Motion

For #1 – 5: A particle moves along a line such that its position is $s(t) = 2t^3 - 9t^2 + 12t - 4$, for $t > 0$.

1) Find when particle is at rest. $t = 1, 2$

2) Find all t for which the velocity is increasing. $(3/2, \infty)$

3) Find all t for which the speed of the particle is increasing. $(1, 3/2) \cup (2, \infty)$

4) Find the speed when $t = 3$ $|v(3)| = 12$

5) Find the acceleration at $t = 1$
$a(1) = 6$

$v(t) = 6t^2 - 18t + 12 = 0$
$6(t^2 - 3t + 2) = 0$
$6(t-2)(t-1) = 0$
$t = 1, 2$

$v(t)$ $\xrightarrow{\;+\;\;-\;\;+\;}$ at $0 \quad 1 \quad 2$

$a(t) = 12t - 18 = 0$
$t = 3/2$

$a(t)$ $\xrightarrow{\;-\;\;+\;}$ at $0 \quad 3/2$

For #6 – 10: A particle moves along a line such that its position is $s(t) = t^4 - 4t^3$.

6) Find velocity in terms of t $v(t) = 4t^3 - 12t^2$

7) Find all t for which the velocity is increasing. $(-\infty, 0) \cup (2, \infty)$

8) Find all t for which the speed of the particle is increasing. $(0, 2) \cup (3, \infty)$

9) Find the speed when $t = 3$ $|v(3)| = 0$

10) Find the acceleration at $t = 2$.
$a(2) = 0$

$v(t) = 4t^3 - 12t^2 = 0$
$4t^2(t - 3) = 0$
$t = 0, 3$

$v(t)$ $\xrightarrow{\;-\;\;-\;\;+\;}$ at $0 \quad 3$

$a(t) = 12t^2 - 24t = 0$
$12t(t - 2) = 0$
$t = 0, 2$

$a(t)$ $\xrightarrow{\;+\;\;-\;\;+\;}$ at $0 \quad 2$
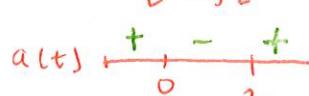
For #11 – 14: The position of a particle moving along a straight line is given by $s = t^3 - 6t^2 + 12t - 8$.

11) The position of the particle is increasing:

A) $t < 2$
B) all t except $t = 2$ (circled)
C) $1 < t < 3$
D) $t < 1$ or $t > 3$
E) $t > 2$

$v(t) = 3t^2 - 12t + 12 = 0$
$3(t^2 - 4t + 4) = 0$
$3(t-2)(t-2) = 0$
$t = 2$

$v(t)$ $\xrightarrow{\;+\;\;+\;}$ at 2

12) The minimum value of the speed is

A) 1
B) 2
C) 3
D) 0
E) none of these

13) The acceleration is positive for

A) $t > 2$ (circled)
B) all t except $t = 2$
C) $t < 2$
D) $t < 1$ or $t > 2$
E) none of these

$a(t) = 6t - 12 = 0$
$6(t - 2) = 0$
$t = 2$

$a(t)$ $\xrightarrow{\;-\;\;+\;}$ at 2

14) The speed of the particle is decreasing for

A) $t > 2$
B) $t < 3$
C) all t
D) $t < 1$ or $t > 2$
E) none of these (circled)

when $v(t)$ & $a(t)$ have same signs

For #15 – 17: A particle moves along a horizontal line, and its position at time t is $s = t^4 - 6t^3 + 12t^2 + 3$.

15) The particle is at rest when t is equal to

A) 1 or 2
B) 0 (circled)
C) 9/4
D) 0, 2, or 3
E) none of these

$v(t) = 4t^3 - 18t^2 + 24t = 0$
$2t(2t^2 - 9t + 12) = 0$
$t = 0 \qquad t = $ no real roots

$v(t)$ $\xrightarrow{\;-\;\;+\;}$ at 0
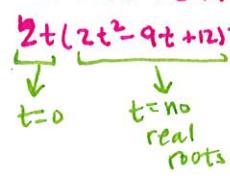
16) The velocity, v, is increasing when

A) $t > 1$
B) $1 < t < 2$
C) $t < 2$
D) $t < 1$ or $t > 2$ (circled)
E) $t > 0$

$a(t) = 12t^2 - 36t + 24 = 0$
$12(t^2 - 3t + 2) = 0$
$12(t - 2)(t - 1) = 0$
$t = 1, 2$

$a(t)$ $\xrightarrow{\;+\;\;-\;\;+\;}$ at $1 \quad 2$

17) The speed of the particle is increasing for

A) $0 < t < 1$ or $t > 2$ (circled)
B) $1 < t < 2$
C) $t < 2$
D) $t < 0$ or $t > 2$
E) $t < 0$

For #18 – 22, use the graph, which shows the velocity of an object moving along a straight line during the time interval $0 \leq t \leq 5$.

18) The object attains its maximum speed when $t = ?$ **2**
19) For what time interval(s) is the speed of the object increasing? **$(1\cdot2, 2) \cup (3, 5)$**
20) The acceleration of the object is positive during what time interval? **$(2, 5)$**
21) For how many times on the interval $(0, 5)$ is the object's acceleration undefined? **3 times** . **($t = 1, 2, 3$)**
22) During the interval $(2, 3)$, what is the object's acceleration (in ft/sec²)? **10 ft/sec²**
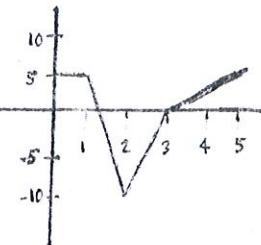
For #23 – 30 use the equation (position) of an object moving along a straight line during $\boxed{t \geq 0}$ Find...

$$\boxed{s(t) = t^3 + t^2 - 8t + 1}$$

Show all work below.

$V(t) = 3t^2 + 2t - 8 = 0$

$(3t - 4)(t + 2) = 0$

$t = 4/3, -2$ ~~✗~~ not in interval

$V(t)$ ⊢————————→
       0   − $\frac{4}{3}$ +

$a(t) = 6t + 2 = 0$

$t = -\frac{1}{3}$ ~~✗~~ not in interval

$a(t)$ ⊢————————→
       0   +

23. when particle is at rest
    $t = 4/3$

24. when particle is moving in positive direction
    $(4/3, \infty)$

25. when particle is moving in negative direction
    $(0, 4/3)$

26. when acceleration is zero
    never

27. when acceleration is +
    $(0, \infty)$

28. when acceleration is −
    never

29. when speeding up
    $(4/3, \infty)$

30. when slowing down
    $(0, 4/3)$