Q. No 2 (i) ➡ **HEAVY RIM OF A FLY WHEEL:**

The fly wheel of an engine is made heavy in the rim

➡ **Diagram**

▲Flywheel of an engine

➡ **REASONS:**

(i) Increase in moment of inertia: By making the rim heavier, more mass in concentrated at greater perpendicular distance from axis of rotation. This also provides it a hoop shape thus its inertia is big.

(ii) Increase in angular momentum: As moment of inertia increases, the angular momentum increases as well

Mathematical Relation: $L \propto I$, $\boxed{L = I\omega}$

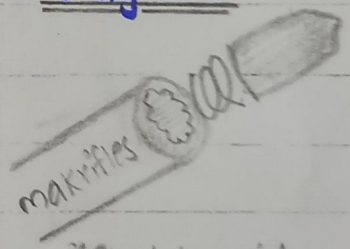
(iii) Stability: The above two points provide stability to the wheel

➡ **CONCLUSION:** Greater angular momentum and moment of inertia offer greater opposition to resistance Thus increasing stability.

Q No. 2 (ii) ➡ **RIFLING OF A RIFLE BARREL:**

Rifling refers to cutting spiral like groove in the interior of the rifle's barrel.

➡ **Diagram**



▲a rifled barrel

➡ **REASONS:**

(i) Translation And Rotational Motion:

A bullet fired from a rifled barrel has translational aswell as rotational motion.

(ii) Aerodynamic shape: Rotational motion provides bullet the required direction and aerodynamic shape.

(iii) Increase In Kinetic energy: The total kinetic energy of the bullet will be, $K.E = (K.E)_{trans} + (K.E)_{rot}$

mathematically; $\boxed{K.E = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2}$

➡ **CONCLUSION:** The above mentioned points provide the bullet stability, a certain direction and a required kinetic energy.

Q No 2(iii) ➡ **DIFFERENCE IN SPIN:**

Hard-boiled egg will spin faster than raw egg with same applied torque

➡ **Explanation:**

(i) Action of Centrifugal force: Centrifugal force of the non-liquid portion of egg will act on the liquid content pushing it towards the shell. This affects the inertia and angular velocity of the raw egg

(ii) Difference in moment of inertia: The moment of inertia of raw egg will be greater than that of the hard boiled egg. Larger moment of inertia will offer larger resistance to motion.

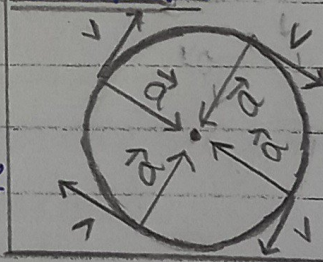
(iii) Difference in anglar velocity: Raw egg will have a smaller angular velocity than the boiled egg. This is because of difference in moment of inertia.

➡ **Conclusion:** Thus it can be concluded that due to difference in moment of inertia and angular velocity, hard egg will spin faster than the raw egg.

Q No.2 (iv) ➡ **DIRECTION OF ACCELERATION OF A BODY MOVING IN A CIRCLE:** Acceleration of such a body is directed towards the centre

➡ **REASONS:**

DIAGRAM



(i) Centripetal force: Centripetal force acts on a body moving in a circle and is centre seeking.

(ii) Newton's 2nd law of motion: In accordance with Newton's second law of motion, direction of acceleration is governed by direction of force. That means $\vec{a}_c$ will be in the direction of $\vec{F}_c$ which is the centre of the circle.

(iii) Mathematical form: $F_c = \frac{mv^2}{r} = m\left(\frac{v^2}{r}\right)$

$$\boxed{F_c = m\vec{a}_c}$$

➡ **CONCLUSION:** To conclude, the acceleration of a body moving uniformly in a circle is directed towards the centre of the circle due to centripetal force and Newton's second law of motion.

Q No. 2(v)

➡ REASONS

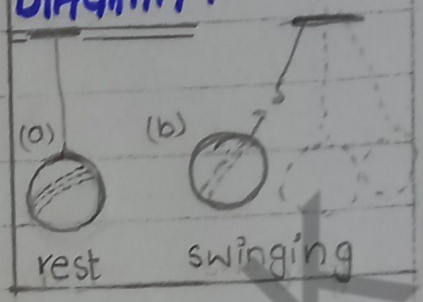
(i) Initial equilibrium state:

Initially, the whole system is at rest which suggests that the tension in the string is equal to the weight of ball.

. mathematically:

$$T = W = mg$$

DIAGRAM:



(ii) Final swinging state:

When the mass oscillates, the equilibrium is disturbed. Tension is increased due to an additional factor of centrifugal force.

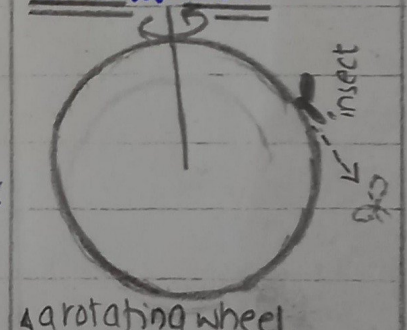
. mathematically: $T = mg + F_{(centrifugal)}$

➡ CONCLUSION: As tension in the string due to swinging motion increases, it exceeds beyond weight of the ball and thus breaks

Q No. 2(vi) **➡ MOTION OF THE INSECT:**

The insect will fly off the wheel tangent to the surface of the wheel as the rotating speed increases.

DIAGRAM:



a rotating wheel.

➡ EXPLANATION:

(i) Role of friction: In the beginning, when the speed of the wheel is slow, the friction cancels out the impact of centrifugal force and thus the insect remains in contact with the wheel.

(ii) Role of centrifugal force: Gradually as the velocity of rotating wheel increases, the centrifugal force increases while friction remains constant. This centrifugal force causes the insect to fly off the rotating wheel in tangential direction.

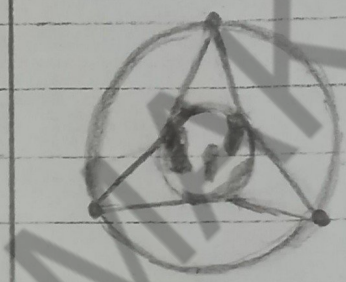
➡ CONCLUSION: Thus as with increasing speed centrifugal force out numbers friction, the insect flys off.

Q No 2(vii)

⇒ MINIMUM NUMBER OF SATELLITES REQUIRED FOR GLOBAL COVERAGE OF TV TRANSMISSION:

Minimum three correctly positioned geo-stationay satellites are required for the global coverage of T.V transmission.

• Diagram:



⇒ REASON:

• To provide 360° coverage:

Each geo-stationary satellite covers 120° of longitude. To provide 360° coverage of the whole Earth's longitude, minimum numbes of correctly positioned satellites is 3.

⇒ CONCLUSION: Thus it can be concluded that just 3 satellite can provide global coverage of T.V each covering 120° of longitude.

Q No. 2(viii) **⇒ MOMENT OF INERTIA:**

• Definition: Moment of inertia is the property of a body to mantain its state of rest or state of uniform angular motion.

• Mathematical form: $I = mr^2$

⇒ SIGNIFICANCE IN ROTATORY MOTION:

(i) Stability: Greater the moment of inertia, greater the stability of rotating body.

(ii) Resistance's opposition: A large moment of inertia provides a greater opposition to resistance in the rotating body's uniform motion or state of rest.

(iii) Relation with angular momentum: Angular momentum and moment of inertia are in direct relation. Hence greater inertia stabalizes angular momentum.

• Mathematical form: $L = I\omega$

Q No 2(xi) ⇒ EXPLANATION:

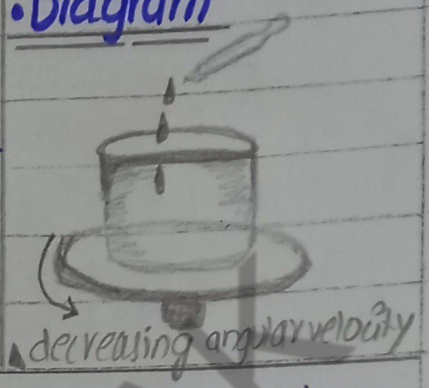
(i) Increase in moment of inertia: As water drops in the beaker, the mass of the system increases. This increases the moment of inertia i.e., $I = mr^2$

(ii) Conservation of angular momentum:
The law of conservation of angular momentum demands that the total angular momentum of the system must remain constant.

- **Mathematical form:** $L = I\omega$, in order to conserve 'L' if 'I' increases, ω shall decrease thus, angular velocity decreases. $\omega \propto \frac{1}{I}$

⇒ **CONCLUSION:** Thus, the slowing down of the system occurs due to conservation of angular momentum.

- **Diagram**



Q No.2 (x) ⇒ PHENOMENON OF WEIGHTLESS-NESS IN A FALLING ELEVATOR:

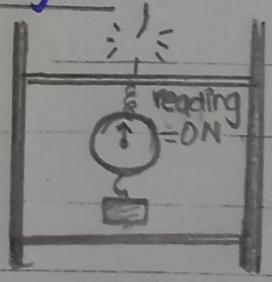
- **Condition:** The elevator is falling freely under gravity i.e., $\vec{a} = g$
- **Mathematical explanation:**

As $T = W - ma$, $a = g$

$T = mg - mg$

$T = 0$

- **Diagram**



$\vec{a} = g = 9.8 ms^{-2}$

- **Result:** As $T = 0$, the weight of an object shown by a spring balance in such a condition will be zero. The object has achieved what's said to be a state of weightlessness.

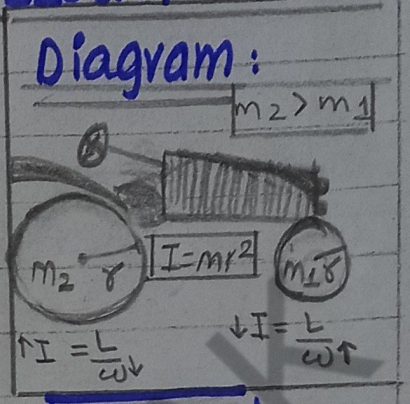
⇒ **CONCLUSION:**
To conclude, when $\vec{a} = \vec{g}$, factor of T comes out to be zero producing these results.

Q No 2(ix) → DIFFERENCE IN ANGULAR VELOCITY OF THE TWO WHEELS: The larger wheel will rotate slowes than the smaller wheel.

→ EXPLANATION:

(i) Moment of inertia: Greates wheel has a greates radius and mass than the smalles wheel thus it'll have greater moment of inertia. **Mathematical form:** $I = mr^2$

Diagram:



(ii) Inverse relation of 'I' with 'ω': As we know; $L = I\omega$, 'I' has inverse relation with 'ω'. $\uparrow I = \frac{L}{\omega\downarrow}$ Thus increase in 'I' decreases angular velocity ω and vice versa.

→ CONCLUSION:

Thus due to a greater radius, mass and moment of inertia, larger wheel rotates slower than the smaller wheel.

Q No. 2 (xviii)