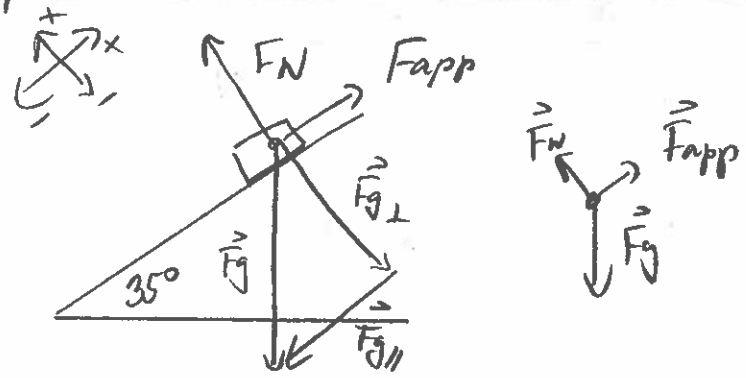
KEY

PHYSICS 12 FORCES – REVIEW

1. Consider a 25.0-kg object on an inclined plane with a degree of elevation of 35°.

a) If the surfaces are frictionless what force and at what direction is required to keep the object at rest? **Include 2 diagrams in your solution – an FBD and a sketch of the situation.**



$\vec{F}_{net} = [0, 0]\ N$

$[0,0] = \vec{F}_N + \vec{F}_{g\perp} + \vec{F}_{g\parallel} + \vec{F}_{app}$ ($\vec{F}_N + \vec{F}_{g\perp} = 0$)

$F_{app} = F_{g\parallel}$

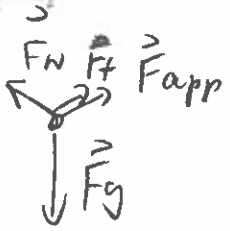
$= mg \sin 35°$

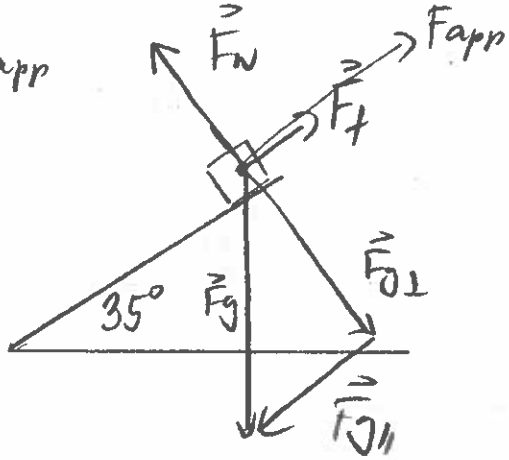
$= (25)(9.8)(\sin 35°)$

$= 140.5262\ N$

$\therefore \vec{F}_{app} = 1.4 \times 10^2\ N$ [up the plane].

b) What force is needed to keep the object at rest if the coefficient of static friction is 0.14? **Include 2 diagrams in your solution – an FBD and a sketch of the situation.**





$F_f = F_N \cdot \mu$

$= F_{g\perp} \cdot \mu$

$= mg \cos\theta \cdot \mu$

$= (25)(9.8)(\cos 35°)(0.14)$

$= 28.0969\ N$

→ against the motion

$\Rightarrow F_{app} = F_{g\parallel} - F_f$

$= 140.5262 - 28.0969$

$= 112.4293\ N$

$\therefore \vec{F}_{app} = 1.1 \times 10^2\ N$ [up the plane]

Note:

$\vec{F}_{app}$ to start it to move

$= F_{g\parallel} + F_f$

$= 168.6231\ N$

$1.7 \times 10^2\ N$ [up the plane]

Textbook: p77#17, p 95 #6-10, p109 #14-16, p110 #18-21, p 115 #22, p121 #23-25

$F_{fk} = F_{g\perp} \cdot 0.10$

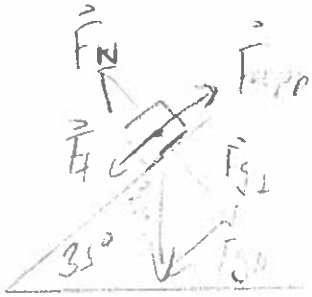
$= (25)(9.8)(\cos 35°)(0.10)$

c) What is the acceleration of the object if it is pushed with force of 300 N [up the plane]. The coefficient of static friction is 0.14 and the coefficient of kinetic friction is 0.10? **Include 2 diagrams in your solution – an FBD and a sketch of the situation.**

$\vec{F}_{net} = \vec{F}_N + \vec{F}_{g\perp} + \vec{F}_{push} + \vec{F}_f + \vec{F}_{g\parallel}$

$= 0 + 300 - 20.0692 - 140.5262$

$= 139.4046$ N [up the plane]



$a = \frac{F_{net}}{m}$

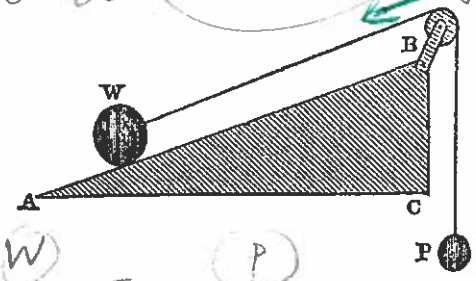
$a = \frac{139.4046}{25}$

$a = 5.6$ m/s²

∴ Object accelerates 5.6 m/s² [up the plane].

2. a) What mass of object P is required in order for the system to remain at rest, provided that the coefficient of static friction is 0.25, $m_W = 4.0$kg and the angle at A is 20°? What is the tension in the rope? **Include FBDs in your solution.**

$\theta = 20°$ $F_{net} = 0$ N



$F_f = mg\cos 20°\mu_s$

$= (4.0)(9.8)(\cos 20°)(0.25)$

$= 9.2090$ N

$\vec{F}_{g\parallel} = mg\sin\theta$

$= (4.0)(9.8)(\sin 20°)$

$= 13.4072$ N [down]

∴ $m_p = 2.3$ kg

(P) $T = 9.8 m_p$

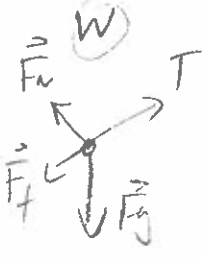
(W) $F_{g\parallel} = T + F_f$

$\frac{F_{g\parallel} - F_f}{9.8} = m_p$

∴ $m_p = 0.43$ kg

∴ $0.43 < m_p < 2.3$ kg

$4.2 \text{N} < T < 23$ N



(P) $T = F_g$

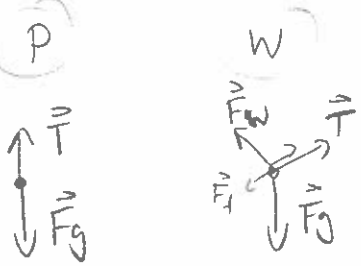
$T = m_p(9.8)$

(W) $F_{g\parallel} + F_f = T$

$9.2090 + 13.4072 = m_p(9.8)$

$m_p = 2.3078$ kg

b) What is the acceleration of the two masses if $m_p = 0.5$ kg and $\mu_k = 0.20$? **Include FBDs in your solution.**



$F_{fk} = F_{g\perp}\mu_k$

$= (4.0)(9.8)(\cos 20°)(0.20)$

$= 7.3672$ N

$F_{g\parallel} = 13.4072$ N

Q: Which direction is $\vec{F}_f$?

∴ The two masses do not accelerate.