

Name \_\_\_\_\_ Period \_\_\_\_\_ Date \_\_\_\_\_  
**Quiz: Linear Motion {Calculations}**

- Show equations and steps for credit.
- Include units for numerical answers for full credit
- Use  $9.8 \text{ m/s}^2$  for the acceleration of gravity

1. A cart is given a push up a very long ramp. When it is  $0.60 \text{ m}$  from the motion sensor it is moving with an initial, instantaneous velocity of  $2.0 \text{ m/s}$ . It slows with a uniform acceleration of  $0.40 \text{ m/s}^2$ .

a. 4.8 m Calculate its position at  $t=3.0$  seconds.  $x_{(3)} = -0.2(3^2) + 2(3) + 0.6 = 4.8 \text{ m}$

b. 0.98 m/s Calculate the ball's instantaneous velocity when its position, relative to the motion sensor, is  $3.8$  meters.

$$x = -\frac{1}{2}(0.4)t^2 + 2t + 0.6$$

$$= -0.2t^2 + 2t + 0.6$$

$$v^2 = v_0^2 + 2a\Delta x$$

$$v^2 = 2^2 + 2(-0.4)(3.8)$$

c. 5.6 m Calculate the largest position reached by the cart.

$$v = 0 \text{ at } x_{\text{max}} \quad 0^2 = 2^2 + 2(-0.4)(\Delta x)$$

$$5.0 = \Delta x$$

d. 10 sec Calculate the time required for the cart to return to its initial position.

$$v = v_0 + at$$

$$-2 \frac{\text{m}}{\text{s}} = 2 \frac{\text{m}}{\text{s}} + (-0.4) \cdot t$$

4. A spaceship moves with an acceleration of  $v = 4.0t^2 - 800$ . Times are in seconds, and velocities are in  $\text{m/s}$ .

a. -700 m/s Calculate the instantaneous velocity at  $t=5.0$  seconds.

$$v = 4(5^2) - 800$$

b. 40 m/s<sup>2</sup> Calculate the instantaneous acceleration at  $t=5.0$  seconds.

$$\frac{dv}{dt} = 8t \quad 8(5)$$

c. 8 m/s<sup>3</sup> Calculate the jerk at  $t=5.0$  seconds.

$$\frac{da}{dt} = 8 = j$$

d. 14 sec Calculate the time when the instantaneous velocity will be zero (not including  $t=0$ ).

$$0 = 4t^2 - 800 = 0$$

5. A speeding car passes a motionless police car. The speeding car is moving at a constant velocity of  $30.0 \text{ m/s}$ . When it is  $100.0$  meters from the police car, the police car starts to accelerate uniformly at a rate of  $8.0 \text{ m/s}^2$

a. 10 sec Calculate the time when the police car will catch the speeder.  $x = x$

(and 2.5 sec before chase started!)

$$x_p = \frac{1}{2}(8)t^2 = 4t^2$$

$$x_s = 30t + 100$$

$$4t^2 = 30t + 100$$

$$4t^2 - 30t - 100 = 0$$

$$(4t + 10)(t - 10) = 0$$

b. 50 m/s Calculate the relative speed of the cars when the police car catches the speeder.

$$v_s = 30 \frac{\text{m}}{\text{s}}$$

$$v_p = 8t, \quad 8 \cdot 10 = 80 \frac{\text{m}}{\text{s}}$$