1. $v = 3+2t$

$dx = vdt \Rightarrow dx = (3+2t)dt$

$$\int dx = \int (3+2t)dt$$

$$x_f - x_i = \left[3t + \frac{2t^2}{2}\right]_0^3$$

$s = (3 \times 3 + 3^2) - 0 \Rightarrow s = 18$ m

3. Power of exponential is dimensionless,

$2Ct = M^0L^0T^0 \Rightarrow CT^1 = M^0L^0T^0 \Rightarrow C = M^0L^0T^{-1}$

$$\text{and } \frac{dv}{v^{3/2}} = BC \Rightarrow \frac{\left[L^1T^{-1}\right]}{\left[L^1T^{-1}\right]^{3/2}} = B\left[M^0L^0T^{-1}\right]$$

$$B = \left[L^{-\frac{1}{2}}T^{\frac{3}{2}}\right]$$

4. $$\vec{v} = \vec{u} + \vec{a}t = \left(4\hat{i} - 5\hat{j}\right) + \left[\frac{1}{4}\hat{i} + \frac{1}{5}\hat{j}\right] \times 2$$

$$= \left(4 + \frac{1}{2}\right)\hat{i} + \left[-5 + \frac{2}{5}\right]\hat{j} = 4.5\hat{i} - 4.6\hat{j} \text{ m/s}$$

5. $$\left|\vec{F}_1\right| = \left|\vec{F}_2\right| = \left|\vec{F}\right|, \left|\vec{R}\right| = F \Rightarrow F^2 = F^2 + F^2 + 2F^2\cos\theta$$

$$\cos\theta = -\frac{1}{2} \Rightarrow \theta = 120^\circ$$

6. $$v = \alpha\sqrt{x} \Rightarrow \frac{dx}{dt} = \alpha\sqrt{x} \Rightarrow \int_0^x \frac{dx}{\sqrt{x}} = \int_0^t \alpha dt$$

$$x = \frac{\alpha^2}{4}t^2 \Rightarrow x \propto t^2$$

7. $$\frac{dv}{dt} = -\alpha v^3 \Rightarrow \int_u^v \frac{dv}{v^3} = -\int_u^v \alpha t$$

$$\Rightarrow -\frac{1}{2v^2}\Big|_u^v = -\alpha t \int_0^t \frac{1}{2v^2} - \frac{1}{2u^2} = \alpha t$$

$$\Rightarrow \frac{1}{v^2} = \frac{1}{u^2} + 2\alpha t \Rightarrow \frac{1}{v^2} = \frac{1+2u^2\alpha t}{u^2}$$

$$\Rightarrow v = \frac{u}{\sqrt{1+2u^2\alpha t}}$$

8. $y = 8t - 5t^2$ $\quad y = 0$ $\quad t = 8/5$ s

$$x = 6 \times \frac{8}{5} = \frac{48}{5} = 9.6\text{m}$$

9. Projection of $\vec{b}$ on $\vec{a} = (\vec{b}.\hat{a})\hat{a}$

$$= \left[\left(2\hat{i} + \hat{j} + 2\hat{k}\right) \cdot \frac{\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)}{3}\right] \frac{\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)}{3}$$

$$= \frac{8}{9}\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)$$

10. Velocity of two boys is different and constant, so relative velocity is non zero and constant.

12. $E = hv$

$ML^2T^{-2} = hT^{-1} \Rightarrow h = [ML^2T^{-1}]$

13. For maximum range $\theta = 45°$

$$R = X = \frac{u^2}{g} \Rightarrow H = \frac{u^2\sin^2 45^\circ}{2g} = \frac{u^2}{4g} = \frac{X}{4}$$

14. Area under a - t graph gives the change in velocity.

15. Both objects are achieving same vertical heights, so both have equal vertical components of velocities. Also both will have equal time of flights $\left(T = \frac{2u\sin\theta}{g}\right)$. As horizontal range of second projectile is more it will have more horizontal component of velocity although flight time is same.

So $T_1 = T_2$ and $u_2 > u_1$

$P_2 = (I_1)^2 \times R = (2)^2 \times (2) = 8$ W

16. $$V_{av} = \frac{50}{4} = 12.5\text{m/s}$$

17. $v = 12 - 3t^2$ $\quad$ when $v = 0$

$0 = 12 - 3t^2 \Rightarrow t = 2\text{s}$

$a = -6t \Rightarrow |a| = 6 \times 2 = 12\text{m/s}^2$

18. A ball thrown under gravity if crosses at time t_1 and t_2 from a certain point at height h, then sum of these times is equal to its flight time.

$T = t_1 + t_2 = 6 + 10 = 16\,sec$

$T = \frac{2u}{g} \quad \therefore u = \frac{gT}{2} = \frac{10\times16}{2} = 80\,m/s$

20. The time taken to cross by the quickest path

$t_1 = \frac{d}{v} = \frac{d}{13}$

The time to cross by shortest path

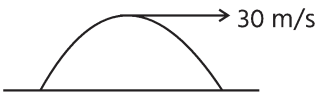
$t_2 = \frac{d}{\sqrt{v_{Boat}^2 - u_{water}^2}} = \frac{d}{\sqrt{13^2 - 5^2}}$

$t_2 = \frac{d}{12}$

$\therefore$ From (1) & (2)

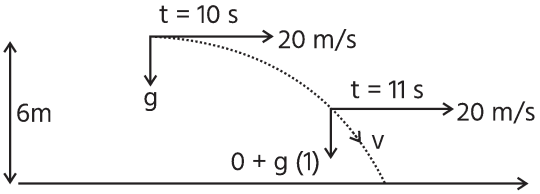
$t_2 - t_1 = 2 \Rightarrow \frac{d}{12} - \frac{d}{13} = 2 \Rightarrow \frac{d}{12\times13} = 2$

$\Rightarrow d = 312m$

21. 

After 4 second under gravity vertical component of velocity becomes zero.

So velocity is $a\vec{v} = 30\hat{j} and \vec{a} = -g\hat{j}$ so angle between $\vec{v} and \vec{a}$ is 90°.

22. 

After 10 second velocity of truck =at

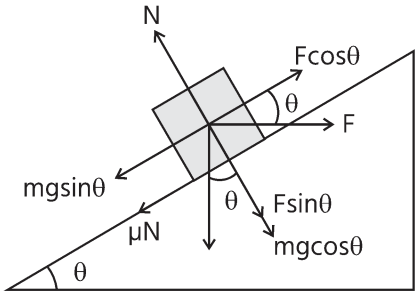
$= 2\times10 = 20m/s$

$v = \sqrt{(20)^2 + (10)^2} \Rightarrow v = 10\sqrt{5}m/s$

23. Argument of trigonometric ratio is dimensionless therefore $\beta t^2 = M^0L^0T^0 \Rightarrow \beta = [M^0L^0T^{-2}]$

and $F = \frac{V_0}{\beta} \Rightarrow M^1L^1T^{-2} = \frac{V_0}{M^0L^0T^{-2}}$

$V_0 = M^1L^1T^{-2}M^0L^0T^{-2} = [M^1L^1T^{-4}]$

24. 

Block begins to slide when

$F\cos\theta = mg\sin\theta + \mu N$

$F\cos\theta = mg\sin\theta + \mu(mg\cos\theta + F\sin\theta)$

$F(\cos\theta - \sin\theta) = mg(\sin\theta + \mu\cos\theta)$

$F = \frac{mg(\sin\theta + \mu\cos\theta)}{(\cos\theta - \mu\sin\theta)}$

25. $mg - \frac{mg}{2} = ma \Rightarrow a = \frac{g}{2}\downarrow$

26. $9VSD = 6MSD \Rightarrow 1VSD = \frac{2}{3}MSD$

$\Rightarrow 1VSD = \frac{2}{3}(0.01mm)$

and L.C. = 1 MSD – 1VSD

$\Rightarrow L.C. = 0.01mm - \frac{2}{3}(0.01)mm$

$= \frac{0.01}{3}mm = 0.0033mm$

27. $\left(\frac{\Delta Q}{Q}\right)\times100 = \left(2 + \frac{1}{2}\times3 + \frac{3}{2}\times1 + 4\times\frac{1}{2}\right)\%$

$= \left(2 + \frac{3}{2} + \frac{3}{2} + 2\right)\% = 7\%$

28. Spring force will not change its value instantly after any disturbance.

$2mg - mg = ma \Rightarrow a = g$

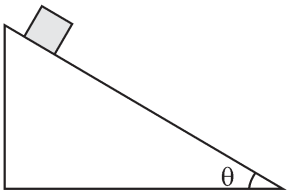
29. $A = \pi r^2 = 3.14 \times (1.2)^2 = 4.5216 cm^2$

Up to correct significant figures A=4.5 cm^2

30. $\rho = \frac{m}{v} = \frac{m}{\frac{4}{3}\pi\left(\frac{d}{2}\right)^3} \Rightarrow \frac{d\rho}{\rho} = \frac{dm}{m} + \frac{3d(d)}{d}$

$\Rightarrow$ maximum % error = 2 + 3 × 3 = 11%

31. $mg = f \Rightarrow w = 0.2 \times 100 = 20$ N

32. 

Acceleration along the plane

a = gsinθ - μxxgcosθ

When velocity is maximum a=0

gsinθ – 0.5 × xgcosθ = 0

$x = \frac{1}{0.5}\frac{\sin\theta}{\cos\theta} \Rightarrow x = 2\tan\theta$

33. $\frac{F}{m+M} = \mu g \qquad F = (m+M)\mu gn$

34. $f_{smax} = \mu_s mg = 0.8 \times 6 \times 10 = 48N$

$F_A = k(2)^2 \Rightarrow F_A = 8N \Rightarrow F_A < f_{smax}$

$f = F_A \Rightarrow f = 8N$

35. $\frac{\Delta x}{x} \times 100\%$

36. $a = g\sin\theta = 10 \times \frac{3}{5} = 6 m/s^2$

37. 

$T - 6 = (1.5)\left(\frac{12-6}{3}\right)$

38. $E \propto M^a A^b V^c \Rightarrow ML^2T^{-2} = KM^a\left(LT^{-2}\right)^b\left(LT^{-1}\right)^c$

a = 1, b + c = 2, –2b – c = –2

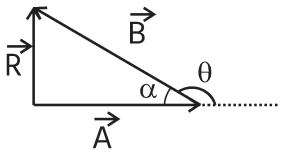
2b + c = 2 $\Rightarrow$ b + c = 2 $\Rightarrow$ b = 0 $\Rightarrow$ c = 2

39. Reading = 1.2 cm + 5 × LC – 0.04 cm

40. $\frac{u}{(g+a)} = \frac{t}{2} \therefore a = \frac{2u}{t} - g$

41. $mg - T = \frac{mg}{4}$

$\Rightarrow T = \frac{3mg}{4} \Rightarrow \frac{T}{mg} = \frac{3}{4}$

42. 

θ = 180 – α

43. Minimum accuracy = 1 MSD – 1 VSD

$= \left(1 - \frac{49}{50}\right)MSD = \frac{1}{50}MSD = \frac{1}{50} \times (0.5mm) = 0.01mm$

44. V=IR

$\therefore$ R% = V% + I%

=4% + 1% = 5%)

45. $F = n\frac{dP}{dt} \Rightarrow F = nmv \Rightarrow n = \frac{F}{mv}$

Answer–Key

1.	3	**2.**	4	**3.**	1	**4.**	2	**5.**	4	**6.**	2	**7.**	3	**8.**	3	**9.**	1	**10.**	4
11.	2	**12.**	4	**13.**	2	**14.**	2	**15.**	2	**16.**	2	**17.**	2	**18.**	3	**19.**	2	**20.**	4
21.	1	**22.**	2	**23.**	3	**24.**	1	**25.**	2	**26.**	3	**27.**	3	**28.**	1	**29.**	4	**30.**	3
31.	1	**32.**	1	**33.**	3	**34.**	1	**35.**	3	**36.**	1	**37.**	4	**38.**	2	**39.**	1	**40.**	3
41.	2	**42.**	2	**43.**	2	**44.**	1	**45.**	3	**46.**	1	**47.**	1	**48.**	4	**49.**	4	**50.**	1
51.	3	**52.**	3	**53.**	4	**54.**	1	**55.**	1	**56.**	4	**57.**	3	**58.**	3	**59.**	4	**60.**	2
61.	3	**62.**	1	**63.**	3	**64.**	3	**65.**	2	**66.**	3	**67.**	4	**68.**	4	**69.**	3	**70.**	4
71.	2	**72.**	4	**73.**	4	**74.**	4	**75.**	2	**76.**	1	**77.**	2	**78.**	4	**79.**	4	**80.**	2
81.	4	**82.**	1	**83.**	4	**84.**	2	**85.**	1	**86.**	4	**87.**	3	**88.**	1	**89.**	2	**90.**	1
91.	4	**92.**	4	**93.**	4	**94.**	1	**95.**	4	**96.**	2	**97.**	4	**98.**	3	**99.**	3	**100.**	3
101.	4	**102.**	4	**103.**	3	**104.**	4	**105.**	3	**106.**	2	**107.**	4	**108.**	3	**109.**	2	**110.**	2
111.	3	**112.**	2	**113.**	4	**114.**	1	**115.**	1	**116.**	1	**117.**	2	**118.**	3	**119.**	4	**120.**	1
121.	3	**122.**	4	**123.**	1	**124.**	1	**125.**	3	**126.**	4	**127.**	4	**128.**	1	**129.**	3	**130.**	3
131.	2	**132.**	3	**133.**	2	**134.**	2	**135.**	4	**136.**	1	**137.**	1	**138.**	4	**139.**	4	**140.**	3
141.	4	**142.**	3	**143.**	4	**144.**	1	**145.**	2	**146.**	4	**147.**	1	**148.**	1	**149.**	2	**150.**	1
151.	3	**152.**	3	**153.**	2	**154.**	2	**155.**	4	**156.**	1	**157.**	1	**158.**	1	**159.**	4	**160.**	4
161.	3	**162.**	1	**163.**	4	**164.**	2	**165.**	2	**166.**	4	**167.**	2	**168.**	2	**169.**	3	**170.**	4
171.	1	**172.**	1	**173.**	4	**174.**	4	**175.**	2	**176.**	2	**177.**	1	**178.**	4	**179.**	2	**180.**	3

1. Velocity of two boys is different and constant, so relative velocity is non zero and constant.

3. $E = hv$

$ML^2T^{-2} = hT^{-1} \Rightarrow h = [ML^2T^{-1}]$

4. $v = 12 - 3t^2$ when $v = 0$

$0 = 12 - 3t^2 \Rightarrow t = 2s$

$a = -6t \Rightarrow |a| = 6 \times 2 = 12 m/s^2$

5. A ball thrown under gravity if crosses at time t_1 and t_2 from a certain point at height h, then sum of these times is equal to its flight time.

$T = t_1 + t_2 = 6 + 10 = 16 sec$

$T = \frac{2u}{g} \quad \therefore u = \frac{gT}{2} = \frac{10 \times 16}{2} = 80 m/s$

7. Power of exponential is dimensionless,

$2Ct = M^0L^0T^0 \Rightarrow CT^1 = M^0L^0T^0 \Rightarrow C = M^0L^0T^{-1}$

$$\text{and } \frac{dv}{v^{3/2}} = BC \Rightarrow \frac{\left[L^1T^{-1}\right]}{\left[L^1T^{-1}\right]^{3/2}} = B\left[M^0L^0T^{-1}\right]$$

$$B = \left[L^{-\frac{1}{2}}T^{\frac{3}{2}}\right]$$

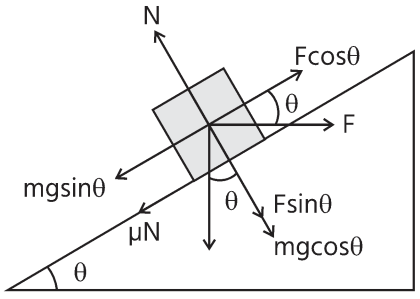
8. $\vec{v} = \vec{u} + \vec{a}t = \left(4\hat{i} - 5\hat{j}\right) + \left[\frac{1}{4}\hat{i} + \frac{1}{5}\hat{j}\right] \times 2$

$= \left(4 + \frac{1}{2}\right)\hat{i} + \left[-5 + \frac{2}{5}\right]\hat{j} = 4.5\hat{i} - 4.6\hat{j} m/s$

9. $\left|\vec{F}_1\right| = \left|\vec{F}_2\right| = \left|\vec{F}\right|, \left|\vec{R}\right| = F \Rightarrow F^2 = F^2 + F^2 + 2F^2\cos\theta$

$\cos\theta = -\frac{1}{2} \Rightarrow \theta = 120^\circ$

10.



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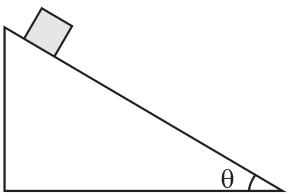

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When velocity is maximum a=0

$g\sin\theta - 0.5 \times xg\cos\theta = 0$

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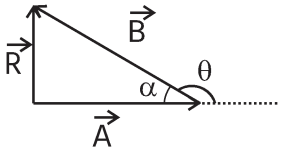
23. 

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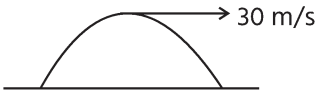
30. 

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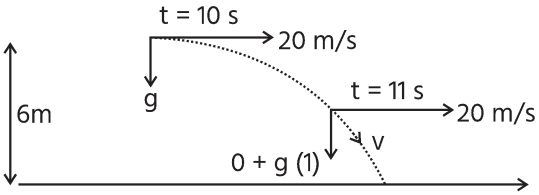
31. 

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$F_A = k(2)^2 \Rightarrow F_A = 8N \Rightarrow F_A < f_{smax}$
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$\therefore$ R% = V% + I%
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$R = X = \frac{u^2}{g}$

$H = \frac{u^2 \sin^2 45^\circ}{2g} = \frac{u^2}{4g} = \frac{X}{4}$

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38. Both objects are achieving same vertical heights, so both have equal vertical components of velocities. Also both will have equal time of flights $\left(T = \frac{2u\sin\theta}{g}\right)$. As horizontal range of second projectile is more it will have more horizontal component of velocity although flight time is same.
So $T_1 = T_2$ and $u_2 > u_1$
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$\Rightarrow \frac{1}{v^2} = \frac{1}{u^2} + 2\alpha t \Rightarrow \frac{1}{v^2} = \frac{1+2u^2\alpha t}{u^2}$

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43. Projection of $\vec{b}$ on $\vec{a} = (\vec{b}.\hat{a})\hat{a}$

$= \left[\left(2\hat{i} + \hat{j} + 2\hat{k}\right) \cdot \frac{\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)}{3}\right] \frac{\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)}{3}$

$= \frac{8}{9}\left(\hat{i} + 2\hat{j} + 2\hat{k}\right)$

44. v = 3+2t
dx=vdt $\Rightarrow$ dx=(3+2t)dt
$\int dx = \int (3 + 2t) dt$

$x_f - x_i = \left[3t + \frac{2t^2}{2}\right]_0^3$

$s = (3 \times 3 + 3^2) - 0 \Rightarrow s = 18$ m

Answer–Key

1.	4	**2.**	2	**3.**	4	**4.**	2	**5.**	3	**6.**	2	**7.**	1	**8.**	2	**9.**	4	**10.**	1
11.	2	**12.**	3	**13.**	1	**14.**	1	**15.**	3	**16.**	2	**17.**	1	**18.**	3	**19.**	3	**20.**	1
21.	4	**22.**	2	**23.**	2	**24.**	2	**25.**	3	**26.**	1	**27.**	4	**28.**	3	**29.**	4	**30.**	1
31.	2	**32.**	3	**33.**	1	**34.**	1	**35.**	3	**36.**	2	**37.**	2	**38.**	2	**39.**	2	**40.**	2
41.	3	**42.**	3	**43.**	1	**44.**	3	**45.**	4	**46.**	4	**47.**	1	**48.**	1	**49.**	3	**50.**	3
51.	2	**52.**	4	**53.**	2	**54.**	4	**55.**	4	**56.**	2	**57.**	4	**58.**	1	**59.**	4	**60.**	3
61.	1	**62.**	4	**63.**	2	**64.**	1	**65.**	2	**66.**	4	**67.**	4	**68.**	3	**69.**	4	**70.**	4
71.	3	**72.**	3	**73.**	4	**74.**	1	**75.**	3	**76.**	3	**77.**	2	**78.**	3	**79.**	1	**80.**	2
81.	1	**82.**	4	**83.**	2	**84.**	1	**85.**	3	**86.**	4	**87.**	1	**88.**	1	**89.**	4	**90.**	4
91.	3	**92.**	4	**93.**	4	**94.**	2	**95.**	4	**96.**	3	**97.**	2	**98.**	4	**99.**	1	**100.**	3
101.	4	**102.**	1	**103.**	4	**104.**	1	**105.**	3	**106.**	2	**107.**	2	**108.**	4	**109.**	1	**110.**	4
111.	2	**112.**	4	**113.**	4	**114.**	4	**115.**	1	**116.**	3	**117.**	4	**118.**	3	**119.**	2	**120.**	3
121.	3	**122.**	4	**123.**	1	**124.**	1	**125.**	1	**126.**	2	**127.**	2	**128.**	2	**129.**	3	**130.**	3
131.	4	**132.**	3	**133.**	4	**134.**	3	**135.**	3	**136.**	4	**137.**	1	**138.**	1	**139.**	4	**140.**	1
141.	1	**142.**	2	**143.**	2	**144.**	4	**145.**	4	**146.**	4	**147.**	2	**148.**	4	**149.**	3	**150.**	4
151.	3	**152.**	2	**153.**	2	**154.**	3	**155.**	1	**156.**	4	**157.**	4	**158.**	1	**159.**	1	**160.**	4
161.	2	**162.**	3	**163.**	2	**164.**	1	**165.**	2	**166.**	2	**167.**	3	**168.**	1	**169.**	4	**170.**	4
171.	2	**172.**	1	**173.**	3	**174.**	3	**175.**	4	**176.**	1	**177.**	2	**178.**	1	**179.**	1	**180.**	4