

武汉理工大学考试试卷 (A 卷)

Test Paper of Wuhan University of Technology (A)

2018~2019 学年 1 学期 工程力学 A 课程 闭卷

2018-2019 Academic Year 1st Semester, Course: Engineering Mechanics A, Closed-book Exam

时间 120 分钟, 60 学时, 4 学分, 总分 100 分, 占总评成绩 70% 年月日

Time: 120mins, 60 class hours, 4 credits, Total Points: 100, Percent in final evaluation result:

70%, Date: _____

题号 No.	一 I	二 II	三 III	四 IV	五 V	六 VI	七 VII	八 VIII	九 IX	十 X	合计 Total
满分 Full marks	27	12	15	14	14	18					100
得分 Score	16	7	15	8	8	4					58

得分
Score 16

I. Fill in the blanks (27 points)

1. The force R is the resultant of three coplanar A , B and C that act at point O of a body, the magnitudes of A , B and C are 20N, 40N and 60N, respectively. The directions of these forces are shown in Fig.1. Determine the magnitude of $R = 42.7\text{N}$ the direction of R is $\theta = 24.9^\circ$ (6 points).

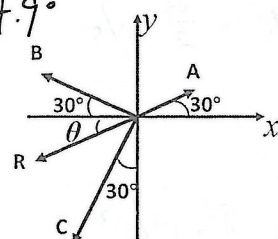


Figure 1

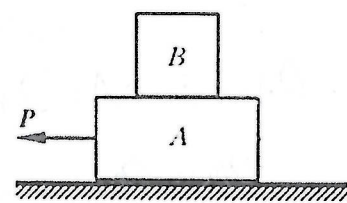


Figure 2

2. The mass of block A is 500N, B weighs 200N, the friction coefficient between block A and the ground is 0.20, and the friction coefficient between block A and block B is 0.25. Then, as shown in figure 2, the minimum force P to pull block A is 190 N, and the friction force between block A and block B is 50 N. (6 points)

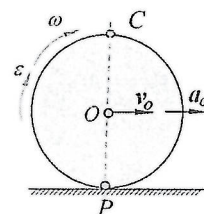


Figure 3

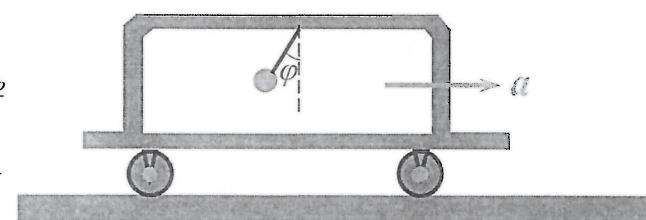


Figure 4

3. The wheel with the radius of R is rolling without slipping as shown in figure 3. At the instant, its angular velocity and angular acceleration are ω and ϵ (clockwise), respectively. P is the contact point with the ground, O is the wheel center point, C is the peak point. Then the velocity of point O is ωR , the acceleration of O is ϵR , the velocity of point P is 0, the acceleration of P is 0, and the velocity of C is $2\omega R$ (10 points)

4. The train runs on a horizontal track, and a pendulum is suspended in the carriage. When the carriage accelerates uniformly to the right, the pendulum is tilted to the left and is stationary relative to the carriage. As shown in figure 4, the acceleration of the train $a = g \tan \phi$. (5 points)

得分
Score 7

II. Suppose that all the systems are frictionless, .Draw the free-body diagrams for components AB , BC and DE in the Figures 5 ~ 7, respectively. (12 points)

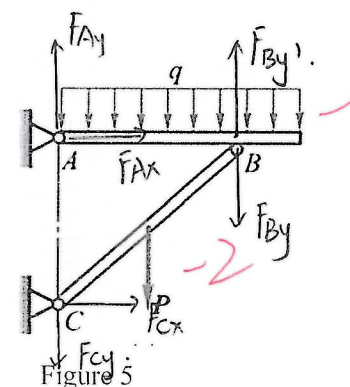


Figure 5

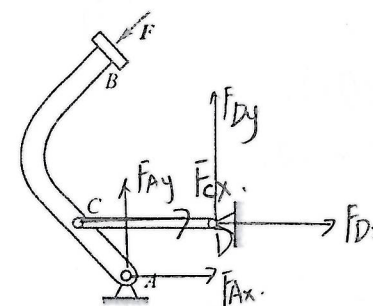


Figure 6

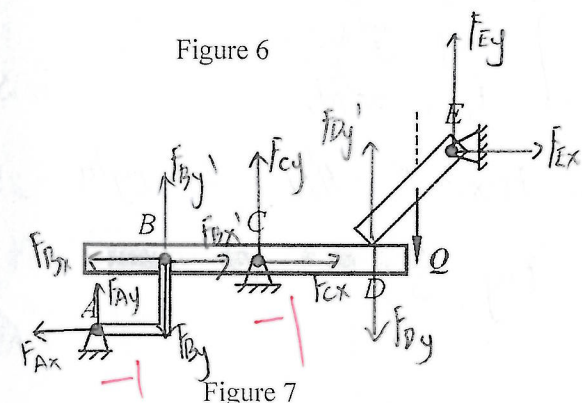


Figure 7

得分 15
Score

III. The composite beam AB , BC and CD are connected through hinge B and C . AB and CD are vertical, BC and AD is horizontal. The end A is the built-in support. The force diagram is as shown in the figure 8. Given that the density of uniformly distributed load $q=4 \text{ kN/m}$, moment of couple $M=10 \text{ kN}\cdot\text{m}$, and mass of all beams can be neglected. Please determine: (1) draw the free-body diagrams of whole, beam BC and CD ; (2) the reactions force of D ; (3) the reactions force at the fixed end A . (15points)

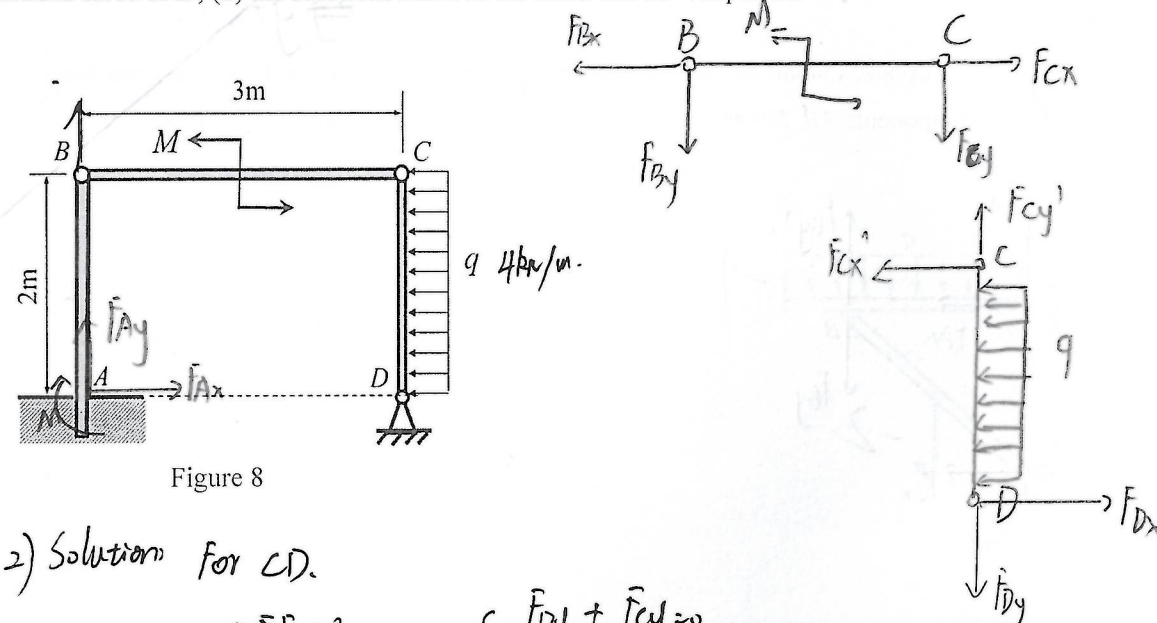


Figure 8

2) Solution for CD .

$$\begin{cases} \sum F_x = 0 \\ \sum F_y = 0 \\ \sum M_D = 0 \end{cases} \Rightarrow \begin{cases} F_{Dy} + F_{Cy} = 0 \\ F_{Cx} + F_{Dx} + q \cdot CD = 0 \\ F_{Cx} \cdot CD + \int_0^2 q \cdot x \cdot dx = 0 \end{cases}$$

for BC

$$\begin{cases} F_{Bx} = F_{Cx} \\ F_{By} = F_{Cy} \\ M + F_{By} \cdot 3 = 0 \end{cases} \Rightarrow \begin{cases} F_{By} = -\frac{10}{3} \text{ kN} \\ F_{Cy} = \frac{10}{3} \text{ N} \\ F_{Cx} = -4 \text{ N} \end{cases}$$

$$\Rightarrow \begin{cases} F_{Dx} = -4 \text{ N to right} \\ F_{Dy} = \frac{10}{3} \text{ N to down} \end{cases}$$

3) Solution To Point A.

$$\begin{aligned} \sum M_A = 0 & \Rightarrow -4 \times 2 = M = 0 \\ M &= -8 \text{ kN}\cdot\text{m} \\ F_{Ax} &= 4 \text{ kN to left} \\ F_{Ay} &= \frac{10}{3} \text{ kN to down} \end{aligned}$$

得分 8
Score

IV. In the mechanism shown in the figure 9. The vehicle is moved horizontally. The rod OA with the length $l=0.5 \text{ m}$ rotates about O . When $\varphi = 30^\circ$, the angular velocity of OA $\omega = 2 \text{ rad/s}$, and angular acceleration $\varepsilon = 4 \text{ rad/s}^2$. Please determine: (1) the velocity of the small vehicle; (2) the acceleration of the small vehicle. (14 points)

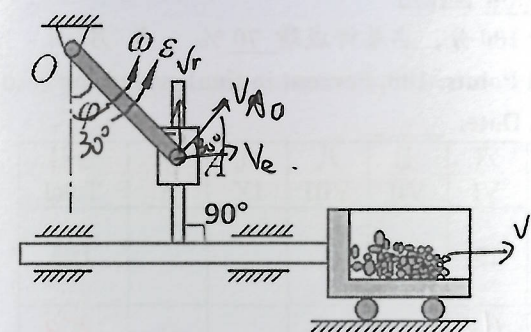


Figure 9

Solution: we know $V_A = \omega \cdot OA = 1 \text{ m/s}$.

$$\text{and } \vec{V}_{Aa} = \vec{V}_{Ae} + \vec{V}_{Ar}$$

$$V_e = V_A \cdot \cos 30^\circ = \frac{\sqrt{3}}{2} \text{ m/s}$$

$$\text{and } V_{\text{vehicle}} = V_e = \frac{\sqrt{3}}{2} \text{ m/s to right.}$$

$$a_{Aa} = 3 \cdot a_A = 2 \text{ m/s}^2$$

$$a_{Ae} = a_{Aa} \cdot \cos 30^\circ = \sqrt{3} \text{ m/s}^2$$

$$a_{\text{vehicle}} = \sqrt{3} \text{ m/s}^2$$

得分 8
Score

V. The line OO_1B is horizontal. The acceleration of point B is a_B .

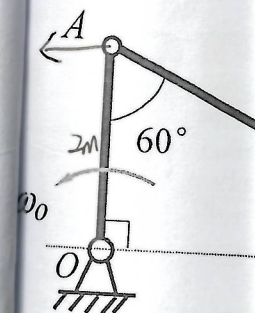


Figure 10

Solution: we know

icle is moved
about O . When
lar acceleration
acceleration of

得分 8
core

V. In the plane mechanism as shown in the figure 10, the crank $OA = 2m$ rotates about the point O at the uniform angular velocity of $\omega_0 = 3 \text{ rad/s}$, connecting rod $AB = 4m$. The wheel with a radius of $r = 0.5m$ rotates around center point O_1 .

line OO_1B is horizontal. In the moment as shown in the figure 10, please determine the velocity and acceleration of point B . (14 points)

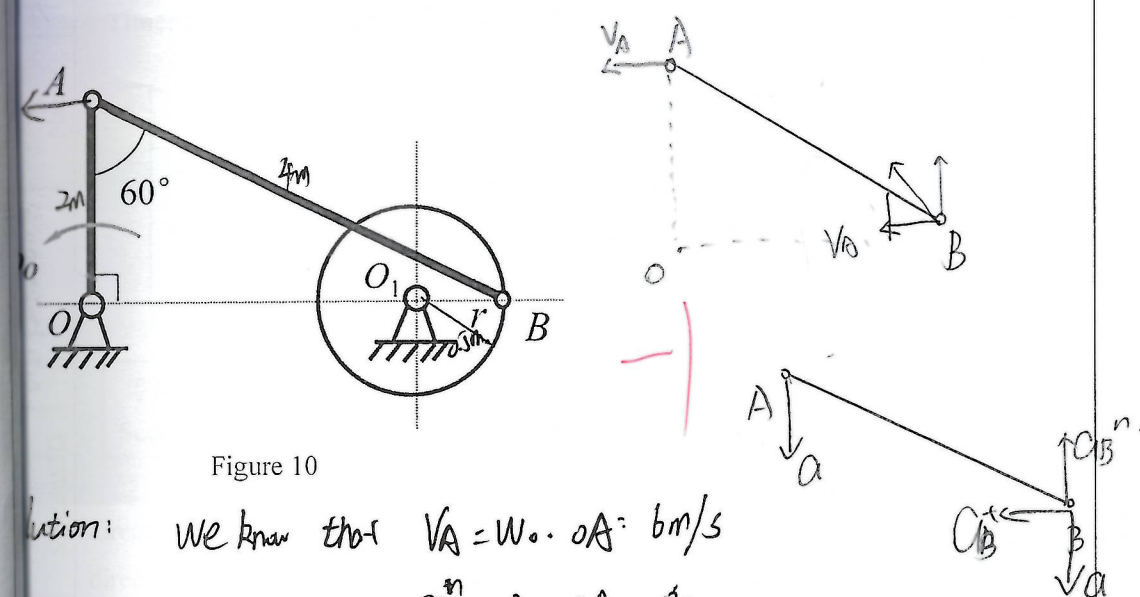


Figure 10

Solution: We know that $v_A = \omega_0 \cdot OA = 6 \text{ m/s}$
 $a_A^n = \omega_0^2 \cdot OA = 18 \text{ m/s}^2$
 $a_A^t = \frac{v_A^2}{OA} = 18 \text{ m/s}^2$

$$\frac{OA}{v_A} = \frac{v_B}{v_B} \cdot \frac{OB}{OB} \Rightarrow \frac{OA}{v_A} = \frac{v_B}{v_B} \cdot \frac{OB}{OB} = 6\sqrt{3} \text{ m/s}$$

$$v_B = 12 \text{ m/s}$$

$$a_B^t = \frac{v_B^2}{r} = \frac{36 \cdot 3}{0.5} = 216 \text{ m/s}^2 \text{ to } O,$$

$$a_B^n = -18 \text{ m/s}^2 \quad -5 \quad \text{to up}$$

得分
Score 4

VI. The homogeneous pole stands still and upright on a smooth horizontal surface. The weights of pole is m and length is l . When the bar falls down due to minor disturbance, please determine the angular velocity and constraining force of the bar when it just reaches the ground are calculated. (18 points)

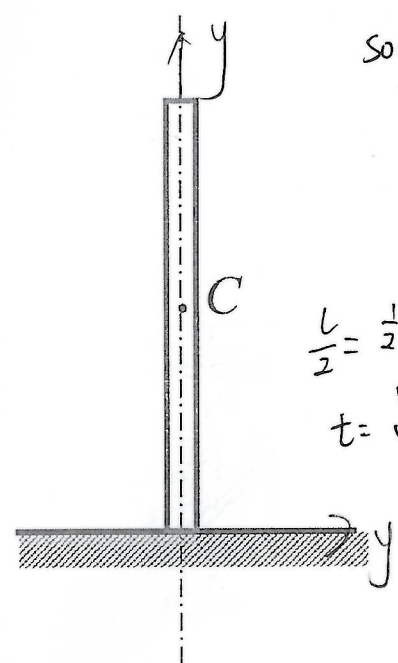
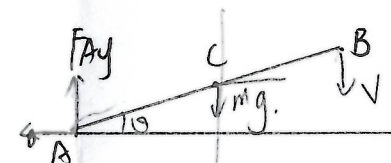


Figure 11

Solution:

The $F = 0$. $\theta = \omega t$
 So x_c won't change.
 $x_B = \frac{l}{2} \cdot \cos \theta$ $x_A = -\frac{l}{2} \cos \theta$
 $y_B = \frac{l}{2} - \frac{l}{2} \sin^2 \theta + \frac{l}{2} \sin \theta$
 $y = y' = -g t + \frac{1}{2} \cdot \omega \cos \omega t$
 $v_x = \frac{\omega l}{2} \sin \omega t$



Solution: we know that $AB = 0$

$$\sin v_c^2 = mg \cdot \frac{1}{2}$$

$$v_c = \sqrt{gl}$$

$$\omega = \frac{v_c}{\frac{l}{2}} = \frac{2\sqrt{gl}}{l} = 2\sqrt{\frac{g}{l}}$$

$$v_B = \omega \cdot l = 2\sqrt{gl}$$

$$F_{Ay} \cdot l = mg \cdot \frac{l}{2}$$

$$L = mg \cdot \frac{l}{2} = F \cdot$$

$$M_A = mg \cdot \frac{l}{2} \cos \theta$$

$$F_{Ay} \cdot l = mg \cdot \frac{l}{2}$$

$$F_{Ay} = 2mg$$

$$\omega = 2\sqrt{\frac{g}{l}}$$

$$F_{Ay} = 2mg$$

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