

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:

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	25	12	15	14	13	16					95

得分
Score 25

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 $R = 52.2N$, the direction of R is $\theta = 24.9^\circ$ (6 points).

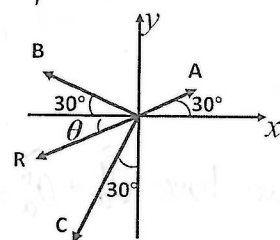


Figure 1

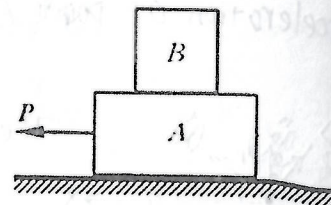


Figure 2

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 140N, and the friction force between block A and block B is 0. (6 points)

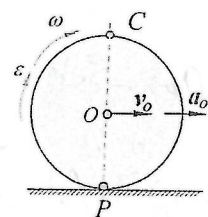


Figure 3

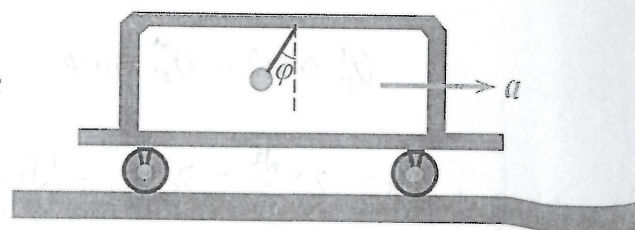


Figure 4

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 $2\epsilon R$, 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 12

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)

Solution: (1) figure 5:

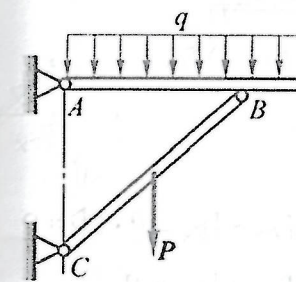
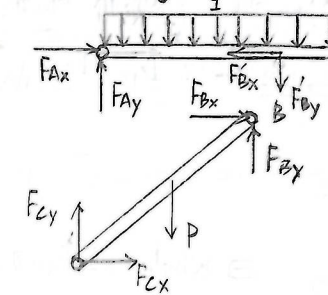


Figure 5



(2) figure 6:

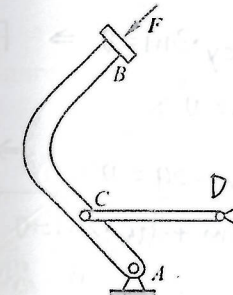
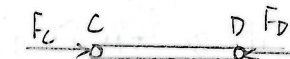


Figure 6



(3) figure 7:

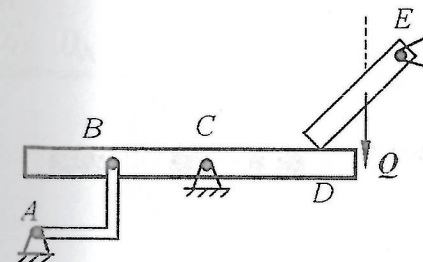
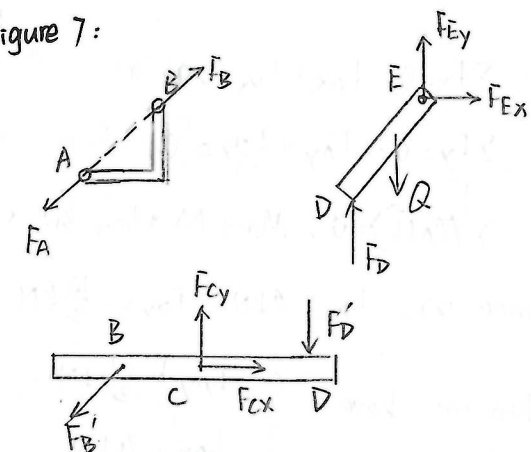


Figure 7



得分
Score 15

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)

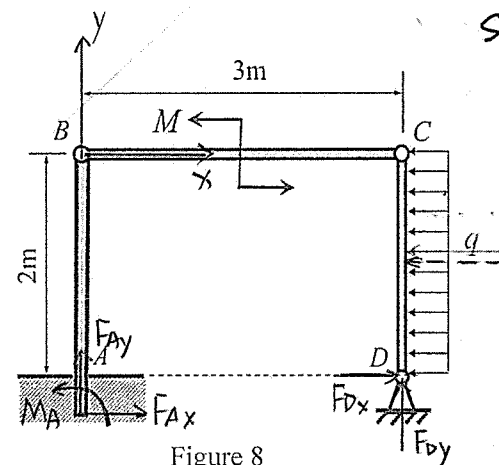
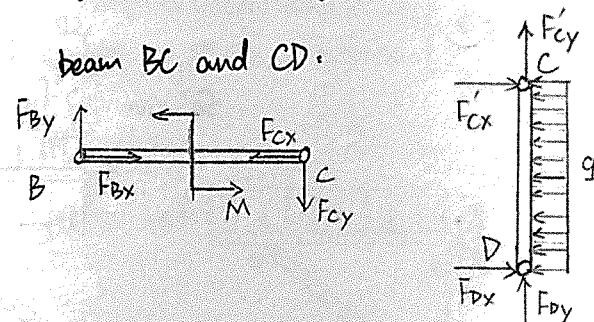


Figure 8

Solution: 1) free-body diagrams of whole = Figure 8.



$$12) BC: \sum M_B(\vec{F}) = 0, M - F_{Cy} \cdot 3m = 0 \Rightarrow F_{Cy} = \frac{10}{3} \text{ kN}.$$

$$CD: \sum F_y = 0, F_{By} + F_{Cy} = 0;$$

$$\sum F_x = 0, F_{Cx} + F_{Dx} - 2q = 0$$

$$\sum M_C(\vec{F}) = 0, -2q \cdot 1m + F_{Dx} \cdot 2m = 0$$

$$\Rightarrow \begin{cases} F_{Dx} = 4 \text{ kN} \\ F_{Dy} = -\frac{10}{3} \text{ kN} \end{cases}$$

$$13) \text{ Whole: } \sum F_x = 0, F_{Ax} + F_{Dx} - 2q = 0$$

$$\sum F_y = 0, F_{Ay} + F_{Dy} = 0$$

$$\sum M_A(\vec{F}) = 0, M_A + M + F_{Dy} \cdot 3m + 2q \cdot 1m = 0$$

$$\text{Since } 12), F_{Dx} = 4 \text{ kN}, F_{Dy} = -\frac{10}{3} \text{ kN}$$

$$\text{Then we have } \begin{cases} F_{Ay} = \frac{10}{3} \text{ kN} \\ F_{Ax} = 4 \text{ kN} \\ M_A = -8 \text{ kN}\cdot\text{m} \end{cases}$$

得分
Score 14

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)

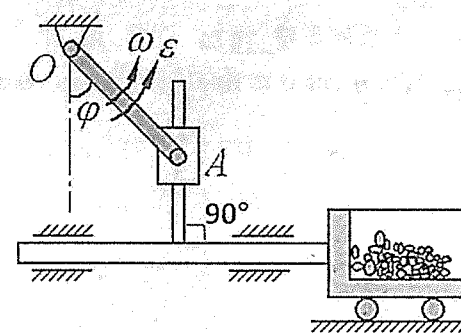
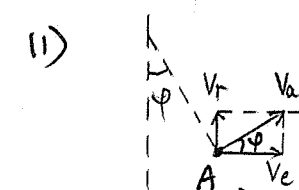


Figure 9

Solution: We choose:

Moving point: point A on rod OA

MRF: small vehicle



$$\text{Then we have } \vec{V}_a = \vec{V}_r + \vec{V}_e$$

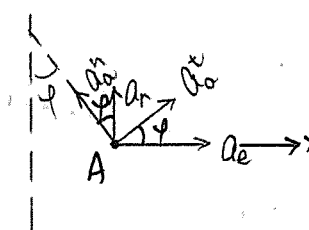
$$\Rightarrow V_e = V_a \cos \varphi = V_a \cos 30^\circ$$

$$V_a = \omega \cdot OA = 1 \text{ m/s}$$

$$\text{Thus } V_e = 1 \times \frac{\sqrt{3}}{2} = \frac{\sqrt{3}}{2} \text{ m/s}$$

$$\text{Therefore } V_{\text{car}} = V_e = \frac{\sqrt{3}}{2} \text{ m/s}$$

12) Analyse the acceleration at point A:



$$\text{Then we have } \vec{a}_a^t + \vec{a}_a^n = \vec{a}_e + \vec{a}_r \quad 1)$$

$$a_a^t = \alpha \cdot OA = 2 \text{ m/s}^2,$$

$$a_a^n = \omega^2 \cdot OA = 2 \text{ m/s}^2$$

Reflect equation 1) to x-axis:

$$a_a^t \cos \varphi - a_a^n \sin \varphi = a_e$$

$$a_e = 2 \times \frac{\sqrt{3}}{2} - 2 \times \frac{1}{2} = (\sqrt{3} - 1) \text{ m/s}^2.$$

$$\text{Therefore the acceleration of car: } a_{\text{car}} = a_e = \sqrt{3} - 1 \text{ m/s}^2$$

得分
Score 13

V. In the pla about the pc rod $AB=4 \text{ m}$.

ne OO_1B is horizontal. In th acceleration of point B. (14

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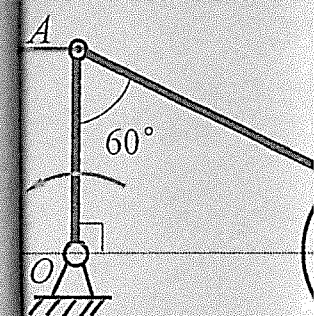


Figure 10

acceleration of

a_B

$$\vec{a}_A^t + \vec{a}_A^n + \vec{a}_{BA}^t + \vec{a}_{BA}^n$$

$$\vec{a}_B^t + \vec{a}_B^n$$

$$\vec{a}_B^t = \vec{a}_A^t + \vec{a}_{BA}^t + \vec{a}_{BA}^n$$

$$\frac{V_B^2}{r} = 21.6 \text{ m/s}^2, a_A^t$$

$$\omega_{AB} \cdot AB = 36 \text{ m/s}^2$$

$$\text{quation (1) to } x-$$

$$a_B^t \cos 30^\circ - a_B^n \sin 30^\circ$$

$$= \sqrt{(a_B^t)^2 + (a_B^n)^2} = 4$$