Subject: **Physics**

Topic: **Forces**

Application: **Emergency rescue**

Using the worksheet and podcast resources

This worksheet is based on the Inventive podcast.

It supports Gatsby Benchmark 4: Careers in the curriculum by introducing a career and role model. The worksheets are based on topics in the KS3 curriculum.

The short audio clips can be used to provide context to the worksheet and could be played during a lesson.

A QR code on the student sheet links directly to the podcast.

KS3 National Curriculum statements

Physics

- Forces as pushes or pulls, arising from the interaction between two objects;
- Using force arrows in diagrams, balanced and unbalanced forces;
- Forces: associated with deforming objects, measured in newtons, measurements of stretch or compression as force is changed.

Note: The Extend activity (Q5 and 6) is a simple practical activity using cardboard and a small mass. It provides opportunity for students to design an investigation, take data and analyse the data to reach a conclusion. You will need:

- strong cardboard strips up to 5 cm wide and 20 cm long; mark the cardboard at 2-5cm intervals to help students report their findings;
- 2 identical supports e.g. small pieces of dowelling that can stand unaided;
- mass - match to the cardboard so visible bending occurs if supports are at each end but minimal bending with supports closer together.

Audio clips from Inventive podcast

Available from: *nustem.uk/inventive/#joshua (scan QR code)*

- **Josh Clip 1:** Introduction to Josh and his 'day job';
- **Josh Clip 2:** The rescue policy of SARAID;
- **Josh Clip 3:** Comparing earthquake and hurricane damage.

Other resources

Josh's career poster

More information about Josh

Meet the engineer

Josh Macabuag

Disaster Risk Engineer

Josh Macabuag is a Civil Engineer, who works as a Disaster Risk engineer. He works for The World Bank, quantifying risks and costs of natural disasters. He also volunteers for SARAID which provides search and rescue assistance (for people) after disasters like earthquakes, hurricanes and collapsed buildings. SARAID's motto is "find a way or make one".

Scan the QR code

to access all the resources and the full podcast from: *nustem.uk/inventive/#joshua*

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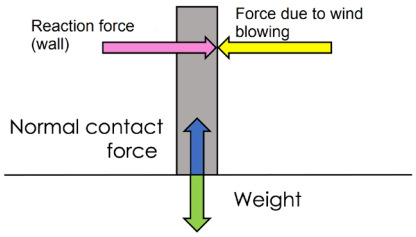
Know

1a. Possible answers include weight (gravitational), friction, upthrust, magnetic, electrostatic, reaction, tension, air resistance, drag, lift

1b. Contact forces: friction, upthrust, normal reaction, tension
Non-contact forces: weight, magnetic, electrostatic

2. The diagram should look similar to the one the right. As the wind blows a force is applied to the fence. There is a reaction force from the fence to oppose the motion caused by the wind.

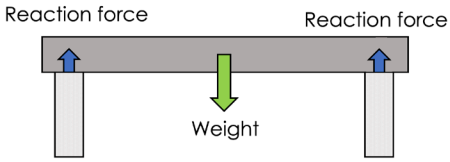


Apply

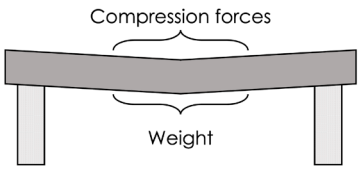
3a. Reaction force: gets smaller
Wind force: gets smaller
Weight:stays the same
Normal contact: stays the same

3b. The fence could be blown sideways / blown over

4a. The weight of the beam acts down from centre of beam; reaction force upwards at each support. The length of each reaction force arrow should be half the length of the weight arrow



4b. The beam is in compression in the centre of its upper surface, and in tension in the centre of its lower surface



4c. Anything sensible e.g. add support in the centre; move side supports closer; use stronger material for beam/make beam stronger

Extend

5. Pupils should use their findings to conclude the best position for the supports. If supports are at the ends then the middle will sag; if the supports are too close together the ends will sag.

6. Provide paper pupils can fold, roll or cut. Make sure pupils don't move the supports during the test; they can use a ruler to compare the maximum dip if comparing different methods. As well as simple folding or rolling, pupils can pleat paper or compare grain direction with strength.

Worksheet version: 2.0, 2022-06

Forces in an emergency

A resultant force is a single force showing the effect of all the forces acting on an object. When the resultant force is zero, we say they are balanced. The object is in equilibrium and does not move, turn or change shape.

Forces can change an object's form, causing deformation. Tension forces cause stretching, and compression forces squash or squeeze the object.

In some materials, the change in shape is proportional to the force applied.

An object's weight appears to act at its centre of mass. The centre of mass is at the centre of a symmetrical object.

A force acting to one side of the centre of mass makes the object turn. The force's turning effect is called its moment.

Meet the engineer

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Link to Josh' story

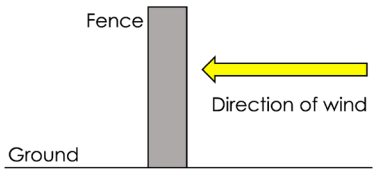
Know

1a. Name six different forces.

1b. Put the forces in two lists: contact forces (between touching objects) and non-contact forces

2. The diagram shows a fence in a storm. A wind is blowing against the fence. The fence is stable, and not moving.

Name, and draw, two pairs of forces that are in equilibrium for the fence.



Apply

3a. Describe how each of the following forces will change if the wind speed reduces.

Choose from: *gets bigger* / *gets smaller* / *stays the same*

Reaction force:

Wind force:

Weight:

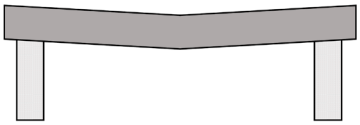
Normal contact:

3b. Describe what will happen to the fence if the wind force is bigger than the reaction force of the fence.

4. The diagram shows a beam on supports. It is symmetrical so its centre of mass is in the middle of the beam.

4a. Add force arrows to show the direction of the weight and normal contact forces on the beam.

4b. The beam is not supported in the middle so it sags/bends/dips. Add a label to your diagram to show where there are compression forces on the beam and where there are tension forces on the beam.



Extend

5. *[Practical]:* You have been given a strip of cardboard, a mass and two identical supports.

Plan and carry out a short investigation to find the best place for the supports so the cardboard strip supports a weight at any point along its length without bending.

Record your results and use them to justify your answer.

6. *[Extension to investigation]:* Paper is less strong than cardboard. You have been given a piece of paper to replace your cardboard strip.

Investigate different ways to fold or roll your paper to strengthen it and create a beam the same size as the cardboard strip, and as strong or stronger.

Record your results and explain what you did.

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Northumbria University NEWCASTLE
University of Salford MANCHESTER
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