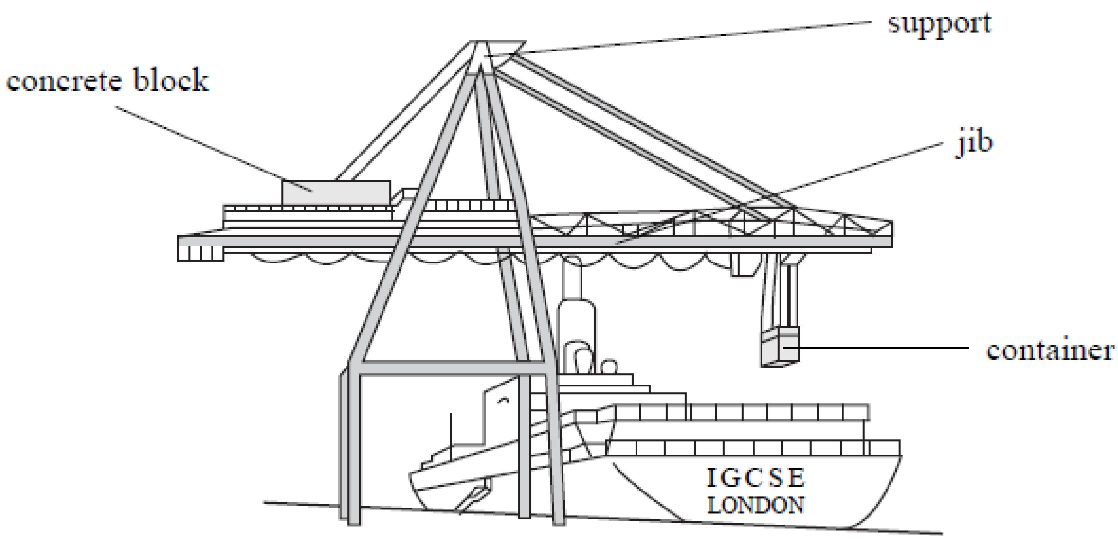
SALTUS GRAMMAR SCHOOL

IGCSE Physics



Unit 4 – Forces and Effects

Name: ………………………………………………………………

Class: ………… **Date:**…………………………………

Summary

Lesson	Objectives : Students will be assessed on their ability to
Newton's Third Law and *g*	• identify various types of forces • demonstrate an understanding of Newton's third law • understand gravitational field strength, *g*, and recall that it is different on other planets and the moon from that on the earth
Orbits	• explain that gravitational force causes the planets to orbit the Sun, causes moons and artificial satellites to orbit the Earth, causes comets to orbit the Sun • use the relationship between orbital speed, orbital radius and time period, • describe the differences in orbits of comets, moons and planets • recall that the solar system is part of the milky way galaxy and that the universe is a large collection of billions of galaxies
Hooke's Law	• describe experiments to investigate how extension varies with applied force for helical springs and metal wires • understand that the initial region of a force-extension graph is associated with Hooke's law
Non-Hookian Materials	• describe how extension varies with applied force for rubber bands • associate elastic behaviour with the ability of a material to recover its original shape after the forces causing deformation have been removed
Moments	• know and use the relationship between the moment of a force and its distance from the pivot. • know and use the principle of moments for a simple system of parallel forces acting in one plane
Centre of Gravity and Stability	• recall that the weight of a body acts through its centre of gravity • understand that the upward forces on a light beam, supported at its ends, vary with the position of a heavy object placed on the beam
Friction	• understand that force is a vector quantity • understand that friction is a force that opposes motion

Important information

This unit consists of seven topics including the test. Curriculum materials can be found within Blackboard and the staff area of the network.

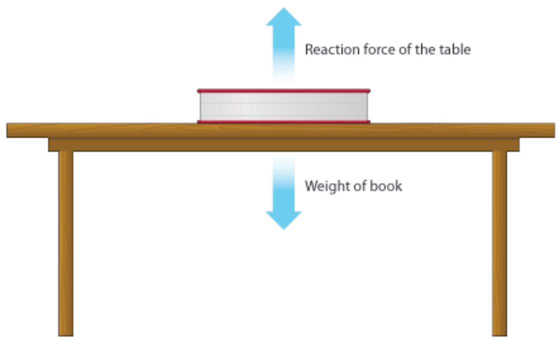
1 – Newton's Third Law and *g*

text ref: pg 39

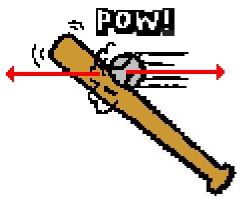
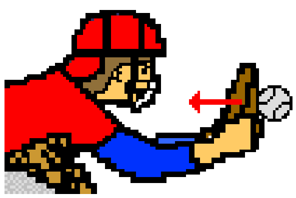
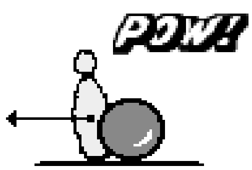
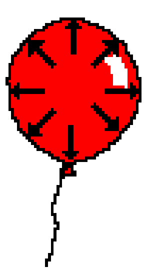
Objectives:

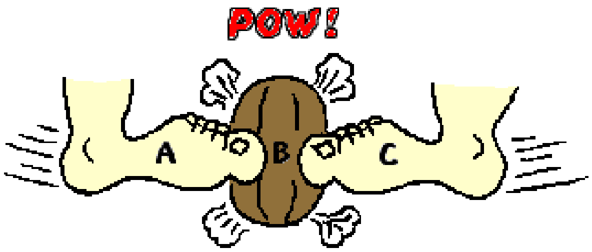
- identify various types of forces
- demonstrate an understanding of Newton's third law
- understand gravitational field strength, *g*, and recall that it is different on other planets and the moon from that on the earth

Notes:



Identify the action and reaction force in each of the following situations. The first one is done for you.

Example	Action	Reaction
	The baseball pushes the bat to the **left** *(an action).*	The bat pushes the ball to the **right** *(the reaction).*
	Baseball pushes glove to the left.	
	Bowling ball pushes pin to the left.	
	Enclosed air particles push the wall of the balloon outwards.	

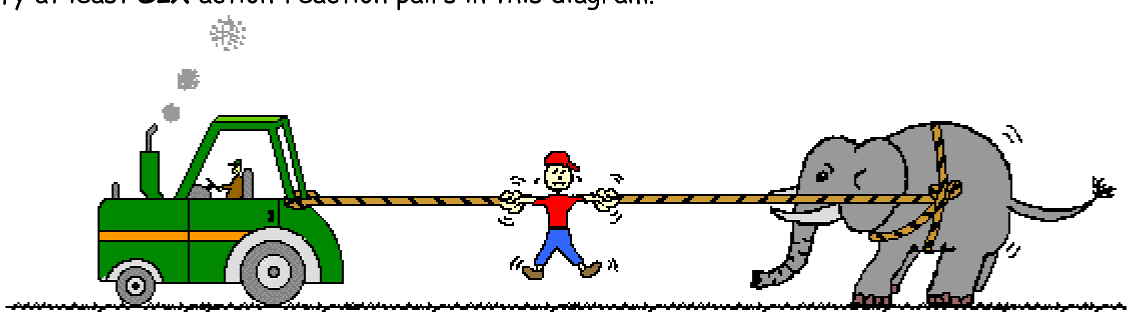


Action-Reaction Pair #1:

Action-Reaction Pair #2:

Identify **BOTH** action-reaction pairs in this situation with Foot A, Ball B, and Foot C

Identify at least **SIX** action-reaction pairs in this diagram.



2 – Gravity and Orbits text ref: pgs 49 - 55

Objectives:

- explain that gravitational force causes the planets to orbit the Sun, causes moons and artificial satellites to orbit the Earth, causes comets to orbit the Sun
- use the relationship between orbital speed, orbital radius and time period,
- describe the differences in orbits of comets, moons and planets
- recall that the solar system is part of the milky way galaxy and that the universe is a large collection of billions of galaxies

Notes:

PhET LAB: Gravity and Orbits

Follow the directions carefully before answering the following questions while using the PhET Simulation "Gravity and Orbits". http://phet.colorado.edu/en/simulation/gravity-and-orbits

1) Run the Simulation, Keep all the default settings, but select the *Earth and Satellite option.* Turn *on all of the options* in the "*Show*" menu, then run and play with the simulation for a while. Which is experiencing a greater gravitational force: The satellite or the earth?

2) Pause the Simulation. Hit "Reset". (not "Reset All"). Alter the mass of the Satellite. Does the mass of the satellite have any impact on its Orbit? Explain.

3) Pause the Simulation. Hit "Reset." Click and drag the "*v*" at the end of the red velocity in order to *decrease* the satellite's velocity.
   a. What happens when you hit play? Why?

   b. Why doesn't this happen to satellites normally?

4) Pause the Simulation. Hit "Reset." Click and drag to *increase* the satellite's velocity. What happens when you hit play? Why?

5) Pause the Simulation. Hit "Reset." Click and drag the satellite itself to move it further away from Earth. What happens when you hit play? Why?

6) Try to create another stable orbit that is further or closer to Earth. What other very important variable is altered with this new orbit?

7) Just for fun. Click and drag Earth to create a very small velocity for Earth. Can the satellite still orbit a moving planet effectively?

8) Pause the Simulation. Hit "Reset." On the top left tabs, change your view so that you are *to scale*. In the *Show* menu, you can now also turn on the "Tape Measure". Run the simulation, with the path shown.
    a. How far out is the satellite?

b. How long does it take for the satellite to orbit Earth?

9) Switch modes, so that you are now looking at just the Earth and the Moon.
   a. How far is the Moon?

   b. How long does it take for the Moon to orbit the Earth?

10) Again Switch modes, so that you are now looking at just the Earth and the Sun.
   a. How far is the Earth from the Sun?

   b. How long does it take for the Earth to orbit the Sun?

PhET LAB: Gravity and Orbits (extension)

1) According to Kepler's third law, The time it takes for one complete orbit is proportional to the mean distance between the centers of two bodies. $T^2 \alpha r^3$. When a constant is included, the equation is:

$$T^2 = \left(\frac{4\pi^2}{GM}\right)r^3$$

Use the adjustable mass controls on the simulation of just the earth and sun to determine what mass the "*M*" in Kepler's equation must refer to. Is it the mass of the orbiting object or the mass of the central object?

2) Hit Reset All. View all three objects in Cartoon mode. Sketch a diagram showing their paths for one full year.

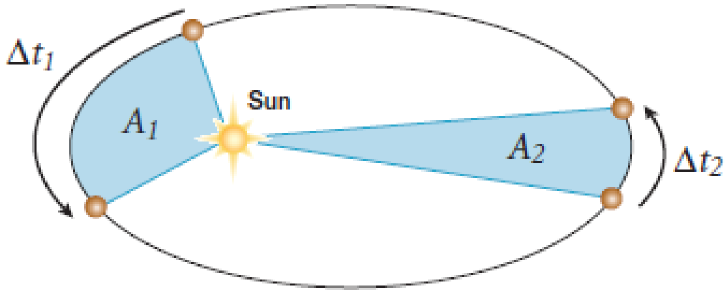
3) Kepler actually proposed three laws.

KEPLER'S LAWS OF PLANETARY MOTION

First Law: Each planet travels in an elliptical orbit around the sun, and the sun is at one of the focal points.

Second Law: An imaginary line drawn from the sun to any planet sweeps out equal areas in equal time intervals.

Third Law: The square of a planet's orbital period (T^2) is proportional to the cube of the average distance (r^3) between the planet and the sun, or $T^2 \propto r^3$.



The diagram above illustrates Kepler's Laws: $A_1 = A_2$. In this case you can see that when a planet is closer to the Sun then it must cover more distance in the same time. It must move faster.

Reset all. Select the Earth and Sun. Choose to show only the path and velocities. Manipulate the Simulation until you achieve an elliptical orbit. The speed of the Earth increases slightly as it orbits closer to the Sun but decreases slightly when it is further from the Sun. (hint: move the Sun itself.)

Circular Motion

Q1 Which of the following is the **best explanation** of acceleration? Circle the appropriate letter.

- **A** an increase in speed
- **B** a change in direction
- **C** an increase in velocity
- **D** a change in velocity
- **E** a change in speed

Q2 The diagram below shows a clock with hands that move **steadily** around the clock-face.

a) Draw and label with 'A' an arrow on the diagram to show the direction of the **velocity** of the tip of the **minute hand**.

b) Draw and label with 'B' an arrow to show the direction of the **acceleration** of the tip of the **hour hand**.

Q3 A **satellite** orbiting the Earth travels at a constant speed.

a) Is the satellite accelerating? Explain your answer.

....

b) Put a tick next to the true statement below.

☐ "If a body is accelerating then there must be a resultant force acting on it."

☐ "The forces acting on a body going round in a circle at a steady speed must be balanced."

c) What is the general name for a force that keeps a body moving in a circular path?

....

d) Draw lines to match up the following bodies with the force that keeps them moving in a circle.

A runner running round a circular track	Gravity
A satellite in orbit round the Earth	Tension
The seats at the ends of the spokes of a spinning fairground ride	Friction

Q4 Circle the correct options in these sentences.

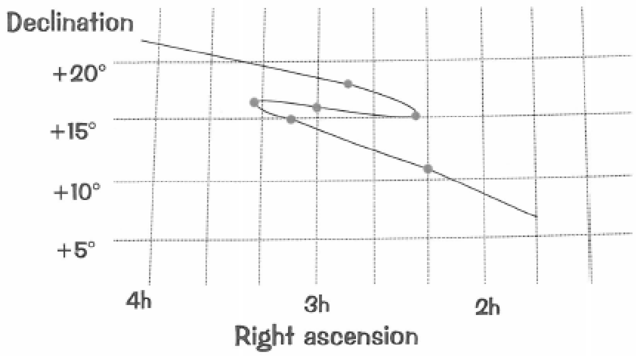
a) The greater the mass of a body, the **smaller** / **greater** the force needed to keep it moving in a circle.

b) The faster the speed of a body, the **smaller** / **greater** the force needed to keep it moving in a circle.

c) A cyclist rides round a circular track at a speed of 20 m/s. The frictional force between his tyres and the track is 1467 N. He speeds up to 21 m/s — the frictional force changes to **1617 N** / **1331 N**.

Coordinates in Astronomy

Q4 The table and diagram below show where **Mars** appeared in the night sky between August 2005 and January 2006.



Date	Right Ascension		Declination (°)
	Hours	Minutes	
09/08/2005	02	20	11.0
08/09/2005	03	11	15.0
13/10/2005	03	22	16.6
01/11/2005	03	00	16.2
14/11/2005	02	41	15.6
02/12/2005	02	24	15.1
15/01/2006	02	49	18.0

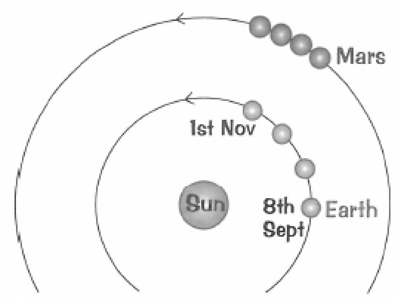
a) On the diagram, mark with an **X** the position of Mars on **November 14th 2005.**

b) How can you tell from the **table** that Mars appears to change direction?

....

....

c) The diagram on the right shows the relative positions of Mars and the Earth in their orbits between September 8th and November 1st 2005.



Which planet orbits the Sun faster — Mars or the Earth? Circle the correct answer.

Mars **Earth**

d) Use the diagram to help you explain why:

i) Mars appeared to move from **west to east** across the sky during September 2005.

....

....

ii) Mars appeared to move from **east to west** during October and November 2005.

....

....

....

Top Tips: If you get stuck on questions about which way a planet seems to be moving from Earth, draw a diagram of the Earth's orbit and the planet's orbit and mark on a few different positions. But remember, the planets aren't really wiggling about — it just looks that way to us Earthlings.

Coordinates in Astronomy

Q1 Which of the following can be seen from Earth with the **naked eye**? Circle your answers.

Mercury **Venus** **Mars** **Jupiter** **Saturn** **Uranus** **Neptune**

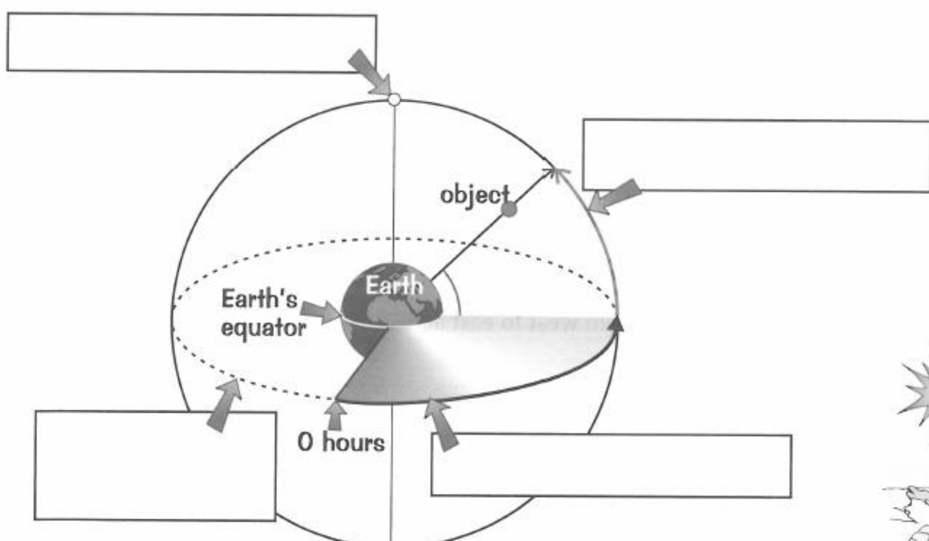
Q2 Tick the boxes to show whether the following statements are **true** or **false**.

		True	False
a)	All planets in the Solar System travel around the Sun at the same speed.	☐	☐
b)	The planets all move in the same direction around the Sun	☐	☐
c)	Mars travels faster than the Earth because it is nearer to the Sun.	☐	☐
d)	The planet Jupiter sometimes appears to move in 'loops' in the sky.	☐	☐

Q3 The positions of objects in the sky are measured using **right ascension** and **declination**.

a) Label the diagram using the words given below.

pole star **declination** **right ascension** **celestial equator**



b) What units are usually used for declination? ....

c) Why does the pole star appear to be a fixed point in the sky?

....

d) Explain why right ascension can be given in units of **degrees** or **time**.

....

Observing the Sky

Q1 From Earth, the Sun, Moon and stars all appear to **cross the sky** at different speeds.

a) Why do they appear to cross the sky?

....

b) **i)** In which direction do they all seem to travel? Circle the correct answer.

northwards **eastwards** **southwards** **westwards**

ii) Explain why this is.

....

Q2 Alex tries to impress a girl with his **constellation** knowledge by pointing out Taurus in the night sky. Being a bit of a ladies' man, he tries this trick again a few weeks later with a different girl but at the same time in the evening. He notices that he can see **different stars** now.

Explain why Alex sees a slightly different part of the sky with his latest girl.

....

....

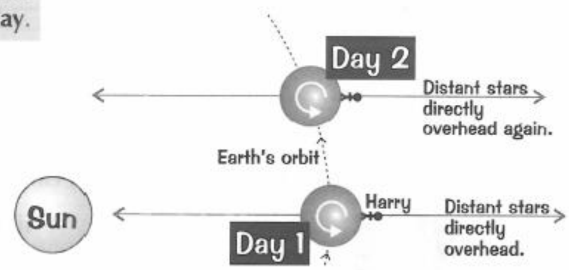
Q3 Harry has drawn a diagram to show how far the Earth moves around the Sun in one **sidereal day**.

a) What is meant by a sidereal day?

....

....

....



b) By how much does the Earth **rotate** in a sidereal day? ....

c) What is the **time difference** between a sidereal and a solar day? ....

d) On the diagram, draw Harry and the Earth's relative positions after one **solar** day.

Q4 Explain why the **Moon** takes **longer** than a sidereal day to return to the same position in the sky.

....

....

....

What does the Moon do while the Earth's spinning?

Top Tips: Make sure you know your sidereal from your solar day (or you'll never know what time to have your lunch), and why the Sun, Moon and stars all seem to cross the sky at different speeds.

Beyond the Solar System

Q1 Fill in the blanks in the sentences below using some of the words from the list.

Milky Way Sun galaxies 100 big asteroids stars Universe billion million

a) The Sun's diameter is about .... times bigger than the Earth. The diameter of the Milky Way is about 600 .... times the diameter of the Sun.

b) The distance between .... is usually millions of times more than the distance between ....

You don't need to know the figures to answer this question.

Q2 Complete this table using the numbers given below.

Object	Estimated Age	Estimated Diameter
Earth		
Sun		
Milky Way	14 000 million years	
Universe		Bigger than 100 000 million light years

5000 million years 5000 million years 14 000 million years
12 800 km 100 000 light years 1.4 million km

Q3 The **light year** is a unit of distance.

a) If the speed of light in a vacuum is 3.0×10^8 m/s, show that 1 light year is approximately equal to 9.5×10^{15} m.

Start by working out the number of seconds in a year.

....

....

b) The most distant objects that the Hubble Space telescope has seen are about 13 billion light years away. Approximately how many metres are there in 13 billion light years?

....

c) A nearby star, Sirius, is 8.2×10^{16} m away.

i) Approximately how many light years away is it? ....

ii) If Sirius suddenly exploded, how long would it be before we could know? ....

Top Tips: Wow. The Universe is older and bigger than I can possibly imagine. I tried to imagine it once, but I felt myself going mad. I'm okay now though. Gark. Gaaaarrrkk. Yep, just fine.

The Solar System

Q1 Here are some questions about objects in the **Solar System**.

a) Some planets look like stars in the night sky. What is different about the **light** we see from planets?

....

b) i) What are **comets**?

....

ii) Why do we only see comets for a very short part of their orbit?

....

....

c) Briefly describe how asteroids were formed.

....

....

Q2 Our ideas about the structure of the Solar System have **changed** over time.

a) Complete the following sentences.

i) The heliocentric model states that all the .... orbit the ....

ii) The orbits in the heliocentric model are all perfect ....

iii) In the heliocentric model the .... is at the centre of the Universe.

b) Give **one** difference between our current model of the Solar System and the heliocentric model.

....

....

c) Briefly describe how **telescopes** in general have helped change our ideas about the Solar System.

....

....

....

....

....

An egocentric model.

<u>3 – Hooke's Law</u>

text ref: pgs 18 - 20

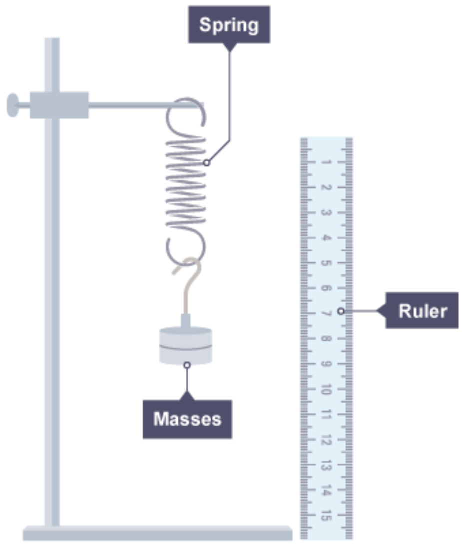
Objectives:

- describe experiments to investigate how extension varies with applied force for helical springs and metal wires
- understand that the initial region of a force-extension graph is associated with Hooke's law

Notes:

LAB: Stretching a Spring

Aim: to demonstrate the behavious of materials under load by applying a load to a spring.



1. Measure the length of the spring before any load has been applied. It is usually around 20 mm.
2. Add masses one at a time, measuring the total length of the spring between the loops – be as accurate as you can.
3. As the load approaches 12 N, ensure that you support the clamp stand and have a cushion under the masses. It generally breaks between 13 – 17 N.
4. To get the extension (stretch), subtract the original length from the length.

SAFETY: wear goggles and be aware that the clamp stand can topple and that the spring WILL break.

Load (N)	Length (mm)	Extension (mm)	Load (N)	Length (mm)	Extension (mm)
0			8		
1			9		
2			10		
3			11		
4			12		
5			13		
6			14		
7			15		

Conclusion:

ANNOTATED GRAPH SHOULD BE STAPLED HERE!

Forces and Elasticity

Q1 Alice is bouncing on a trampoline. Springs around the edge hold the trampoline bed in place.

a) The springs that hold the trampoline bed are **elastic objects**. Describe what 'elastic' means.

....

b) When she is at the top of a bounce Alice has **gravitational potential energy**. This is transferred to **kinetic energy** as she falls back down, but at the bottom of the bounce her kinetic energy is **zero**. Explain what happens to her kinetic energy.

....

....

c) Alice exerts a force of 600 N on the trampoline at the bottom of her bounce

i) There are 30 springs that support the trampoline bed. Calculate the **force exerted per spring**. Assume that **only the springs extend**, and that this force is **evenly spread** across the springs.

....

ii) An individual spring extends by **10 cm** at the bottom of a bounce. Calculate its **spring constant**.

....

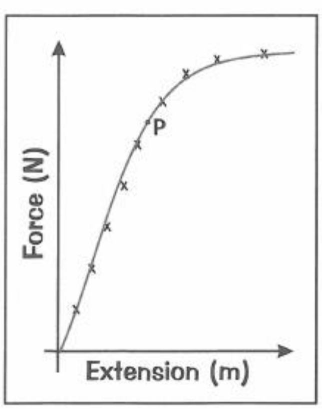
....

Q2 Nick the bungee jumper is checking his bungee cords.

a) One cord has a spring constant **45 N/m**. Calculate how much force is required to stretch it by **15 m**.

....

b) Nick conducts an experiment to find how much force it takes to stretch the bungee rope by different amounts. His results are plotted on the graph below and a best fit line is drawn.



i) Name the point labelled **P**.

....

ii) Nick repeats his experiment with the **same bungee cord** and plots the results in a graph. Will he get an identical force-extension curve? Explain your answer.

....

....

....

Weight, Mass and Gravity

Q1 Fill in the gaps in the following paragraph using the words below:

kilograms	newtons	mass	weight	gravitational

The .... of an object is just the amount of 'stuff' it's made up of. It doesn't change, regardless of where in the universe it is, and it's measured in ....

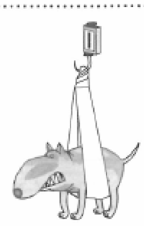
.... is a force and is measured in .... — it's the .... force that one object (e.g. a planet) exerts on another (e.g. an apple).

Q2 Joni has been feeding her dog Fluffy a bit too much bacon. The vet decides he needs to go on a diet.

$g = 10$ N/kg

a) Joni puts Fluffy on some scales and finds he has a mass of **58 kg**. Calculate his **weight**.

....



b) After three weeks of Fluffy eating only 'Skinny Dog' biscuits, Joni weighs Fluffy by putting him in a sling and hanging him from a **newton meter**. He now has a weight of **460 N**. How much **mass** has he lost?

....

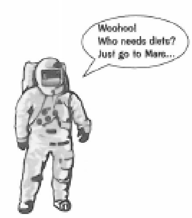
....

Q3 An astronaut goes to Mars to do some experiments.

a) Explain why her **mass** stays the same but her **weight** changes.

....

....



b) She takes a rock that weighs **50 N** on Earth. Using a set of scales designed for use on Earth, she finds that the mass of the rock appears to be **1.9 kg** on Mars. Calculate the **gravitational field strength** on Mars.

....

....

Top Tips: Gravity may be keeping you down to the earth, but compared to the other fundamental forces, it is actually **surprisingly weak**. Think about it — you have whole Earth pulling you downwards but you can jump and hop and skip away from it without too much effort. Then think about how much effort it can take to pull opposite ends of a small magnet apart. The fact is, **anything that has mass has gravity**, but objects have to be pretty humongous before anyone notices.

4 – Non-Hookian Materials text ref: pg 20

Objectives:

- describe how extension varies with applied force for rubber bands
- associate elastic behaviour with the ability of a material to recover its original shape after the forces causing deformation have been removed

Notes:

LAB: Stretching a Rubber Band

Aim: to demonstrate the behavious of a non-Hookian material using a rubber band.

1. Measure the length of the rubber band before any load has been applied.
2. Add masses one at a time, measuring the total length of the spring between the loops – be as accurate as you can.
3. As the load approaches 12 N, ensure that you support the clamp stand and have a cushion under the masses.
4. Unload the masses – one at a time. Record the length of the rubber band.
5. To get the extension (stretch), subtract the original length from the length.

SAFETY: wear goggles and be aware that the clamp stand can topple and that the rubber band MAY break.

Loading		**Unloading**	
Load (N)	**Extension (mm)**	**Load (N)**	**Extension (mm)**
0		15	
1		14	
2		13	
3		12	
4		11	
5		10	
6		9	
7		8	
8		7	
9		6	
10		5	
11		4	
12		3	
13		2	
14		1	
15		0	

ANNOTATED GRAPH SHOULD BE STAPLED HERE!

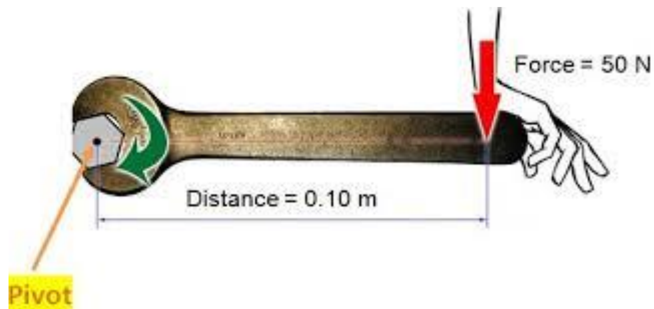
5 – Moments

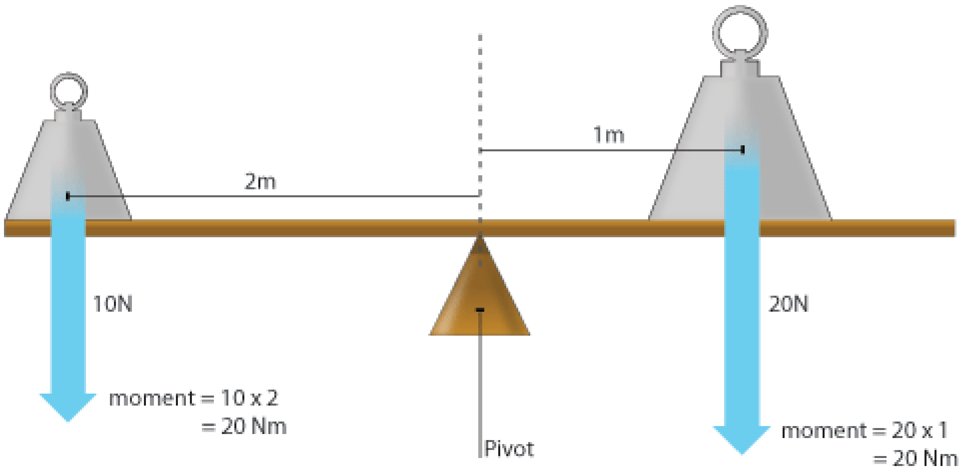
text ref: pgs 42 - 48

Objectives:

- know and use the relationship between the moment of a force and its distance from the pivot.
- know and use the principle of moments for a simple system of parallel forces acting in one plane

Notes:




1m
2m
10N
20N
moment = 10 x 2
= 20 Nm
Pivot
moment = 20 x 1
= 20 Nm

PhET LAB: Balancing Act

The simulation can be found at https://phet.colorado.edu/en/simulation/balancing-act (if using the iPad – run using HTML 5)

Part 1:

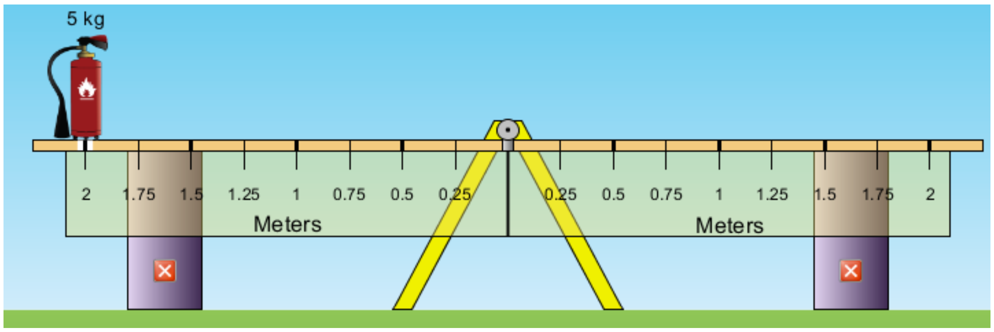
Objective: To be able to determine the variables that affect the balancing of a seesaw and predict where an object of a certain mass will have to be placed to balance the seesaw.

Method:

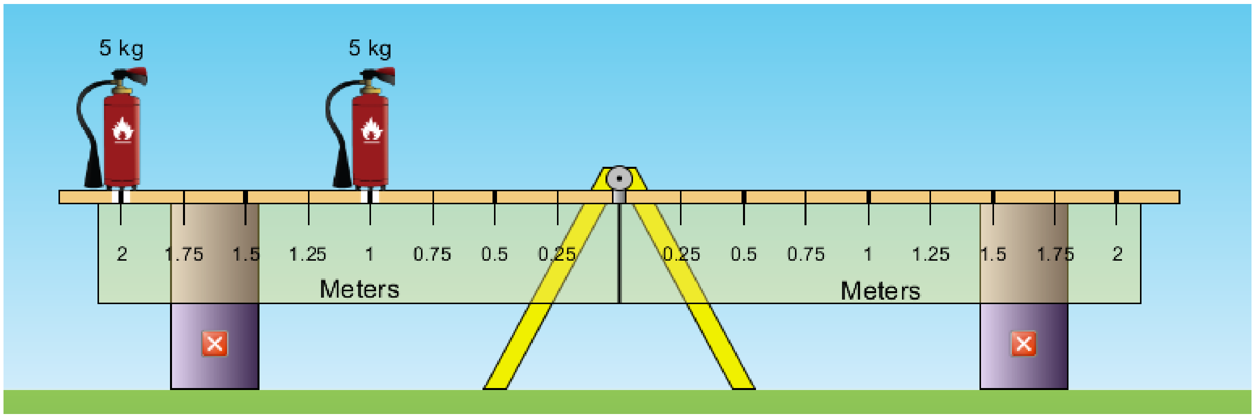
1. Investigate *Balancing Act* using the *Intro* tab at the top by moving the tanks and trash cans around and removing the supports to try to balance the seesaw. While you play with this tool, make observations about when the beam balances and when it doesn't. Use the tools on the side (mass labels, rulers, forces from objects and the level) to help you make your observations. Describe what you discovered about balancing the seesaw.

2. Use the scenarios below to make predictions about where the 10 kg trash can would need to be placed, without using *Balancing Act.* Sketch what you think the beams would look like for the following scenarios and justify your reasoning. **CHECK AFTERWARDS!**

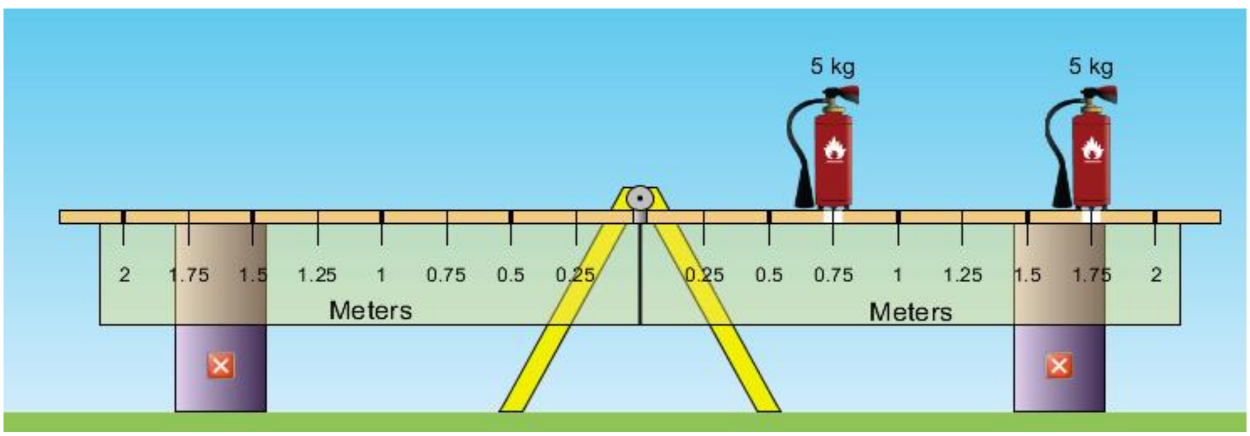
Scenario 1:



Scenario 2:



Scenario 3:

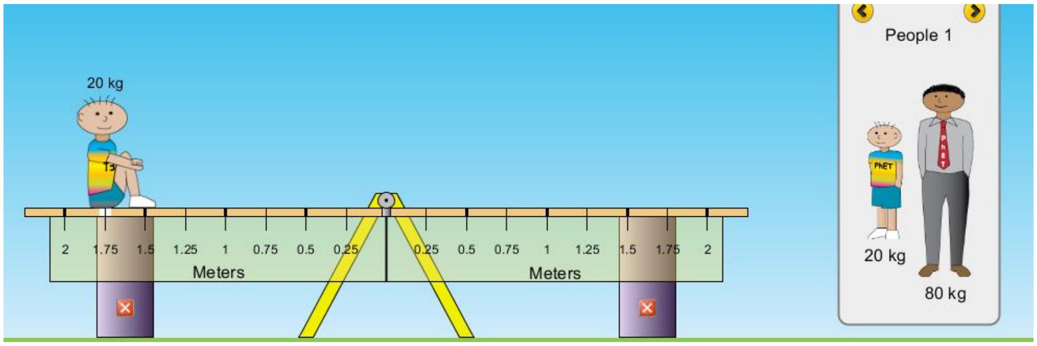


Part 2:

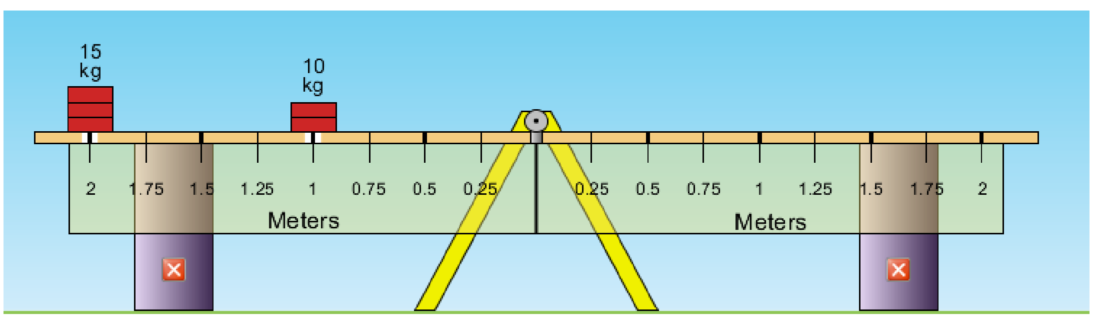
Objectives: To be able to calculate where a mass needs to be placed on a beam to balance the beam and then confirm or correct their calculations using the *Balancing Act* simulation.

Method:

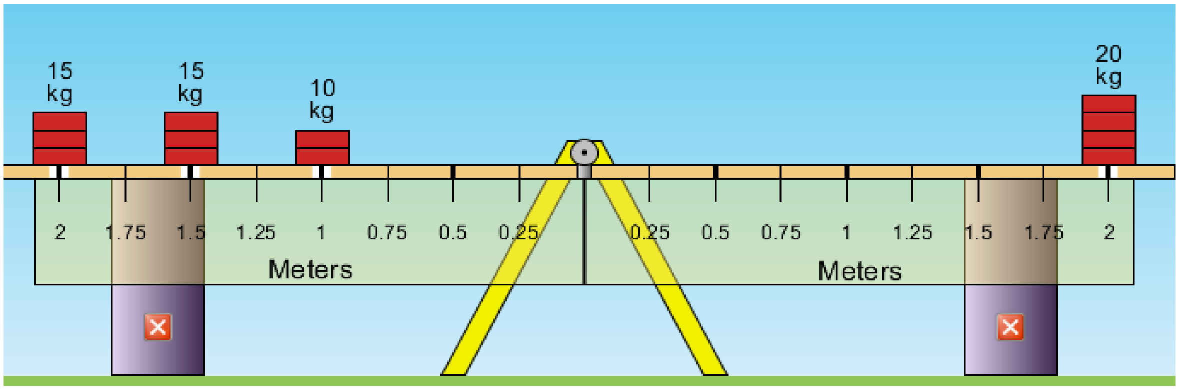
1. Calculate where the 80 kg man would need to sit to balance the beam. Show all work including formulas and substitutions with units. CHECK AFTERWARDS!



2. Predict where you would place the 20 kg pile of bricks to balance the beam? Show all calculations including formula and substitutions with units.

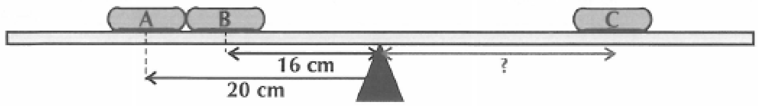


3. Calculate where a 15kg pile of bricks would need to be placed to balance the beam. Show all calculations.



Balanced Moments and Levers

Q1 A 2 N weight (Weight A) sits 20 cm to the left of the pivot of a balance.
A 5 N weight (Weight B) is placed 16 cm to the left of the pivot.



a) What is the moment exerted by **Weight A**? ....

b) What is the moment exerted by **Weight B**? ....

c) How far to the right of the pivot should Weight C (8 N) be placed to **balance** A and B?

....

....

d) If all three of the weights were exactly **twice as far** away from the pivot, would the balance tip over to one side? Explain your answer.

....

Q2 Barbara uses a wheelbarrow to move things around her allotment.
She says "I love my wheelbarrow. It makes it so much easier to lift everything."

Explain **how** a wheelbarrow reduces the amount of force needed to lift an object.

....

....

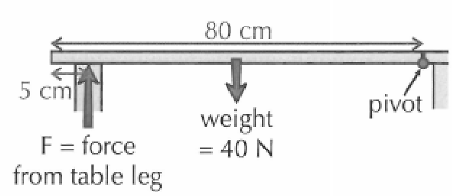
....

....

....

Q3 One side of a drop-leaf table is pivoted on a hinge and supported 5 cm from its edge by a table leg.
The table leaf is 80 cm long and weighs 40 N.

Find the force, F, exerted by the table leg (when the table leaf is fully extended).



....

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Turning Forces and the Centre of Mass

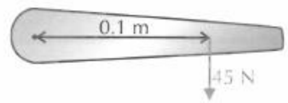
Q1 a) Fill in the blanks in the following passage using the words supplied.

pivot	perpendicular	moment	force

The turning effect of a .... is called its ....
It can be found by multiplying the force by the .... distance from
the line of action of the force to the ....

b) What are the units in which moments are measured? ....

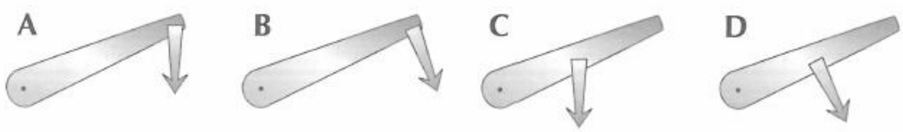
Q2 To open a door, its handle needs to be **rotated clockwise**.



a) A force of 45 N is exerted vertically downwards on the door-handle at a distance of 0.1 m from the pivot. What is the **moment** of the force?

....

b) Pictures **A**, **B**, **C** and **D** show equal forces being exerted on the handle.



Which of the forces shown (**A**, **B**, **C** or **D**) exerts:

i) the largest moment? .... **ii)** the smallest moment? ....

Q3 Some pupils want to find the centre of mass of an **irregularly shaped** piece of cardboard. They are equipped with a stand to hang the card from, a plumb line and a pencil. They make a hole near one edge of the card and hang it from the stand.

a) What steps should they take next in order to find the centre of mass?

....

....

....

....

b) The pupils are now trying to find the centres of mass of some regularly shaped pieces of cardboard. Using lines of symmetry, find the centre of mass of each of these shapes:

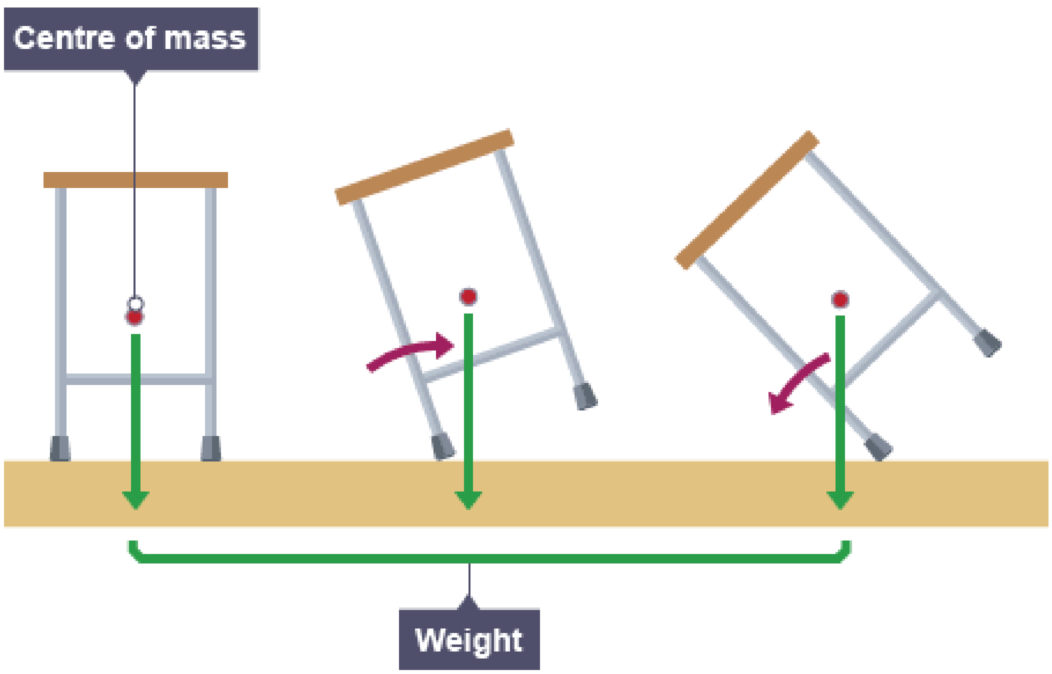
6 – Centre of Gravity and Stability

text ref: pgs 42 - 48

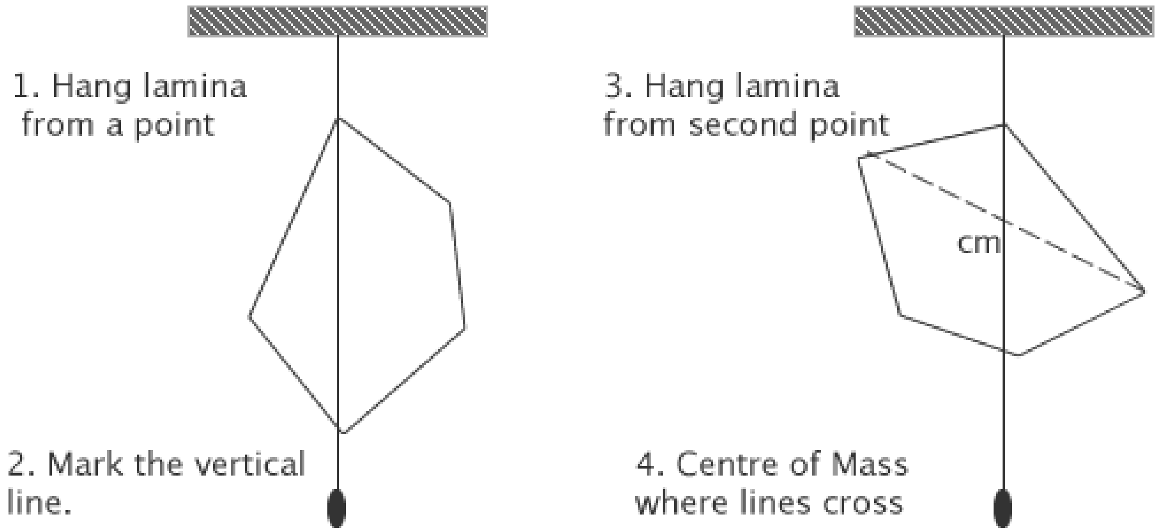
Objectives:

- recall that the weight of a body acts through its centre of gravity
- understand that the upward forces on a light beam, supported at its ends, vary with the position of a heavy object placed on the beam

Notes:



LAB: Finding the Centre of Gravity (Mass)



You can find the centre of mass of a lamina, a flat object, by hanging the lamina (posh names for a flat piece of card) from a point and a plumb bob and line next to it (this is a mass on a string). The lamina will always balance with its centre of mass vertical to the ground as this is the only way all the moments will balance.

Draw a pencil line along the line of the plumb bob then hang the lamina from another point and repeat the experiment. The centre of mass should be where the two lines cross. You can check this with a third hanging point.

Warning: The centre of mass of the lamina will not always be within the object itself – especially if you cut out an awkward shape….

Moments, Stability and Pendulums

Q1 The top drawer of a two-drawer filing cabinet is full of heavy files, but the bottom drawer is empty.

Why is the cabinet in danger of falling over if the top drawer is fully pulled out?

Q2 The pictures show three different designs for **vases**.

Which vase will be **most stable**? Explain your answer.

Q3 The diagram to the right shows a cart being used to carry coal along a slope. The centre of mass of the cart, when full, is shown.

a) Explain why the cart **doesn't** topple over when on the slope.

b) Suggest **one** way in which the stability of the cart could be improved.

Q4 A magician is using a pendulum to practise hypnotism. The pendulum swings with a time period of 1.25 s.

a) Calculate the frequency of the pendulum.

b) The magician decides the time period of the pendulum's swing needs to be longer to work best. Suggest **one** way in which he could increase the time period of the pendulum.

Top Tips: You should be able to look at an object and describe how its design affects its stability. You're always looking for the same sort of things though — where its centre of mass is and how wide its base is. My massive bottom means I'm fairly stable and very difficult to topple.

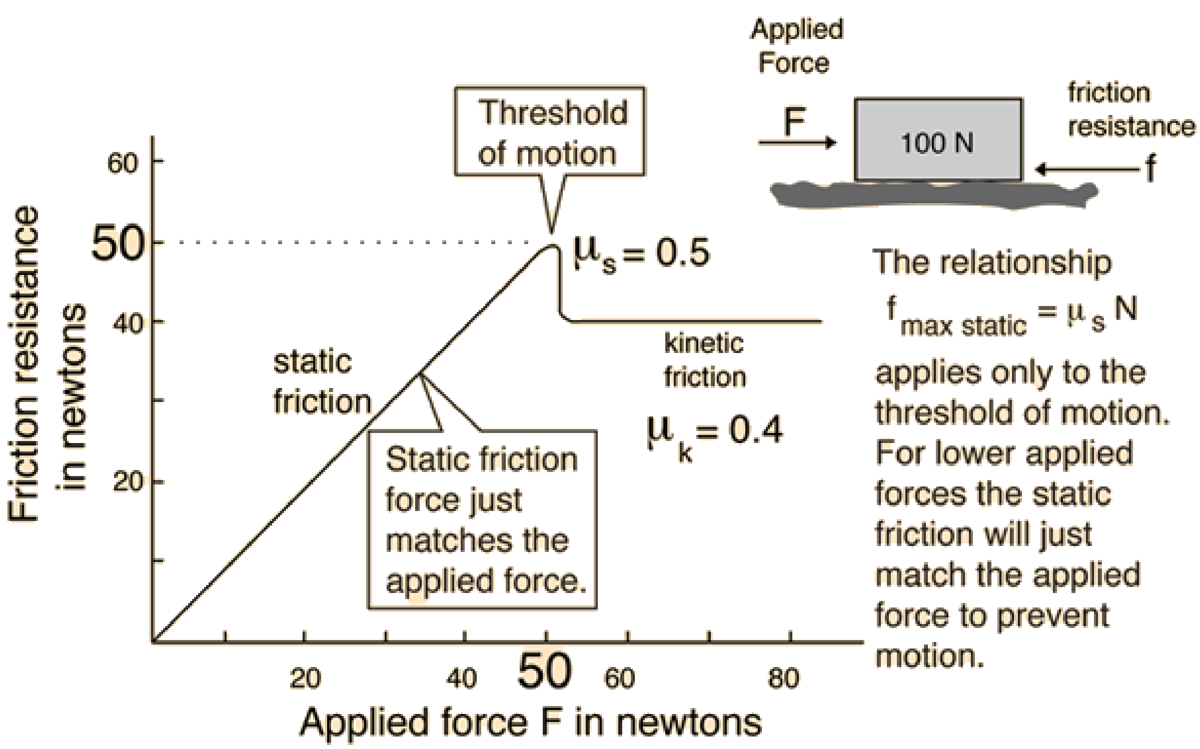
8 – Friction

text ref: pgs 25 - 27

Objectives:

- understand that force is a vector quantity
- understand that friction is a force that opposes motion

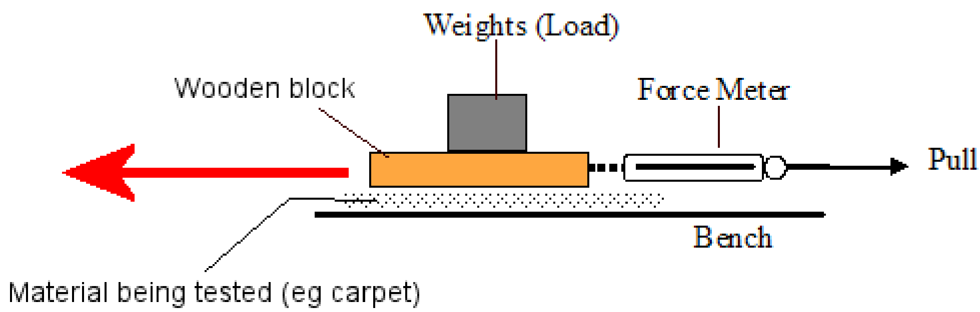
Notes:



LAB: Investigating Surface Friction (Laptop)

Aim: to investigate how the nature of the surfaces and the mass of the object affects the friction.

Diagram:



Lab Notes:

Syllabus – Edexcel IGCSE Physics 4PH0

1.23 recall and use the relationship between the moment of a force and its distance from the pivot:

moment = force × perpendicular distance from the pivot

1.24 recall that the weight of a body acts through its centre of gravity

1.25 recall and use the principle of moments for a simple system of parallel forces acting in one plane

1.26 understand that the upward forces on a light beam, supported at its ends, vary with the position of a heavy object placed on the beam

1.27 describe how extension varies with applied force for helical springs, metal wires and rubber bands

1.28 recall that the initial linear region of a force-extension graph is associated with Hooke's law

1.29 associate elastic behaviour with the ability of a material to recover its original shape after the forces causing deformation have been removed.

d) Astronomy

Students will be assessed on their ability to:

1.30 recall that the moon orbits the earth and that some planets also have moons.

1.31 understand gravitational field strength, g, and recall that it is different on other planets and the moon from that on the earth.

1.32 explain that gravitational force

- causes the planets to orbit the sun
- causes the moon and artificial satellites to orbit the earth
- causes comets to orbit the sun

1.33 use the relationship between orbital speed, orbital radius and time period

$$\text{orbital speed} = \frac{2 \times \pi \times \text{orbital radius}}{\text{time period}}$$

$$v = \frac{2 \times \pi \times r}{T}$$

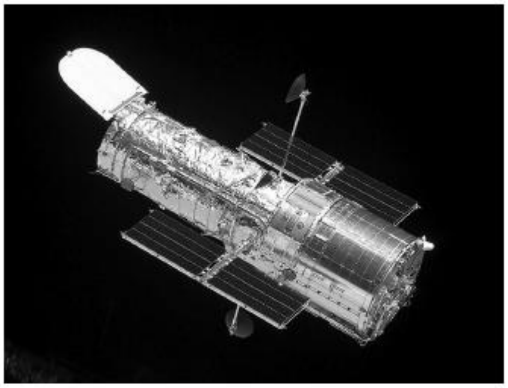
1.34 describe how the orbit of a comet differs from that of a planet

1.35 recall that the solar system is part of the milky way galaxy

- describe a galaxy as a large collection of billions of stars
- state that the universe is a large collection of billions of galaxies.

PAST IGCSE QUESTIONS

1 Hubble and Kepler are the names of two space telescopes.



Hubble telescope

Kepler telescope

(a) The Hubble telescope is in a circular orbit around the Earth.

The Kepler telescope is in a circular orbit around the Sun.

(i) The orbit of the Hubble telescope is most like the orbit of a **(1)**

☐ **A** comet

☐ **B** moon

☐ **C** planet

☐ **D** star

(ii) The orbit of the Kepler telescope is most like the orbit of a **(1)**

☐ **A** comet

☐ **B** moon

☐ **C** planet

☐ **D** star

(iii) The force that keeps space telescopes in orbit is **(1)**

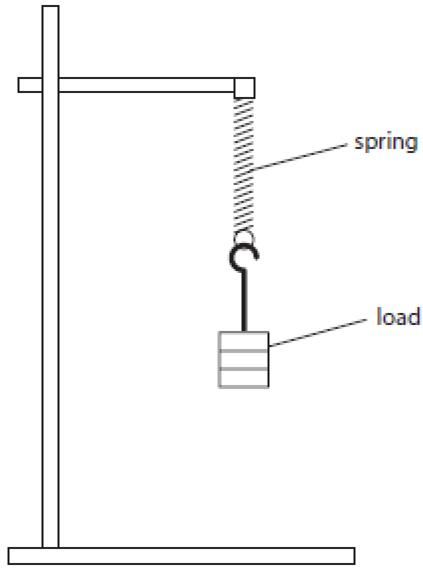
☐ **A** friction

☐ **B** gravity

☐ **C** lift

☐ **D** upthrust

9 A student investigates how the extension of a spring varies when he hangs different loads from it.



(a) Write a plan for the student's investigation.

Your plan should include details of how the student can make accurate measurements.

You may add to the diagram to help your answer.

(5)

....

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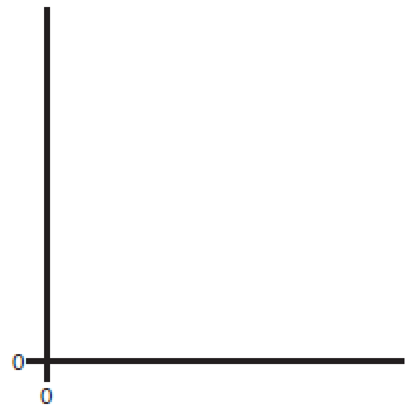
(b) The student finds that the spring obeys Hooke's law.

Draw a graph on the axes to show the Hooke's law relationship.

Label the axes.

(3)



(c) The student concludes that the spring shows elastic behaviour.

Explain what is meant by the term **elastic behaviour**.

(2)

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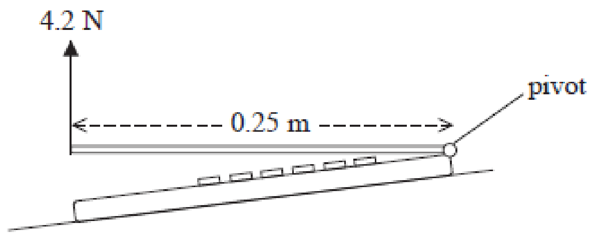
(Total for Question 9 = 10 marks)

5 The diagram shows the side view of a laptop computer.



A student opens the computer with an upward force of 4.2 N.

The force is applied 0.25 m from the pivot.

(a) (i) State the equation linking moment, force and distance.

(1)

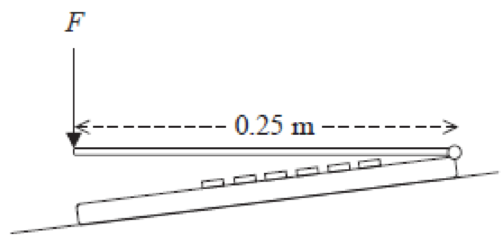
(ii) Calculate the moment of the force that opens the computer.

(2)

Moment = ... N m

(b) The student finds that 4.2 N is the **minimum** upward force needed to open the computer.

Then the student applies a downward force, *F*, to close the computer.



Explain why the minimum force needed to close the computer is likely to be less than 4.2 N.

(2)

....

....

....

....

(Total for Question 5 = 5 marks)

11 A student investigates the extension of an elastic band for different forces.

(a) (i) List the laboratory apparatus that the student needs for this investigation.

(3)

(ii) Extension, force and temperature are variables for this investigation.

Draw a line from each variable to its type.

(2)

variable	**type of variable**
extension	control
force	dependent
temperature	independent

(iii) Describe how the student can measure the extension of the elastic band when he adds a force of 12 N.

(2)

(b) The student obtains this data as he first adds weights to the elastic band (loading) and as he then removes weights from the band (unloading).

Force in N	Extension in cm Loading
0	0.0
2	2.3
4	5.3
6	9.8
8	15.3
10	20.0

Force in N	Extension in cm Unloading
0	0.0
1	1.4
3	5.0
7	14.8
9	19.1
10	20.0

He plots the loading data on a graph as shown.

(i) Suggest how the student could improve the quality of his data. **(2)**

....

....

....

....

(ii) Draw a curve of best fit through the loading data. **(1)**

(iii) On the same axes, plot the unloading data. **(2)**

(iv) Draw a curve of best fit through the unloading data. **(1)**

(v) The student concludes that the band is an elastic material and that it obeys Hooke's law.

Discuss whether his conclusion is correct.

You should support your argument with data. **(3)**

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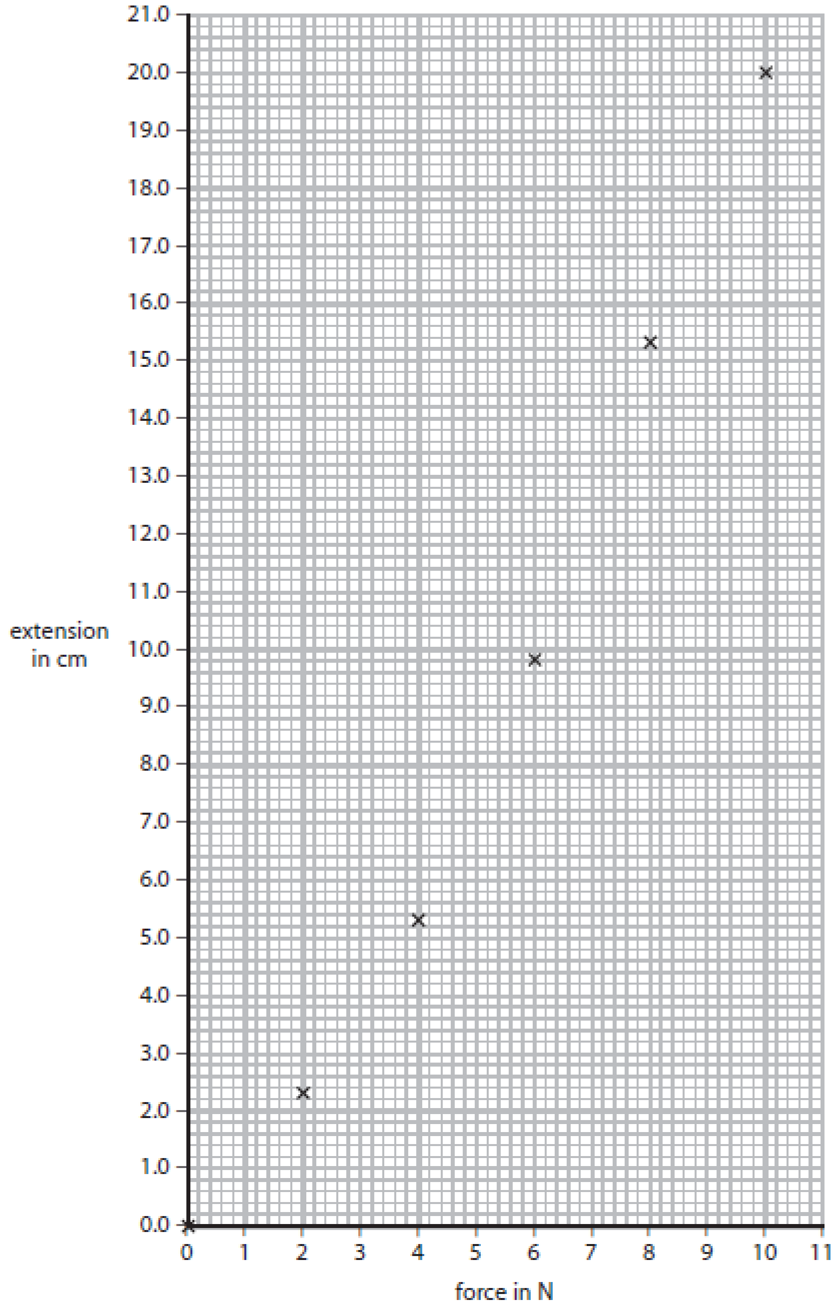

(Total for Question 11 = 16 marks)

10 The table shows some data about planets in our Solar System.

Planet	**Diameter in km**	**Distance from Sun in 10^6 km**	**Time of orbit in Earth days or Earth years**	**Mass of planet in 10^{24} kg**
Mercury	4 880	58	88 d	0.33
Venus	12 100	108	224 d	4.9
Earth	12 800	150	365 d	6.0
Mars	6 790	228	687 d	0.64
Jupiter	143 000	778	11.9 y	1 900
Saturn	121 000	1 427	29.5 y	570
Uranus	51 000	2 870	84 y	87
Neptune	50 000	4 497	165 y	100

Use data from the table to answer these questions.

(a) Which planet has about the same diameter as the Earth?

(1)

....

(b) Jupiter has the largest gravitational field strength.

Suggest a reason for this.

(1)

....

....

(c) (i) State the equation linking density, mass and volume.

(1)

(ii) Calculate the density of Neptune in kg/km³.

You may assume that Neptune is a sphere and that its volume is given by

$$\text{volume} = \frac{4\pi r^3}{3}$$

(3)

density = ... kg/km³

(d) Calculate the orbital speed of Earth in km/s.

(3)

orbital speed = ...km/s

(e) A student says

'The smaller the planet, the shorter its period of orbit.'

Use data from the table to evaluate this statement.

(3)

(Total for Question 10 = 12 marks)