UNIVERSITY OF JOHANNESBURG

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| **PROGRAM** | : | NATIONAL DIPLOMA<br>*ENGINEERING: MECHANICAL (EXT)*<br>*ENGINEERING: INDUSTRIAL (EXT)* |
| **SUBJECT** | : | **MECHANICS I** |
| **CODE** | : | **CHM111T** |
| **DATE** | : | MAIN EXAMINATION<br>28 NOVEMBER 2016 |
| **DURATION** | : | 12h30 – 15h30 |
| **WEIGHT** | : | 40 : 60 |
| **TOTAL MARKS** | : | 100 |

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| **EXAMINER** | : | MR T.A. BALOYI |
| **MODERATOR** | : | MR S.L. GQIBANI |
| **NUMBER OF PAGES** | : | 5 PAGES |

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| **INSTRUCTIONS** | : | ANSWER ALL THE QUESTIONS. |
| | : | ALL DIMENSIONS ON DIAGRAMS ARE IN mm UNLESS OTHERWISE SPECIFIED. |
| | : | ONLY NEAT SKETCHES OF A SUITABLE SIZE WILL BE GIVEN CREDIT. |
| | : | ONE CALCULATOR PER CANDIDATE. |

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## QUESTION 1

Figure 1 shows the tensions in the tight and slack sides of a rope passing round a pulley of weight 400 N. Calculate the magnitude and direction of the resultant force on the bearings.

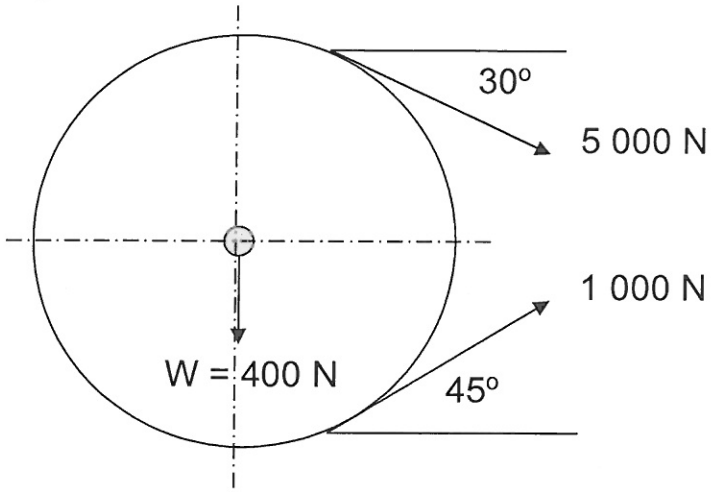


**Figure 1**

**[10]**

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## QUESTION 2

Figure 2 shows three blocks interacting. A 15 kg wedge is used to lift a 60 kN block as shown. The coefficient of friction between the 60 kN block and the wall is 0,35 and on both sides of the wedge is 0,25. Determine the smallest magnitude of force P required to push the 60 kN block upwards.

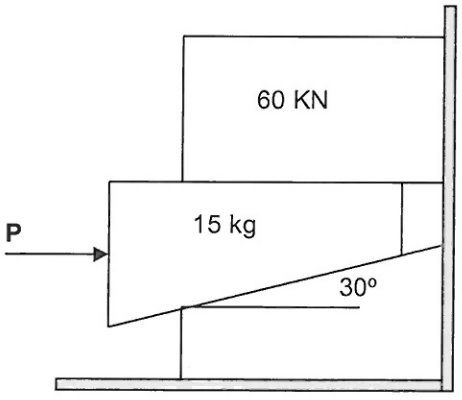


**Figure 2**

**[12]**

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## QUESTION 3

The cable and the beam shown in Figure 3 support a load of 1 200 N. The beam is uniform and weighs 500 N. Determine:

3.1 the tensile force in the cable and; (5)

3.2 the reaction at A. (5)

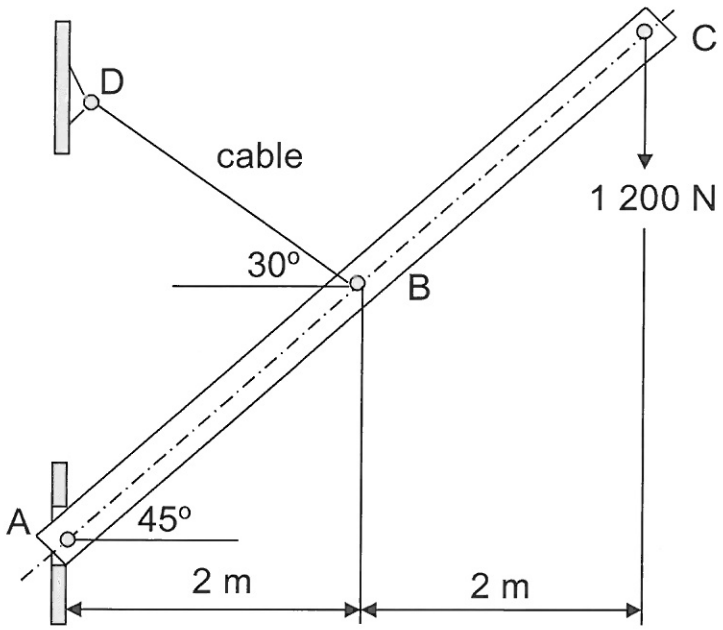


**Figure 3**

**[10]**

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## QUESTION 4

The stepped machine component shown in Figure 4 is made from two different materials. The step with the larger diameter has a density three times that of the density of the smaller section. Each step has a conical hole drilled into it to depths of 45 mm and 30 mm respectively. Calculate the position of the centre of gravity measured from the left end.

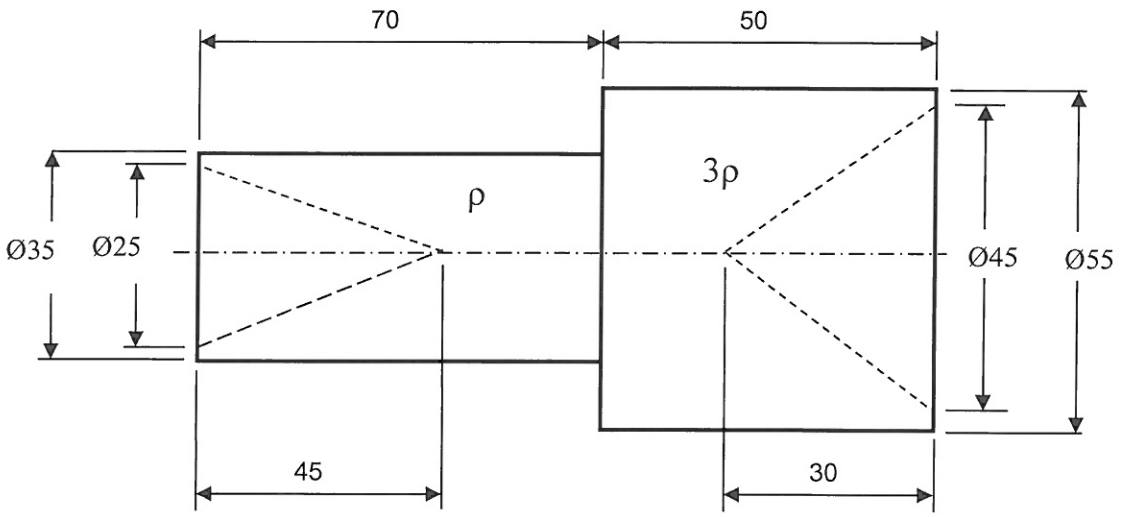


**Figure 4**

**[12]**

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## QUESTION 5

The driver of a train shuts off the power and the train is then uniformly retarded. In the first 30 seconds the train covers 110 m and it comes to rest in a further 30 seconds. Determine:

5.1 the initial speed of the train before power is cut off, (7)

5.2 the total distance travelled before to rest (3)

**[10]**

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## QUESTION 6

A helical spring has a free length of 320 mm and a spring rate of 0,65 N/mm.

6.1 Sketch a graph and use it to calculate the work done to compress this spring to 85 mm from its free length. (5)

6.2 Calculate the work required to compress this spring from 210 mm long to 105 mm in length. (5)

**[10]**

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## QUESTION 7

The front and back wheels of a racing car have effective diameters of 600 mm and 720 mm respectively. The car moves with uniform acceleration from 180 km/hr to 252 km/hr over a distance of 500 m. Calculate:

7.1 the linear acceleration of the racing car and the angular acceleration of each wheel set; (4)

7.2 the number of revolutions completed by each set of wheels during acceleration; (3)

7.3 the final angular velocity, in rad/s and r/min, respectively, of each wheel set. (3)

**[10]**

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## QUESTION 8

A water jet from a nozzle has a diameter of 20 mm and strikes a wall at 90°. Calculate the force of the water on the wall if the nozzle discharges 12 litres of water per second.

**[6]**

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## QUESTION 9

Calculate the force applied by a diesel unit on a train, total mass 200 000 kg and tractive resistance 10 000N, to accelerate the train uniformly from rest to 42 km/h over a distance of 1 km:

9.1 directly upwards against a plane of 1 in 100 (5)

9.2 down a plane of 1 in 200 (5)

**[10]**

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## QUESTION 10

A loaded bus has a mass of 20 000 kg and a constant tractive resistance of 64 N/Mg mass. The unit moves in neutral gear from rest directly down a slope of 1 in 70 over a distance of 400 m and then moves over a horizontal surface until it comes to rest. Calculate:

10.1 the velocity of the loaded bus when it reaches the bottom of the slope after 400 m and (6)

10.2 the distance it will still travel before coming to rest. (4)

**[10]**

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