ANSWER

Exercise - 1

1	B	**2.**	D	**3.**	C
4.	**4.8 Ma²**	**5.**	$1/\sqrt{2}$		
6.	B	**7.**	D	**8.**	D
9.	A	**10.**		**11.**	C
12.	D	**13.**	C	**14.**	C
15.	C	**16.**	D	**17.**	C
18.	C	**19.**	D	**20.**	B
21.	AC	**22.**	D	**23.**	D
24.	C	**25.**	A	**26.**	D
27.	C	**28.**	B	**29.**	C
30.	C	**31.**	D	**32.**	C
33.	A	**34.**	D	**35.**	B
36.	A	**37.**		**38.**	
39.	B	**40.**	D	**41.**	A
42.	B	**43**	D		

Exercise - 2

SECTION (A) :

A 1. 20 s

A 2. (a) $\langle w \rangle = 2a / 3 = 4$ rad/s;

$\langle \beta \rangle = \sqrt{3ab} = 6$ rad/s²;

(b) $\beta = 2\sqrt{3ab} = 12$ rad /s².

A 3. $t = \sqrt[3]{(4/a)\tan\alpha} = 7$ s

SECTION (B) :

B 1. (i) $I = \frac{a\ell^4}{4}$ (ii) $\frac{a\ell^4}{36}$

B 2. 1.5×10^{-3} kg-m³, 4.0×10^{-3} kg-m³

B 3. $\frac{100}{1000}(1^2 + 2^2 + 3^2 + ...) \times 10^{-6} = 0.43$ kg-m²

B 4. $\frac{MR^2}{2} - M\left(\frac{4R}{3\pi}\right)^2$ **B 5.** $\frac{M\ell^2}{3}$

B 6. $\frac{14\, mr^2}{5}$

B 7. $\sqrt{\frac{1}{m}\left(I - \frac{m\ell^2}{12}\right)} = \sqrt{\frac{7}{60}} = 0.34$ m

B 8. (a) $I = (1/2)\,\pi\rho bR^4 = 2.8$ g.m²]

B 9. $I = m(a^2 + b^2)$] **B 10.** $ma^2/12$

B 11. $\sqrt{2}\,r$ **B 12.** $r/\sqrt{2}$

B 13. $\frac{2\rho a^7}{21}$ **B 14.** $\frac{m\ell^2}{6}$

B 15. (a) $2\pi\left(\frac{Aa^4}{4} + \frac{Ba^5}{5}\right)$

B 16. (b) $I = 3/10\, mR^2$

SECTION (C) :

C 1. **N = (aB – bA)k, where k is the unit vector of the z axis** $\ell = |aB - bA|/\sqrt{A^2 + B^2}$

C 2. $\ell = |aB - bA|/\sqrt{A^2 + B^2}$

C 3. $v_2 = v_1 \frac{r_1\rho_1\eta_2}{r_2\rho_2\eta_1} = 5\ \mu m/s$

SECTION (D) :

D 1. $P = \frac{w}{2}\cot\theta$ or $P = \frac{mg}{2}\cot\theta$

D 2. 76 g, 42 g, $\frac{21}{38}$.

D 3. 1.04 N in the left string and 1.12 N in the right

D 4. 43 N

D 5. (a) T = 225 N (b) $F_x = 225$ N, $F_y = 300$ N

D 6. $\frac{L\cos\theta\sin^2\theta}{2h - L\cos^2\theta\sin\theta}$ **D 7.** $\frac{3W}{8}$

SECTION (E) :

E 1. $\frac{3Ft^2}{2m\ell}$

E 2. **(a)** $\frac{2g(m_1 - m_2)}{\ell(m_1 + m_2)} = \frac{60}{7} = 8.4$ rad/s²

(b) (i) $\frac{2g(m_1 - m_2)}{\ell(m_1 + m_2 + m_3/3)} = \frac{90}{22} = 8.0$ rad/s²,

(ii) $(m_1 g - m_1 \alpha\frac{\ell}{2}) = 29$ N ;

$(m_2 g + m_2 \alpha\frac{\ell}{2}) = 27.6$ N

E 3. (a) $\frac{3g}{4L}$ (cw) (b) $N = \frac{13mg}{16}\uparrow$,

$F = \left(\frac{3\sqrt{3}}{16}\right) mg \rightarrow$ (c) $\frac{3\sqrt{3}}{13}$

E 4. (a) $\frac{3g}{2\sqrt{2}\ell}$ (cw) (b) $\frac{3}{2}g\downarrow$ (c) $\frac{Mg}{4}\uparrow$

E 5. **(a)** $\frac{g}{7}$ m/s² **(b)** 0.125 m/s²

E 6. **(a)** $\frac{g}{11}$ **(b)** $\frac{20g}{31}$ N

E 7. **T = 1/2mg, a = gmr²/I**

E 8. (a) $\frac{213}{73}$ m/s↓ (b) 40.9 N

E 9. $\tau = 3/4\ \omega R/kg$. **E 10.** $<\omega> = 1/3\ w_0$

E 11. $x = \frac{2L}{3}$

E 12. $\frac{M}{m} = \sqrt{15}$

SECTION (F) :

F 1. $\sqrt{\frac{3g}{\ell}}$ = 5.4 rad/s **F 2.** w = $\sqrt{5}$ rad/s

F 3. $\frac{1}{19}\sqrt{380g}$ **F 4.** $\omega = \sqrt{\frac{9g}{4\ell}}$

F 5. 0.5 m/s **F 6.** $\alpha = \frac{3g\cos\theta}{2\ell}$

SECTION (G) :

G 1. $0.9\sqrt{2}$ dmg

G 2. (a) T = 2mg (b) N = 6mg (c) $\frac{3g}{5L}$ (d) $\sqrt{\frac{6g}{5L}}$

SECTION (H) :

H 1. 16 kg m²/s **H 2.** $2\hat{k}$ kg m²/s

H 3. 0.5 kg-m²/s, 75 J

H 4. 19.7 rad/s **H 5.** 2.4 rad/s

H 6. 0.04 kg-m² **H 7.** 12 rad/s

H 8. $\omega = \frac{45}{14}$ = 3.21 rad/s (ccw), $v_s = \frac{1}{7}$ 0.143 m/s ←

H 9. $\frac{4\pi m}{M+2m}$ **H 10.** 6.3 m/s

H 11. 41°

H 12. (a) $\omega = \frac{12V}{7L}$ (b) $v = \frac{7}{12}\sqrt{2gL}$ = 3.5 m/s

H 13. 0.8 rev/s

SECTION (I) :

I 1. (a) $\frac{4v_0}{3}$ (b) $\frac{5v_0}{3\ell}$ (c) $v_x = \frac{v_0}{2}$, $v_y = \frac{2v_0}{3}$

I 2. (a) $w_A = v^2 / R$ = 2.0 m/s², the vector w_A is permanently directed to the centre of the wheel ; (b) s = 8R = 4.0 m]

I 3. $\frac{7}{10}mv^2$

I 4. **(a) $v_A = 2\omega t$ = 10.0 cm/s,**

$v_B = \sqrt{2}\ \omega t$ = 7.1 cm/s, v_0 = 0 ;

(b) $\omega_A = 2\omega\sqrt{1+(\omega t^2/2R)^2}$ = 5.6 cm/s²,

$\omega_B = \omega\sqrt{1+(1-\omega t^2/R)^2}$ = 2.5 cm/s²,

$\omega_0 = \omega^2 t^2 / R$ = 2.5 cm/s²

I 5. **$R_A = 4r$, $R_B = 2\sqrt{2}\ r$**

I 7. 3m

SECTION (J) :

J 1. 50 m/s

J 2. (a) 300 mm from A

(b) α = 4.00 rad/s² (ccw) ; $\bar{a}$ = 1.800 m/s² →

J 3. $\frac{\omega\ell}{6}$ m/s, $\frac{\ell}{6}$ m below the centre of the rod

J 4. $\sqrt{10gh/7}$ **J 5.** $\frac{3v^2}{4g}$

J 6. $\sqrt{\frac{10}{7}g\ell\sin\theta}$ **J 7.** 17 mg/7

J 8. $v = \sqrt{\frac{14gR}{3}}$

J 9. (a) 1.633 N (b) 1.224 m

J 10. (a) T = w (b) $\alpha = rg/k^2$ (ccw)

J 11. $\frac{2}{3}g$ **J 12.** (a) $\frac{2}{5}\tan\theta$ (b) $\frac{7}{8}mgl\sin\theta$

J 13. 3.3 N **J 14.** $\frac{25}{9}$ m/s ←

J 15. **$\ell = 2aF_2/mw = 1.0$**

J 16. (i) (a) 3 g/L (cw)

(b) $\left(\frac{\sqrt{3}}{2}\hat{i} + \hat{j}\right)$ g = 1.323 g ∠ 49.1º

(c) $\left(\frac{\sqrt{3}}{2}\hat{i} - 2\hat{j}\right)$ g = 2.18 g ∠ −66.6º

(ii) (a) g/L (cw) (b) $-\left(\frac{\sqrt{3}}{2}\right)$ g $\hat{i}$

(c) $-\left(\frac{\sqrt{3}}{2}\hat{i} + \hat{j}\right)$ g = 1.323 g ∠ −130.9º

J 17. (a) $\theta = \cos^{-1}\frac{4}{7}$ (b) $v = \sqrt{\frac{4}{7}gr}$ (c) $\frac{k_T}{k_R} = 6$

J 18. $\sqrt{\frac{27}{7}g(R-r)}$

J 19. (a) mg(H-R-R sinθ), (b) $\frac{10}{7}g\left(\frac{H}{R} - 1 - \sin\theta\right)$,

$-\frac{5}{7}$ g cosθ (c) 4.9 N, 0.196 N upward

J 20. (i) (a) $\frac{1.2g}{\ell}$ (cw) (b) $-03.(\hat{i}+2\hat{j})$ g

(ii) (a) $24g/17\ell$ (cw) (b) $12g/17\downarrow$

(iii) $2.4g/\ell$ (cw) (b) $0.5g\downarrow$

J 21. $\frac{9\pi+16}{18\pi}$

J 22. $F_{max} = 3kmg/(2-3k)$; $w_{max} = 2kg/(2-3k)$

J 23. $w = 3g(M+3m)/(M+9m+I/R^2)$

SECTION (K) :

K 1. (a) $v = 0$ (b) $\omega = \frac{v}{5a}$ (c) $\frac{3}{5}mv^2$

K 2. $\frac{v_0}{3}(\leftarrow), \frac{2v_0}{3}(\rightarrow)$

K 3. (a) $\frac{Ft}{m}$ (b) $\frac{6Ft}{m\ell}$ (c) $\frac{2F^2t^2}{m}$ (d) $\frac{F\ell t}{2}$

K 4. $\frac{\pi L}{12}$

K 5. $\omega = \frac{1.7v}{2R}$ $V_{min} = \frac{2}{1.7}\sqrt{0.3gR}$

K 6. 2R/3 above the centre

K 7. ωR/3 **K 8.** 3v/5

K 9. (a) $\frac{5\bar{v}_0}{2r}$ (ccw) (b) $\frac{\bar{v}_0}{\mu_k g}$

K 10. (a) $t = \frac{6a\pi}{\sqrt{3}v_0}$

(b) $s = \frac{a}{\sqrt{3}}\sqrt{1+(2\pi+\sqrt{3})^2}$

K 11. (a) $\frac{mL\sqrt{gh}}{\sqrt{2}}, \sqrt{\frac{8gh}{3L}}$ (b) $\frac{3}{2}L$

K 12. 3v/7

K 13. $\omega = \frac{\bar{v}_1}{L}\frac{12\sin\beta}{3\sin^2\beta+1}$ (cw)

K 14. $H = \left(\frac{1-3\cos^2\theta}{1+3\cos^2\theta}\right)^2$; $h = \frac{49\pi\ell}{144}$

SECTION (L) :

L 1. $\frac{1}{2}mg\,a\sin\theta$

Exercise - 3

1. **(a)** $v = \frac{2v_0}{3}$; $t_0 = \frac{v_0}{3\mu g}$

(b) $w = -\mu mg(v_0 t - \frac{3}{2}\mu g t^2)$; $-\frac{1}{6}mv_0^2$

2. $\frac{mg}{6}$, up

3. (a) 6 N

(b) $\vec{\tau}_1 = 0.6\hat{k} - 0.6\hat{j}$, $\vec{\tau}_2 = -0.6\hat{k} - 0.6\hat{j}$

4. B

5. $4.8\,Ma^2$

6. w(d – x)/d, wx/d

7. (a) $\vec{F} = \frac{2mV}{\Delta t}\hat{i} - \frac{2mV}{\sqrt{3}\Delta t}\hat{k}$; $\vec{N} = \left(\frac{2mV}{\sqrt{3}\Delta t} + mg\right)\hat{k}$,

(b) $\vec{\tau} = -\left(\frac{4mVh}{\sqrt{3}\Delta t}\right)\hat{j}$

8. $v = \sqrt{5gR}$ **9.** A

10. A, B, C **11.** C **12.** C

13. (a) $a_C = \frac{4F}{3m_1+8m_2}$; $a_P = \frac{8F}{3m_1+8m_2}$

(b) friction at the top of the cylinder = $3m_1F/(3m_1+8m_2)$ towards right, friction at the bottom = $m_1F/(3m_1+8m_2)$ towards right

14. **A** **15.** C **16.** D **17.** B

18. **(a)** $\frac{m}{M} = \frac{1}{4}$ **(b)** $AP = \frac{2L}{3}$ **(c)** $v_p = \frac{v_0}{2\sqrt{2}}$

19. **20.** **21.** $\theta = 60^\circ$ **22.** B

23. A

24. **(a)** x = 0.1 m **(b)** ω = 1 rad/s **(c)** never

25. B **26.** B

27. **(a)** $\sqrt{3}\ m\omega^2\ell$

(b) $F_y = \sqrt{3}\ m\omega^2\ell$ $F_x = -F/4$

28. A **29.** C **30.** B **31.** B

32. B **33.** B **34.** B

35. $\frac{3mv}{\ell(M+3m)}$ **36.** **A**

37. **C, D** **38.** **A, B**

