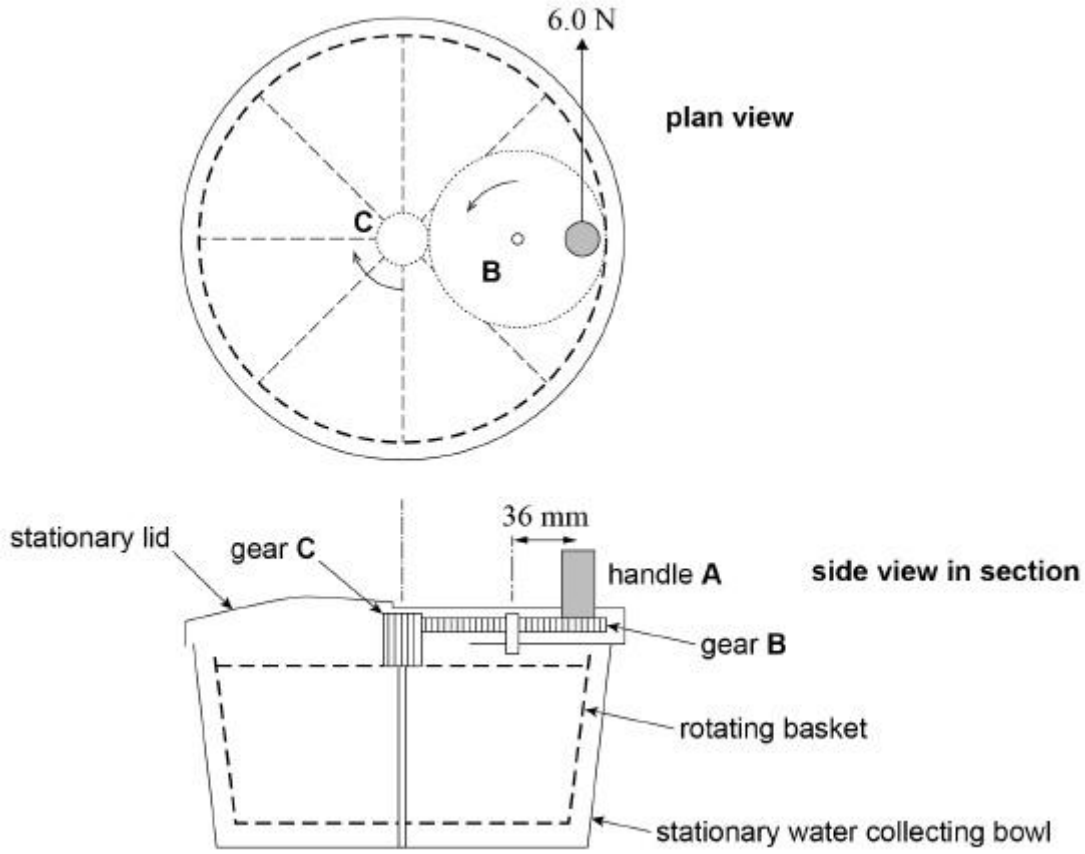
Name of the Student:_____
Max. Marks : 17 Marks **Time : 17 Minutes**

Q1.

The diagram shows the basic principle of operation of a hand-operated salad spinner used to dry washed salads.



The salad is placed in the basket and the lid is attached.

When handle **A** is turned the basket and its contents spin rapidly. Water on the salad is driven through holes in the basket into the stationary water collecting bowl. The pivot for gear **B** is fixed to the lid. This pivot and the lid do not move. When gear **B** rotates, gear **C** also rotates but at a greater angular speed. Gear **C** is fixed to the basket and rotates it.

A force of 6.0 N is applied to handle **A** as shown. Handle **A** is at a radius of 36 mm from its centre of rotation.

(a) Calculate the input torque.

Downloaded from www.merit-minds.com

torque = _____ N m

(1)

(b) Gear **C** rotates four times for every one revolution of gear **B**.

Deduce whether it is possible for the torque on gear **C** to be greater than one quarter of the input torque.

_____

_____

_____

_____

_____

_____

(2)

(c) It takes 2.1 s for the empty basket to reach an angular speed of 76 rad s^{-1}.
The torque on gear **C** is a constant 0.054 N m during this time. Frictional losses are negligible.

Calculate the moment of inertia of the basket about its axis of rotation.

moment of inertia = _____ kg m^2

(2)

(d) The gears are made from polymer (plastic). An early version of this salad spinner suffered from damaged gear teeth.

Explain with reference to angular impulse why a great force is put on the gear teeth if the user tries to stop the loaded basket too quickly using the handle.

_____

_____

_____

_____

_____

_____

_____

_____

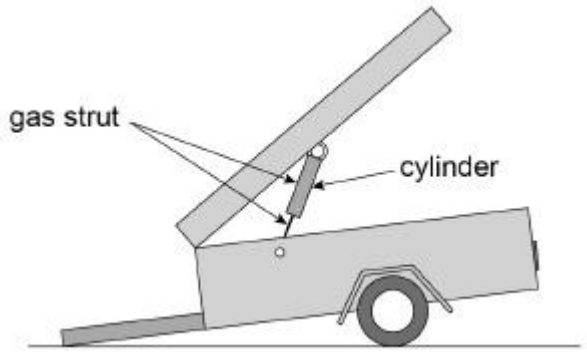
(3)

(Total 8 marks)

Q2.

Downloaded from www.merit-minds.com

The diagram shows a gas strut supporting the lid of a trailer.



A fixed mass of nitrogen gas is sealed into the cylinder of the strut.

(a) The gas is initially at a pressure of 1.2×10^{6} Pa, a volume of 9.0×10^{-5} m^3 and a temperature of 290 K.

When the lid is closed quickly the gas is compressed rapidly to a final volume of 6.8×10^{-5} m^3.

Calculate the pressure and temperature of the gas at the end of the compression assuming the compression to be an adiabatic process.

adiabatic index γ for nitrogen = 1.4

pressure = _____ Pa

temperature = _____ K

(4)

(b) Explain why the rapid compression of the gas can be assumed to be an adiabatic process.

_____

_____

_____

_____

_____

(2)

(c) When the lid is closed slowly, the compression can be assumed to be isothermal.

The gas can be compressed either isothermally or adiabatically from the same initial conditions to the same final volume.

Compare without calculation the work done in each process.

Downloaded from www.merit-minds.com

(3)
(Total 9 marks)

Downloaded from www.merit-minds.com