PART (A) : PHYSICS

SINGLE CORRECT ANSWER TYPE

This section contains 20 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONLY ONE option can be correct.

Marking scheme: +4 for correct answer, 0 if not attempted and –1 in all other cases.

1. $x = a(\theta + \sin\theta);\ y = a(1 - \cos\theta)$, then $\frac{dy}{dx}$.

   (A) $\frac{\sin\theta}{(1+\cos\theta)}$

   (B) $\frac{\cos\theta}{1+\sin\theta}$

   (C) $\frac{1+\cos\theta}{\sin\theta}$

   (D) $\frac{\sin\theta}{1-\cos\theta}$

2. $\int_2^5 \frac{1}{(2+3x)}dx$ is -

   (A) $\frac{15}{2}$

   (B) $\frac{7}{5}$

   (C) $\frac{1}{3}\ln\frac{17}{8}$

   (D) $\ln\frac{17}{8}$

3. The resistance $R = \frac{V}{i}$ where $V = 100 \pm 5$ volts and $i = 10 \pm 0.2$ ampere. What is the total error in R?

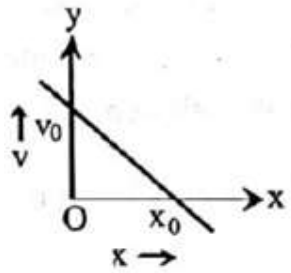
   (A) 5%

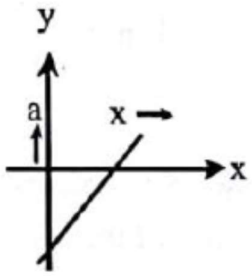
   (B) 7%

   (C) 5.2%

   (D) $\frac{5}{2}\%$

4. Depict the shown v-x graph in a-x graph :



(A)


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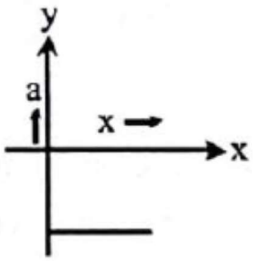

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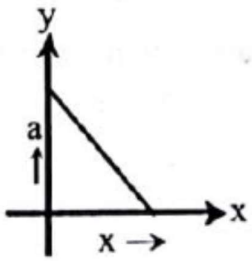
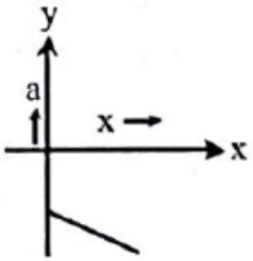


(D)


5. A body A starts from rest with an acceleration a_1. After 2 seconds, another body B starts from rest with an acceleration a_2. If they travel equal distance in the 5^{th} second, after the start of A, then the ratio $a_1 : a_2$ is equal to -

(A) 5 : 9
(B) 5 : 7
(C) 9 : 5
(D) 9 : 7

6. A particle has initial velocity of 17 ms^{-1} towards east and constant acceleration of 2 ms^{-2} due west. The distance covered by it in 9th second of motion is:

(A) 0 m
(B) 0.5 m
(C) 0.25 m
(D) 0.3 m

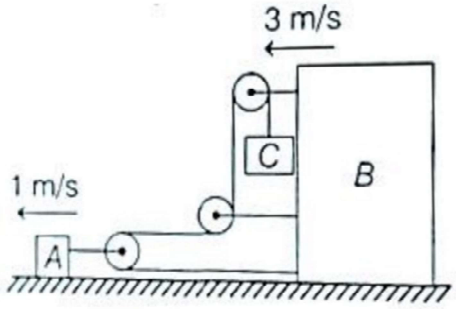
7. A particle is projected from the ground with an initial velocity of 20 m/s at an angle 30^o with horizontal. The magnitude of change in velocity in a time interval from $t = 0$ to $t = 0.5$s is
($g = 10$ m/s^2)

(A) 5 m/s
(B) 2.5 m/s
(C) 2 m/s
(D) 4 m/s

8. A particle A is projected vertically upwards. Another particle B of same mass is projected at an angle of 45^o. Both reach the same height. The ratio of the initial kinetic energy of A to that of B is

(A) 1 : 2
(B) 2 : 1
(C) $1:\sqrt{2}$
(D) $\sqrt{2}:1$

9. The velocities of A and B are marked in the figure. The velocities of block C is (Assume that the pulleys are ideal and string inextensible) :



(A) 5 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s

10. A stone is thrown vertically upward with an initial speed u from the top of a tower. It reaches the ground with a speed $3u$. The height of the tower is

(A) $3u^2/g$

(B) $4u^2/g$

(C) $6u^2/g$

(D) $9u^2/g$

11. A body starts from rest and is uniformly accelertated for 30 s. The distance travelled in the first 10 s is x_1, next 10 s is x_2 and the last 10 s is x_3. Then, $x_1 : x_2 : x_3$ is

(A) 1 : 2 : 4

(B) 1 : 2 : 5

(C) 1 : 3 : 5

(D) 1 : 3 : 9

12. A particle is projected at an angle of 60° above the horizontal with a speed of 10 m/s. After some time the direction of its velocity makes an angle of 30° above the horizontal. The speed of the particle at this instant is

(A) $\frac{5}{\sqrt{3}}$ m/s

(B) $5\sqrt{3}$ m/s

(C) 5 m/s

(D) $\frac{10}{\sqrt{3}}$ m/s

13. A balloon is moving upwards with velocity 10 m/s. It releases a stone which comes down to the ground in 11 s. The height of the balloon from the ground at the moment when the stone was dropped is (g = 10 m/s^2)

(A) 495 m

(B) 592 m

(C) 362 m

(D) 500 m

14. From a balloon rising vertically upwards at 5 m/s, a stone is thrown up at 10 m/s relative to the balloon. Its velocity with respect to ground after 2 sec is - (Assume g = 10 m/s^2)

(A) 0

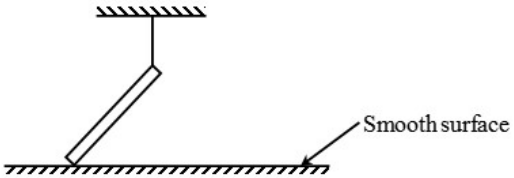
(B) 20 m/s

(C) 10 m/s

(D) 5 m/s

15. Write the dimensions of $\frac{a}{b}$ in the relation $P = \frac{a - t^2}{bx}$, where P is the pressure, x is the distance and t is the time.
(A) $M^{-1}L^{0}T^{-2}$
(B) $ML^{0}T^{-2}$
(C) $ML^{0}T^{2}$
(D) MLT^{-2}

16. Which figure represents the correct F.B.D. of rod of mass m as shown in figure?



(A) 

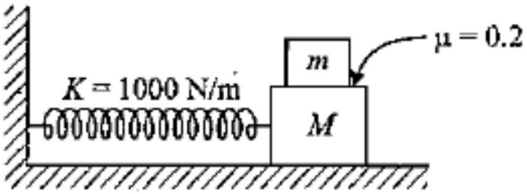
(B) 

(C) 

(D) None of these

17. In an equilateral ΔABC, AL, BM and CN are medians. Forces along BC and BA represented by them will have a resultant represented by -
(A) $2AL$
(B) $2BM$
(C) $2CN$
(D) AC

18. A block of mass $M = 4$ kg is kept on a smooth horizontal plane. A bar of mass $m = 1$ kg is kept on it. They are connected to a spring as shown & the spring is compressed. Then what is the maximum compression in the spring for which the bar will not slip on the block when released if coefficient of friction between them is 0.2 & spring constant = 1000 N/m : (Take $g = 10$ m/s^2)

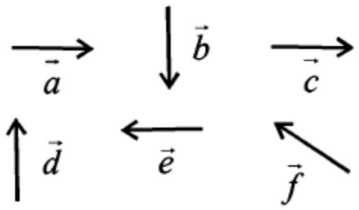


(A) 1 cm
(B) 1 m
(C) 1.25 cm
(D) 10 cm

19. What force must man exert on rope to keep platform in equilibrium: (Take $g = 10$ m/s^2)

(A) 100 N
(B) 200 N
(C) 300 N
(D) 500 N

20. Six vectors, $\vec{a}, \vec{b}, \vec{c}, \vec{d}, \vec{e}$ and $\vec{f}$ have the magnitudes and directions indicated in the figure. Which of the following statements is true?



(A) $\vec{b}+\vec{c}=\vec{f}$
(B) $\vec{d}+\vec{c}=\vec{f}$
(C) $\vec{d}+\vec{e}=\vec{f}$
(D) $\vec{b}+\vec{e}=\vec{f}$

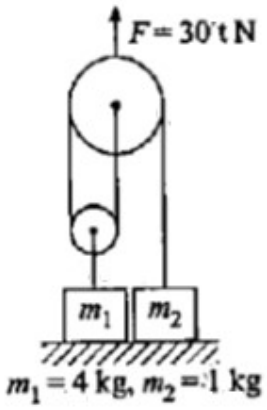
NUMERICAL VALUE TYPE

This section contains 10 questions. **Attempt any 5 questions out of 10.** Each question is numerical value type. For each question, enter the correct numerical value (in decimal notation (e.g. 6.25, 7.00, 7, –0.33, –.30, 30.27, –127.30).

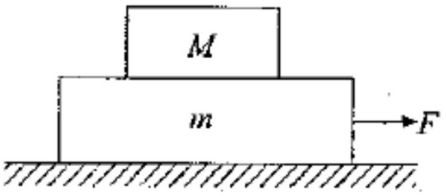
Marking scheme: +4 for correct answer, 0 if not attempted and 0 in all other cases.

21. A water fountain on the ground sprinkles water all around it. If the speed of water coming out of the fountain is v, then total maximum area around the fountain that gets wet is $k\pi\frac{v^4}{2g^2}$, find k

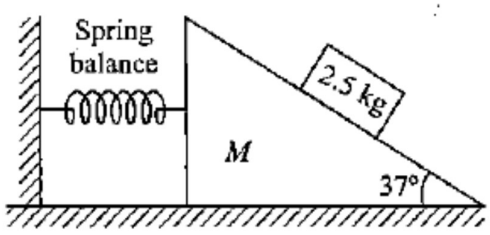
22. Force F is applied on upper pulley and masses of the blocks are shown in the diagram. If $F = 30t$ where t is time in second. Find the time (in seconds) when m_1 loses contact with floor: (Take $g = 10$ m/s^2)



23. A board of mass $m = 1$ kg lies on a table and a block of $M = 2$ kg is placed on the board. What minimum force F *(in N)* must be applied on the board in order to pull it out from under the load? The coefficient of friction between the load and the board is $\mu_1 = 0.25$ and that between board and table is $\mu_2 = 0.5$: (Take $g = 10$ m/s^2)



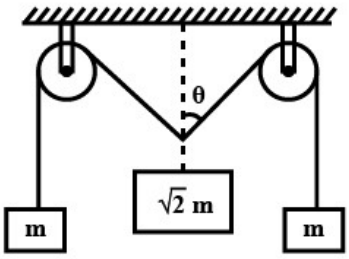
24. Find the spring force (in N) in the spring balance as shown in figure. Assume that mass M is in equilibrium:



25. In a cricket match, a batsman hits the ball in air. A fielder, originally standing at a distance of 12 *m* due east of the batsman, starts running 0.6 s after the ball is hit. He runs towards north at a constant speed of 5 m/s and just manages to catch the ball 2.4 s after he starts running. The horizontal component of velocity of ball is $n\sqrt{2}$ m/s during its flight. Find n.

26. The resultant of two vectors $\vec{A}$ and $\vec{B}$ is perpendicular to the vector $\vec{A}$ and its magnitude is equal to half the magnitude of vector $\vec{B}$. The angle between $\vec{A}$ and $\vec{B}$ (in degrees) is

27. The pulley and strings shown in the figure are smooth and of negligible mass. For the system to remain in equilibrium, the angle θ should be (in degrees)



28. A player stops a football weighing 0.5 kg which comes flying towards him with a velocity of 10 m/s. If the impact lasts for 1/50 sec, and the ball bounces back with a velocity of 15 m/s, then the average force (in N) involved is

29. A car having a mass of 1000 kg is moving at a speed of 30 metres/sec. Brakes are applied to bring the car to rest. If the frictional force between the tyres and the road surface is 5000 newtons, the car will come to rest in 'n' secs, find n

30. A block of mass *m* is resting on a smooth horizontal surface. One end of a uniform rope of mass (*m*/3) is fixed to the block, which is pulled in the horizontal direction by applying a force *F* at the other end. The tension in the middle of the rope is $T = \frac{nF}{8}$, find n