

(2)

$$y + y^2 = \ln|x| + \frac{x^2}{2} + C$$

$$y(1) = 1 \Rightarrow 2 = 0 + \frac{1}{2} + C \Rightarrow C = \frac{3}{2}$$

\therefore Solution of I.V.P. is

$$y^2 + y = \ln|x| + \frac{x^2}{2} + \frac{3}{2}$$

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(a) Rate of change $\frac{dP}{dr} \propto -4\pi r \cdot P^2(r)$

and proportionality is D . $\therefore \frac{dP}{dr} = -4\pi r D P^2$

$$(b) \frac{dP}{dr} = -4\pi r D P^2 \Rightarrow -\frac{dP}{P^2} = 4\pi r D dr \text{ . Integrating}$$

$$\Rightarrow \frac{1}{P} = 2\pi r^2 D + C \quad \text{i.e. } P = \frac{1}{C + 2\pi r^2 D}$$

$$\text{I.C. } P(0) = 1 \Rightarrow P(0) = 1 = \frac{1}{C} \Rightarrow C = 1$$

$$\text{i.e. } P = \frac{1}{1 + 2\pi r^2 D}$$

(c) It means that a new individual just born is guaranteed to survive (i.e. not born and immediately dies) without immediately dying

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