Topic : Unit and Dimension

1. If e is the electric charge of an electron, c is the speed of light in free space, and h is planck's constant, ϵ_0 is permittivity of free space. The dimension of $\frac{e^2}{4\pi\epsilon_0 hc}$ is

   A. $[LC^{-1}]$

   B. $[M^0L^0T^0]$

   C. $[MLT^0]$

   D. $[MLT^{-1}]$

2. The work done by a gas molecule in an isolated system is given by,

   $W = \alpha\beta^2 e^{-x^2/\alpha kT}$

   Where x is the displacement, k is the Boltzmann constant, T is the temperature, α and β are constants, then the dimension of β will be :

   A. $[M^0LT^0]$

   B. $[M^2LT^2]$

   C. $[MLT^{-2}]$

   D. $[ML^2T^{-2}]$

3. Match List - I with List - II.

List - I	List - II
$a.\ h$ (Planck's Constant)	$i.\ [MLT^{-1}]$
$b.\ E$ (Kinetic Energy)	$ii.\ [ML^2T^{-1}]$
$c.\ V$ (Electric Potential)	$iii.\ [ML^2T^{-2}]$
$d.\ P$ (Linear Momentum)	$iv.\ [ML^2I^{-1}T^{-3}]$

Choose the correct answer from the options given below.

A. $(a) \rightarrow (ii), (b) \rightarrow (iii), (c) \rightarrow (iv), (d) \rightarrow (i)$

B. $(a) \rightarrow (i), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (iii)$

C. $(a) \rightarrow (iii), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (i)$

D. $(a) \rightarrow (iii), (b) \rightarrow (iv), (c) \rightarrow (ii), (d) \rightarrow (i)$

4. The pitch of the screw gauge is $1\ \mathrm{mm}$ and there are 100 divisions on the circular scale. When nothing is put in between the jaws, the zero of the circular scale lies 8 divisions below the reference line. When a wire is placed between the jaws, the first linear scale division is clearly visible while 72^{nd} division on circular scale coincides with the reference line. The radius of the wire is :

A. $1.64\ \mathrm{mm}$

B. $1.80\ \mathrm{mm}$

C. $0.82\ \mathrm{mm}$

D. $0.90\ \mathrm{mm}$

5. In a typical combustion engine, the work done by a gas molecule is given by,

$W = \alpha^2 \beta e^{-\beta x^2/kT}$

Where x is the displacement, k is the Boltzmann constant, T is the temperature, α and β are constants, then the dimension of α will be :

A. $[M^0 L T^0]$

B. $[M^2 L T^0]$

C. $[M L T^{-2}]$

D. $[M L^2 T^{-2}]$

6. If C and V represent capacitance and voltage respectively then what is the dimension of λ where $\lambda = \dfrac{C}{V}$?

A. $[M^{-2} L^{-4} I^3 T^7]$

B. $[M^{-2} L^{-3} I^2 T^6]$

C. $[M^{-1} L^{-3} I^{-2} T^{-7}]$

D. $[M^{-3} L^{-4} I^3 T^7]$

7. In order to determine the Young`s Modulus of a wire of radius $0.2\ \mathrm{cm}$ (measured using a scale of least count $= 0.001\ \mathrm{cm}$) and length $1\ \mathrm{m}$ (measured using a scale of least count $= 1\ \mathrm{mm}$), a weight of mass $1\ \mathrm{kg}$ (measured using a scale of least count $= 1\ \mathrm{g}$) was hanged to get the elongation of $0.5\ \mathrm{cm}$ (measured using a scale of least count $0.001\ \mathrm{cm}$). What will be the fractional error in the value of Young`s Modulus determined by this experiment.

A. 9%

B. 1.4%

C. 0.9%

D. 0.14%

8. The vernier scale used for measurement has a positive zero error of $0.2 \mathrm{~mm}$. If while taking a measurement it was noted that 0 on the vernier scale lies between $8.5 \mathrm{~cm}$ and $8.6 \mathrm{~cm}$, vernier coincidence is 6, then the correct value of measurement is ________cm.

(Least count $= 0.01 \mathrm{~cm}$)

A. $8.36 \mathrm{~cm}$

B. $8.56 \mathrm{~cm}$

C. $8.58 \mathrm{~cm}$

D. $8.54 \mathrm{~cm}$

9. In the experiment of Ohm's law, a potential difference of $5.0 \mathrm{~V}$ is applied across the end of a conductor of length $10.0 \mathrm{~cm}$ and diameter of $5.00 \mathrm{~mm}$. The measured current in the conductor is $2.00 \mathrm{~A}$. The maximum permissible percentage error in the resistivity of the conductor is:

A. 7.5

B. 3.9

C. 8.4

D. 3.0

10. The time period of a simple pendulum is given by $T=2\pi\sqrt{\frac{l}{g}}$. The measured value of the length of pendulum is $10 \mathrm{~cm}$ known to $1 \mathrm{~mm}$ accuracy. The time for 200 oscillations of the pendulum is found to be 100 second using a clock of $1 \mathrm{~s}$ resolution. The percentage accuarcy in the determination of g using this pendulum is x. The value of x to the nearest integer is.

A. 5%

B. 4%

C. 3%

D. 2%

11. The radius of a sphere is measured to be (7.50 ± 0.85) cm. Suppose the percentage error in its volume is $x\%$. The value of x, to the nearest integer, is ______.

12. Match List-I with List-II

List-I	List-II
(a) Capacitance, C	(i) $M^1L^1T^{-3}A^{-1}$
(b) Permitivity of free space, ϵ_0	(ii) $M^{-1}L^{-3}T^4A^2$
(c) permeabilityof free space, μ_0	(iii) $M^{-1}L^{-2}T^4A^2$
(d) electric field, E	(iv) $M^1L^1T^{-2}A^{-2}$

Choose the correct answer from the options given below.

A. $(a) \rightarrow (iii), (b) \rightarrow (ii), (c) \rightarrow (iv), (d) \rightarrow (i)$

B. $(a) \rightarrow (iii), (b) \rightarrow (iv), (c) \rightarrow (ii), (d) \rightarrow (i)$

C. $(a) \rightarrow (iv), (b) \rightarrow (ii), (c) \rightarrow (iii), (d) \rightarrow (i)$

D. $(a) \rightarrow (iv), (b) \rightarrow (iii), (c) \rightarrow (ii), (d) \rightarrow (i)$

13. A physical quantity $'y'$ is represented by the formula $y = m^2r^{-4}g^xl^{-\frac{3}{2}}$. If the percentage errors found in y, m, r, l and g are $18, 1, 0.5, 4$ and p respectively, then find the value of x and p

A. $5 \text{ and } \pm 2$

B. $4 \text{ and } \pm 3$

C. $\frac{16}{3} \text{and } \pm \frac{3}{2}$

D. $8 \text{ and } \pm 2$

14. In a screw gauge, the fifth division of the circular scale coincides with the reference line, when the ratchet is closed. There are 50 divisions on the circular scale, and the main scale moves by $0.5\ \mathrm{mm}$ on a complete rotation. For a particular observation, the reading on the main scale is $5\ \mathrm{mm}$ and the 20^{th} division of the circular scale coincides with the reference line. Calculate the true reading.

A. $5.20\ \mathrm{mm}$

B. $5.25\ \mathrm{mm}$

C. $5.15\ \mathrm{mm}$

D. $5.00\ \mathrm{mm}$

15. Assertion A : If in five complete rotations of the circular scale, the distance travelled on main scale of the screw gauge is $5\ \mathrm{mm}$ and there are 50 total divisions on circular scale, then least count is $0.001\ \mathrm{cm}$.

Reason R :

$$\text{Least Count} = \frac{\text{Pitch}}{\text{Total divisions on circular scale}}$$

In the light of the above statements, choose the most appropriate answer from the options given below :

A. A is not correct but R is correct.

B. Both A and R are correct and R is the correct explanation of A.

C. A is correct but R is not correct.

D. Both A and R are correct and R is NOT the correct explanation of A.

16. The entropy of any system is given by, $S=\alpha^2\beta\ln\left[\frac{\mu kR}{J\beta^2}+3\right]$ where α and β are the constants. μ, J, k and R are the number of moles, mechanical equivalent of heat, Boltzmann constant and gas constant respectively. Choose the incorrect option.

Take $S=\frac{dQ}{T}$

A. α and J have the same dimension.

B. S, β, k and μR have the same dimension.

C. S and α have different dimensions.

D. α and k have the same dimension.

17. If time (t), velocity (v), and angular momentum (l) are taken as the fundamental units. Then the dimension of mass (m) in terms of $t,\ v$ and l is :

A. $[t^{-1}v^{1}l^{-2}]$

B. $[t^{1}v^{2}l^{-1}]$

C. $[t^{-2}v^{-1}l^{1}]$

D. $[t^{-1}v^{-2}l^{1}]$

18. The force is given in terms of time t and displacement x by the equation $F=A\cos Bx+C\sin Dt$. The dimensional formula of $\frac{AD}{B}$ is:

A. $[M^0LT^{-1}]$

B. $[ML^2T^{-3}]$

C. $[M^1L^1T^{-2}]$

D. $[M^2L^2T^{-3}]$

19. If E, M, l and G denote the quantities as energy, angular momentum, mass and constant of gravitation respectively, then the dimensions of P in the formula $P = E\,l^2 M^{-5} G^{-2}$ are

A. $[M^1 L^1 T^{-2}]$

B. $[M^{-1} L^{-1} T^2]$

C. $[M^0 L^1 T^0]$

D. $[M^0 L^0 T^0]$

20. Match List - I with List - II :

	List - I		List - II
(a)	Magnetic Induction	(i)	$ML^2T^{-2}A^{-1}$
(b)	Magnetic Flux	(ii)	$M^0L^{-1}A$
(c)	Magnetic Permeability	(iii)	$MT^{-2}A^{-1}$
(d)	Magnetization	(iv)	$MLT^{-2}A^{-2}$

Choose the most appropriate answer from the options given below:

A. $(a)-(ii), (b)-(iv), (c)-(i), (d)-(iii)$

B. $(a)-(ii), (b)-(i), (c)-(iv), (d)-(iii)$

C. $(a)-(iii), (b)-(i), (c)-(iv), (d)-(ii)$

D. $(a)-(iii), (b)-(ii), (c)-(iv), (d)-(i)$

21. Which of the following is not a dimensionless quantity?

A. Quality factor

B. Power factor

C. Relative magnetic permeability (μ_r)

D. Permeability of free space (μ_0)

22. If E and H represents the intensity of electric field and magnetizing field respectively, then the unit of E/H will be:

A. mho

B. ohm

C. joule

D. newton

23. Match List - I with List - II.

	List _ I		List - II
(a)	R_H(Rydberg constant)	(i)	$kgm^{-1}s^{-1}$
(b)	h(Planck's constant)	(ii)	kgm^2s^{-1}
(c)	μ_B(Magnetic field energy density)	(iii)	m^{-1}
(d)	η(coefficient of viscocity)	(iv)	$kgm^{-1}s^{-2}$

Choose the most appropriate answer from the options given below :

A. $(a)-(ii),(b)-(iii),(c)-(iv),(d)-(i)$

B. $(a)-(iii),(b)-(ii),(c)-(i),(d)-(iv)$

C. $(a)-(iv),(b)-(ii),(c)-(i),(D)-(iii)$

D. $(a)-(iii),(b)-(ii),(c)-(iv),(d)-(i)$

24. If force (F), length (L) and time (T) are taken as the fundamental quantities. Then what will be the dimension of density :

A. $[FL^{-3}T^3]$

B. $[FL^{-5}T^2]$

C. $[FL^{-4}T^2]$

D. $[FL^{-3}T^2]$

25. If velocity $[V]$ time $[T]$ and force $[F]$ are chosen as the base quantities, the dimensions of the mass will be

A. $\left[F\ T^{-1}\ V^{-1}\right]$

B. $\left[F\ V\ T^{-1}\right]$

C. $\left[F\ T^{2}\ V\right]$

D. $\left[F\ T\ V^{-1}\right]$

Topic : Motion in 1-D

1. A particle is dropped from the top of a building . When it crosses a point $5 \mathrm{~m}$ below the top , another particles starts to fall from a point $25 \mathrm{~m}$ below the top , both particles reach the bottom of the building simultaneously. The height of the building is :
$[g=10 \mathrm{~m} / \mathrm{s}^{2}]$

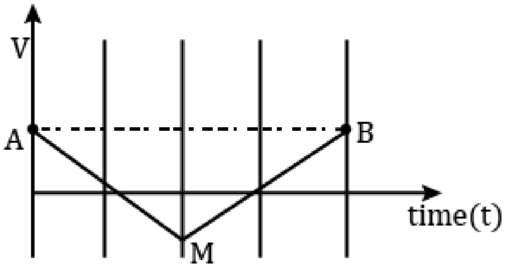
A. $45 \mathrm{~m}$

B. $35 \mathrm{~m}$

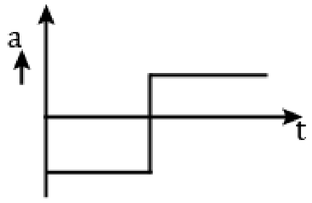
C. $25 \mathrm{~m}$

D. $50 \mathrm{~m}$

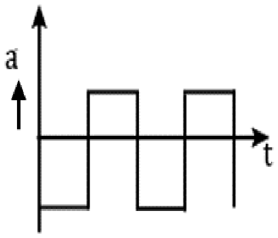
2. If the velocity-time graph has the shape AMB, what would be the shape of the corresponding acceleration-time graph?



A.

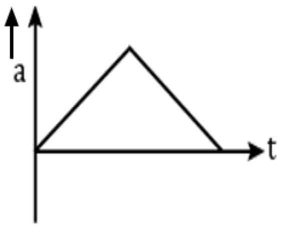


B.



C.

D.



3. An engine of a train, moving with uniform acceleration, passes the signal post with velocity u and the last compartment passes the signal post with velocity v. The velocity with which the middle point of the train passes the signal post is :

A. $\sqrt{\dfrac{v^2-u^2}{2}}$

B. $\sqrt{\dfrac{v-u}{2}}$

C. $\sqrt{\dfrac{v^2+u^2}{2}}$

D. $\sqrt{\dfrac{v+u}{2}}$

4. A scooter accelerates from rest for time t_1 at a constant rate α_1 and then retards at constant rate α_2 for time t_2 and comes to rest. The correct value of $\frac{t_1}{t_2}$ will be -

A. $\dfrac{\alpha_1+\alpha_2}{\alpha_2}$

B. $\dfrac{\alpha_2}{\alpha_1}$

C. $\dfrac{\alpha_1+\alpha_2}{\alpha_1}$

D. $\dfrac{\alpha_1}{\alpha_2}$

5. The velocity of a particle is $v=v_0+gt+Ft^2$. Its position is $x=0$ at $t=0$; then its displacement after time $(t=1\ \mathrm{s})$ is:
(g and F are constants)

A. $v_0+\dfrac{g}{2}+F$

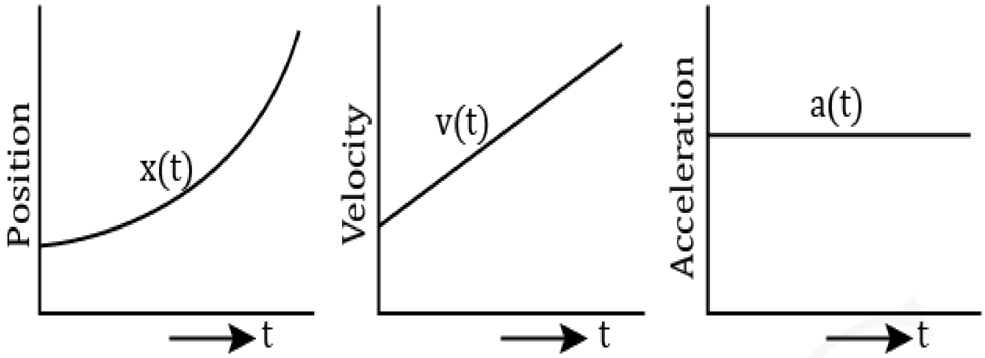
B. $v_0+2g+3F$

C. v_o+g+F

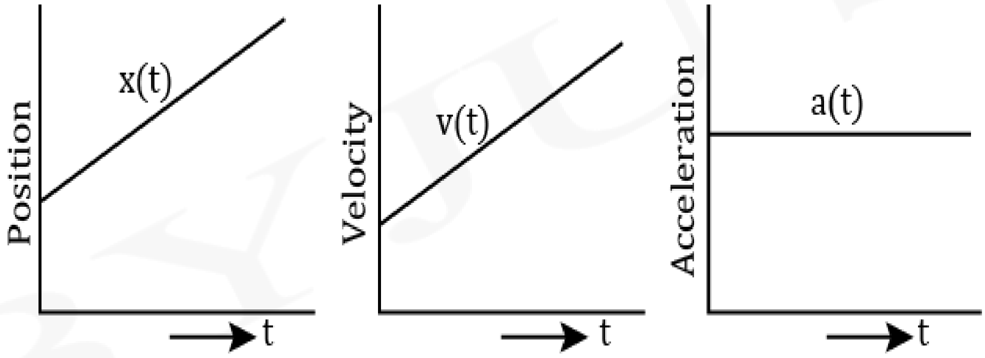
D. $v_0+\dfrac{g}{2}+\dfrac{F}{3}$

6. The position, velocity and acceleration of a particle moving with a constant acceleration can be represented by:

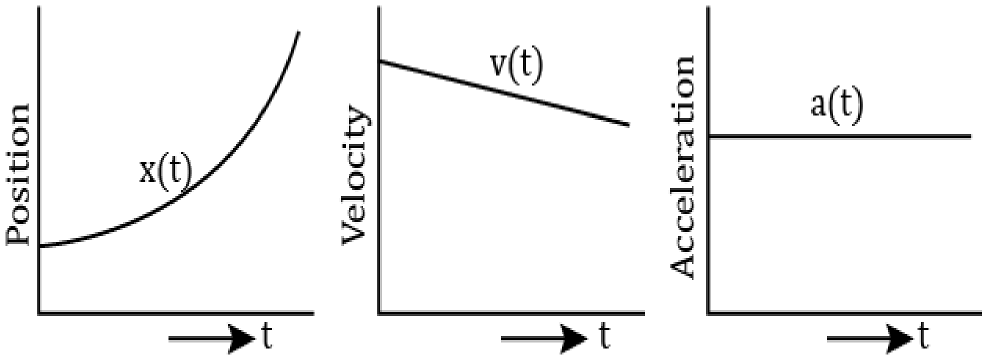
A.



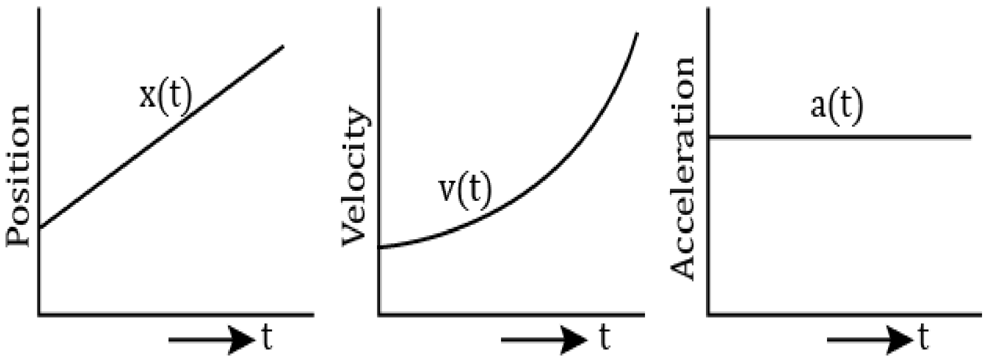
B.



C.



D.



7. Water droplets are coming from an open tap at a particular rate. The spacing between a droplet observed at 4^{th} second after its fall, to the next droplet, is $34.3\ \text{m}$. At what rate the droplets are coming from the tap ? (Take $g = 9.8\ \text{m/s}^2$)

   A. $3\ \text{drops/s}$

   B. $2\ \text{drops/s}$

   C. $1\ \text{drop/s}$

   D. $\frac{1}{7}\text{drops/s}$

8. The relation between time t and distance x for a moving body is given as $t = mx^2 + nx$, where m and n are constants. The retardation of the motion is :
(Where v stands for velocity)

   A. $2mv^3$

   B. $2mnv^3$

   C. $2nv^3$

   D. $2n^2v^3$

9. A balloon was moving upwards with a uniform velocity of $10\ \text{ms}^{-1}$. An object of finite mass is dropped from the balloon when it was at a height of $75\ \text{m}$ from the ground level. The height of the balloon from the ground when the object strikes the ground will be around :
(Take $g = 10\ \text{ms}^{-2}$)

   A. $300\ \text{m}$

   B. $200\ \text{m}$

   C. $125\ \text{m}$

   D. $250\ \text{m}$

10. The instantaneous velocity of a particle moving in a straight line is given as $v = \alpha t + \beta t^2$, where α and β are constants. The distance travelled by the particle between $1\ \mathrm{s}$ and $2\ \mathrm{s}$ is

A. $3\alpha + 7\beta$

B. $\frac{3}{2}\alpha + \frac{7}{3}\beta$

C. $\frac{\alpha}{2} + \frac{\beta}{3}$

D. $\frac{3}{2}\alpha + \frac{7}{2}\beta$

11. A ball is thrown up with a certain velocity so that it reaches a height $'h'$. Find the ratio of the two different times of the ball reaching $\frac{h}{3}$ in both the directions.

A. $\frac{\sqrt{2}-1}{\sqrt{2}+1}$

B. $\frac{1}{3}$

C. $\frac{\sqrt{3}-\sqrt{2}}{\sqrt{3}+\sqrt{2}}$

D. $\frac{\sqrt{3}-1}{\sqrt{3}+1}$

12. Water drops are falling from a nozzle of a shower onto the floor, from a height of $9.8\ \mathrm{m}$. The drops fall at a regular interval of time. When the first drop strikes the floor, at that instant, the third drop begins to fall. Locate the position of the second drop from the floor when the first drop strikes the floor.

A. $2.45\ \mathrm{m}$

B. $7.35\ \mathrm{m}$

C. $2.94\ \mathrm{m}$

D. $4.18\ \mathrm{m}$

13. A helicopter is rising up from ground with an acceleration of $g\ \mathrm{m/s^2}$, starting from rest after raising a height h it attains a velocity of $v\ \mathrm{m/s}$. At this instant, a particle is now released from the helicopter. Take $t = 0$ at releasing time, calculate the time t when particle reaches to the ground.

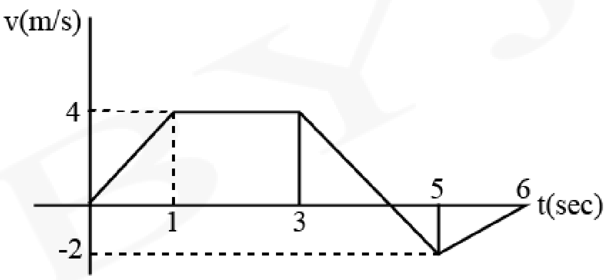
A. $\sqrt{\dfrac{2h}{g}}$

B. $2\sqrt{\dfrac{2h}{g}}$

C. $\left(1+\sqrt{2}\right)\sqrt{\dfrac{2h}{g}}$

D. $4\sqrt{\dfrac{2h}{g}}$

14. Velocity-time graph of the particle is shown in figure. Find the displacement of the particle.



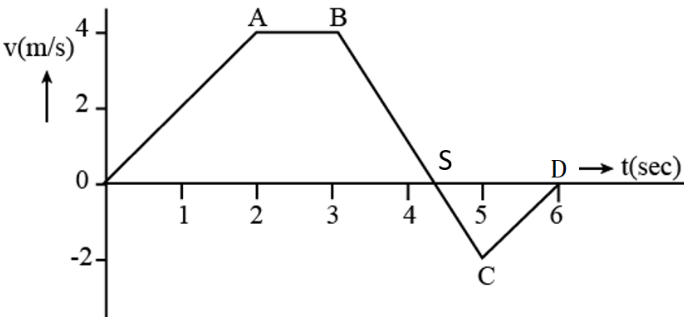
A. $7\ \mathrm{m}$

B. $11\ \mathrm{m}$

C. $5\ \mathrm{m}$

D. $15\ \mathrm{m}$

15. The velocity v and time t graph of a body in a straight line motion is shown in the figure. The point S is at $4.333\ \mathrm{sec}$. The total distance covered by the body in $6\ \mathrm{s}$ is



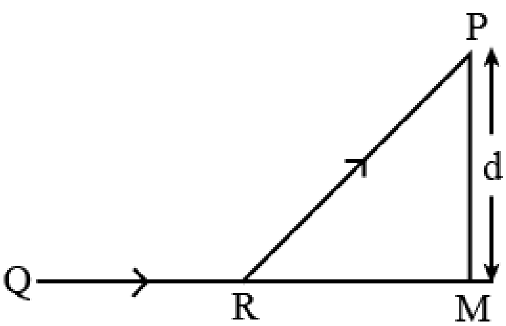
A. $\frac{37}{3}\mathrm{m}$

B. $11\ \mathrm{m}$

C. $\frac{49}{4}\mathrm{m}$

D. $12\ \mathrm{m}$

16. A man in a car at location Q on a straight highway is moving with speed v. He decides to reach a point P in a field at a distance d from the highway (point M) as shown in the figure. Speed of the car in the field is half to that on the highway. What should be the distance RM, so that the time taken to reach P is minimum ?



A. $\frac{d}{\sqrt{3}}$

B. $\frac{d}{2}$

C. $\frac{d}{\sqrt{2}}$

D. d

17. The velocity of a particle is $v = v_0 + gt + ft^2$. If its position is $x = 0$ at $t = 0$, then its displacement after unit time $(t = 1)$ is

A. $v_0 + g/2 + f$

B. $v_0 + 2g + 3f$

C. $v_0 + g/2 + f/3$

D. $v_0 + g/2 + 2f$

18. In a car race on straight road, car A takes a time t less than car B at the finishing point and passes the finishing point with a speed $'v'$ more than that car B. Both the cars start from rest and travel with constant acceleration a_1 and a_2 respectively. Then v is equal to

A. $\dfrac{a_1 + a_2}{2}$

B. $\sqrt{2a_1a_2}t$

C. $\dfrac{2a_1a_2}{a_1 + a_2}t$

D. $\sqrt{a_1a_2}t$

19. A particle moves from the point $(2.0\hat{i} + 4.0\hat{j})\ \mathrm{m}$, at $t = 0$, with an initial velocity $(5.0\hat{i} + 4.0\hat{j})\ \mathrm{ms}^{-1}$. It is acted upon by a constant acceleration $(4.0\hat{i} + 4.0\hat{j})\ \mathrm{ms}^{-2}$. What is the distance of the particle from the origin at time $2\ \mathrm{s}$?

A. $20\sqrt{2}\ \mathrm{m}$

B. $10\sqrt{2}\ \mathrm{m}$

C. $5\ \mathrm{m}$

D. $15\ \mathrm{m}$

20. A particle is moving with speed $v = b\sqrt{x}$ along positive $x-$axis. Calculate the speed of the particle at time $t = \tau$ (assume that the particle is at origin at $t = 0$)

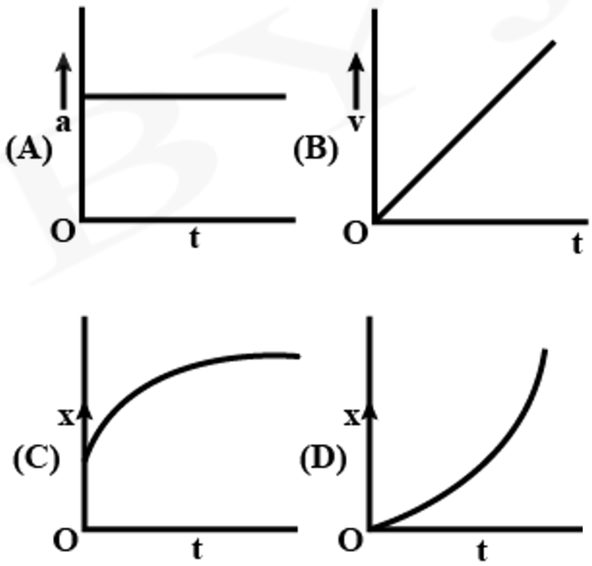
A. $\frac{b^2\tau}{4}$

B. $\frac{b^2\tau}{2}$

C. $b^2\tau$

D. $\frac{b^2\tau}{\sqrt{2}}$

21. A particle starts from origin O from rest and moves with a uniform acceleration along the positive $x-$axis. Identify all figures that correctly represent the motion quantitatively.
($a =$ acceleration, $v =$ velocity, $x =$ displacement, $t =$ time)



A. (A),(B), (C)

B. (A)

C. (A), (B), (D)

D. (B),(C)

22. The position of a particle as a function of time, t is given by $x(t) = at + bt^2 - ct^3$, where, $a,\ b$ and c are constants. When the particle attains zero acceleration, then its velocity will be:

A. $a + \dfrac{b^2}{4c}$

B. $a + \dfrac{b^2}{c}$

C. $a + \dfrac{b^2}{2c}$

D. $a + \dfrac{b^2}{3c}$

23. The position vector of a particle changes with time according to the relation $\vec{r}(t) = 15t^2\hat{i} + (4 - 20t^2)\hat{j}$. What is the magnitude of the acceleration at $t = 1$?

A. 40

B. 100

C. 50

D. 25

24. Two trains A and B moving with speed of $36\ \mathrm{km/hr}$ and $72\ \mathrm{km/hr}$ respectively in opposite direction. A man moving in train A with speed of $1.8\ \mathrm{km/hr}$ opposite to the direction of train A. Find velocity of man as seen from train B (in $\mathrm{m/s}$).

A. $32\ \mathrm{m/s}$

B. $29.5\ \mathrm{m/s}$

C. $32.5\ \mathrm{m/s}$

D. $28\ \mathrm{m/s}$

Topic : Motion in 2-D

1. The trajectory of a projectile in a vertical plane is, $y = \alpha x - \beta x^2$, where α, β are constants, x and y are respectively the horizontal and vertical distances of the projectile from the point of projection. The angle of projection and the maximum height attained are respectively given by :

A. $\tan^{-1}\alpha,\ \dfrac{\alpha^2}{4\beta}$

B. $\tan^{-1}\beta,\ \dfrac{\alpha^2}{2\beta}$

C. $\tan^{-1}\alpha,\ \dfrac{\alpha^2}{2\beta}$

D. $\tan^{-1}\beta,\ \dfrac{\alpha^2}{4\beta}$

2. Two particles are projected from the same point with the same speed u such that they have the same range R, but different maximum heights, h_1 and h_2. Which of the following is correct ?

A. $R^2 = 4\ h_1 h_2$

B. $R^2 = 16\ h_1 h_2$

C. $R^2 = 2\ h_1 h_2$

D. $R^2 = h_1 h_2$

3. The co-ordinates of a moving particle at any time $'t'$ are given by $x = \alpha t^3$ and $y = \beta t^3$. The speed of the particle at time $'t'$ is given by

A. $3t\sqrt{\alpha^2 + \beta^2}$

B. $3t^2\sqrt{\alpha^2 + \beta^2}$

C. $t^2\sqrt{\alpha^2 + \beta^2}$

D. $\sqrt{\alpha^2 + \beta^2}$

4. The position of a projectile launched from the origin at $t=0$ is given by $\vec{r}=(40\hat{i}+50\hat{j})\ \mathrm{m}$ at $t=2\ \mathrm{s}$. If the projectile was launched at an angle θ from the horizontal, then θ is
$(\text{Take } g=10\ \mathrm{ms}^{-2})$

A. $\tan^{-1}\frac{2}{3}$

B. $\tan^{-1}\frac{3}{2}$

C. $\tan^{-1}\frac{7}{4}$

D. $\tan^{-1}\frac{4}{5}$

5. A projectile is given an initial velocity of $(\hat{i}+2\hat{j})\ \mathrm{m/s}$, where $\hat{i}$ is along the ground and $\hat{j}$ is along the vertical. If $g=10\ \mathrm{m/s^2}$, the equation of its trajectory is :

A. $y=x-5x^2$

B. $4y=2x-5x^2$

C. $4y=x-5x^2$

D. $y=2x-5x^2$

6. The maximum range of a bullet fired from a toy pistol mounted on a car at rest is $R_0=40\ \mathrm{m}$. What will be the acute angle of inclination of the pistol for maximum range when the car is moving in the direction of firing with uniform velocity $v=20\ \mathrm{m/s}$ on a horizontal surface ?
(Take $g=10\ \mathrm{m/s^2}$)

A. 60°

B. 30°

C. 75°

D. 45°

7. A ball projected from the ground at an angle of 45°just clears a wall in front. If the point of projection is $4\ \mathrm{m}$ from the foot of the wall and the ball strikes the ground at a distance of $6\ \mathrm{m}$ on the other side of the wall, the height of the wall is :

A. $4.4\ \mathrm{m}$

B. $2.4\ \mathrm{m}$

C. $3.6\ \mathrm{m}$

D. $1.6\ \mathrm{m}$

8. A boy can throw a stone up to a maximum height of $10\ \mathrm{m}$. The maximum horizontal distance that the boy can throw the same stone up to will be

A. $20\sqrt{2}\ \mathrm{m}$

B. $10\ \mathrm{m}$

C. $10\sqrt{2}\ \mathrm{m}$

D. $20\ \mathrm{m}$

9. A projectile can have the same range R for two angles of projection. If T_1 and T_2 be times of flight in two cases, then the product of the two times of flight is directly proportional to

A. R

B. $\frac{1}{R}$

C. $\frac{1}{R^2}$

D. R^2

10. A ball is thrown from a point with a speed v_0 at an elevation angle of θ. From the same point and at the same instant, a person starts running with a constant speed $\frac{v_0}{2}$ to catch the ball. Will the person be able to catch the ball? If yes, what should be the angle of projection θ ?

A. No

B. $\text{yes},\ 30^\circ$

C. $\text{yes},\ 60^\circ$

D. $\text{yes},\ 45^\circ$

11. A boy playing on the roof of a $10\ \text{m}$ high building throws a ball with a speed of $10\ \text{m/s}$ at the angle of 30° with the horizontal. How far from the throwing point will be the ball be at the height of $10\ \text{m}$ from the ground ?
$(\text{Take, } g = 10\ \text{m/s}^2)$

A. $5.20\ \text{m}$

B. $4.33\ \text{m}$

C. $2.60\ \text{m}$

D. $8.66\ \text{m}$

12. A player kicks a football with an initial speed of $25\ \text{ms}^{-1}$ at an angle of 45° from the ground. What are the maximum height and the time taken by the football to reach at the highest point during motion ? $(\text{Take } g = 10\ \text{ms}^{-2})$

A. $h_{max} = 10\ \text{m},\ T = 2.5\ \text{s}$

B. $h_{max} = 15.625\ \text{m},\ T = 1.77\ \text{s}$

C. $h_{max} = 15.625\ \text{m},\ T = 3.54\ \text{s}$

D. $h_{max} = 3.54\ \text{m},\ T = 0.125\ \text{s}$

13. A particle starts from the origin at $t = 0$ with an initial velocity of $3.0\hat{i}\ \mathrm{m/s}$ and moves in the $x - y$ plane with a constant acceleration $(6.0\hat{i} + 4.0\hat{j})\ \mathrm{m/s^2}$. The $x-$coordinate of the particle at the instant when its $y-$coordinate is $32\ \mathrm{m}$ is D meters. The value of D is:

A. 32

B. 50

C. 60

D. 40

14. A particle of mass m is projected with a speed of u from the ground at an angle $\theta = \frac{\pi}{3}$ w.r.t. horizontal (x-axis). When it has reached its maximum height, it collides completely inelastically with another particle of the same mass and velocity $u\hat{i}$. The horizontal distance covered by the combined mass before reaching the ground is:

A. $\frac{3\sqrt{3}}{8}\frac{u^2}{g}$

B. $\frac{3\sqrt{2}}{4}\frac{u^2}{g}$

C. $\frac{5}{8}\frac{u^2}{g}$

D. $2\sqrt{2}\frac{u^2}{g}$

15. Starting from the origin at time $t = 0$, with initial velocity $5\hat{j}\ \mathrm{ms^{-1}}$, the particle moves in the $x - y$ plane with a constant acceleration of $(10\hat{i} + 4\hat{j})\ \mathrm{m/s^2}$. At time t, its coordinates are $(20\ \mathrm{m},\ y_0\ \mathrm{m})$. The values of t and y_0 are, respectively:

A. $2\ \mathrm{s}$ and $18\ \mathrm{m}$

B. $4\ \mathrm{s}$ and $52\ \mathrm{m}$

C. $2\ \mathrm{s}$ and $24\ \mathrm{m}$

D. $5\ \mathrm{s}$ and $25\ \mathrm{m}$

16. Two guns A and B can fire bullets at speeds $1\ \mathrm{km/s}$ and $2\ \mathrm{km/s}$ respectively, they are fired in all possible directions. The ratio of maximum areas covered by the bullets fired by the two guns, on the ground is:

A. $1:16$

B. $1:2$

C. $1:4$

D. $1:8$

17. A body is projected at $t=0$ with a velocity $10\ \mathrm{ms}^{-1}$ at an angle 60° with the horizontal. The radius of curvature of its trajectory at $t=1$ is R. Neglecting air resisteance and taking acceleration due to gravity $g=10\ \mathrm{m/s}^2$, the value of R is:

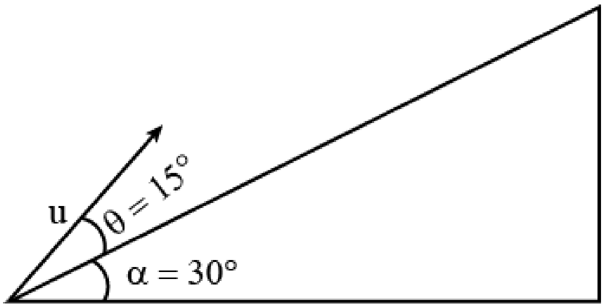
A. $10.3\ \mathrm{m}$

B. $2.8\ \mathrm{m}$

C. $2.5\ \mathrm{m}$

D. $5.1\ \mathrm{m}$

18. A plane is inclined at an angle $\alpha = 30^\circ$ with respect to the horizontal. A particle is projected with a speed $u = 2\ \mathrm{m/s}$, from the base of the plane, as shown in figure. The distance from the base, at which the particle hits the plane, is close to:
(Take $g = 10\ \mathrm{m/s^2}$)



A. $20\ \mathrm{cm}$

B. $180\ \mathrm{cm}$

C. $26\ \mathrm{cm}$

D. $14\ \mathrm{cm}$

19. A shell is fired from a fixed artillery gun with an initial speed u such that it hits the target on the ground at a distance R from it. If t_1 and t_2 are the values of the time taken by it to hit the target in two possible ways, the product $t_1 t_2$ is:

A. $\frac{R}{4g}$

B. $\frac{R}{g}$

C. $\frac{R}{2g}$

D. $\frac{2R}{g}$

20. The trajectory of the projectile near the surface of the earth is given as $y = 2x - 9x^2$. If it was launched at an angle θ_0 with speed v_0 then $(g = 10 \text{ m/s}^2)$

A. $\theta_0 = \sin^{-1}\dfrac{1}{\sqrt{5}} \text{and } v_0 = \dfrac{3}{5}\text{ms}^{-1}$

B. $\theta_0 = \cos^{-1}\dfrac{2}{\sqrt{5}} \text{and } v_0 = \dfrac{3}{5}\text{ms}^{-1}$

C. $\theta_0 = \cos^{-1}\dfrac{1}{\sqrt{5}} \text{and } v_0 = \dfrac{5}{3}\text{ms}^{-1}$

D. $\theta_0 = \sin^{-1}\dfrac{2}{\sqrt{5}} \text{and } v_0 = \dfrac{3}{5}\text{ms}^{-1}$

Topic : Relative Motion

1. A butterfly is flying with a velocity $4\sqrt{2}\ \mathrm{m/s}$ in North-East direction. Wind is slowly blowing at $1\ \mathrm{m/s}$ from North to South. The resultant displacement of the butterfly in 3 seconds is :

   A. $3\ \mathrm{m}$

   B. $20\ \mathrm{m}$

   C. $12\sqrt{2}\ \mathrm{m}$

   D. $15\ \mathrm{m}$

2. A boy reaches the airport and finds that the escalator is not working. He walks up the stationary escalator in time t_1. If he remains stationary on a moving escalator, then the escalator takes him up in time t_2. The time taken by him to walk up on the moving escalator will be:

   A. $\dfrac{t_1 t_2}{t_2 - t_1}$

   B. $\dfrac{t_1 + t_2}{2}$

   C. $\dfrac{t_1 t_2}{t_2 + t_1}$

   D. $t_2 - t_1$

3. Ship A is sailing towards north-east with velocity vector $\vec{v} = 30\hat{i} + 50\hat{j}\ \mathrm{km/hr}$ where $\hat{i}$ points east and $\hat{j}$ north. Ship B is at a distance of $80\ \mathrm{km}$ east and $150\ \mathrm{km}$ north of Ship A and is sailing towards west at $10\ \mathrm{km/hr}$. A will be at minimum distance from B in,

   A. $2.2\ \mathrm{hrs}$

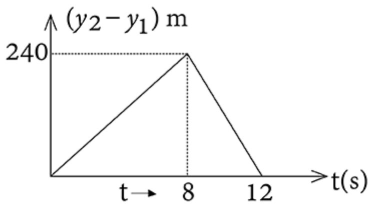
   B. $4.2\ \mathrm{hrs}$

   C. $2.6\ \mathrm{hrs}$

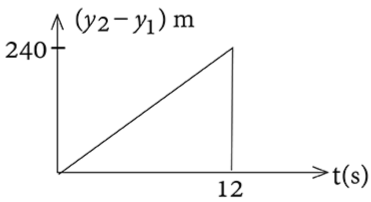
   D. $3.2\ \mathrm{hrs}$

4. Two stones are thrown up simultaneously from the edge of a cliff $240 \mathrm{~m}$ high with initial speed $10 \mathrm{~m/s}$ and $40 \mathrm{~m/s}$ respectively. Which of the following graph best represents the time variation of relative position of the second stone with respect to the first? (Assume stones do not rebound after hitting the ground and neglect air resistance, take $g = 10 \mathrm{~m/s^2}$)
(The figures are schematic and not drawn to scale.)

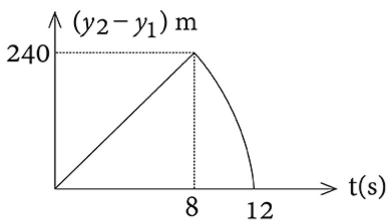
A.



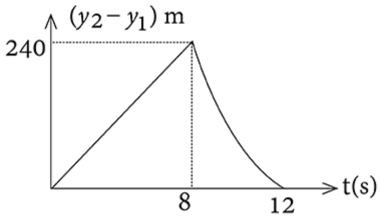
B.



C.



D.



5. When a car is at rest, its driver sees raindrops falling on it vertically. When driving the car with speed v, he sees that raindrops are coming at an angle 60° from the horizontal. On further increasing the speed of the car to $(1+\beta)v$, this angle changes to 45°. The value of β is close to :

A. 0.50

B. 0.41

C. 0.37

D. 0.73

6. A passenger train of length $60\ \mathrm{m}$ travels at a speed of $80\ \mathrm{km/hr}$. Another freight train of length $120\ \mathrm{m}$ travels at a speed of $30\ \mathrm{km/h}$. The ratio of times taken by the passenger train to completely cross the freight train when :
(i)they are moving in the same direction, and
(ii) in the opposite directions is:

A. $\frac{11}{5}$

B. $\frac{5}{2}$

C. $\frac{3}{2}$

D. $\frac{25}{11}$

7. The stream of a river is following with a speed of $2\ \mathrm{km/h}$. A swimmer can swim at a speed of $4\ \mathrm{km/h}$. What should be the direction of swimmer with respect to the flow of the river to cross the river straight?

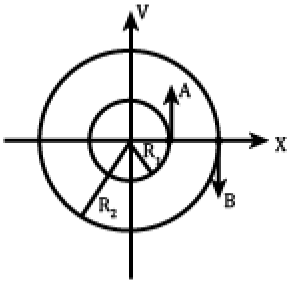
A. 90°

B. 150°

C. 120°

D. 60°

8. Two particles A and B are moving on two concentric circles of radii R_1 and R_2 with equal angular speed ω. At $t = 0$, their positions and direction of motion are shown in the figure :



The relative velocity $\overrightarrow{v_A} - \overrightarrow{v_B}$ at $t = \dfrac{\pi}{2\omega}$ is given by :

A. $\omega(R_1 + R_2)\hat{i}$

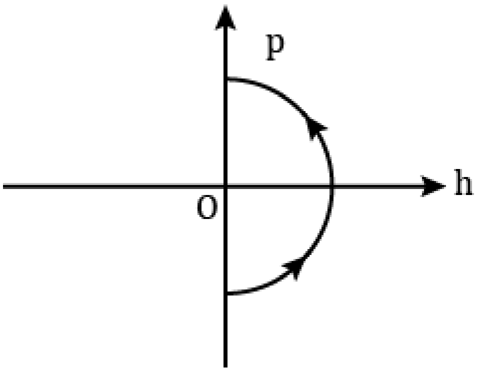
B. $-\omega(R_1 + R_2)\hat{i}$

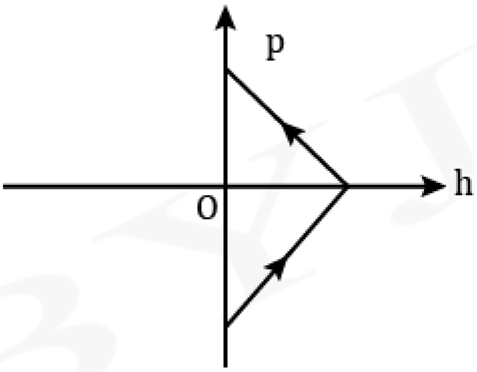
C. $\omega(R_2 - R_1)\hat{i}$

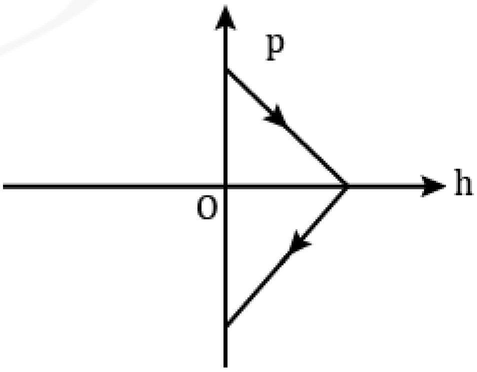
D. $\omega(R_1 - R_2)\hat{i}$

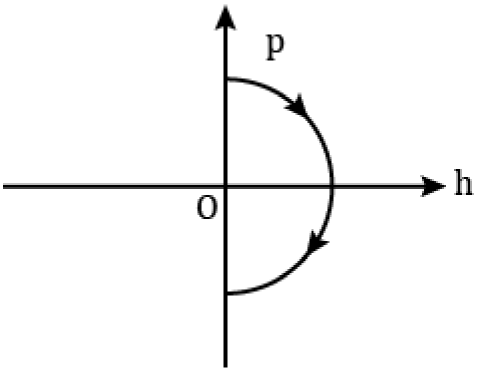
Topic : Newton law of Motion

1. A ball is thrown vertically up (taken as $+\mathrm{z}$ - axis) from the ground. The correct momentum-height $(\mathrm{p}$ - $\mathrm{h})$ diagram is: (Given $p=mv$)

A. 

B. 

C. 

D. 

2. A lift is moving down with acceleration a. A man in the lift drops a ball inside the lift. The acceleration of the ball as observed by the man in the lift and a man standing stationary on the ground are respectively

A. $g,\ g$

B. $g-a,\ g-a$

C. $g-a,\ g$

D. $a,\ g$

3. When forces F_1, F_2, F_3 are acting on a particle of mass m such that F_2 and F_3 are mutually perpendicular, then the particle remains stationary. If the force F_1 is now removed then the magnitude of acceleration of the particle is

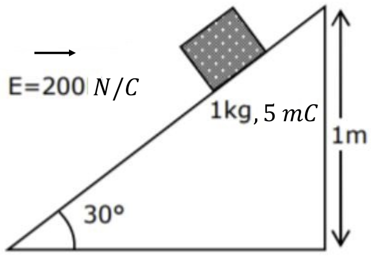
A. $\frac{F_1}{m}$

B. $\frac{F_2 F_3}{m F_1}$

C. $\frac{(F_2 - F_3)}{m}$

D. $\frac{F_2}{m}$

4. An inclined plane making an angle of 30° with the horizontal is placed in a uniform horizontal electric field $200\ \mathrm{N/C}$ as shown in the figure. A body of mass $1\ \mathrm{kg}$ and charge $5\ \mathrm{mC}$ is allowed to slide down from rest from a height of $1\ \mathrm{m}$. If the coefficient of friction is 0.2, find the time taken by the body to reach the bottom.



$$\left[g = 9.8\ \mathrm{m/s^2};\ \sin 30^{\circ} = \frac{1}{2};\ \cos 30^{\circ} = \frac{\sqrt{3}}{2}\right]$$

A. $2.3\ \mathrm{s}$

B. $0.46\ \mathrm{s}$

C. $1.3\ \mathrm{s}$

D. $0.92\ \mathrm{s}$

5. A particle of mass M orginally at rest is subjected to a force whose direction is constant but magnitude varies with time according to the relation

$$F = F_0\left[1 - \left(\frac{t-T}{T}\right)^2\right]$$

where F_0 and T are constants. The force acts only for the time interval $2T$. The velocity v of the particle after time $2T$ is :

A. $\frac{2F_0T}{M}$

B. $\frac{F_0T}{2M}$

C. $\frac{4F_0T}{3M}$

D. $\frac{F_0T}{3M}$

6. A particle is projected with velocity v_o along $x-$axis. A damping force is acting on the particle which is proportional to the square of the distance from the origin,$i.e.\ ma=-\alpha x^2$. The distance at which the particle stops :

A. $\left(\frac{2mv_o^2}{3\alpha}\right)^{\frac{1}{3}}$

B. $\left(\frac{3mv_o^2}{2\alpha}\right)^{\frac{1}{2}}$

C. $\left(\frac{3mv_o^2}{2\alpha}\right)^{\frac{1}{3}}$

D. $\left(\frac{2mv_o^2}{3\alpha}\right)^{\frac{1}{2}}$

7. Two forces P and Q, of magnitude $2F$ and $3F$ respectively are at an angle θ with each other. If the force Q is doubled, then their resultant also gets doubled. Then the angle θ is

A. 120°

B. 60°

C. 90°

D. 30°

8. A small ball, of mass m, is thrown upward with a velocity u, from the ground. The ball experiences a resistive force mkv^2 where v is its speed. The maximum height attained by the ball is :

A. $\frac{1}{2k}\tan^{-1}\left(\frac{ku^2}{g}\right)$

B. $\frac{1}{k}\ln\left(1+\frac{ku^2}{2g}\right)$

C. $\frac{1}{k}\tan^{-1}\frac{ku^2}{g}$

D. $\frac{1}{2k}\ln\left(1+\frac{ku^2}{g}\right)$

9. A mass of $10 \mathrm{~kg}$ is suspended vertically by a rope from the roof. When a horizontal force is applied on the rope at some point, the rope deviated at an angle 45° at the roof point. If the suspended mass is at equilibrium, the magnitude of the force applied is $\left(g=10 \mathrm{~ms}^{-2}\right)$

A. $200 \mathrm{~N}$

B. $140 \mathrm{~N}$

C. $70 \mathrm{~N}$

D. $100 \mathrm{~N}$

10. A particle of mass m is moving in a straight line. Starting at time $t=0$, a force $F=kt$ acts in the same direction on the moving particle during time interval T so that its momentum changes from p to $3p$. Here k is a constant. The value of T is :

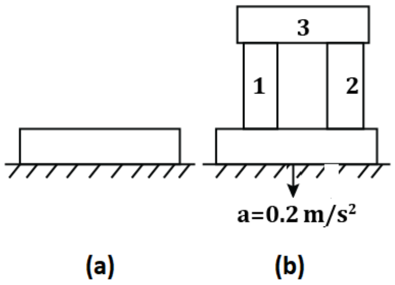
A. $2\sqrt{\frac{k}{p}}$

B. $2\sqrt{\frac{p}{k}}$

C. $\sqrt{\frac{2k}{p}}$

D. $\sqrt{\frac{2p}{k}}$

11. A steel block of mass $10\ \mathrm{kg}$ rests on a horizontal floor as shown in the figure (a). When three iron cylinders are placed on it as shown in the figure (b), the block and cylinders go down with an acceleration $0.2\ \mathrm{m/s}^2$. The normal reaction R exerted by the floor, if masses of the iron cylinders are $20\ \mathrm{kg}$ each, is -



A. $716\ \mathrm{N}$

B. $686\ \mathrm{N}$

C. $714\ \mathrm{N}$

D. $684\ \mathrm{N}$

12. A force $\vec{F} = (40\hat{i} + 10\hat{j})\ \mathrm{N}$ acts on a body of mass $5\ \mathrm{kg}$. If the body starts from rest, its position vector $\vec{r}$ at time $t = 10\ \mathrm{s}$, will be :

A. $(100\hat{i} + 400\hat{j})\ \mathrm{m}$

B. $(100\hat{i} + 100\hat{j})\ \mathrm{m}$

C. $(400\hat{i} + 100\hat{j})\ \mathrm{m}$

D. $(400\hat{i} + 400\hat{j})\ \mathrm{m}$

13. The initial mass of a rocket is $1000\ \mathrm{kg}$. Calculate at what rate the fuel should be burnt so that the rocket is given an acceleration of $20\ \mathrm{ms}^{-2}$. the gases come out at a relative speed of $500\ \mathrm{ms}^{-1}$ with respect to the rocket : [use $g = 10\ \mathrm{ms}^{-2}$]

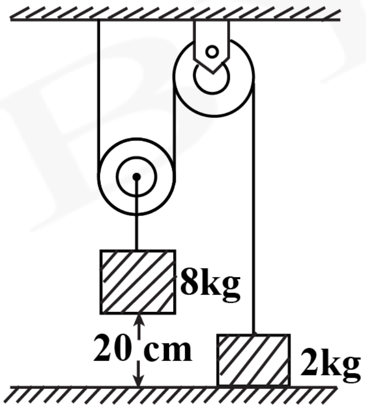
A. $60\ \mathrm{kg\ s}^{-1}$

B. $6.0 \times 10^2\ \mathrm{kg\ s}^{-1}$

C. $500\ \mathrm{kg\ s}^{-1}$

D. $10\ \mathrm{kg\ s}^{-1}$

14. The boxes of masses $2\ \mathrm{kg}$ and $8\ \mathrm{kg}$ are connected by a massless string passing over smooth pulleys. Calculate the time taken by box of mass $8\ \mathrm{kg}$ to strike the ground starting from rest.
$(\text{Use } g = 10\ \mathrm{m/s^2})$:



A. $0.2\ \mathrm{s}$

B. $0.34\ \mathrm{s}$

C. $0.25\ \mathrm{s}$

D. $0.4\ \mathrm{s}$

15. Statement I:

If three forces $\overrightarrow{F_1}$, $\overrightarrow{F_2}$ and $\overrightarrow{F_3}$ are represented by three sides of a triangle and $\overrightarrow{F_1}+\overrightarrow{F_2}=-\overrightarrow{F_3}$, then these forces are concurrent forces and satisfy the condition for equilibrim.

Statement II :

A triangle made up of three forces $\overrightarrow{F_1}, \overrightarrow{F_2}$ and $\overrightarrow{F_3}$ as its sides taken in the same order, satisfy the condition for translatory equilibrium.

In the light of the above statements, choose the most appropriate answer from options given below.

A. Both Statement I and Statement II are true.

B. Both Statement I and Statement II are false

C. Statement I is true but Statement II is false.

D. Statement I is false but Statement II is true

16. A ball is thrown upward with an initial velocity V_0 from the surface of the earth. The motion of the ball is affected by a drag force equal to $m\gamma v^2$ (where m is mass of the ball, v is its instantaneous velocity and γ is a constant). Time is taken by the ball to rise to its zenith is:

A. $\frac{1}{\sqrt{\gamma g}}\tan^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

B. $\frac{1}{\sqrt{\gamma g}}\sin^{-1}\left(\sqrt{\frac{\gamma}{g}}V_0\right)$

C. $\frac{1}{\sqrt{\gamma g}}\ln^{-1}\left(1+\sqrt{\frac{\gamma}{g}}V_0\right)$

D. $\frac{1}{\sqrt{2\gamma g}}\tan^{-1}\left(\sqrt{\frac{2\gamma}{g}}V_0\right)$

17. A body of mass $5\ \mathrm{kg}$ under the action of constant force $\overrightarrow{F} = F_x\hat{i} + F_y\hat{j}$ has velocity at $t = 0\ \mathrm{sec}$ as $\overrightarrow{v} = (6\hat{i} - 2\hat{j})\ \mathrm{m/s}$ and at $t = 10\ \mathrm{sec}$ as $\overrightarrow{v} = +6\ \hat{j}\ \mathrm{m/s}$. The force $\overrightarrow{F}$ is

A. $(-3\hat{j} + 4\hat{j})\ \mathrm{N}$

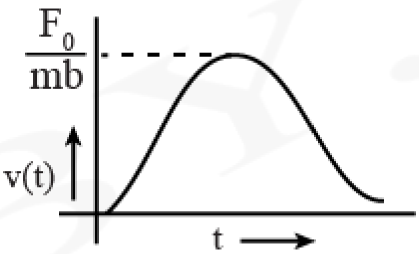
B. $\left(-\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}\right)\ \mathrm{N}$

C. $(3\hat{j} - 4\hat{j})\ \mathrm{N}$

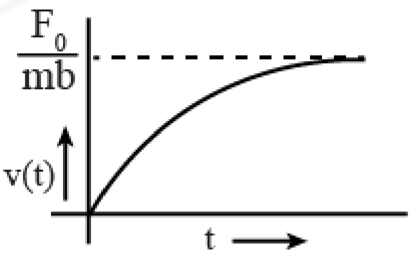
D. $\left(-\frac{3}{4}\hat{i} - \frac{4}{5}\hat{j}\right)\ \mathrm{N}$

18. A particle of mass m is at rest at the origin at time $t = 0$. It is subjected to a force $F(t) = F_0 e^{-bt}$ in the x direction. Its speed $v(t)$ is depicted by which of the following curves?

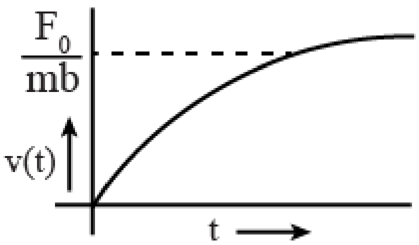
A.



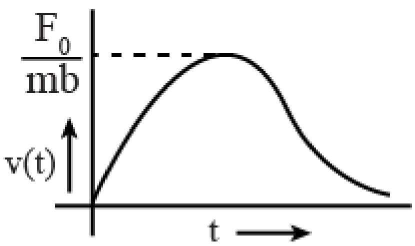
B.



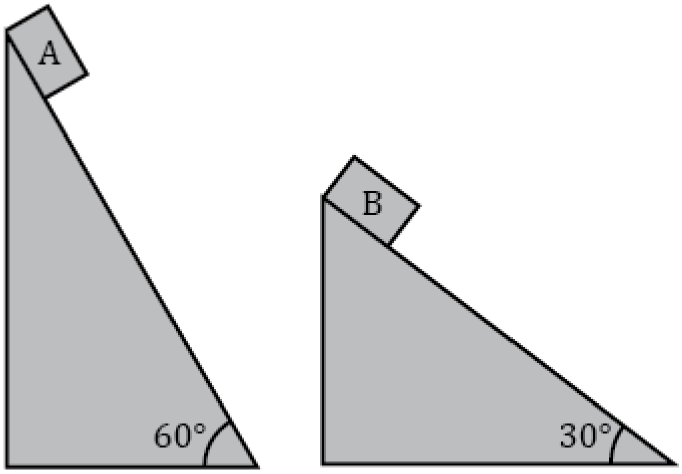
C.



D.



19. Two fixed frictionless inclined plane making an angle 30° and 60° with the vertical as shown in the figure. Two blocks A and B are placed on the two planes. What is the relative vertical acceleration of A with respect to B?



A. $4.9\ \mathrm{ms^{-2}}$ in horizontal direction

B. $9.8\ \mathrm{ms^{-2}}$ in vertical direction

C. Zero

D. $4.9\ \mathrm{ms^{-2}}$ in vertical direction

20. A ball of mass $2.0\ \mathrm{kg}$ is thrown vertically upwards by applying a force by hand. If the hand moves $0.2\ \mathrm{m}$ while applying the force and the ball goes up to $2\ \mathrm{m}$ height further, find the magnitude of the force. (Consider $g = 10\ \mathrm{m/s^2}$)

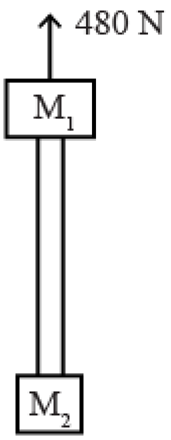
A. $4\ \mathrm{N}$

B. $16\ \mathrm{N}$

C. $20\ \mathrm{N}$

D. $22\ \mathrm{N}$

21. Two blocks of mass $M_1 = 20\ \mathrm{kg}$ and $M_2 = 12\ \mathrm{kg}$ are connected by a metal rod of mass $8\ \mathrm{kg}$. The system is pulled vertically up by applying a force of $480\ \mathrm{N}$ as shown. The tension at the mid-point of the rod is:



A. $144\ \mathrm{N}$

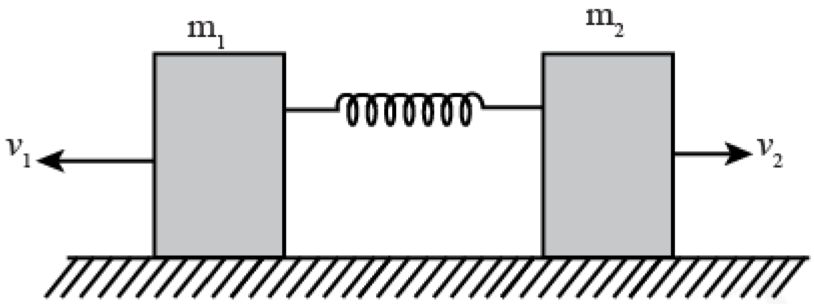
B. $96\ \mathrm{N}$

C. $240\ \mathrm{N}$

D. $192\ \mathrm{N}$

22. A spring is compressed between two blocks of masses m_1 and m_2 placed on a horizontal frictionless surface as shown in the figure. When the blocks are released, they have initial velocity of v_1 and v_2 as shown. The blocks travel distances x_1 and x_2 respectively before coming to rest.

The ratio $\left(\frac{x_1}{x_2}\right)$ is



A. $\frac{m_2}{m_1}$

B. $\frac{m_1}{m_2}$

C. $\sqrt{\frac{m_2}{m_1}}$

D. $\sqrt{\frac{m_1}{m_2}}$

23. A light string passing over a smooth light pulley connects two blocks of masses m_1 and m_2 (vertically). If the acceleration of the system is $\frac{g}{8}$, then the ratio of the masses is

A. $8:1$

B. $9:7$

C. $4:3$

D. $5:3$