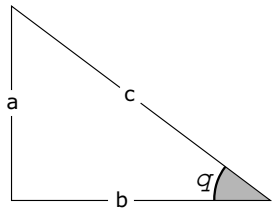
Resolution of Forces

Name & Set _____

You may find the following trig. relationships useful when resolving forces



$\sin\theta = a/b$,

$\cos\theta = b/c$,

$\tan\theta = a/b$,

$\tan\theta = \frac{\sin\theta}{\cos\theta}$

1 A car of mass 1,100 kg rests upon an plane that is inclined at 10° to the horizontal.

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(a) What is the weight of the car?

_____

_____ [2]

(b) Assuming that there are no frictional forces acting between the can and the surface on which it rests, draw a free-body diagram for the car. [2]

(c) What is the magnitude of the normal contact force between car and inclined plane?

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_____ [2]

(d) What is the magnitude of the force acting on the car parallel to the plane?

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_____ [2]

(e) describe the motion of the car in terms of its velocity.

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_____ [2]

2 A car of mass 800 kg rolls down an inclined plane with constant velocity. If the plane is inclined at 15° to the horizontal

(a) Draw a free body diagram for the car.

(b) Calculate the normal contact force between the plane and the car.

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_____ [2]

(c) Calculate the friction force acting on the car.

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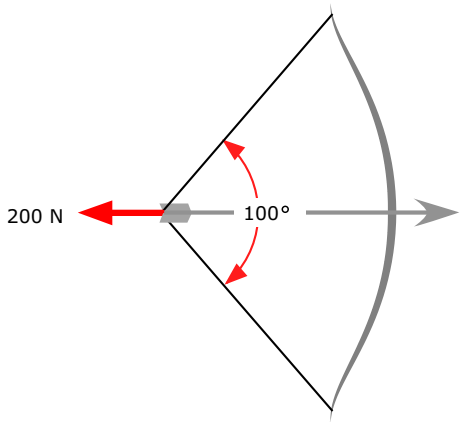
3 An arrow notched in a bow string, is pulled back with a force of 200 N. The angle between the upper and lower part of the string is 100°

(a) Draw a free-body diagram for the bow string.



(b) Calculate the magnitude of the tension in the bow string.

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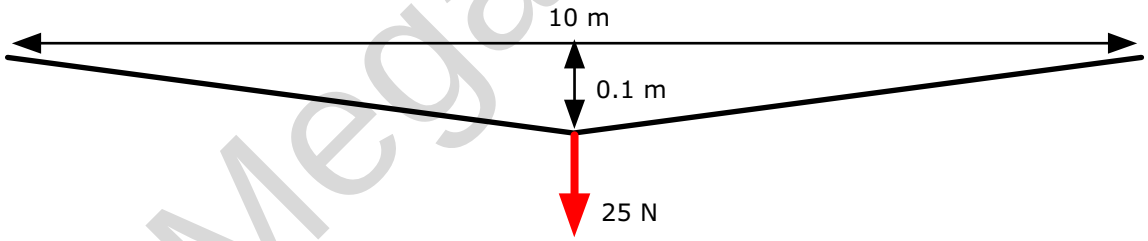
4 A thin clothesline strung between fixed points 10 metres apart supports a single suit that weighs 25 N. The suit is hung from the centre of the line and this causes the line to sag 10 cm below the horizontal at this point. What is the tension in the line?



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5 A tightrope walker of mass 70 kg stands at the mid-point of a wire 9 metres long and strung between two posts 8.8 metres apart.

(a) Draw a free-body diagram for the rope walker.

(b) what angle does the wire make with the horizontal?

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_____ [2]

(c) Calculate the tension in the wire in this situation.

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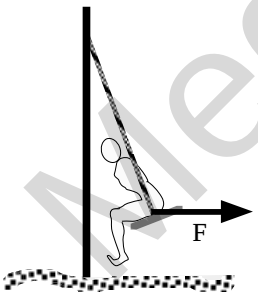
_____ [2]

6 A child weighing 300 N sits in a swing that is held stationary by a horizontal force, F, applied to the seat of the swing as shown in the diagram on the right. If the rope supporting the swing makes an angle of 30° with the vertical

(a) Draw a free-body diagram for the child. [2]



(b) Calculate the tension in the swing.

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_____ [2]

(c) Calculate the magnitude of the force, F.

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_____ [2]

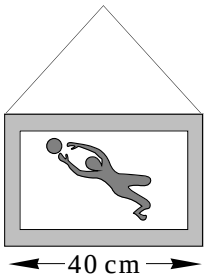
What, if any, is the effect on the tension of a tight-rope wire as someone crosses over it? i.e. how does the tension vary as the person moves from one side to the centre?
Draw a diagram to illustrate your answer.

[2]

7 A manufacturer claims that a washing line is capable of withstanding a tension of 300 N. An object of mass 5 kg is hung from the centre of a length of this line strung between two points 18 m apart. The line sags 0.6 m and then breaks. Make suitable calculations to explain why the line broke.

[2]

8 A picture of weight of 100 N hangs symmetrically by a single cord that is attached to each side of the frame as shown in the diagram on the right and passes over a hook in the wall. If the width of the frame is 40 cm and the supporting cord has a total length of 60 cm



(a) Calculate the tension in the wire.

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_____ [2]

(b) What is the effect on the tension of making the wire (i) longer and (ii) shorter?

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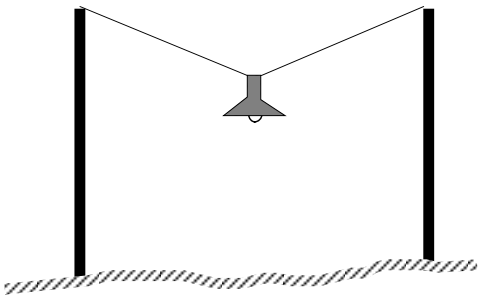
10 If it is necessary to suspend a lamp at a particular height above the ground by means of wires or ropes attached to the top of two poles some distance apart then it is better to use tall poles rather than short ones.



(a) Why is this?

Use the information given in the problem below to answer this.

A lamp is suspended above the centre of a road by means of a wire attached to the top of two tall poles either side of the road. The mass of the lamp is 4 kg and its height above the road is 5 metres. The supporting posts are 6 m apart and 8 m tall.

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_____ [2]

(b) Calculate the tension in the supporting wire.

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_____ [2]

(c) What would the effect be on the tension of making the posts (i) taller (ii) shorter, all other factors being the same? The lamp remains at the same height above the ground.

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_____ [2]

11 Why is it easier to *pull* a heavy garden roller than it is to *push* it? Answer this question with the help of free-body diagrams.

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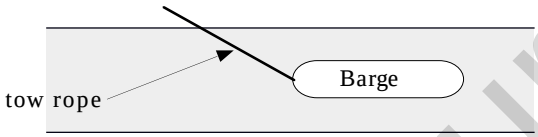
12 Why is it better to use a long tow rope to pull a barge than it is to use a short one? Answer this question with the help of free-body diagrams.



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13 Two tug boats are employed to tow a large ship. One pulls north with a force of 25,000 N and the other one pulls north-west with a force of 30,000 N. Determine the resultant force by scale diagram.

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_____ [2]

Extension problems

14 A car of mass 800 kg reaches the bottom of a ramp travelling at a speed of 20 ms^{-1}. If the ramp is inclined at 10 ° to the horizontal and the frictional forces between car and ramp amount to 10% of the weight of the car, calculate how far up the ramp can the car travel if its engine is switched off at the instant it reaches the bottom of the ramp?

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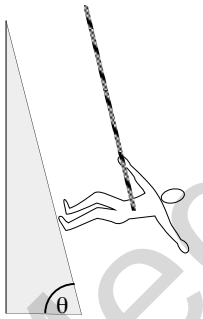
_____ [2]

15 As part of the preparation for landing a man on the moon, astronauts were suspended from a harness in such a way that they could walk parallel to the ground along an inclined plane. By inclining the plane to a suitable angle to the horizontal, the reaction force due to the inclined plane can be made to match the moon's gravitational pull on the astronaut. The moon's gravitational field strength is 1.6 N/kg.



By the resolving the tension in the rope supporting the harness when the astronaut is suspended from it, calculate the angle to the horizontal at which the plane must be inclined.

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_____ [2]