JEE MAIN ANSWER KEY & SOLUTIONS

SUBJECT :- PHYSICS
CLASS :- 11th **PAPER CODE :- CWT-4**
CHAPTER :- NEWTON'S LAWS OF MOTION

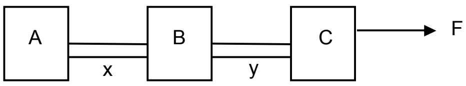
ANSWER KEY

1.	(A)	**2.**	(D)	**3.**	(C)	**4.**	(D)	**5.**	(D)	**6.**	(A)	**7.**	(D)
8.	(C)	**9.**	(C)	**10.**	(C)	**11.**	(D)	**12.**	(B)	**13.**	(B)	**14.**	(B)
15.	(C)	**16.**	(C)	**17.**	(C)	**18.**	(C)	**19.**	(B)	**20.**	(C)	**21.**	5
22.	45	**23.**	53	**24.**	68	**25.**	5	**26.**	8	**27.**	8	**28.**	3
29.	4	**30.**	2										

SOLUTIONS

1. (A)

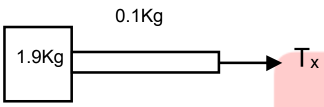
Sol. Acceleration of system is a = F/8



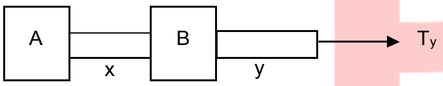
Maximum tension in string x occurs at front end equals to

$T_x = \frac{F}{8}\times 2 = \frac{F}{4} \le 100$

$F \le 400$ N ..... (1)



Maximum tension in string Y occurs at front end



$T_y = \frac{F}{8}\times 4 \le 220 \Rightarrow F \le 440$ N .... (2)

String x breaks before y $\Rightarrow F_{max} = 400$ N

2. (D)

Sol. In figure-1 $F_{BC} = 2m\left(\frac{F}{9m}\right) = \frac{2F}{9}$

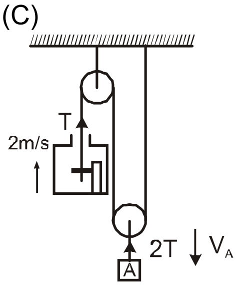
$F_{AB} = 5m\left(\frac{F}{9m}\right) = \frac{5F}{9}$

In figure-2 $F_{BC} = 7m\left(\frac{F}{9m}\right) = \frac{7F}{9}$

$F_{AB} = 4m\left(\frac{F}{9m}\right) = \frac{4F}{9}$

3. (C)

Sol.



Velocity of a point on spring near motor
V_M = 5 m/s – 3m/s
= 2m/s upwards

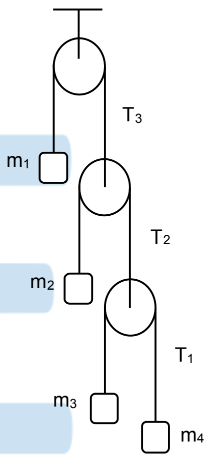
From constraint relation

$$\frac{V_A}{V_M} = \frac{T_M}{T_A} = \frac{T}{2T}$$

$\Rightarrow \quad V_A = \frac{V_M}{2} = \frac{2}{2}$ = 1m/s downwards

4. (D)

Sol.



Tension in string connecting m_3 & m_4 is

$T_1 = \frac{2m_3m_4}{m_3+m_4}g$

$T_2 = m_2 g = 2T_1$

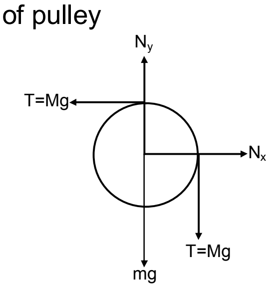
$\Rightarrow m_2 = \frac{4m_3m_4}{m_3+m_4}$

$T_3 = m_1 g = 2T_2 = 4T_1$

$m_1 = \frac{8m_3m_4}{m_3+m_4}$

5. (D)

Sol. FBD of pulley



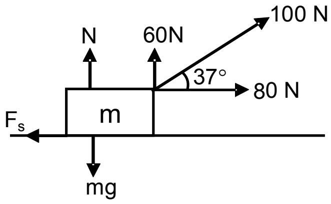
$N_x = Mg$
$N_y = (M + m)g$
$F = \sqrt{N_x^2 + N_y^2}$

6. (A)

7. (D)

Sol. Tension in string = 100 N in equilibrium

F.B.D. of A



$N = mg - 60$

$F_s = 80 \le \mu N$

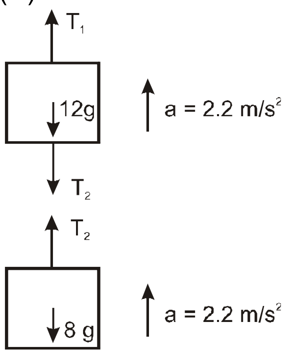
$80 \le \frac{1}{2}(mg - 60)$

$mg \ge 220$

$m \ge 22$

8. (C)

Sol.



$T_2 - 8g = 8a$ [Newton's II law for 8 kg block]

$\Rightarrow \quad T_2 = 8 \times 2.2 + 8 \times 9.8$

$= 96$ N

$T_1 - 12\,g - T_2 = 12\,a$

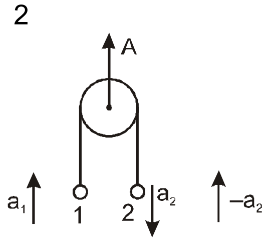
[Newton's II law for 12 kg block]

$\Rightarrow \quad T_1 = 12 \times 2.2 + 12 \times 9.8 + 96$

$T_1 = 240$ N

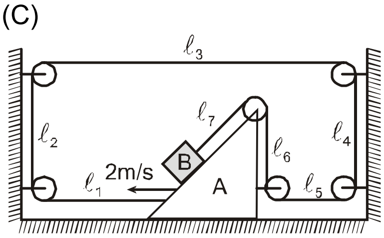
9. (C)

Sol. $A = \frac{a_1 - a_2}{2}$



10. (C)

Sol.



ℓ_2, ℓ_3, ℓ_4, ℓ_6 are remain constant. $\ell_1 + \ell_5$ = constant so, ℓ_7 will also be constant, so, only velocity of B is along horizontal = 2 m/s.

11. (D)

Sol. $\vec{F} = m\vec{a}$

$\vec{a} = \frac{d\vec{v}}{dt}$

12. (B)

Sol. In free fall gravitation force acts.

13. (B)

Sol $\vec{F} = 6\hat{i} - 8\hat{j} + 10\hat{k}$

$\vec{F} = m\vec{a}$

$|\vec{F}| = m|\vec{a}|$

$\sqrt{6^2 + 8^2 + 10^2} = m\,1 \quad m = 10\sqrt{2}$ kg.

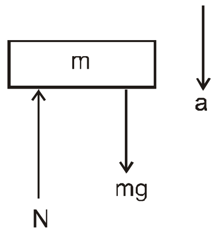
14. (B)

Sol. N = m (g – a) , N < mg if a (↓)

N = m (g – a) a (↓)N < mg

and N > mg if a (↑)

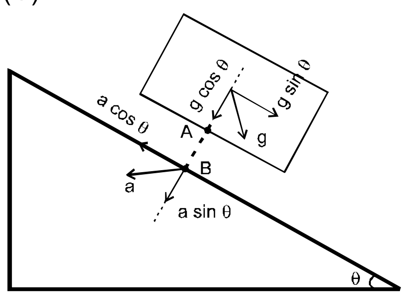
Reading of spring balance is less than m if a (↓) and reading of spring balance is



greater than m if a (↑)

15. (C)

Sol.



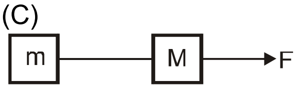
acceleration of point A and B must be some along the line ⊥ to the surface

$\Rightarrow \quad a \sin\theta = g \cos\theta$

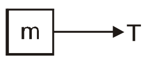
$a = g \cot\theta$

16. (C)

Sol.



$a_{system} = \frac{F}{M + m}$



$T = ma_{system} = \frac{mF}{M + m}$

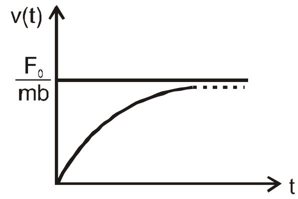
17. (C)

Sol. $F = ma = F_0 e^{-bt}$

$$\frac{dv}{dt} = \frac{F_0}{m} e^{-bt}$$

$$\int_0^v dv = \frac{F_0}{m}\int_0^t e^{-bt} dt$$

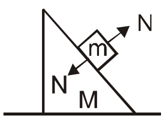
$$v = \frac{F_0}{m}\left[\frac{e^{-bt}}{-b}\right]_0^t$$

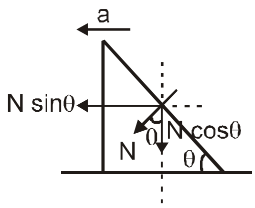


$$v = \frac{F_0}{mb}\left(1 - e^{-bt}\right)$$

18. (C)

Sol.

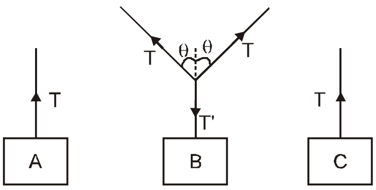




$a = \frac{N\sin\theta}{M}$ along (– ve x axis)

19. (B)

Sol.



T = mg

2Tcosθ = T'

T' = Mg

2mg cosθ = Mg

$\cos\theta = \frac{M}{2m} < 1$

M < 2m

20. (C)

Sol. Consider the situation in gravity free space.

21. 5

Sol. For sliding

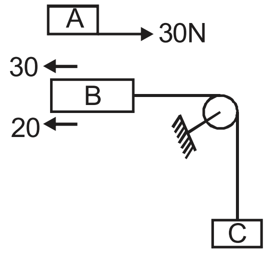
mg sin θ_0 + mg sin θ_0 > (μ_1 mg cos θ_0 + μ_2 mg cos θ_0)

$\Rightarrow$ 2 tan θ_0 > 0.6 + 0.2

$\Rightarrow$ 2 cot θ_0 < $\frac{4}{0.8}$ = 5

22. 45

Sol.



Given Condition is possible if $a_B - a_A = 2m/s^2$

And $a_A = \frac{30}{5} = 6m/s^2 \Rightarrow a_B = 8m/s^2$ B & C will move with same acc. a_B

$\Rightarrow mg - 50 = (m+5)a_B$

$10m - 50 = 8m + 40$

$\Rightarrow m = 45kg$

23. 53

Sol. $\frac{N_1 + N_2}{\sqrt{2}} = mg\cos\theta$

$mg\sin\theta - \mu(N_1 + N_2) = ma$

mg sin $\theta - \sqrt{2}\,\mu$ mg cosθ = 0 $\boxed{\tan\theta = \sqrt{2}\mu}$

24. 68 N

Sol. Maximum possible acceleration of 4kg block

$\frac{f max}{m} = \frac{20}{4} = 5m/s^2$

Now, $f_s - 20 = 6 \times 8$

F = 68N

25. 5

Sol. $T = \frac{mg}{4} = 5N$

Draw FBD, apply Newton's 2nd law of motion.

26. 8

Sol. $a = \frac{F - \mu mg}{m}$ -- (i)

$T_{mid} = -\frac{\mu mg}{2} = \frac{m}{2}a$

$T_{mid} = \frac{\mu mg}{2} + \frac{F - \mu mg}{2} = \frac{F}{2}$

27. 8

Sol. Let Wedge is moving rightward with acceleration a and mass m has an acceleration A with respect to wedge along the surface of the wedge in upward direction, so

$$\frac{h}{\sin\alpha} = \frac{1}{2}At^2 \Rightarrow A = \frac{2h}{t^2 \sin\alpha}$$

With the help of FBD of mass m in the frame of wedge, we can write

$$A = a\cos\alpha - g\sin\alpha \Rightarrow \frac{2h}{t^2 \sin\alpha} = a\cos\alpha - g\sin\alpha$$

$\Rightarrow a = g$

$$\tan\alpha \quad + \quad \frac{2h}{t^2 \sin\alpha \cos\alpha} = 10 \times \frac{3}{4} + 2 \times 3$$

$$\times \frac{5}{3} \times \frac{5}{4} \times \frac{1}{5 \times 5} = 8 m/s^2$$

28. 3

Sol. $v_{nm} = \dfrac{v_B + {}^{v_A}\!/_2}{2} = \dfrac{4 + {}^{4}\!/_2}{2} = \dfrac{4+2}{2} = 3$

29. 4

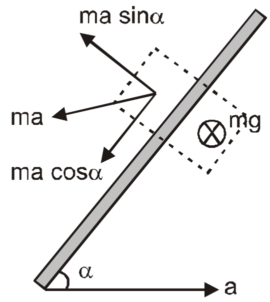
Sol. $a_A = \dfrac{d^2y}{dt^2} = \dfrac{1}{2}$

$a_B = 8a_A$ by constrained relation

$a_B = 4\ m/s^2$

30. 2

Sol.



acceleration of bead along rod is

$$\frac{ma\cos\alpha}{m} = a\cos\alpha$$

$$\frac{1}{2} a \cos \alpha t^2 = \ell$$

$$t = \sqrt{\frac{2\ell}{a\cos\alpha}} = 2sec$$