PHYSICS

DPP

DAILY PRACTICE PROBLEMS

DPP No. 20

Total Marks : 26

Max. Time : 28 min.

Topics : Rectilinear Motion, Relative Motion, Newton's Law of Motion

Type of Questions		M.M., Min.
Single choice Objective ('–1' negative marking) Q.1 to Q.6	(3 marks, 3 min.)	[18, 18]
Subjective Questions ('–1' negative marking) Q.7 to Q.8	(4 marks, 5 min.)	[8, 10]

1. Mark the correct statement(s).
(A) if speed of a body is varying, its velocity must be varying and it must have zero acceleration
(B) if velocity of a body is varying, its speed must be varying
(C) a body moving with varying velocity may have constant speed
(D) a body moving with varying speed may have constant velocity if its direction of motion remains constant.

2. At a harbour, a boat is standing and wind is blowing at a speed of $\sqrt{2}$ m/sec. due to which, the flag on the boat flutters along north–east. Now the boat enters in to river, which is flowing with a velocity of 2 m/sec. due north. The boat starts with zero velocity relative to the river and its constant acceleration relative to the river is 0.2 m/sec^2 due east. In which direction will the flag flutter at 10 seconds ?
(A) south-east (B) south–west (C) 30º south of west (D) west

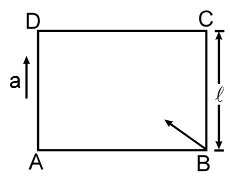
3. A point moves in a straight line under the retardation a v^2, where 'a' is a positive constant and v is speed. If the initial speed is u , the distance covered in ' t ' seconds is :
(A) a u t (B) $\frac{1}{a}$ ln(a u t) (C) $\frac{1}{a}$ ln (1 + a u t) (D) a ln (a u t)

4. The velocity of a car moving on a straight road increases linearly according to equation, v = a + b x, where a & b are positive constants. The acceleration in the course of such motion: (x is the distance travelled)
(A) increases (B) decreases (C) stay constant (D) becomes zero

5. Which one of the following cannot be explained on the basis of Newton's third law of motion?
(A) rowing of boat in a pond (B) motion of jet in the sky
(C) rebounding of a ball from a wall (D) returning back of body thrown above

6. At a particular instant velocity and acceleration of a particle are $(-\hat{i}+\hat{j}+2\hat{k})$m/s and $(3\hat{i}-\hat{j}+\hat{k})$m/s^2 respectively at the given instant particle's speed is :
(A) increasing (B) decreasing (C) constant (D) can't be say

7. In the figure the top view of a compartment of a train is shown. A man is sitting at a corner 'B' of the compartment. The man throws a ball (with respect to himself) along the surface of the floor towards the corner 'D' of the compartment of the train. The ball hits the corner 'A' of the compartment, then find the time at which it hits A after the ball is thrown. Assume no other collision during motion and floor is smooth. The length of the compartment is given as 'ℓ' and the train is moving with constant acceleration 'a' in the direction shown in the figure.



8. A balloon is ascending vertically with an acceleration of 0.4 m/s^{-2}. Two stones are dropped from it at an interval of 2 sec. Find the distance between them 1.5 sec. after the second stone is released.
(g = 10 m/sec^2)

Answers Key

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1. (C) **2.** (B) **3.** (C) **4.** (A) **5.** (D)

6. (B) **7.** $t = \sqrt{\frac{2\ell}{a}}$ **8.** 52 m

Hint & Solutions

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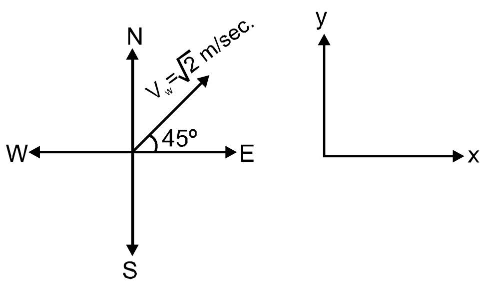
1. If speed of a particle changes, the velocity of the particle definitely changes and hence the acceleration of the particle is nonzero.
Velocity of a particle change without change in speed.
When speed of a particle varies, its velocity cannot be constant.

2. $V_w = 1\hat{i} + 1\hat{j}$



$V = at$
$V = (0.2)\ 10$
$= 2$ m/sec.
$V_{boat} = 2\hat{i} + 2\hat{j}$
$V_{w/boat} = V_w - V_{boat}$
$V_{w/boat} = (1\hat{i} + 1\hat{j}) - (2\hat{i} + 2\hat{j}) = -1\hat{i} - 1\hat{j}$
So, the flag will flutter towards south–west.

3. The retardation is given by

$$\frac{dv}{dt} = -av^2$$

integrating between proper limits

$$\Rightarrow \; -\int_u^v \frac{dv}{v^2} = \int_0^t a\,dt \quad \text{or} \quad \frac{1}{v} = at + \frac{1}{u}$$

$$\Rightarrow \; \frac{dt}{dx} = at + \frac{1}{u} \quad \Rightarrow \quad dx = \frac{u\;dt}{1+aut}$$

integrating between proper limits

$$\Rightarrow \; \int_0^s dx = \int_0^t \frac{u\,dt}{1+aut} \quad \Rightarrow \quad S = \frac{1}{a}\,\ell n\,(1 + aut)$$

4. $V = a + bx$

(V increases as x increases)

$$\frac{dV}{dt} = b\,\frac{dx}{dt} = bV$$

hence acceleration increases as V increases with x.

6. $\vec{v} = -\hat{i} + \hat{j} + 2\hat{k}$

$\vec{a} = 3\hat{i} - \hat{j} + \hat{k}$

$\vec{a}.\vec{v} = -3 - 1 + 2 < 0$

hence $\theta > 90°$ between $\vec{a}$ and $\vec{v}$

so speed is decreasing

$\vec{a}.\vec{v} = -3 - 1 + 2 < 0$

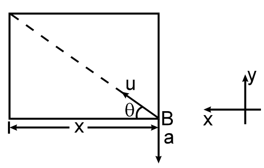
7. Solving the problem in the frame of train. Taking origin as corner 'B'

Along x axis x-

$x = u\cos\theta t$ ....(1)

Along y axis y-

$$y = u_y t + \frac{1}{2} a_y t^2$$



$0 = u \sin\theta\, t - \frac{1}{2}at^2$ ....(2)

As the ball is thrown towards 'D'

$\tan\theta = \frac{\ell}{x}$ .....(3)

From equation (1), (2) & (3) we get

t = $\sqrt{\frac{2\ell}{a}}$ required time after which ball hit the corner.

8. At position A balloon drops first particle So,
$u_A = 0$, $a_A = -g$, $t = 3.5$ sec.

$S_A = \left(\frac{1}{2}gt^2\right)$ . ...(i)

Balloon is going upward from A to B in 2 sec.so distance travelled by balloon in 2 second.

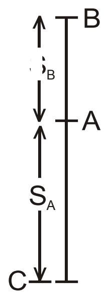
$\left(S_B = \frac{1}{2}a_B t^2\right)$ ....(ii)

$a_B = 0.4\ m/s^2$, $t = 2$ sec.

$S_1 = BC = (SB + SA)$ ....(iii)

Distance travell by second stone which is droped from balloon at B
$u_2 = u_B = a_B t = 0.4 \times 2 = 0.8$ m/s
$t = 1.5$ sec.

$\left(S_2 = u_2 t - \frac{1}{2}gt^2\right)$ ....(iv)



Distance between two stone
$\Delta S = S_1 - S_2$.