I. NO CALCULATOR: A particle moves along a line according to a law of motion,  $t \ge 0$ , where t is measured in seconds and s(t) is measured in feet.

- a. When is the particle at rest? JYA.
- b. When is the particle moving to the right? To the left? JYA.
- c. Is the **velocity** increasing or decreasing at t = 1? JYA.
- d. Is the **velocity** increasing or decreasing at t = 5? JYA.
- e. At t=7 is the speed increasing or decreasing? JYA.

1. 
$$s(t) = t^3 - 6t^2 + 9t$$
 2.  $s(t) = t^3 - 12t^2 + 36t$ 

3. 
$$s(t) = \cos\left(\frac{\pi t}{4}\right), \quad [0, 2\pi)$$
 4.  $s(t) = 0.01t^4 - 0.04t^3$ 

# II. NO CALCULATOR: A particle moves along the x-axis so that its velocity at time t is given by v(t) whose graph is shown below. Justify each answer.



### III. CALULATOR: A particle moves along a line according to a law of motion, $t \ge 0$ . The velocity function is given.



## Part I: Odd Answers

1.

- a) t=1, 3 because v(t)=0
- b) Right:  $(0, 1)U(3, \infty)$  since v(t) > 0, Left: (1, 3) since v(t) < 0
- c) The velocity is decreasing at t=1 because a(1)<0.
- d) The velocity is increasing at t=5 because a(5) > 0.
- e) At t=7 the speed is increasing because v(7)>0 and a(7)>0.

3.

- a) t=0, 4 because v(t)=0
- b) Right:  $(4, 2\pi)$  since v(t)>0, Left: (0, 4) since v(t)<0
- c) The velocity is decreasing at t=1 because a(1)<0.
- d) The velocity is increasing at t=5 because a(5)>0.
- e) At t=7 the speed is increasing because v(7)>0 and a(7)>0.

## Part II Answers

- 1 t = 0, 3, 5; v(t) = 0 at these times
- 2 t = 3, 5; v(t) = 0 at these times and v(t) changes signs at these times
- 3 (3, 5); v(t) > 0 on this interval
- 4 (0, 3) and (5, 6); v(t) < 0 on these intervals
- 5 (1, 3) and (4, 5); v(t) and the slope of v(t) have opposite signs
- (0, 1) and (3, 4) and (5, 6); v(t) and the slope of v(t) have the same signs
- 7 (1, 4); the slope of v(t) is positive
- 8 (0, 1) and (4, 6); the slope of v(t) is negative
- 9 t = 0, 2, 4, 6; v(t) = 0 at these times
- 10 t = 2, 4, 6; v(t) = 0 at these times and v(t) changes signs at these times
- 11 (2, 4) and (6, 7) v(t) > 0 on this interval
- 12 (0, 2) and (4, 6); v(t) < 0 on these intervals
- (1, 2) and (3, 4) and (5, 6); v(t) and the slope of v(t) have opposite signs
- (0, 1) and (2, 3) and (4, 5) and (6, 7); v(t) and the slope of v(t) have the same signs
- 15 (1, 3) and (5, 7); the slope of v(t) is positive
- 16 (0, 1) and (3, 5); the slope of v(t) is negative

### Part III Answers

1.

- a) Left: (1.772, 2.507) since v(t)<0
- b) Right: (0, 1.772)U(2.507, 3) since v(t)>0
- c) Yes, since f'(1.7)>0 and f''(1.7)<0
- d) No, since f'(2.4)>0 and f''(2.4)>0
- e) t=1.772 and 2.507 since v(t)=0

f) -0.230