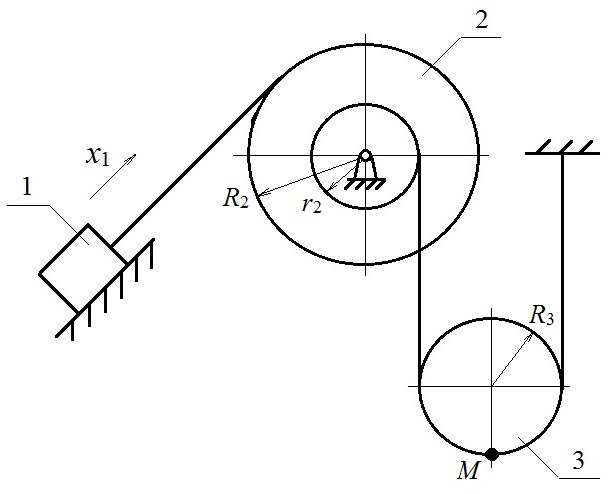
**ТМ-9 part 1**

Determine laws of motion of bodies 2 and 3 (fig. 1), absolute velocity and acceleration of point *М*. It is known, that the law of motion of body 1 is *x*1 = 5*t*2, m; external radius of body 2 is *R*2 = 1 m, internal radius of body 2 is *r*2 = 0.5 m, and a radius of body 3 is *R*3 = 0.75 m, time parameter is *t* = 1 s.



**Fig. 1** Initial scheme

**Solution**

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| Given:  *x*1 = 5*t*2, m  *R*2 = 1 m  *r*2 = 0.5 m  *R*3 = 0.75 m  *t* = 1 s  Find:  *φ*2, *φ*3, *vM*, *aM* | E:\Онищенко\ТМ-9ч1.розр.сх2.jpg |
|  | **Fig. 2** Calculation scheme |

Construct a calculation scheme (fig. 2). Place additional points *A*, *B*, *C*, *D*, *P* on it, and directions of motion of bodies 2 and 3, directions of angular velocity *ω*3 and angular acceleration *ε*3 of body 3, and a vector of absolute velocity *vM*.

Body 1 moves linearly, body 2 rotates, and body 3 performs plane motion. Body 1 and point *A* are connected through an ideal string (the one that doesn’t deform). Points *B* and *D*, *P* and a support are also connected through an ideal string.

Direction of motion of body 1 is given in the initial data. If body 1 moves linearly along an inclined surface and is connected with point *A* through an ideal string, then body 2 rotates clockwise (designated as *φ*2 in fig. 2). Direction of motion of body 3 can be determined analogically. Body 3 rotates counterclockwise (designated as *φ*3 in fig. 2).

If a string is ideal, then movement of body 1 is equal to a length of a string, which is wound up on external radius of body 2. Analogically, a length of a string, which is unwound from internal radius of body 2, is equal to a length of a string, which is wound up on radius of body 3. Express string lengths using the angle and radius of rotation.

Determine the equations of kinematic connections

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From where the laws of motion of bodies 2 and 3 are

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Determine angular velocity *ω*3 and angular acceleration *ε*3 of body 3.

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*ω*3 and *ε*3 are directed counterclockwise since they are positive for a positive *t*.

Body 3 performs plane motion and is connected with a support through a string. Then a center of rotation (instantaneous center of velocity) of body 3 is point *Р*.

Determine absolute velocity of point *М*.

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At the moment of time *t* = 1 s

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Absolute acceleration of a body, which performs plane motion, is determined as a vector sum of accelerations of a pole , normal , and tangent accelerations of the considered point around this pole. The pole is the point, acceleration of which is known or is easy to calculate. Define point *С* as a pole since it is a center of mass of body 3 and moves linearly.

Determine acceleration of point *С*

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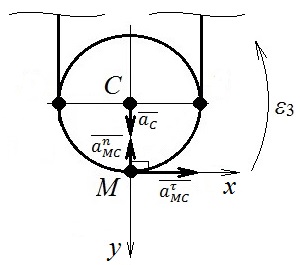
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Determine normal and tangent accelerations of point *М* relatively to the pole *С* at the moment of time *t* = 1 s

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In order to determine absolute acceleration of point *М*, project the vectors of determined accelerations on coordinate axes *x* and *y* (fig. 3). Note that normal acceleration is directed from point *M* to the pole *C*, and tangent acceleration is perpendicular to the normal acceleration and is directed along angular acceleration .



**Fig. 3** Acceleration calculation scheme

Then absolute acceleration *aM* of point *М*

**Answer:** , , , .