solutions

Physics 2414
Midterm #1 – Spring 2013

Version A

Multiple choice (6 points each)

1) A boat is able to move through still water at 20 m/s. It makes a round trip to a town 3.0 km upstream. If the river flows at 5 m/s, the time required for this round trip is:
   a. 120 s
   b. 150 s
   c. 240 s
   d. 300 s
   e. 320 s

upstream $v = 20 - 5\ m/s = 15\ m/s$
downstream $v = 20 + 5\ m/s = 25\ m/s$
$t_{up} = \frac{3000\ m}{15\ m/s} = 200\ s$
$t_{down} = \frac{3000\ m}{25\ m/s} = 120\ s$
$total = 200 + 120 = 320\ s$

2) A cubic box with an edge exactly 1 cm has a volume of:
   a. 10^{-9} m^3
   b. 10^{-6} m^3
   c. 10^{-3} m^3
   d. 10^{3} m^3
   e. 10^{6} m^3

$1\ cm^3 \left| \frac{10^{-2}\ m}{1\ cm} \right| \frac{10^{-2}\ m}{1\ cm} \left| \frac{10^{-cm}\ m}{1\ cm} \right| = 10^{-6}\ m$

3) Suppose $A=B^nC^m$, where A has dimensions LT, B has dimensions L^2T^{-1}, and C has dimensions LT^2. Then the exponents n and m are:
   a. 2/3; 1/3
   b. 2; 3
   c. 4/5; -1/5
   d. 1/5; 3/5
   e. ½; 1/2

$LT = (L^2T^{-1})^n (LT^2)^m$
$LT = L^{2n} T^{-n} L^m T^{2m}$
$LT = L^{2n+m} T^{2m-n}$

$2n + m = 1$
$2m - n = 1$
$m = 3/5$
$n = 1/5$

4) A particle moves in a straight line. When its acceleration is positive and increasing:
   a. Its velocity must be positive
   b. Its velocity must be negative
   c. It must be slowing down
   d. It must be speeding up
   e. None of the above must be true

5) At a stop light, a truck traveling at 15 m/s passes a car as it starts from rest. The truck travels at a constant velocity and the car accelerates at $3 m/s^2$. How much time does the car take to catch up to the truck?

a. 5 s
b. 10 s
c. 12 s
d. 15 s
e. 20 s

$x_T = v_T t$

$x_c = \frac{1}{2} a_c t^2$

set equal $15 m/s\, t = \frac{1}{2}(3) t^2$

$15 m/s = \frac{3}{2} t$

$t = 10 s$

6) Which of the following statements is correct for an object released from rest?

a. The average velocity during the first second of time is 4.9 m/s
b. During each second the object falls 9.8 m
c. The acceleration changes by 9.8 m/s^2 every second
d. The object falls 9.8 m during the first second of time
e. The acceleration of the object is proportional to its weight

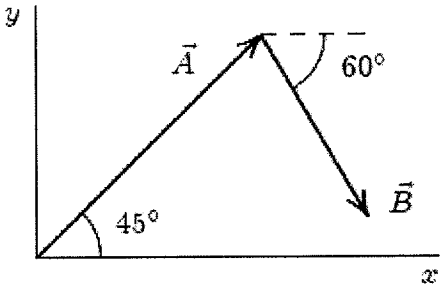
7) In the diagram vector $\vec{A}$ has magnitude 12 m and vector $\vec{B}$ has magnitude 8 m, the x component of $\vec{A} + \vec{B} =$

a. 5.5 m
b. 7.6 m
c. 12.5 m
d. 14.4 m
e. 15.4 m

$A_x = A \cos 45^\circ = 12 \cos 45^\circ = 8.48$

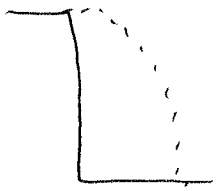
$B_x = B \cos 60^\circ = 8 \cos 60^\circ = 4$

$A_x + B_x = 12.5$



8) A boy on the edge of a vertical cliff 20 m high throws a stone horizontally outward with a speed of 20 m/s. It strikes the ground at what horizontal distance from the foot of the cliff and with what speed?

a. 30 m, 20 m/s
b. 40 m, 20 m/s
c. 40 m, 28 m/s
d. 30 m, 28 m/s
e. 40 m, 23 m/s



$V_{0x} = 20 m/s$

$V_{0y} = 0$

$y = \frac{1}{2} g t^2$ $\quad 20 = \frac{1}{2}(9.8 m/s^2) t^2$

time $= \sqrt{\frac{40}{9.8}} = 2.02 s$

$X = V_{0x} t = 20 m/s \cdot 2.02 s = 40 m$

$V_y = 0 - gt = 9.8 m/s^2 \cdot 2.02 s = 19.8 m/s$

$V = \sqrt{V_x^2 + V_y^2} = \sqrt{(20 m/s)^2 + (19.8 m/s)^2}$

$V = 28 m/s$

9) A cannon fires a projectile as shown. The dashed line shows the trajectory in the absence of gravity. Points MNOP correspond to the position of the projectile at one second intervals. If g= 10 m/s^2, the lengths X, Y, Z are:

a. 5 m, 10 m, 15 m
b. 5 m, 20 m, 45 m
c. 10 m, 40 m, 90 m
d. 10 m, 20 m, 30 m
e. 0.2 m,0.8 m, 1.8 m

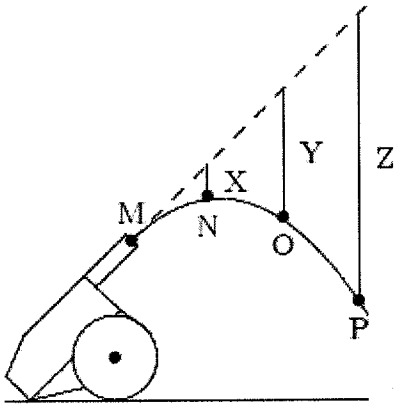
$y = \frac{1}{2} g t^2$ if $g = 10$

$y = 5t^2$

$t = 1 \quad y = 5$ m

$t = 2 \quad y = 20$ m

$t = 3 \quad y = 45$ m



10) Steve usually takes a train to his job in New York. The train has an average speed of 50 m/s. Due to a problem with the train, one day he flew on a jet for 4/5 of the trip at 100 m/s and then took a taxi for the last 1/5 of the trip. What speed must the taxi driver drive in order to get Steve to New York in the same amount of time it usually takes him to arrive by train?

a. 10.4 m/s
b. 12.6 m/s
c. 13.3 m/s
d. 16.7 m/s
e. 18.3 m/s

train: $t = \frac{d}{50 \text{ m/s}}$

Jet $t = \frac{\frac{4d}{5}}{100 \text{ m/s}}$

taxi: $t = \frac{\frac{d}{5}}{V_{taxi}}$

$t_1 = t_2 + t_3$

$\frac{d}{50} = \frac{4d}{500} + \frac{d}{5 V_{taxi}}$

$.02 = .008 = \frac{1}{5V}$

$V = 16.7$ m/s

11) A truck slows down from a speed of 41 m/s to rest in 9.40 s. How far did it travel in that time?

a. 193 m
b. 385 m
c. 578 m
d. 965 m
e. None of the above

$0 = 41\ m/s - a(9.4\ s)$

$a = -4.36\ m/s^2$

$x = (41\ m/s)(9.4\ s) - \frac{1}{2}(4.36)(9.4\ s)^2$

$385.4\ m - 192.6\ m = 193\ m$

12) A football is kicked on level ground with an initial velocity of 20 m/s with an angle 20° from the horizontal. How long is the ball in the air?

a. 1.0 s
b. 1.4 s
c. 2.8 s
d. 4.1 s
e. 0.8 s

$V_y = 20\ m/s \cdot \sin 20^\circ = 6.84$

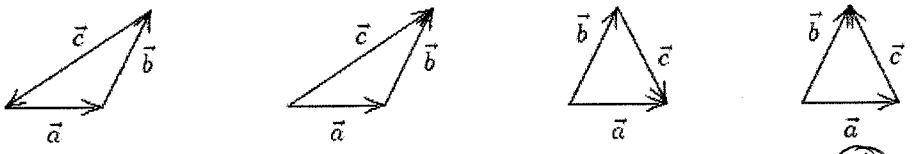
time top: $0 = 6.84 - gt \quad t = .698$

total time = 2× time top $= 1.4\ s$

13) The average speed of an object during a given time interval of time is always:

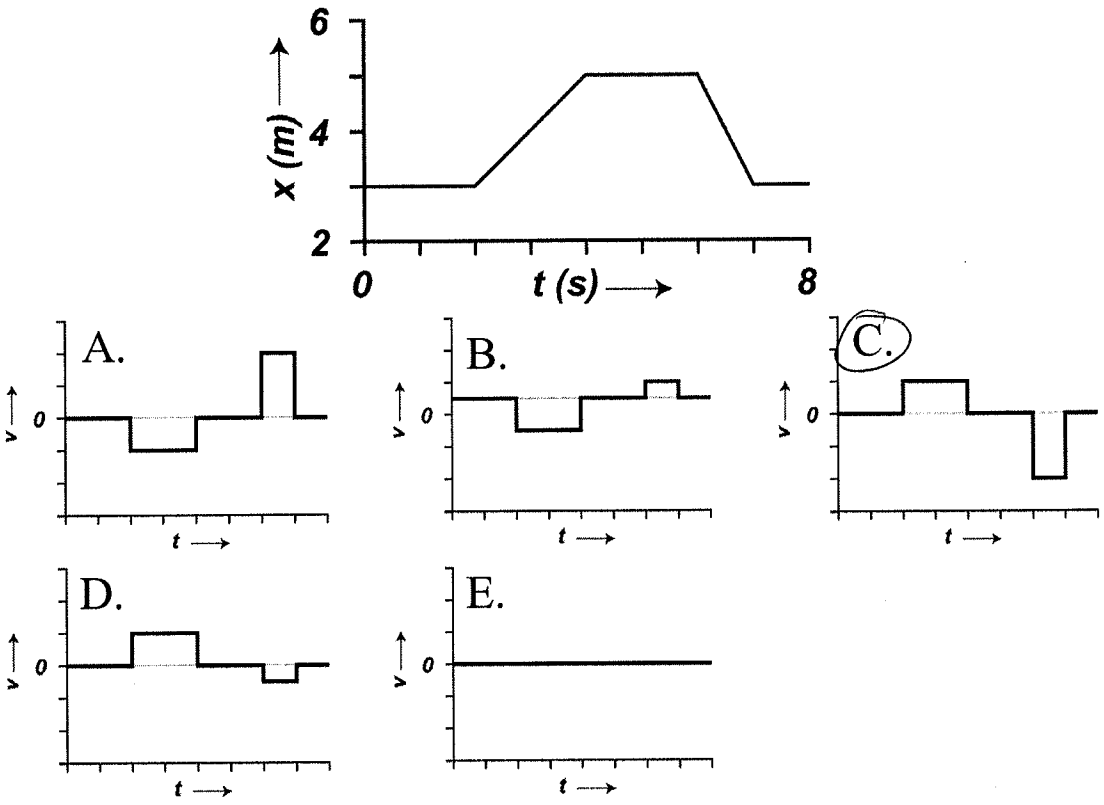
a. The magnitude of its average velocity over the interval
b. The distance covered during the time interval divided by the time interval
c. One-half its speed at the end of the interval
d. Its acceleration multiplied by the time interval
e. One-half its acceleration multiplied by the time interval

14) The vectors $\vec{a}$, $\vec{b}$ and $\vec{c}$ are related by $\vec{c} = \vec{b} - \vec{a}$, which diagram below illustrates this?



E None of the above

15) Which velocity vs time graph corresponds to the following graph of position vs time?



16) Two balls are hit with the same speed, but at different angles. A blue ball is hit at an angle of 30° above the horizontal and a red ball is hit an angle of 60° above the horizontal. The blue ball is twice as heavy as the red ball. If you compare the highest point in the trajectory of the blue ball with the highest point in the trajectory of the red ball, which statement below is true about the velocities and accelerations of the balls?

	Ball with greatest velocity at the apex of their respective flights	Ball with greatest acceleration at the apex of their respective flights
a.	blue	blue
b.	red	red
(c.)	blue	same
d.	red	same
e.	same	same

$V_y = 0$ at top

$V_{bx} = V \cos 30^\circ = .866\,V$

$V_{rx} = V \cos 60^\circ = .5\,V$

$V_{bx} > V_{rx}$ so V_{blue} larger at top

always same acceleration