but the acceleration vector changes.

b) The velocity vector of the car changes, but the acceleration vector does not.

(c) The velocity vector of the car changes and the acceleration vector changes.

d) The speed changes and the acceleration changes.

e) Both the velocity and acceleration vectors remain constant.