YAKEEN NEET 2.0

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Motion in a Straight Line

Physics | Assignment Solution 03

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Sangharsh Assignment - 3

Motion in Straight line

MR*

$\int v\,dt$

$\int a\,dt = \Delta v$

$\int a\,dt$

x (Position) → velocity (v) → acc^n ($\vec{a}$)

$v = \left(\frac{dx}{dt}\right)$ slope

$\frac{dv}{dt} = a$ = slope

$\frac{da}{dt}$ = Jerk

1. A body is moving with variable acceleration (a) along a straight line. The average acceleration of body in time interval t_1 to t_2 is

(1) ~~$\frac{a[t_2+t_1]}{2}$~~ (2) ~~$\frac{a[t_2-t_1]}{2}$~~

(3) $\frac{\int_{t_1}^{t_2} a\,dt}{t_2+t_1}$ (4) $\frac{\int_{t_1}^{t_2} a\,dt}{t_2-t_1}$ ✓

2. A particle moves in a straight line and its position x at time t is given by $x^2 = 2 + t$. Its acceleration is given by

(1) $\frac{-2}{x^3}$ (2) $-\frac{1}{4x^3}$ ✓

(3) $-\frac{1}{4x^2}$ (4) $\frac{1}{x^2}$

3. A particle moves a distance x in time t according to equation $x = (t + 5)^{-1}$. The acceleration of particle is proportional to **[2010]**

(1) (velocity)$^{3/2}$ (2) (distance)^2

(3) (distance)$^{-2}$ (4) (velocity)$^{2/3}$

7.

8.

9.

10.

$$\langle a \rangle_{Avg} = \frac{\int_{t_1}^{t_2} a\,dt}{\int_{t_1}^{t_2} dt} = \frac{\int_{t_1}^{t_2} a\,dt}{t_2 - t_1} \checkmark$$

$$x^2 = 2 + t$$

$$x = (2+t)^{1/2}$$

$$\frac{dx}{dt} = v = \frac{1}{2}(2+t)^{-1/2}$$

$$a = \frac{1}{2} \times \left(-\frac{1}{2}\right)(2+t)^{-3/2}$$

$$a = -\frac{1}{4}\frac{1}{(2+t)^{\frac{1}{2}\times 3}} = -\frac{1}{4x^3} \checkmark$$

$$v = -1(t+5)^{-2}$$

$$a = +2(t+5)^{-3}$$

4. If acceleration of object $\boxed{a = 2x^{3/2}}$ then find velocity at x where initial velocity at $x = 0$ is 4 m/s.

$a = 2x^{3/2}$

$\frac{dv}{dt} = 2x^{3/2}$ ×

$v\frac{dv}{dx} = 2x^{3/2}$

$\int_4^v v\,dv = \int_{x=0}^{x} 2x^{3/2}\,dx$

$\left(\frac{v^2}{2}\right)_4^v = 2\frac{x^{5/2}}{5/2}$

$\frac{v^2-16}{2} = \frac{4}{5}x^{5/2}$

$\boxed{v^2 = \frac{8}{5}x^{5/2}+16}$ Ans

5. The relation between time t and distance x is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is:

(1) $2\alpha v^3$ ✓
(2) $2\beta v^2$
(3) $2\alpha\beta v^2$
(4) $2\beta^3 v^3$

$t = \alpha x^2 + \beta x$

diff^n w.r.t. 'x'

$\frac{dt}{dx} = \alpha 2x + \beta$

\# $\boxed{v = \frac{1}{2\alpha x+\beta}}$

$a = v\frac{dv}{dx}$

$\frac{dv}{dx} = \frac{2\alpha}{(2\alpha x+\beta)^2}$ divide

6. If $a = 3t^2 + 2t$, initial velocity is 5 m/s. Find the velocity at $t = 4$s. The motion is in straight line, a is acceleration in m/s^2 and t is time in seconds.

$t=0$

4. If acceleration of object $\boxed{a = 2x^{3/2}}$ then find velocity at x where initial velocity at $x = 0$ is 4 m/s.

5. The relation between time t and distance x is $t = \alpha x^2 + \beta x$ where α and β are constants. The retardation is:

(1) $2\alpha v^3$ (2) $2\beta v^2$

(3) $2\alpha\beta v^2$ (4) $2\beta^3 v^3$

$t = \alpha x^2 + \beta x$

diffⁿ w.r.t. 'x'

$\frac{dt}{dx} = \alpha 2x + \beta$

$* \boxed{V = \frac{1}{2\alpha x + \beta}}$

6. If $a = 3t^2 + 2t$, initial velocity is 5 m/s. Find the velocity at $t = 4$s. The motion is in straight line, a is acceleration in m/s^2 and t is time in seconds.

$t = 0$

$a = 3t^2 + 2t$ — (1)

$\int_5^v dv = \int_0^4 3t^2\,dt + \int_0^{t=4} 2t\,dt$

$[v]_5^v = 3\left(\frac{t^3}{3}\right)_0^4 + 2\left(\frac{t^2}{2}\right)_0^4$

$v - 5 = 64 + 16 = 80$

$\boxed{v = 85\,m/s}$

7. A particle in moving in a straight line such that its velocity is given by $v = 12t - 3t^2$, where v is in m/s and t is in seconds. If at $t = 0$, the particle is at the origin, find the displacement at $t = 3$s.

8. The deceleration experienced by a moving motorboat after its engine is shut-off is given by $dv/dt = -kv^3$, where k is a constant. If v_0 is the magnitude of the velocity at shut-off, find the velocity as a function of t.

9. The motion of a body is given by $dv/dt = 6 - 3v$, where v is in m/s. Find

(a) the velocity in terms of t and

(b) terminal velocity. The motion starts from rest.

10. A particle is moving in one dimension (along x axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $x = -3t^3 + 18t^2 + 16t$, where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is ________ m/s.

[1 Feb, 2024 (Shift-I)]

7

$V = 12t - 3t^2$

$\frac{dx}{dt} = 12t - 3t^2$

$\int_{x=0}^{x} dx = \int_{t=0}^{t=3} (12t - 3t^2)\,dt$

$(x_f - x_i) = disp^n = \cancel{12}^{\,6}\frac{t^2}{\cancel{2}} - \cancel{3}\frac{t^3}{\cancel{3}}$

$= 6(t^2)_0^3 - (t^3)_0^3$

$= 6[9-0] - 27$

$= 36 - 27$

$= 9m$

#

$\frac{dv}{dt} = -kv^3$

$\int_{v_0}^{v} \frac{dv}{v^3} = -\int_{t=0}^{t} k\,dt$

$\left(\frac{v^{-3+1}}{-3+1}\right)_{v_0}^{v} = -kt$

$v^{-2} = 2kt$

$\boxed{v^{-2} - v_0^{-2} = 2kt}$

7. A particle in moving in a straight line such that its velocity is given by $v = 12t - 3t^2$, where v is in m/s and t is in seconds. If at $t = 0$, the particle is at the origin, find the displacement at $t = 3$s.

8. The deceleration experienced by a moving motorboat after its engine is shut-off is given by $dv/dt = -kv^3$, where k is a constant. If v_0 is the magnitude of the velocity at shut-off, find the velocity as a function of t.

9. The motion of a body is given by $dv/dt = 6 - 3v$, where v is in m/s. Find

(a) the velocity in terms of t and

(b) $\boxed{\text{terminal velocity}}$. The motion starts from rest.

$\rightarrow v = \text{const} \Rightarrow a = 0$

10. A particle is moving in one dimension (along x axis) under the action of a variable force. It's initial position was 16 m right of origin. The variation of its position (x) with time (t) is given as $\boxed{x = -3t^3 + 18t^2 + 16t,}$ where x is in m and t is in s. The velocity of the particle when its acceleration becomes zero is ________ m/s.

[1 Feb, 2024 (Shift-I)]

$\rightarrow V = -9t^2 + 36t + 16$

$a = -18t + 36 = 0$ ($t = 2$ sec) then Put value of t=2sec in Velocity.

(9)

$\frac{dv}{dt} = 6 - 3v_T$ $\frac{dv}{dt} = 0$

$6 - 3v_T = 0$

$v_T = \frac{6}{3} = 2$ m/s

$\rightarrow \frac{dv}{dt} = 6 - 3v$

$\int_0^v \frac{dv}{6-3v} = \int_{t=0}^{t} dt$

$\frac{\log(6-3v)_0^v}{-3} = t$

$\log(6-3v) - \log 6 = -3t$

$\log_e\left(\frac{6-3v}{6}\right) = -3t$

$\frac{6-3v}{6} = e^{-3t}$

$\Rightarrow 1 - \frac{v}{2} = e^{-3t}$

$\boxed{2(1-e^{-3t}) = v}$ Ans

11. A particle moves in a straight line so that its displacement x at any time t is given by $x^2 = 1 + t^2$. Its acceleration at any time t is x^{-n} where $n = 3$ ________. [6 April, 2024 (Shift-II)]

$$\boxed{x^2 = 1 + t^2} \quad \text{— (1)}$$

diffⁿ w.r.t. 'x'

$$2x = 0 + \frac{dt^2}{dx} \times \left(\frac{dt}{dt}\right)$$

$$\cancel{2}x = \cancel{2}t \times \frac{dt}{dx}$$

$$x = \frac{t}{v} \qquad \boxed{v = \frac{t}{x}} \quad \text{— (1)}$$

$$v = \frac{t}{x} \text{ (division Rule)}$$

diffⁿ w.r.t. 'time'

$$\frac{dv}{dt} = \frac{1 \times x - \frac{dx}{dt} t}{x^2}$$

$$a = \frac{x - vt}{x^2} = \frac{x - \frac{t^2}{x}}{x^2}$$

$$a = \frac{\frac{x^2 - t^2}{x}}{x^2} = \frac{1}{x^3}$$

$$a = \frac{1}{x^3} = x^{-3}$$

12. The position of a particle as a function of time ts, is given by $\boxed{x(t) = at + bt^2 - ct^3}$ where a, b and c are constants. When the particle attains zero acceleration, then its velocity will be: [9 April, 2019 (Shift-II)]

$$v = a + 2tb - c\,3t^2$$

$$\boxed{a = 2b - 3c(2t)}$$

(1) $a + \frac{b^2}{4c}$ (2) $a + \frac{b^2}{c}$

(3) $a + \frac{b^2}{2c}$ (4) $a + \frac{b^2}{3c}$

$$0 = 2b - 6ct$$

$$t = \frac{\cancel{2}b}{3\cancel{6}c} = \frac{b}{3c}$$ Put this time in velo

13. A particle is moving with speed $v = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at $t = 0$) **[12 April, 2019 (Shift-II)]**

(1) $\frac{b^2\tau}{4}$ (2) $\frac{b^2\tau}{2}$

(3) $b^2\tau$ (4) $\frac{b^2\tau}{\sqrt{2}}$

14. The coordinates of a particle moving in a plane are given by $x(t) = a\cos(pt)$ and $y(t) = b\sin(pt)$ where $a, b\ (< a)$ and p are positive constants of appropriate dimensions. Then, **[IIT-JEE 1999]**

(1) The path of the particle is an ellipse

(2) The velocity and acceleration of the particle are normal to each other at $t = \pi/2p$

(3) The acceleration of the particle is always directed towards a focus

(4) The distance traveled by the particle in time interval $t = 0$ to $t = \pi/2p$ is a

15. A particle moves along the x-axis and has its displacement x varying with time t according to the equation $x = c_0(t^2 - 2) + c(t - 2)^2$ where c_0 are constants of appropriate dimensions. Then, which of the following statements is correct?

[03 April, 2025 (Shift-II)]

(1) the acceleration of the particle is $2c_0$

(2) the acceleration of the particle is $2c$

(3) the initial velocity of the particle is $4c$

(4) the acceleration of the particle is $2(c + c_0)$

17.

18.

19.

$V = b\sqrt{x}$ — 1

$\frac{dx}{dt} = b\sqrt{x}$

$\int \frac{dx}{\sqrt{x}} = \int b\, dt$

$\frac{x^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} = bt$

$\frac{x^{1/2}}{1/2} = bt$

$x^{1/2} = \frac{bt}{2}$

$x = \frac{b^2t^2}{4}$

$\frac{dx}{dt} = \frac{b^2(\cancel{2}t)}{\cancel{4}_2} = \frac{b^2t}{2}$

13. A particle is moving with speed $v = b\sqrt{x}$ along positive x-axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at $t = 0$) **[12 April, 2019 (Shift-II)]**

(1) $\frac{b^2\tau}{4}$ (2) $\frac{b^2\tau}{2}$

(3) $b^2\tau$ (4) $\frac{b^2\tau}{\sqrt{2}}$

Next Chapn

14. The coordinates of a particle moving in a plane are given by $x(t) = a\cos(pt)$ and $y(t) = b\sin(pt)$ where a, b ($< a$) and p are positive constants of appropriate dimensions. Then, **[IIT-JEE 1999]** IIT-Adv

(1) The path of the particle is an ellipse ✓

(2) The velocity and acceleration of the particle are normal to each other at $\boxed{t = \pi/2p}$

done in vector

(3) The acceleration of the particle is always directed towards a focus

(4) The distance traveled by the particle in time interval $t = 0$ to $t = \pi/2p$ is a

15. A particle moves along the x-axis and has its displacement x varying with time t according to the equation $x = c_0(t^2 - 2) + c(t - 2)^2$ where c_0 are constants of appropriate dimensions. Then, which of the following statements is correct? **[03 April, 2025 (Shift-II)]**

$V = c_0 2t + c 2(t-2)^1 \times 1$

$V = 2c_0 t + 2c(t-2)$

$a = 2c_0 + 2c$

(1) the acceleration of the particle is $2c_0$ ✗

(2) the acceleration of the particle is $2c$ ✗

(3) the initial velocity of the particle is $4c$ ✗

(4) the acceleration of the particle is $2(c + c_0)$

17.

18.

19.

$\boxed{x = a\cos(pt)}$ $\boxed{y = b\sin(pt)}$

$\frac{x}{a} = \cos(pt)$ $\frac{y}{b} = \sin(pt)$

IIT-Adv

$\frac{x^2}{a^2} + \frac{y^2}{b^2} = \cos^2(pt) + \sin^2(pt)$

$$\boxed{\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1}$$

$\vec{r} = a\cos(pt)\hat{i} + b\sin(pt)\hat{j}$

$\vec{V} = -ap\sin(pt)\hat{i} + bp\cos(pt)\hat{j}$

$\vec{a}$ — — — —

(4) the acceleration of the particle is $2(c + c_0)$

16. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is: (Where v stands for velocity)

[25 July, 2021 (Shift-II)]

(1) $2n^2v^2$ (2) $2mnv^3$

(3) $2mv^3$ (4) $2nv^3$

$t = mx^2 + nx$

dim^n Check

17. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between 1s and 2s is: **[25 July, 2021 (Shift-II)]**

must

(1) $\frac{\alpha}{2}+\frac{\beta}{3}$

(2) $\frac{3}{2}\alpha+\frac{7}{3}\beta$

(3) $\frac{3}{2}\alpha+\frac{7}{2}\beta$

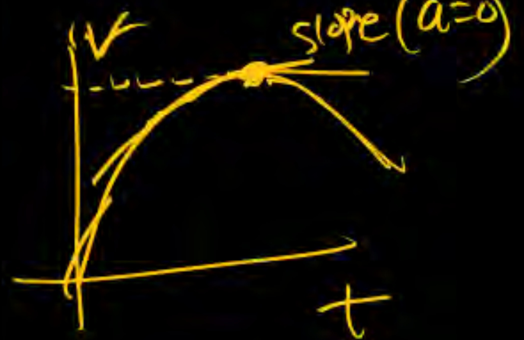
(4) $3\alpha+7\beta$

$V = \alpha t + \beta t^2$

$\int dx = \int \alpha t\, dt + \int \beta t^2\, dt$

$x = \alpha\left(\frac{t^2}{2}\right)_1^2 + \beta\left(\frac{t^3}{3}\right)_1^2$

$= \frac{3\alpha}{2} + \frac{7\beta}{3}$



18. The distance x covered by a particle in one dimensional motion varies with time t as $x^2 = at^2 + bt + c$. If the acceleration of the particle depends on x as x^{-n}, where n is an integer, the value of n is ________. **[9 Jan, 2020 (Shift-1)]**

$\boxed{x^2 = at^2 + bt + c}$ → same do not solve

19. The motion of a particle along a straight line is described by the equation: $x = 8 + 12t - t^3$, where x is in meter and t in second.

must

(i) the initial velocity of particle is 12 m/s.

(ii) the retardation of particle when velocity is zero is 12 m/s^2.

(iii) when acceleration is zero, displacement is 8 m.

(iv) the maximum velocity of particle is 12 m/s.

(1) (i), (ii)

(2) (ii), (iii)

(3) (i), (ii), (iii)

(4) All options are correct

$\boxed{x = 8 + 12t - t^3}$

$\boxed{\frac{dx}{dt} = 0 + 12 - 3t^2 = v}$

$\boxed{a = -6t}$

$0 = -6t$

$V = 12 - 3t^2$

(4) All options are correct

a
d
:

]

20. The position x of a particle with respect to time t along the x-axis is given by $x = 9t^2 - t^3$ where x is in meter and t in second. What will be the position of this particle when it achieves maximum speed along the positive x direction.

[CBSE PMT 2007]

$x_{t=3} = 9(3)^2 - (3)^3$

$= 9 \times 9 - 27 = 54\,m$

$x = 9t^2 - t^3$

$V = 9(2t) - 3t^2$

$\boxed{V = 18t - 3t^2}$

$\frac{dv}{dt} = 18 - 6t = 0$

$18 = 6t$

$\boxed{t = 3\,sec}$

Speed max.

y will be max^m or minima at $\left(\frac{dy}{dx}\right) = 0$

V will be max^m or minima at $a = \left(\frac{dV}{dt}\right) = 0$

21. The deceleration experienced by a moving motor boat, after its engine is cut off, is given by $dv/dt = -k\,v^3$ where k is constant. If v_0 is the magnitude of the velocity at cut-off. The velocity v at a time t after the cut off will be

(1) $\dfrac{v_0}{\sqrt{1+2ktv_0^2}}$ (2) $\dfrac{v_0}{2k}$

(3) $\dfrac{v_0}{\sqrt{1+2kt}}$ (4) $\dfrac{v_0}{\sqrt{2kt}}$

22. An object moving with a speed of 6.25 m/s is decelerated at a rate given by $\dfrac{dv}{dt} = -2.5\sqrt{v}$, where v is the instantaneous speed. The time taken by the object to come to rest, would be **[AIEEE 2011]**

(1) 1 s (2) 2 s

(3) 4 s (4) 8 s

$a = -kv^3$

done

$\dfrac{1}{v^2} - \dfrac{1}{v_0^2} = 2kt$

$\dfrac{1}{v^2} = 2kt + \dfrac{1}{v_0^2}$

$\dfrac{1}{v^2} = \dfrac{2ktv_0^2+1}{v_0^2}$

$v = \sqrt{\dfrac{v_0^2}{2ktv_0^2+1}}$

$\dfrac{v_0}{\sqrt{1+2ktv_0^2}}$

$\dfrac{dv}{dt} = -2.5\sqrt{v}$

$\int_{6.25}^{0} \dfrac{dv}{v^{1/2}} = -\int_{t=0}^{t} 2.5\,dt$

$\dfrac{v^{-\frac{1}{2}+1}}{-\frac{1}{2}+1} = -2.5t$

$(2\sqrt{v})_{6.25}^{0} = -2.5t$

$2(0-\sqrt{6.25}) = -2.5t$

$+2\sqrt{6.25} = +2.5t$

$\sqrt{6.25 \times 4} = 2.5t$

$5 = 2.5t$

$t = 2$

26.

23. The distance covered by a particle varies with time as $x = \frac{k}{b}(1 - e^{-bt})$. The speed of particle at time t is

must

(1) $k\,e^{-bt}$ (2) $kb\,e^{-bt}$

(3) $\left(\frac{k}{b^2}\right)e^{-bt}$ (4) $\left(\frac{k}{b}\right)e^{-bt}$

$x = \frac{k}{b}(1 - e^{-bt})$

$\frac{dx}{dt} = v = \frac{k}{b}\left[0 - e^{-bt}(-b)\right]$

$= \frac{k}{\cancel{b}}\cancel{b}\,e^{-bt}$

$= k\,e^{-bt}$

Ans

24. A particle, initially at rest, starts moving in a straight line with an acceleration $a = 6t + 4$ m/s^2. The distance covered by it in 3s is

must

$t=0$ $(u=0)$

$x \; v \; a$

(1) 15 m (2) 30 m

(3) 45 m (4) 60 m

$\frac{dv}{dt} = 6t + 4$

$\int_0^v dv = \int_0^t 6t\,dt + \int_0^t 4\,dt$

$v = \cancel{6}^{3}\frac{t^2}{\cancel{2}} + 4t$

$v = 3t^2 + 4t$

$\frac{dx}{dt} = 3t^2 + 4t$

$\int dx = \int 3t^2 dt + \int 4t\,dt = \left(t^3 + 2t^2\right)_0^3$

$= \cancel{3}\frac{t^3}{\cancel{3}} + \cancel{4}^{2}\frac{t^2}{\cancel{2}}$

$= 27 + 2(3)^2$

$= 27 + 18$

25. A particle moves with an initial velocity v_0 and retardation αv, where v is its velocity at any time t.

(i) The particle will cover a total distance $\frac{v_0}{\alpha}$.

(ii) The particle will come to rest after time $\frac{1}{\alpha}$.

(iii) The particle will continue to move for a very long time.

(iv) The velocity of the particle will become $\frac{v_0}{2}$ after time $\frac{\ln 2}{\alpha}$.

(1) (i), (ii)

(2) (ii), (iii)

(3) (i), (iii), (iv)

(4) All

$V = V_0 e^{-\alpha t}$

$\int dx = V_0 e^{-\alpha t} dt$

$\text{distance} = \left[\frac{V_0 e^{-\alpha t}}{-\alpha}\right]_0^{\alpha} = \frac{V_0}{-\alpha}[0-1] = \frac{V_0}{\alpha}$

26. The motion of a body is given by the equation $dv/dt = 6 - 3v$; where v is in m/s. If the body was at rest at $t = 0$

(i) the terminal speed is 2 m/s.

(ii) the magnitude of the initial acceleration is $6\ m/s^2$.

(iii) The speed varies with time as $v = 2(1 - e^{-3t})$ m/s

(iv) The speed is 1 m/s, when the acceleration is half the initial value

(1) (i), (ii) (2) (ii), (iii), (iv)

(3) (i), (ii), (iii) (4) All

Solved

$\boxed{u = V_0 \text{ at time } t}$

$acc = -\alpha v$

$a = -\alpha v$

$\frac{dv}{dt} = -\alpha v$

$\int_{V_0}^{V} \frac{dv}{v} = -\int_{t=0}^{t} \alpha\, dt$

$(\log_e v)_{V_0}^{V} = -\alpha t$

$\log v - \log V_0 = -\alpha t$

$\log_e \frac{V}{V_0} = -\alpha t$

$\frac{V}{V_0} = e^{-\alpha t}$

$\boxed{V = V_0 e^{-\alpha t}}$

$t = \alpha$ v will be zero

$\frac{dx}{dt} = V_0 e^{-\alpha t}$

$\int dx = \int V_0 e^{-\alpha t} dt$

$\text{dist}^n = \left(\frac{V_0 e^{-\alpha t}}{-\alpha}\right)_0^{\alpha}$

$= \frac{-V_0}{\alpha}[0-1] = \frac{V_0}{\alpha}$

THANK YOU