SECTION-I

Single Correct Answer Type 15 Q. [3 M (–1)]

1. Find the component of $\vec{r}$ in the direction of $\vec{a}$:–

(A) $\frac{(\vec{r}.\vec{a})\vec{a}}{a^2}$ (B) $\frac{(\vec{r}.\vec{a})\vec{a}}{a}$ (C) $\frac{(\vec{r}\cdot\vec{a})\hat{r}}{r}$ (D) $\frac{(\vec{r}\cdot\vec{a})\hat{r}}{r^2}$

2. The engine of a motorcycle can produce a maximum acceleration 5 m/s^2. Its brakes can produce a maximum retardation 10 m/s^2. If motorcyclist start from point A and reach at point B. What is the minimum time in which it can cover if distance between A and B is 1.5 km. (Given : that motorcycle comes to rest at B)

(A) 30 sec (B) 15 sec (C) 10 sec (D) 5 sec

3. The coordinates of a moving particle at any time t are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time t is given by :- **[AIEEE-2003]**

(A) $3t\sqrt{\alpha^2+\beta^2}$ (B) $3t^2\sqrt{\alpha^2+\beta^2}$ (C) $t^2\sqrt{\alpha^2+\beta^2}$ (D) $\sqrt{\alpha^2+\beta^2}$

4. A particle is thrown upwards from ground. It experiences a constant resistance force which can produce retardation 2 m/s^2. The ratio of time of ascent to the time of descent is [g=10 m/s^2]

(A) 1 : 1 (B) $\sqrt{\frac{2}{3}}$ (C) $\frac{2}{3}$ (D) $\sqrt{\frac{3}{2}}$

5. The acceleration vector along x–axis of a particle having initial speed v_0 changes with distance as $a = \sqrt{x}$. The distance covered by the particle, when its speed becomes twice that of initial speed is:–

(A) $\left(\frac{9}{4}v_0\right)^{\frac{4}{3}}$ (B) $\left(\frac{3}{2}v_0\right)^{\frac{4}{3}}$ (C) $\left(\frac{2}{3}v_0\right)^{\frac{4}{3}}$ (D) $2v_0$

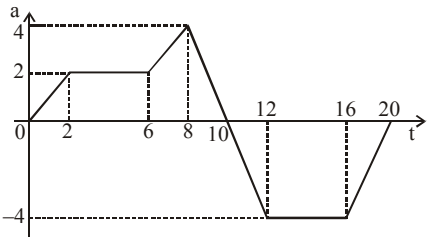
6. The relation between time t and distance x is $t = ax^2 + bx$, where a and b are constants. The acceleration is :- **[AIEEE-2005]**

(A) $-2abv^2$ (B) $2bv^3$ (C) $-2av^3$ (D) $2av^2$

7. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at 2 m/s^2. He reaches the ground with a speed of 3m/s. At what height, did he bail out ? **[AIEEE-2005]**

(A) 91 m (B) 182 m (C) 293 m (D) 111 m

8. If initial velocity of particle is 2 m/s, the maximum velocity of particle from t = 0 to t = 20 sec is :



(A) 20 m/s (B) 18 m/s (C) 22 m/s (D) 24 m/s

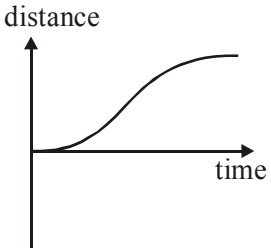
9. An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by

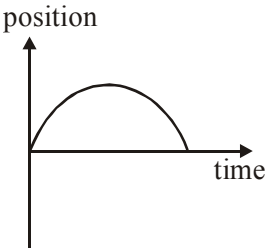
$$\frac{dv}{dt} = -2.5\sqrt{v}$$

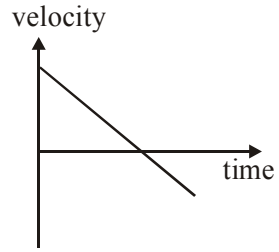
where v is the instantaneous speed. The time taken by the object, to come to rest, would be :- **[AIEEE-2011]**

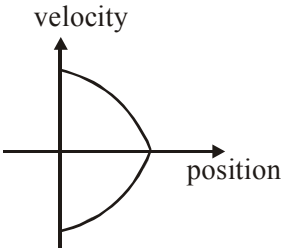
(A) 4 s (B) 8 s (C) 1 s (D) 2 s

10. All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up.
[JEE-Main-2018]

(A) 

(B) 

(C) 

(D) 

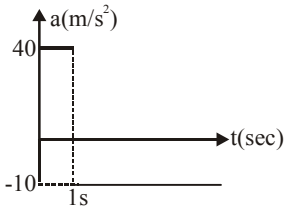
11. Consider an expanding sphere of instantaneous radius R whose total mass remains constant. The expansion is such that the *instantaneous* density ρ remains uniform throughout the volume. The rate of fractional change in density $\left(\frac{1}{\rho}\frac{d\rho}{dt}\right)$ is constant. The velocity v of any point on the surface of the expanding sphere is proportional to :
[JEE Advanced-2017]

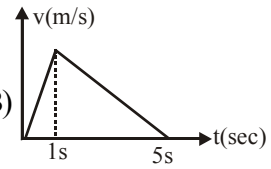
(A) R^3 (B) $\frac{1}{R}$ (C) R (D) $R^{2/3}$

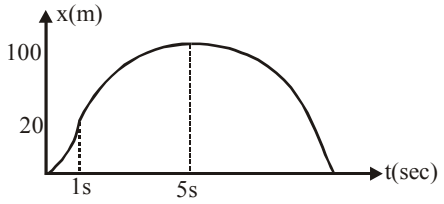
12. A small block slides without friction down an inclined plane starting from rest. Let S_n be the distance travelled from time $t = n - 1$ to $t = n$. Then $\frac{S_n}{S_{n+1}}$ is :-
[IIT-JEE' 2004 (Scr)]

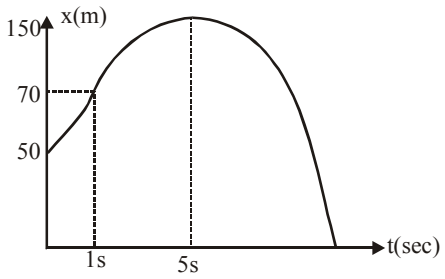
(A) $\frac{2n-1}{2n}$ (B) $\frac{2n+1}{2n-1}$ (C) $\frac{2n-1}{2n+1}$ (D) $\frac{2n}{2n+1}$

13. A diwali rocket was fired from a 50 m tall building. It has a constant acceleration of 40 m/s^2 for 1 sec before it runs out of fuel. Choose the **INCORRECT** Graph.

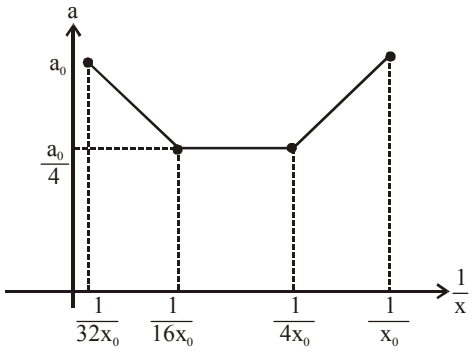
(A) 

(B) 

(C) 

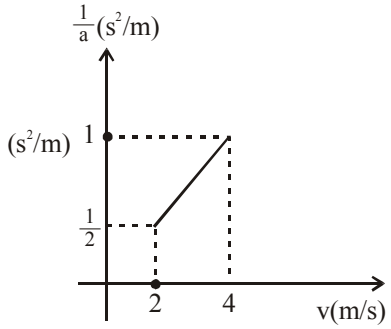
(D) 

14. Figure show acceleration $-\left(\frac{1}{\text{displacement}}\right)$ graph of a particle moving along 'x' axis. Initial velocity of the particle is given as $v_0\left(\sqrt{\frac{a_0x_0}{16}}\right)$. x co-ordinate of the particle is increasing in whole journey. Initial x co-ordinate of the particle is :-



(A) $32\,x_0$ (B) x_0 (C) $4\,x_0$ (D) $16\,x_0$

15. Given graph is $\frac{1}{\text{acceleration}}$ vs velocity graph. If the time interval during which velocity changes from 2m/s to 4m/s is given by Δt seconds. Then find the value of $2\Delta t$:-



(A) 3 (B) 4 (C) 5 (D) 6

Multiple Correct Answer Type 2 Q. [4 M (–1)]

16. In terms of potential difference V, electric current I, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation(s) is(are) **[JEE Advanced-2015]**

(A) $\mu_0 I^2 = \varepsilon_0 V^2$ (B) $\varepsilon_0 I = \mu_0 V$ (C) $I = \varepsilon_0 cV$ (D) $\mu_0 cI = \varepsilon_0 V$

17. The motion of a body is given by the equation $\frac{dv(t)}{dt} = 6.0 - 3\,v(t)$; where v (t) is the speed in m/s & t in sec., if the body was at rest at t = 0 : **[JEE '95, 2]**

(A) the terminal speed is 2.0 m/s

(B) the magnitude of the initial acceleration is 6.0 m/s²

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

(D) the speed is 1.0 m/s when the acceleration is half the initial value .

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question no. 18 to 20

In a certain system of absolute units the acceleration produced by gravity in a body falling freely is denoted by 5, the kinetic energy of a 500 kg shot moving with velocity 400 metres per second is denoted by 2000 & its momentum by 100.

18. The unit of length is :-

(A) 15 m (B) 50 m (C) 25 m (D) 100 m

19. The unit of time is :-

(A) 10 s (B) 20 s (C) 5 s (D) 15 s

20. The unit of mass is :-

(A) 200 kg (B) 400 kg (C) 800 kg (D) 1200 kg

SECTION-II

Numerical Answer Type Question 4 Q.[3(0)]
(upto second decimal place)

1. A bird is at a point P (4, –1, –5) and sees two points P_1 (–1, –1, 0) and P_2 (3, –1, –3). At time t = 0, it starts flying with a constant speed of 10 m/s to be in line with points P_1 and P_2 in minimum possible time t. Find t, if all coordinates are in kilometers.

2. Two particle A and B are moving in same direction on same straight line. A is ahead of B by 20m. A has constant speed 5 m/sec and B has initial speed 30 m/sec and retardation of 10 m/sec^2. Then if x (in m) is total distance travelled by B as it meets A for second time. Then value of x will be.

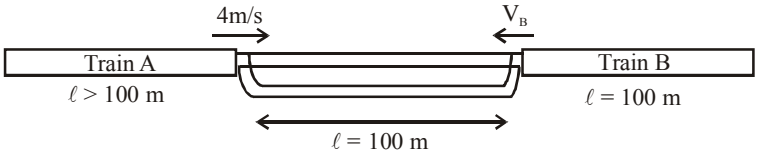
3. A train, travelling at 20 km/hr is approaching a platform. A bird is sitting on a pole on the platform. When the train is at a distance of 2 km from pole, brakes are applied which produce a uniform deceleration in it to stop it at pole. At that instant the bird flies towards the train at 60 km/hr and after touching the nearest point on the train flies back to the pole and then flies towards the train and continues repeating itself. Calculate how much distance will the bird have flown before the train stops?

4. A particle is moving with uniform acceleration along x-axis with initial velocity along positive x. At $t = \frac{3\sqrt{2}}{\sqrt{2}-1}$ s the magnitude of displacement becomes $\frac{1}{3}$ the total distance travelled. By this time the x coordinate of particle is still positive. The instant (in sec) at which displacement becomes zero is

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 1 Q. [4 M (0)]

1. Two trains A and B are moving on a straight track towards each other. At t = 0, the situation is as shown in the diagram below. The driver of train B realises that in order to avoid a collision, B must fit into the side track. Length of side track is equal to the length of the train B and length of train A is large as compared to side track. The train A continues with the same speed of 4 m/s. The magnitude of minimum decleration of train B in order to avoid the collision is $\frac{\alpha}{25}$ m/s^2. Then α is.



SECTION-IV

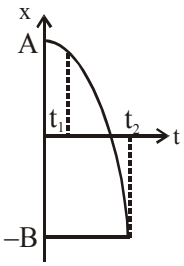
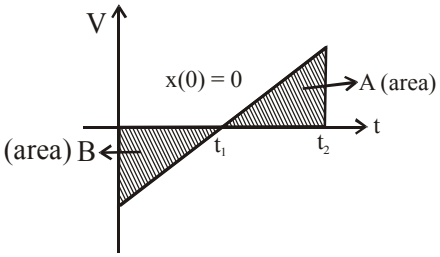
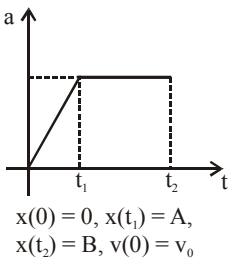
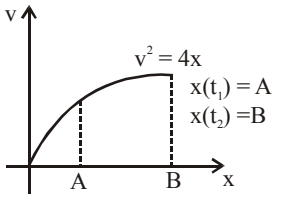
Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Match the column :-

Column–I : Shows graph of One Dimension motion of a particle. Symbols have their usual meaning such as $x(0)$ = initial position, $x(t_1)$ = position at $t = t_1$, $v(0)$ = initial velocity.

Column-II : Shows physical quantities. Displacement and distance are asked for $0 < t < t_2$, and average values are asked for $0 < t < t_2$

V_0, A & B are positive constant

Column-I	**Column-II**
(A) 	(P) |Displacement| = Distance
(B) 	(Q) |Instantaneous velocity| = |Instantaneous speed|
(C) 	(R) |Average velocity| ≤ Average speed
(D) 	(S) Instantaneous acceleration = Average acceleration
	(T) Displacement = A – B and Distance = A + B

Subjective Type 4 Q. [4 M (0)]

1. A driver takes 0.20 s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of 6.0m/s^2, find the distance travelled by the car after he sees the need to put the brakes on

2. The length, breadth & height of a cuboid depends on time t as $L = 1 + \sin t$; $b = t^2 - 1$; $h = (t + 1)$ find the rate of change of volume with time at $t = \frac{\pi}{2}$ sec.

3. A particle starts from rest at t = 0 and x = 0 to move with a constant acceleration = +2 m/s^2, for 20 seconds. After that, it moves with –4 m/s^2 for the next 20 seconds. Finally, it moves with positive acceleration for 10 seconds until its velocity becomes zero.

(a) What is the value of the acceleration in the last phase of motion?

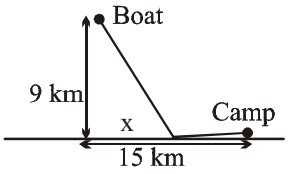
(b) What is the final x-coordinate of the particle?

(c) Find the total distance covered by the particle during the whole motion.

4. A fishing boat is anchored 9 km away from the nearest point on shore. A messenger must be sent from the fishing boat to a camp, 15 km from the point on shore closest to the boat. If the messenger can walk at a speed of 5km per hour and can row at 4 km per hour.

(i) Form an expression relating time taken to reach the camp t with distance x on shore where he lands.

(ii) At what point on shore must he land in order to reach the camp in the shortest possible time?



SECTION-I

Single Correct Answer Type **15 Q. [3 M (–1)]**

1. Ans. (A) **2. Ans. (A)** **3. Ans. (B)** **4. Ans. (B)**
5. Ans. (B) **6. Ans. (C)** **7. Ans. (C)** **8. Ans. (C)**
9. Ans. (D) **10. Ans. (A)** **11. Ans. (C)** **12. Ans. (C)**
13. Ans. (C) **14. Ans. (B)** **15. Ans. (A)**

Multiple Correct Answer Type **2 Q. [4 M (–1)]**

16. Ans. (A,C) **17. Ans. (A,B,C,D)**

Linked Comprehension Type **(1 Para × 3Q.) [3 M (-1)]**
(Single Correct Answer Type)

18. Ans. (B) **19. Ans. (C)** **20. Ans. (A)**

SECTION-II

Numerical Answer Type Question **4 Q.[3(0)]**
(upto second decimal place)

1. Ans. 100 s **2. Ans.** 50 **3. Ans.** 12 km **4. Ans.** 12

SECTION-III

Numerical Grid Type (Ranging from 0 to 9) **1 Q. [4 M (0)]**

1. Ans. 8

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

1. Ans. (A) → (P,Q,R) ; (B) → (Q,R,S,T) ; (C) → (P,Q,R) ; (D) → (P,Q,R,S)

Subjective Type **4 Q. [4 M (0)]**

1. Ans. 21.75 metre. **2. Ans.** $\frac{3}{2}\pi^2 + 2\pi - 2$ **3. Ans.** (a) 4 m/s^2, (b) 200, (c) 1000 m

4. Ans. (i) $t = \frac{\sqrt{x^2 + (9)^2}}{4} + \frac{15 - x}{5}$ (ii) 3 km from the camp.

GUIDED REVISION

SECTION-I

Single Correct Answer Type **15 Q. [3 M (–1)]**

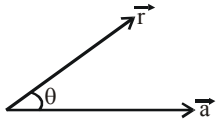
1. Find the component of $\vec{r}$ in the direction of $\vec{a}$:–

$\vec{a}$ की दिशा में $\vec{r}$ का घटक है :-

(A) $\frac{(\vec{r}.\vec{a})\vec{a}}{a^2}$ (B) $\frac{(\vec{r}.\vec{a})\vec{a}}{a}$ (C) $\frac{(\vec{r}\cdot\vec{a})\hat{r}}{r}$ (D) $\frac{(\vec{r}\cdot\vec{a})\hat{r}}{r^2}$

Ans. (A)

Sol.



component of $\vec{r}$ in direction of $\vec{a} = (r\cos\theta)\hat{a}$

$= r\left(\frac{\vec{r}.\vec{a}}{ra}\right)\left(\frac{\vec{a}}{a}\right) = \frac{(\vec{r}.\vec{a})\vec{a}}{a^2}$

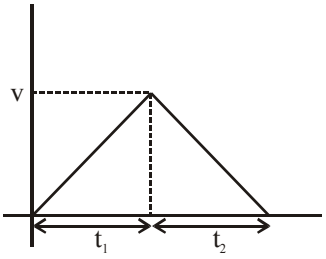
2. The engine of a motorcycle can produce a maximum acceleration 5 m/s^2. Its brakes can produce a maximum retardation 10 m/s^2. If motorcyclist start from point A and reach at point B. What is the minimum time in which it can cover if distance between A and B is 1.5 km. (Given : that motorcycle comes to rest at B)

किसी वाहन का इंजन 5 ms^{-2} का अधिकतम त्वरण उत्पन्न कर सकता है। इसके ब्रेक 10 ms^{-2} का अधिकतम मंदन उत्पन्न कर सकते हैं। यदि वाहक बिन्दु A से गति प्रारम्भ करता है तथा बिन्दु B तक पहुँचता है। वह न्यूनतम समय जिसमें यह A व B के मध्य 1.5 km की दूरी तय कर लेगा, है- (दिया है : वाहन बिन्दु B पर विरामावस्था में आ जाता है।)

(A) 30 sec (B) 15 sec (C) 10 sec (D) 5 sec

Ans. (A)

Sol. $1500 = \frac{1}{2}\times v\times t_1 + \frac{1}{2}\times v\times t_2$



$\frac{3000}{v} = t_1 + t_2$ ... (i)

$t_1 = \frac{v}{5}$

$t_2 = \frac{v}{10}$

$t_1 + t_2 = \frac{3v}{10}$ ... (ii)

from equation (i) and (ii)

$t_1 + t_2 = 30$ sec

3. The coordinates of a moving particle at any time t are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time t is given by :-

किसी समय t पर किसी गतिमान कण के निर्देशांक $x = \alpha t^3$ व $y = \beta t^3$ हैं। समय t पर कण की चाल है–

[AIEEE-2003]

(A) $3t\sqrt{\alpha^2+\beta^2}$ (B) $3t^2\sqrt{\alpha^2+\beta^2}$ (C) $t^2\sqrt{\alpha^2+\beta^2}$ (D) $\sqrt{\alpha^2+\beta^2}$

Ans. (B)

Sol. $\vec{v} = \dfrac{dx}{dt} = \dfrac{d\left(\alpha t^3\right)}{dt}$

$\vec{v}_x = \alpha 3t^2$

$\vec{v}_y = \beta 3t^2$

$3t^2\sqrt{\alpha^2+\beta^2}$

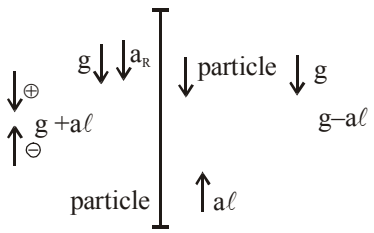
4. A particle is thrown upwards from ground. It experiences a constant resistance force which can produce retardation 2 m/s^2. The ratio of time of ascent to the time of descent is [g=10 m/s^2]

एक कण को धरातल से उर्ध्वाधर ऊपर की ओर फेंकने पर यह एक नियत प्रतिरोधी बल का अनुभव करता है, जिसके कारण उसमें उत्पन्न मंदन 2 m/s^2 है, तो कण के ऊपर जाने व नीचे आने के समयों का अनुपात है:– [g=10 m/s^2]

(A) 1 : 1 (B) $\sqrt{\dfrac{2}{3}}$ (C) $\dfrac{2}{3}$ (D) $\sqrt{\dfrac{3}{2}}$

Ans. (B)

Sol.



$h = \dfrac{1}{2}(g-a)(t_D)^2$ ... (i) (by using $s = ut + \dfrac{1}{2}at^2$)

$h = \dfrac{1}{2}(g+a)(t_u)^2$ ... (ii) (by using $s = vt - \dfrac{1}{2}at^2$)

by dividing (i) and (ii)

$\dfrac{10+2}{10-2} = \left(\dfrac{t_D}{t_u}\right)^2$

$\dfrac{12}{8} = \left(\dfrac{t_D}{t_u}\right)^2$

$$\frac{t_u}{t_D} = \sqrt{\frac{2}{3}}$$

5. The acceleration vector along x–axis of a particle having initial speed v_0 changes with distance as $a = \sqrt{x}$. The distance covered by the particle, when its speed becomes twice that of initial speed is:–

प्रारम्भिक चाल v_0 वाले एक कण का x- अक्ष के अनुदिश त्वरण सदिश, दूरी के साथ $a = \sqrt{x}$ के अनुसार परिवर्तित होता है। जब कण की चाल प्रारम्भिक चाल की दुगुनी हो जाये उस समय कण द्वारा तय की गई दूरी होगी:-

(A) $\left(\frac{9}{4}v_0\right)^{\frac{4}{3}}$ (B) $\left(\frac{3}{2}v_0\right)^{\frac{4}{3}}$ (C) $\left(\frac{2}{3}v_0\right)^{\frac{4}{3}}$ (D) $2v_0$

Ans. (B)

Sol. $\int_{v_0}^{2v_0} vdv = \int adx = \int_0^x \sqrt{x}dx$

$$\frac{4v_0^2 - v_0^2}{2} = \frac{2}{3}x^{3/2}$$

$$x = \left(\frac{3v_0}{2}\right)^{4/3}$$

6. The relation between time t and distance x is $t = ax^2 + bx$, where a and b are constants. The acceleration is :-

[AIEEE-2005]

समय t तथा दूरी x के बीच सम्बन्ध को $t = ax^2 + bx$ द्वारा व्यक्त किया गया है, यहाँ a तथा b स्थिरांक हैं। यहाँ त्वरण है :-

(A) $-2abv^2$ (B) $2bv^3$ (C) $-2av^3$ (D) $2av^2$

Ans. (C)

Sol. $t = ax^2 + bx$

$1 = 2ax\ v + bv$

$$v = \frac{1}{2ax + b}$$

$$\frac{dv}{dx} = -\frac{1}{(2ax + b)^2} \times 2a\frac{dh}{dt}$$

$a = -v^2 2a \times v$

$a = -2av^3$

7. A parachutist after bailing out falls 50 m without friction. When parachute opens, it decelerates at 2 m/s^2. He reaches the ground with a speed of 3m/s. At what height, did he bail out ?

[AIEEE-2005]

कोई पैराशूटिस्ट पैराशूट सहित कूदने पर 50 m बिना किसी घर्षण के गिरता है। पैराशूट के खुलने पर उसमें 2 m/s^2 का मंदन होता है तथा वह 3 m/s की चाल से पृथ्वी पर पहुँचता है। किस ऊँचाई पर वह पैराशूट सहित कूदा था :-

(A) 91 m (B) 182 m (C) 293 m (D) 111 m

Ans. (C)

Sol. $v^2 - u^2 = 2as$

$v^2 = 2 \times 9.8 \times 50$

$v^2 = 980$

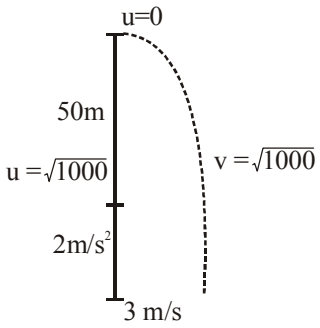
$v = \sqrt{980}$

$v^2 - u^2 = 2as$

$980 - 9 = 2 \times 2s$

$971 = 4s$

$s = \dfrac{971}{4} = 242.75$

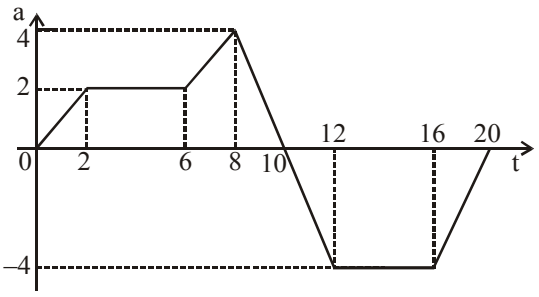


Total height = 242.75 + 50 = 292.75 m ≈ 293 m

N_Sheet_18/

8. If initial velocity of particle is 2 m/s, the maximum velocity of particle from t = 0 to t = 20 sec is :

प्रदर्शित चित्र में यदि कण का प्रारम्भिक वेग 2 m/s हो तो t = 0 से t = 20 sec के लिये कण का अधिकतम वेग होगा :-



(A) 20 m/s (B) 18 m/s (C) 22 m/s (D) 24 m/s

Ans. (C)

Sol. $v_i = 2$ m/s

For $0 \le t \le 10$, Δv = Area = 20 m/s

$\therefore v_{max} = v_i + \Delta v = 2 + 20 = 22$ m/s

9. An object, moving with a speed of 6.25 m/s, is decelerated at a rate given by

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

where v is the instantaneous speed. The time taken by the object, to come to rest, would be :-

6.25 m/s की चाल से गतिशील एक वस्तु के मन्दन की दर इससे दी जाती है।

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

जहाँ v तात्क्षणिक चाल है। वस्तु को विराम अवस्था में आने में लगा समय है :- **[AIEEE-2011]**

(A) 4 s (B) 8 s (C) 1 s (D) 2 s

Ans. (D)

Sol. $a = \frac{dv}{dt} = -2.5\sqrt{v}$

$$\therefore \int_{6.25}^{0} \frac{dv}{\sqrt{v}} = -2.5\int_{0}^{t} dt$$

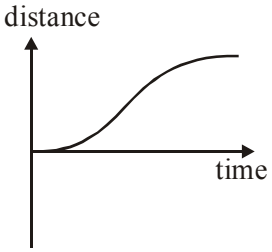
$\Rightarrow t = 2$ sec

10. All the graphs below are intended to represent the same motion. One of them does it incorrectly. Pick it up.

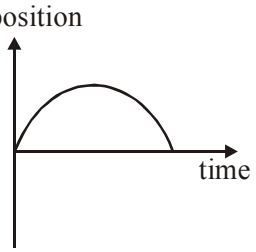
दिये गये सारे ग्राफ एक ही गति को दर्शाते है। कोई एक ग्राफ उस गति को गलत तरीके से दर्शाता हैं वह ग्राफ है :

[JEE-Main-2018]

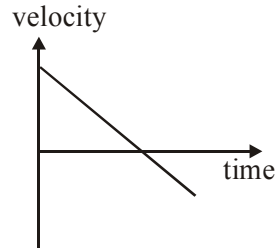
(A)



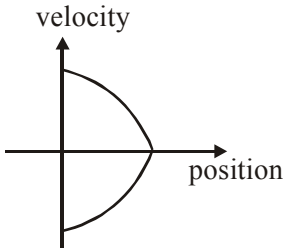
(B)



(C)

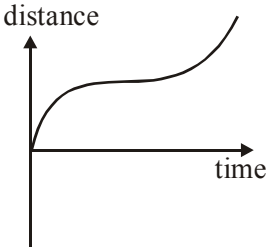


(D)



Ans. (A)

Sol. In this question option (2) and (4) are the corresponding position - time graph and velocity –position graph of option (3) and its distance – time graph is given as



Hence incorrect graph is option (1)

11. Consider an expanding sphere of instantaneous radius R whose total mass remains constant. The expansion is such that the *instantaneous* density ρ remains uniform throughout the volume. The rate of fractional change in density $\left(\frac{1}{\rho}\frac{d\rho}{dt}\right)$ is constant. The velocity v of any point on the surface of the expanding sphere is proportional to :

एक प्रसारी गोले (expanding sphere) का तात्क्षणिक (instantaneous) त्रिज्या R एवं द्रव्यमान M अचर रहता है। प्रसार के दौरान इसका तात्क्षणिक घनत्व ρ पूरे आयतन में एकसमान रहता है एवं आंशिक घनत्व की दर $\left(\frac{1}{\rho}\frac{d\rho}{dt}\right)$ अचर (constant) है। इस प्रसारी गोले के पृष्ठ पर एक बिन्दु का वेग v निम्न के समानुपाती होगा : **[JEE Advanced-2017]**

(A) R^3 (B) $\frac{1}{R}$ (C) R (D) $R^{2/3}$

Ans. (C)

Sol. Density of sphere is $\rho = \frac{m}{v} = \frac{3m}{4\pi R^3}$

$$\Rightarrow \frac{1}{\rho}\frac{d\rho}{dt} = -\frac{3}{R}\frac{dR}{dt}$$

Since $\Rightarrow \frac{1}{\rho}\frac{d\rho}{dt}$ is constant

$$\therefore \frac{dR}{dt} \propto R$$

Velocity of any point on the circumfrence V is equal to $\frac{dR}{dt}$ (rate of change of radius of outer layer).

12. A small block slides without friction down an inclined plane starting from rest. Let S_n be the distance travelled from time $t = n - 1$ to $t = n$. Then $\frac{S_n}{S_{n+1}}$ is :- **[IIT-JEE' 2004 (Scr)]**

एक छोटा ब्लॉक स्थिरावस्था से प्रारम्भ करके एक आनत तल से बिना घर्षण के फिसलता है। ब्लॉक द्वारा t = n – 1 से t = n में तय दूरी S_n हो तो $\frac{S_n}{S_{n+1}}$ होगा :-

(A) $\frac{2n-1}{2n}$ (B) $\frac{2n+1}{2n-1}$ (C) $\frac{2n-1}{2n+1}$ (D) $\frac{2n}{2n+1}$

Ans. (C)

Sol. $S_n = S_n - S_{n-1}$

$$= \mu n + \frac{1}{2}an^2 - \left((n-1)\mu + \frac{1}{2}a(n-1)^2\right) = \frac{an^2}{2} - \frac{a(n-1)^2}{2} = \frac{an^2 - a(n^2+1-2n)}{2}$$

$$= \frac{an^2 - an^2 - a + 2an}{2} = \frac{2an - a}{2}$$

$S_{n+1} = S_{n+1} - S_{n-1+1}$

$$= \frac{1}{2}a(n+1)^2 - \left(\frac{an^2}{2}\right) = \frac{a\left(n^2+1+2n\right)-an^2}{2} = \frac{a+2an}{2}$$

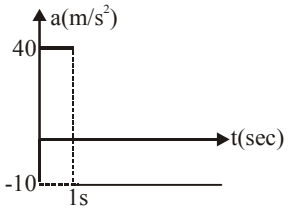
$$\frac{S_n}{S_{n+1}} = \frac{2an-\frac{a}{2}}{2an+\frac{a}{2}} = \frac{2n-1}{2n+1}$$

N_Sheet_18/

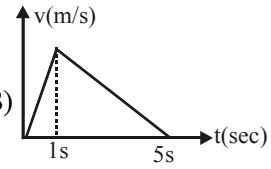
13. A diwali rocket was fired from a 50 m tall building. It has a constant acceleration of 40 m/s^2 for 1 sec before it runs out of fuel. Choose the **INCORRECT** Graph.

एक पटाखा रॉकेट को 50 m ऊंची ईमारत से दागा जाता है। ईंधन खत्म होने से पहले 1 s तक इसका नियत त्वरण 40 m/s^2 है। गलत ग्राफ चुनिये।

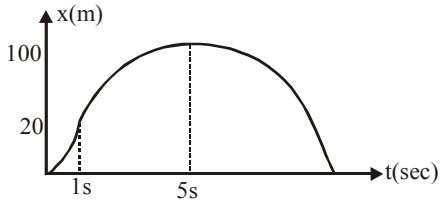
(A)



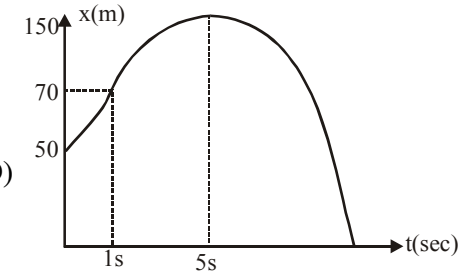
(B)



(C)

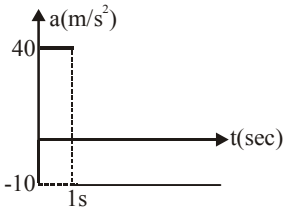


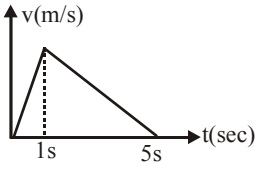
(D)

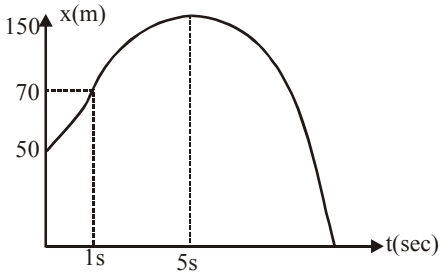


Ans. (C)

Sol. From t = 0 to t = 1 sec acceleration of rocket is 40 m/s^2 and after it runs out of fuel, it falls, freely under gravity to ground with g = –10 m/s^2. Hence correct graphs are





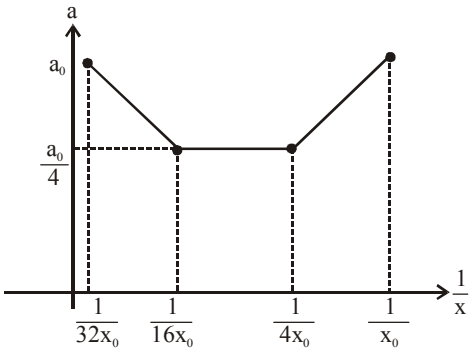


In s-t graph rocket starts from 50 m tall building and reaches ground.

N_Sheet_18/

14. Figure show acceleration $-\left(\frac{1}{\text{displacement}}\right)$ graph of a particle moving along 'x' axis. Initial velocity of the particle is given as $v_0\left(\sqrt{\frac{a_0x_0}{16}}\right)$. x co-ordinate of the particle is increasing in whole journey. Initial x co-ordinate of the particle is :-

चित्र में x अक्ष के अनुदिश गतिशील कण के त्वरण–$\left(\frac{1}{\text{विस्थापन}}\right)$ आरेख को दर्शाया गया है। कण के प्रारम्भिक वेग को $v_0\left(\sqrt{\frac{a_0x_0}{16}}\right)$ द्वारा दिया जाता है। इस सम्पूर्ण गति में कण का x निर्देशांक बढ़ रहा है। कण का प्रारम्भिक x निर्देशांक होगा:-



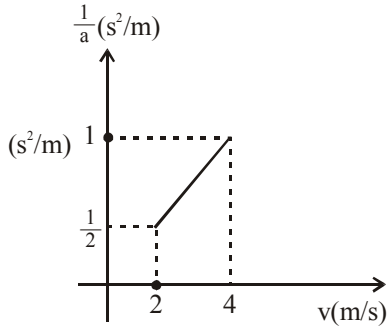
(A) $32\,x_0$ (B) x_0 (C) $4\,x_0$ (D) $16\,x_0$

Ans. (B)

Sol. By looking at symmetry, the best option among the given options is B. It has to be solved by logic

15. Given graph is $\frac{1}{\text{acceleration}}$ vs velocity graph. If the time interval during which velocity changes from 2m/s to 4m/s is given by Δt seconds. Then find the value of $2\Delta t$:-

प्रदर्शित आरेख $\frac{1}{\text{त्वरण}}$ तथा वेग के मध्य आरेख को दर्शाता है। यदि वेग का मान Δt सेकण्ड समयान्तराल के दौरान 2m/s से 4m/s तक परिवर्तित होता हो तो $2\Delta t$ का मान होगा :-



(A) 3 (B) 4 (C) 5 (D) 6

Ans. (A)

Sol. $\frac{1}{a}=\frac{1}{4}v$

$\frac{dt}{dv}=\frac{1}{4}v$

$\int_{t_1}^{t_2} dt=\int_{2}^{4}\frac{v}{4}dv$

$t_2-t_1=\frac{1}{4}\times\frac{1}{2}[16-4]=\frac{3}{2}$

Multiple Correct Answer Type 2 Q. [4 M (–1)]

16. In terms of potential difference V, electric current I, permittivity ε_0, permeability μ_0 and speed of light c, the dimensionally correct equation(s) is(are)

विभवान्तर V, विद्युत धारा I, विद्युतशीलता ε_0, पारगम्यता μ_0 तथा प्रकाश की चाल c के पदों में विमीय रूप से सही विकल्प है (हैं)। **[JEE Advanced-2015]**

(A) $\mu_0 I^2=\varepsilon_0 V^2$ (B) $\varepsilon_0 I=\mu_0 V$ (C) $I=\varepsilon_0 cV$ (D) $\mu_0 cI=\varepsilon_0 V$

Ans. (A,C)

Sol. Using $C=\frac{1}{\sqrt{\mu_0 \in_0}}$ & $R=\sqrt{\frac{\mu_0}{\in_0}}$ we can check the correctness.

(A) $\mu_0 I^2=\in_0 V^2$

$\frac{\mu_0}{\epsilon_0} = \frac{V^2}{I^2} = R^2$

$\therefore R^2 = R^2$ correct

(B) $\epsilon_0 I = \mu_0 V$

$\frac{\epsilon_0}{\mu_0} = \frac{V}{I}$

$\frac{1}{R^2} = R$ not correct

(C) $I = \epsilon_0 cV$

$\frac{I}{V} = \epsilon_0\ c = \frac{\epsilon_0}{\sqrt{\mu_0\ \epsilon_0}}$

$\frac{1}{R} = \sqrt{\frac{\epsilon_0}{\mu_0}} = \frac{1}{R}$ correct

(D) $\mu_0 CI = \epsilon_0 V$

$\frac{\mu_0 C}{\epsilon_0} = \frac{V}{I}$

$\frac{\mu_0}{\epsilon_0}\frac{1}{\sqrt{\mu_0\ \epsilon_0}} = R$

$\therefore\ \frac{1}{\epsilon_0}\sqrt{\frac{\mu_0}{\epsilon_0}} = R \Rightarrow \frac{R}{\epsilon_0} = R$ incorrect

17. The motion of a body is given by the equation $\frac{dv(t)}{dt} = 6.0 - 3\ v(t)$; where v (t) is the speed in m/s & t in sec., if the body was at rest at t = 0 : **[JEE '95, 2]**

(A) the terminal speed is 2.0 m/s

(B) the magnitude of the initial acceleration is 6.0 m/s²

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

(D) the speed is 1.0 m/s when the acceleration is half the initial value .

एक कण समीकरण $\frac{dv(t)}{dt} = 6.0 - 3\ v(t)$ के अनुसार गति करता है, जहां v(t), m/s में चाल तथा t, sec में समय है। यदि कण t = 0 पर विरामावस्था में था तो :- **[JEE '95, 2]**

(A) कण की सीमान्त चाल 2.0 m/s है।

(B) इसके प्रारम्भिक त्वरण का परिमाण 6.0 m/s² है।

(C) इसकी चाल, समय के साथ $v(t) = 2(1 - e^{-3t})$ m/s के अनुसार परिवर्तित होती है।

(D) जब त्वरण प्रारम्भिक मान का आधा हो जाता है, इसकी चाल 1.0 m/s है।

Ans. (A,B,C,D)

Sol. $\frac{dv(t)}{dt} = 6.0 - 3v(t) = 0$ (for terminal speed)

(A) $6 = 3v$

$v = 2$ m/s

(B) initial acceleration at $t = 0$ is $= 6 - 3(0)$

$= 6$ m/s^2

(C) $\frac{dv}{dt} = 6 - 3v \Rightarrow \int_0^v \frac{dv}{6-3v} = \int_0^t dt \Rightarrow \left|\frac{-1}{3}\ell n(6-3v)\right|_0^v = t$

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

$6[1-e^{-3t}] = 3v \Rightarrow v = 2(1-e^{-3t})$

$v = 2(1 - e^{-3t})$ m/s

(D) $a = 3$ m/s^2

$3v = 6 - 3$

$3v = 3$

$v = 1$ m/s

Linked Comprehension Type (1 Para × 3Q.) [3 M (-1)]
(Single Correct Answer Type)

Paragraph for Question no. 18 to 20

In a certain system of absolute units the acceleration produced by gravity in a body falling freely is denoted by 5, the kinetic energy of a 500 kg shot moving with velocity 400 metres per second is denoted by 2000 & its momentum by 100.

निरपेक्ष इकाइयों की किसी विशिष्ट पद्धति में मुक्त रूप से गिरती हुई वस्तु के लिये गुरूत्व के कारण उत्पन्न त्वरण 5 से, 400 m/s से गतिशील 500 किग्रा द्रव्यमान के गोले की गतिज ऊर्जा 2000 से एवं इसका संवेग 100 से निरूपित करें तो:-

18. The unit of length is :-

लम्बाई की इकाई है :-

(A) 15 m (B) 50 m (C) 25 m (D) 100 m

Ans. (B)

19. The unit of time is :-

समय की इकाई है:-

(A) 10 s (B) 20 s (C) 5 s (D) 15 s

Ans. (C)

20. The unit of mass is :-

द्रव्यमान की इकाई है :-

(A) 200 kg (B) 400 kg (C) 800 kg (D) 1200 kg

Ans. (A)

Sol. (18 to 20)

$10\ m/s^2 = 5\dfrac{L}{T^2}$

$\dfrac{1}{2}\times(500kg)(400m/s)^2 = 2000\ ML^2T^{-2}$

$(500\ kg)\ (400\ m/s) = 100\ MLT^{-1}$

Solve above equation to get L, T & M

SECTION-II

Numerical Answer Type Question **4 Q.[3(0)]**

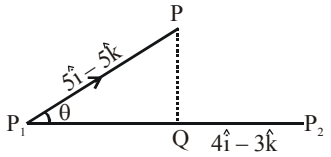
(upto second decimal place)

1. A bird is at a point P (4, –1, –5) and sees two points P_1 (–1, –1, 0) and P_2 (3, –1, –3). At time t = 0, it starts flying with a constant speed of 10 m/s to be in line with points P_1 and P_2 in minimum possible time t. Find t, if all coordinates are in kilometers.

एक पक्षी बिन्दु P (4, –1, –5) पर है तथा दो बिन्दुओं P_1 (–1, –1, 0) तथा P_2 (3, –1, –3) को देखता है। समय t = 0 पर, बिन्दुओं P_1 से P_2 को जोड़ने वाली रेखा में न्यूनतम संभव समय t में होने के लिये 10 m/s की नियत चाल से उड़ना प्रारम्भ करता है। यदि सभी निर्देशांक किलोमीटर में हो तो t का मान ज्ञात कीजिए।

Ans. 100 s

Sol.



$PP_1 = 5\sqrt{2}$

$\cos\theta = \dfrac{25+15}{\left(5\sqrt{2}\right)\times 5} = \dfrac{7}{5\sqrt{2}},\quad \sin\theta = \dfrac{1}{5\sqrt{2}}$

$PQ = (PP_1)\sin\theta = 5\sqrt{2}\times\dfrac{1}{5\sqrt{2}} = 1$

$t = \dfrac{PQ}{v} = \dfrac{1000}{10} = 100\ sec$

2. Two particle A and B are moving in same direction on same straight line. A is ahead of B by 20m. A has constant speed 5 m/sec and B has initial speed 30 m/sec and retardation of 10 m/sec^2. Then if x (in m) is total distance travelled by B as it meets A for second time. Then value of x will be.

दो कण A तथा B एक सरल रेखा पर समान दिशा में गतिशील है। A, B से 20m आगे है। A की नियत चाल 5 m/s तथा B की प्रारम्भिक चाल 30 m/s व मंदन 10 m/s^2 है। यदि B को A से दूसरी बार मिलने तक कुल x दूरी तय करनी पड़ी हो तो x का मान (मीटर में) ज्ञात कीजिए।

Ans. 50

Sol. A & B meets at t = 1 and 4. B turns at t =3 so B travelled 50 m distance

3. A train, travelling at 20 km/hr is approaching a platform. A bird is sitting on a pole on the platform. When the train is at a distance of 2 km from pole, brakes are applied which produce a uniform deceleration in it to stop it at pole. At that instant the bird flies towards the train at 60 km/hr and after touching the nearest point on the train flies back to the pole and then flies towards the train and continues repeating itself. Calculate how much distance will the bird have flown before the train stops?

एक रेलगाड़ी 20 km/hr की चाल से प्लेटफॉर्म की ओर आती है तथा एक चिड़िया प्लेटफॉर्म पर एक खम्भे पर बैठी है। जब रेलगाड़ी, खम्भे से 2 km की दूरी पर होती है, तो उसमें ब्रेक लगाकर एकसमान मंदन उत्पन्न करते हैं ताकि यह खम्भे पर आकर रूक जाये और ठीक उसी समय चिड़िया 60 km/hr की चाल से रेल की ओर उड़ती है तथा ट्रेन के सबसे नजदीक सिरे को छूकर वापस खम्भे की तरफ आती है तथा फिर ट्रेन की ओर उड़ती है, फिर यही प्रक्रिया अपनाती है, तो ट्रेन के रूकने तक चिड़िया द्वारा तय की गई दूरी का मान ज्ञात कीजिये।

Ans. 12 km

Sol. Time required to reach train to platform

$$S_{rev} = U_{avg}t = \left(\frac{V+U}{2}\right)t$$

$$2km = \left(\frac{20km/hr}{2}\right)t$$

$$t = \frac{1}{5}hr = 12\,min$$

Distance travelled by bird

= speed × time

$$= 60\ (km/hr) \times \frac{1}{5}hr = 12\ km$$

4. A particle is moving with uniform acceleration along x-axis with initial velocity along positive x. At $t = \frac{3\sqrt{2}}{\sqrt{2}-1}s$ the magnitude of displacement becomes $\frac{1}{3}$ the total distance travelled. By this time the x coordinate of particle is still positive. The instant (in sec) at which displacement becomes zero is

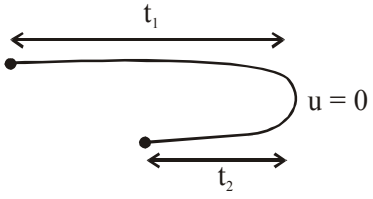
एक कण x-अक्ष पर एकसमान त्वरण से गतिशील है। इसका प्रारम्भिक वेग, धनात्मक x दिशा में है। $t = \frac{3\sqrt{2}}{\sqrt{2}-1}s$ पर इसके विस्थापन का परिमाण कुल तय दूरी का एक तिहाई है। इस दौरान कण का x निर्देशांक धनात्मक ही रहता है। किस क्षण (सेकण्ड में) विस्थापन शून्य हो जाता है ?

Ans. 12

Sol. $t_1 + t_2 = t$

$$\frac{1}{3}(distance) = displacement$$

$$\frac{1}{3}\left[\frac{1}{2}at_1^2 + \frac{1}{2}at_2^2\right] = \left[\frac{1}{2}a(t)^2 - \frac{1}{2}a(t_2)^2\right]$$



$\Rightarrow t_1^2 + (t - t_1)^2 = 3\left[t_1^2 - \left(t - t_1\right)^2\right]$

$\Rightarrow t_1 = 6$ for $t = \dfrac{3\sqrt{2}}{\sqrt{2}-1}$

so answer is $2t_1 = 12$

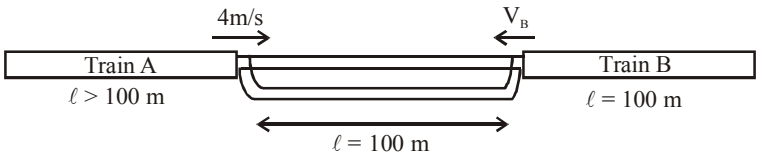
SECTION-III

Numerical Grid Type (Ranging from 0 to 9) 1 Q. [4 M (0)]

N_Sheet_18/

1. Two trains A and B are moving on a straight track towards each other. At t = 0, the situation is as shown in the diagram below. The driver of train B realises that in order to avoid a collision, B must fit into the side track. Length of side track is equal to the length of the train B and length of train A is large as compared to side track. The train A continues with the same speed of 4 m/s. The magnitude of minimum decleration of train B in order to avoid the collision is $\dfrac{\alpha}{25}$ m/s^2. Then α is.

दो ट्रेन A तथा B एक सीधे पथ पर एक-दूसरे की ओर गतिशील है। t = 0 पर स्थिति को नीचे चित्र में दर्शाया गया है। B के चालक को यह आभास होता है कि दुर्घटना को रोकने के लिए ट्रेन B को चित्र में दर्शाये अनुसार पास वाले पथ पर होना चाहिए। इस पास वाले पथ की लम्बाई ट्रेन B की लम्बाई के बराबर है तथा ट्रेन A की लम्बाई पास वाले पथ की तुलना में अधिक है। ट्रेन A, 4 m/s की समान चाल से लगातार गति करती रहती है। दुर्घटना से बचने के लिए ट्रेन B के न्यूनतम मंदन का परिमाण $\dfrac{\alpha}{25}$ m/s^2 हो तो α का मान ज्ञात कीजिए।



Ans. 8

Sol. $t_A = \dfrac{100}{4} = 2.5\,\text{sec}$

$0 = v_B^2 + 2a(100)$

$0 = v_B + a(25)$ $\qquad a = -\dfrac{v_B}{25}$

$0 = v_B^2 + 2(-v_B)^4$

$v_B = 8$ m/s $\qquad a = -\dfrac{8}{25}\,\text{m/s}^2$

SECTION-IV

Matrix Match Type (4 × 5) **1 Q. [8 M (for each entry +2(0)]**

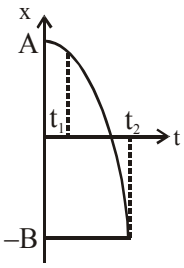
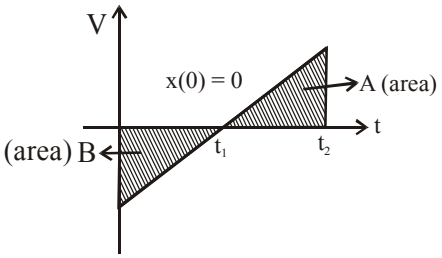
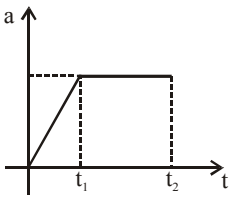
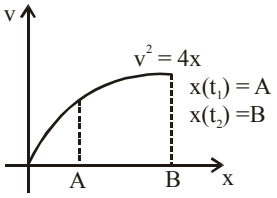
N_Sheet_18/

1. Match the column :-

Column–I : Shows graph of One Dimension motion of a particle. Symbols have their usual meaning such as $x(0)$ = initial position, $x(t_1)$ = position at $t = t_1$, $v(0)$ = initial velocity.

Column-II : Shows physical quantities. Displacement and distance are asked for $0 < t < t_2$, and average values are asked for $0 < t < t_2$

V_0, A & B are positive constant

Column-I	**Column-II**
(A) 	(P) |Displacement| = Distance
(B) 	(Q) |Instantaneous velocity| = |Instantaneous speed|
(C)  $x(0) = 0, x(t_1) = A,$ $x(t_2) = B, v(0) = v_0$	(R) |Average velocity| ≤ Average speed
(D) 	(S) Instantaneous acceleration = Average acceleration
	(T) Displacement = A – B and Distance = A + B

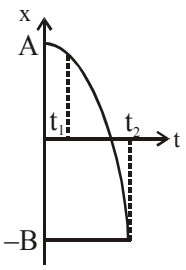
कॉलम मिलान कीजिए :-

कॉलम–I कण की एक विमीय गति के आरेख को दर्शाता है। यहाँ संकेतो के सामान्य अर्थ है यथा $x(0)$ = प्रारम्भिक स्थिति, $x(t_1)$ = समय $t = t_1$ पर स्थिति, $v(0)$ = प्रारम्भिक वेग

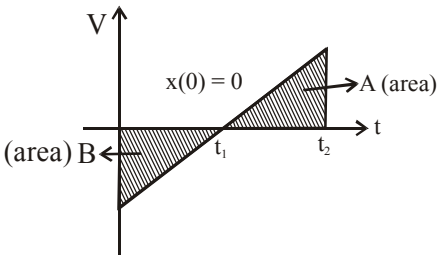
कॉलम-II भौतिक राशियों को दर्शाता है। यहाँ विस्थापन तथा दूरी $0 < t < t_2$ के लिए और औसत मान $0 < t < t_2$ के लिए पूछे गये है।

V_0, A व B धनात्मक नियतांक है

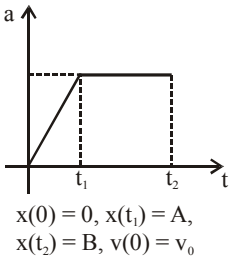
कॉलम-I **कॉलम-II**

(A) 

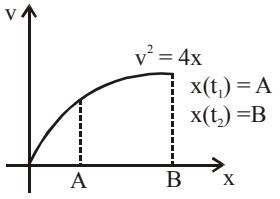
(P) |विस्थापन| = दूरी

(B) 

(Q) |तात्क्षणिक वेग| = |तात्क्षणिक चाल|

(C) 

(R) |औसत वेग| ≤ औसत चाल

(D) 

(S) तात्क्षणिक त्वरण = औसत त्वरण

(T) विस्थापन = A – B तथा दूरी = A + B

Ans. (A) → **(P,Q,R) ; (B) → (Q,R,S,T) ; (C) → (P,Q,R) ; (D) → (P,Q,R,S)**

Sol. If particle is not changing direction

Distance = |displacement|

Avg speed = |Avg. velocity|

For all 1-D motion, instantaneous speed = |Instantaneousl velocity|

Subjective Type 4 Q. [4 M (0)]

1. A driver takes 0.20 s to apply the brakes after he sees a need for it. This is called the reaction time of the driver. If he is driving a car at a speed of 54 km/h and the brakes cause a deceleration of 6.0m/s^2, find the distance travelled by the car after he sees the need to put the brakes on

Sol. Distance covered by the car during the application of brakes by driver –

$$s_1 = ut = \left(54 \times \frac{5}{18}\right)(0.2) = 15 \times 0.2 = 3.0 \text{ meter}$$

After applying the brakes; v = 0 u = 15 m/s, a = 6 m/s^2 s_2 = ?

Using $v^2 = u^2 - 2as \Rightarrow 0 = (15)^2 - 2 \times 6 \times s_2 \Rightarrow 12\, s_2 = 225 \Rightarrow s_2 = \frac{225}{12} = 18.75 \text{ metre}$

Distance travelled by the car after driver sees the need for it $s = s_1 + s_2 = 3 + 18.75 = 21.75$ metre.

एक ड्राईवर किसी को सामने देखकर ब्रेक लगाने की आवश्यकता होने पर 0.20 सेकण्ड के उपरान्त ब्रेक लगा पाता है। यह ड्राईवर का प्रतिक्रिया समय कहलाता है। उसकी कार 54 किमी/घण्टा की चाल से चल रही है तथा ब्रेक लगाने पर 6.0 मीटर/सेकण्ड^2 का अवमंदन उत्पन्न होता है। ब्रेक लगाने की आवश्यकता होने से कार के पूर्णतया: विरामावस्था में आने तक कार द्वारा तय दूरी ज्ञात करिये।

Sol. ड्राईवर द्वारा ब्रेक लगाने के दौरान कार द्वारा तय दूरी

$$s_1 = ut = \left(54 \times \frac{5}{18}\right)(0.2) = 15 \times 0.2 = 3.0 \text{ meter}$$

ब्रेक लगाने के बाद v = 0, u = 15 m/s, a = 6 मीटर/सेकण्ड^2 s_2 = ?

$v^2 = u^2 - 2as \Rightarrow 0 = (15)^2 - 2 \times 6 \times s_2 \Rightarrow 12\, s_2 = 225 \Rightarrow s_2 = \frac{225}{12} = 18.75 \text{ metre}$ का उपयोग करते हुये

ब्रेक लगाने की आवश्यकता होने से कार के पूर्णतया विरामावस्था में आने तक तय दूरी $s = s_1 + s_2 = 3 + 18.75 = 21.75$ मीटर

2. The length, breadth & height of a cuboid depends on time t as $L = 1 + \sin t$; $b = t^2 - 1$; $h = (t + 1)$ find the rate of change of volume with time at $t = \frac{\pi}{2}$ sec.

किसी घनाभ की लम्बाई, चौड़ाई व ऊंचाई समय के साथ क्रमश: $L = 1 + \sin t$; $b = t^2 - 1$; $h = (t + 1)$ के अनुसार परिवर्तित होती है। $t = \frac{\pi}{2}$ sec पर आयतन में समय के साथ परिवर्तन की दर ज्ञात कीजिये।

Ans. $\frac{3}{2}\pi^2 + 2\pi - 2$

Sol. $L = 1 + \sin t$

$b = t^2 - 1$

$n = (t + 1)$

$v = Lbh$

$v = (1 + \sin t)(t^2 - 1)(t + 1)$

$$\frac{dv}{dt} = (1 + \sin t)(t^2 - 1) + (1 + \sin t)(t + 1)(2t) + (t^2 - 1)(t + 1)(\cos t)$$

$$\frac{dv}{dt} = 2\left(\frac{\pi^2}{4} - 1\right) + \left(2\pi\left(\frac{\pi}{2} + 1\right)\right) = 2\left(\frac{\pi^2 - 4}{4}\right) + \left(2\pi\left(\frac{\pi + 2}{2}\right)\right) = \frac{\pi^2}{2} - 2 + \pi^2 + 2\pi$$

$$= \frac{3\pi^2}{2} + 2\pi - 2$$

3. A particle starts from rest at t = 0 and x = 0 to move with a constant acceleration = +2 m/s^2, for 20 seconds. After that, it moves with –4 m/s^2 for the next 20 seconds. Finally, it moves with positive acceleration for 10 seconds until its velocity becomes zero.

(a) What is the value of the acceleration in the last phase of motion?

(b) What is the final x-coordinate of the particle?

(c) Find the total distance covered by the particle during the whole motion.

एक कण t = 0 पर x = 0 से 20 सेकण्ड के लिये नियत त्वरण +2 m/s^2 से गति करना प्रारम्भ करता है। इसके पश्चात् यह अगले 20 सेकण्ड तक –4 m/s^2 से गति करता है। अंत में इसका वेग शून्य होने तक यह अगले 10 सेकण्ड के लिए धनात्मक त्वरण से गति करता है।

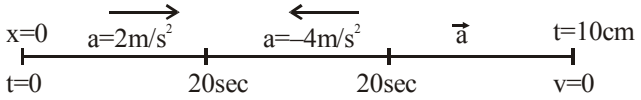
(a) गति के अंतिम भाग में त्वरण का मान क्या है?

(b) कण का अंतिम x-निर्देशांक क्या है?

(c) सम्पूर्ण गति के दौरान कण द्वारा तय की गयी कुल दूरी ज्ञात कीजिए।

Ans. (a) 4 m/s^2, (b) 200, (c) 1000 m

Sol. $s = ut + \frac{1}{2}at^2$



$$s = \frac{1}{2} \times 2 \times 400$$

$$s = 400 \text{ m}$$

$$s = \left(\frac{u + v}{2}\right)t$$

$$400 = \left(\frac{v}{2}\right)20$$

$$v = 40 \text{ m/s}$$

$$u = 40 \text{ m/s}$$

$$a = -4 \text{m/s}$$

$$t = 20 \text{ sec}$$

$$s = 40 \times 20 - \frac{1}{2} \times 4 \times 400 = 800 - 800 = 0$$

$s = \frac{40+v}{2} \times 20$

$0 = 400 + 10v$

$v = -40$ m/s

$v = -40$ m/s

$v = 0$

$t = 10$

$s = \frac{-40}{2} \times 10 = -200$

$s = -40 \times 10 + \frac{1}{2} a \times 100$

$-200 = -400 + 50a$

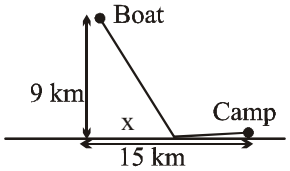
$200 = 50\ a$

$a = 4$ m/s

Now $S = 40 \times 10 - \frac{1}{2} \times 4 \times 100 = 200\text{m}$

total distance = 400 + 200 + 200 + 200 = 1000 m.

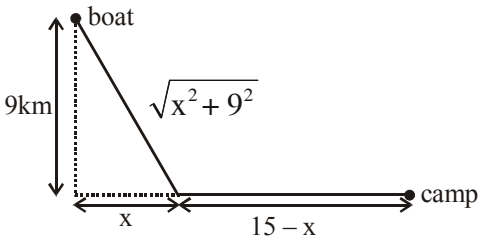
4. A fishing boat is anchored 9 km away from the nearest point on shore. A messenger must be sent from the fishing boat to a camp, 15 km from the point on shore closest to the boat. If the messenger can walk at a speed of 5km per hour and can row at 4 km per hour.
(i) Form an expression relating time taken to reach the camp t with distance x on shore where he lands.
(ii) At what point on shore must he land in order to reach the camp in the shortest possible time?
किसी नाव को किनारे पर स्थित निकटतम् बिन्दु से 9 km दूरी पर एंकर द्वारा रोक दिया जाता है। इस नाव से एक संदेश वाहक को राहत केम्प भेजना है जो कि किनारे पर स्थित नाव के समीपस्थ बिन्दु से 15 km दूर है। यदि संदेश वाहक 5 km/h की चाल से चल सकता हो तथा 4 km/h से नाव चला सकता हो तो
(i) केम्प तक पहुँचने में लगे समय t तथा जहाँ वह नाव से उतरा वहाँ से दूरी x के मध्य व्यंजक व्युत्पन्न कीजिये।
(ii) उसे किनारे पर किस बिन्दु पर उतरना चाहिये ताकि वह केम्प तक न्यूनतम संभावित समय में पहुँच सके ?



Ans. (i) $t = \frac{\sqrt{x^2 + (9)^2}}{4} + \frac{15-x}{5}$ (ii) 3 km from the camp.

Sol. so $t = \frac{\sqrt{x^2 + 9^2}}{4} + \frac{15-x}{5}$

$\frac{dt}{dx} = 0$; for minimum time taken to reach the



$$0 = -\frac{1}{5} + \frac{2}{8}\frac{x}{\sqrt{x^2 + 9^2}}$$

$$\frac{1}{5} = \frac{x}{4\sqrt{\left(x^2 + 9^2\right)}}$$

$$\frac{16}{25} = \frac{x^2}{x^2 + 9^2}$$

$16x^2 + 16 \times 81 = 25\ x|2$

$9x^2 = 16 \times 81$

$x = \sqrt{144} = 12$ km

so 3km from comp.