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1.) Determine the stationary point, (ii) coordinate of the stationary point and (iii) nature of the stationary point of the curve $y = t^3 - \frac{t^2}{2} - 2t + 4$

(i) @ stationary point $dy/dt = 0$

$$\frac{dy}{dt} = 3t^2 - \frac{2t}{2} - 2$$

$$\frac{dy}{dt} = 3t^2 - t - 2$$

@ stationary point

$$3t^2 - t - 2 = 0$$

$$3t^2 - 3t + 2t - 2 = 0$$

$$3t(t-1) + 2(t-1) = 0$$

$$(3t+2)(t-1) = 0$$

$$3t + 2 = 0 \; ; \; t - 1 = 0$$

$$3t = -2 \; ; \; t = 1$$

$$t = -2/3$$

$$\therefore t = -2/3 \text{ Or } 1$$

(ii) Coordinate of the stationary point.

@ $t = -2/3$

$$y = (-2/3)^3 - (-2/3)^2 - 2(-2/3) + 4$$

$$y = -\frac{8}{27} - \frac{2}{9} + \frac{4}{3} + 4$$

$$= \frac{-8 - 6 + 36 + 108}{27} = \frac{130}{27} = 4.81$$

@ $t = -2/3$

$\left(-\frac{2}{3}, \frac{130}{27}\right)$

@ $t = 1$

$$y = (1)^3 - \frac{(1)^2}{2} - 2(1) + 4$$

$$= 1 - \frac{1}{2} - 2 + 4$$

$$= \frac{1}{2} + 2$$

$$= \frac{5}{2} = 2.5$$

@ $t = 1$

$\left(1, \frac{5}{2}\right)$

(iii) Nature of the stationary point of the curve

$\frac{d^2y}{dt^2}$ where $dy/dt = 3t^2 - t - 2$

$$\frac{d^2y}{dt^2} = 6t - 1$$

at $t = -2/3$

$$\frac{d^2y}{dt^2} = 6\left(-\frac{2}{3}\right) - 1$$

$$= -4 - 1 = -5$$ (this is at maximum point)

@ $t = 1$

$$\frac{d^2y}{dt^2} = 6(1) - 1$$

$$= 5$$ (this is at minimum point).

2) If $y = 2y^2 - 5x^4 - 2 - 7y^3 = 0$, find dy/dx

$$d/dx(2y^2) - d/dx(5x^4) - d/dx(2) - d/dx(7y^3) = 0$$

$$4y\, dy/dx - 20x^3 - 21y^2\, dy/dx = 0$$

$$(4y - 21y^2)\, dy/dx = 20x^3$$

$$\therefore dy/dx = \frac{20x^3}{4y - 21y^2}$$

3) Find dy/dx if $4x^2 + 2xy^3 - 5y^2 = 0$ and evaluate dy/dx when $x = 1$ and $y = 2$

$$dy/dx = d/dx(4x^2) + d/dx(2xy^3) - d/dx(5y^2) = 0$$

$$8x + 6xy^2\, dy/dx + 2y^3 - 10y\, dy/dx = 0$$

$$6xy^2\, dy/dx - 10y\, dy/dx + 8x + 2y^3 = 0$$

$$8x + 2y^3 = dy/dx\,(10y - 6xy^2)$$

$$\therefore dy/dx = \frac{8x + 2y^3}{10y - 6xy^2}$$

Evaluate when $x = 1$ and $y = 2$

$$dy/dx = \frac{8(1) + 2(2)^3}{10(2) - 6(1)(2)^2}$$

$$= \frac{8 + 16}{20 - 24} = \frac{24}{-4} = -6$$