Charotar English Medium School, Anand

First Internal Examination-2018

Subject:physics **STD-11** **Total Marks : 50**
Hours : 2 **ANSWER KEY** **Date : 1-10-2018**

Section-A **(10)**

Q1. Answer the following questions for <u>One</u> mark:

1.Which phenomenon is occurred during weak nuclear force ?

Ans : b- particle (b-decay)

2.Pressure P=FK where F is force, obtain dimension of K.

Ans: P=FK

$K=P/F=M^1L^{-1}T^{-2}/M^1L^1T^{-2}$

$M^0L^{-2}T^0$

3. Write supplementary unit of SI

Ans : 1) Radian 2)Steradian 3) Curie

4.What is acceleration ? what is its direction? Also give its unit ?

Ans: the time rate of change of velocity is called acceleration. Its direction is in the direction of change in velocity, its unit is m/s^2

5.Give important condition of vector addition.

Ans : The condition is that the vectors which are supposed to be added must be same physical quantities.

6.A bus of mass 1000 kg is standing stationary on bus station. What is its linear momentum ?

Ans : m=1000 kg

V = 0 (stationary)

P= mv= 1000(0)= 0

7. What will be the work done on the body moving with constant speed ?

Ans : Zero

8. 1 Mega watt=…………….. erg/second.

Ans : 10^{13}

9.On which factor centre of mass of rigid body depends ?

Ans : Centre of mass depends upon the mass distribution and rigid body,shape and size of the body as well as the axis of system.

10. state any one kepler's law.

Ans : i) all planets move in elliptical orbits with the sun situated at one of the foci of the ellipse.

ii) the line tha joins any planet to the sun sweeps equal areas in equal interval of time.

iii) the square of the time period of revolution of a planet is proportional to the cube of the semimajor axis of thr ellipse traced out by the planet.

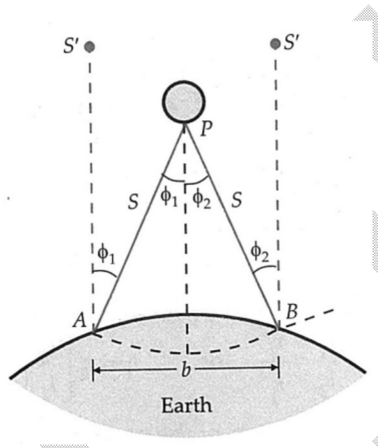
Section-B

Q2. Answer the following questions for TWO marks: **(12)**

1) Explain parallax method to measure distance between the earth and the planet.

ANS : **Distance of the moon or any planet.** To measure the distance S of the moon or a far away planet P, we observe it simultaneously from two different positions (observatories) A and B on the earth, separated by a large distance AB = b. WE select a distant star S' whose position and direction can be taken approximately same from A and B.

- Now ∠PAS' = ϕ_1 and ∠PBS' = ϕ_2 are measured from the two observations at the same time. As b << s, so we can take AB as an arc of length b.



Now $\theta = \frac{\text{Arc}}{\text{Radius}} = \frac{b}{s}$

$\therefore \quad S = \frac{b}{\theta}$.

where θ = ∠APB = $\phi_1 + \phi_1$, is the parallactic angle.

2) A physical quantity P is related to four observables a, b, c and d as follows:

$$P = a^3b^2/(\sqrt{c}d)\ .$$

The percentage errors in measurement of a, b, c and d are 1%, 3%, 4% and 2%, respectively. What is the percentage error in the quantity P? If the value of P calculated using the above relation turns out to be 3.763, to what should you round off the result?

ANS : $P = \dfrac{a^3b^2}{(\sqrt{c}d)} = a^3b^2\, c^{-1/2}\, d^{-1}$

$\therefore$ Maximum fractional error in the measurement

$$\frac{\Delta P}{P} = 3\frac{\Delta a}{a} + 2\frac{\Delta b}{b} + \frac{1}{2}\frac{\Delta c}{c} + \frac{\Delta d}{d}$$

As $\dfrac{\Delta a}{a} = 1\%$, $\dfrac{\Delta b}{b} = 3\%$, $\dfrac{\Delta c}{c} = 4\%$ and $\dfrac{\Delta d}{d} = 2\%$

$\therefore$ Maximum fractional error in the measurement

$$\frac{\Delta P}{P} = 3 \times 1\% + 2 \times 3\% + \frac{1}{2} \times 4\% + 2\%$$

$= 3\% + 6\% + 2\% + 2\% = 13\%$

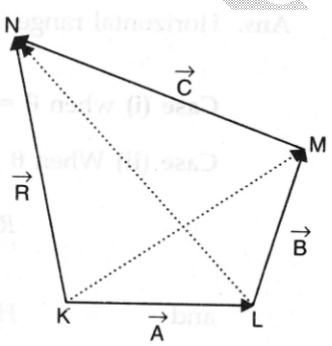
If $P = 3.763$, then $\Delta P = 13\%$ of $P = \dfrac{13P}{100} = \dfrac{13 \times 3.763}{100} = 0.489$

As the error lies in first decimal place, the answer should be rounded off to first decimal place. Hence, we shall express the value of P after rounding it off as P = 3.8.

3) Show that the vector addition is associative.

ANS : To show that vector addition is associate, we consider addition of three vectors $\vec{A}, \vec{B}$ and $\vec{C}$ in two different manners. Let us first add $\vec{A}$ and $\vec{B}$ to obtain a vector $\overrightarrow{KM}$ and then $\vec{C}$ add to it so as to get the resultant vector $\overrightarrow{KN}$. It means that

$$\left(\vec{A} + \vec{B}\right) + \vec{C} = \overrightarrow{KN} = \vec{R} \quad \dots \text{(i)}$$



Again we add $\vec{B}$ and $\vec{C}$ to obtain a vector $\overrightarrow{LN}$. Now to vector $\vec{A}$ add $\overrightarrow{LN}$ so as to get a resultant $\overrightarrow{KN} = \vec{R}$ as shown in Fig. It means that

$$\left(\vec{A}\right) + \left(\vec{B} + \vec{C}\right) = \overrightarrow{KL} + \overrightarrow{LN} = \vec{R} \quad \dots \text{(ii)}$$

From (i) and (ii), it is clear that $\left(\vec{A} + \vec{B}\right) + \vec{C} = \vec{A} + \left(\vec{B} + \vec{C}\right)$

That is the vector addition is associate.

4) State and explain Newton's second law of motion.

ANS : Newton's second law of motion states that the rate of change momentum of a rigid body is directly proportional to the force applied on it.

The law implies that when a bigger force is applied on a body of given mass, its linear momentum changes faster and vice - versa. The momentum will change in the direction of the applied force.

Let, $\quad m$ = mass of a body,

$\vec{v}$ = velocity of the body

$\therefore$ The linear momentum of the body

$$\vec{p} = m\vec{v} \qquad \ldots(i)$$

Now, suppose $\vec{F}$ = external force applied on the body in the direction of motion of the body.

$\Delta\vec{p}$ = a small change in linear momentum of the body in a small time Δ t.

Rate of change of linear momentum of the body = $\frac{\Delta\vec{p}}{\Delta t}$

According to Newton's second law,

$$\frac{\Delta\vec{p}}{\Delta t} \text{ or } \vec{F} \alpha \frac{\Delta\vec{p}}{\Delta t}$$

or $$\vec{F} = k\frac{\Delta\vec{p}}{\Delta t} \qquad \ldots(ii)$$

where k is a constant of proportionality.

Taking the limit $\Delta t \to 0$, the term $\frac{\Delta\vec{p}}{\Delta t}$ becomes the derivatives or differential coefficient of $\vec{p}$ w.r.t. time t. It is denoted by $\frac{d\vec{p}}{dt}$

$$\therefore \qquad \vec{F} = k\frac{d\vec{p}}{dt}$$

Using eqn (i), $$\vec{F} = k\frac{d}{dt}(m\vec{v}) = km\frac{d\vec{v}}{dt} \qquad \ldots(iii)$$

$$\vec{F} = km\vec{a}$$

where $\vec{a} = \frac{d\vec{v}}{dt}$ = represents acceleration of the body.

OR

Explain why? A cricketer moves his hands backwards while holding a catch.

ANS : In holding a catch, the impulse imparted to the hands = F $\times$ Δt = change in momentum of the ball when a cricketer lowers his hands to take a catch, he increases the time taken to stop the ball. As time t increases the force F applied on the hands of the cricketer by the ball decreased and his hands feel less hurt.

5) Write any four characteristics of dot product.

ANS : **Properties of scalar product:**

(i) The scalar product is commutative i.e., $\vec{A}\cdot\vec{B} = \vec{B}\cdot\vec{A}$

(ii) The scalar product is distributive over addition i.e., $\vec{A}\cdot(\vec{B}+\vec{C}) = \vec{A}\cdot\vec{B} + \vec{A}\cdot\vec{C}$

(iii) If $\vec{A}$ and $\vec{B}$ are two vectors perpendicular to each other, then their scalar product is zero.
$\vec{A}\cdot\vec{B}$ = AB cos 90^0 = 0

(iv) If $\vec{A}$ and $\vec{B}$ are two parallel vectors having same direction, then their scalar product has the maximum positive magnitude.
$\vec{A}\cdot\vec{B}$ = AB cos 0^0 = AB

(v) If $\vec{A}$ and $\vec{B}$ are two parallel vectors having opposite directions, then their scalar product has the maximum negative magnitude.

$\vec{A}\cdot\vec{B}$ = AB cos 180^0 = - AB

(vi) The scalar product of a vector with itself is equal to the square of its magnitude.

$\vec{A}\cdot\vec{A}$ = A · A cos 0^0 = A · A = A^2 = $|\vec{A}|^2$

(vii) Scalar product of two similar base vectors is unity and that of two different base vectors is zero.

$\hat{i}\cdot\hat{i}$ = (1)(1) cos 0^0 = 1

$\therefore \hat{i}\cdot\hat{i}=\hat{j}\cdot\hat{j}=\hat{k}\cdot\hat{k}=1$

$\hat{i}\cdot\hat{j}$ = (1)(1) cos 90^0 = 0

$\therefore \hat{i}\cdot\hat{j}=\hat{j}\cdot\hat{k}=\hat{k}\cdot\hat{i}=0$

(viii) Scalar product of two vectors $\vec{A}$ and $\vec{B}$ is equal to the sum of the product of their corresponding rectangular components.

$\vec{A}\cdot\vec{B} = A_xB_x + A_yB_y + A_zB_z$

(ix) The cosine of the angle θ between and is given by

$$\cos\theta = \frac{\vec{A}\cdot\vec{B}}{|\vec{A}||\vec{B}|} = \frac{A_xB_x + A_yB_y + A_zB_z}{\sqrt{A_x^2+A_y^2+A_z^2}\sqrt{B_x^2+B_y^2+B_z^2}}$$

6) The dimensional formula for universal constant of Gravitation ?

ANS : **Dimensions of G.** As $F = G\frac{m_1m_2}{r^2}$

$\therefore \quad G = \frac{Fr^2}{m_1m_2}$

➢ Dimensions of $G = \frac{MLT^{-2}\times L^2}{M\times M} = [M^{-1}L^3T^{-2}]$

Section-C

Q3. Answer the following questions for <u>THREE</u> marks: (18)

1) A car moving along a straight highway with speed of 126 km h^{-1} is brought to a stop within a distance of 200 m. What is the retardation of the car (assumed uniform), and how long does it take for the car to stop?

ANS : Given u = 126 km/h = 126 × $\frac{5}{18}$ m/s = 35 m/s

S = 200 m and v = 0

As $v^2 - u^2 = 2as$

$\therefore \quad 0 - (35)^2 = 2a \times 200$

$\Rightarrow \quad a = \frac{-(35)^2}{400} = -3.06\ m/s^2$

Also, $v = u + at$

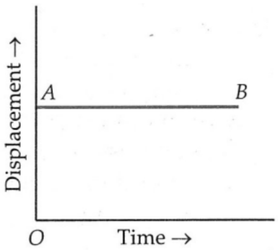
$\Rightarrow \quad t = \frac{v-u}{a} = \frac{0-35}{-3.06} = 11.4$ s.

2) Discuss the nature of motion from the given distance-time graphs.

(i) When body at rest.

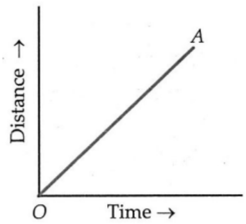
(ii) When body moving with uniform speed in positive direction.

(iii) When it performs non-uniform motion.

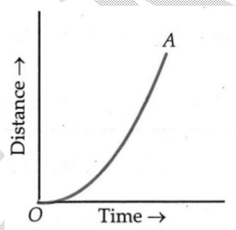


ANS : For a body at rest, the distance-time graph is a straight line AB, as shown in Fig. As the slope of AB is zero, so speed of the body is zero.

For a body moving with uniform speed, the distance-time graph is a straight line inclined to the time-axis, as shown in . As the graph passes through O, so distance travelled at t = 0 is also zero.



The distance-time graph in. represents accelerated (speeding up) motion, because the slope of the graph is increasing with time.



3) A circular race track of radius 300 m is banked at angle of 15°. If the coefficient of friction between the wheels of a race car and the road is 0.2, what is the (i) optimum speed of the race car to avoid wear and tear on tyres and (ii) maximum permissible speed to avoid slipping?[tan 15° = 0.2679]

ANS : The optimum speeed $v_\circ$ is given by eqation

$v_\circ = (R\ g \tan\theta)^{1/2}$

Here, $R = 300$m, $\theta = 15^\circ$, $g = 9.8$ ms^{-2}, $\mu_s = 0.2$

We have $v_\circ = 28.1$ ms^{-1}

The maximum permissible speed v_{max} is given by equation.

$$v_{max} = \left(Rg\frac{\mu_s + \tan\theta}{1-\mu_s \tan\theta} \right)^{1/2}$$

$$v_{max} = \left(\frac{300 \times 9.8 \times (0.2 + \tan 15^\circ)}{1-(0.2 \times \tan 15^\circ)} \right)^{1/2}$$

$$v_{max} = \left(\frac{2940 \times (0.4679)}{0.9464} \right)^{1/2}$$

$$= (1453.535)^{1/2} = 38.1 \text{ms}^{-1}$$

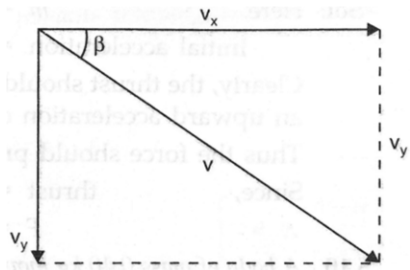
OR

A truck starts from rest and accelerates uniformly at 2.0 ms^{-2}. At t = 10 s, a stone is dropped by a person starting on the top of the truck (6 m high from the ground). What are the (a) velocity, and (b) acceleration of the stone at t = 11s? (Neglect air resistance.)

ANS : ➢ $u = 0, a = 2\ ms^{-2}, t = 10s$

Using equation, $v = u + at$, we get

$v = 0 + 2 \times 10 = 20\ ms^{-1}$



(a) Let us first consider horizontal motion. The only force acting on the stone is force of gravity which acts vertically downwards.

Its horizontal component is zero. Moreover, air resistance is to be neglected. So, horizontal motion is uniform motion.

∴ $v_x = v = 20\ ms^{-1}$

Let us now consider vertical motion which is controlled by force of gravity.

$u = 0, a = g = 10\ ms^{-2}, t = (11 - 10)\ s = 1s$

Using $v = u + at$, $v_y = 0 + 10 \times 1 = 10\ ms^{-1}$

Resultant velocity,

$$v = \sqrt{v_x^2 + v_y^2}$$

⇒ $$v = \sqrt{20^2 + 10^2}\ ms^{-1}$$

$$= \sqrt{500}\ ms^{-1}$$

$$= 22.36\ ms^{-1}$$

$$\tan\beta = \frac{v_y}{v_x} = \frac{10}{20} = \frac{1}{2} = 0.5$$

or $\beta = \tan^{-1}(0.5) = 26.56^\circ$

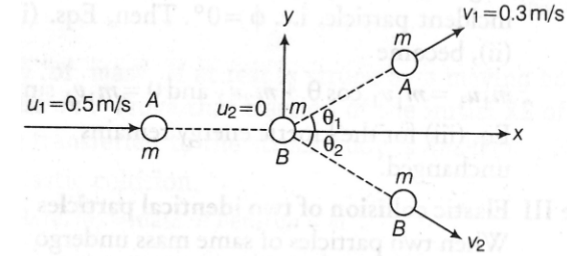
or $\beta = 26^\circ\ 34'$. This angle is with the horizontal.

(b) The moment the stone is dropped from the car, horizontal force on the stone is zero. The only acceleration of the stone is that due to gravity. This gives a vertically downward acceleration of 10 ms^{-2}. This is also the net acceleration of the stone.

4) Consider the collision depicted in figure to be between two billiard balls with equal masses $m_1 = m_2$. The first ball is called the cue while the second ball is called the target. The billiard player

wants to sink the target ball in a corner pocket, which is at an angle $\theta_2 = 37^0$. Assume that the collision is elastic and that friction and rotational motion are not important. Obtain θ_1.

a.



By conservation of momentum, we have $mu_1 + 0 = mv_1 + mv_2$

or $u_1 = v_1 + v_2$ … (i)

By conservation of energy, we have

$$\frac{1}{2}mu_1^2 = \frac{1}{2}mv_1^2 + \frac{1}{2}mv_2^2$$

or $u_1^2 = v_1^2 + v_2^2$ … (ii)

From Eq.(i), we have

$u_1 \cdot u_1 = (v_1 + v_2) \cdot (v_1 + v_2)$

$= v_1 \cdot v_1 + v_1 \cdot v_2 + v_2 \cdot v_1 + v_2 \cdot v_2$

or $u_1^2 = v_1^2 + v_2^2 + 2v_1 \cdot v_2$

or $u_1^2 = u_1^2 + 2v_1 \cdot v_2$ [using Eq.(ii)]

or $v_1 \cdot v_2 = 0$

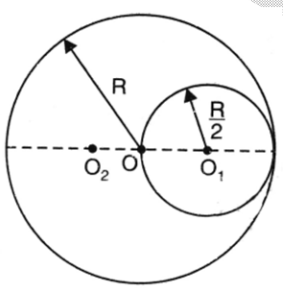
Thus, the angle between v_1 and v_2 is 90^0.

or $\theta_1 + \theta_2 = 90^0$

$\therefore\ \theta_1 = 90^0 - \theta_2 = 90 - 37^0 = 53^0$

5) From a uniform disk of radius R, a circular hole of radius R/2 is cut out. The centre of the hole is at R/2 from the centre of the original disc. Locate the centre of gravity of the resulting flat body.

ANS : Let from a bigger uniform disc of radius R with centre O a smaller circular hole of radius $\frac{R}{2}$ with its centre at O_1 (where $OO_1 = \frac{R}{2}$) is cut out. Let centre of gravity or the centre of mass of remaining flat body be at O_2, where $OO_2 = x$. If σ be mass per unit area, then mass of whole disc $M_1 = \pi R^2\sigma$ and mass of cut out part



$$M_2 = \pi\left(\frac{R}{2}\right)^2 \sigma = \frac{1}{4}\pi R^2\sigma = \frac{M_1}{4}$$

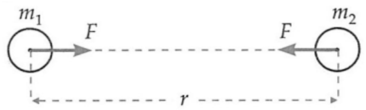
$$\therefore\quad x = \frac{M_1(0) - M_{2(OO_1)}}{M_1 - M_2} = \frac{0 - \frac{M_1}{4} \times \frac{R}{2}}{M_1 - \frac{M_1}{4}} = -\frac{R}{6}$$

i.e., O_2 is at a distance $\frac{R}{6}$ from center of disc on diametrically opposite side to centre of hole.

6) State Newton's law of gravitation. Hence define G with its unit and why is called a universal gravitational constant?

ANS : **Statement of Newton's law of gravitation.** In 1687, Newton published the universal law of gravitation in his book Principia. This law can be stated as follows :

- Every particle in the universe attracts other particle with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. This force acts along the line joining the two particles.



- Consider two bodies of masses m_1 and m_2 and separated by distance r. According to the law of gravitation, the force of attraction F between them is such that

$F \propto m_1$ and $F \propto \frac{1}{r^2}$

$\therefore \quad F \propto G\frac{m_1 m_2}{r^2}$

or $\quad F = G\frac{m_1 m_2}{r^2}$

- Where G is a constant called universal gravitational constant.
- **Definition of G.** If $m_1 = m_2 = 1$ and r = 1, then

$$F = G$$

- The universal gravitational constant may be defined as the force of attraction between two bodies of unit mass each and placed unit distance apart.
- In SI, the gravitational constant is equal to the force of attraction between two bodies of 1 kg each and placed 1 m apart.
- In cgs system, the gravitational constant is equal to the force of attraction between two bodies of 1 g each and placed 1 cm apart.
- **Dimensions of G.** As $F = G\frac{m_1 m_2}{r^2}$

$\therefore \quad G = \frac{Fr^2}{m_1 m_2}$

- Dimensions of $G = \frac{MLT^{-2} \times L^2}{M \times M} = [M^{-1}L^3T^{-2}]$
- **Units of G.** As $G = \frac{Fr^2}{m_1 m_2}$
- $\therefore$ SI unit of $G = \frac{Nm^2}{kg \times kg} = Nm^2kg^{-2}$.
- Similarly, cgs unit of G = **dyn cm^{2}g^{-2}.**

- **Value of G.** In SI, $G = 6.67 \times 10^{-11}\ Nm^2kg^{-2}$
- In cgs system, $G = 6.67 \times 10^{-8}$ dyn cm^2g^{-2}.
- The value of G does not depend on the nature and size of the bodies. It also does not depend on the nature of the medium between the two bodies. That is why G is called universal gravitational constant.

Section-D

Q4. Answer the following questions for <u>FIVE</u> marks: (10)

1) A cricket ball is thrown at a speed of 28 ms^{-1} in a direction 30^o above the horizontal. Calculate
 (i) The maximum height
 (ii) The time taken by the ball to return to the same level and
 (iii) The distance from the thrower to the point where the ball returns to the same level

OR

A particle starts from the origin at t = 0 s with a velocity of 10.0 $\hat{j}$ m/s and moves in the x-y plane with a constant acceleration of $\left(8.0\hat{i} + 2.0\hat{j}\right)$ ms^{-2}.

(a) At what time is the x-coordinate of the particle 16 m? What is the y-coordinate of the particle at that time?

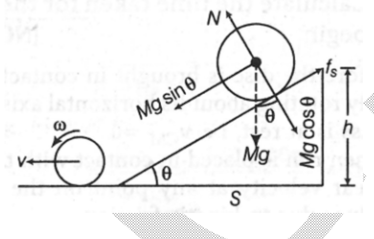
(b) What is the speed of the particle at the time?

2) Derive an expression for the kinetic energy, velocity and friction force on an inclined plane of inclination for θ the body rolling without sliding.

ANS

Let a body of mass M and radius R is rolling down a plane increased at an angle θ with the horizontal and forces acting on the body are also shown in figure.

Let a be the downward acceleration of the body. The equations of motion for the body can be written as



$N - Mg \cos\theta = 0$

$F = Ma = Mg \sin\theta - f$

As the force of friction f provides the necessary torque for rolling, so

$\tau = f \times R = I\alpha = MK^2$

or $f = M\dfrac{K^2}{R^2}\cdot a$

where, K is the radius of gyration of the body about its axis of rotation. Clearly,

$Ma = Mg\sin\theta - M\dfrac{K^2}{R^2}\cdot a$

or $a = \dfrac{g\sin\theta}{(1 + K^2/R^2)}$

Let h be height of the inclined plane and s the distance travelled by the body down the plane. The velocity v attained by the body at the bottom of the inclined plane can be obtained as follows

$v^2 - u^2 = 2as$

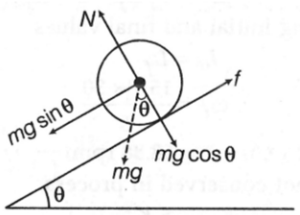
or $v^2 - 0^2 = 2 \cdot \dfrac{g \sin\theta}{(1 + K^2/R^2)} \cdot s$

or $v^2 = \dfrac{2gh}{1 + K^2/R^2}$ $\left[\because \dfrac{h}{s} = \sin\theta\right]$

or $v = \sqrt{\dfrac{2gh}{(1 + K^2/R^2)}}$

When a cylinder rolls down on an inclined plane, then forces involved are

(i) Weight mg (ii) Normal reaction N (iii) Friction *f*



From free body diagram, $N - mg\cos\theta = 0$

or $N = mg\cos\theta$

Also, if a = acceleration of centre of mass down the plane, then

$F_{net} = ma = mg\sin\theta - f$ … (i)

As friction produces torque necessary for rotation,

$\tau = I\alpha = fR$

$\Rightarrow f = \dfrac{I\alpha}{R} = \dfrac{Ia}{R^2}$ $\left[\because \alpha = \dfrac{a}{R}\right]$

Substituting for *f* in Eq.(i), we get

$ma = mg\sin\theta - \dfrac{Ia}{R^2}$

$\Rightarrow a = g\sin\theta - \dfrac{Ia}{mR^2}$

For cylinder, $I = \dfrac{1}{2}mR^2$

$\therefore a = g\sin\theta - \dfrac{a}{2}$

$\Rightarrow \dfrac{3a}{2} = g\sin\theta$

$\Rightarrow a = \dfrac{2g\sin\theta}{3}$

BEST OF LUCK