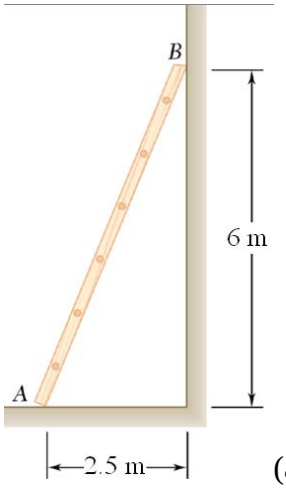
MEEN 10030 – Engineering Mechanics

Stage 1 – Summer 2007

Prof. Michael Gilchrist
Dr Liang Cui
Prof. Josef Vander Sloten

Attempt 4 Questions
Equal marks for all questions
Examination time – 2 hrs

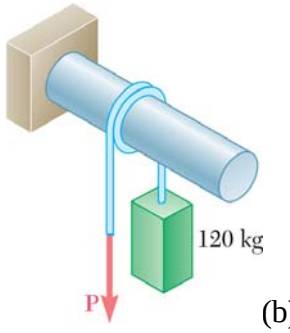
Question 1:



(a)

(a)
A ladder *AB* of mass 10 kg leans against a wall as shown. Assuming that the coefficient of static friction μ_s is the same at both surfaces of contact, determine the smallest value of μ_s for which equilibrium can be maintained.

[12 marks]



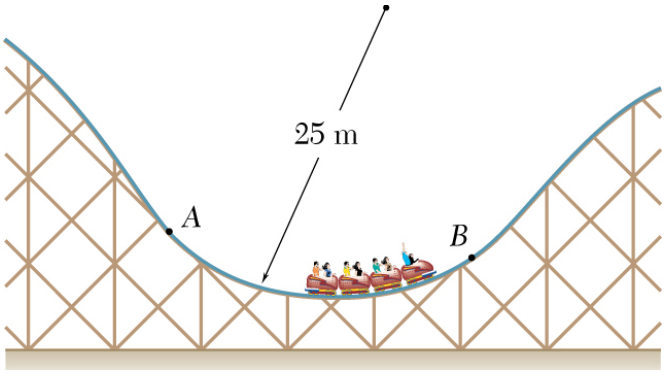
(b)

(b)
A 120-kg block is supported by a rope which is wrapped 1.5 circles around a horizontal rod. Knowing that the coefficient of static friction between the rope and the rod is 0.15, determine the smallest force **P** to hold the block.

[13 marks]

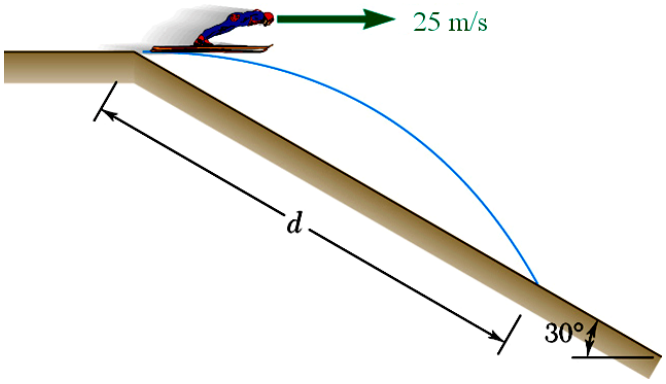
ANSWERS:
(a): $\mu_s = 0.2$
(b): P = 286N

Question 2:



(a)
Determine the maximum speed that the cars of the roller-coaster can reach along the circular portion AB of the track if the normal component of their acceleration cannot exceed $3g$ (g = 9.81 m/s^2).

[13 marks]

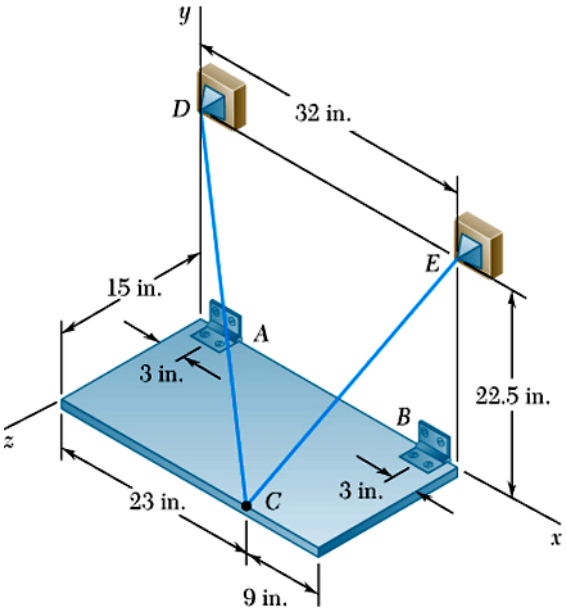


(b)
A ski jumper starts with a horizontal take off velocity of 25 m/s and lands on a straight landing hill inclined at 30^o.
Determine
(i) the time between take-off and landing
(ii) the length d of the jump
(iii) the maximum vertical distance between the jumper and the landing hill.

[12 marks; equal marks per part]

ANSWERS:
(a): v_{max} = 27.1m/s
(b): Time = 1.47s; Length d = 84.9m; Maximum vertical distance = 10.6m

Question 3:



A 285-lb uniform rectangular plate is supported in the position shown by hinges *A* and *B* and by cable *DCE* which passes over a frictionless hook at *C*. assuming that the tension is the same in both parts of the cable, and assuming that the hinge *A* and *B* exert only force reactions, and hinge *B* does not exert any axial thrust, determine

(a) The tension in the cable [13 marks]
(b) The reaction at *A* and *B*. [12 marks]

ANSWERS:

(a): T = 200 lb

(b): $\vec{A} = (33.3\,\text{lb})\vec{i} + (109.6\,\text{lb})\vec{j} + (41.1\,\text{lb})\vec{k}$

$\vec{B} = (32.8\,\text{lb})\vec{j} + (53.9\,\text{lb})\vec{k}$

Question 4:

(a) State the theorems of Pappus and Guldinus.

[12 marks]

(c) Determine Q_y, the first moment with respect to the y-axis, for the area bounded by the parabola $y^2 = 4ax$ and the lines $y = 0$ and $x = b$.

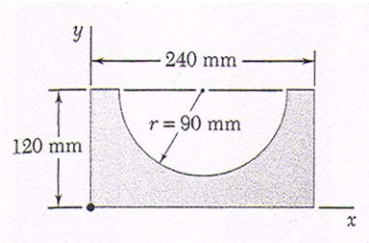
[13 marks]

ANSWERS:

(a): statement of the theorems

(b): $(4/5)\ b^2\ (ab)^{1/2}$

Question 5:



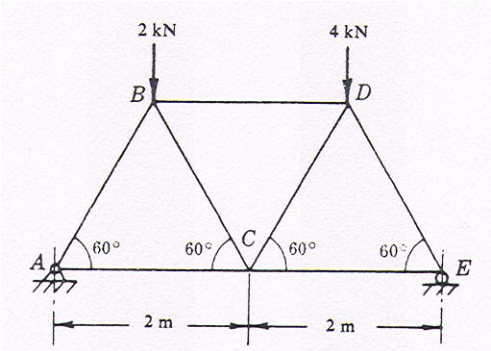
Determine the moment of inertia of the shaded area with respect to the *x*-axis.

[25 marks]

ANSWER:

$I_x = 45.9 \times 10^6 \text{ mm}^4$

Question 6:



This simple truss supports two loads, as shown. Construct a free body diagram and thereby determine reactions and the forces in each member.

[25 marks]

ANSWER:

3 marks for construction of FBD

$R_{Avertical}$ = 2500N

$R_{Ahorizontal}$ = 0N

R_E = 3500N

F_{AB} = 2890N (C)

F_{AC} = 1450N (T)

F_{BC} = 577N (T)

F_{BD} = 1730N (C)

F_{CD} = 577N (C)

F_{CE} = 2020N (T)

F_{DE} = 4030N (C)