1. In equilibrium, \( \sum F = 0 \)  
\( \sum F_x = 0 \)  
\( F_x + 0 = 0 \)  
\( F_x = 0 \)  
\( F_y + 10 - 20 = 0 \)  
\( F_y = 10 \) N  
So \( |F| = \sqrt{10^2 + 10^2} = 10 \) N

2. How far from point P is \( F_y \)?  
\( \sum F_x = 0 \)  
\( F_x + 10 \times 3 - 20 \times 2 = 0 \)  
\( F_x = 40 - 30 = 10 \)  
\( x = \frac{10}{10} = 1 \) m

3. Plank in uniform 4 m long 40 N.  
Concentrated mass is 60 kg 1 m from right end. In equilibrium,
\( \sum T = 0 \)  
\( 60 \times 1 + 40 \times 2 - F_1 \times 4 = 0 \)  
\( 4F_1 = 60 + 80 = 140 \)  
\( F_1 = \frac{140}{4} = 35 \) N

\( F_2 = 100 - 35 = 65 \) N

4. Jupiter moon has \( M = 1.08 \times 10^{23} \) kg  \( R = 2.41 \times 10^7 \) m  
How much does 25 kg from weigh on that moon
\( W = \frac{G M m}{R^2} = \frac{6.67 \times 10^{-11} \times 1.08 \times 10^{23} \times 25}{(2.41 \times 10^7)^2} \)  
\( W = 310.0 \) N
5. What is escape vel.?

Use same formula as $R \to \infty$, $V_y = 0$

so $E at \ surface = 0$

$$\frac{1}{2} m V_{esc}^2 - G \frac{mM}{R} = 0$$

$$V_{esc}^2 = \frac{2GM}{R}$$

$$V_{esc} = \sqrt{\frac{2GM}{R}}$$

$$= \sqrt{\frac{2 \times 6.67 \times 10^{-11} \times 1.08 \times 10^{24}}{2.41 \times 10^8}} = 2450 m/s$$

6. Fully frictionless.

pully frictionless.

uniform cyl. $M = 3kg$, $r = .5m$

$m = 2kg$

find block's accel.

$a = \frac{F}{m}$, $a = \frac{g}{T}$

dere $T = \frac{1}{2} \pi r$

$$T \times r = \frac{1}{2} m v^2 \frac{a}{r} \Rightarrow T = \frac{1}{2} m g$$

$$mg - T = ma$$

$$mg - \frac{1}{2} m g = ma$$

$$a = \frac{m}{m + \frac{M}{2}} g = \frac{2}{2 + \frac{7}{2}} 10 = \frac{2}{\frac{9}{2}} 10$$

$$= \frac{4}{9} 10 = \frac{40}{9}$$

$$a = \frac{5.7 m/s^2}{(5.714)}$$

$T = ?$

$$T = \frac{1}{2} m g = \frac{1}{2} \times 3 \times 5.714 = 8.57 N$$
9. A half-pipe is frictionless. What is ascent at pt shown. 

\[ \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{4} \]

\[ = \frac{10}{4} = 2.5 \text{ m/s}^2 \]

must be \( a_e \) plus \( a_a \)

10. 

\[ \frac{80 \text{ m/s}}{30^\circ} \]

After 3 s what is height

\[ y = v_{oy}t + \frac{1}{2}at^2 = v_{oy}t - \frac{1}{2} t^2 \]

\[ v_{oy} = 60 \text{ m/s} \]

\[ y = 30 \times 3 - \frac{1}{2} (3^2) = 90 - 4.5 = 85 \text{ m} \]

11. What is speed \((at t = 3 \text{ s})\)

\[ v_x = v_{ox} = 60 \text{ m/s} \]

\[ v_y = v_{oy} - gt = 30 - 10 \times 3 = 0 \]

speed \( = 60 \text{ m/s} \)

12. \( |a| = 10 \text{ m/s}^2 \text{ during entire freefall} \)
3 kg released from rest. If takes 4s to bring
3 kg to full speed, find any power exerted by F

\[ W_{nc} = \Delta E = E_f - E_i = \frac{1}{2} m v_f^2 + 0 - (0 + mgh) \]

\[ = \frac{1}{2} \times 3 \times 4^2 - 3 \times 10 \times 2 \]

\[ = 24 J - 60 J = -36 J \]

\[ P_{avg} = \frac{\Delta W}{\Delta t} = \frac{-36 J}{4s} = -9 \text{ Watts} \]

14. 

Spooling string: 

\[ V_{avg} = \frac{r}{t} \]

\[ \text{speed of string center} \]

let \( r \) be radius of spool \( I = mr^2 \)

\[ \text{let} \ m \ \text{be mass of string} \]

at bottom \( \Delta E = 0 \)

\[ E_i = E_f \]

\[ mgR = \frac{1}{2} mv^2 + \frac{1}{2} I \omega^2 + 0 \]

solid disk

\[ mgR = \frac{1}{2} mv^2 + \frac{1}{2} mr^2 (V_{avg})^2 \]

\[ mgR = mr^2 \]

\[ v = \sqrt{gR} \]

\[ = \sqrt{10 \times 4} = 6.32 \text{ m/s} \]

15. at bottom, acceleration: 

\[ \frac{v^2}{R} = \frac{40}{4} = 10 = \frac{gR}{R} = g \text{ up.} \]
10. \[ m = 3 \text{ kg} \]
\[ r = 0.4 \text{ m} \]

Total I for rotation about nail,
\[ I = I_{cg} + Md^2 = mr^2 + mr^2 \]
\[ = 2mr^2 = 2 \times 3 \times (0.4)^2 \]
\[ = 0.48 \times 16 = 7.68 \text{ kg m}^2 \]

17. A DVD is rotating \( 8 \text{ rad/s} \)

begins slowing down at \( \alpha = 2 \text{ rad/s}^2 \)

since "slowing down" \( \alpha = -2 \text{ rad/s}^2 \)

what \( \theta - \theta_0 \) when it comes to rest.

\[ \omega^2 = \omega_0^2 + 2 \alpha (\theta - \theta_0) \]

\( (\theta - \theta_0) = \frac{\omega^2 - \omega_0^2}{2\alpha} = \frac{0 - (8)^2}{2(-2)} \)

\( \theta - \theta_0 = -64 \]
\[ -4 = +16 \text{ rad} \]

18. Car at 20 m/s around hvy. curve track

\( R = 100 \text{ m} \)

two wheel without slip

\( \mu_s \) must be

\[ a_c = \frac{v^2}{R} = \frac{20^2}{100} = \frac{400}{100} = 4 \text{ m/s}^2 \]

\[ F_{fr} = ma_c \]

\[ F_{fr} = F_{max} = \mu_s mg \]

\[ F_{fr} = ma_c = 4m \]

so, \( 4m \leq \mu_s mg \)

\( M_3 \geq \frac{4}{8} = 0.4 \)

so, maybe 0.6 and maybe 0.4

are both possible answers.

19. \[ \frac{96}{3} \]

\[ 96 - 6g = 60 \]
\[ 6a = 96 - 60 \]
\[ a = 6 \text{ m/s}^2 \]

\[ a = 6 \text{ m/s}^2 \]

\[ \frac{96}{3} = 3.6 \]

\[ a = 6 \text{ m/s}^2 \]

\[ T - 3g = 3.6 \]
\[ T = 18 + 30 = 48 \text{ N} \]
20. \( m = 4 \, \text{kg} \), \( F_t = 24 \) N, block, speed up. 
\( u = 0.5 \), \( u_k = ? \) 
\( a = 2 \, \text{m/s}^2 \)

\[ F_k = 24 - 4 \times 2 = 16 \, \text{N} \]

21. \( F_t \) applies to a 3 m long rod some 24 N, but opposite dir.

22. \( F_t \) reduces and block slows down @ 2 m/s^2

\( a = -2 \, \text{m/s}^2 \)

\[ F_t - 16 = m(-2) \]

\[ F_t = 16 - 2 \times 4 = 8 \, \text{N} \]

23. Block comes to rest then a \( F_t = 16 \) N applied.

\[ F_k \leq F_{k,\text{max}} = \mu_k \cdot F_n = 0.5 \cdot (40) = 20 \]

The \( F_k = 16 \) opposes \( F_t \) and block remains @ rest.

24. \( W_{nc} = \Delta E = E_f - E_i = 0 - \frac{1}{2} k \cdot x^2 \)

\[ W_{nc} = -\frac{1}{2} \cdot 800 \cdot ( -2 \, \text{m})^2 = -400 \cdot (4) = -1600 \, \text{J} \]

25. \( W_{nc} = -F_k \cdot d \Rightarrow F_k = \frac{1600}{1} = 160 \, \text{N} \)

16 = \( F_k = \mu_k \cdot F_n = \mu_k \cdot M_g = \mu_k \cdot 4 \, \text{kg} \cdot 10 \, \text{m/s}^2 \)

\[ \mu_k = \frac{160}{40} = 0.4 \]

\( \mu = \text{must be} \mu_k = 0.4 \)
26. \( x \) is slope, \( t \) is time.

Displacement is \( x_2 = x_1 \) for segment.

Distance all are positive.

\[
\begin{align*}
\|1 - 2\| &= \sqrt{(1 - (-2))^2} = 3 \\
\|0 - (-2)\| &= \sqrt{0 - (-2)^2} = 2 \\
\end{align*}
\]

Distance \( = \frac{2 + 3}{5} = 1 \)

26 at what time is speed? Yes,

when slope becomes more positive.

\( 0 < t < 3 \) est slope.

\( 3 < t < 4 \) slope becomes more negative.

so 3.53 qualifies, no others.

27. \( W_{mc} = \Delta E = \frac{1}{2} k_x x^2 - \frac{1}{2} k_y y^2 \)

\[
= \frac{1}{2} k_x \left( \frac{1}{2} \times 200 \text{ kgs}^2 (5 \text{ m/s})^2 \right) \\
= 100 \times 2.5 = 2500 \text{ J}
\]

28. \( \Delta \beta = 0 \times \beta_x = 10 \times 3 = 3 \text{ kgm/s} \)

\( \beta_y = 20 \text{ m/s} \times 2 = 4 \text{ kgm/s} \)

\( \sqrt{3^2 + 4^2} \) overall mass. \( \beta = 5 \)

combined .5 kg \( = 10 \text{ m/s} \)

29. \( k_i = \frac{1}{2} \times 3 \times 10^2 + \frac{1}{2} \times 2 \times 20^2 \)

\[= 15 + 40 = 55 \]

\( k_f = \frac{1}{2} (0.5) (10^2) = 25 \text{ Jout} = 30 \text{ J} \)
30. $F_x = 0 \Rightarrow \text{eq. no change in } x$

\[ x_c = \frac{50 \times 50 + 2 \times 50 + 4 \times 100}{50 + 50 + 100} = \frac{101 \times 400}{201} = \frac{50}{201} = 2.5 \]

Find \[ d \]

\[ d = \frac{50 \times d + 150 (2 - d)}{200} = \frac{50d + 300 + 150d}{201} = \frac{25d + 1.5 + 75d}{201} \]

This is 2.5 from inside.

\[ 1d = 2.5 - 1.5 - 1 \implies d = 1 \text{ m} \]

31. m m Ei in Kf is same.

32. Last in on that put another is similar Ug inside Kp if large I in ring.


\[
I = \begin{cases} 
MR^2 & \text{Cyl.} \\
\frac{1}{2} MR^2 & \text{Solid Sph.} \\
\frac{2}{5} MR^2 & \text{Hollow Sph.}
\end{cases}
\]

in mtr. 1 3 4 2