**Chapter 8 Summary of terms**

**Circular Motion**

* Linear speed (= tangential speed)

(= speed) = distance traveled per unit time = distance traveled**/**time taken

* A point on the outside edge of a merry-go-round travels a greater distance in 1 complete rotation than a point nearer the center
* Travelling a greater distance in the same time means greater speed
* Axis : straight line about which rotation takes place
* Linear speed is greater on outer the edge of a rotating object than it is closer to the axis
* Tangential speed: It is the linear speed of something moving along a circular path
  + Because the direction of motion is tangent to

the circumference of the circle

* For, circular motion, linear speed = tangential speed (units m**/**s or km**/**h)

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* Rotational Speed (= angular speed = ꭃ)
* Revolution: motion of an object turning around an axis that lies outside the object
* Rotation: Spinning motion that occurs when an object rotates about an axis located within the object (usually an axis through its center of mass)
* Earth makes 1 revolution about the Sun each year and it rotates about its polar axis once per day
* ꭃ involves the number of rotations or revolutions per unit of time
* All parts of the rigid merry-go-round turn about the axis of rotation in the same amount of time
* All parts share the :
  + same revolutions per unit time
  + same number of rotations or the same rate of rotation
* Rotational rates are expressed in revolutions per minute (= RPM)

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Relationship between tangential speed (T.S.) and rotational speed (R.S)

* T.S. = radial distance from the axis of rotation x R.S.
* v = r x ꭃ
* At the very center of the rotating platform, you have no speed at all: you merely rotate
* But as you approach the edge of the platform, you find yourself moving faster and faster
* You move faster:
  + if the rate of rotation increases (ꭃ)
  + if you are further away from the axis (= r)
* If you move out twice as far from the rotational axis at the center, you move twice as fast

**Check point, page 124**

1. Imagine a ladybug sitting halfway between the rotational axis and the outer edge of the turntable. When the turntable has a rotational speed of 20 RPM and the bug has a tangential speed of 2 cm/s. What will be the rotational and tangential speeds of her friend who sits at the outer edge?
2. Trains ride on a pair of tracks. For straight line motion, both tracks are the same length. Not so for tracks along a curve. Which track is longer, the one on the outside of the curve or the one on the inside?

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**Exercises Page 146**

1. While riding on a carnival Ferris wheel, Sam Nasty horses around and climbs out of his chair and along the spoke so he is halfway to the axis.
   1. How does the rotational speed compare with that of his friends who remains in the chair?
   2. How does his tangential speed compare?
   3. Why are your answers different?
2. A large wheel is coupled to a wheel with half the diameter.
   1. How does the rotational speed of the smaller wheel compare with that of the larger wheel?
   2. How do the tangential speeds at the rims compare (assuming the belt doesn’t slip)

**Rotational Inertia**

* An object rotating about an axis tends to remain rotating about the same axis unless interfered with by some external influence
* This property of an object to resist changes in its rotational state of motion is called rotational inertia (R.I)
* In the absence of outside influences, a rotating top keeps rotating, while a top at rest remains at rest
* R.I depends on mass
* R.I depends on the distribution of the mass about the axis of rotation
  + The greater the distance between an object’s mass concentration and the axis, the greater the R.I
  + The greater the R.I, the greater is the difficulty in changing its rotational state
  + e.g., a circus tightrope walker who carries a long pole to aid balance
* R.I of any object depends on the axis about which it rotates e.g., different rotations of a pencil
* R.I decreases when we run with our legs bent and it allows us to rotate them back and forth more quickly
  + A long legged person tends to walk with slower strides than a person with short legs e.g. Giraffe run with slower gait than mice

**Exercise page 146**

7. Flamingoes are frequently seen standing on one leg with the other leg lifted. Is the R.I enhanced with long legs?

**Torque**

* It is the rotational counterpart of force
* It tends to twist or change the state of rotation of things
* If you want to a make a stationary object rotate, apply torque
* If you want a rotating object to change rotational speed, apply torque
* The lever arm
  + about any axis of rotation is the perpendicular distance from the axis to the line along which the force acts.
  + it will always be the shortest distance between the axis of rotation and the line along which the force acts
* Torque = lever arm x force that tends to produce rotation
* e.g, kids of different weights playing on a seesaw
  + If the 2 torques are equal and opposite,
    - making the net torque zero,
      * no rotation is produced
* e.g., stubborn bolt is more likely to turn when the applied force is perpendicular to the handle
* Mechanical equilibrium (M.E):
  + Anything in M.E doesn’t accelerate linearly or rotationally

**Conditions for mechanical equilibrium**

* the sum of the forces acting on a body or any system must equal zero
* and, the net torque on a body or on a system must also be zero

**Check Point page 130**

1. If a pipe effectively extends a wrench handle to 3 times its length, by how much will the torque increase for the same applied force?
2. Consider the balanced seesaw in Fig 8.18. Suppose the girl on the left suddenly gains 50 N, such as by being handed a bag of apples. Where should she sit in order to balance, assuming the heavier boy does not move?

**Exercise page 146**

19. Can a force produce a torque when there is no lever arm?

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**Center of mass and center of gravity**

* Center of mass (c.m): For a given body, the center of mass is the average position of all the mass that makes up the object
  + e.g., For ball
    - a symmetrical object
    - its c.m is at its geometrical center
* An object has a c.m, whether or not its under the influence of gravity
* Center of gravity(c.g.): It is the average position of weight distribution
* Since weight and mass are proportional ( w = mxg)
* The c.m and c.g refer to the same point of an object
* e.g., an exploding cannonball
  + the internal forces that act in the explosion do not change the c.g of the projectile
  + if air resistance can be neglected, the c.g of the dispersed fragments as they fly through the air will be the same location as the c.g would have been if the explosion hadn’t occurred

**Check point page 131**

1. Where is the c.g of a donut?
2. Can an object have more than one c.g?

**Locating the center of gravity**

* Balancing an object provides a simple method of locating its c.g
* e.g,
  + for a meter stick, has its c.g at its midpoint
  + and for a boomerang, c.g is outside its physical structure,

not within the material of the boomerang

**Check Point page 132**

1. Where is the c.m of Earth’s atmosphere?
2. A uniform meterstick supported at the 25 cm mark balances when a 1 kg rock is suspended at the 0 cm end. What is the mass of the meterstick?

**Stability**

* The location of c.g is important for stability
* Draw a line straight down from the c.g of an object of any shape

* + - If it falls inside the base of object, it’s in stable **->** balance
    - If it falls outside the base, it’s unstable **->** topple
    - e.g., leaning tower of Pisa and lady trying to touch her feet

**Check point page 135**

1. Why is it dangerous to slide open the top drawers of a fully loaded file cabinet that is not secured to the floor?
2. When a car drives off a cliff, why does it rotate forward as it falls?

**Exercise page 146-147**

21. When the line of a force intersects the c.m of an object, can that force produce a torque about the object’s c.m?

25. Which is more difficult – doing sit-ups with your knees bent, or with your legs straight out? Why?

27. Why must you bend forward when carrying a heavy load on your back?

29. Why is it easier to carry the same amount of water in two buckets, one in each hand, than in a single bucket?

33. Why is it important to secure file cabinets to the floor, especially cabinets with heavy loads in top drawers?

**Angular momentum**

* Things that rotate, remain rotating, until something stops them.
* A rotating object has an inertia of rotation
* This inertia of rotation of rotating objects is called angular momentum
* e.g., a planet orbiting around Sun
* or e.g., a rock whirling at the end of a string

**Angular momentum = rotationl inertia x rotational velocity**

* For, the case when an object that is small compared with the radial distance to its axis of rotation

**Angular momentum = linear momentum x radial distance = mvr**

Rotational version of Newton’s first law:

* An object or system of objects will maintain its angular momentum unless acted upon by an external net torque

**Conservation of Angular Momentum**

* The law of conservation of angular momentum states:
* If no external net torque acts on a rotating system, the angular momentum of the system remains constant
* e.g., A figure skater
  + she starts to whirl with her armsand perhaps a leg extended
  + and then draws her arms and leg in
  + to obtain greater rotational speed
  + because whenever body contracts, its rotational speed increases