PART (A) : PHYSICS

SECTION – I : SINGLE CORRECT ANSWER TYPE
(Maximum Marks : 30)

This section contains 10 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D) for its answer, out of which ONLY ONE is correct.

Marking Scheme : +3 for correct answer, 0 if not attempted and -1 in all other cases.

1. Find the minimum value of the function $y = x^3 - 7x^2 + 8x + 5$.
   (A) –7
   (B) 4
   (C) –11
   (D) –5

2. The momentum of a moving particle given by $P = t\ln t$. Net force acting on this particle is defined by equations $F = \frac{dp}{dt}$. The net force acting on the particle is zero at time
   (A) $t = 0$
   (B) $t = \frac{1}{e}$
   (C) $t = \frac{1}{e^2}$
   (D) None of these

3. The velocity of a particle is $\mathbf{v} = 6\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 2\hat{\mathbf{k}}$. The component of the velocity of a particle parallel to vector $\mathbf{a} = \hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$ in vector form is
   (A) $6\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$
   (B) $2\hat{\mathbf{i}} + 2\hat{\mathbf{j}} + 2\hat{\mathbf{k}}$
   (C) $\hat{\mathbf{i}} + \hat{\mathbf{j}} + \hat{\mathbf{k}}$
   (D) $6\hat{\mathbf{i}} + 2\hat{\mathbf{j}} - 2\hat{\mathbf{k}}$

4. If $\left|\hat{\mathbf{a}} - \hat{\mathbf{b}}\right| = \sqrt{2}$, then calculate the value of $\left|\hat{\mathbf{a}} - \sqrt{3}\hat{\mathbf{b}}\right|$.
   (A) 1
   (B) 2
   (C) 3
   (D) 4

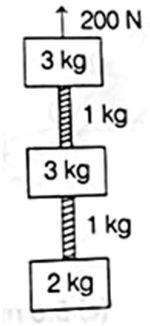
5. The radius of a thin wire is 0.16 mm. The area of cross-section taking significant figure into consider in square mm^2 is
(A) 0.0804
(B) 0.080
(C) 0.08
(D) 0.080384

6. A particle is falling freely. If the sum of the distances travelled in the t^{th} and $(t+1)^{th}$ second is 100 m, then its velocity after t seconds (in m/s) is (take $g = 10\ m/s^2$)
(A) 20
(B) 30
(C) 50
(D) 60

7. An object is projected so that it just clears two vertical walls each of height 7.5 m and separation 50 m. If time of passing between the two walls is 2.5 s, then find horizontal range of the object. (take $g = 10\ m/s^2$)
(A) 70 m
(B) 75 m
(C) 105 m
(D) 150 m

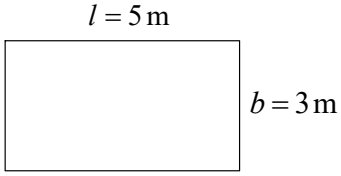
8. Raindrops are falling vertically with a velocity of 10 m/s. To a cyclist moving on a straight road the raindrops appear to be coming with a velocity of 20 m/s. The velocity of cyclist is
(A) 10 m/s
(B) $10\sqrt{3}$ m/s
(C) 20 m/s
(D) $10\sqrt{5}$ m/s

9. In the situation shown blocks are connected with the help of ropes. Find tension at the middle of each rope. Masses of blocks and ropes are indicated in figure. ($g = 10\ m/s^2$)



(A) 90 N, 160 N
(B) 60 N, 140 N
(C) 50 N, 130 N
(D) 70 N, 150 N

10. Find the area of the rectangle.



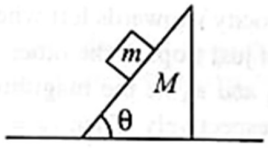
(A) 20 m^2
(B) 15 m^2
(C) 20.0 m^2
(D) 15.0 m^2

SECTION – II : MULTIPLE CORRECT ANSWER TYPE
(Maximum Marks : 20)

This section contains 5 multiple choice questions. Each question has 4 options (A), (B), (C) and (D) for its answer, out of which ONE OR MORE than ONE option can be correct.

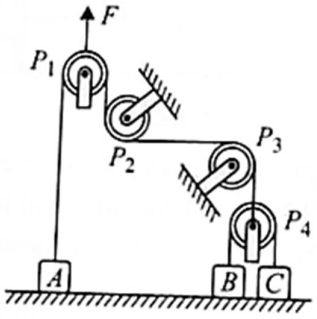
Marking Scheme : +4 for correct answer, +1 Partial Mark, 0 if not attempted and -1 in all other cases.

11. In the figure shown, friction exists at each contact surface with coefficient of friction μ and the blocks are at rest. Then,



(A) net force on block m is zero
(B) friction force on m is $mg\sin\theta$
(C) normal force by the horizontal surface on M is $(M+m)g$
(D) friction force between wedge and horizontal surface is $mg\sin\theta\cos\theta$

12. Pulleys P_2 and P_3 are smooth and fixed. The light pulley P_1 is moving upwards by applying a force F of 120 N. The pulley P_4 is also light and movable. Block A, B and C of their respective masses 1 kg, 2 kg and 3 kg are initially placed at the smooth horizontal surface. Then, choose the correct options. (g = 10 m/s^2)



(A) The acceleration of block A is 50 m/s^2
(B) The acceleration of block B is 5 m/s^2

(C) The acceleration of block C is zero

(D) The pulley P_1 has non-zero acceleration

13. A particle is projected vertically upwards with velocity u from a point O. When it returns to the point of projection

(A) its average velocity is zero

(B) its displacement is zero

(C) its average speed is $u/2$

(D) its average speed is u

14. A train is passing through a platform of length 50 m with uniform velocity. It takes 15 s to cross the platform and 5 s to cross a man standing on the platform. Mark the correct option(s).

(A) The length of train is 25 m

(B) The length of train is 50 m

(C) The speed of train is 10 ms^{-1}

(D) The speed of train is 5 ms^{-1}

15. For a body in a uniformly accelerated motion, the distance of the body from a reference point at time t is given by, $x = at + bt^2 + c$ where a, b and c are constants. The dimensions of c are the same as those of

(A) x

(B) at

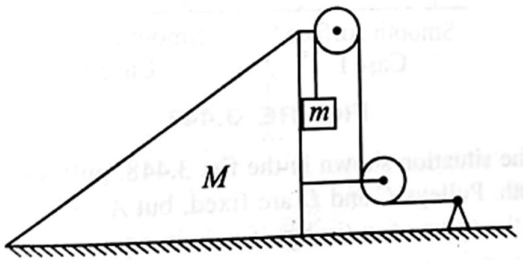
(C) bt^2

(D) b/a

SECTION – III : INTEGER ANSWER TYPE
(Maximum Marks : 10)

This section contains 5 questions. The answer to each question is a **SINGLE DIGIT INTEGER ranging from 0 to 9, BOTH INCLUSIVE.**
Marking scheme: +2 for correct answer, 0 if not attempted and 0 in all other cases.

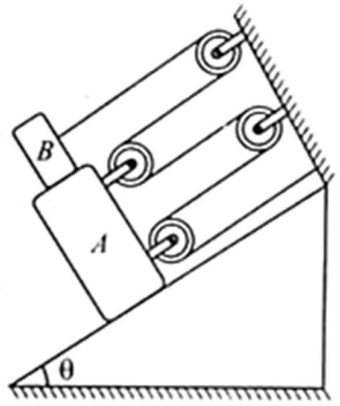
16. In the arrangement shown in figure, the mass of the wedge M is 10 kg and the mass of the body m is 4 kg. The coefficient of friction between wedge M and mass m is 0.5. There is no friction between wedge and horizontal surface. Neglecting the masses of pulley and strings, the acceleration of the wedge M in m/s^2 is (Take g = 10 m/s^2)



17. A man moves 10 m in a direction 37° East of North, then $5\sqrt{2}$ m in South-East direciton and finally 20 m in a direction 53° South of West. If the magnitude of resultant displacement of man is $\sqrt{34n}$ m, find the value of n.

18. Two tall buildings are 200 m apart. A ball must be thrown horizontally with a speed (2N + 2) m/s from the window 540 m above the ground in one building, so that it will enter a window 50 m above the ground in the other. Then he value of N is (Take $g = 9.8\ ms^{-2}$)

19. Two block A and B each of mass 1 kg are connected by light string as shown in the figure. Pulleys are smooth and light. The coefficient of static friction for all surfaces is $\mu = 0.5$. The minimum value of θ at which blocks begin to slide is $\tan^{-1}(n/6)$. Find the value of n. (take $g = 10\ m/s^2$)



20. In the situation shown in the figure, all strings and pulleys are ideal. If tension in the string connecting blocks A and C is $(1350/11n)$ N, find the value of n. ($g = 10\ ms^{-2}$)