

CAMEROON GENERAL CERTIFICATE OF EDUCATION BOARD

Probatoire De Brevet de Technicien Examination

JUNE 2016

Date: Thursday 26-05-2016

Series/ Specialties	Automobile Repair Mechanics (MA), Sheet-Metal and Metallic Construction (MF-CM)
Subject Title	Applied Mechanics - Syllabus E
Subject Code No.	00-6001-E
Type of Exam	WRITTEN
Weighting (Coef.)	SEE INSIDE

Duration: 14:00 - 16:00

General Instructions

*You are reminded of the necessity for good English and orderly presentation of your material.
Where calculations are involved show your working, giving your answer at each stage.*

Content: QUESTION BOOKLET

Specific Instructions

1. This paper consists of two booklets:
-a question booklet, and
-an answer booklet
2. You are required to read the question booklet and write down your answers in the answers in the answer booklet
3. At the end of the paper, hand in the answer booklet ONLY
4. Where you find that there is need to tear off any sheets, so as to ease referencing or to hand in with the answer booklet, please feel free to tear off such sheets using a Straightedged ruler.

Turn over

APPLIED MECHANICS PAPER

Authorized Documents: None

Authorized means of calculation: Any non-programmable pocket electronic calculator.

The paper is comprised of three (03) independent parts on 05 pages numbered from 1/5 to 5/5.

- STATICS
- KINEMATICS
- STRENGTH OF MATERIAL

THEME: ELECTRIC CAR JACK

I- SETTING UP

Figure 1 represents a car jack which makes it possible to raise motor vehicles to be able to dismount a wheel or to reach the lower part of the chassis. It is here about a model which presents the particularity of being equipped with an electrical motor.

II- FUNCTIONING

The car jack is presented in folded configuration (low position, figure 2). They place it under the vehicle at the level of the mark registered on the chassis. After connection on the socket cigar-lighter of the car, the user controls the deployment or the fold of the jack via a control placed on the wire supply. The jack is set in motion by an energy chain made up of the following elements:

- The electrical motor equipped with a gears reducer not represented;
- A screw-nut mechanism (9-7), on the output of the reducer, allows the movement of the deformable parallelogram composed of arms 2, 3, 4 and 5 articulated at A, B, C, D, E and F;
- The parallelogram, while being contracted horizontally lengthens vertically. Consequently the clevis 6 moves vertically and allows the upward or downward movement of the vehicle.

III- WORD REQUIRED

III-A STATICS STUDY / 8 marks

Aim : To determine the required effort on screw 9 to support the maximum loading of the vehicles as well as the reactions of the ground 0 at S and T under the same load.

Hypotheses:

- The mechanism is at the height of 280mm;
- All the parts are represented in this position and their weights are neglected;
- The jack is in equilibrium under the maximum weight $\|\vec{P}\| = 10000\text{N}$ of a vehicle;
- For this study, frictions are neglected;
- The study is carried out in the symmetry plane of the device;
- The scale of the forces is $1\text{ cm} \Leftrightarrow 1000\text{ N}$.

Questions:

A-1 Equilibrium of the arm 5.

They isolate 5. Apply the Fundamental Principle of Statics to the equilibrium of the arm 5, deduce the support of the mechanical actions at points F and D and draw it. 0.5mk

A-2 Equilibrium of the head 6.

A-2-1 They isolate 6. Fill the table bill of external mechanical actions applied to 6. 0,75mk

A-2-2 Draw the support of $\vec{E}_{4/6}$ by justifying it. 0,75mk

A-3 Equilibrium of the arm 3.

They isolate 3. Apply the Fundamental Principle of Statics to the equilibrium of the arm 3, deduce the support of the mechanical at points B and D and draw it. 0.5mk

A-4 Equilibrium of the nut 7.

A-4-1 They isolate 7. Fill the table bill of external mechanical actions applied to 7. 0,75mk

A-4-2 While taking $\|\vec{F}_{5/6}\| = 7100\text{N}$, determine graphically $\|\vec{D}_{3/7}\|$ and $\|\vec{D}_{9/7}\|$. 2,25mks

A-5 Equilibrium of the jack.

While taking $\|\vec{P}\| = 10000\text{N}$, determine analytically the reactions on the ground 0 $\|\vec{S}_{0/1}\|$ and $\|\vec{T}_{0/1}\|$ on the support. 2,5mks

III-B KINEMATICS STUDY / 7 marks

Aim: To determine the trajectories of the points D and G of the jack and the equations of the movement of the point G during the start-up phase

Hypotheses:

- The jack is in low position (figure 2). It is deployed to lift a car;
- All the movements are in the plan (\vec{x}, \vec{y}) .

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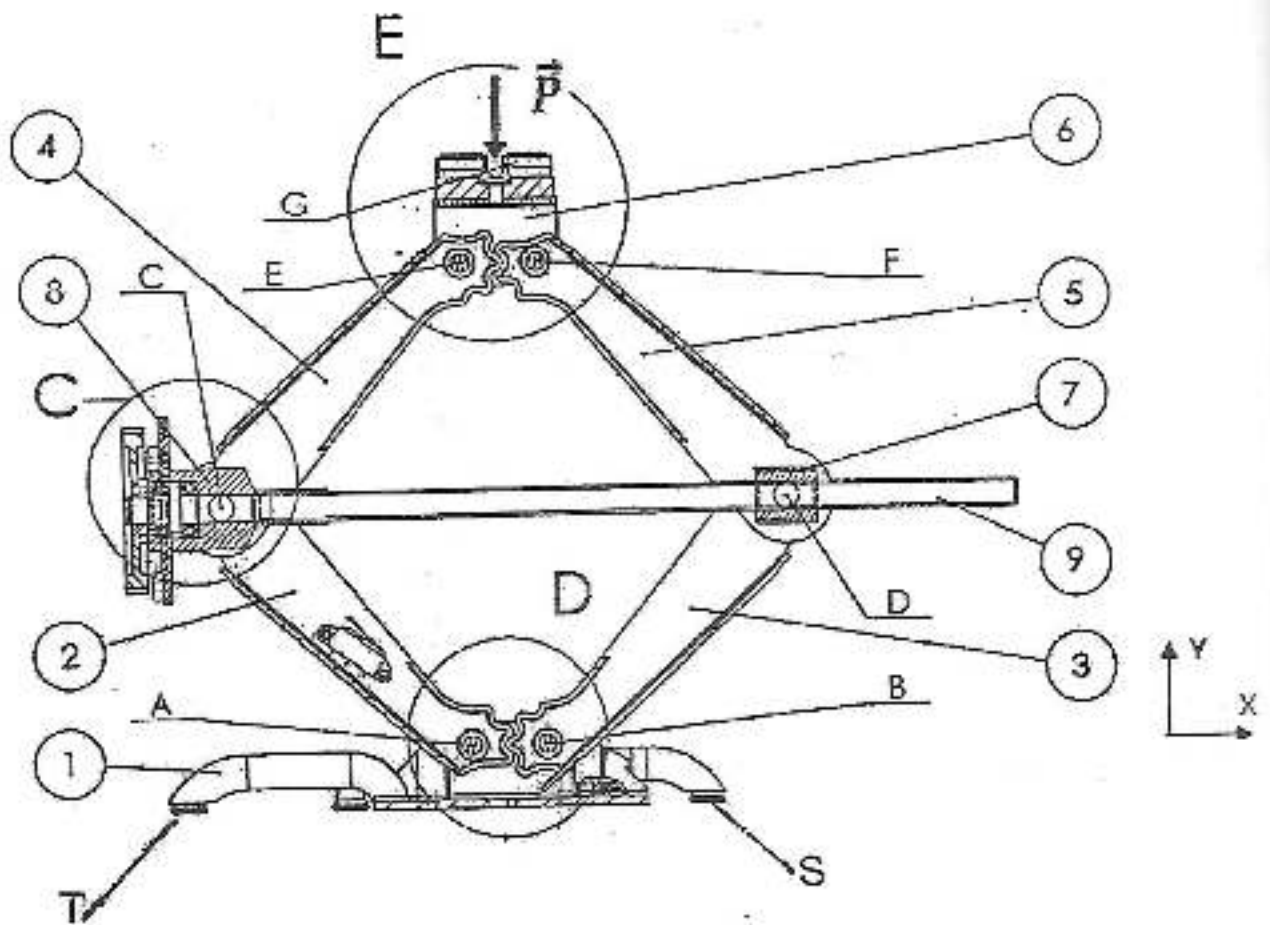


Figure 1

(Only the lifting part is represented, without reducer and without motor. The threads are represented in simplified mode)

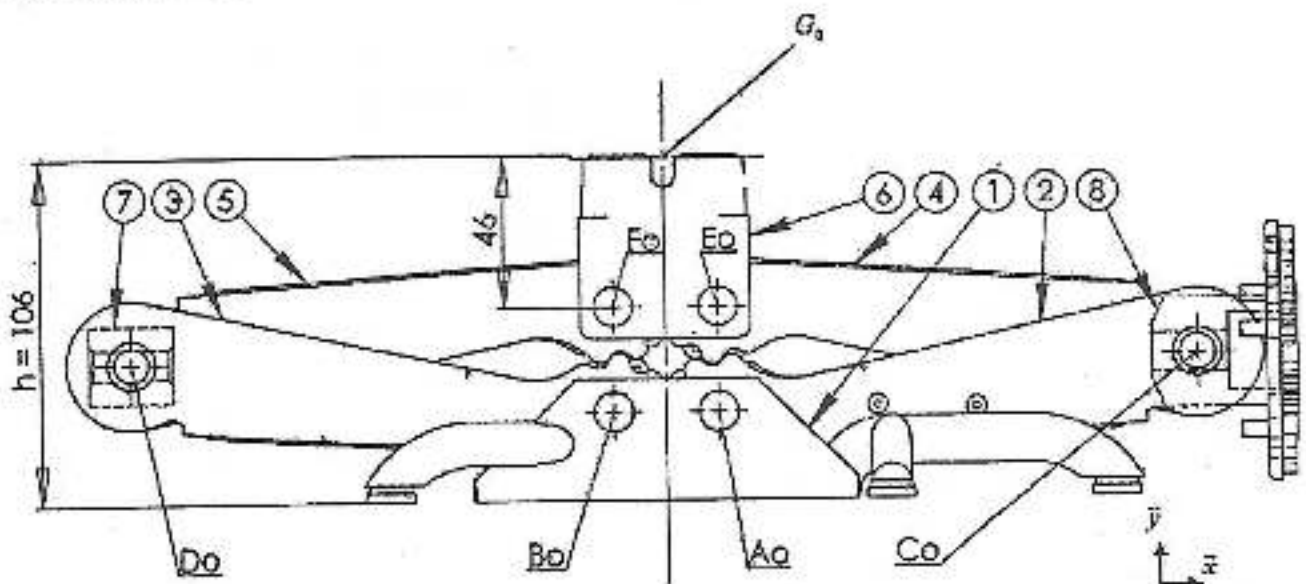


Figure 2

- ($A_0, D_0, C_0, D_0, E_0, F_0$ and G_0 correspond respectively to the starting position of the points A, B, C, D, E, F and G).
- All the layouts will be made on the sheet 4 /5

Questions:

- B-1 Give the nature of the following movements: $M^{VI} 3/1$, $M^{VI} 6/1$ and $M^{VI} 5/1$. 1,5mks
- B-2 Determine and draw the trajectory of point D during the movement of 3 in respect with 1. ($T_{D3/1}$) 1mk
- B-3 Determine and draw the trajectory of point G during the movement of 6 in respect with 1. ($T_{G6/1}$). 1mk
- B-4 Determine and draw the supports of the velocity vectors of points D and G: $\vec{V}_{D3/1}$ and $\vec{V}_{G6/1}$. 1mk
- B-5- They consider the rectilinear translational movement of the point G during its rise. This movement includes three phases which are successively start-up, the uniform rise and the braking.
- The origin of the X-coordinates is the G_0 point. The unit of time is the second, the length is in meter.
- During the start-up phase, for which $0 \leq t \leq 0,5$, the movement of the point G is uniformly varied such as: at the instant $t = 0$; $x = 0$ and $V = 0$; and at the instant $t = 0,5$; $V = 0,8m/s$.
- B-5-1 Calculate the acceleration a_G of the point G during this phase. 0.5mk
- B-5-2 Determine the equations of the movement of the point G. 1.5mks
- B-5-3 Calculate the X-coordinate of the point G at the instant $t = 0,5s$. 0.5mk

III – C STRENGTH OF MATERIAL / 5 marks

Aim: To dimension the pin A ensuring the linkage between 1 and 2

Hypotheses and data :

- The clevis pin A is modeled by the diagram opposite.
- The slip yield stress is $R_{e0} = 458N/mm^2$.
- The adopted coefficient of safety $s = 3$.
- The effort supported by the clevis pin A is $\|\vec{F}\| = 1500N$.

Questions:

- C-1 Give the nature of the stress to which is subjected the pin A. 1,5mks
- C-2 give the number of loaded sections. Indicate those sections. 1mk
- C-3 Calculate the minimal diameter which makes it possible to this pin to resist the aforementioned stress. 2mks

