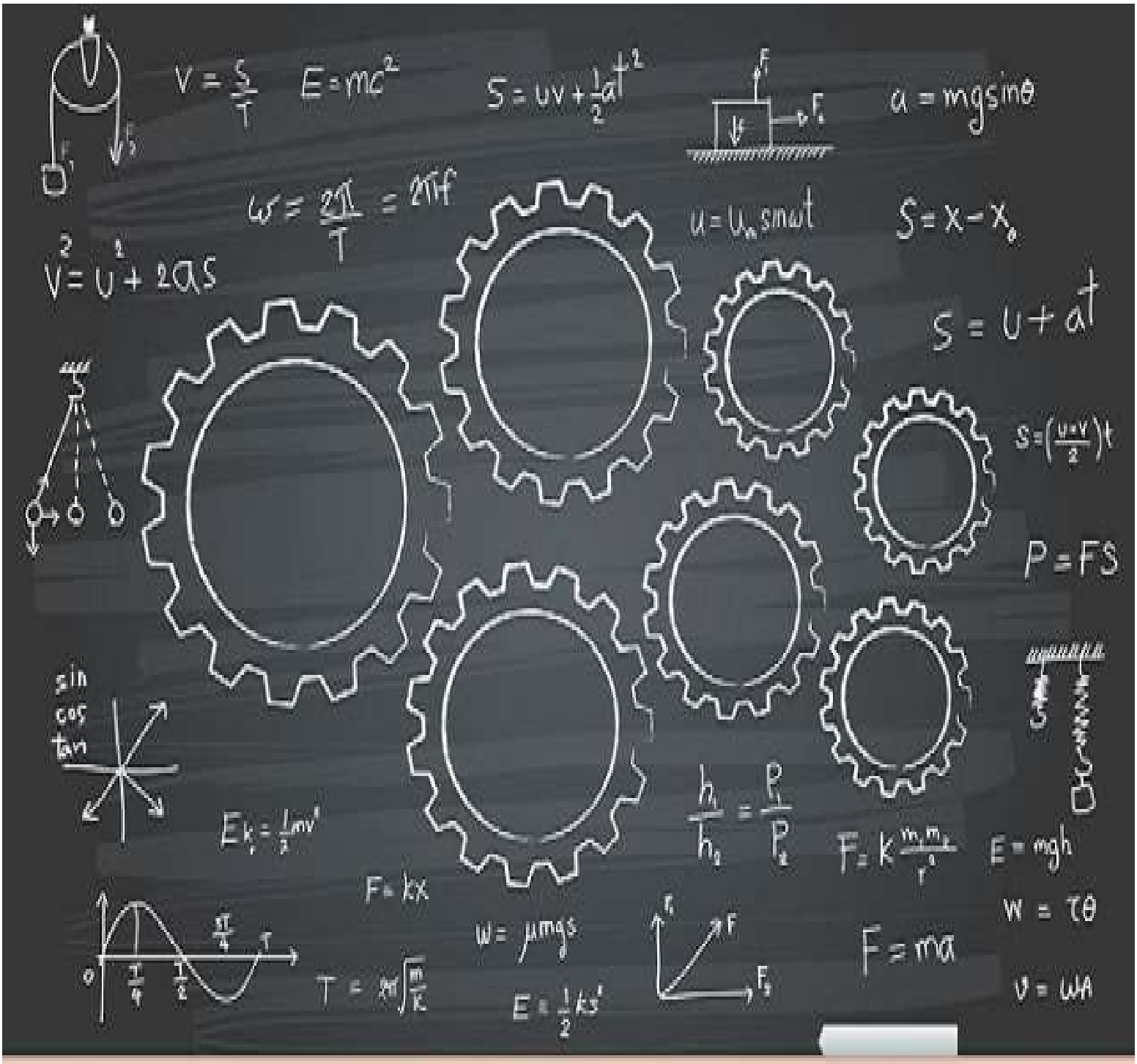


CHAPTER **(2)**

MECHANICS

MECHANICS

MECHANICS

Displacement

The changing amount in the position of the object in particular direction.

$$\Delta d = d_f - d_i$$

Displacement (change in position)

[m] = Final position [m] - Initial position [m]

The chart of (place- Time): estimates the position of the object in specific time, or estimates the time in specific position.

Example (1)

A car travels along a straight road 100 m east then 50 m west. Find distance and displacement of the car.

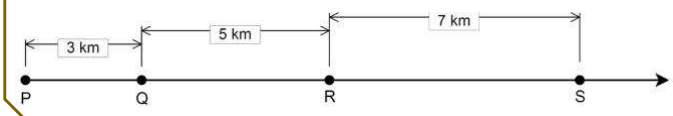
Solution

Distance is 100 meters + 50 meters = 150 meters
Displacement is 100 meters – 50 meters = 50 meters, to the east.

Example (2)

A car moving along in a straight highway from point P to point Q to point R and to point S, then back to point Q and finally to the point R as shown in the figure below.

A. Find the distance travelled by car.
B. Find the displacement of the car.



Solution

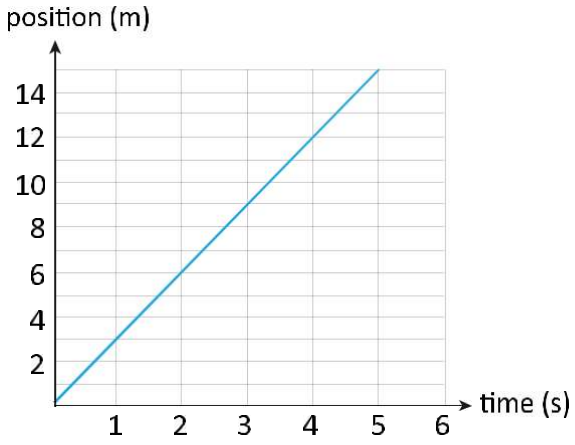
Given the distances, PQ = 3 km, QR = 5 km and RS = 7 km Also, SQ = 7 + 5 =12 km, PR = 3 + 5 = 8 km

A. Distance travelled by the car = PQ + QR + RS + SQ + QR = 3 + 5 + 7 + 12 + 5 = 32 km
B. Displacement of the car = the shortest distance between the final point R and the initial point P = PR = 8 km

Example (3)

In this example, we want to know how to read a position-time graph. Consider the graph below, and answer the following questions.

A. When did the object reach 12 m beyond the starting point?
B. Where was the object after 2 seconds?
C. Find the displacement in the time interval 3s to 4s.



Solution

In x−t graph, the vertical axis is the position of the moving object at any instant of time relative to the starting point. Here, the object starts its motion from the origin x=0 at time t=0.

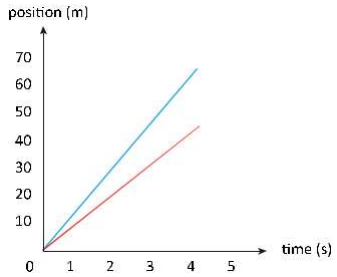
A. As you see from the graph, at position y=12, the time is t= 4s.

B. Inversely, a point in the horizontal axis (time) is given and wants the corresponding point on the y axis (position). At t =2s, the position is exactly 6 meters.

C. First, locate the initial and final points as below. Initial point has coordinate (x=9, t=3) and final point is (x= 12, t=4s). By definition, displacement is subtraction of initial position from final position so $\Delta x = x_f - x_i = 12 - 9 = 3m$

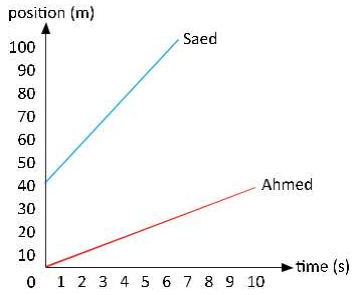
1. The next diagram represents the movements of two runners , at the time 4 s the distance between them in meters is:

A 20 B 45
C 60 D 110



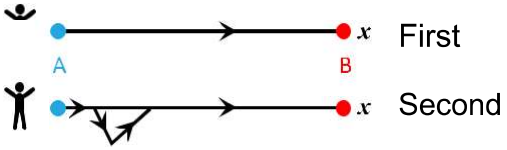
2. In the Following diagram , calculate the time needed for Saed to move from 60 m to 90 m in seconds.

A 1 B 2
C 3 D 4



3. In the next form, two people moved in two different paths from A to B, so they both moved as:

A same distance and displacement
B two different displacements, two different distances
C same distance, bigger displacement for second person
D same displacement, bigger distance for second person

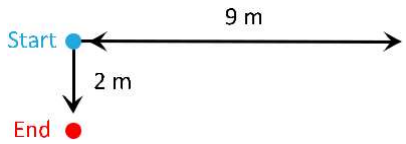


4. An object moves in 3m radius circular path , when it reaches to the starting point again , then the displacement in m equals:

A 0 B 3
C 6 D 9.42

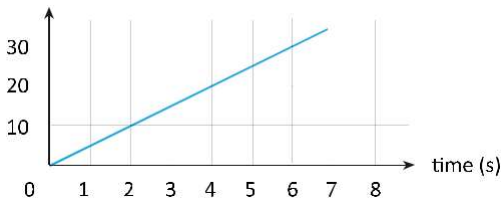
5. In the diagram , a cat is moving on a horizontal 9 m wall , goes back then continues it's movement in 2 m down, calculate its displacement in meters:

A 2 B 9
C 11 D 20



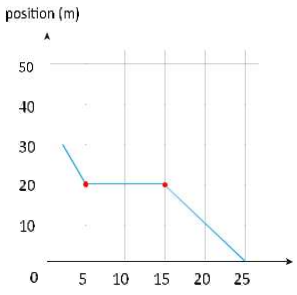
6. The following chart shows the movement of a object through specific time, choose the correct statement.

A after 4s, the distance is 5m
B after 5s, the distance is 20 m
C after 3s, the distance is 45 m
D after 6s, the distance is 30 m



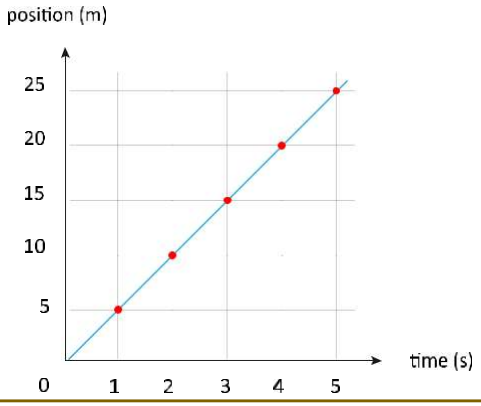
7. The following chart shows the movement of a pupil in his school, choose the correct statement.

A pupil stops for 10s
B pupil starts moving from his school
C pupil reaches school after 15s
D pupil's distance was 10m after 10s of moving



8.The following chart shows the movement of a runner, his speed is:

A 3 m/s
B 5 m/s
C 15 m/s
D 25 m/s



9. Acceleration is

A change in displace-ment divided on time
B change of object's position in specific direction
C change in position divided on amount of changed time
D change in velocity divided on amount of changed time

10. The object is accelerating if .....

A only velocity change
B decelerate speed
C nly movement direction change
D set speed and direction

11. A object's speed changed from 4m/s to 7.5m/s in one second, the acceleration equals ..... *m/s²*

A -11.5
B -3.5
C 3.5
D 11.5

Velocity

Average velocity (velocity): position change divided on time of changing.

$$\bar{v} = \frac{\Delta d}{\Delta t} = \frac{d_f - d_i}{\Delta t}$$

$$\text{Velocity}[\text{m s}] = \frac{displacement[m]}{change\,in\,time[s]} = \frac{\text{final position}[\text{m}] - \text{initial position}[\text{m}]}{change\,in\,time[s]}$$

Slope (position – time) equals the average velocity, positive relation; the greater the slop of curve, the greater speed.

Acceleration

Average acceleration: changing in velocity divided on the time when change happens.

$$\text{Average acceleration}[m/s^2] = \frac{velocity[m/s]}{change\,in\,time[s]} = \frac{\text{final velocity}[\text{m/s}] \quad \text{intial velocity}[\text{m/s}]}{change\,in\,time[s]}$$

Slope (velocity – time) equals the average vector acceler-ation, positive relation; the greater the slop of curve, the greater acceleration.

Example

The speed of a car is 45 m/s The driver reduces the speed of car to 3 m/s in 1.5 s, calculate the acceleration of the car.

Solution

Final velocity vf = 3 m/s and initial velocity v_i = 45 m/s.we have time, t = 1.5 sec. Therefore, by applying the average acceleration formula, we will get:

$$a_{ave} = \frac{\Delta v}{\Delta t} \qquad a_{ave} = \frac{3m/s - 45m/s}{1.5s} \qquad a_{ave} = -28m/s^2$$

12. Calculate the acceleration of object with changing speed average 30m/s in two seconds .

A 60 m/s²
B 30 m/s²
C 15 m/s²
D 5 m/s²

13. An object moves in an accelerating speed 4m/s in each second, which statement is correct?

A speed= 4 m/s
B total time = 4 s
C acceleration = 4 m/s²
D total distance = 4 m

14. A race car accelerating speed from 4 m/s to 36 m/s in 4 seconds, it's acceleration in m/s² equals.

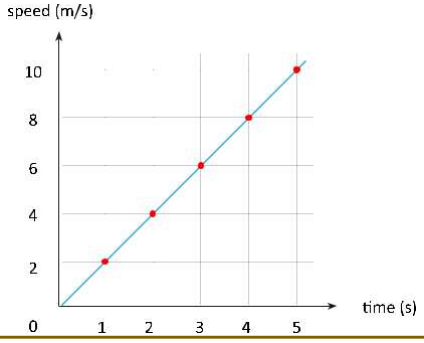
A 7
B 8
C 9
D 10

15. Car A changes speed from 10 m/s to 30 m/s in 4 seconds, Car B changes speed from 22 m/s to 33 m/s in 11 seconds, acceleration of Car A ... . acceleration of Car B

A bigger than
B less than
C equals
D half

16. The Followin chart represents curve of (speed – time),
calculate acceleration in m/s²

A 2
B 8
C 18
D 32

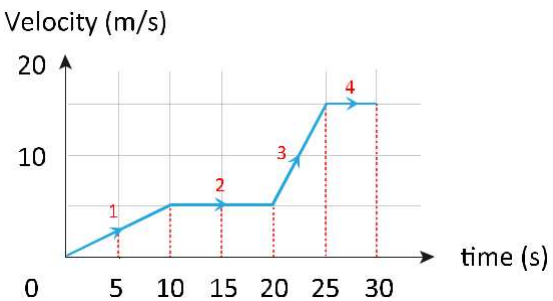


17. The next dotted object.

A decelerate
B accelerate
C slow down
D constant speed

18. In the chart, car passed in four stages, each stage with a different speed, which one is the most acceleration?

A 1
B 2
C 3
D 4

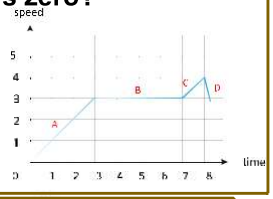


19. If an acceleration of a car is zero, so it's speed is.

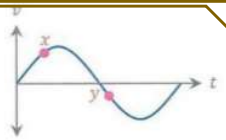
A constant
B decreasing
C increasing
D variable

20. The chart shows the speed of a runner, in which time the acceleration equals zero?

A A
B B
C C
D D



21. The chart shows speed curve v rated to t for a straight line moving car, at point y the car is.



A zero acceleration
B under position of point X
C greater speed than at point X
D opposite the direction at point X

22. An object moving from rest in regular accelera-tion 2 m/s², after 7s, its speed is.

A 3.5 m/s
B 3 m/s
C 9 m/s
D 14 m/s

23. A car accelerated from rest in constant rate 5m/s2, it needs ..... s to reach the speed 30m/s.

A 150
B 35
C 25
D 6

24. If a bike accelerated from rest regularly in rate 4m/s2, its speed reaches 24m/s after ..... seconds.

A 96
B 28
C 20
D 6

25. A car's speed is 30m/s, then it slows down in rate 6m/s2, after 4 seconds its speed will be ..... m/s

A 6
B 26
C 36
D 54

26. **An object starts moving from rest in 5m/s² acceleration, how much is the speed after 10m?**

A 2 m/s
B 5 m/s
C 8 m/s
D 10 m/s

Acceleration Sign

+	Acceleration vector in positive direction (object's speed increases)
-	Acceleration vector in negative direction (object's speed decreases)

Motion with constant acceleration

Equations

$$v_f = v_i + \bar{a}t_f$$
$$d_f = d_i + v_i t_f + \frac{1}{2}\bar{a}t_f^2$$
$$v_f^2 = v_i^2 + 2\bar{a}\left(d_f - d_i\right)$$

v_f = final velocity , v_i = intial velocity, a = average acceleration $\left[m/s^2\right]$
t_f = final time, d_f = final position, d_i = intial position

Acceleration in Gravity

- Acceleration gravity(g): the acceleration of an object falling freely due to an effect of gravity in it, ignoring the effect of air resistant.

Acceleration Sign

+	Object falls down (speed increases)
-	Object throws up (speed decreases)

- If an object threw up then its speed decreases till it reaches zero at the highest point, while its acceleration stays constant and doesn't depend on the mass, equals g=9.8m/s².

- Movement equations in gravity.

$$v_f = v_i + gt_f$$
$$d_f = d_i + v_i t_f + \frac{1}{2}gt_f^2$$
$$v_f = v_i^2 + 2g\left(d_f - d_i\right)$$

v_f = final velocity , v_i = intial velocity, g = gravity acceleration $\left[m/s^2\right]$
t_f = final time, d_f = final position, d_i = intial position

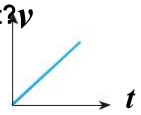
27. **An objects been thrown up, so it.**

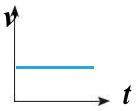
A acceleration decreases
B stops because of decrease
C acceleration is positive
D acceleration is zero at highest point

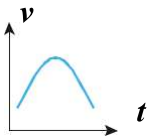
28. **Two balls, one of them is bigger than the other, we throw them up at same intermediate speed, if we Ignore air resistant at balls, so the balls will.**

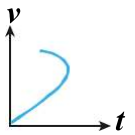
A stop at same time and height
B stop at same time, but different heights
C stop at different times, but same height
D stop at different times and heights

29. **which curve represents the speed of free falling object?**

A 

B 

C 

D 

30. **An object free falls from a building , it reaches earth surface after 10s, its speed at the time con-tacting earth is.** ($g=98m/s^2$)

A 9.8 m/s
B 98 m/s
C 980 m/s
D 9800 m/s

Solution

$$v_f = v_i + gt_f$$

V_i = 0 m/s because of free falling object.
V_f = 0 + 9.8 x 10 = 98 m/s so the answer is B

31. **An object been thrown up, how much is its speed at two seconds before the highest point?**

A $2\times98 m/s$
B $0.5\times9.8 m/s$
C $v_f - v_i$
D $v_i - v_f$

32. An object thrown up with intermediate speed 100m/s, its speed after 5s will be.

A $(5)_{m/s}$ B $(100+5)m/s$
C $(100-5\times 9\,8)_{m/s}$ D $(100+5\times 9.8)m/s$

33. An object thrown up at 49m/s speed, if the gravitational acceleration is ,how much time it needs to reach the highest point?

A 9.8 s B 2.5 s
C 4 s D 5 s

34. A fountain throw water up at 30 m/s speed, how much seconds the water needs to reach the beginning point again?

A 0.5 B 3
C 6 D 12

35. Which power represents intensity?

A gravity B push
C friction D pull

36. An object's resistance to any change in its state is

A reaction B save momentum low
C kinetic friction D inertia

37. A falling of the rider from his bike at sudden stop is an example of.

A reaction B save momentum low
C kinetic friction D inertia

38. If a 100N horizontal force affected a 20kg object and moved it at same direction of force, so the acceleration is ..... m/s^2

A 0.2 B 2
C 5 D 9.8

Solution

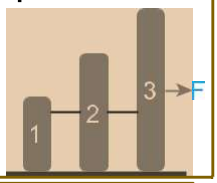
$a = \frac{F}{m}$ = 100/20 = 5 m/s2 , Answer is C

39. A 60N horizontal force affected 15kg object, its acceleration is.

A 0,25 m/s² B 4 m/s²
C 45 m/s² D 900 m/s²

40. A 10N Force affected three objects (as shown), their weights are 2kg, 3kg,5kg respectively , so the acceleration of the whole group is.... m/s^2

A 1 B 2
C 3.3 D 5



41. The acceleration that the object gains proportion to ...

A velocity, directly B (B) velocity, inversely
C (C) affected force, directly D affected force, inversely

Force

- **Contact Force**
  A force that is generated when an object from external environment contacts the system.
  Examples
  Friction, Pulsating Force, Horizontal force.

- **Field Force**
  A force that affects objects without contact be-tween them.
  Examples
  Magnetic Force, Electric Force, Gravity.

Newton's Laws

- First Law of Newton: An object at rest stays at rest and object in motion stays in motion with the same speed unless acted upon unbalanced force.
- Inertia: is the resistance of any physical object **to any change in its velocity. This includes changes to the objects speed or direction of motion.**
- One of inertia's applications: the passenger in the car rushes forward when it stopped suddenly.
- Second law of Newton: The acceleration of an object is directly proportional to the net force and inversely proportional to its mass. $a = \frac{F}{m}$

- Acceleration [m/s2] , Force [N] , Mass [kg] Weight: The force of gravity acting on an object. $F=mg$
- Weight [N], Mass [kg], Gravitational acceleration [m/s²]
- The mass stays the same everywhere, independent of location, but the weight changes with location because of the change in the gravitational acceleration.
- Third law of Newton: When to bodies interact, the apply forces to one another that are equal in magnitude and opposite in direction, and known as law of action and reaction.
- The resultant vector of two vectors in the same direction is given as R = A + B
- The resultant vector of two vectors in opposite direction is given as R = A – B ; where A > B
- Don't forget that, the resultant of two equivalent vectors and in opposite direction is zero (Equilibrium)
- The resultant vector of two perpendicular vectors is given as: $R^2 = A^2 + B^2$
- The resultant vector of two vectors make angle Θ in between is given as $R^2 = A^2 + B^2 - 2AB \cos \Theta$

42. The weight of a person is 160 N, which of the following statements is false?

A The gravitational force on the person equal to 160 N
B His body acts on the scale by 160 N
C The scale acts on his body by 160 N force.
D His mass is 160 kg.

43. A person mass is 100 kg, his mass on Moon is:

A 0 kg
B 100 kg
C 160 kg
D 980 kg

44. The resultant force for F1= 225 N and F2 = 165 N, if both in the same direction

A 60 N
B 225 N
C 390 N
D 400 N

Solution:

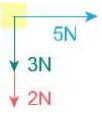
Fresultant = F1 + F2 = 225 + 165
= 390 N , So the answer is C

45. Ahmad moves 20 m to the west then back to the east of 15 m, determine the distance and dis-placement of Mohamed.

A distance 5 m, displacement 35 m
B distance 5 m, displacement 5 m
C distance 35 m, dis-placement 5 m
D distance 35 m, displacement 35 m

46. Three forces 5 N, 3 N, and 2 N act on a rigid body, which of the following statements where the body in equilibrium (no acceleration).

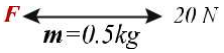
A 

B 

C 

D 

47. In the figure, a rope with 0.5 kg mass, two opposite forces exerted on it then it moves to the right with 2 m/s² acceleration, determine the force in N.



A 22
B 19
C 12
D 10

Solution:

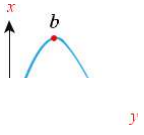
20 – F = ma
20 – F = 0.5 x 2 = 1
20–F=1
F = 20 -1 = 19 N , Answer is B

48. Yousef moves 8m to the north, then 12 m to the east, continues 8 m to the north again, determine the displacement of Yousef in m.

A 10
B 14
C 20
D 28

49. The diagram shows a projected upwards object, if a, c are at same high, which one of these statements is correct?

A $v=v$ $_{a\ \ b}$
B $v_a = v_b$
C $v=v$
D $v_a = v_b = v_c$



50. A projectile was fired at an angle of 30° in 39.2m/s speed, how much time it needs to reach the highest point? $(g = 9.8 m/s^2)$

A 1 B 2
C 3 D 4

51. A bee is standing on a spinning wheel, 2m away from wheel's center, if the tangential velocity for the bee is 3m/s, how much is the centripetal acceleration?

A 18 m/s² B 6 m/s²
C 4.5 m/s² D 1.5 m/s²

52. A 3kg weighted object rotates around its axis in constant speed, it completes a full turn in 20s, how much is its angular velocity in (rad/s)?

A $\frac{\pi}{20}$ B $\frac{\pi}{10}$
C 20π D 40π

53. An object weighted 0.8kg tied to the end of a massless 2m long rope and moving in a horizontal circular path, if the object's speed is 2m/s, so the tension force in the string equals ..... Newton.

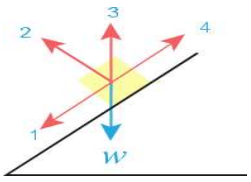
A 7.84 B 4 C 32 D 1.6

54. A 0.2kg object hanged with a 1m long string, How much is the affected centripetal force on the object when it completed a turn in 3.14s?

A 0.2N B 0.4N C 0.6N D 0.8N

55. In the diagram, an object weighted W slides on a inclineat planc without friction, which one of the arrows represents the vertical force?

A 1 B 2
C 4 D 3



Projectile motion

Determine the time of flight,maximum hight and horizontal range

$$\text{Time of flight, } t = \frac{2v_0\sin\theta}{g}$$

$$\text{Maximum height reached, } H = \frac{v_0^2\sin^2\theta}{2g}$$

$$\text{Horizontal range, } R = \frac{v_0^2\sin 2\theta}{g}$$

V_0 is the initial velocity [m/s], θ is the angle with the horizontal, and g is the gravitational acceleration [m/s2].

- The circular motion: is the motion of an object with con-stant speed in a uniform circular path with constant ra-dius.
- The centripetal acceleration: is the acceleration of an object moves in uniform circular motion and its direction to the center of the circular path.

$$a_c = \frac{v^2}{r}$$

$$a_c = \omega^2 r$$

$$a_c = \frac{4\pi^2 r}{T^2}$$

$$\omega = \frac{2\pi}{T}$$

is the centripetal acceleration [m/s2], v is the tangential velocity [m/s], w is the angular velocity [rad/s], r is the radius [m], T is periodic time [s].

- The centripetal force : is the resultant force that causes the centripetal acceleration and directed to the center of the circular path.

F is the centripetal force [N], m is he mass [kg], ac is the acceleration [m/s²]

Vertical force

- Vertical force: is a contact force, in which a surface vertically affected an object.
- Vertical force on a horizontal surface equals the ob ject's weight.

$$F_N = F_g = mg$$

$$F_N = vertical\ force[N], F_g = oject's\ weight, m = mass, g = gravity$$

- Friction Force: is a force that prevent the moving of objects or stops them.
- Types of friction: static, kinetic.

$$f_k = \mu_k F_N = \mu_k mg$$

- Friction doesn't depend on the space of the contacting objects.
- The static friction equals zero, if no force affects the object.

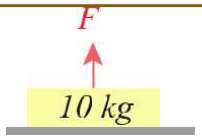
56. A 2kg object put on a horizontal surface, how much is the vertical force that affect the object? (g=10m/s²)

A 0.02N B 0.2N C 2N D 20N

57. **In the diagram, how much is FN ?** $(g = 9.8m/s^2)$

A 0.98N B 9.8N C 98N D 980N

Solution:



FN - Fg = 0
FN = Fg = mg = 10 x 9.8 = 98 N ,
the answer is C .

58. **Naser stands on a chair horizontally and holds a 5 kg box, if Ahmad weights 50kg how much is the vertical power that the chair affects Ahmad in Newton?** $(g = 9\ 8m/s^2)$

A 539 B 490 C 49 D 10

59. **A pupil pushes a 10kg table on a horizontal surface with a coefficient of kinetic friction 0.2, how much is the kinetic friction force?** $(g = 9\ 8m/s^2)$

A 10 B 20 C 25 D 100

60. **If a coefficient of kinetic friction between 50 N weighted object and the surface is 0.25, the friction force between object and surface equals…**

A 200 N B 50.25 N
C 49.75 N D 12.5 N

Solution:

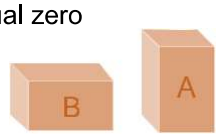
F_f = 0.25 x 50 = 12.5 N , so the answer is D

61. **A 3kg weighted box, affected by 30 N force towards east, calculate the friction force if the coefficient of kinetic friction is 0.2?** $(g = 10m/s^2)$

A 6N B 60N C 18N D 3N

62. **Which of these two boxes has the biggest friction force? Note that both have the same weight and**

A Box A B Box B
C both are similar, equal zero D both are similar, but don't equal zero



Kepler's Lows

First Low of Kepler: All planets move about the Sun in elliptical orbits, having the Sun in one of the foci. Second Low of Kepler: A radius vector joining any planet to the Sun sweeps out equal areas in equal lengths of time.

Third low of Kepler: The squares of the sidereal periods (of revolution) of the planets are directly proportional to the cubes of their mean distances from the Sun.

The sidereal period of planet depends on the radius of its orbit around the Sun. $\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{r_A}{r_B}\right)^3$

Acceleration of objects due to gravity

- To Calculate the gravitational acceleration at earth surface $g = G = \frac{m^E}{r_E^2}$
- **Note:** Gravitational acceleration directly proportional to the Earth's mass, and inversely to the square of the radius of Earth.
- Gravitational acceleration decreases as far the object goes from the earth's surface.

Circular Motion

- The complete rotation of the body around it self makes an angle = 2π radian.
- Angular displacement (Θ): The shortest angle between the initial and the final position for an object in a circular motion around a fixed point is known as the angular displacement; it is considered a vector quantity.
- Number of cycles (N), that covered by the rotated object around itself is given as:
- Angular velocity (ω): the rate of change of angular position of a rotating body.
- Angular acceleration (α): is the change in angular velocity divided by time of change.
- Relation between Linear and angular motion:

VARIABLE	TRANSLATIONAL	ANGULAR
Displacement	$s = rq$	$q = \frac{s}{r}$
Velocity	$v = rw$	$w = \frac{v}{r}$
Acceleration	$a = ra$	$a = \frac{a}{r}$
Time	t	t

Linear displacement (s)[m], Radius (r) [m], Angular dis-placement (Θ) [rad], Linear velocity (v) [m/s], Angular velocity (ω) [rad/s], Linear acceleration [am/s²], Angular acceleration [rad/s²].

63. According to Kepler's First Law, all planet's orbits

A circular B linear
C elliptical D spherical

64. The squares of the sidereal periods (of revolution) of the planets are directly proportional to the cubes of their mean distances from the Sun." This is the ...

A Third Law of Kepler B First Law of Kepler
C Einstein Law D Newton's Law

65. According to the Third Low of Kepler, the period of revolution of a Planet around the Sun proportional to its distance from Sun as....

A $T^2 \propto r^3$ B $T^3 \propto r^2$
C $T^3 \propto \frac{1}{r^2}$ D $T^2 \propto \frac{1}{r^3}$

66. One of the factors that affects the periodic time of a planet around the Sun is...

A The radius of planet's orbit B The mass of the planet
C The size of the sun D The size of the planet

67. If the Earth's mass doubles, then the gravity acceleration will.

A reduce to half B reduce to quarter
C double D not change

68. How much is the gravity acceleration on a height $9.6X10^6$ m from Earth's center in m/s^2 ? (Earth's radius is $6.4X10^6$m)

A $\frac{2}{3}g$ B $\frac{4}{9}g$ C $\frac{3}{2}g$ D $\frac{9}{4}g$

Solution

$$a = g\left(\frac{6.4x10^6}{9.6x10^6}\right)^2 = \frac{4}{9}g$$ Ans is B

69. As far as the object goes from Earth's surface, the gravity will

A increase B decrease
C constant D fluctuate

70. An object weighted W and mass m at Earth's surface, when it is very high above Earth's surface ...

A m decreases , W constant B both increases
C W decreases, m increases D W decreases, m constant

71. The one full complete cycle in radian is:

A π B 2π C 360° D 400°

72. The change in the angle of rotation during the rotation of an object around a fixed point is:

A Frequency B Angular acceleration
C Angular displacement D Angular velocity

73. When an object makes a complete cycle then its angular displacement in radian is:

A $\frac{1}{2\pi}$ B $\frac{\pi}{2}$ C 2π D π

74. The angular displacement of the minute hand during a half minute in radian is:

A B C D

75. If the second hand covers 5 minutes rotation, what is the angular displacement in radian?

A 5π B 10π C 25π D 25π

Solution

Second hand complete one cycle each minute,
so 5 minutes means 5 complete rotations
So, 5 x 2π = 10π, Ans. is B

76. How many complete cycle for an object cover an angular displacement = 50π rad?

A 50 B 25 C 5 D 0.5

77. What is the angular velocity in rad/s of a point on the car's tire with radius of 0.4 m and its linear speed is 40 m/s?

A 1 B 10 C 100 D 1600

Solution

V = r w -----> 40 = 0.4 w
W = 40/0.4 = 100 rad/s, Ans. is C

78. The unit of angular velocity is:

A m/s B m/s^2 C rad/s D rad/s^2

79. The change in angular velocity divided by time is:

A Angular displace-ment B Frequency
C Angular Linear ve D ty acceleration

Torque: is a measure of the extent of force that affects an object and leads to its rotation.

$\tau = F \times r$ $\tau = Fr\sin\theta$

Arm of force or lever arm: is the vertical distance from the axis of rotation to the point of influence of the force.

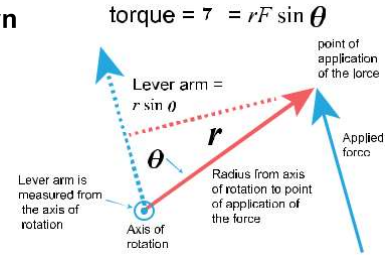
$L = r\sin\theta$

Torque [N.m], L is Arm of force or lever arm [m], r is radius of rotation [m], and Θ is the angle between the applied force and the radius of rotation.

Need to know:

- If the exerted force is parallel to the axes of rotation then the torque is zero.
- To produce maximum torque with minimum force, then the exerted force must be perpendicular on the axes of rotation (sinΘ =90) and applied on the farthest point from the point of exerted force.

As shown below:



80. A 20N force vertically affected a door, 0.5m far from axis of rotation , How much is the torque in International Measurement Units?

A 10 B 10.5 C 20.5 D 40

81. How much is the amount of torque created by a 260N force vertically affected a point 10cm verti -cally far from axis of rotation, (N.M unit)?

A 0 B 26 C 260 D 2600

Solution

T = F x r = 260 x 0.1 = 26 N.m
Ans. is B

82. A 20N force vertically affected a door, 0.5m far from axis of rotation, How much is the torque in International Measurement Units?

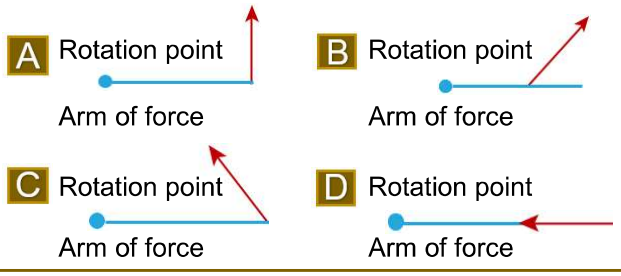
A The parallel distance from the axis of rotation to the point of influence of the force.

B The parallel displacement from the axis of rotation to the point of influence of the force.

C The angular displacement from the axis of rotation to the point of influence of the force.

D The vertical distance from the axis of rotation to the point of influence of the force.

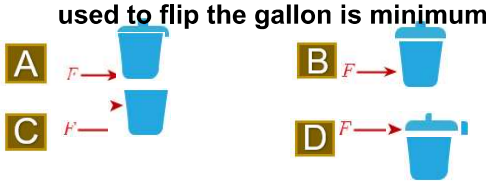
83. A force has the same amount affected a free rota-tion door, in which case won't be any torque?



84. A door with four rings A,B,C,D are used to open it, which ring is used to open the door with the least

A A B B C C D D

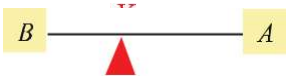
85. A kid tries to flip a gallon of water using pushing force, in which statement the force that used to flip the gallon is minimum?



Equilibrium Conditions

To be in a mechanical equilibrium.

- An object should be in transitional equilibrium; the sum of forces equals zero.
- An object should be in rotational equilibrium; sum of torques equals zero.
- Note: an object in circular path is not stable, due to the change of direction of velocity vector in the path.



86. In the diagram, to be balanced.

A the mass of B is bigger than A, closer to X

B the mass of A is bigger than B, further from X

C different mass, same distance from X

D same mass, different distance from X

87. An object affected by two forces or more, would be equilibrium if

A sum of forces = zero, sum of torques ≠ zero

B sum of forces = zero, sum of torques = zero

C sum of forces ≠ zero, sum of torques = zero

D sum of forces ≠ zero, sum of torques ≠ zero

88. If the sum of forces and sum of torques affected an object equals zero, so.

A (the object is in transitional equilibrium and in rotational equilibrium.

B the object is in transitional equilibrium and not in rotational equilibrium.

C the object is not in transitional equilibrium neither in rotational equilibrium.

D the object is not in transitional equilibrium and in rotational equilibrium.

89. The sum of forces affected an object doesn't equal zero, if the object is in.

A kinetic equilibrium

B static equilibrium

C moves in constant speed in a circular line path

D moves in constant speed in straight

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Ans	A	C	D	A	A	D	A	B	D	A	C	C	C	B	A	A	B	C
Question	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Ans	A	B	D	D	D	D	A	D	B	A	A	B	A	C	D	C	A	D
Question	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54
Ans	D	C	B	A	C	D	B	C	C	D	B	C	C	B	C	B	D	D
Question	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Ans	B	D	C	A	B	D	A	C	C	A	A	A	C	A	B	D	B	C
Question	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	
Ans	C	C	B	B	C	C	C	A	B	D	D	D	D	A	B	A	C	