Particle Motion

A particle moves along a horizontal line. Its position function is $s(t)$ for $t \geq 0$. For each problem, find the velocity function $v(t)$, the times t when the particle changes directions, and the intervals of time when the particle is moving left and moving right.

1) $s(t) = -t^3 + 24t^2 - 144t$

$v(t) = -3t^2 + 48t - 144$
Changes direction at: $t = \{4, 12\}$,
Moving left: $0 \leq t < 4$, $t > 12$,
Moving right: $4 < t < 12$

2) $s(t) = -t^3 + 22t^2 - 105t$

$v(t) = -3t^2 + 44t - 105$
Changes direction at: $t = \{3, \frac{35}{3}\}$,

Moving left: $0 \leq t < 3$, $t > \frac{35}{3}$,

Moving right: $3 < t < \frac{35}{3}$

3) $s(t) = t^4 - 15t^3$

$v(t) = 4t^3 - 45t^2$

Changes direction at: $t = \{\frac{45}{4}\}$,

Moving left: $0 < t < \frac{45}{4}$,

Moving right: $t > \frac{45}{4}$

4) $s(t) = t^4 - 8t^3$

$v(t) = 4t^3 - 24t^2$
Changes direction at: $t = \{6\}$,
Moving left: $0 < t < 6$, Moving right: $t > 6$

A particle moves along a horizontal line. Its position function is $s(t)$ for $t \geq 0$. For each problem, find the acceleration function $a(t)$, the times t when the acceleration is 0, and the intervals of time when the particle is slowing down and speeding up.

5) $s(t) = -t^3 + 12t^2$

$a(t) = -6t + 24$
Acceleration zero at: $t = \{4\}$,
$(-)\ a:\qquad 4 < t < 8,$
$(+)\ a:\qquad 0 < t < 4, t > 8$

6) $s(t) = -t^3 + 28t^2 - 196t$

$a(t) = -6t + 56$
Acceleration zero at: $t = \{\frac{28}{3}\}$,

$(-)\ a\qquad : 0 \leq t < \frac{14}{3}, \frac{28}{3} < t < 14,$

$(+)\ a\qquad : \frac{14}{3} < t < \frac{28}{3}, t > 14$

1) $s(t) = -t^4 + 12t^3$

$a(t) = -12t^2 + 72t$

Acceleration zero at: $t = \{0, 6\}$,

$(-)$ a: $\quad 6 < t < 9$,

$(+)$ a: $\quad 0 < t < 6, t > 9$

8) $s(t) = -t^4 + 15t^3$

$a(t) = -12t^2 + 90t$

Acceleration zero at: $t = \{0, \frac{15}{2}\}$,

$(-)$ a: $\frac{15}{2} < t < \frac{45}{4}$,

$(+)$ a: $0 < t < \frac{15}{2}, t > \frac{45}{4}$

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9) $s(t) = -t^3 + 4t^2 + 60t$

$v(t) = -3t^2 + 8t + 60$, $a(t) = -6t + 8$

Changes direction at: $t = \{6\}$,

Moving left: $t > 6$,

Moving right: $0 \leq t < 6$

Acceleration zero at: $t = \{\frac{4}{3}\}$,

$(-)$ a: $\quad \frac{4}{3} < t < 6$,

$(+)$ a: $\quad 0 \leq t < \frac{4}{3}, t > 6$

10) $s(t) = t^4 - 15t^3$

$v(t) = 4t^3 - 45t^2$, $a(t) = 12t^2 - 90t$

Changes direction at: $t = \{\frac{45}{4}\}$,

Moving left: $0 < t < \frac{45}{4}$,

Moving right: $t > \frac{45}{4}$

Acceleration zero at: $t = \{0, \frac{15}{2}\}$,

$(-)$ a: $\quad \frac{15}{2} < t < \frac{45}{4}$,

$(+)$ a: $0 < t < \frac{15}{2}, t > \frac{45}{4}$