

Max Marks: 300

JR_WEEK-14 (21-09-2026)

Time: 180 mins

Chemistry

 1. 1 cc N_2O at N.T.P. contains:

- A) 1.8224×10^{22} atoms
 B) $\frac{6.02}{22400} \times 10^{23}$ molecules
 C) $\frac{1.32}{224} \times 10^{23}$ electrons
 D) All of the above

 2. The molecular weight of O_2 and SO_2 are 32 and 64 respectively. At $15^\circ C$ and 150 mmHg pressure, one litre of O_2 contains " N " molecules. The number of molecules in two litres of SO_2 under the same conditions of temperature and pressure will be:

- A) $\frac{N}{2}$
 B) N
 C) $2N$
 D) $4N$

 3. The number of gram molecules of oxygen in 6.02×10^{24} CO molecules is:

- A) 10 g molecules
 B) 5 g molecules
 C) 1 g molecule
 D) 0.5 g molecules

 4. The total number of valence electrons in of xN_3^- ion is (N_A is the Avogadro's number):

- A) $2.1N_A$
 B) $4.2N_A$
 C) $1.6N_A$
 D) $3.2N_A$

 5. The number of atoms in 4.25 g of NH_3 is approximately:

- A) 1×10^{23}
 B) 2×10^{23}
 C) 4×10^{23}
 D) 6×10^{23}

6. Oxidation numbers of A, B, C are +2, +5 and -2 respectively. Possible formula of compound is

- A) $A_2(BC_2)_2$
 B) $A_3(BC_4)_2$
 C) $A_2(BC_3)_2$
 D) $A_3(B_2C)_2$

7. Molarity of liquid HCl, if density of solution is 1.17 g/cc is

- A) 36.5
 B) 18.25
 C) 32.05
 D) 42.10

8. Percentage of Se in peroxidase anhydrous enzyme is 0.5% by weight (atomic wt. = 78.4) then minimum molecular weight of peroxidase anhydrous enzyme is

- A) 1.568×10^4
 B) 1.568×10^3
 C) 15.68
 D) 2.136×10^4

9. Which has maximum molecules?

- A) 7 g N_2
 B) 2 g H_2
 C) 16 g NO_2
 D) 16 g O_2

10. The maximum number of molecules is present in

- A) 15, L of H_2 gas at STP
 B) 5, L of N_2 gas at STP
 C) 0.5, g of H_2 gas
 D) 10, g of O_2 gas

 11. The number of atoms in 0.1 mol of a triatomic gas is ($N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$):

- A) 6.026×10^{22}
 B) 1.806×10^{23}
 C) 3.600×10^{21}
 D) 1.800×10^{22}

12. Which has the maximum number of molecules among the following?:

- A) 44 g CO_2 B) 48 g O_3
C) 8 g H_2 D) 64 g SO_2

13. 6.02×10^{20} molecules of urea are present in 100 mL of its solution. The concentration of solution is:

- A) 0.001 M B) 0.1 M
C) 0.02 M D) 0.01 M

14. Equal masses of H_2 , O_2 and methane have been taken in a container of volume V at temperature $27^\circ C$ in identical conditions. The ratio of the volumes of gases $H_2 : O_2 : \text{methane}$ would be:

- A) 8 : 16 : 1 B) 16 : 8 : 1
C) 16 : 1 : 2 D) 8 : 1 : 2

15. A mixture of gases contains H_2 and O_2 gases in the ratio of 1 : 4(w/w). What is the ratio of the two gases in the mixture?:

- A) 16 : 1 B) 2 : 1
C) 1 : 4 D) 4 : 1

16. Suppose the elements X and Y combine to form two compounds XY_2 and X_3Y_2 . When 0.1 mole of XY_2 weighs 10g and 0.05 mole of X_3Y_2 weighs 9g, the atomic weights of X and Y are:

- A) 40, 30 B) 60, 40
C) 20, 30 D) 30, 20

17. In which case is number of molecules of water maximum?:

- A) 18 mL of water B) 0.18 g of water
C) D) 10^{-3} mol of water
0.00224 L of water vapours at 1 atm and 273K

18. The highest number of helium atoms is in:

- A) 4 mol of helium B) 4 u of helium
C) 4 g of helium D) 2.271098 L of helium at STP

19. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R
Assertion A : 3.1500 g of hydrated oxalic acid dissolved in water to make 250.0 mL solution will result in 0.1 M oxalic acid solution. Reason R : Molar mass of hydrated oxalic acid is 126 g mol^{-1} . In the light of the above statements, choose the correct answer from the options given below:

- A) A is false but R is true B) A is true but R is false
C) Both A and R are true but R is NOT the correct explanation of A D) Both A and R are true and R is the correct explanation of A

20. Match List I with List II:

LIST I	LIST II
A 16g of $CH_4(g)$	I. Weight 28g
B 1g of $H_2(g)$	II 60.2×10^{23} electrons
C 1 mole of $N_2(g)$	III Weight 32g
D 0.5 mol of $SO_2(g)$	IV Occupies 11.4L volume at STP

- A) A-II, B-IV, C-I, D-III B) A-II, B-IV, C-III, D-I
C) A-II, B-III, C-IV, D-I D) A-I, B-III, C-II, D-IV

21. Haemoglobin contains 0.334% of iron by weight. The molecular weight of haemoglobin is approximately 67200. The number of iron atoms (Atomic weight of Fe is 56) present in one molecule of haemoglobin is:

22. The molarity of 1 L orthophosphoric acid (H_3PO_4) having 70% purity by weight (specific gravity 1.54 g cm^{-3}) is _____ M. (Molar mass of $H_3PO_4 = 98 \text{ g mol}^{-1}$)

23. The density of 3M solution of NaCl is 1.0 g mL^{-1} . Molality of the solution is _____ $\times 10^{-2} \text{ m}$ (Nearest integer). Given: Molar mass of Na and Cl is 23 and 35.5 g mol^{-1} respectively.

24. The normality of H_2SO_4 in the solution obtained on mixing 100 mL of 0.1 M H_2SO_4 with 50 mL of 0.1 M $NaOH$ is _____ $\times 10^{-1}$ N. (Nearest Integer)

25. The mole fraction of a solute in a 100 molal aqueous solution $\times 10^{-2}$ (Round off to the nearest integer). [Given, atomic masses $H : 1.0$ u, $O : 16.0$ u]

Maths

26. $\lim_{x \rightarrow 0} \frac{\sqrt{1+\sin x} - \sqrt{1-\sin x}}{x} =$

A) -1

C) 2

B) 1

D) -2

27. $\lim_{x \rightarrow 0} \left\{ \frac{\sin x - x + \frac{x^3}{6}}{x^5} \right\} =$

A) 1/120

C) 1/20

B) -1/120

D) None of these

28. $\lim_{x \rightarrow 0} \left[\frac{1}{x} - \frac{\log(1+x)}{x^2} \right] =$

A) 1/2

C) 1

B) -1/2

D) -1

29. $\lim_{x \rightarrow 0} \frac{\tan x - \sin x}{x^3} =$

A) 1/2

C) 2/3

B) -1/2

D) None of these

30. $\lim_{x \rightarrow 0} \frac{x^2 - \tan 2x}{\tan x} =$

A) 2

C) 0

B) -2

D) None of these

31. $\lim_{x \rightarrow 0} \frac{e^{x^2} - \cos x}{x^2} =$

A) 3/2

C) 1

B) -1/2

D) None of these

32. $\lim_{x \rightarrow 0} \frac{\sqrt{\frac{1}{2}(1-\cos 2x)}}{x} =$

A) 1

C) 0

B) -1

D) None of these

33. $\lim_{n \rightarrow \infty} (4^n + 5^n)^{1/n}$ is equal to

A) 4

C) e

B) 5

D) None of these

34. The value of $\lim_{x \rightarrow \infty} \frac{x^2 \sin \frac{1}{x} - x}{1-|x|}$ is

A) 0

C) -1

B) 1

D) None of these

35. $\lim_{x \rightarrow \infty} \sqrt{\frac{x+\sin x}{x-\cos x}} =$

A) 0

C) -1

B) 1

D) None of these

36. The value of $\lim_{x \rightarrow 0} \left(\frac{a^x + b^x + c^x}{3} \right)^{2/x}; (a, b, c > 0)$ is

A) $(abc)^3$

C) $(abc)^{1/3}$

B) abc

D) None of these

37. $\lim_{x \rightarrow 0} \left(\frac{1+5x^2}{1+3x^2} \right)^{1/x^2} =$

A) e^2

C) e^{-2}

B) e

D) e^{-1}

38. $\lim_{x \rightarrow 0} \frac{xe^x - \log(1+x)}{x^2}$ equals

A) 2/3

C) 1/2

B) 1/3

D) 3/2

39. $\lim_{x \rightarrow 0} \frac{x \tan 2x - 2x \tan x}{(1-\cos 2x)^2}$ is

A) 2

C) 1/2

B) -2

D) -1/2

40. The value of $\lim_{x \rightarrow 0} \frac{(1 - \cos 2x) \sin 5x}{x^2 \sin 3x}$ is

- A) 10/3
B) 3/10
C) 6/5
D) 5/6

41. $\lim_{x \rightarrow 0^+} \frac{\tan(5x)^{1/3} \log_e(1+3x^2)}{(\tan^{-1} 3\sqrt{x})^2 (e^{5(x)^{4/3}} - 1)}$ is equal to

- A) 5/3
B) 1
C) 1/3
D) 1/15

42. If $\lim_{x \rightarrow \infty} \left(1 + \frac{a}{x} + \frac{b}{x^2}\right)^{2x} = e^2$, then the values of a and b are

- A) $a = 1, b = 2$
B) $a = 1, b \in R$
C) $a \in R, b = 2$
D) $a \in R, b \in R$

43. The value of $\lim_{x \rightarrow 0} \frac{27^x - 9^x - 3^x + 1}{\sqrt{5} - \sqrt{4 + \cos x}}$ is

- A) $\sqrt{5}(\log 3)^2$
B) $8\sqrt{5} \log 3$
C) $16\sqrt{5} \log 3$
D) $8\sqrt{5}(\log 3)^2$

44. The value of $\lim_{n \rightarrow \infty} \frac{1}{1 \cdot 3} + \frac{1}{3 \cdot 5} + \frac{1}{5 \cdot 7} + \dots + \frac{1}{(2n-1)(2n+1)}$ is equal to

- A) 1/2
B) 1/3
C) 1/4
D) None of these

45. The value of the constant α and β such that

$$\lim_{x \rightarrow \infty} \left(\frac{x^2 + 1}{x + 1} - \alpha x - \beta \right) = 0 \text{ are respectively}$$

- A) (1, 1)
B) (-1, 1)
C) (1, -1)
D) (0, 1)

46. For $\alpha, \beta, \gamma \in R$, if $\lim_{x \rightarrow 0} \frac{x^2 \sin \alpha x + (\gamma - 1)e^{x^2}}{\sin 2x - \beta x} = 3$, then $\beta + \gamma - \alpha$ is equal to:

47. If $\lim_{x \rightarrow 0} \frac{3 + \alpha \sin x + \beta \cos x + \log_e(1-x)}{3 \tan^2 x} = \frac{1}{3}$, then $2\alpha - \beta$ is equal to:

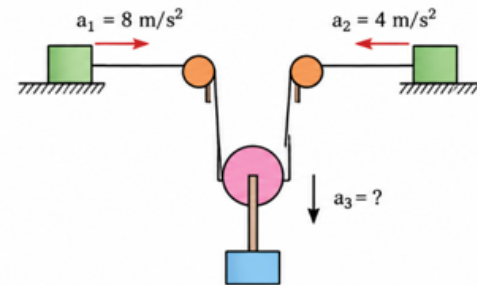
48. If $\lim_{x \rightarrow 0} \frac{\alpha x e^x - \beta \log_e(1+x) + \gamma x^2 e^{-x}}{x \sin^2 x} = 10, \alpha, \beta, \gamma \in R$, then the value of $\alpha + \beta + \gamma$ is _____.

49. If $\lim_{x \rightarrow 0} \left\{ \frac{1}{x^8} \left(1 - \cos \frac{x^2}{2} - \cos \frac{x^2}{4} + \cos \frac{x^2}{2} \cos \frac{x^2}{4} \right) \right\} = 2^{-k}$, then the value of k is _____.

50. $\lim_{m \rightarrow \infty} \left(\cos \frac{x}{m} \right)^m =$

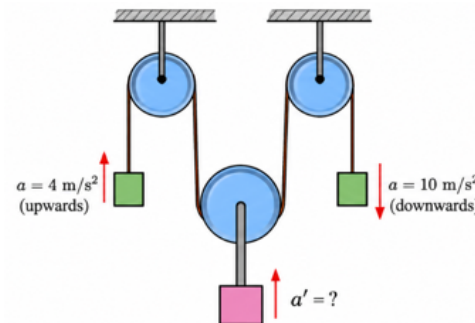
Physics

51. Find the acceleration a_3 of the bottom movable pulley in the given pulley system, where the acceleration of the first block is $a_1 = 8 \text{ m/s}^2$ to the right and the acceleration of the second block is $a_2 = 4 \text{ m/s}^2$ to the left. The bottom pulley moves vertically downward.



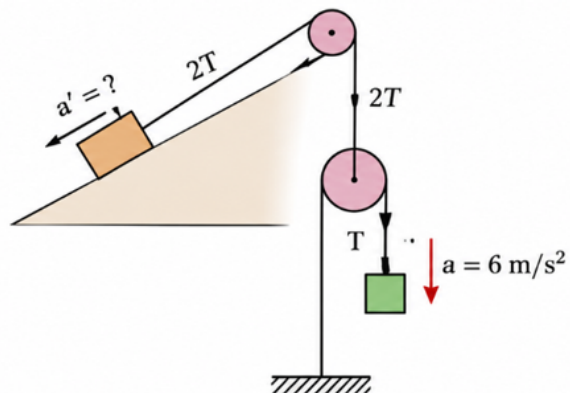
- A) 4 m/s^2
B) 5 m/s^2
C) 6 m/s^2
D) 8 m/s^2

52. Find a' in the following string-pulley system, where the left block moves upwards with acceleration $a_1 = 4 \text{ m/s}^2$ and the right block moves downwards with acceleration $a_2 = 10 \text{ m/s}^2$. Find the magnitude of acceleration of the central movable pulley.



- A) 2 m/s^2
B) 3 m/s^2
C) 4 m/s^2
D) 7 m/s^2

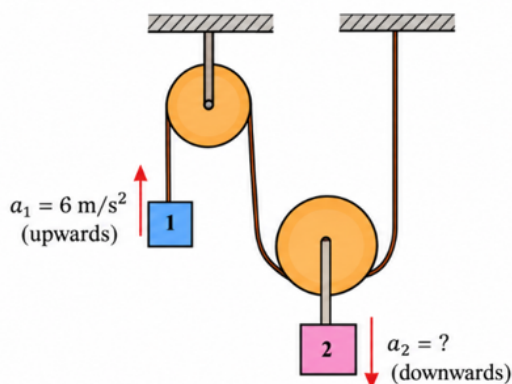
53. Find the acceleration a' of the block on the inclined plane in the given pulley system, where the small block moves downwards with acceleration



$$a = 6 \text{ m/s}^2.$$

- A) 2 m/s^2
 B) 3 m/s^2
 C) 4 m/s^2
 D) 6 m/s^2

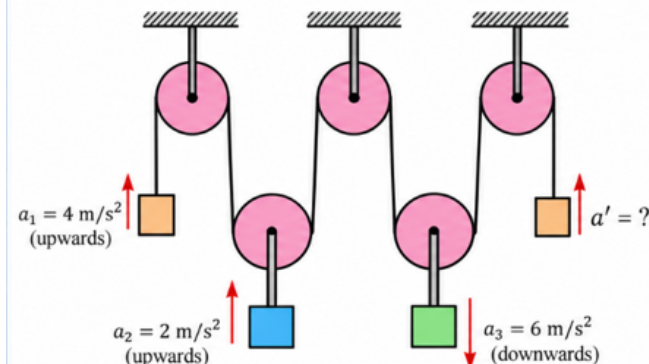
54. Find a_2 in the given pulley system where block 1 moves upwards with acceleration $a_1 = 6 \text{ m/s}^2$ and block 2 moves downwards with acceleration



$$a_2.$$

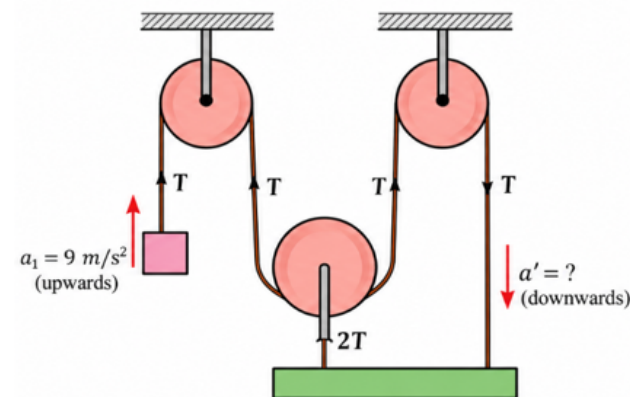
- A) 1 m/s^2
 B) 2 m/s^2
 C) 3 m/s^2
 D) 6 m/s^2

55. Find a' in the given string-pulley system where the first block moves upwards with acceleration $a_1 = 4 \text{ m/s}^2$, the second block moves upwards with acceleration $a_2 = 2 \text{ m/s}^2$, and the third block moves downwards with acceleration $a_3 = 6 \text{ m/s}^2$.



- A) 1 m/s^2
 B) 2 m/s^2
 C) 3 m/s^2
 D) 4 m/s^2

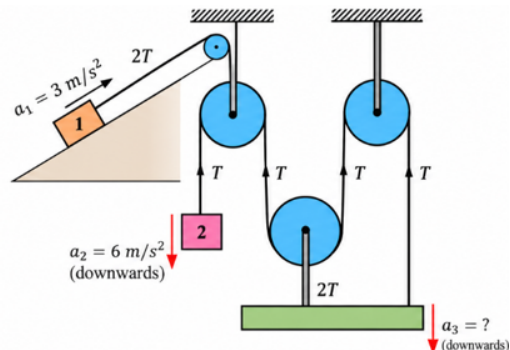
56. Find a' in the given figure where the left block moves upwards with acceleration $a_1 = 9 \text{ m/s}^2$ and the green platform moves downwards with



acceleration a' .

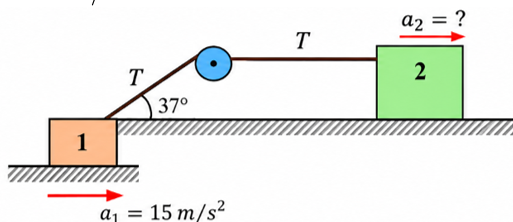
- A) 1 m/s^2
 B) 2 m/s^2
 C) 3 m/s^2
 D) 6 m/s^2

57. Find the acceleration a_3 of the platform in the given string-pulley system where block 1 moves up the incline with acceleration $a_1 = 3m/s^2$ and block 2 moves downwards with acceleration $a_2 = 6m/s^2$.



- A) $-2m/s^2$ B) $-3m/s^2$
C) $-4m/s^2$ D) $-5m/s^2$

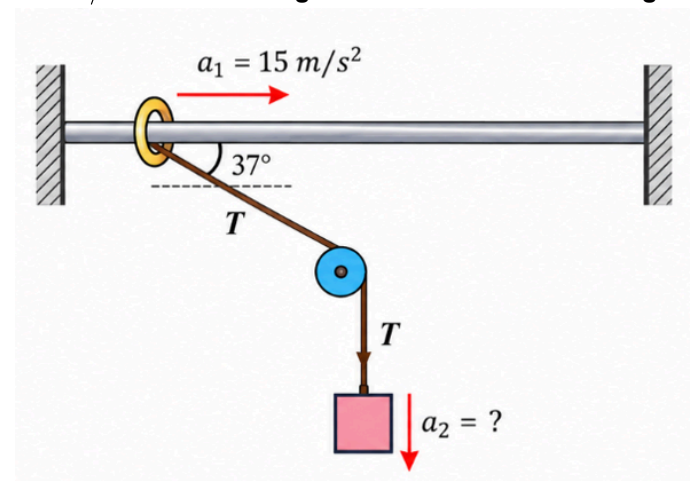
58. Find a_2 in the given system where block 1 moves horizontally to the right with acceleration $a_1 = 15m/s^2$ and the tension T makes an angle of 37°



with the horizontal.

- A) $9m/s^2$ B) $12m/s^2$
C) $15m/s^2$ D) $18m/s^2$

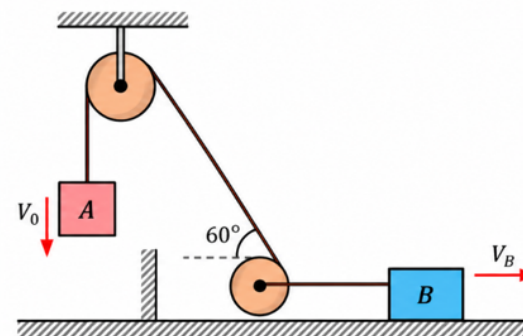
59. Find a_2 in the given system where a ring slides along a horizontal rod with acceleration $a_1 = 15m/s^2$ and the string attached to it makes an angle of



37° with the rod.

- A) $9m/s^2$ B) $12m/s^2$
C) $15m/s^2$ D) $18m/s^2$

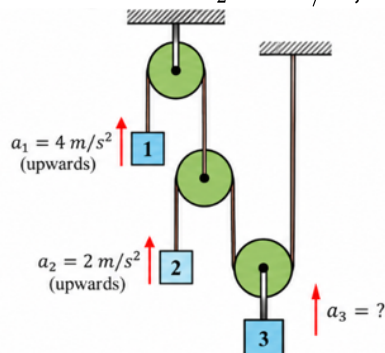
60. In the figure, find the velocity of block B, if the velocity of block A is V_0 in the downward direction and the string makes an angle of 60° with the



horizontal.

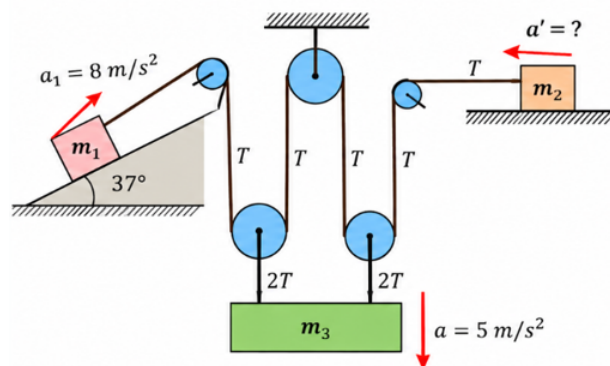
- A) $\frac{V_0}{1 + \cos 60^\circ}$ B) $\frac{V_0}{1 + \sin 60^\circ}$
C) $V_0(1 + \cos 60^\circ)$ D) $\frac{V_0}{\cos 60^\circ}$

61. Find a_3 in the given string-pulley system where the first block moves upwards with acceleration $a_1 = 4m/s^2$, the second block moves upwards with acceleration $a_2 = 2m/s^2$, and the third block has acceleration a_3 .



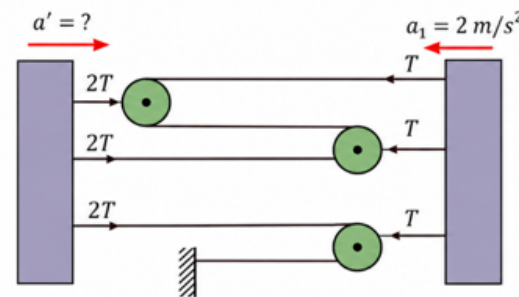
- A) $-2m/s^2$ B) $-3m/s^2$
C) $-4m/s^2$ D) $-6m/s^2$

62. Find the acceleration a' of the block on the horizontal surface in the given pulley system where the bottom platform moves downwards with acceleration $a = 5m/s^2$ and the block on the inclined plane moves upwards with acceleration $a_1 = 8m/s^2$.



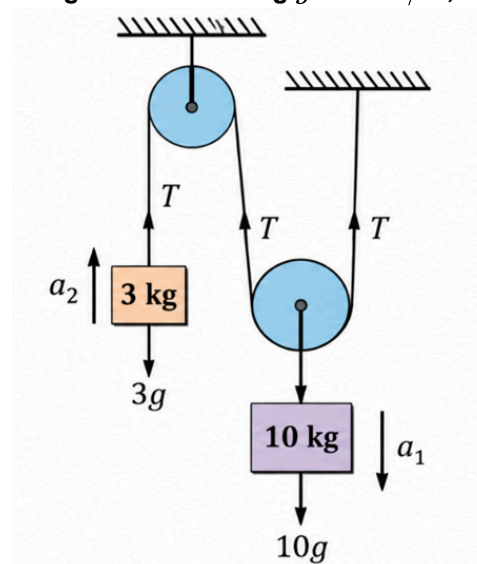
- A) $10m/s^2$ B) $12m/s^2$
C) $14m/s^2$ D) $16m/s^2$

63. In the given string-pulley system, the right block moves horizontally with acceleration $a_1 = 2m/s^2$, the intermediate pulley moves with acceleration $a_2 = 6m/s^2$, and the lower movable pulley moves with acceleration $a_3 = 4m/s^2$. Find the acceleration a' of the left block.



- A) $6m/s^2$ B) $8m/s^2$
C) $10m/s^2$ D) $12m/s^2$

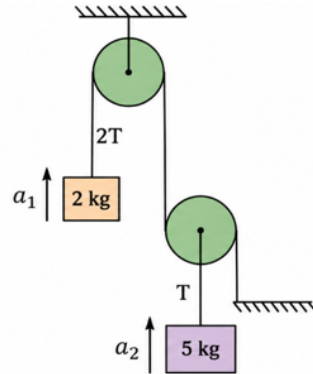
64. A pulley system contains a 3kg block and a 10kg block as shown in the given arrangement. The pulley and string are ideal. Taking $g = 10m/s^2$,



find the acceleration of each block.

- A) $a_1 = \frac{20}{11} m/s^2$, $a_2 = \frac{40}{11} m/s^2$ B) $a_1 = \frac{10}{11} m/s^2$, $a_2 = \frac{20}{11} m/s^2$
C) $a_1 = \frac{40}{11} m/s^2$, $a_2 = \frac{20}{11} m/s^2$ D) $a_1 = \frac{20}{11} m/s^2$, $a_2 = \frac{20}{11} m/s^2$

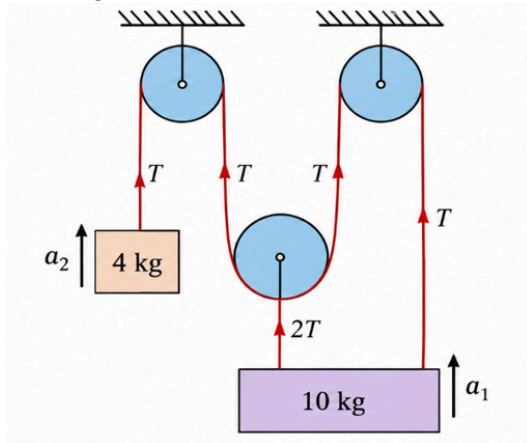
65. A pulley system contains a 2kg block and a 5kg block as shown in the same arrangement. The pulleys and strings are ideal. Taking $g = 10\text{m/s}^2$,



find the acceleration of each block.

- A) $a_1 = \frac{40}{11}\text{m/s}^2$, $a_2 = -\frac{80}{11}\text{m/s}^2$ B) $a_1 = \frac{20}{11}\text{m/s}^2$, $a_2 = -\frac{40}{11}\text{m/s}^2$
 C) $a_1 = \frac{80}{11}\text{m/s}^2$, $a_2 = -\frac{40}{11}\text{m/s}^2$ D) $a_1 = \frac{40}{11}\text{m/s}^2$, $a_2 = -\frac{40}{11}\text{m/s}^2$

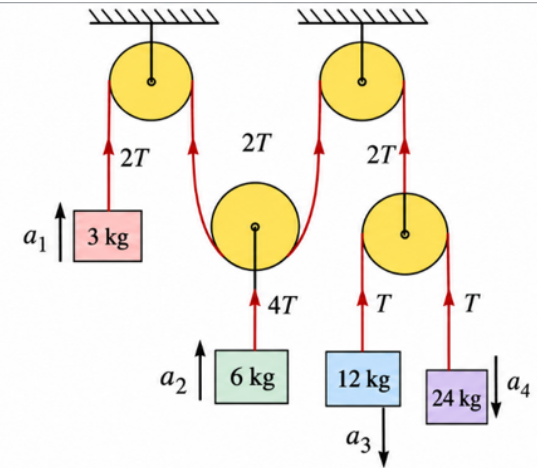
66. Find the acceleration of each block in the given pulley system containing a 4kg block and a 10kg block. The pulleys and strings are ideal. Take



$g = 10\text{m/s}^2$.

- A) $a_1 = \frac{10}{23}\text{m/s}^2$, $a_2 = -\frac{30}{23}\text{m/s}^2$ B) $a_1 = \frac{15}{23}\text{m/s}^2$, $a_2 = -\frac{45}{23}\text{m/s}^2$
 C) $a_1 = \frac{10}{23}\text{m/s}^2$, $a_2 = -\frac{20}{23}\text{m/s}^2$ D) $a_1 = \frac{20}{23}\text{m/s}^2$, $a_2 = -\frac{30}{23}\text{m/s}^2$

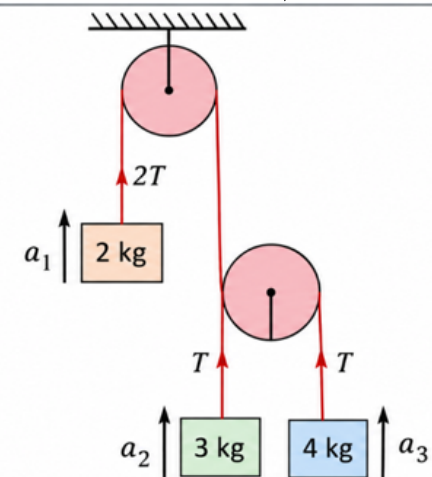
67. Find the acceleration of each block in the given pulley system containing blocks of masses 3kg, 6kg, 12kg, and 24kg, taking $g = 10\text{m/s}^2$. Assume



ideal pulleys and strings.

- A) $a_1 = \frac{290}{99}\text{m/s}^2$, $a_2 = \frac{290}{99}\text{m/s}^2$, $a_3 = \frac{830}{99}\text{m/s}^2$, $a_4 = \frac{1950}{99}\text{m/s}^2$
 B) $a_1 = \frac{830}{99}\text{m/s}^2$, $a_2 = \frac{1950}{99}\text{m/s}^2$, $a_3 = -\frac{4}{99}\text{m/s}^2$, $a_4 = -\frac{1950}{99}\text{m/s}^2$
 C) $a_1 = \frac{580}{99}\text{m/s}^2$, $a_2 = \frac{580}{99}\text{m/s}^2$, $a_3 = \frac{1680}{99}\text{m/s}^2$, $a_4 = \frac{580}{99}\text{m/s}^2$
 D) $a_1 = \frac{1680}{99}\text{m/s}^2$, $a_2 = \frac{580}{99}\text{m/s}^2$, $a_3 = -\frac{8}{99}\text{m/s}^2$, $a_4 = -\frac{1680}{99}\text{m/s}^2$

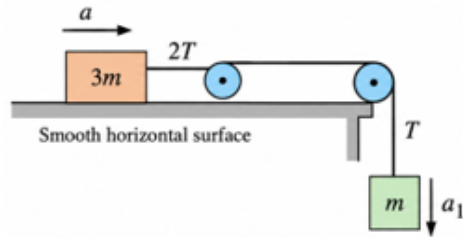
68. Find the acceleration of each block in the given pulley system containing blocks of masses 2kg, 3kg, and 4kg, taking $g = 10\text{m/s}^2$. Assume the



pulleys and strings are ideal.

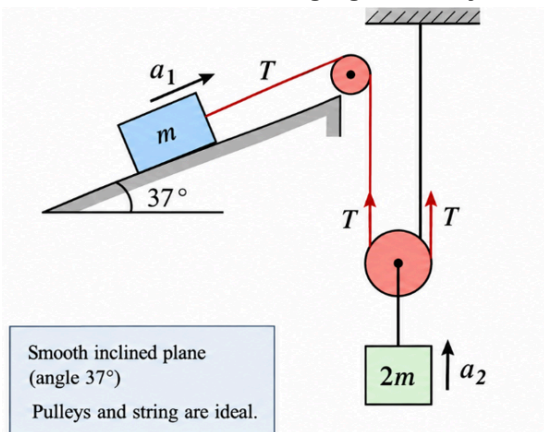
- A) $a_1 = \frac{170}{31}\text{m/s}^2$, $a_2 = -\frac{150}{31}\text{m/s}^2$, $a_3 = -\frac{1500}{331}\text{m/s}^2$
 B) $a_1 = \frac{1500}{331}\text{m/s}^2$, $a_2 = -\frac{170}{31}\text{m/s}^2$, $a_3 = -\frac{1500}{331}\text{m/s}^2$
 C) $a_1 = \frac{170}{31}\text{m/s}^2$, $a_2 = -\frac{300}{31}\text{m/s}^2$, $a_3 = \frac{3400}{331}\text{m/s}^2$
 D) $a_1 = \frac{3400}{331}\text{m/s}^2$, $a_2 = -\frac{150}{31}\text{m/s}^2$, $a_3 = -\frac{1500}{331}\text{m/s}^2$

69. Find the acceleration of the hanging mass m in the given string-pulley system, where a block of mass $3m$ rests on a smooth horizontal surface and block m hangs vertically. The pulleys and string are ideal.



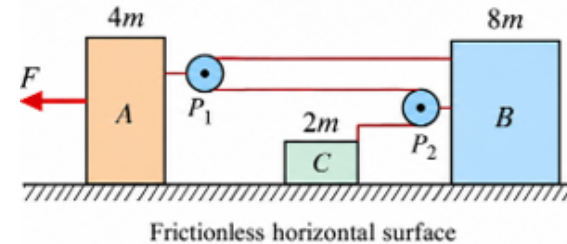
- A) $\frac{2g}{7}$
 B) $\frac{4g}{7}$
 C) $\frac{3g}{7}$
 D) $\frac{5g}{7}$

70. Find the acceleration of both blocks in the given string-pulley system, where a block of mass m is on a smooth inclined plane of angle 37° and a block of mass $2m$ is hanging vertically. Take $\sin 37^\circ = \frac{3}{5}$.

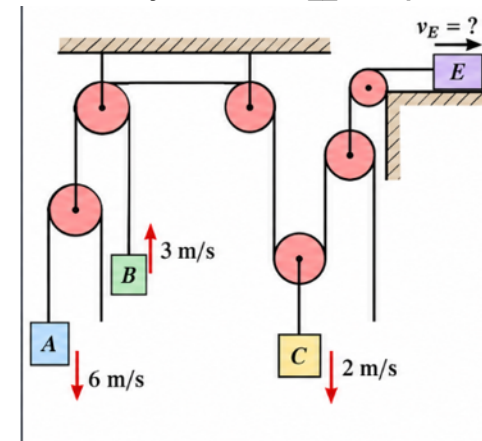


- A) $a_1 = \frac{4g}{15}$, $a_2 = -\frac{2g}{15}$
 B) $a_1 = \frac{2g}{15}$, $a_2 = -\frac{g}{15}$
 C) $a_1 = \frac{g}{5}$, $a_2 = -\frac{g}{10}$
 D) $a_1 = \frac{2g}{5}$, $a_2 = -\frac{g}{5}$

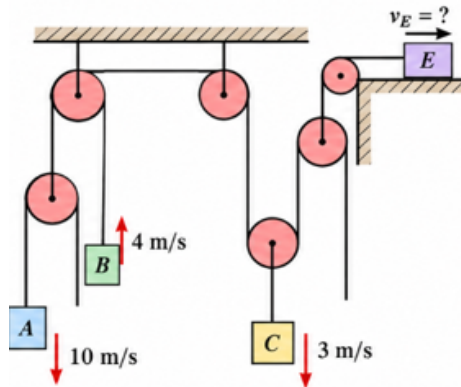
71. In the same pulley arrangement, block A has mass $4m$, block B has mass $8m$, and block C has mass $2m$. If a horizontal force F acts on block A toward the left and all surfaces are frictionless, find the acceleration of block B will be $\frac{F}{xm}$. Find x value



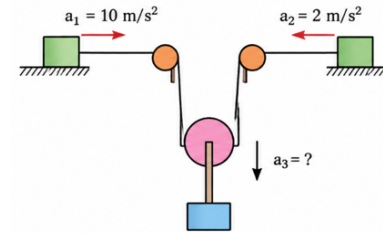
72. In a similar compound string-pulley system, block A moves downward with velocity 6 m/s , block B moves upward with velocity 3 m/s , and block C moves downward with velocity 2 m/s . Taking upward as positive, find the velocity of block E . $___\text{ m/s}$ upwards



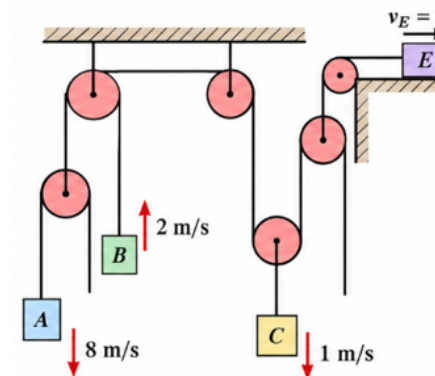
73. In another similar compound string-pulley system, block A moves downward with velocity 10m/s , block B moves upward with velocity 4m/s , and block C moves downward with velocity 3m/s . Taking upward as positive, find the velocity of block E . ___m/s upwards



74. Find the acceleration a_3 of the bottom movable pulley in the given pulley system, where the acceleration of the first block is $a_1 = 10\text{m/s}^2$ to the right and the acceleration of the second block is $a_2 = 2\text{m/s}^2$ to the left. The bottom pulley moves vertically downward. ___ $x\text{m/s}^2$ Find x value



75. In a compound string-pulley system, take upward velocity as positive. Block A moves downward with velocity 8m/s , block B moves upward with velocity 2m/s , and block C moves downward with velocity 1m/s . Find the velocity of block E . ___m/s Upwards



ANSWER KEY

Chemistry

1.	4	8.	1	15.	4	22.	11
2.	3	9.	2	16.	1	23.	364
3.	2	10.	1	17.	1	24.	1
4.	3	11.	2	18.	1	25.	64
5.	4	12.	3	19.	4		
6.	2	13.	4	20.	1		
7.	3	14.	3	21.	4		

Maths

26.	2	33.	2	40.	1	47.	5
27.	1	34.	1	41.	3	48.	3
28.	1	35.	2	42.	2	49.	8
29.	1	36.	4	43.	4	50.	1
30.	2	37.	1	44.	1		
31.	1	38.	4	45.	3		
32.	1	39.	3	46.	7		

Physics

51.	3	58.	2	65.	1	72.	10
52.	2	59.	2	66.	1	73.	15
53.	2	60.	1	67.	1	74.	6
54.	3	61.	2	68.	1	75.	13
55.	4	62.	3	69.	2		
56.	3	63.	2	70.	1		
57.	3	64.	1	71.	14		

SOLUTIONS

Q1.

Answer: D

Explanation:

At N.T.P., 22400 cc of any gas contains 6.02×10^{23} molecules. Evaluating the number of molecules, total atoms (3 per molecule), and total electrons (22 per molecule) in 1 cc confirms that options A, B, and C are all correct expressions.

Q2.

Answer: C

Explanation:

According to Avogadro's Law, equal volumes of all gases under identical conditions of temperature and pressure contain equal numbers of molecules. Therefore, 2 L of SO_2 contains twice as many molecules as 1 L of O_2 .

Q3.

Answer: B

Explanation:

6.02×10^{24} molecules of CO represent 10 moles (10 g-atoms) of oxygen atoms. Since O_2 is diatomic, 10 g-atoms of oxygen equal 5 g-molecules of O_2 .

Q4.

Answer: C

Explanation:

The formula mass of N_3^- is 42 g mol^{-1} , so 4.2 g contains 0.1 mol of ions. Each N_3^- ion has 16 valence electrons ($3 \times 5 + 1$), giving $0.1 \times 16N_A = 1.6N_A$ total valence electrons.

Q5.

Answer: D

Explanation:

4.25 g of NH_3 corresponds to 0.25 mol of NH_3 molecules (1.5×10^{23} molecules). Since each NH_3 molecule has 4 atoms, the total number of atoms is $4 \times 1.505 \times 10^{23} \approx 6.023 \times 10^{23}$.

Q6.

Answer: B

Q7.

Answer: C

Q8.

Answer: A

Q9.

Answer: B

Q10.

Answer: A

Q11.

Answer: B

Explanation:

Number of atoms equals Moles $\times N_A \times$ Atomicity. For 0.1 mol of a triatomic gas, Atoms = $0.1 \times 6.023 \times 10^{23} \times 3 = 1.806 \times 10^{23}$.

Q12.

Answer: C

Explanation:

Comparing mole quantities: 44 g $CO_2 = 1$ mol, 48 g $O_3 = 1$ mol, 64 g $SO_2 = 1$ mol, whereas 8 g $H_2 = 4$ mol ($4N_A$ molecules), which is maximum.

Q13.

Answer: D

Explanation:

6.02×10^{20} molecules equal 10^{-3} moles. Dividing by volume in litres (0.1 L) yields a molarity of $\frac{10^{-3}}{0.1} = 0.01 \text{ M}$.

Q14.

Answer: C

Explanation:

By Avogadro's hypothesis, gas volume ratios equal mole ratios. For equal mass w , mole ratio is $\frac{w}{2} : \frac{w}{32} : \frac{w}{16}$, which simplifies to 16 : 1 : 2.

Q15.

Answer: D

Explanation:

Moles of $H_2 = \frac{1}{2}$ and moles of $O_2 = \frac{4}{32} = \frac{1}{8}$. The molar ratio
 $n_{H_2} : n_{O_2} = \frac{1}{2} : \frac{1}{8} = 4 : 1$.

Q16.

Answer: A

Explanation:

Setting up molar mass equations $x + 2y = 100$ and $3x + 2y = 180$ gives
 $2x = 80 \implies x = 40$ and $y = 30$.

Q17.

Answer: A

Explanation:

18 mL of water has a mass of 18 g (density = 1 g/mL), representing 1 mol ($1N_A$ molecules), which is larger than options B ($10^{-2}N_A$), C ($10^{-4}N_A$), and D ($10^{-3}N_A$).

Q18.

Answer: A

Explanation:

4 mol of He contains $4N_A$ atoms. By comparison, 4 u equals 1 atom, 4 g equals $1N_A$ atoms, and 2.271098 L equals $0.1N_A$ atoms.

Q19.

Answer: D

Explanation:

Hydrated oxalic acid ($H_2C_2O_4 \cdot 2H_2O$) has a molar mass of 126 g mol^{-1} . Dissolving 3.15 g (0.025 mol) in 250 mL yields 0.1 M solution, making R the factual explanation for A.

Q20.

Answer: A

Explanation:

16 g $CH_4 = 1 \text{ mol}$ ($60.2 \times 10^{23} \text{ e}^-$). 1 g $H_2 = 0.5 \text{ mol}$ (11.4 L at STP).
1 mol $N_2 = 28 \text{ g}$. 0.5 mol $SO_2 = 32 \text{ g}$.

Q21.

Answer: 4

Explanation:

The mass of iron in one molecule of haemoglobin is $\frac{0.334}{100} \times 67200 = 224.45 \text{ amu}$.
Dividing by the atomic weight of iron (56) gives approximately 4 iron atoms.

Q22.

Answer: 11

Explanation:

Calculating the mass of 1 L solution from density and multiplying by 70% purity gives 1078 g of pure H_3PO_4 . Dividing by its molar mass (98 g mol^{-1}) yields 11 moles in 1 L, which equals 11 M.

Q23.

Answer: 364

Explanation:

In 1000 mL of solution (mass 1000 g), 3 moles of NaCl weigh 175.5 g. The mass of solvent is 824.5 g, giving a molality of $\frac{3}{0.8245} \approx 3.64 \text{ m} = 364 \times 10^{-2} \text{ m}$.

Q24.

Answer: 1

Explanation:

100 mL of 0.1 M H_2SO_4 provides 20 meq. 50 mL of 0.1 M $NaOH$ provides 5 meq.
Remaining H_2SO_4 is 15 meq in 150 mL, giving $0.1 \text{ N} = 1 \times 10^{-1} \text{ N}$.

Q25.

Answer: 64

Explanation:

100 molal solution has 100 moles solute in 1000 g (55.55 moles) water. Mole fraction
 $\chi = \frac{100}{100+55.55} = 0.643 = 64.3 \times 10^{-2} \approx 64 \times 10^{-2}$.

Q26.

Answer: B

Explanation:

Multiply the numerator and denominator by the conjugate $\sqrt{1 + \sin x} + \sqrt{1 - \sin x}$ and apply the standard limit $\lim_{x \rightarrow 0} \frac{\sin x}{x} = 1$.

Q27.

Answer: A

Explanation:

Substitute the Maclaurin series expansion of $\sin x = x - \frac{x^3}{6} + \frac{x^5}{120} - \dots$ into the limit.

Q28.

Answer: A

Explanation:

Combine the terms into a single fraction and substitute the Maclaurin series for $\log(1+x)$.

Q29.

Answer: A

Explanation:

Factor out $\tan x$ to write the expression as $\frac{\tan x}{x} \cdot \frac{1-\cos x}{x^2}$.

Q30.

Answer: B

Explanation:

Divide both numerator and denominator by x and evaluate the standard limits.

Q31.

Answer: A

Explanation:

Split the limit into $\frac{e^{x^2}-1}{x^2} + \frac{1-\cos x}{x^2}$ and evaluate each term.

Q32.

Answer: A

Explanation:

Use $1 - \cos 2x = 2 \sin^2 x$ to simplify the numerator to $|\sin x|$.

Q33.

Answer: B

Explanation:

Factor out 5^n from inside the n -th root expression.

Q34.

Answer: A

Explanation:

Substitute $t = 1/x$ as $x \rightarrow \infty$ and use the Maclaurin expansion of $\sin t$.

Q35.

Answer: B

Explanation:

Divide the terms inside the radical by x and use the squeeze theorem for $\frac{\sin x}{x}$ and $\frac{\cos x}{x}$.

Q36.

Answer: D

Explanation:

The limit has 1^∞ indeterminate form and evaluates to $(abc)^{2/3}$.

Q37.

Answer: A

Explanation:

Use the 1^∞ formula $e^{\lim_{x \rightarrow 0} \frac{1}{x^2} \left(\frac{1+5x^2}{1+3x^2} - 1 \right)}$.

Q38.

Answer: D

Explanation:

Expand xe^x and $\log(1+x)$ up to x^2 terms.

Q39.

Answer: C

Explanation:

Expand $\tan 2x$, $\tan x$, and $1 - \cos 2x$ up to dominant powers of x .

Q40.

Answer: A

Explanation:

Use $1 - \cos 2x = 2 \sin^2 x$ and apply standard trigonometric limits.

Q41.

Answer: C

Explanation:

Replace each standard function near 0 with its asymptotic linear approximation.

Q42.

Answer: B

Explanation:

Apply 1^∞ limit formula $e^{\lim_{x \rightarrow \infty} 2x(a/x + b/x^2)} = e^{2a}$ to find $a = 1$.

Q43.

Answer: D

Explanation:

Factor numerator as $(3^x - 1)^2(3^x + 1)$ and rationalize denominator.

Q44.

Answer: A

Explanation:

Use partial fractions $\frac{1}{(2r-1)(2r+1)} = \frac{1}{2} \left(\frac{1}{2r-1} - \frac{1}{2r+1} \right)$ to sum telescoping series.

Q45.

Answer: C

Explanation:

Combine terms into one fraction and set coefficients of x^2 and x in numerator to 0.

Q46.

Answer: 7

Explanation:

Use Taylor expansion of numerator and denominator near $x = 0$ to find $\gamma = 1, \beta = 2, \alpha = -4$.

Q47.

Answer: 5

Explanation:

Expand numerator using Taylor series up to x^2 to determine $\alpha = 1$ and $\beta = -3$.

Q48.

Answer: 3

Explanation:

Expand numerator up to x^3 and solve linear equations for α, β, γ .

Q49.

Answer: 8

Explanation:

Factor numerator as $\left(1 - \cos \frac{x^2}{2}\right) \left(1 - \cos \frac{x^2}{4}\right)$ and expand.

Q50.

Answer: 1

Explanation:

Use $\cos\left(\frac{x}{m}\right) = 1 - \frac{x^2}{2m^2} + \dots$ in 1^∞ limit form.

Q51.

Answer: C

Explanation:

For an inextensible rope, the total change in rope length is zero. The two horizontal portions decrease due to the motion of the blocks, while the two vertical portions increase due to the downward motion of the movable pulley. Therefore, $-a_1 - a_2 + 2a_3 = 0$ $2a_3 = a_1 + a_2$
 $a_3 = \frac{8+4}{2} = 6m/s^2$

Q52.

Answer: B

Explanation:

For the inextensible string, $-a_1 + a_2 + 2a' = 0$ Substituting, $-4 + 10 + 2a' = 0$
 $2a' = -6$ Thus, the central pulley accelerates upwards with magnitude $a' = 3m/s^2$

Q53.

Answer: B

Explanation:

For the movable pulley, the acceleration constraint is $2Ta' = Ta$ Therefore, $2a' = a$
 $a' = \frac{a}{2}$ $a' = \frac{6}{2} = 3m/s^2$

Q54.

Answer: C

Explanation:

For the movable pulley, the displacement of block 1 is twice the displacement of block 2.

$$\text{Therefore, } a_1 = 2a_2 \quad a_2 = \frac{a_1}{2} \quad a_2 = \frac{6}{2} = 3m/s^2$$

Q55.

Answer: D

Explanation:

Taking downward direction as positive, the string constraint is $-a_1 - 2a_2 + 2a_3 + a' = 0$

Substituting the values, $-4 - 2(2) + 2(6) + a' = 0 \Rightarrow -4 - 4 + 12 + a' = 0$

$a' = -4m/s^2$ The negative sign means the third/right block moves upwards. Thus,

$$|a'| = 4m/s^2$$

Q56.

Answer: C

Explanation:

The movable pulley and the green platform move together. Therefore, three segments of the string change their lengths due to the downward motion of the platform. Hence,

$$a_1 = 3a' \quad a' = \frac{a_1}{3} \quad a' = \frac{9}{3} = 3m/s^2$$

Q57.

Answer: C

Explanation:

For the given string-pulley arrangement, the acceleration constraint is $2a_1 + a_2 + 3a_3 = 0$

Substituting the values, $2(3) + 6 + 3a_3 = 0 \Rightarrow 12 + 3a_3 = 0 \Rightarrow a_3 = -4m/s^2$

Q58.

Answer: B

Explanation:

Using the string constraint, the component of a_1 along the inclined string equals a_2 .

$$a_2 = a_1 \cos 37^\circ \quad \text{Using } \cos 37^\circ = \frac{4}{5}, \quad a_2 = 15 \times \frac{4}{5} = 12m/s^2$$

Q59.

Answer: B

Explanation:

The acceleration of the hanging block is the component of the ring's acceleration along the string.

$$a_2 = a_1 \cos 37^\circ \quad \text{Using } \cos 37^\circ = \frac{4}{5}, \quad a_2 = 15 \times \frac{4}{5} = 12m/s^2$$

Q60.

Answer: A

Explanation:

Using the constant-length condition of the string, $V_0 = V_B + V_B \cos 60^\circ$ Therefore,

$$V_B = \frac{V_0}{1 + \cos 60^\circ}$$

Q61.

Answer: B

Explanation:

For the given arrangement, the string-length constraint is $a_1 + a_2 + 2a_3 = 0$ Substituting,

$$4 + 2 + 2a_3 = 0 \Rightarrow 2a_3 = -6 \Rightarrow a_3 = -3m/s^2$$

Q62.

Answer: C

Explanation:

The platform is connected to four variable string segments. Therefore, $4a = a_1 + a'$

$$\text{Hence, } a' = 4a - a_1 \quad a' = 4(5) - 8 \Rightarrow a' = 12m/s^2$$

Q63.

Answer: B

Explanation:

Using the string-length constraints successively, $2a_3 = a'$ and $2a_2 = a' + a_p$ where a_p is the acceleration of the upper-left movable pulley. For the upper string, $a_1 + a_2 = 2a_p$

$$\text{Substituting the given values gives } a' = 8m/s^2$$

Q64.

Answer: A

Explanation:

For the movable pulley, $a_2 = 2a_1$ For the 10kg block: $100 - 2T = 10a_1$ For the 3kg block: $T - 30 = 3a_2$ Using $a_2 = 2a_1$: $T - 30 = 6a_1$ Hence, $100 - 2(30 + 6a_1) = 10a_1$ $40 = 22a_1$ Therefore, $a_1 = \frac{20}{11} \text{m/s}^2$ and $a_2 = 2a_1 = \frac{40}{11} \text{m/s}^2$.

Q65.

Answer: A

Explanation:

The string constraints give $a_2 = -2a_1$ For the 2kg block: $2T - 20 = 2a_1$ For the 5kg block: $T - 50 = 5a_2$ Using $a_2 = -2a_1$: $T = 50 - 10a_1$ Therefore, $2(50 - 10a_1) - 20 = 2a_1$ $80 = 22a_1$ Hence, $a_1 = \frac{40}{11} \text{m/s}^2$ and $a_2 = -\frac{80}{11} \text{m/s}^2$.

Q66.

Answer: A

Explanation:

From the string-length constraint, $a_2 = -3a_1$ For the 4kg block: $T - 40 = 4a_2$ For the 10kg block: $3T - 100 = 10a_1$ Using $a_2 = -3a_1$, $T - 40 = -12a_1$ $T = 40 - 12a_1$ Therefore, $3(40 - 12a_1) - 100 = 10a_1$ $20 = 46a_1$ Hence, $a_1 = \frac{10}{23} \text{m/s}^2$ and $a_2 = -\frac{30}{23} \text{m/s}^2$.

Q67.

Answer: A

Explanation:

Since all four masses are scaled by the same factor compared with the standard 2 : 4 : 8 : 16 system, the acceleration values remain unchanged. For the 3kg block: $2T - 30 = 3a_1$ For the 6kg block: $4T - 60 = 6a_2$ For the 12kg block: $T - 120 = 12a_3$ For the 24kg block: $T - 240 = 24a_4$ The pulley constraints give the corresponding acceleration relations. Solving simultaneously gives $T = \frac{640}{33} \text{N}$ and therefore $a_1 = a_2 = \frac{290}{99} \text{m/s}^2$ $a_3 = -\frac{830}{99} \text{m/s}^2$ $a_4 = -\frac{910}{99} \text{m/s}^2$

Q68.

Answer: A

Explanation:

For the 2kg block: $2T - 20 = 2a_1$ For the 3kg block: $T - 30 = 3a_2$ For the 4kg block: $T - 40 = 4a_3$ The string constraints give $a_2 + a_3 = -2a_1$ Solving, $T = \frac{480}{31} \text{N}$ Therefore, $a_1 = \frac{170}{31} \text{m/s}^2$ $a_2 = -\frac{150}{31} \text{m/s}^2$ $a_3 = -\frac{190}{31} \text{m/s}^2$

Q69.

Answer: B

Explanation:

For the horizontal block: $3ma = 2T$ For the hanging block: $mg - T = ma_1$ The string constraint gives: $a_1 = 2a$ Thus, $mg - T = 6T/3 = 2T$ $mg = 3T$ $T = \frac{mg}{3}$ Therefore, $a_1 = \frac{2T}{3m} \times 2 = \frac{4g}{7}$

Q70.

Answer: A

Explanation:

For the m block: $T - mg \sin 37^\circ = ma_1$ $T - \frac{3mg}{5} = ma_1$ For the $2m$ block: $2T - 2mg = 2ma_2$ $T - mg = ma_2$ The string constraint is $a_1 + 2a_2 = 0$ Therefore, $a_1 = \frac{4g}{15}$, $a_2 = -\frac{2g}{15}$

Q71.

Answer: 14

Explanation:

The mass ratio remains $4m : 8m : 2m = 2 : 4 : 1$ compared with the original system. Since all masses are doubled while F remains unchanged, the acceleration is halved: $a_B = \frac{1}{2} \left(\frac{F}{7m} \right)$ Therefore, $a_B = \frac{F}{14m}$

Q72.

Answer: 10

Explanation:

$v_A = -6$, $v_B = 3$, $v_C = -2$ First string: $v_A + 2v_P = 0 \Rightarrow v_P = 3 \text{m/s}$ Second string: $v_B + v_Q - 2v_P = 0 \Rightarrow v_Q = 3 \text{m/s}$ Third string: $v_C + v_E - 2v_Q = 0 \Rightarrow v_E = 8 \text{m/s}$. Therefore, $v_E = 8 \text{m/s}$ upward.

Q73.

Answer: 15

Explanation:

$v_A = -10$, $v_B = 4$, $v_C = -3$ First string: $v_A + 2v_P = 0 \Rightarrow v_P = 5\text{m/s}$ Second string: $v_B + v_Q - 2v_P = 0 \Rightarrow v_Q = 6\text{m/s}$ Third string: $v_C + v_E - 2v_Q = 0 \Rightarrow v_E = 15\text{m/s}$. Hence, $v_E = 15\text{m/s}$ upward.

Q74.

Answer: 6

Explanation:

Using the constant-length condition of the rope, $-a_1 - a_2 + 2a_3 = 0$ Therefore,
 $a_3 = \frac{a_1+a_2}{2}$ $a_3 = \frac{10+2}{2} = 6\text{m/s}^2$

Q75.

Answer: 13

Explanation:

Take upward as positive: $v_A = -8$, $v_B = +2$, $v_C = -1$ For the three strings:
 $v_A + 2v_P = 0$ $v_B + v_Q - 2v_P = 0$ $v_C + v_E - 2v_Q = 0$ Thus, $v_P = 4\text{m/s}$,
 $v_Q = 6\text{m/s}$, and $v_E = 13\text{m/s}$ upward.