

OCR

Oxford Cambridge and RSA

Level 3 Cambridge Technical in Engineering
05822/05823/05824/05825/05873**Unit 3: Principles of mechanical engineering****Monday 21 May 2018 Morning****Duration: 1 hour 30 minutes****C303/1806****You must have:**

- the formula booklet for Level 3 Cambridge Technical in Engineering (inserted)
- a ruler (cm/mm)
- a scientific calculator

First Name						Last Name				
Centre Number						Candidate Number				
Date of Birth	D	D	M	M	Y	Y	Y	Y		

INSTRUCTIONS

- Use black ink. You may use an HB pencil for graphs and diagrams.
- Complete the boxes above with your name, centre number, candidate number and date of birth.
- Answer **all** the questions.
- Write your answer to each question in the space provided. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- The acceleration due to gravity is denoted by $g \text{ m s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$

INFORMATION

- The total mark for this paper is **60**.
- The marks for each question are shown in brackets [].
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- An answer may receive no marks unless you show sufficient detail of the working to indicate that a correct method is being used.
- Final answers should be given to a degree of accuracy appropriate to the context.
- This document consists of **16** pages.

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Question No	Mark
1	/11
2	/12
3	/9
4	/14
5	/6
6	/8
Total	/60

Answer **all** the questions.

- 1 (a) A Class one lever of length 1.2 m has a load of 50 kg positioned at one end. At the other end of the lever is an input force, F_1 N, sufficient to lift the load. The fulcrum is located 0.5 m from the load.

- (i) Draw a diagram showing the lever and the forces acting on it. You should show clearly the direction in which the input force must be applied in order to lift the load.

[2]

- (ii) Calculate the minimum value of F_1 required to lift the load. The mass of the lever can be neglected.

.....
 [2]

- (iii) Calculate the velocity ratio (VR) of the lever.

..... [1]

- (b) Name **one** application that uses a Class two lever.

..... [1]

- (c) Name **one** reason why a wormgear and wormwheel gear system would be used in preference to a spur gear system.

.....
 [1]

- (d) Give **one** reason why a toothed belt would be used rather than a flat belt.

.....
 [1]

- (e) A gear train consists of an input gear with 40 teeth, an output gear with 30 teeth and an idler gear between them with 60 teeth. This is shown in Fig. 1.

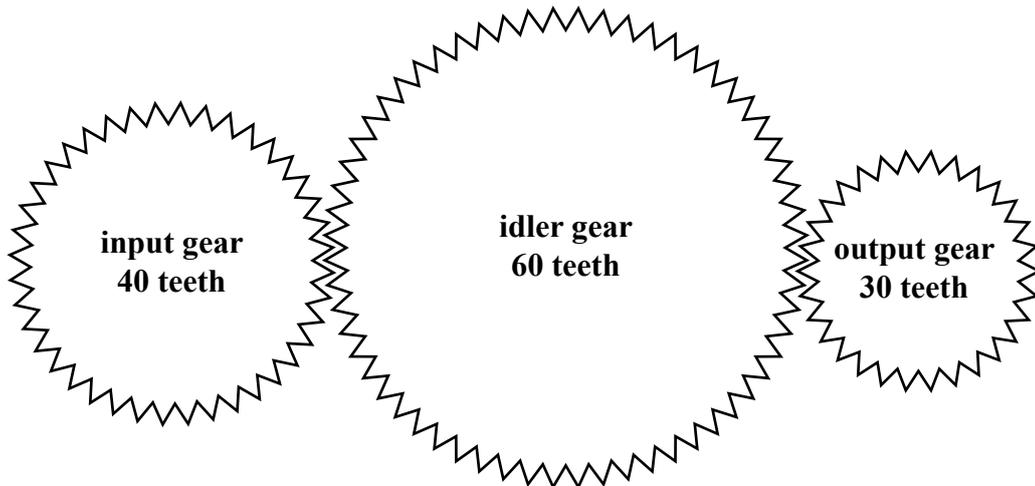


Fig. 1

- (i) Calculate the overall velocity ratio of the gear system.

.....
 [2]

- (ii) The output gear must rotate at a speed of 90 rpm. Calculate the speed required for the input gear.

..... [1]

- 2 A van of mass 2400 kg is travelling up a slope with a rough surface inclined at 4° to the horizontal. The engine of the van produces a driving force of P N. The coefficient of friction between the road surface and the tyres of the van is 0.3.

(i) Draw a diagram showing all the forces acting on the van.

[2]

(ii) Calculate the magnitude of the friction force acting on the van.

.....
.....
..... [3]

(iii) Calculate the acceleration of the van when $P = 10\,000$.

.....
.....
..... [3]

The van reaches the top of the slope travelling at a speed of 9.2 m s^{-1} . It then travels with a constant acceleration of 0.9 m s^{-2} for a distance of 75 m until it reaches a bend in the road.

(iv) Calculate the speed reached by the van.

.....
..... [2]

(v) Calculate the increase in kinetic energy of the van between the time it reaches the top of the slope and the time it reaches the bend in the road.

.....
..... [2]

Turn over for the next question

- 3 (a) Fig. 2 shows the cross-section of a beam in which all dimensions are in millimetres (mm). The beam is 14 m long and made from steel with a density of 8000 kg m^{-3} .

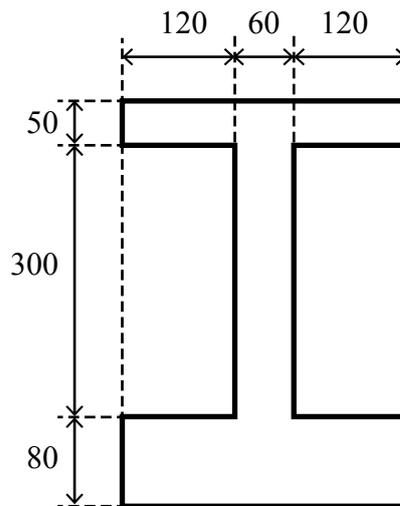


Fig. 2

- (i) Calculate the area of the cross-section, giving your final answer in m^2 .

.....

 [3]

- (ii) Calculate the mass of the beam.

.....
 [2]

- (iii) The beam is subjected to a load which causes an axial strain of 8×10^{-4} . Calculate the change in length of the beam.

..... [1]

- (iv) Explain what would happen to the material of the beam if it were subjected to operational stress levels above the elastic limit.

.....
 [1]

(b) A bolt in single shear is subjected to a shear force of 120 kN. It experiences a shear stress of 200 MPa. Calculate the shear area of the bolt.

.....
..... [2]

Turn over for the next question

- 4 (a) A particle is subjected to four forces as shown in Fig. 3. Calculate the magnitude of forces P and Q so that the particle remains in equilibrium.

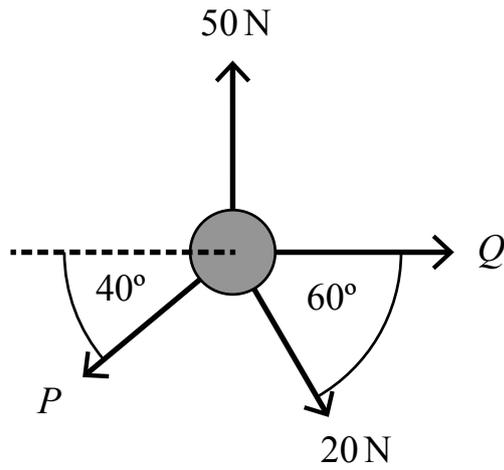


Fig. 3

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..... [4]

- (b) Fig. 4 shows a uniform metal plate aligned within a Cartesian coordinate system, (x, y) , with the origin at point O. All dimensions shown are in metres (m).

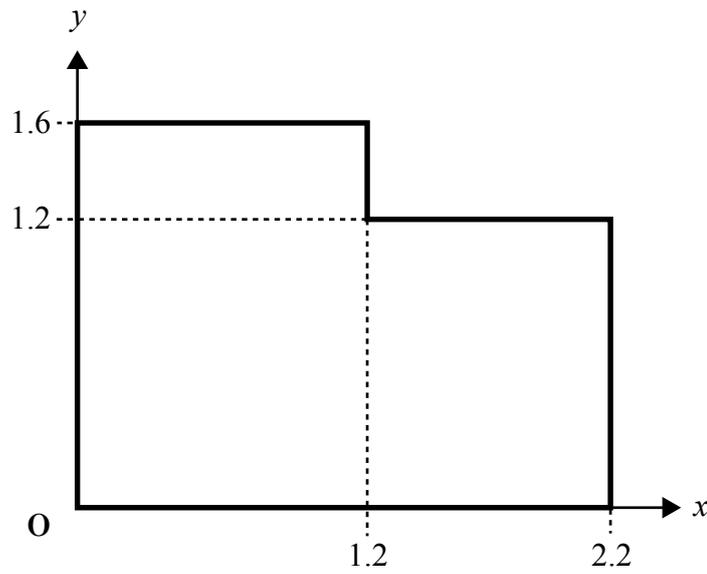


Fig. 4

Calculate the coordinates of the centroid of the metal plate.

.....

.....

.....

..... [4]

- (c) Fig. 5 shows a plate in the shape of a trapezium, ABCD. The plate is subjected to a force of 10 N at corner A, a force of 12 N at corner B and a force of 15 N at corner D. All lengths shown are in metres (m).

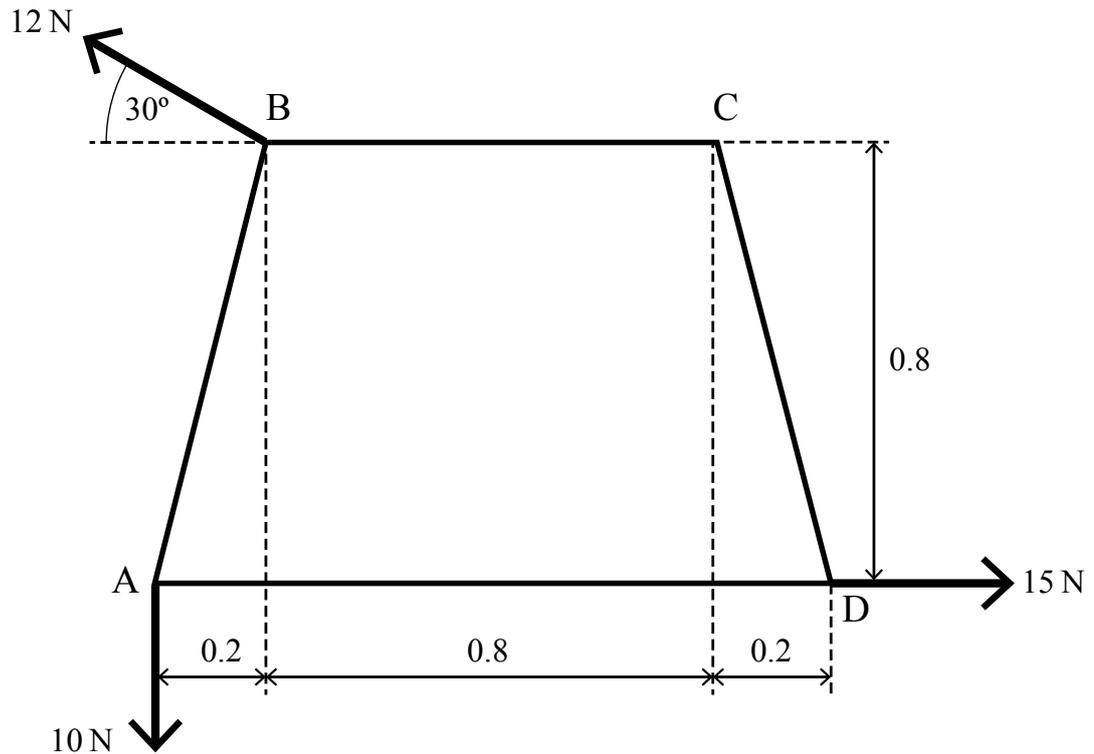


Fig. 5

- (i) Calculate the magnitude of the resultant force acting on the plate.

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.....

.....

..... [4]

- (ii) Calculate the moment about corner B.

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..... [2]

5 A motorcycle and its rider with a combined mass of 250 kg travels along a smooth, straight and level road for a period of 30 seconds while the engine produces an average power of 5 kW.

- (i) Calculate the work done by the engine. You must give appropriate units with your answer.

.....
..... [2]

- (ii) During the 30 s time period the motorcycle travels a distance of 600 m. Calculate the average driving force of the engine.

.....
..... [1]

- (iii) During the 30 s time period the speed of the motorcycle increases from 5 m s^{-1} to 28 m s^{-1} . A resistance force opposes its motion during this time. Using an energy method calculate the work done by this resistance force.

.....
.....
..... [3]

- 6 (a) Fig. 6 shows a beam of length of 8 m which is simply supported at ends A and B. The self weight of the beam produces a uniformly distributed load (UDL) of 350 N m^{-1} . The beam is also subjected to two forces of 800 N and 600 N acting vertically downward at the positions indicated.

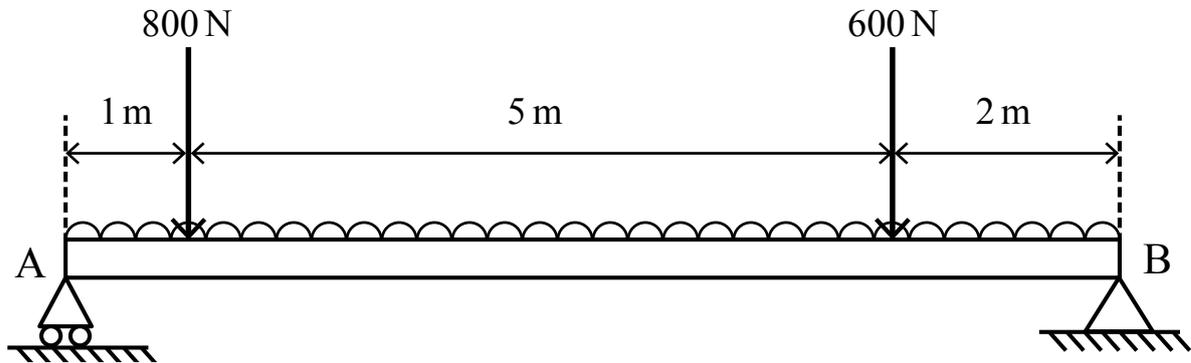


Fig. 6

- (i) Calculate the reactions at the two supports.

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.....

.....

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.....

..... [5]

- (ii) Name the type of support shown at end B.

..... [1]

- (iii) A horizontal force of 200 N acting to the right is now applied at end A. State the magnitude, direction and location of the reaction force as a result of this additional force.

..... [1]

- (b) Give an example of something that could cause a point load to act on a beam.

..... [1]

END OF QUESTION PAPER

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