

Design & Technology

Edexcel GCSE

Pulleys and Belts

Materials required for questions

- Pencil
- Rubber
- Calculator

Instructions

- Use black ink or ball-point pen
- Try answer all questions
- Use the space provided to answer questions
- Calculators can be used if necessary
- For the multiple choice questions, circle your answer

Advice

- Marks for each question are in brackets
- Read each question fully
- Try to answer every question
- Don't spend too much time on one question

Good luck!

Q1. What is a pulley?

- A** A wheel with a groove around the outside
- B** A toothed wheel that meshes with another
- C** A rod that pivots around a fixed point

Q2. In a crossed belt drive, the two pulleys turn

- A** in the same direction
- B** in opposite directions
- C** at 90° to each other

Q3. A 20 mm diameter driver pulley turns a 60 mm diameter driven pulley.
What is the velocity ratio?

- A** 1:3
- B** 2:1
- C** 3:1

Q4. Which type of belt cannot slip?

- A** Toothed (timing) belt
- B** Flat belt
- C** V-belt

Q5. A small driver pulley turns a large driven pulley. The driven pulley will turn

- A** faster than the driver
- B** slower than the driver
- C** at the same speed as the driver

Q6. What does a tensioner (jockey pulley) do?

- A** Reverses the direction of the belt
- B** Increases the speed of the output
- C** Keeps the belt tight so it does not slip

Q7. A model boat is driven by a motor and a pulley system. The pulley system has a velocity ratio of 5:1. The input speed is 2000 revolutions per minute (rpm).

Calculate the output speed of the pulley system. Use the formula: velocity ratio = input speed $\div$ output speed. Give your answer in rpm. **(2 marks)**

Q8. A student considered a pulley system when prototyping a drone. In the system, the driver pulley is half the diameter of the driven pulley.

Q8a. Explain why the driven pulley rotates slower than the driver pulley. **(2 marks)**

Q8b. The pulley system has a velocity ratio of 1:2. The speed of the driver pulley is 20 revolutions per minute. Calculate the speed of the driven pulley. Show all workings. **(2 marks)**

A different pulley system uses two pulleys, both 20 mm in diameter. The distance between the centres of the pulleys is 50 mm.

Q8c. Calculate the length of the pulley belt required for the system. Show all workings. **(3 marks)**

Q8d. Explain one advantage of using a pulley system when developing the design of the drone. **(2 marks)**

Q9. A record player uses a rubber belt to drive the turntable. The motor pulley has a diameter of 20 mm and the turntable has a diameter of 180 mm.

Q9a. Calculate the velocity ratio of the driven pulley. Show all workings. **(2 marks)**

Q9b. Describe the differences between a simple gear train and a pulley and belt drive. **(4 marks)**

Q10. The cord in a litter picker moves through a pulley mechanism when the trigger is pulled.

Describe the function of a pulley mechanism. **(2 marks)**

Answers

Q1. A

Q2. B

Q3. C

Q4. A

Q5. B

Q6. C

Q7.

A calculation that includes:

- Correct transposition of the formula: output speed = input speed $\div$ velocity ratio (1)
- Correct calculation: $2000 \div (5/1) = 400$ rpm (1)

Q8a.

Two marks for a short but clear explanation. For example:

- One revolution of the driver is half a revolution of the driven pulley
- The driver pulley is half the size of the driven pulley
- If the driver pulley rotates one revolution per minute, the driven pulley can only rotate half a revolution in one minute

Q8b.

Speed of driver pulley is 20 (1); speed of driven pulley = $20 \times 1/2 = 10$ revolutions per minute (1). Credit any other appropriate method.

Q8c.

- $3.142 \times 20 = 62.84$ (circumference of one pulley) (1)
- $2 \times 50 = 100$ (length between the centres of the pulleys) (1)
- Total length = $100 + 62.84 = 162.84$ mm (1)

Credit any other appropriate method of calculation.

Q8d.

Two marks for a short but clear explanation of one advantage, e.g.:

- Pulleys are readily available in different sizes and forms, e.g. flat pulleys, V pulleys
- It is easy to change the size of the pulleys, or to change belts
- Pulleys can be designed to be lightweight, which is essential for the drone to fly

Q9a.

Velocity ratio = diameter of driven pulley $\div$ diameter of driver pulley = 180 mm $\div$ 20 mm (1) = 9 or 9:1 (1).

Q9b.

Up to 2 marks for two differences simply stated; up to 2 additional marks if described and/or compared:

- Gear train: driver and driven shafts rotate in opposite directions. Pulley drive: shafts can rotate in the same or opposite directions
- Gear train: distance between input and output shafts is limited. Pulley drive: shafts can be a greater distance apart
- Gear train: an engagement drive. Pulley drive: a friction drive
- Gear train: cannot tolerate misalignment. Pulley drive: can tolerate a small amount of misalignment
- Gear train: lubrication required, more expensive to maintain. Pulley drive: little or no lubrication or maintenance, cheaper
- Gear train: not affected by small temperature changes. Pulley drive: belt length can increase with temperature and the belt can slip
- Gear train: shafts connected by rigid links. Pulley drive: shafts connected by a flexible element (belt)

Q10.

Up to two marks for a description, e.g. it changes the direction of a force (1); it gives mechanical advantage/makes the task easier/reduces the force or effort needed (1).