

Motion in a Straight Line — NEET Physics PYQ (2005-2021)

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NEET 2021

1. A small block slides down on a smooth inclined plane, starting from rest at time $t = 0$. Let S_n be the distance travelled by the block in the interval $t = n - 1$ to $t = n$.

Then, the ratio S_n/S_{n+1} is :

- (A) $(2n - 1)/(2n)$
- (B) $(2n - 1)/(2n + 1)$
- (C) $(2n + 1)/(2n - 1)$
- (D) $(2n)/(2n - 1)$

NEET 2020 · Q177

2. A ball is thrown vertically downward with a velocity of 20 m/s from the top of a tower. It hits the ground after some time with a velocity of 80 m/s. The height of the tower is : ($g = 10 \text{ m/s}^2$)

- (A) 360 m
- (B) 340 m
- (C) 320 m
- (D) 300 m

NEET 2018 · Q34

3. A toy car with charge q moves on a frictionless horizontal plane surface under the influence of a uniform electric field E . Due to the force qE , its velocity increases from 0 to 6 m/s in one second duration. At that instant the direction of the field is reversed. The car continues to move for two more seconds under the influence of this field. The average velocity and the average speed of the toy car between 0 to 3 seconds are respectively

- (A) 1 m/s, 3.5 m/s
- (B) 1 m/s, 3 m/s
- (C) 2 m/s, 4 m/s
- (D) 1.5 m/s, 3 m/s

NEET 2017 · Q151

4. Preeti reached the metro station and found that the escalator was not working. She walked up the stationary escalator in time t_1 . On other days, if she remains stationary on the moving escalator, then the escalator takes her up in time t_2 . The time taken by her to walk up on the moving escalator will be:

- (A) $(t_1 + t_2)/2$
- (B) $t_1 t_2 / (t_2 - t_1)$
- (C) $t_1 t_2 / (t_2 + t_1)$
- (D) $t_1 - t_2$

NEET 2016 Phase 2 · Q2

5. Two cars P and Q start from a point at the same time in a straight line and their positions are represented by $x_P(t) = at + bt^2$ and $x_Q(t) = ft - t^2$. At what time do the cars have the same velocity?

- (A) $(a - f)/(1 + b)$
- (B) $(a + f)/(2(b - 1))$
- (C) $(a + f)/(2(1 + b))$
- (D) $(f - a)/(2(1 + b))$

6. If the velocity of a particle is $v = At + Bt^2$, where A and B are constants, then the distance travelled by it between 1s and 2s is:

- (A) $(3/2)A + 4B$
- (B) $3A + 7B$
- (C) $(3/2)A + (7/3)B$
- (D) $A/2 + B/3$

AIPMT 2015

7. A particle of unit mass undergoes one-dimensional motion such that its velocity varies according to $v(x) = \beta x^{-2n}$, where β and n are constants and x is the position of the particle. The acceleration of the particle as a function of x , is given by:

- (A) $-2n\beta^2 e^{(-4n+1)}$
- (B) $-2n\beta^2 x^{(-2n-1)}$
- (C) $-2n\beta^2 x^{(-4n-1)}$
- (D) $-2\beta^2 x^{(-2n+1)}$

NEET 2013

8. A stone falls freely under gravity. It covers distances h_1 , h_2 and h_3 in the first 5 seconds, the next 5 seconds and the next 5 seconds respectively. The relation between h_1 , h_2 and h_3 is

- (A) $h_1 = 2h_2 = 3h_3$
- (B) $h_1 = h_2/3 = h_3/5$
- (C) $h_2 = 3h_1$ and $h_3 = 3h_2$
- (D) $h_1 = h_2 = h_3$

AIPMT 2012 Prelims

9. The motion of a particle along a straight line is described by equation $x = 8 + 12t - t^3$, where x is in metre and t in second. The retardation of the particle when its velocity becomes zero is

- (A) 12 m s^{-2}
- (B) 24 m s^{-2}
- (C) zero
- (D) 6 m s^{-2}

AIPMT 2011 Mains

10. A particle covers half of its total distance with speed v_1 and the rest half distance with speed v_2 . Its average speed during the complete journey is

- (A) $v_1^2 v_2^2 / (v_1^2 + v_2^2)$
- (B) $(v_1 + v_2)/2$
- (C) $v_1 v_2 / (v_1 + v_2)$
- (D) $2v_1 v_2 / (v_1 + v_2)$

AIPMT 2011 Prelims

11. A boy standing at the top of a tower of 20 m height drops a stone. Assuming $g = 10 \text{ m s}^{-2}$, the velocity with which it hits the ground is

- (A) 5.0 m/s
- (B) 10.0 m/s
- (C) 20.0 m/s
- (D) 40.0 m/s

AIPMT 2010 Prelims · Q2

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

- (A) $(\text{Velocity})^{2/3}$
- (B) $(\text{Velocity})^{3/2}$
- (C) $(\text{Distance})^2$
- (D) $(\text{Distance})^{-2}$

13. A ball is dropped from a high rise platform at $t = 0$ starting from rest. After 6 seconds another ball is thrown downwards from the same platform with a speed v . The two balls meet at $t = 18$ s. What is the value of v ? (Take $g = 10 \text{ m/s}^2$)

- (A) 60 m/s
- (B) 75 m/s
- (C) 55 m/s
- (D) 40 m/s

14. A bus is moving with a speed of 10 m s^{-1} on a straight road. A scooterist wishes to overtake the bus in 100 s. If the bus is at a distance of 1 km from the scooterist, with what speed should the scooterist chase the bus?

- (A) 40 m s^{-1}
- (B) 25 m s^{-1}
- (C) 10 m s^{-1}
- (D) 20 m s^{-1}

15. A particle starts its motion from rest under the action of a constant force. If the distance covered in first 10 seconds is S_1 and that covered in the first 20 seconds is S_2 , then:

- (A) $S_2 = 3S_1$
- (B) $S_2 = 4S_1$
- (C) $S_2 = S_1$
- (D) $S_2 = 2S_1$

16. The distance travelled by a particle starting from rest and moving with an acceleration $(4/3) \text{ m s}^{-2}$, in the third second is

- (A) $19/3 \text{ m}$
- (B) 6 m
- (C) 4 m
- (D) $10/3 \text{ m}$

17. A particle moves in a straight line with a constant acceleration. It changes its velocity from 10 m s^{-1} to 20 m s^{-1} while passing through a distance 135 m in t second. The value of t is

- (A) 9
- (B) 10
- (C) 1.8
- (D) 12

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

- (A) 54 m
- (B) 81 m
- (C) 24 m
- (D) 32 m

19. A car moves from X to Y with a uniform speed v_u and returns to X with a uniform speed v_d . The average speed for this round trip is

- (A) $\sqrt{v_u v_d}$
- (B) $v_d v_u / (v_d + v_u)$
- (C) $(v_u + v_d)/2$
- (D) $2v_d v_u / (v_d + v_u)$

20. A particle moving along x-axis has acceleration f , at time t , given by $f = f_0(1 - t/T)$, where f_0 and T are constants. The particle at $t = 0$ has zero velocity. In the time interval between $t = 0$ and the instant when $f = 0$, the particle's velocity (v_x) is

- (A) $(1/2)f_0 T^2$
- (B) $f_0 T^2$
- (C) $(1/2)f_0 T$
- (D) $f_0 T$

21. Two bodies, A (of mass 1 kg) and B (of mass 3 kg) are dropped from heights of 16 m and 25 m, respectively. The ratio of the time taken by them to reach the ground is :

- (A) 5/4
- (B) 8/5
- (C) 5/8
- (D) 4/5

22. The displacement x of a particle varies with time t as $x = ae^{(-\alpha t)} + be^{(\beta t)}$, where a , b , α and β are positive constants. The velocity of the particle will :

- (A) go on decreasing with time
- (B) be independent of α and β
- (C) drop to zero when $\alpha = \beta$
- (D) go on increasing with time

23. A ball is thrown vertically upward. It has a speed of 10 m/s when it has reached one half of its maximum height. How high does the ball rise ? (Taking $g = 10 \text{ m/s}^2$)

- (A) 6 m
- (B) 10 m
- (C) 14 m
- (D) 18 m

Answer key and explanations

1. Answer: (B) $(2n - 1)/(2n + 1)$

Starting from rest with constant acceleration a , distance in the n th second $S_n = (a/2)(2n - 1)$, and $S_{n+1} = (a/2)(2n + 1)$. So $S_n/S_{n+1} = (2n - 1)/(2n + 1)$; the reverse ratio is greater than 1, impossible for an accelerating block.

2. Answer: (D) 300 m

$v^2 = u^2 + 2gh$ gives $80^2 = 20^2 + 2 \times 10 \times h$, so $6400 - 400 = 20h$ and $h = 300$ m. Ignoring the initial downward speed would give 320 m.

3. Answer: (B) 1 m/s, 3 m/s

$a = 6 \text{ m/s}^2$. 0–1 s: 3 m forward. 1–2 s: decelerates from 6 to 0, another 3 m forward. 2–3 s: accelerates backward from rest, 3 m back. Net displacement 3 m and distance 9 m in 3 s, so average velocity 1 m/s and average speed 3 m/s.

4. Answer: (C) $t_1 t_2 / (t_1 + t_2)$

With escalator length L her speed is L/t_1 and the escalator's is L/t_2 . Moving together the speeds add, so $t = L/(L/t_1 + L/t_2) = t_1 t_2 / (t_1 + t_2)$, which is shorter than either time. The average $(t_1 + t_2)/2$ wrongly averages times instead of adding speeds.

5. Answer: (D) $(f - a)/(2(1 + b))$

Differentiating, $v_P = a + 2bt$ and $v_Q = f - 2t$. Setting them equal gives $2t(1 + b) = f - a$, so $t = (f - a)/(2(1 + b))$. Writing $a + f$ in the numerator comes from a sign slip when differentiating $-t^2$.

6. Answer: (C) $(3/2)A + (7/3)B$

Distance = $\int_1^2 (At + Bt^2) dt = A(2^2 - 1^2)/2 + B(2^3 - 1^3)/3 = (3/2)A + (7/3)B$ (the velocity does not change sign for positive A, B). $A/2 + B/3$ is the result of integrating from 0 to 1 instead.

7. Answer: (C) $-2n\beta^2x^{(-4n-1)}$

$a = v dv/dx$. With $v = \beta x^{-2n}$, $dv/dx = -2n\beta x^{-2n-1}$, so $a = \beta x^{-2n} \times (-2n\beta x^{-2n-1}) = -2n\beta^2 x^{-4n-1}$. Using only dv/dx gives the $-2n-1$ power, which is not an acceleration.

8. Answer: (B) $h_1 = h_2/3 = h_3/5$

Starting from rest, distances covered in successive equal time intervals are in the ratio 1 : 3 : 5 (Galileo's law of odd numbers). So $h_2 = 3h_1$ and $h_3 = 5h_1$, i.e. $h_1 = h_2/3 = h_3/5$. Equal distances would hold only for uniform velocity.

9. Answer: (A) 12 m s^{-2}

$v = dx/dt = 12 - 3t^2$, which is zero at $t = 2 \text{ s}$. $a = dv/dt = -6t = -12 \text{ m s}^{-2}$ at $t = 2 \text{ s}$, so the retardation is 12 m s^{-2} . Zero is wrong because velocity being zero does not make acceleration zero.

10. Answer: (D) $2v_1v_2/(v_1 + v_2)$

Each half takes d/v_1 and d/v_2 , so average speed = $2d/(d/v_1 + d/v_2) = 2v_1v_2/(v_1 + v_2)$, the harmonic mean. The arithmetic mean $(v_1 + v_2)/2$ would apply only to equal time intervals, not equal distances.

11. Answer: (C) 20.0 m/s

For a stone dropped from rest, $v^2 = 2gh = 2 \times 10 \times 20 = 400$, so $v = 20 \text{ m/s}$. Forgetting the factor 2 under the root gives about 14 m/s, and $v = gh$ would give an unphysical 200 m/s.

12. Answer: (B) (Velocity) $^{3/2}$

With $x = (t + 5)^{-1}$, $v = -(t + 5)^{-2}$ and $a = 2(t + 5)^{-3}$. Since $|v| = (t + 5)^{-2}$, $(t + 5)^{-3} = |v|^{3/2}$, so $a \propto (\text{velocity})^{3/2}$. In terms of distance $a = 2x^3$, so neither $(\text{distance})^2$ nor $(\text{distance})^{-2}$ fits.

13. Answer: (B) 75 m/s

At $t = 18 \text{ s}$ the first ball has fallen $\frac{1}{2} \times 10 \times 18^2 = 1620 \text{ m}$. The second ball moves for 12 s: $12v + \frac{1}{2} \times 10 \times 12^2 = 12v + 720$. Equating gives $12v = 900$, $v = 75 \text{ m/s}$.

14. Answer: (D) 20 m s^{-1}

The scooter must close 1000 m in 100 s, so its speed relative to the bus is 10 m s^{-1} . Its ground speed = $10 + 10 = 20 \text{ m s}^{-1}$. Answering 10 m s^{-1} gives only the relative speed.

15. Answer: (B) $S_2 = 4S_1$

From rest under constant force, $S = \frac{1}{2}at^2$, so $S \propto t^2$. Doubling the time from 10 s to 20 s makes $S_2 = 4S_1$. $S_2 = 3S_1$ is the distance in the second 10 s, not the total.

16. Answer: (D) $10/3 \text{ m}$

Distance in the n th second from rest = $(a/2)(2n - 1) = (2/3)(2 \times 3 - 1) = 10/3 \text{ m}$. 6 m is the total distance covered in the first three seconds, $(1/2)(4/3)(3^2)$, not the distance in the third second alone.

17. Answer: (A) 9

For uniform acceleration $s = (u + v)t/2$, so $135 = (10 + 20)t/2$ and $t = 9 \text{ s}$. Check: $a = (20^2 - 10^2)/(2 \times 135) = 10/9 \text{ m s}^{-2}$, and $(20 - 10)/(10/9) = 9 \text{ s}$.

18. Answer: (A) 54 m

$v = dx/dt = 18t - 3t^2$ and $a = 18 - 6t$; speed is maximum when $a = 0$, i.e. $t = 3 \text{ s}$. Then $x = 9(9) - 27 = 54 \text{ m}$. 81 m is just the $9t^2$ term without subtracting t^3 .

19. Answer: (D) $2vd vu/(vd + vu)$

For equal distances d each way, total time = $d/vu + d/vd$, so average speed = $2d/(d/vu + d/vd) = 2vu vd/(vu + vd)$, the harmonic mean. The arithmetic mean $(vu + vd)/2$ is wrong because more time is spent at the lower speed.

20. Answer: (C) $(1/2)f_0T$

$f = 0$ at $t = T$. $v = \int_0^T f_0(1 - t/T) dt = f_0T - f_0T/2 = \frac{1}{2}f_0T$. f_0T would be the velocity if the acceleration stayed at f_0 throughout.

21. Answer: (D) $4/5$

In free fall from rest, $h = \frac{1}{2}gt^2$, so $t = \sqrt{(2h/g)}$ and does not depend on mass. $t_A/t_B = \sqrt{(16/25)} = 4/5$. Inverting the ratio or including the masses gives the wrong options.

22. Answer: (D) go on increasing with time

$v = -\alpha e^{(-\alpha t)} + \beta e^{(\beta t)}$ and $dv/dt = \alpha^2 e^{(-\alpha t)} + \beta^2 e^{(\beta t)} > 0$ for all t , so the velocity keeps increasing. It clearly depends on α and β , and $\alpha = \beta$ does not make it zero for all times.

23. Answer: (B) 10 m

From H/2 to the top the speed drops from 10 m/s to 0: $10^2 = 2g(H/2) = gH$, so $H = 100/10 = 10$ m. 5 m would be just the upper half.

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