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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	27	12	15	14	13	16					97

得分
Score

27

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

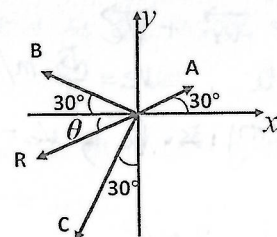


Figure 1

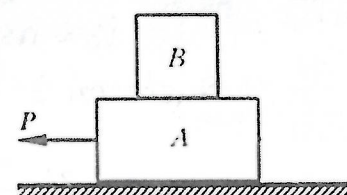


Figure 2

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

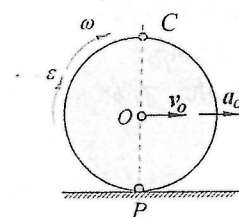


Figure 3

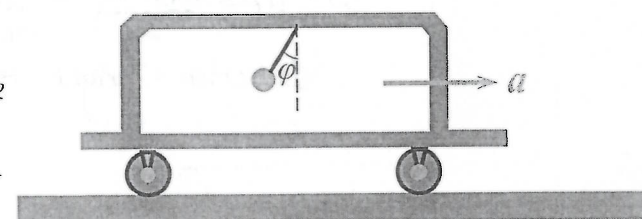


Figure 4

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 $\omega^2 R$, 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 $a = \underline{\tan \phi g}$. (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)

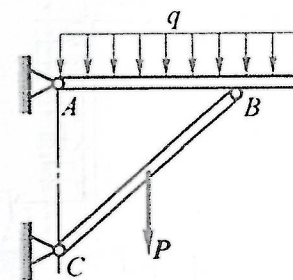


Figure 5

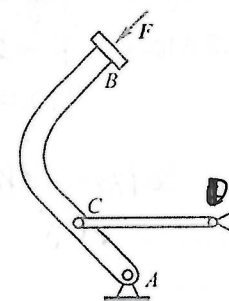
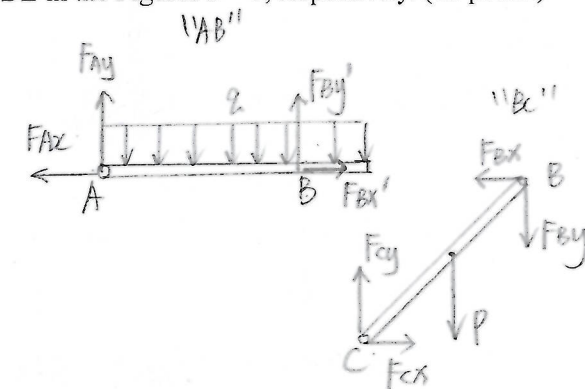


Figure 6

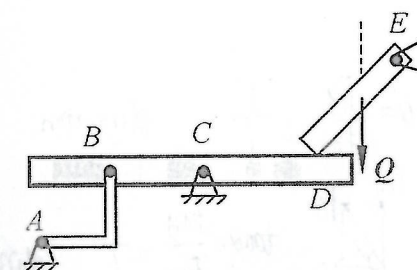
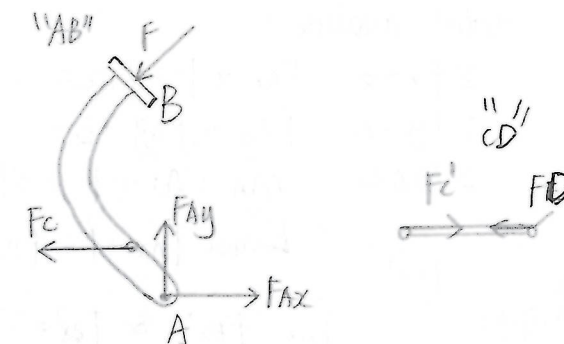
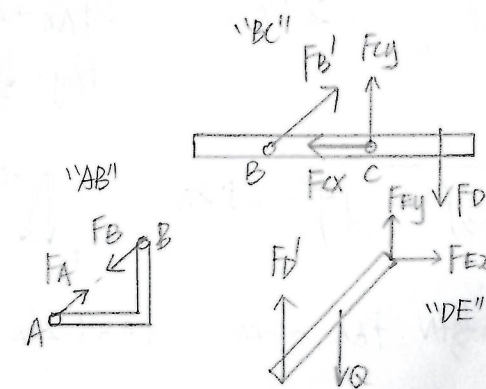


Figure 7



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 . (15 points)

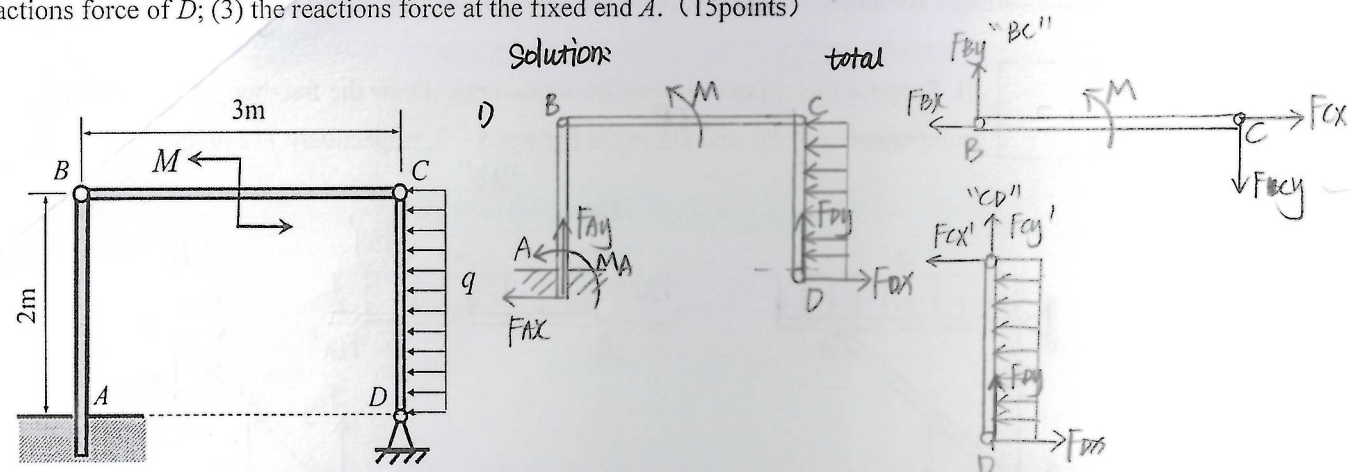


Figure 8

Solution: $F = L_{AB} q = 8 \text{ kN}$.

total analyse:

$$\sum F_x = 0 \quad F_{Ax} + F = F_{Dx}$$

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

$$\sum M_A = 0 \quad M_A + M + F + 3F_{Dy} = 0$$

because $F_{Ax} + F = F_{Dx}$ $F_{Dx} = 4 \text{ kN}$ so $F_{Ax} = -4 \text{ kN}$

$$F_{Ax} = F_{Bx}' \quad \text{so } F_{Bx}' = -4 \text{ kN}$$

$$F_{Ay} = F_{By}'$$

$$\sum M_B = 0 \quad -2F_{Ax} + M_A = 0 \quad M_A = 8 \text{ kN}\cdot\text{m} \quad F_{Dy} = -\frac{10}{3} \text{ kN}$$

$$F_{Ay} = \frac{10}{3} \text{ kN}$$

$$2) F_D = \sqrt{\left(\frac{10}{3}\right)^2 + 4^2} = \sqrt{\frac{244}{9}} \approx 5.2 \text{ kN}$$

$$\tan \theta = \frac{F_{Dy}}{F_{Dx}} = \frac{5}{4} \quad \text{direction}$$

$$3) F_{Ay} = \frac{10}{3} \text{ kN} \quad F_{Ax} = +4 \text{ kN} \quad F_A \approx 5.2 \text{ kN}$$

$$\tan \alpha = \frac{F_{Ay}}{F_{Ax}} = \frac{5}{4} \quad \text{direction}$$

得分 14
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)

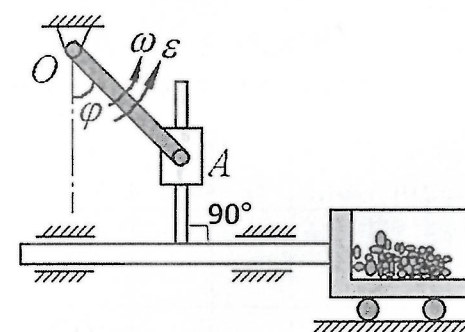
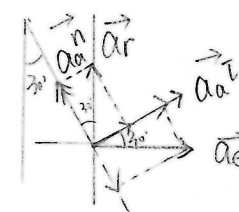
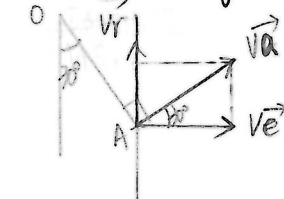


Figure 9

Solution: we choose A as study point. A on rod OA.

MRF: the car and rod

FRF: the ground



A's absolute movement is doing circular

$$v_a = \omega l \Rightarrow v_a = 1 \text{ m/s}$$

according to the rule that $\vec{v}_a = \vec{v}_r + \vec{v}_t$

$$v_e = \cos 30^\circ v_a \quad v_e = \frac{\sqrt{3}}{2} \text{ m/s}$$

So the car's velocity is $\vec{v}_e$ $v_e = \frac{\sqrt{3}}{2} \text{ m/s}$ direction $\vec{v}_e$

$$a_a^n = \omega^2 l = 4 \times \frac{1}{2} = 2 \text{ m/s}^2$$

$$a_a^t = \varepsilon l = 2 \text{ m/s}^2 \quad \vec{a}_a^n + \vec{a}_a^t = \vec{a}_e + \vec{a}_r$$

$$a_a^n = a_r \cos 30^\circ - a_e \sin 30^\circ$$

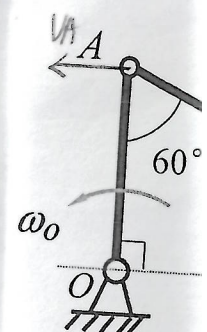
$$a_a^t = a_e \cos 30^\circ + \sin 30^\circ a_r$$

$$\text{so } a_e = \frac{2\sqrt{3}-2}{2} = \sqrt{3}-1 \text{ m/s}^2 = 0.73 \text{ m/s}^2$$

direction right to the right $\vec{a}_e$

得分 7
Score

The line OO_1B is
nd acceleration



tion: A is d
B's

Choose A as bo
poi

$$\vec{a}_B = \vec{a}_{Bn} +$$