Solutions

Physics 2414
Midterm #1 – Fall 2012

Version A

Multiple choice (6 points each)

1) An equation for a parameter Q is found to be $Q=3T^4$. If T is measured to be 2.0 ± 0.1 cm what is the value and uncertainty on Q?
   a. 48 ± 0.05 cm^4
   b. 48 ± 2.4 cm^4
   (c) 48 ± 9.6 cm^4
   d. 48 ± 2.0 cm^4
   e. 48 ± 0.1 cm^4

$Q = 3(2)^4 = 48$
% unc on $T = \frac{0.1}{2} = 5\%$
% unc on $Q = 4 \cdot 5\% = 20\%$
unc on $Q = 20\% \cdot 48 = 9.6$

2) A rock is thrown upward from the surface of the earth. The rock rises to some maximum height and falls back toward the surface of the earth. Which statement concerning this situation is true? Neglect air resistance.
   a. As the ball rises, its acceleration vector points upward
   (b) The ball is a "freely falling body" for the duration of its flight
   c. The acceleration of the ball is 0 when the ball is at its highest point
   d. The speed of the ball is negative while the ball falls back toward the earth
   e. The velocity and acceleration of the ball always point in the same direction

3) Which one of the following situations is not possible
   a. A body has zero velocity and non-zero acceleration
   b. A body travels with a northward velocity and a northward acceleration
   c. A body travels with a northward velocity and a southward acceleration
   (d) A body travels with a constant velocity and a time-varying acceleration
   e. A body travels with a constant acceleration and a time-varying velocity

4) The area under a curve in an acceleration versus time graph gives
   a. Acceleration
   (b) Velocity
   c. Displacement
   d. Position
   e. None of the above

5) A car starts from rest and accelerates at 4.0 m/s^2 for 5.0s, then maintains that velocity for 10s, and then decelerates at the rate of 2.0 m/s^2 for 4.0s. What is the final speed of the car?
   a. 20 m/s
   b. 16 m/s
   (c) 12 m/s
   d. 10 m/s
   e. 8 m/s

$V = V_0 + at$
$V_0 = 0$ so $V = (4\ m/s^2)(5\ s) = 20\ m/s$
V stays at 20 m/s for 10s
$V = 20\ m/s - (2\ m/s^2)(4\ s) = \underline{12\ m/s}$

$a_1 = 3\,m/s^2$
$a_2 = 5\,m/s^2$

$x = \frac{1}{2}a_1 t_1^2 \quad x = \frac{1}{2}a_2 t_2^2 \quad t_2 = t_1 - 6$

set equal

$\frac{1}{2}3t_1^2 = \frac{1}{2}5(t_1-6)^2$

$3t_1^2 = 5(t_1^2 - 12t_1 + 36) = 5t_1^2 - 60t_1 + 180$

6) A car starts from rest and accelerates uniformly at 3.0 m/s^2. A second car starts from rest 6.0s later at the same point and accelerates uniformly at 5.0 m/s^2. How long does it take the second car to overtake the first car?
   a. 12.6 s
   b. 19.6 s
   c. 20.6 s
   d. 24.6 s
   e. 26.6 s

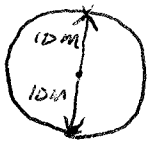
$2t_1^2 - 60t_1 + 180 = 0$

$t_1 = \frac{60 \pm \sqrt{60^2 - 4\cdot 2\cdot 180}}{4}$

$t_1 = \frac{60 \pm 46.5}{4}$ $\quad t_1 = 26.6 \rightarrow t_2 = 20.6$ $\quad t_1 = 3.375 \rightarrow t_2 = -2.625$

t_2 cannot be negative

7) A jogger runs halfway around a circular path of radius 10.0 m. What is the displacement of the jogger?
   a. 0 m
   b. 31.4 m
   c. 5.0 m
   d. 10.0 m
   e. 20.0 m



8) If vector **A** has components A_x=-3.0 and A_y=-4.0 and vector **B** has components B_x=3.0 and B_y=-8.0, what is the magnitude of vector **C**=**A**-**B**?
   a. 13
   b. 16
   c. 144
   d. 7.2
   e. 19.3

$C_x = A_x - B_x = -3 - 3 = -6$

$C_y = A_y - B_y = -4 + 8 = 4$

$C = \sqrt{4^2 + (-6)^2} = 7.2$

9) On Monday there is no wind and you are riding a bike north for 1 mile and then south for 1 mile. Your average speed on Monday is V. On Tuesday there is a wind from the north blowing at V/2 and you again ride your bike north for 1 mile and then south for 1 mile. What is true about the total time for the bike rides?
   a. The time on Tuesday will be same as the time on Monday
   b. The time on Tuesday will be the time on Monday multiplied by 4/3
   c. The time on Tuesday will be the time on Monday multiplied by 3/4
   d. The time on Tuesday will be the time on Monday multiplied 2
   e. The time on Tuesday will be the time on Monday multiplied by ½

monday $t_m = \frac{d}{v} + \frac{d}{v} = \frac{2d}{v}$

tuesday $t = \frac{d}{v + v/2} + \frac{d}{v - v/2}$

$t_T = \frac{d(v - v/2) + d(v + v/2)}{v^2 - v^2/4}$

$t_T = \frac{2dv}{v(v - v/4)} = \frac{2d}{v(1 - 1/4)}$

$t_T = \frac{t_m}{3/4} = \frac{4}{3}t_m$

10) A ball is thrown horizontally from the top of a tower with a speed V. A stone is thrown downward with the same speed V. What is true about the speed of the ball and the stone right before they hit the ground.
   a. The ball has a higher speed than the stone
   b. The stone has a higher speed than the ball
   c. The ball and stone have the same speed
   d. It is impossible to tell from the information given

thrown horizontally

initial $v_x = V$, $v_y = 0$

final $v_x = V$, $v_y^2 = 2gx$

total speed $v_f^2 = V^2 + 2gx$

speed $= \sqrt{V^2 + 2gx}$

thrown downward

initial $v_x = 0$, $v_y = V$

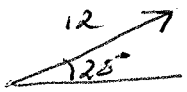
final $v_x = 0$, $v_y^2 = V^2 + 2gx$

speed: $v_f^2 = V^2 + 2gx \Rightarrow$ speed $= \sqrt{V^2 + 2gx}$

define $\downarrow +$

11) A jumper in the long-jump goes into a jump with a speed of 12 m/s at an angle of 20° above the horizontal. How long is the jumper in the air?

a. .42 s
b. .84 s
c. .92 s
d. .76 s
e. .61 s



$V_y = 12 \sin 20° = 4.1$ m/s

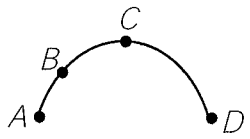
at top $V = 0$

$0 = 4.1 \text{ m/s} - gt \quad t = \frac{4.1}{2} = .418$

total time $.418 * 2 = .84$

12) If your car is accelerating, then
a. Its velocity cannot be zero
b. Its speed cannot be constant
c. Its velocity must be increasing
d. Its position cannot be zero
e. None of the above

13) You hit a golf ball into the air and notice that the ball follows the parabolic path shown in the figure to the right. At which point on the path is the velocity vector changing most rapidly with time?



a. A
b. B
c. C
d. D
e. It is changing at the same rate at all four points

14) A projectile is fired at an angle of 10° below the vertical with an initial speed of 50 m/s. What are the magnitudes of the horizontal and vertical components of the velocity in m/s after 3 seconds.

a. $V_x=49$ $V_y=29$
b. $V_x=49$ $V_y=38$
c. $V_x=50$ $V_y=29$
d. $V_x=49$ $V_y=79$
e. $V_x=50$ $V_y=48$

$V_x = 50 \cos 10° = 49$

$V_y = 50 \sin 10° + gt = 38$

15) The distance d (in meters) that a particle moves can be calculated from $d=at^2+bt^3$ where a and b are constants and t is the time (in seconds). The dimensions on the quantities a and b are

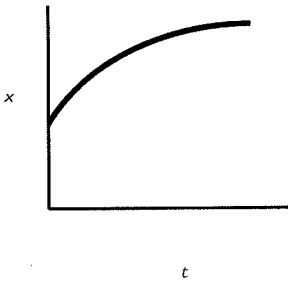
a. m^3/s, m^3/s^2
b. m^3/s, m^2/s^3
c. m/s^2, m^2/s
d. m/s^2, m/s^3
e. m/s, m/s^2

$m = a s^2 + b s^3$

$a: \frac{m}{s^2}$

$b: \frac{m}{s^3}$

16) A train moves along a long straight track. The graph to the right shows a plot of position (x) as a function of time (t) for this train. The graph shows that the train



a. doesn't move at all.
b. speeds up all the time.
c. slows down all the time.
d. moves at a constant velocity.
e. speeds up part of the time and slows down part of the time.