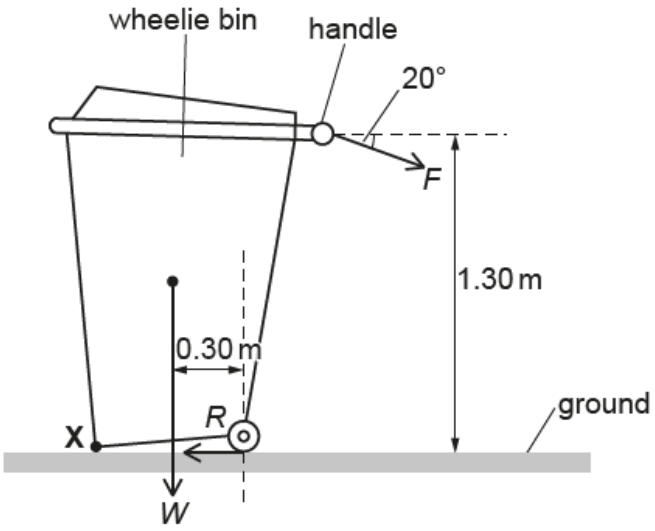
Equilibrium – 2021/20 GCE Physics A Component 01

1. Nov/2021/Paper_H556_01/No.19

A wheelie bin is tipped onto its wheels by applying two forces *F* and *R*.



F is applied to the handle. *F* is to the right at an angle 20° below the horizontal.
The height of the handle above the ground is 1.30 m.
R is a horizontal force applied to the left to the wheels.
The total weight of the wheelie bin and its contents is *W*.
The perpendicular distance between the line of action of the weight and the bottom of the wheels is 0.30 m.

The wheelie bin and contents have a total mass of 40 kg.

(a) State the **principle of moments**.

.....

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

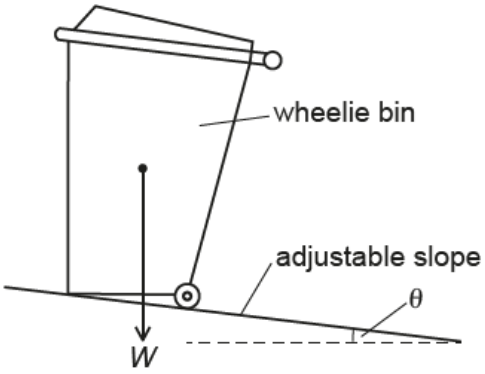
(b) **(i)** Show that the magnitude of the minimum force *F* which lifts the front end of the wheelie bin (point **X**) off the ground is 96 N.

[3]

(ii) Use your answer to **(b)(i)** to calculate the magnitude of the force R required to stop the wheelie bin from moving to the right.

R = ... N **[2]**

(c) The wheelie bin in now placed on an adjustable slope. The wheels are now fixed so they cannot move.



The angle θ made by the slope with the horizontal is steadily increased from zero.

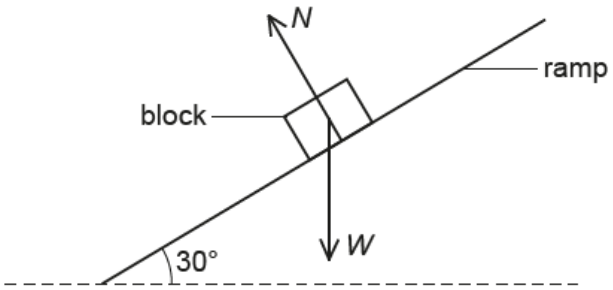
Explain, without calculation, at what angle θ the wheelie bin starts to topple clockwise.

.....

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

2. Nov/2020/Paper_H556_01/No.8

A wooden block is **stationary** on a ramp.

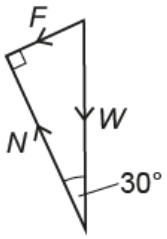


The diagram is **not** drawn to scale.

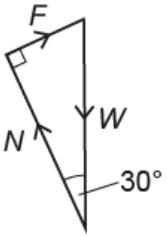
The block has weight *W*. The normal contact force on the block is *N*. The frictional force *F* on the block is not shown on the diagram.

Which triangle of forces diagram is correct?

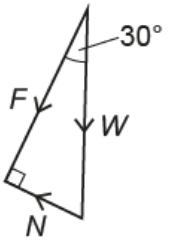
A



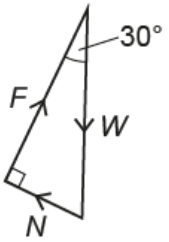
B



C



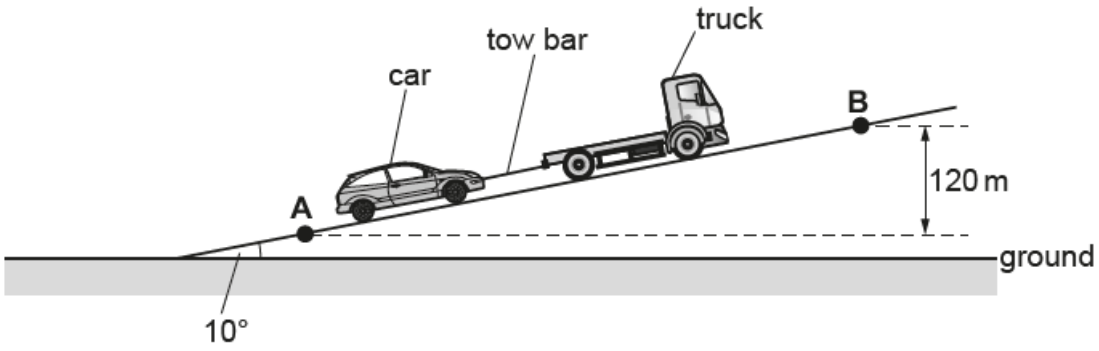
D



Your answer ☐ **[1]**

3. Nov/2020/Paper_H556_01/No.16(a_ d)

A truck pulls a car up a slope at a **constant** speed.
The truck and the car are joined with a steel tow bar, as shown in the diagram.

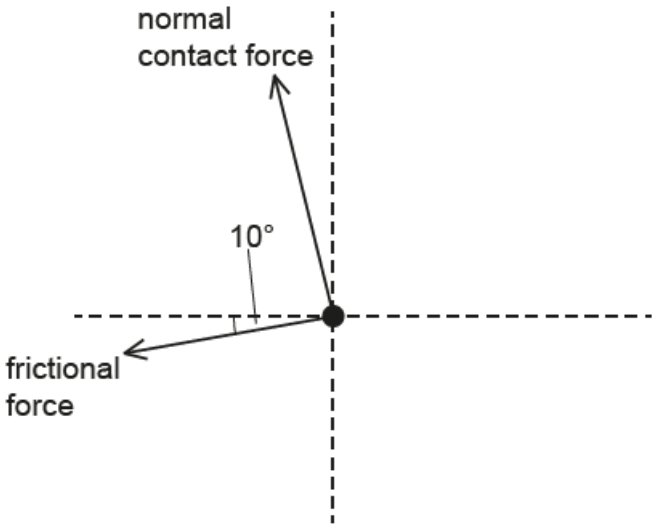


The diagram is **not** drawn to scale.

The slope is 10° to the horizontal ground.
The mass of the car is 1100 kg.
The car travels from **A** to **B**. The vertical distance between **A** and **B** is 120 m.

(a) There are four forces acting on the **car** travelling up the slope.

Complete the free-body diagram below for the car and label the missing forces.



[2]

(b) Show that the component of the weight of the car W_s acting down the slope is about 1900 N.

[1]

(c) The total frictional force acting on the car as it travels up the slope is 300 N.

Calculate the force provided by the tow bar on the car.

force = ... N **[1]**

(d) Calculate the work done by the force provided by the tow bar as the car travels from **A** to **B**.

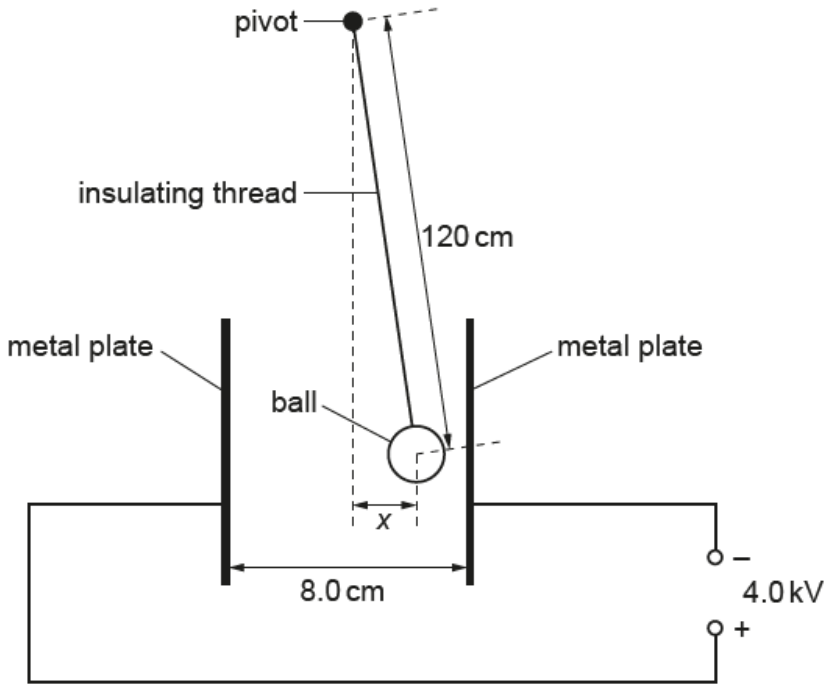
work done = ... J **[3]**

4. Nov/2020/Paper_H556_03/No.1(a)

A ball coated with conducting paint has weight 0.030 N and radius 1.0 cm. The ball is suspended from an insulating thread. The distance between the pivot and the centre of the ball is 120 cm.

The ball is placed between two vertical metal plates. The separation between the plates is 8.0 cm. The plates are connected to a 4.0 kV power supply.

(a) The ball receives a positive charge of 9.0 nC when it is made to touch the positive plate. It then repels from the positive plate and hangs in equilibrium at a displacement x from the vertical, as shown below. The diagram is **not** drawn to scale.



(i) Show that the electric force acting on the charged ball is 4.5×10^{-4} N.

[2]

(ii) Draw, on the diagram above, arrows which represent the **three** forces acting on the ball. Label each arrow with the name of the force it represents. **[2]**

(iii) By taking moments about the pivot, or otherwise, show that $x = 1.8$ cm.

[2]