PART (A) : PHYSICS

SECTION-I: (SINGLE CHOICE QUESTIONS)

This section contains **06 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

1. A particle moves along an arc of a circle of radius R. Its velocity depends on the distance 's' covered as $v = a\sqrt{s}$, where a is a constant, then the angle α between the vector of the total acceleration and the vector of velocity as a function of s will be

(A) $\tan\alpha = \frac{R}{2s}$ (B) $\tan\alpha = \frac{2s}{R}$ (C) $\tan\alpha = \frac{2R}{s}$ (D) $\tan\alpha = \frac{s}{2R}$

1. (B)

$v = a\,s^{1/2}$

$a_t = v\frac{dv}{ds} = \frac{a^2}{2}$

$a_{cp} = \frac{v^2}{R} = \frac{a^2 s}{R}$

$\tan\alpha = \frac{a_{cp}}{a_t} = \frac{2s}{R}$

2. A man walks in rain with a velocity of $5\,kmh^{-1}$. The rain drops strike at him at an angle of 45° with the horizontal. Velocity of the rain if it is falling vertically downwards

(A) $5\,kmh^{-1}$ (B) $4\,kmh^{-1}$ (C) $3\,kmh^{-1}$ (D) $1\,kmh^{-1}$

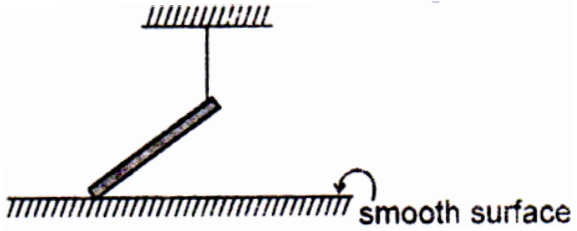
2. (A)

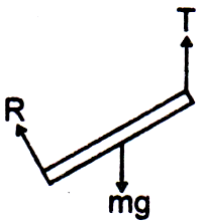
3. A body is thrown vertically up in a lift with a velocity u relative to the lift and the time of flight (from floor of the lift to the floor back) is found to be 't'. The acceleration with which the lift is moving up is:

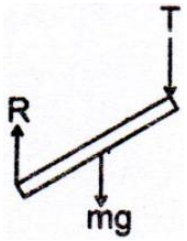
(A) $\frac{u-gt}{t}$ (B) $\frac{2u-gt}{t}$ (C) $\frac{u+gt}{t}$ (D) $\frac{2u+gt}{t}$

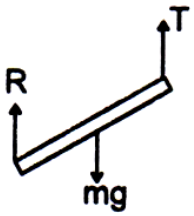
3. (B)

4. Which figure represents the correct representation of forces on rod of mass m as shown in figure?



(A) 

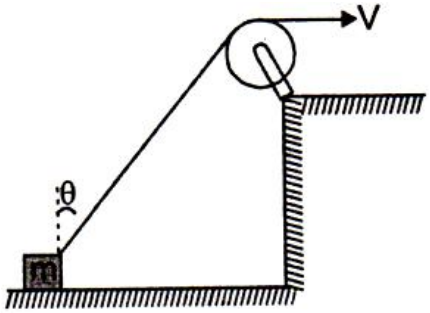
(B) 

(C) 

(D) None of these

4. (C)

5. A block is dragged on smooth plane with the help of a rope which moves with velocity v. The horizontal velocity of the block is :



(A) v

(B) $\frac{v}{\sin\theta}$

(C) $v\sin\theta$

(D) $\frac{v}{\cos\theta}$

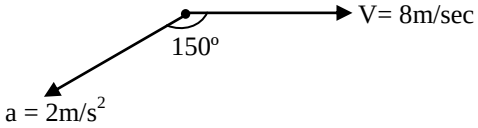
5. (B)

Equate velocity along the string.

$v_{block}\sin\theta = v$

$v_{block} = \frac{v}{\sin\theta}$

6. The instantaneous velocity and acceleration of a point mass moving in a plane at any given moment are as shown. The minimum radius of curvature of trajectory at the given moment will be



(A) 2 m (B) 4m (C) 8m (D) 16 m

6. (C)

SECTION-II : (MULTIPLE CHOICE QUESTIONS)

This section contains **08 multiple choice questions.** Each question has four choices (A), (B), (C) and (D) out of which **ONE or MORE than one is/are correct.**

7. Consider linear motion of an object. Everywhere ($\wedge$) represents the unit vector. Choose the **CORRECT** option(s):-

(A) If $\hat{a}.v = 1$ then object is moving with increasing speed without change in direction

(B) If $\hat{a}.v = -1$ then object changes its direction after some time

(C) If $\hat{r}.v < 0$ then object is moving towards origin

(D) If $\hat{r}.v < 0$ then object is moving away from origin

7. (ABC)

8. Equation of trajectory of a particle moving in $x-y$ plane is given by $y = 10x - 2x^2$ (x, y are in meters), Assume acceleration of gravity as $10 m/s^2$ in negative y-direction. Choose **CORRECT** statement(s):

(A) Maximum height of the particle is 12.5 m

(B) Range of the particle is $x = 5$ m

(C) At $x = 2.25$ particle is moving at an angle of 45^o with x-axis

(D) Initially particle is projected at an angle of 53^o

8. (ABC)

$y = 10x - 2x^2$

At max height, $\frac{dy}{dx} = 0$

$x = \frac{5}{2}$ m

$y = 12.5$m

$y = 10x\left(1 - \frac{x}{5}\right)$

Range = 5 m

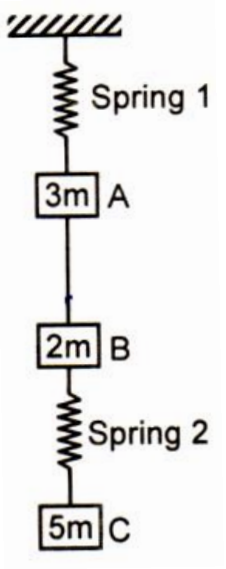
9. In the given figure, the system is in equilibrium. If the string between A and B is cut, then

(A) The instantaneous acceleration of A just after the string is cut is $\frac{7g}{3}$ upwards

(B) The instantaneous acceleration of B just after the string is cut is $\frac{7g}{2}$ downwards

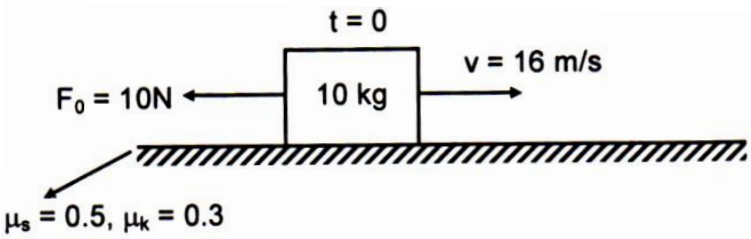
(C) The instantaneous acceleration of C just after the string is cut is g downwards

(D) The tension in the spring 1 just after the string is cut is 10 mg



9. (ABD)

10. A block of mass 10 kg is placed on a rough horizontal surface with static friction coefficient equal to 0.5 and kinetic friction coefficient equal to 0.3. The block is given a horizontal velocity of 16 m/s towards right direction and a constant horizontal force of $F_0 = 10$N is applied to the left. Then choose the correct option(s): $(g = 10 m/s^2)$



(A) The time instant t_0 at which the block stops is 8 sec

(B) The time instant t_0 at which the block stops is 4 sec

(C) The block will move left after stopping momentarily due to applied external force $F_0 = 10N$

(D) The friction force between the block and the ground after the block stops is equal to 10N towards right direction

10. (BD)

11. If wind is blowing in horizontal direction (providing only a constant horizontal force to the particle), then as compared to the situation in which the wind is not blowing, choose the correct alternative(s) for ground to ground projectile in a vertical plane:

(A) time of flight of projectile remains unchanged

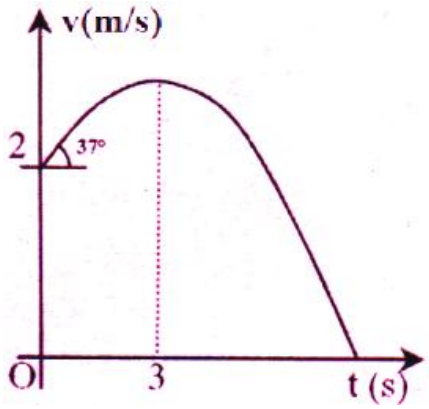
(B) horizontal range of projectile must decrease

(C) horizontal range of projectile may remain same

(D) maximum height attained by the projectile remains unchanged

11. (AD)

12. A particle starts moving with velocity 2m/s in a straight line under an acceleration varying linearly with time. Its velocity time graph is as shown in figure. Its velocity is maximum at $t = 3$ sec., then choose correct option(s). ($\tan 37^o = \frac{3}{4}$).



(A) at $t = 6$ body will stop

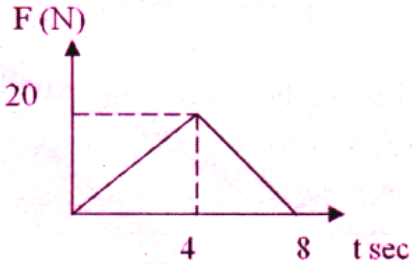
(B) at $t = 8$ body will stop

(C) Acceleration $(a) = \frac{-5}{4} m/s^2$ when body will stop

(D) Velocity at $t = 3$ second is $\frac{25}{8} m/s$

12. (BCD)

13. A box of mass $m = 4kg$ rests on a rough horizontal surface where co-efficient of static and kinetic friction are $\mu_s = \mu_k = 0.25$. The box is acted upon by a horizontal force F, which varies as shown, then choose the correct option(s).



(A) The box starts moving at the instant $t = 2.0$ sec

(B) The maximum velocity acquired by the box is 5.0 m/sec

(C) The box stops at the instant t = 9.0 sec

(D) The box stops at the instant t = 8.0 sec

13. (ABC)

14. A particle moves with constant speed v along a regular hexagon ABCDEF in the same order. Then the magnitude of the average velocity for its motion from A to

(A) F is $\frac{v}{5}$ (B) D is $\frac{v}{3}$ (C) C is $v\frac{\sqrt{3}}{2}$ (D) B is v

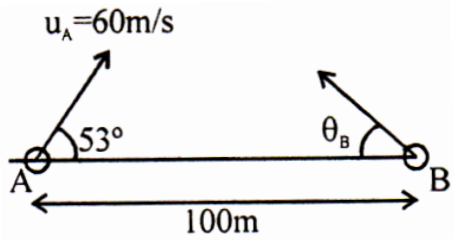
14. (ACD)

SECTION-III : (PARAGRAPH TYPE)

This section contains **4 multiple choice questions** relating to **TWO** paragraphs with **TWO questions on each paragraph.** Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**

PARAGRAPH FOR QUESTIONS NO. 15 & 16

Two particles A and B are projected in same vertical plane as shown in the figure. Their initial position $(t = 0)$, speeds and angles of projection are indicated.

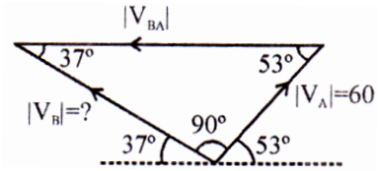


15. If initial angle of projection $\theta_B = 37^o$, what should be initial speed of projection of particle B, so that it hits particle A

(A) 80 m/s (B) 75 m/s (C) 40 m/s (D) 45 m/s

15. (A)

Using sine rule



$$\frac{60}{\sin 37^o} = \frac{V_B}{\sin 53^o}$$

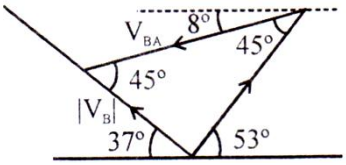
$$V_B = 80\, m/s$$

16. An observer on particles A observes that particle B is moving at angle 8° with horizontal in downward direction. Initial angles of projection of each particle remain same as previous question. Speed of particle B may be

(A) 80 m/s (B) 75 m/s (C) 60 m/s (D) 40 m/s

16. (C)

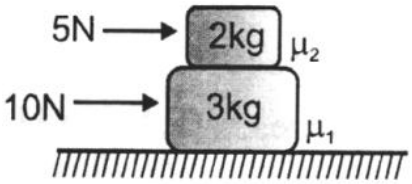
$$\frac{V_B}{\sin 45^o} = \frac{60}{\sin 45^o}$$



$V_B = 60^o$

PARAGRAPH FOR QUESTIONS NO. 17 & 18

Two blocks of mass 2kg and 3kg are placed as shown. External horizontal forces are applied as shown. μ_1 is friction coefficient between ground and 3kg block and μ_2 is friction coefficient between 3kg block and 2kg block.



17. If $\mu_1 = \mu_2 = 0$ then the magnitude of acceleration of 3kg w.r.t 2kg block at $t = 0$:

(A) $\frac{5}{2} m/s^2$ (B) $\frac{10}{3} m/s^2$ (C) $\frac{5}{6} m/s^2$ (D) zero

17. (C)

18. If $\mu_1 = 0.1$ and $\mu_2 = 0.2$, $g = 10 m/s^2$ then what will be the acceleration of 2kg block at $t = 0$?

(A) $\frac{1}{2} m/s^2$ (B) $\frac{5}{2} m/s^2$ (C) 2 m/s^2 (D) zero

18. (C)