PSTT Chain Reaction Upper Key Stage 2 Forces Planning

https://www.youtube.com/watch?v=qybUFnY7Y8w

http://practicalaction.org/squashed-tomato-challenge-5

http://www.2learn.ca/kids/listSciG4.aspx?Type=47

https://www.rubegoldberg.com/education/rube-works-game/

http://www.notebookingnook.com/freebie-simple-machines-notebooking-pages-matchbooks/

http://www.123homeschool4me.com/2015/03/simple-machines-printable-mini-book.html

https://en.m.wikibooks.org/wiki/Wikijunior:How_Things_Work/The_Six_Simple_Machines

https://docs.google.com/presentation/d/1t0mDlCW5JP6WJGW0lNTHbf73dUST0kXuppYVnUYr2TA/edit#slide=id.p

http://www-tc.pbskids.org/zoom/grownups/clubzoom/pdfs/ClubZOOMeng_F_marbleride.pdf

NEW

http://blog.connectionsacademy.com/build-your-own-rube-goldberg-machine/

http://www.explainthatstuff.com/gears.html

http://www.explainthatstuff.com/toolsmachines.html

http://www.neok12.com/Simple-Machines.htm

http://www.123homeschool4me.com/2015/10/simple-machines-inclined-planes.html

http://easyscienceforkids.com/all-about-simple-machines/

http://www.sciencebuddies.org/science-fair-projects/project_ideas/Phys_p065.shtml#background

video http://www.bbc.co.uk/education/clips/zrp6n39

friction videos http://www.bbc.co.uk/education/topics/zsxxsbk/resources/1

gravity videos http://www.bbc.co.uk/education/topics/zf66fg8/resources/1

forces videos http://www.bbc.co.uk/education/topics/zvpp34j/resources/3

http://www.bbc.co.uk/bitesize/ks2/science/physical_processes/forces_action/play/

Year 5 – Lesson 1

Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
This lesson is an introduction to the unit – the children will be using the forces knowledge and skills to design and build a Rube Goldberg model at the end of the unit (good links to D.T. possible).	This lesson needs use of a computer room or Ipads/ netbooks etc. What is a Rube Goldberg machine? Who was Rube Goldberg? Introduction lesson – Explain that at the end of this unit they will be creating their own machines in small groups/teams. How many different forces can you spot? Can you name them? Show the following 3 film clips: 1) Honda Car https://www.youtube.com/watch?v=Z57kGB-mI54 2) The Page Turner https://www.youtube.com/watch?v=GOMIBdM6N7Q (mp4 version available) 3) OK Go! (advert (not on mp4 version) which precedes clip – NOT suitable for children) https://www.youtube.com/watch?v=qybUFnY7Y8w (mp4 version available) There are lots more videos on dominoes and lolly sticks such as those from American High Schools on the internet, so why not find some more of your own https://www.youtube.com/watch?v=cv5WLLYo-fk	The links below are all problem solving activities where they need to adjust/create machines to solve certain problems. http://www.fossweb.com/delegate/ssi-foss-ucm/Contribution%20Folders/FOSS/multimedia_2E/Variables_MM/activities/whiteboard/rubegoldberg/index.html http://pbskids.org/zoom/games/goldburgertogo/rubegame.html http://www.infinitecat.com/games/tom-n-jerry.html http://www.msichicago.org/fileadmin/Activities/Games/simple_machines/	What have they learnt?	Computers, netbooks or Ipads Web links

All a very effective "hook" – they inspired ideas and generated good discussion about the forces seen.

Very engaging – children captivated with all these

It should be possible to login as a guest

A big hit. All achieved success in the end.

More challenging

All these games promoted great conversations between pupils about how to improve.

Year 5 – Lesson 2

Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
I can explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. I can take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate	Show a clip of Tim Peake floating on the ISS. http://www.telegraph.co.uk/news/science/space/12135602/Tim-Peake-holds-CosmicClassroom-to-answer-questions-of-British-schoolchildren.html What keeps us on Earth? Why is Tim Peake floating? Introduce/discuss the force of gravity. In pairs discuss what gravity is, then ask volunteers to try and explain. Watch http://www.tigtagworld.co.uk/film/what-is-gravity-PRM00080/ (Subscription needed) *Gravity is the natural phenomenon by which objects attract each other with a force (the size of the force of attraction depends on: the masses involved – the bigger the masses the greater the force; and the distance between them - the greater the distance the smaller the force). The attractive force of gravity acts between the centres of two objects.* For people standing on the Earth's surface, the effect of gravity is to attract us towards the centre of the Earth. As a result, no matter where you stand on the Earth, you don't fall off. Talk about scientist: Isaac Newton Watch http://www.tigtagworld.co.uk/film/isaac-newton-PRM00689/ (Subscription needed) Who was he? What is he famous for? Show clip of pendulum clocks working. https://www.youtube.com/watch?v=Bpe1z1KIpE0 How do they work? What force is working? How is it effecting the pendulum?	Provide the children with the resources - String, stopwatch, playdough or plasticene, stand and clamp and a challenge card: (see Matrix) Using the resources in your tray to create your own pendulum clock. Can you make each swing of your pendulum take exactly 1 second? How can you change the speed? What slows it down or speeds it up? • Change the length of the pendulum string. I suggest trying quite a few different lengths. • For example, try big differences first, such as 30cm (you've already done this), 50cm, 75cm, 100cm and even longer. The desk may not be high enough for longer pendulum lengths, the top of a door frame would be good for lengths up to about 2 metres. • Then why not try smaller differences in the string's length such as 10cm, 20cm, 30cm, 40cm, 50cm, 60cm, 70cm, 80cm, 90cm & 100cm (or 1 metre)? • Change the distance you move the bob to the left or right before releasing it. Remember that when you move the bob in this way you are actually changing the 'hanging angle' of your pendulum. Can you think of an original ways of displaying your results using a table, chart or graph? Children create a storyboard of their investigation using a combination of pictures and words to both illustrate what they did and what they learnt including what effect gravity had on their pendulum. Links to Matrix pendulum activities	Discuss how they achieved the challenge. How did they make the swing exactly 1 second? What did they do to increase/decrease the speed of the swing? What science is happening?	String stopwatch Playdough or plasticine Stand and clamp *(borrow from local secondary school)* Dr Mark's circus science p23 &24 (available on Amazon in paperback or CD rom) Teacher resources used:- Giant pendulum outside, from netball post with water bottle almost empty/full or paint onto wallpaper strips.

We didn't have clamps so we improvised and it worked well. We used pencils off a table.

SEN worked in group with adult support to access learning.

I am using this as a final Y5 fair test enquiry assessment.

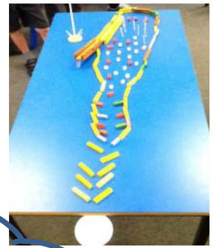
This promoted lots of discussions about different graph designs and what columns to use.

Storyboards are a really imaginative way of recording especially for reluctant writers.

It's brilliant to have links which save time searching!

We hung pendulum strings from a rope stretched across the classroom.

Year – 5 – Lesson 3

Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
I can identify the effects of air resistance, water resistance and **friction**, that act between moving surfaces I can use test results to make predictions to set up further tests We chose a child who cycles to school to be our "expert". Good discussions. The children predicted the sandpaper would slow down the marble more than it actually did. Much discussion generated. We made paper aeroplanes too. Identified features that helps it to travel furthest distance and modified as necessary.	To illustrate how powerful friction can be, interlace the pages of 2 paperback books and try to pull the apart (like tug of war) **Part 1** • If possible have a bicycle at the front of the room on a table (so all can see). *More than 1 bike is even more engaging!* • With a partner ask children to describe any forces that are used when riding a bike. • Discuss what the children have written down as a class. • Can anyone name any of the forces? **Part 2** Model a marble rolling down a smooth slope (e.g. slightly tilted table to aid visibility). Repeat over the same gradient with a different surface. Repeat both runs – ask someone to rime with a stopwatch this time. What do children notice? What has caused this? **Introduce/discuss friction**. What is it? What causes it? Watch: http://www.tigtagworld.co.uk/film/what-is-friction-PRM00084/ (Subscription needed) http://www.bbc.co.uk/education/clips/zk2qxnb Model creating the start of a simple run creating angled slopes (quite steep to start) attached to a table with **masking tape**. How could we slow it down? Discuss/Model changing the angle of the slope and the materials used. • As the marble moves down a ramp, there is friction between the surface of the marble and the surface of the ramp. • Friction is a dragging force that happens when objects roll or slide against each other. • The strength of the force of friction depends in part on the types of surfaces involved. Rough surfaces produce more friction than smooth surfaces. • If you roll a marble across a ***smooth surface***, like a ramp covered in aluminium foil, there is ***little friction to slow it down***. • If you roll a marble across a ***rough surface***, like a ramp covered in sandpaper, there is ***more friction to slow it down***. Relate it to riding a bike on grass/gravel compared to riding on the pavement. What else could be used other than friction to slow the marble down? (going uphill – gravity)	Who can make the slowest marble run? Give children set parameters for example: • All use the **surface area of the top of 1 table**. • All the tables will be all be tilted at the same **angle for example 45°**. • *How will you angle the ramp so that the marble moves slowly but doesn't stop?* • *Could you include sections which go uphill without the marble stopping or going backwards?* • *What materials can you add to the ramp to increase the friction to slow it down?* • *What other parts could you build to slow down the marble?* Remember to keep testing with the marble as you go *Ext : Make it travel in a specific time e.g. 1 minute* Remember to record and photograph the final marble runs. Children will need to take (or request) photos of specific sections of their marble run to illustrate how they made use of different force such as gravity, friction, air resistance. They must then stick the photos in their books and annotate what force and how it worked in their model.	Ask the children to sort the different everyday scenario cards into those which show **lots of friction** and those which show **not much friction**. As an extension, they can then be asked to sort each column into useful and not useful as an additional, challenge task. This allows children to observe where friction is all around us and the effects of friction or not much friction in everyday life. If appropriate, introduce competition: http://www.cleapss.org.uk/attachments/article/0/Marble_Comp_A5_02.pdf We got lots of learning from this investigation - we did the lesson twice as children wanted to improve their model We did a lesson on shoe soles friction first – what does "best" mean?	Marbles Stopwatch Camera(s) Construction materials e.g. Cardboard Masking Tape Kitchen roll inners Sandpaper Water bottles etc Links to Matrix marble run activities Top tip Use boards for the marble runs so you can continue improving them at a later date. 

Trip to a theme park works well here – providing a great practical forces workshop investigation about friction.

Year – 5 – Lesson 4				
Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
I can identify the effects of **air resistance, water resistance** and friction, that act between moving surfaces I can report and present findings from enquiries, in oral and written forms such as displays and other presentations	**Air resistance** Objects fall to the ground because all things are attracted by the force of gravity towards the centre of the Earth. How high up would an object need to be to still be attracted to Earth by gravity? • Show children the video clip of Felix Baumgartner's free fall from space on YouTube https://www.youtube.com/watch?v=FHtvDA0W34I • What happened? He came back to Earth because of gravity. • What did Felix use to reduce the effect of gravity pulling him down and to ensure a safe landing? • Introduce parachutes. *If available children can experience air resistance by wearing a parachute and comparing running across the playground with and without it.* Drop two pieces of paper, one flat and one screwed up. Children learned earlier that things fall at the same rate, so why did they land differently? Explain that gravity is pulling them down the same, but air is getting trapped and trying to push back up. This is air resistance. http://www.askaboutireland.ie/learning-zone/primary-students/5th-+-6th-class/science/gravity/some-ideas-about-gravity/gravity-and-dropping-thin/ OR http://www.bbc.co.uk/education/clips/zjntsbk http://www.bbc.co.uk/education/clips/zwynvcw **Water Resistance** Why is it hard work to walk through water? What are fish shaped the way they are? Why are boats shaped the way they are? Water resistance is a force (friction) acting on objects. You are going to investigate how different shapes act in water.	If feasible, half the class investigate air resistance and the other half investigates water resistance then swap *(these will reduce the number of resources required)* **Water Resistance** Investigate the effect of water resistance by looking for the shapes which fall the slowest/fastest. Children should be encouraged to repeat their tests and understand why they need to repeat. **Air Resistance** Using these resources, follow the instructions to create a hovercraft. Old unwanted CD Sports bottle cap Lump of modelling clay Balloon Collar template  *If this activity isn't possible, investigating either the size or material of parachutes is a good substitute ensuring the results are understood.* Each group needs to then create a poster on sugar paper to report on what they have **learnt** through their investigations.	What are the similarities and differences between water and air resistance? Make sure children are aware that air and water resistance are also types of **friction**. 	Each group needs: **Water resistance** 2 identical containers e.g. 2 litre drinks bottles with the top cut off Modelling clay/playdough/ plasticine **Air resistance** Old unwanted CD Sports bottle cap Lump of modelling clay Balloon Collar template

We designed new parachutes for a local flying club, to give real-life context/ purpose to this activity

We discussed air resistance in real life situations, clothes for cyclists, car shapes,

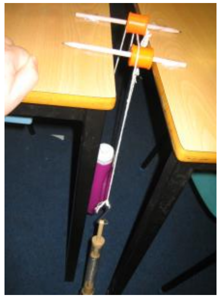
We designed and created a boat for a "Great Anglo-Saxon boat race" – Historical/D & T link.

We did this over two lessons:
1. Air - parachutes
2. Water – objects sinking

We loved this activity.
We tested different caps and balloons on different surfaces.
Then we played an Air Hockey game
"We had to use our brains but it was such fun.
We would never have thought of it ourselves."

Year – 5 – Lesson 5 and 6 - Over at least 2 if not 3 lessons

Adapted to a challenge "what is the smallest weight needed to lift a rubber?

Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
I can recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect. I can take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate	Forces act in the direction that they are applied. Machines can be used to alter the direction of the movement created by an applied force. Gears, levers and pulleys can provide a mechanical advantage. This means that the force needed to move an object is reduced – *links could be made to building the pyramids.* Look at and sort pictures of everyday objects (and some objects if available) Show some at objects and work out how they work Ask the groups to think about different machines that make their lives easier but don't use electricity. Ask them to write down or draw their ideas. Give the groups around 5 minutes to complete this task. Demonstrate some examples of simple mechanisms and explain that in their activities in this and the next lesson they will be exploring these and other mechanisms. **Gears** • Use a bicycle to demonstrate to the children how gears work. • Put a strip of coloured sticky tape on the back wheel. This makes it is easier to count the number of revolutions made by the wheel. • Hold the rear wheel above the ground. Starting with the pedal at the top of its motion, ask a child to slowly turn the pedal for one complete revolution. Ask: • How far did the rear wheel turn? • Show the children how far the wheel would move across the ground during one complete turn compared to the distance moved by the pedal. The children should see that the gears transfer the force on the pedal to the wheels (via a chain) and change the distance moved by the force.	1) **Lever-** Make a lever out of the given materials and explore the relationship of the fulcrum to the load. Use washers or 2 pence on a 30cm ruler (lever) balancing an eraser (fulcrum). *See activity sheet.* 2) **Inclined Plane-** • Make inclined planes with boards varying the slope of the board. • Tie string around a stack of books (e.g. dictionaries). • Hook a force metre to the rubber bands and pull the books up the different inclined planes. • Use the force metre to pull the books straight up without using the inclined planes. *See activity sheet.* 3) **Pulleys-** Before you try anything new to investigate, remember first to try to predict what you might expect to happen. • What do you think the talcum powder (or baking flour) is useful for? • What do you notice when you use four or five complete to and fro's of the rope between the sticks? • What do you notice when you use only one complete to and fro of the rope between the sticks? • What about trying to pull the sticks together with two friends pulling on each stick? *See activity sheet.*	Can the children give examples in their homes and other areas of life today where these mechanisms might be used? We used this idea in our contraption to slow speed of the ball – it worked a treat.  1 pulley  2 pulleys	Bicycle *See Dr Mark's circus science* (available on Amazon in paperback or CD rom) *http://www.tigtagworld.co/.uk/mindmap/#/lessons/CLASS00300* (Subscription needed) Lever Can of paint Short/long handled lever (e.g. flathead screwdriver) Wooden ruler Object to lift (2p coins) 30cm rulers erasers Inclined Plane 2 Boards varying in lengths String Rubber bands Ruler Heavy Book Force metre Inclined Plane worksheet Links to Matrix lever activities Pulleys Object to lift Pulley worksheet Sticks *e.g. rounders posts, broom sticks* Rope Pneumatics Tubing Syringes Gears Chalk

Sticky tape a great idea

Linked to gears and pulleys at Salisbury Cathedral.

We also watched "Will gears let children pull a piano uphill with their bikes - BBC Bitesize

We investigated the direction of turn of gears and how small and large gears move together (speed). See Matrix for further details.

Levers

Begin discussion by putting a can of paint on table and asking students how you can get it open.
Can you do it without a tool?
What kind of tool would you use?
Does anyone know what kind of simple machine could do this job?

Creating this simple lever allows you to demonstrate how a small amount of force can lift large loads.

- Pose some questions:
  - How could two people stand on the plank and have it balance with both ends off the ground?
  - Who would it be easiest to balance with?
  - Have them identify someone they think they could balance with, and get pairs of volunteers to have a go at balancing.
  - Why did they choose that person to balance with?

- Explore what happens when one person moves forwards or backwards along the plank.
- Now ask: ‘If I got on the plank – could you lift my end up and balance me?’
- Discuss where you should stand, and where a student should stand.
- Add another student if one is not enough.
- Ask ‘what could we do to the plank to make things balance?’ Direct their responses towards making their side longer.

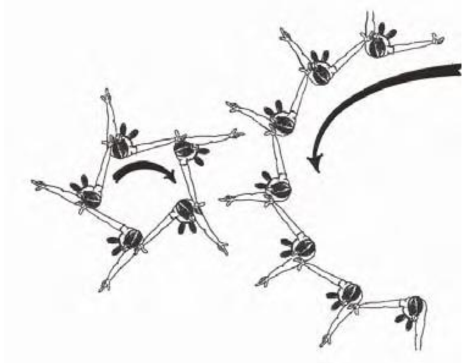
4) Wheels

- As with the inclined plane, – Tie string around a stack of books (e.g. dictionaries).
- Hook a force metre to the string and pull the books along the table.
- Lie the stack of books on pencils (of the same size) and repeat comparing measurements on the force metre.

See activity sheet.

5) Gears – large space outside if possible

Human gear *(see diagram)*



- Make a large circle of **15 or 20** children so that each person is facing the back of the person in front.
- Mark the circle on the ground with chalk or the rope. This marks the path the children are to follow.
- Repeat these steps to make a small gear wheel with **five** children.

Discussion:
- How many times did the small wheel turn when the large wheel turned once?
- What was it like being in either wheel – did you move differently? How?
- In which direction did the wheels turn (clockwise/anticlockwise)?

This activity can be difficult if children do not remain on task! Use with teambuilding / cooperative aims.

Make sure to mark the circles first as this activity is tricky.

We are planning a “Circus Week” soon and some of these ideas will fit well

Links to Matrix gear activities

Wheels
Books
String
Force metres

		How could you use gears to speed up or slow down a rotation? *See activity sheet.* **6) Simple pneumatic/hydraulic machine.** ***(if resources available)*** **http://resources.hwb.wales.gov.uk/VTC/pneumatic_pumps/eng/index.html** Create a machine using syringes, tubing and air/coloured water to demonstrate how applying a force in one direction can produce movement in another. Explore • Empty one syringe completely. • Attach a length of tubing to the other syringe and fill both the syringe and tubing with water. • Attach the empty syringe to the other end of the tubing. • **Push** the syringe plunger. • Notice as the force is transferred through the air/water to the other syringe, which moves out. • Now **pull** the first syringe plunger back out to draw the second syringe plunger back in. Development • *Could make an opening monster/creature mouth/head using tubing/syringes/balloons and a decorated egg box.* Children will then create a book on simple mechanisms illustrating: • How they work, • What advantages there are in using them, • Examples of where they are used in everyday life.	We also did pneumatic water rockets, which was a big hit We had children asking to do these activities in Golden Time!	

A group of 6 completed our final contraption in lunch-time Science Club. I supplied a piece of guttering but they found all the other parts they needed in school and built it themselves. We had a marble run, domino run, ball on smooth surface which pushed a train to set it off along a track. This operated a see-saw lever. They tested and improved it may times, so in the end it worked well.

We spent 5 hours constructing ours in Science Club and it still needs modifications – the children have really enjoyed it and it could easily be a whole half-term Science project.

Year 5 – Lesson 7 and 8				
Learning Objective	Introduction	Class differentiated activities	Plenary	Resources
I can apply knowledge of forces and skills learnt to create a Rube Goldberg style model. I can recording data and results of increasing complexity using scientific diagrams. Make links with DT	Show film clips from the start of the unit. How many different forces can you spot? Can you spot any more now? Can you name any more? http://autorepair.about.com/library/multimedia/hhonda-ad-300k.swf https://www.youtube.com/watch?v=qybUFnY7Y8w (mp4 version available) Discuss the task and how to get started. e.g. What resources are available (including any they could bring in from home). What aspects of the unit they could include. *Practical Action – Squashed Tomatoes* https://practicalaction.org/squashed-tomato-challenge-5	Set task: Working in small groups (approx. 4): **Use the knowledge and skills gain through this unit to design and create a working Rube Goldberg model.** By the end of the first lesson the design and list of resources should be completed. In the second lesson, the model needs to be constructed, tested and improved. Similar to the marble run, children will need to take (or request) photos of specific sections of their model to illustrate how they made use of different force such as gravity, friction, air resistance. They must then stick the photos in their books and annotate what force and how it worked in their model.	First lesson Discuss any difficulties encountered and discuss possible solutions. Share ideas Identify resources Second lesson Allow sufficient time for all models to be demonstrated (could be recorded).	All resources from previous lessons plus others identified by groups such as dominoes etc Camera(s) Links to any Matrix activities

We didn't record anything as we did this at lunchtime Science Club

This really showed who can persevere and problem solve. Also some disputes as children learn to collaborate

Love this challenge as it is a real-life problem to solve with design and engineering links.

We set this challenge as a homework activity over half-term. They brought their models into school and we used ideas from these at Science Club to upscale for our Inter-school contraption.