PART (A) : PHYSICS

SECTION – I : SINGLE CORRECT ANSWER TYPE
(Maximum Marks : 45)

This section contains 15 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. A car going due North at $10\sqrt{2}$ ms^{-1} turns right through an angle of 90° without changing speed. The change in velocity of car is
   (A) 20 ms^{-1} in South-East direction
   (B) $10\sqrt{2}$ ms^{-1} in South-East direction
   (C) 20 ms^{-1} in South-East direction
   (D) 20 ms^{-1} in South-East direction

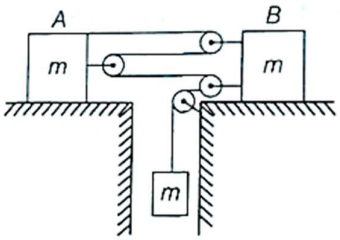
2. If the constant forces $2\hat{i}-5\hat{j}+6\hat{k}$ and $-\hat{i}+2\hat{j}-\hat{k}$ act on a particle due to which it is displaced from a point A (4, –3, –2) to a point B (6, 1, –3), then the total work done by the forces is
   (A) 15 units
   (B) –15 units
   (C) 9 units
   (D) –9 units

3. What is the maximum percentage error in the measurement of time period of a pendulum if maximum errors in the measurements of l and g are 2% and 4% respectively?
   (Use $T=2\pi\sqrt{\frac{\ell}{g}}$, T = Time period)
   (A) 6%
   (B) 4%
   (C) 3%
   (D) 5%

4. If momentum p, area A and time T are taken to be the fundamental quantities, then the dimensional formula for energy is
   (A) $[p^2AT^{-1}]$
   (B) $[pA^{-1}T^{-2}]$
   (C) $[pA^{1/2}T^{-1}]$
   (D) $[P^{1/2}AT^{-1}]$

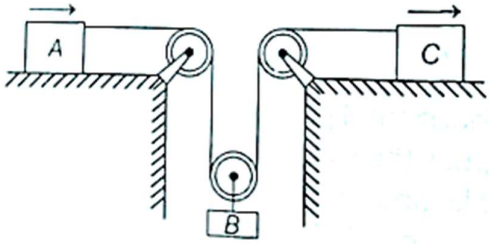
5. Amount of solar energy received on the earth's surface per unit area per unit time is defined solar constant. Dimensional formula of solar constant is
(A) $[MLT^{-2}]$
(B) $[ML^0T^{-3}]$
(C) $[M^2L^0T^{-1}]$
(D) $[ML^2T^{-2}]$

6. All the surfaces are frictionless, then acceleration of the block *B* is



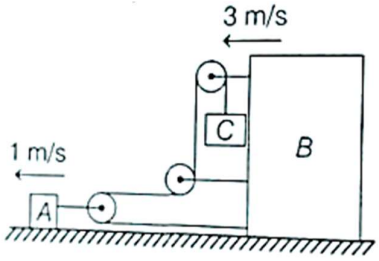
(A) $\frac{2g}{13}$
(B) $\frac{3g}{13}$
(C) $\frac{4g}{13}$
(D) $\frac{g}{13}$

7. Blocks *A* and *C* start from rest and move to the right with acceleration $a_A = \frac{t}{2}\,\text{m/s}^2$ and $a_C = 2\,\text{m/s}^2$. Here, *t* is in seconds. The time when block *B* again comes to rest is



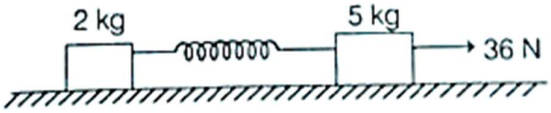
(A) 2 s
(B) 4 s
(C) 8 s
(D) 6 s

8. The velocities of A and B are marked in the figure. The velocity of block C is (assume that the pulleys are ideal and string inextensible.)



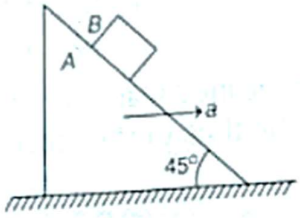
(A) 5 m/s
(B) 2 m/s
(C) 3 m/s
(D) 4 m/s

9. Two blocks A and B are connected by ideal spring of force contact 100 N/m and moving on a smooth horizontal surface under the influence of a force 36 N. What is the extension in the spring, when acceleration of 2 kg is twice that of 5 kg?



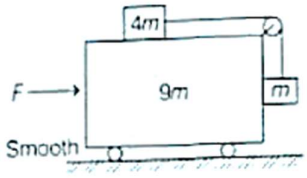
(A) 4 cm
(B) $\frac{36}{7}$cm
(C) $\frac{72}{7}$cm
(D) 16 cm

10. If the coefficient of friction between A and B is μ, the maximum horizontal acceleration of the wedge A for which B will remain at rest w.r.t. the wedge is



(A) g
(B) $g\left(\frac{1+\mu}{1-\mu}\right)$
(C) $\frac{g}{\mu}$
(D) $g\left(\frac{1-\mu}{1+\mu}\right)$

11. Find minimum force required to applied to the trolley of mass $9m$, so that blocks of masses $4m$ and m remain stationary with respect to the trolley. Ground is smooth. Coefficient of friction between each block and trolley is 0.2.



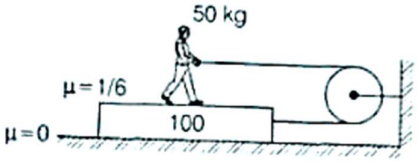
(A) $\frac{mg}{3}$

(B) $\frac{2mg}{3}$

(C) mg

(D) $\frac{4mg}{3}$

12. A man of mass 50 kg is pulling on a plank of mass 100 kg kept on a smooth floor as shown with force of 100 N. If both man and plank move together, find force of friction acting on man.



(A) $\frac{100}{3}$ N, towards left

(B) $\frac{100}{3}$ N, towards right

(C) $\frac{250}{3}$ N, towards left

(D) $\frac{250}{3}$ N, towards right

13. The equation of motion of a projectile is $y = 12x - \frac{3}{4}x^2$. What is the range of the projectile?

(A) 18 m
(B) 16 m
(C) 12 m
(D) 21.6 m

14. At a height 0.4 m from the ground, the velocity of a projectile in vector form is $\vec{v} = \left(6\hat{i} + 2\hat{j}\right) \text{ms}^{-1}$. The angle of projection of projectile with horizontal is (take g =10 m/s^2)

(A) 45°
(B) 60°
(C) 30°
(D) $\tan^{-1}$ (3/4)

15. A stone is thrown vertically upward with an initial velocity u from the top of a tower, reaches the ground with a velocity $3u$. The height of the tower is

(A) $3u^2/g$

(B) $4u^2/g$

(C) $6u^2/g$

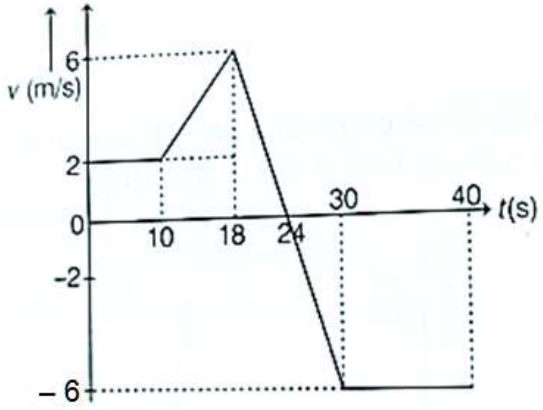
(D) $9u^2/g$

SECTION – II : MULTIPLE CORRECT ANSWER TYPE
(Maximum Marks : 15)

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

16. A particle moves in a straight line with the velocity as shown in the figure. At $t = 0$, $x = -16$ m. Then,



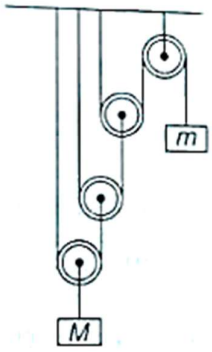
(A) the maximum value of the position coordinate of the particle is 54 m

(B) the maximum value of the position coordinate of the particle is 70 m

(C) the particle is at the position of 36 m at $t = 18$ s

(D) the particle is at the position of 36 m at $t = 30$ s

17. A situation is shown in the figure. Suppose, $M = 6\ m$. All the string used are light and pulleys are light and smooth. Now select the correct alternative(s).



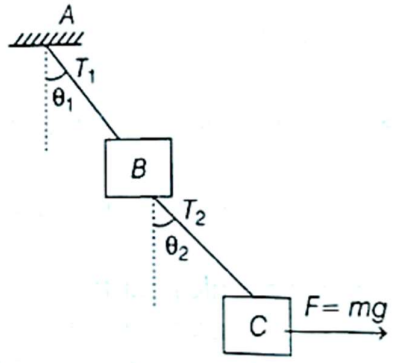
(A) Acceleration of m is $\frac{8g}{35}$ along downward.

(B) Acceleration of M is $\frac{4g}{35}$ along downward.

(C) If speed of m at some instant is v, then speed of M at that instant is $\frac{v}{4}$.

(D) If speed of m at some instant is v, then speed of M at that instant is $\frac{v}{8}$.

18. The blocks B and C in the figure have mass m each. The strings AB and BC are light, having tensions T_1 and T_2, respectively. The system is in equilibrium with a constant horizontal force mg acting on C



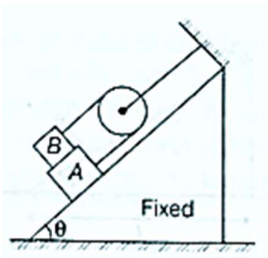
(A) $\tan\theta_1 = 2$

(B) $\tan\theta_2 = 1$

(C) $T_1 = \sqrt{5}\,mg$

(D) $T_2 = \sqrt{2}\,mg$

19. In the arrangement shown in figure, pulley is smooth and massless and string is light. Friction coefficient between A and B is μ. Friction is absent between A and plane. Select the correct alternative(s).



(A) Acceleration of the system is zero if $\mu \geq \frac{m_B - m_A}{2m_B}\tan\theta$ and $m_B > m_A$

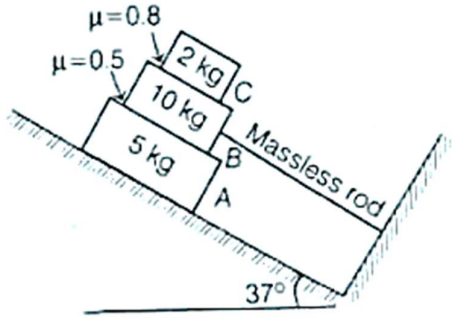
(B) Force of friction between A and B is zero if $m_A = m_B$

(C) B moves downwards if $m_B > m_A$

(D) Tension in the string is $mg(\sin\theta - \mu\cos\theta)$, if $m_A = m_B = m$

20. In the given figure, the inclined plane is frictionless and coefficient of friction between the blocks is shown. All the three blocks A, B and C are stationary. Then. Choose the correct option(s).

(take $g = 10\ m/s^2$)



(A) Friction force on block *A* is 30 N
(B) Friction force on block *C* is 12.8 N
(C) Thrust in the rod is 102 N
(D) Block *A* will accelerate down