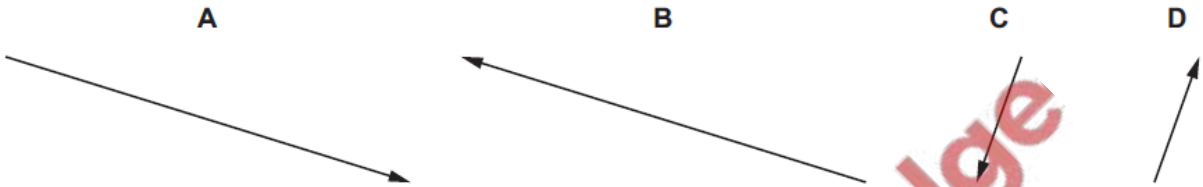
Forces – 2023 Nov AS Physics 9702

1. Nov/2023/Paper_ 9702/11/No.4

The diagram shows two coplanar forces, *P* and *Q*, drawn to scale.

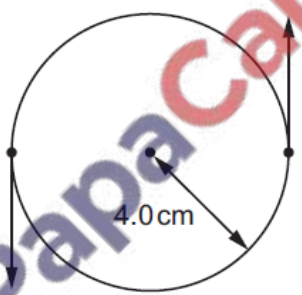
Force *R* is given by $R = Q - P$.

Which diagram represents *R*?



2. Nov/2023/Paper_ 9702/11/No.11

A minimum torque of 20 N m must be applied to the lid of a jar for it to open. The radius of the lid is 4.0 cm.

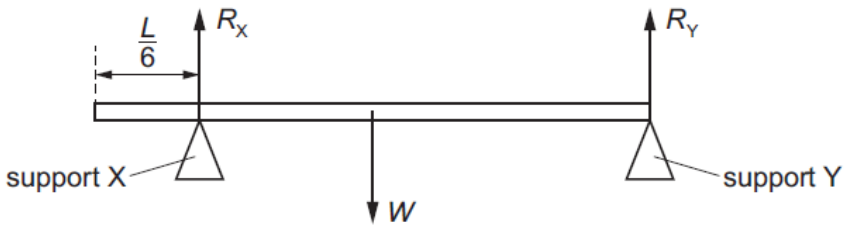


What is the minimum force *F* that must act on each side of the lid in order to open it?

A 2.5 N **B** 5.0 N **C** 250 N **D** 500 N

3. Nov/2023/Paper_ 9702/11/No.12

A uniform bar of length L and weight W rests horizontally on two supports X and Y.



Support X exerts a vertical force R_X at a distance of $\frac{L}{6}$ from one end of the bar.

Support Y exerts a vertical force R_Y at the other end of the bar.

The bar is in equilibrium.

What is the ratio $\frac{R_X}{R_Y}$?

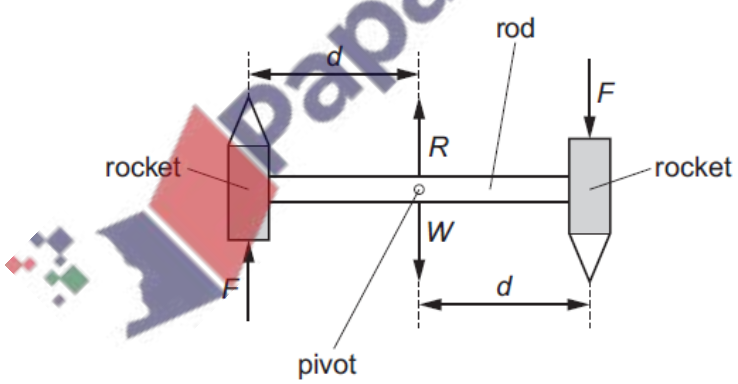
A $\frac{3}{2}$ **B** $\frac{2}{3}$ **C** $\frac{3}{5}$ **D** $\frac{2}{5}$

4. Nov/2023/Paper_ 9702/11/No.13

A type of firework is made by connecting two rockets, facing in opposite directions, to a rod, as shown.

The rod is attached to a frictionless pivot so that the firework can rotate in a vertical plane.

The firework has weight W. The pivot exerts a force R on the rod that is equal and opposite to W.



Each rocket exerts a force of magnitude F on the rod at a perpendicular distance d from the pivot. The forces exerted by the rockets are always in opposite directions.

Air resistance is negligible.

Which statement is correct?

A The firework is in equilibrium because the resultant force acting on it is zero.

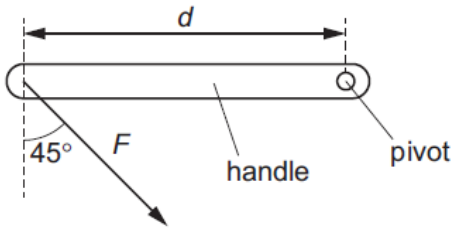
B The firework is in equilibrium because the resultant torque acting on it is zero.

C The firework is not in equilibrium because the resultant force acting on it is not zero.

D The firework is not in equilibrium because the resultant torque acting on it is not zero.

5. Nov/2023/Paper_ 9702/12/No.11

A force F is applied at an angle of 45° to a door handle at a distance d from the pivot of the handle, as shown.



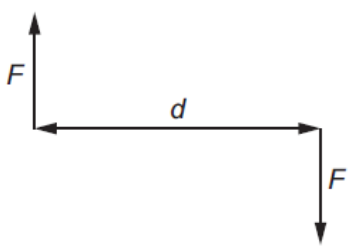
What is the moment of the force about the pivot?

A $\frac{Fd}{\sqrt{2}}$ **B** Fd **C** $Fd\sqrt{2}$ **D** $2Fd$

6. Nov/2023/Paper_ 9702/12/No.12

A couple consists of two forces, each of magnitude F, that act in opposite directions in the same plane.

The perpendicular distance between the two forces is d.

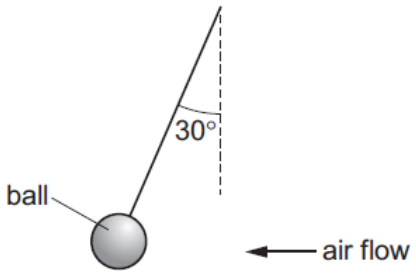


What is the torque of the couple?

A $\frac{Fd}{2}$ **B** $\frac{F}{d}$ **C** Fd **D** $2Fd$

7. Nov/2023/Paper_ 9702/12/No.13

The diagram shows an experiment to determine the force exerted on a ball by a horizontal air flow.



The ball is suspended by a light string and weighs 0.15 N.

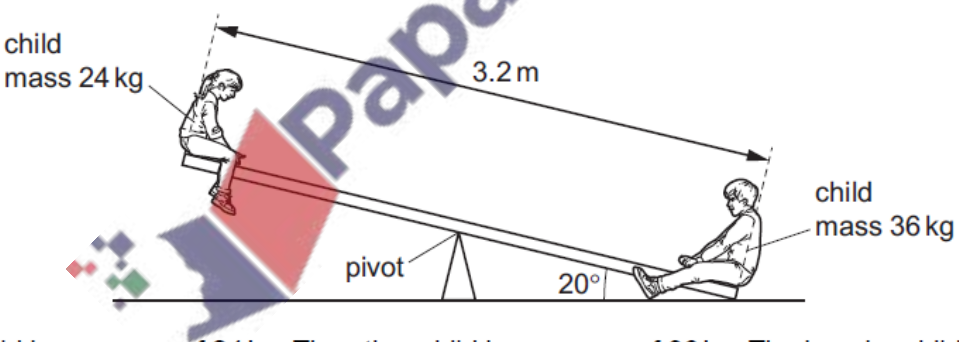
The deflection of the string from vertical is 30°. The ball is in equilibrium.

What is the force on the ball from the air flow?

A 0.075 N **B** 0.087 N **C** 0.26 N **D** 0.30 N

8. Nov/2023/Paper_ 9702/13/No.11

A uniform rigid beam of length 3.2 m is pivoted at its centre. Two children sit at the opposite ends of the beam, as shown.



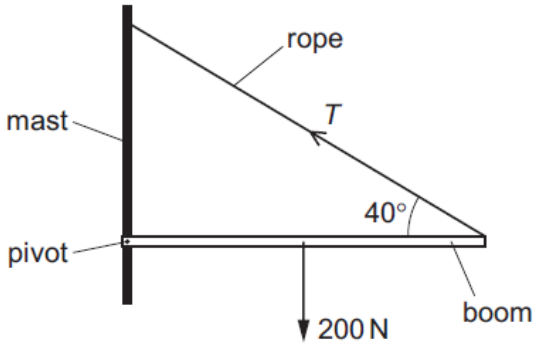
One child has a mass of 24 kg. The other child has a mass of 36 kg. The heavier child causes one end of the beam to permanently rest on the ground, so that the beam makes an angle of 20° to the horizontal ground.

What is the moment of the weight of the 24 kg child about the pivot?

A 72 N m **B** 130 N m **C** 350 N m **D** 380 N m

9. Nov/2023/Paper_ 9702/13/No.12

Two parts of a sailing boat are the mast and the boom. The mast is a vertical rigid beam and the boom is a horizontal rigid beam. One end of the boom is attached to the mast by a pivot. The other end of the boom is connected to the mast by a rope, as shown.



The rope is at an angle of 40° to the horizontal and exerts a tension force T on the boom. The weight of the boom is 200 N. The mass of the boom is uniformly distributed along its length. The boom is in equilibrium.

What is the magnitude of T?

A 130 N **B** 160 N **C** 260 N **D** 310 N

10. Nov/2023/Paper_ 9702/21/No.2(a)

A hot-air balloon floats just above the ground. The balloon is stationary and is held in place by a vertical rope, as shown in Fig. 2.1.

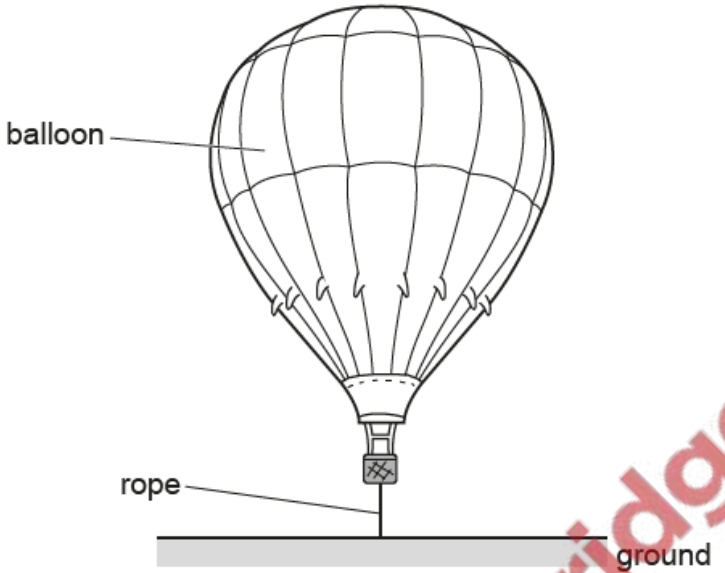


Fig. 2.1

The balloon has a weight W of 3.39×10^4 N. The tension T in the rope is 4.00×10^2 N.
Upthrust U acts on the balloon.
The density of the surrounding air is $1.23\,\text{kg}\,\text{m}^{-3}$.

(a) (i) On Fig. 2.1, draw labelled arrows to show the directions of the three forces acting on the balloon. [2]

(ii) Calculate the volume, to three significant figures, of the balloon.

volume = ... m^3 [3]

(iii) The balloon is released from the rope.

Calculate the initial acceleration of the balloon.

acceleration = ... $m\,s^{-2}$ [3]

11. Nov/2023/Paper_ 9702/23/No.3(a)

(a) State the conditions for a system to be in equilibrium.

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