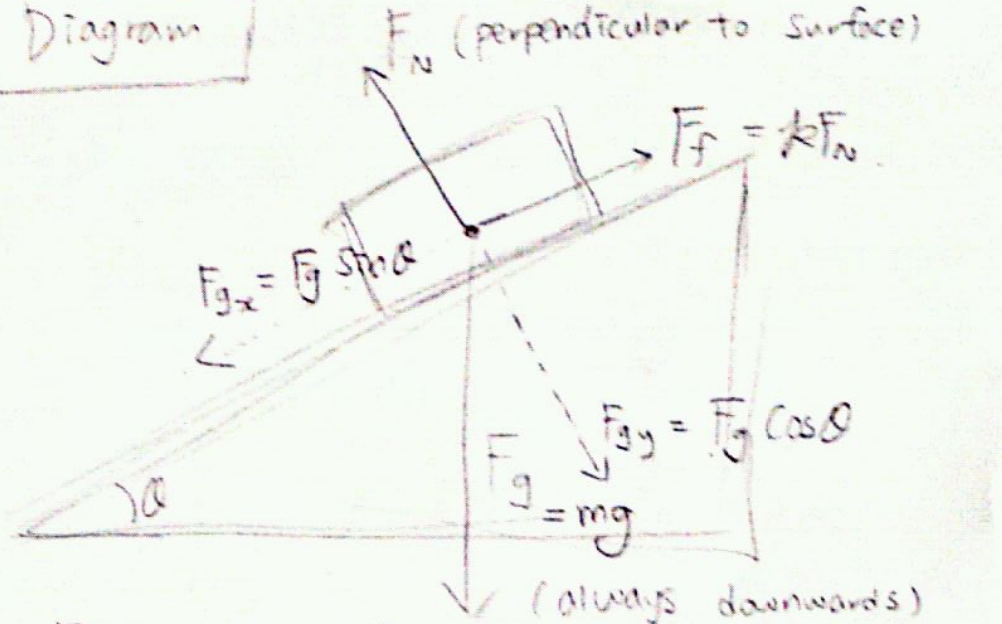
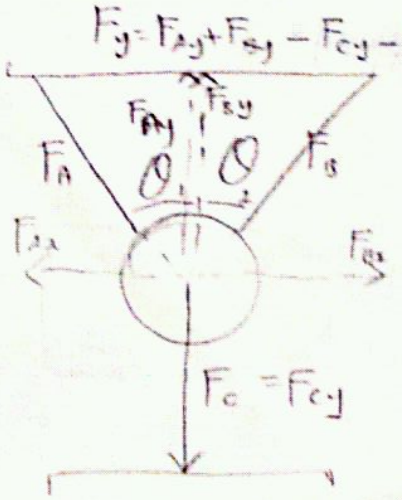
Dynamics : Newton's law of motion

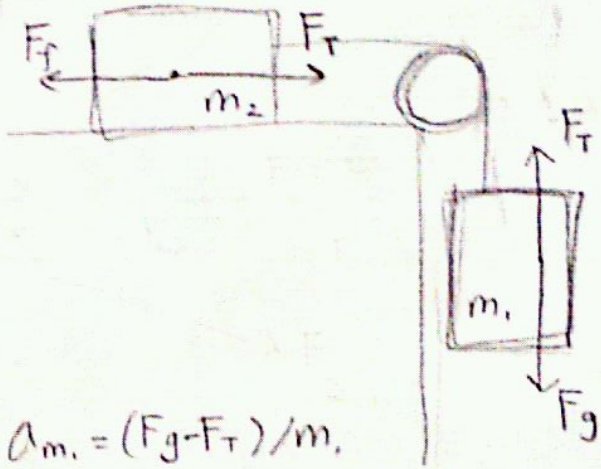
Newton's laws

- first law : law of inertia
  (every object continues in its state of rest, or of uniform velocity in a ~~straight~~ line, as long as no net force acts on it.)
- second law : $F = ma$ ☆
  ($\rightarrow F_G = mg$)
- Third law : $F_A = -F_B$.
  (wherever one object exerts force on second object, the second exerts equal force in opposite direction)

Diagram





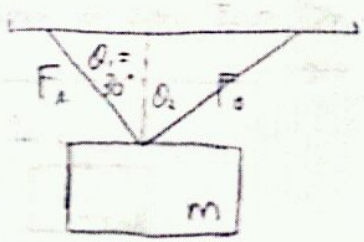


$a_{m_1} = (F_g - F_T)/m_1$

$a_{m_2} = (F_T - F_f)/m_2$

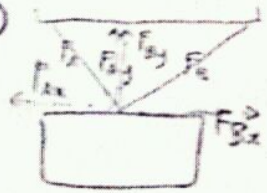
Example

(Q)



What is the mass of the object when $F_A = 20N$, $\theta_1 = 30°$, and $F_B = 30N$?

(A)



$F_{Ax} = F_{Bx}$

$F_A \sin\theta_1 = F_B \sin\theta_2$

$20 \cdot \sin\theta_1 = 30 \cdot \sin\theta_2$

$\theta_1 = \sin^{-1}\left(\frac{20 \cdot \sin 30°}{30}\right)$

$\theta_2 = 19.47°$

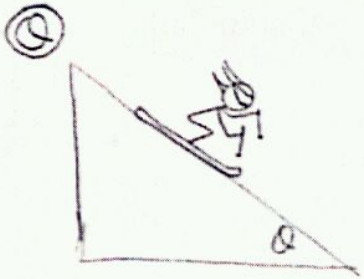
$F_g = F_{Ay} + F_{By} = 20\cos\theta_1 + 30\cos\theta_2$

$= 20 \cdot \cos 30 + 30\cos 19.47$

$= 45.6$

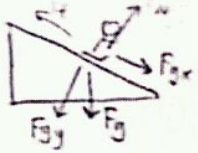
$m \cdot g = F_g \qquad m = \frac{F_g}{g} = \frac{45.6}{9.8} = 4.653\,kg$

(Q)



A skier is going down the slope (mass = 60kg) with acceleration of $5m/s^2$. What's the coefficient of friction when slope is 30° inclined?

(A)



$F_N = F_{gy} = F_g \times \cos\theta$

$= 60 \times 10 \times \cos 30 = 519.62$

$F_f = k F_N = k \cdot 519.62$

$F_{gx} - F_f = F_{net} = ma = 60 \times 5 = 300N$

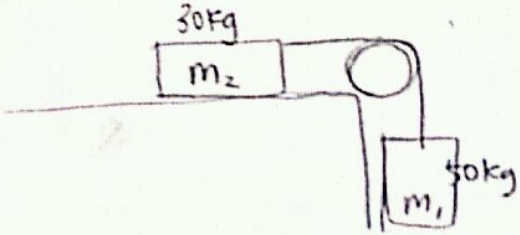
$F_g \sin 30 - 519.62k = 300$

$519.62k = 300 - 600\sin 30 = 0$

$k = 0$

there's no friction

(Q)



What's the tension of the string if acceleration of m_1 is $5m/s^2$?

$F = ma = 50 \times 5 = 250\,N$

$F_g - F_T = 250$

$50 \times 9.8 - F_T = 250$

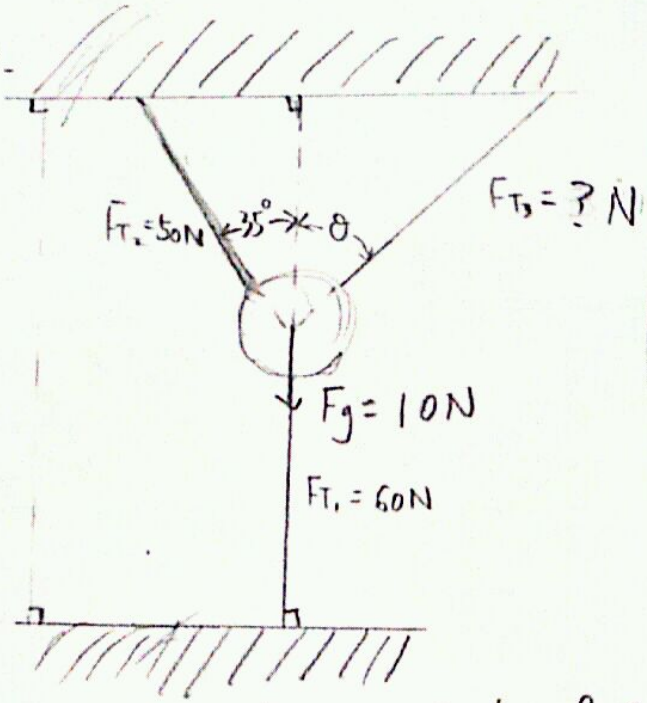
$F_T = 240N$

A1

Multiple Choice

DYNAMICS

A.

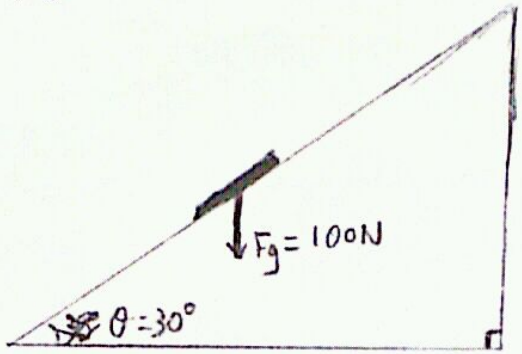


What is the magnitude of F_{T_2} and θ?

(A) 34.4N; 33.6° (B) 34.4N; 56.4°

(C) 40.8N; 44.6° (D) 40.8N; 45.4°

B.



A random blob with an average surface is sliding on an incline with a constant speed of 5m/s. Calculate the magnitude of the coefficient of friction between the bottom of the blob and the incline.

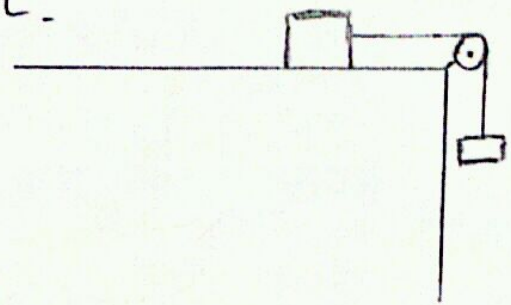
(A) 0.577

(B) 1.73

(C) 0.5

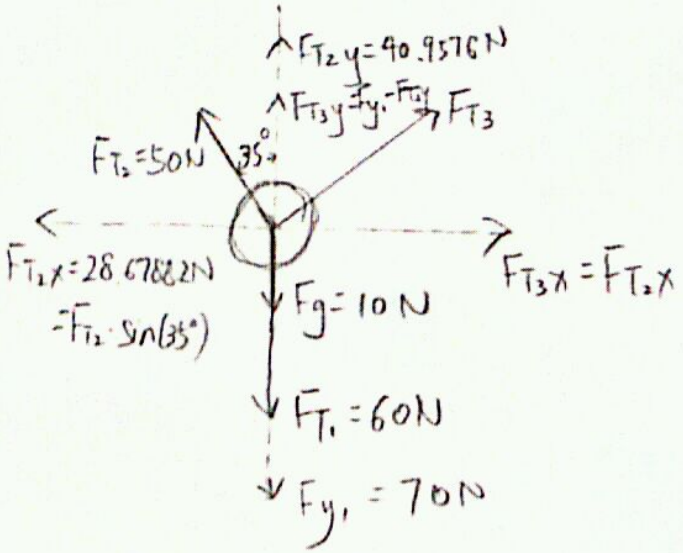
(D) 0.87

C.



Answer Key

A. Free-body Diagram, Vectors



Equilibrium

Answer: (C)

B. Free-body Diagram.

Answer: (A)