1.7 Mechanisms and Motion

AQA 8552 · Calculator allowed · about 30 minutes

Total Marks

Name: _____ Date: ____ / ____ / _____

Answer ALL questions.

1 A display turntable rotates continuously in one direction about a fixed vertical axis. Name the type of motion.

(Total for Question 1 is 1 mark)

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2 A 15-tooth driver turns a 45-tooth gear. That gear is fixed to the same shaft as a 10-tooth compound driver, which meshes with a 40-tooth output gear. The input turns at 240 rpm. Find the output speed. Assume ideal gears and no slip.

(Total for Question 2 is 3 marks)

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3 A hand-operated mixing paddle must turn continuously in one direction. Its handle is turned by the user, and the paddle shaft must turn more slowly but with greater ideal torque. Choose a suitable mechanism from a pair of meshing gears, a crank and slider, or a cam and follower. The available gears are 12-tooth input and 36-tooth output gears. Explain the choice and calculate the output speed ratio as output speed divided by input speed.

(Total for Question 3 is 3 marks)

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4 A small ventilation flap must repeatedly move from 0 degrees to 60 degrees and back, with a pause at each end. The motor shaft rotates continuously. The design must use one simple mechanism selected from a crank and slider, a cam and follower, or a pair of meshing gears. Select the best mechanism and explain how its output suits the requirement.

(Total for Question 4 is 3 marks)

5 A toy car moves in a straight line along a level track without changing its orientation. Name the type of motion.

(Total for Question 5 is 1 mark)

6 A windscreen wiper blade turns through 70 degrees, stops, then turns back through 70 degrees about the same pivot. State the type of motion.

(Total for Question 6 is 1 mark)

7 A crank pin moves around a circular path while a connecting rod makes a piston move back and forth along a straight guide. State the motion conversion at the mechanism output.

(Total for Question 7 is 1 mark)

8 A first-class lever has its pivot midway between the effort and load. The effort acts 0.30 m from the pivot and the load acts 0.30 m from it. An effort of 40 N is applied at right angles to the lever. Calculate the load force when balanced.

(Total for Question 8 is 2 marks)

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9 A second-class lever is used to lift a 180 N load. The pivot-to-effort distance is 0.75 m and the pivot-to-load distance is 0.25 m. Both forces act at right angles. Calculate the ideal effort force.

(Total for Question 9 is 2 marks)

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10 A lever has an effort arm of 0.80 m and a load arm of 0.20 m. The effort is 25 N and the lever is balanced, with both forces at right angles. Calculate the load force.

(Total for Question 10 is 2 marks)

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11 A 12-tooth driver gear turns clockwise at 90 revolutions per minute and meshes directly with a 36-tooth driven gear. State the driven gear direction and calculate its speed.

(Total for Question 11 is 3 marks)

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12 A 20-tooth driver gear turns at 120 rpm and meshes directly with a 30-tooth driven gear. Calculate the driven gear speed and state whether the output has increased or decreased speed.

(Total for Question 12 is 3 marks)

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Mark scheme · 1.7 Mechanisms and Motion

Question 1

rotary (circular) motion **B1**

Answer: Rotary motion

Question 2

first stage speed = 240 x 15/45 = 80 rpm **M1**

second stage speed = 80 x 10/40 **M1**

output speed = 20 rpm **A1**

Answer: 20 rpm

Question 3

select a pair of meshing gears **B1**

ratio = driver teeth / driven teeth = 12/36 **M1**

output speed / input speed = 1/3; output turns more slowly, giving an ideal torque increase by a factor of 3 **A1**

Answer: Pair of meshing gears; speed ratio 1:3 (output/input = 1/3), ideal torque multiplication 3

Question 4

select a cam and follower **B1**

a shaped cam driven by the continuous rotary shaft can make a follower move back and forth **B1**

a cam profile with dwell regions can pause the flap at both ends; connect follower to pivoted flap to give angular oscillation **B1**

Answer: Cam and follower; its profile can create reciprocating follower motion with dwell, linked to the flap pivot to produce the required oscillation.

Question 5

linear motion **B1**

Answer: Linear motion

Question 6

oscillating motion **B1**

Answer: Oscillating motion

Question 7

rotary motion to reciprocating motion **B1**

Answer: Rotary to reciprocating motion

Question 8

mechanical advantage = effort arm / load arm = 0.30 / 0.30 = 1 **M1**

load = effort x mechanical advantage = 40 x 1 = 40 N **A1**

Answer: 40 N

Question 9

effort x 0.75 = 180 x 0.25, or effort = load x load arm / effort arm **M1**

effort = 180 x 0.25 / 0.75 = 60 N **A1**

Answer: 60 N

Question 10

mechanical advantage = 0.80 / 0.20 = 4 **M1**

load = 25 x 4 = 100 N **A1**

Answer: 100 N

Question 11

driven gear turns anticlockwise **B1**

speed ratio is 12 / 36 = 1/3; driven speed = 90 x 1/3 **M1**

30 revolutions per minute **A1**

Answer: Anticlockwise at 30 rpm

Question 12

speed ratio = driver teeth / driven teeth = 20 / 30 = 2/3 **M1**

driven speed = 120 x 2/3 = 80 rpm **A1**

speed decreases **B1**

Answer: 80 rpm; speed decreases

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