CLASS : CC (ADVANCED)   LAW OF MOTION, FRICTION, CIRCULAR M.M. 92 TEST -21
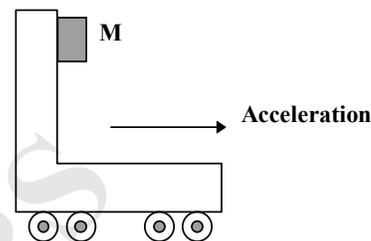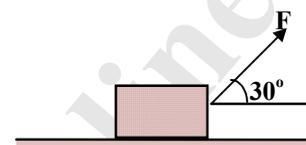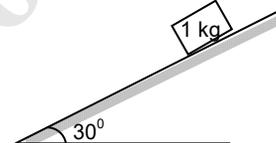
[SINGLE CORRECT CHOICE TYPE]

Q.1 An accelerated system with a vertical wall has co-efficient of friction μ between block and walls as shown in the figure. A block M of mass 1 kg just remains in equilibrium with the vertical wall, when the system has an acceleration of 20 m/s^2. The co-efficient of friction has a value **[3]**

(A) 0.10   (B) 0.25
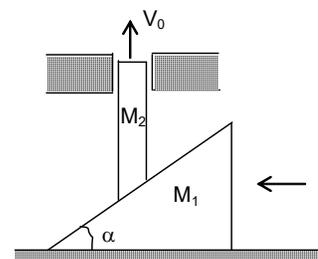
(C) 0.50   (D) 1

Q.2 A mass m rests on a horizontal surface. The coefficient of friction between the mass and the surface is μ. A force F is acting on the body as shown in the figure. The force of friction on mass m by surface is **[3]**

(A) μmg (B) $F\dfrac{\sqrt{3}}{2}$

(C) $\mu\left[mg - \dfrac{\sqrt{3}}{2}F\right)$ (D) $\mu\left[mg + \dfrac{\sqrt{3}}{2}F\right)$

Q.3 A block of mass 1 kg is accelerating downwards on an rough inclined plane of inclination 30° with acceleration 2.5 m/s^2. Find the contact force between the block and surface. ($g = 10$ m/s^2) **[3]**

(A) $10\sqrt{3}$ N   (B) $5\sqrt{3}$ N

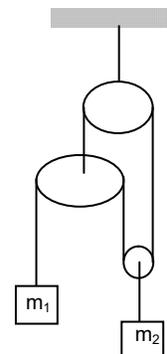(C) $\dfrac{5\sqrt{3}}{2}$ (D) none of these

Q.4 The force F is applied horizontally on the wedge of mass M_1 so as to raise the rod of mass M_2 upwards with a constant velocity v_0 as shown in the figure. The value of F is (neglect friction at the contact surfaces) **[3]**

(A) $M_1 g\tan\alpha$ (B) $M_2 g\tan\alpha$

(C) $(M_1 + M_2)\, g\cos\alpha$ (D) $\left(\dfrac{M_1 M_2}{M_1 + M_2}\right)g\cos\alpha$

Q.5 A light inextensible string has a breaking strength of w newtons. With what maximum acceleration it can pull a block of weight $\dfrac{w}{5}$ newtons vertically upwards. **[3]**

(A) 4g   (B) 5g   (C) g/5   (D) 4g/5

Q.6 Pulley mass system is shown in figure pulleys and strings are ideal. acceleration of m_2 and m_1 **[3]**

(A) $a_1 = 2a_2$

(B) (B) $a_2 = 2a_1$

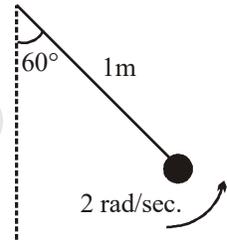(C) $a_1 = a_2 = g$

(D) data insufficient

Q.7 Two men P & Q of masses M and m(<M) hold a light rope passing over a smooth fixed pulley P and Q climb up the rope so that the acceleration of Q upward is double that of P downward. The tension in the rope is **[3]**

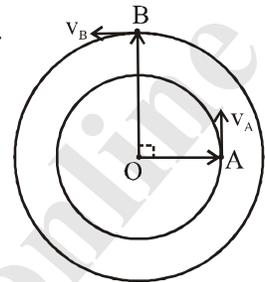(A) $\dfrac{2Mm}{M+m}g$ (B) $\dfrac{3Mm}{M+2m}g$ (C) $\dfrac{3Mm}{2(M+m)}g$ (D) $\dfrac{3Mm}{2M+m}g$

Q.8 A simple pendulum of mass 0.5 kg, during its swing in the vertical plane, is observed to have an angular velocity of 2 rad/s in the position shown. The instantaneous tension in the string is (g = 10 m/s²) **[3]**

(A) 2.5 N   (B) 4 N
(C) 4.5 N   (D) 5 N

Q.9 Two particles A and B are moving on two different concentric circles of radii r and $\sqrt{3}\,r$ with different velocities $v_A = v$ and $v_B = 2v$ respectively. Angular velocity of B relative to A as observed by A is: **[3]**

(A) $\dfrac{\left(2\sqrt{3}+1\right)v}{4r}$ (B) $\dfrac{v}{2r}$

(C) $\dfrac{\left(2-\sqrt{3}\right)v}{\sqrt{3}\,r}$ (D) $\dfrac{\left(2\sqrt{3}-1\right)v}{r}$
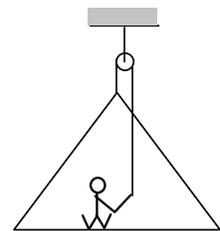
Q.10 A particle of mass 'm' originally at rest, is subjected to a force whose direction is constant but whose magnitude varies with according to the relation $F = F_0\, t\left[\dfrac{2}{T} - \dfrac{t}{T^2}\right]$ where F_0 and T are constants. Then speed of the particle after a time 2T is **[3]**

(A) $\dfrac{3F_0 T}{4m}$ (B) $\dfrac{4F_0 T}{3m}$ (C) $\dfrac{2F_0 T}{5m}$ (D) $\dfrac{F_0 T}{m}$
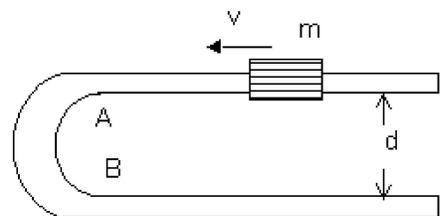
Q.11 A man of mass 50 kg stands on a frame of mass 30 kg he pulls on a light rope which passes over a pulley. The other end of the rope is attached to the frame. For the system to be in equilibrium what force man must exert on the rope **[3]**
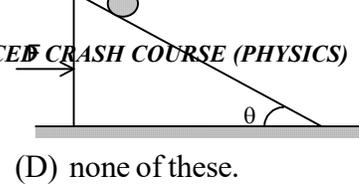
(A) 40 g   (B) 80 g   (C) 30 g   (D) 50 g

Q.12 A U shaped smooth wire has a semi-circular bending between A and B as shown in the figure. A bead of mass 'm' moving with uniform speed v through the wire enters the semicircular bend at A and leaves at B. The average force exerted by the bead on the part AB of the wire is, **[3]**

(A) 0   (B) $\dfrac{4mv^2}{\pi d}$

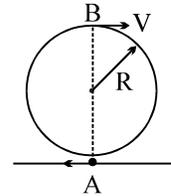(C) $\dfrac{2mv^2}{\pi d}$ (D) none of these.

Q.13 In the given figure, the wedge is acted on by a constant horizontal force F. The wedge is moving on a smooth horizontal surface. A ball of mass 'm' is at rest relative to the wedge. The ratio of forces exerted on 'm' by the wedge when F is acting and force exerted by wedge

when it is at rest. Assuming no friction between the wedge and the ball, is equal to **[3]**

(A) $\sec^2\theta$ (B) $\cos^2\theta$ (C) 1   (D) none of these.

Q.14 A body is thrown with a velocity of 10 m/s at an angle of 45° to the horizontal. The radius of curvature of its trajectory in $t = 1/\sqrt{2}$ sec after the body began to move is : **[3]**

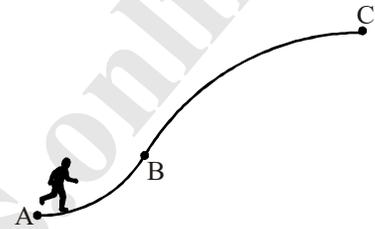(A) 0 m   (B) 2.5 m   (C) 5 m   (D) None

Q.15 Particle A is moving in a horizontal plane with constant velocity V as shown. Another particle B is moving in a circle with same speed V. At the moment when A is diametrically opposite to B, the radius of curvature of B as seen by A will be (Radius of circle is R) **[3]**

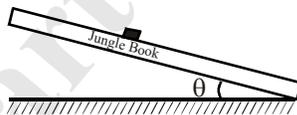(A) R   (B) R/2   (C) 2R   (D) 4R

[PARAGRAPH TYPE]
Paragraph for question nos. 16 to 18

An athelete of mass 80 kg is running on a rough track whose cross-section is shown below. The lower part AB of track is a cylindrical valley of radius 100 m and upper part BC is a cylindrical hill of radius 200 m. The two parts join such that there is no sudden change of slope of the track. The speed of the athelete on the track is always 5m/s. A is the lowest point of the valley, B is the point at which valley ends and hill starts and C is the top of the hill. While moving from A to C, the athelete travels a horizontal distance of 150 m.
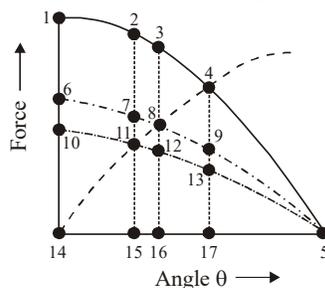
Q.16 Find the time taken by the athelete in going from A to C **[3]**

(A) 5π sec   (B) 10π sec   (C) 15π sec   (D) 20π sec

Q.17 The correct order of normal force experienced by athelete is : **[3]**

(A) $N_A > N_B > N_C$ (B) $N_A < N_B < N_C$ (C) $N_A > N_C > N_B$ (D) $N_C > N_A > N_B$

Q.18 The magnitude of friction force experienced by the athelete is : **[3]**

(A) zero throughout   (B) decreases continuously during motion from A to C
(C) increases continuously from A to C   (D) attains a maximum value at B

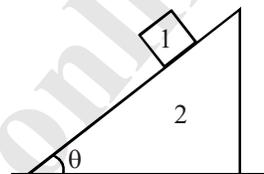## [MULTIPLE CORRECT CHOICE TYPE]
Paragraph for question nos. 19 to 21

Given graph is a plot of magnitude of normal, limiting friction, kinetic friction and static frction versus angle of inclination θ for the coin lying on book. 17 points are labeled with numbers. The coin slips at a certain angle θ_c. The coefficient of static friction is 0.6, and the coefficient of kinetic friction is 0.4. First consider the range of θ for which the coin is stationary. Which points of the curves can represent

Q.19 The magnitude of the normal force on the coin from the book, **[4]**
(A) 6   (B) 2   (C) 3   (D) 11

Q.20 The magnitude of the static frictional force on the coin from the book **[4]**
(A) 8   (B) 4   (C) 11   (D) 9

Q.21 Next, consider the range of θ for which the coin slides. Which points can give the magnitude of the kinetic frictional force on the coin from the book? **[4]**
(A) 12   (B) 13   (C) 11   (D) 8

Q.22 A heavy particle is tied to the end A of a string of length 1.6 m. Its other end O is fixed. It revolves as a conical pendulum with the string making 60° with the vertical. Then **[4]**
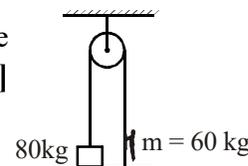
(A) its period of revolution is $\dfrac{4\pi}{7}$ sec.

(B) the tension in the string is doubled the weight of the particle

(C) the velocity of the particle = $2.8\sqrt{3}$ m/s

(D) the centripetal acceleration of the particle is 9.8√3 m/s^2.

Q.23 Block-1 and wedge 2 can move relative to each other. Block-1 has mass m and wedge-2 has also some mass. Inclined plane inclination is θ. There is friction coefficient μ between 1 and 2. Ground is smooth. 1 and 2 are released from rest to move then choose the correct statement(s). **[4]**
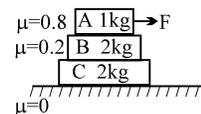

(A) If μ > tan θ then block-1 and wedge-2 both will not move.
(B) If μ > tan θ then block-1 will not move w.r.t. wedge-2 but wedge-2 will move.
(C) If μ < tan θ then block-1 and wedge-2 both will move.
(D) If μ < tan θ then block-1 will move w.r.t. wedge-2 but wedge-2 will not move.

Q.24 A man of mass 60 kg starts climbing up a massless rope by exerting 900 N on the string. After 2 sec, he is exhausted. He stops climbing and holds on to the rope. **[4]**

(A) String will become slack for some time.
(B) The speed of man at end of 2 sec. is 10 m/s
(C) Just after t = 2 sec, the acceleration of man & block will be same in magnitude
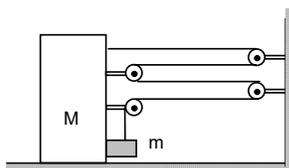(D) The acceleration of man just after 2 sec is g/7.

Q.25 Three blocks lie on each other as shown. Horizontal force F (variable) is applied on block A. Choose the correct statements. (g = 10 m/s^2) **[4]**

(A) maximum acceleration of block B can be 2 m/s^2.
(B) slipping between B and C cannot take place.
(C) slipping between A and B starts when F is more than 8N
(D) maximum acceleration of block C can be 3 m/s^2.

[SUBJECTIVE TYPE]

Q.26 A block of mass M is connected with a particle of mass m by a light inextensible string as shown in figure. Assuming all contacting surfaces as smooth, find the acceleration of the wedge after releasing the system. **[5]**
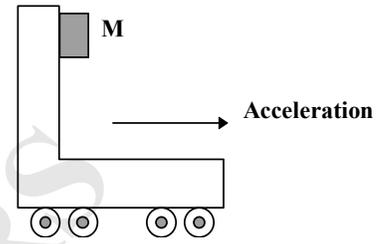
Q.27   A car is moving in a circular path of radius 50 m, on a flat rough horizontal ground. The mass of the car is 1000 kg. At a certain moment, when the speed of the car is 5 m/s, the driver is increasing speed at the rate of 1 m/s^2. Find the value of static friction on tyres (total) at this moment, in Newtons.   **[5]**
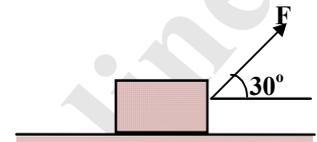
CLASS : CC (ADVANCED)   LAW OF MOTION, FRICTION, CIRCULAR M.M. 92 TEST -21
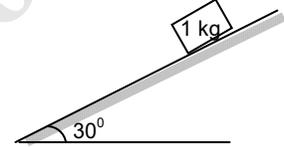
[SINGLE CORRECT CHOICE TYPE]

Q.1 An accelerated system with a vertical wall has co-efficient of friction μ between block and walls as shown in the figure. A block M of mass 1 kg just remains in equilibrium with the vertical wall, when the system has an acceleration of 20 m/s². The co-efficient of friction has a value **[3]**
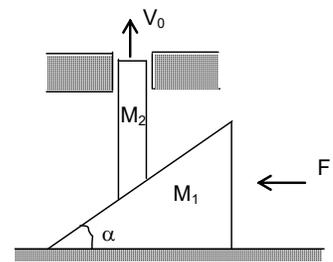
(A)0.10   (B) 0.25

(C*) 0.50   (D) 1

Q.2 A mass m rests on a horizontal surface. The coefficient of friction between the mass and the surface is μ. A force F is acting on the body as shown in the figure. The force of friction on mass m by surface is **[3]**

(A) μmg (B*) $F\dfrac{\sqrt{3}}{2}$

(C) $\mu\left[mg - \dfrac{\sqrt{3}}{2}F\right]$ (D) $\mu\left[mg + \dfrac{\sqrt{3}}{2}F\right]$

Q.3 A block of mass 1 kg is accelerating downwards on an rough inclined plane of inclination 30º with acceleration 2.5 m/s². Find the contact force between the block and surface. (g= 10 m/s²) **[3]**

(A) $10\sqrt{3}$ N   (B) $5\sqrt{3}$ N

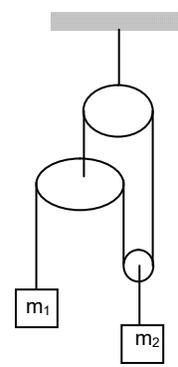(C) $\dfrac{5\sqrt{3}}{2}$ (D*) none of these

Q.4 The force F is applied horizontally on the wedge of mass M_1 so as to raise the rod of mass M_2 upwards with a constant velocity v_0 as shown in the figure. The value of F is (neglect friction at the contact surfaces) **[3]**

(A) $M_1 g \tan\alpha$ (B*) $M_2 g \tan\alpha$

(C) $(M_1 + M_2) g \cos\alpha$ (D) $\left(\dfrac{M_1 M_2}{M_1 + M_2}\right) g \cos\alpha$

Q.5 A light inextensible string has a breaking strength of w newtons. With what maximum acceleration it can pull a block of weight $\dfrac{w}{5}$ newtons vertically upwards. **[3]**

(A*) 4g   (B) 5g   (C) g/5   (D) 4g/5

Q.6 Pulley mass system is shown in figure pulleys and strings are ideal. acceleration of m_2 and m_1 **[3]**

(A) $a_1 = 2a_2$

(B) (B) $a_2 = 2a_1$

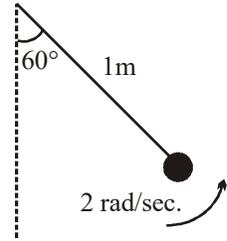(C*) $a_1 = a_2 = g$

(D) data insufficient

Q.7 Two men P & Q of masses M and m(<M) hold a light rope passing over a smooth fixed pulley P and Q climb up the rope so that the acceleration of Q upward is double that of P downward. The tension in the rope is **[3]**

(A) $\dfrac{2Mm}{M+m}g$ (B*) $\dfrac{3Mm}{M+2m}g$ (C) $\dfrac{3Mm}{2(M+m)}g$ (D) $\dfrac{3Mm}{2M+m}g$
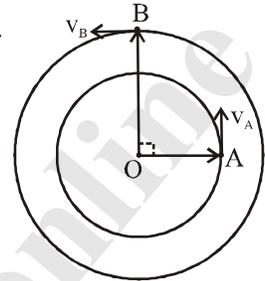
Q.8 A simple pendulum of mass 0.5 kg, during its swing in the vertical plane, is observed to have an angular velocity of 2 rad/s in the position shown. The instantaneous tension in the string is (g = 10 m/s^2) **[3]**

(A) 2.5 N   (B) 4 N
(C*) 4.5 N   (D) 5 N

Q.9 Two particles A and B are moving on two different concentric circles of radii r and $\sqrt{3}$ r with different velocities $v_A = v$ and $v_B = 2v$ respectively. Angular velocity of B relative to A as observed by A is: **[3]**

(A*) $\dfrac{(2\sqrt{3}+1)v}{4r}$ (B) $\dfrac{v}{2r}$

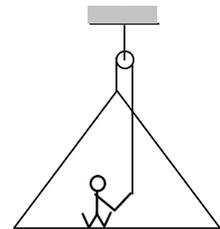(C) $\dfrac{(2-\sqrt{3})v}{\sqrt{3}\,r}$ (D) $\dfrac{(2\sqrt{3}-1)v}{r}$

Q.10 A particle of mass 'm' originally at rest, is subjected to a force whose direction is constant but whose magnitude varies with according to the relation $F = F_0 t\left[\dfrac{2}{T} - \dfrac{t}{T^2}\right]$ where F_0 and T are constants. Then speed of the particle after a time 2T is **[3]**

(A) $\dfrac{3F_0T}{4m}$ (B*) $\dfrac{4F_0T}{3m}$ (C) $\dfrac{2F_0T}{5m}$ (D) $\dfrac{F_0T}{m}$
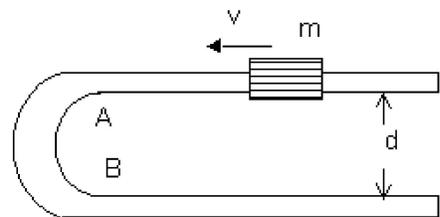
Q.11 A man of mass 50 kg stands on a frame of mass 30 kg he pulls on a light rope which passes over a pulley. The other end of the rope is attached to the frame. For the system to be in equilibrium what force man must exert on the rope **[3]**

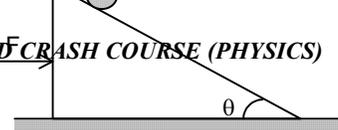(A*) 40 g   (B) 80 g   (C) 30 g   (D) 50 g

Q.12 A U shaped smooth wire has a semi-circular bending between A and B as shown in the figure. A bead of mass 'm' moving with uniform speed v through the wire enters the semicircular bend at A and leaves at B. The average force exerted by the bead on the part AB of the wire is, **[3]**

(A) 0   (B*) $\dfrac{4mv^2}{\pi d}$

(C) $\dfrac{2mv^2}{\pi d}$ (D) none of these.

Q.13 In the given figure, the wedge is acted on by a constant horizontal force F. The wedge is moving on a smooth horizontal surface. A ball of mass 'm' is at rest relative to the wedge. The ratio of forces exerted on 'm' by the wedge when F is acting and force exerted by wedge

when it is at rest. Assuming no friction between the wedge and the ball, is equal to **[3]**

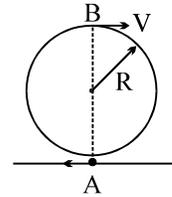(A*) $\sec^2\theta$ (B) $\cos^2\theta$ (C) 1   (D) none of these.

Q.14 A body is thrown with a velocity of 10 m/s at an angle of 45° to the horizontal. The radius of curvature of its trajectory in t = $1/\sqrt{2}$ sec after the body began to move is : **[3]**

(A) 0 m   (B) 2.5 m   (C*) 5 m   (D) None

Q.15 Particle A is moving in a horizontal plane with constant velocity V as shown. Another particle B is moving in a circle with same speed V. At the moment when A is diametrically opposite to B, the radius of curvature of B as seen by A will be (Radius of circle is R) **[3]**
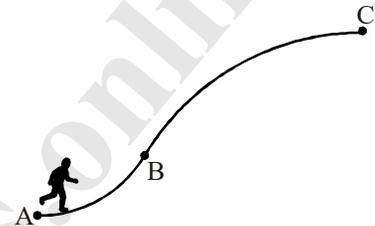
(A) R   (B) R/2   (C) 2R   (D*) 4R

[PARAGRAPH TYPE]
Paragraph for question nos. 16 to 18

An athelete of mass 80 kg is running on a rough track whose cross-section is shown below. The lower part AB of track is a cylindrical valley of radius 100 m and upper part BC is a cylindrical hill of radius 200 m. The two parts join such that there is no sudden change of slope of the track. The speed of the athelete on the track is always 5m/s. A is the lowest point of the valley, B is the point at which valley ends and hill starts and C is the top of the hill. While moving from A to C, the athelete travels a horizontal distance of 150 m.

Q.16 Find the time taken by the athelete in going from A to C **[3]**

(A) 5π sec   (B*) 10π sec   (C) 15π sec   (D) 20π sec

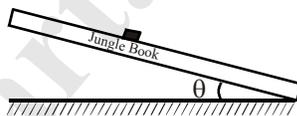**Q.17** The correct order of normal force experienced by athelete is : **[3]**

(A) $N_A > N_B > N_C$ (B) $N_A < N_B < N_C$ (C*) $N_A > N_C > N_B$ (D) $N_C > N_A > N_B$

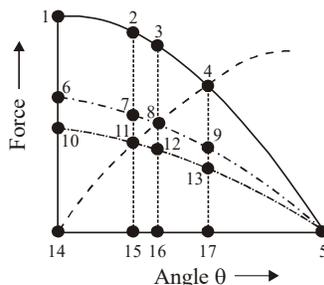**Q.18** The magnitude of friction force experienced by the athelete is : **[3]**

(A) zero throughout   (B) decreases continuously during motion from A to C
(C) increases continuously from A to C   (D*) attains a maximum value at B

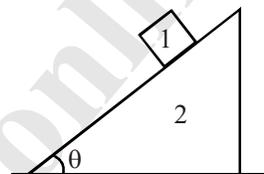## [MULTIPLE CORRECT CHOICE TYPE]
Paragraph for question nos. 19 to 21

Given graph is a plot of magnitude of normal, limiting friction, kinetic friction and static frction versus angle of inclination θ for the coin lying on book. 17 points are labeled with numbers. The coin slips at a certain angle θ_c. The coefficient of static friction is 0.6, and the coefficient of kinetic friction is 0.4. First consider the range of θ for which the coin is stationary. Which points of the curves can represent
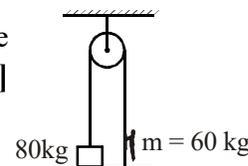
Q.19 The magnitude of the normal force on the coin from the book, **[4]**
(A) 6 (B*) 2 (C*) 3 (D) 11

Q.20 The magnitude of the static frictional force on the coin from the book **[4]**
(A*) 8 (B) 4 (C*) 11 (D) 9

Q.21 Next, consider the range of θ for which the coin slides. Which points can give the magnitude of the kinetic frictional force on the coin from the book? **[4]**
(A*) 12 (B*) 13 (C) 11 (D) 8

Q.22 A heavy particle is tied to the end A of a string of length 1.6 m. Its other end O is fixed. It revolves as a conical pendulum with the string making 60° with the vertical. Then **[4]**

(A*) its period of revolution is $\dfrac{4\pi}{7}$ sec.

(B*) the tension in the string is doubled the weight of the particle

(C*) the velocity of the particle = $2.8\sqrt{3}$ m/s

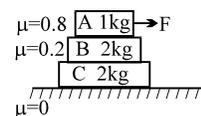(D*) the centripetal acceleration of the particle is $9.8\sqrt{3}$ m/s^2.

Q.23 Block-1 and wedge 2 can move relative to each other. Block-1 has mass m and wedge-2 has also some mass. Inclined plane inclination is θ. There is friction coefficient μ between 1 and 2. Ground is smooth. 1 and 2 are released from rest to move then choose the correct statement(s). **[4]**
(A*) If μ > tan θ then block-1 and wedge-2 both will not move.
(B) If μ > tan θ then block-1 will not move w.r.t. wedge-2 but wedge-2 will move.
(C*) If μ < tan θ then block-1 and wedge-2 both will move.
(D) If μ < tan θ then block-1 will move w.r.t. wedge-2 but wedge-2 will not move.

Q.24 A man of mass 60 kg starts climbing up a massless rope by exerting 900 N on the string. After 2 sec, he is exhausted. He stops climbing and holds on to the rope. **[4]**
(A*) String will become slack for some time.
(B*) The speed of man at end of 2 sec. is 10 m/s
(C*) Just after t = 2 sec, the acceleration of man & block will be same in magnitude
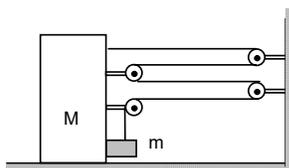(D) The acceleration of man just after 2 sec is g/7.

Q.25 Three blocks lie on each other as shown. Horizontal force F (variable) is applied on block A. Choose the correct statements. (g = 10 m/s^2) **[4]**
(A*) maximum acceleration of block B can be 2 m/s^2.
(B*) slipping between B and C cannot take place.
(C) slipping between A and B starts when F is more than 8N
(D) maximum acceleration of block C can be 3 m/s^2.

[SUBJECTIVE TYPE]

Q.26 A block of mass M is connected with a particle of mass m by a light inextensible string as shown in figure. Assuming all contacting surfaces as smooth, find the acceleration of the wedge after releasing the system. **[5]**

Ans. $a = \dfrac{4mg}{M + 17m}$

Q.27 A car is moving in a circular path of radius 50 m, on a flat rough horizontal ground. The mass of the car is 1000 kg. At a certain moment, when the speed of the car is 5 m/s, the driver is increasing speed at the rate of 1 m/s². Find the value of static friction on tyres (total) at this moment, in Newtons. **[5]**

[Ans. $500\sqrt{5}$]