NEWTON'S LAWS OF MOTION

1. A particle of mass m is moving in the *xy*-plane such that its velocity at a point (*x*, *y*) is given as $\vec{v} = \alpha\left(y\hat{x} + 2x\hat{y}\right)$zd , where α is a non-zero constant. What is the force $\vec{F}$ acting on the particle ?

[JEE(Advanced) 2023]

(A) $\vec{F} = 2m\alpha^2\left(x\hat{x} + y\hat{y}\right)$

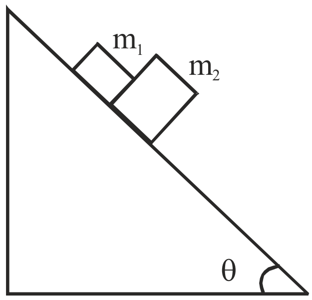
(B) $\vec{F} = m\alpha^2\left(y\hat{x} + 2x\hat{y}\right)$

(C) $\vec{F} = 2m\alpha^2\left(y\hat{x} + x\hat{y}\right)$

(D) $\vec{F} = m\alpha^2\left(x\hat{x} + 2y\hat{y}\right)$

2. A block of mass m_1 = 1 kg another mass m_2 = 2kg, are placed together (see figure) on an inclined plane with angle of inclination θ. Various values of θ are given in List I. The coefficient of friction between the block m_1 and the plane is always zero. The coefficient of static and dynamic friction between the block m_2 and the plane are equal to μ = 0.3. In List II expressions for the friction on block m_2 are given. Match the correct expression of the friction in List II with the angles given in List I, and choose the correct option. The acceleration due to gravity is denoted by g. **[JEE(Advanced) 2014]**

[useful information : tan (5.5°) ≈ 0.1 ; tan(11.5°) ≈ 0.2 ; tan (16.5°) ≈ 0.3]



List–I		**List–II**	
(P)	θ = 5°	(1)	$m_2g \sin\theta$
(Q)	θ = 10°	(2)	$(m_1 + m_2)g \sin\theta$
(R)	θ = 15°	(3)	$\mu m_2 g\cos\theta$
(S)	θ = 20°	(4)	$\mu(m_1 + m_2)g \cos\theta$

Code :

(A) P-1, Q-1, R-1, S-3

(B) P-2, Q-2, R-2, S-3

(C) P-2, Q-2, R-2, S-4

(D) P-2, Q-2, R-3, S-3

SOLUTIONS

1. Ans. (A)

Sol. $\vec{v} = \alpha(y\hat{x} + 2x\hat{y})$

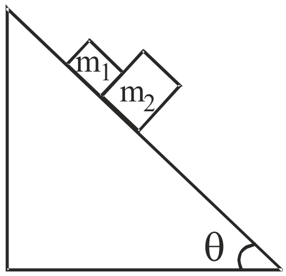
$v_x = \alpha y \qquad v_y = 2\alpha x$

$\frac{dv_x}{dt} = \alpha\frac{dy}{dt} = 2\alpha^2 x \qquad \frac{dv_y}{dt} = 2\alpha v_x = 2\alpha^2 y$

$\therefore \ \vec{F} = m\vec{a} = 2m\alpha^2(x\hat{x} + y\hat{y})$

2. Ans. (D)

Sol.



The system slip down if

$(m_1 + m_2)\, g \sin\theta > \mu m_2 g \cos\theta$

$\tan\theta > \frac{\mu m_2}{m_1 + m_2} > \frac{0.3 \times 2}{3}$

$\tan\theta > 0.2$

$\Rightarrow \theta > 11.5°$

For P and Q system will remain stationary hence friction = $(m_1 + m_2)\, g \sin\theta$

For R and S system will move hence limiting friction acts friction = $\mu m_2 g \cos\theta$