Background pattern

Description automatically generated with low confidence

**Year 10 – Student Booklet A**

**KS4 Forces 1**

Graphical user interface, text, application

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A cartoon of a person sitting under a tree

Description automatically generated with medium confidence

Shape

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**Lesson Breakdown**

Lesson 1: Classifying forces (4.5.1.1 & 4.5.1.2)

Lesson 2: Gravity, mass & weight (4.5.1.3)

Lesson 3:  Resultant forces & resolving resulting forces (4.5.1.4)

Lesson 4: Resolving resultant forces – Higher tier only

Lesson 5: Work done (4.5.2)

Lesson 6: Forces and elasticity (4.5.3) - theory

Lesson 7: Required practical (4.5.3) - extension of a spring

Lesson 8: Required practical (4.5.3) - analysis

Lesson 9: Moments, levers and gears (4.5.4) - Physics only

Lesson 10: Pressure in fluids – Physics only

Lesson 11: Pressure at right angles to a surface – Physics only

Lesson 12: Atmospheric pressure – Physics only

**Keystone words**

1. **Vector**
2. **Scalar**
3. **Contact**
4. **Non-contact**
5. **Resultant**
6. **Extensio****n**

**Lesson 1: Classifying forces**

**Objective: You are learning to classify forces as contact / non-contact or push / pull forces.**

**Do It Now**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**I wasn’t there, but I still care.**

This is the first lesson of the topic.

Complete the ‘Do It Now’ activity shown above.

**Connect**

**Q1.**

The picture shows a man called Aristotle. He lived in Greece over 2000 years ago.

A person with a beard

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          Aristotle said that the heavier an object is, the faster it will fall to the ground.

(a)     The drawings below show a bowling ball, a cricket ball and a ping-pong ball.  
Lila dropped them all at the same time from the same height.

A close up of a ball

Description automatically generated with medium confidence                           A close up of a ball

Description automatically generated                                

bowling ball                               cricket ball                         ping-pong  
mass = 5 000 g                         mass = 160 g                    mass = 2.5 g

          If Aristotle was correct, which of the three balls would you expect to reach the ground first?  
Give the reason for your answer.

.....................................................................................................................

.....................................................................................................................

1 mark

(b)     Joe said that it would be a fairer test if Lila had only used a cricket ball and a hollow plastic ball as shown below.

A close up of a ball

Description automatically generated                                   A picture containing circle, oval, mirror, dishware

Description automatically generated

cricket ball                            hollow plastic ball  
mass = 160 g                            mass = 56 g

          Why was Joe correct?

.....................................................................................................................

.....................................................................................................................

1 mark

(c)     About 400 years ago in Italy, a man called Galileo had a different idea. He said that all objects dropped from the same height would reach the ground at the same time.

(i)      Lila dropped a hammer and a feather at the same time from the same height.

A picture containing text, sketch, white, hammer

Description automatically generated    A black and white feather

Description automatically generated with low confidence

         If Galileo was correct, which, if either, would reach the ground first?

.............................................................................................................

1 mark

(ii)     Gravity acts on both the hammer and the feather as they fall. Give the name of **one** other force which acts on them as they fall.

..........................................

1 mark

(iii)     An astronaut on the moon dropped a hammer and a feather at the same time from the same height.

A child in an astronaut suit

Description automatically generated with medium confidence

         How would the results of the astronaut’s experiment on the Moon be different from Lila’s experiment on the Earth?

.............................................................................................................

         Explain your answer.

.............................................................................................................

.............................................................................................................

2 marks

Maximum 6 marks

c)     About 400 years ago in Italy, a man called Galileo had a different idea. He said that all objects dropped from the same height would reach the ground at the same time.

(i)      Lila dropped a hammer and a feather at the same time from the same height.

A picture containing text, sketch, white, hammer

Description automatically generated    A black and white feather

Description automatically generated with low confidence

         If Galileo was correct, which, if either, would reach the ground first?

.............................................................................................................

1 mark

(ii)     Gravity acts on both the hammer and the feather as they fall. Give the name of **one** other force which acts on them as they fall.

..........................................

1 mark

(iii)     An astronaut on the moon dropped a hammer and a feather at the same time from the same height.

A child in an astronaut suit

Description automatically generated with medium confidence

         How would the results of the astronaut’s experiment on the Moon be different from Lila’s experiment on the Earth?

.............................................................................................................

         Explain your answer.

.............................................................................................................

.............................................................................................................

2 marks

**Notes:**

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**Information**

Scientists often make measurements. The physical quantities they measure fall into two categories: scalars and vectors. Scalar and vector quantities are treated differently in calculations.

**A scalar** is a physical quantity is something that can be measured. Scalar quantities only have a magnitude.

**Examples of scalar quantities**

Some examples of scalar quantities include:

* temperature, eg 10 degrees Celsius (°C)
* mass, eg 5 kilograms (kg)
* energy, eg 2,000 joules (J)
* distance, eg 19 metres (m)
* speed, eg 8 metres per second (m/s)
* density, eg 1,500 kilograms per metre cubed (kg/m³)

A **vector** quantity has both magnitude and an associated direction. This makes them different from scalar quantities, which just have magnitude.

**Examples of vector quantities**

Some examples of vector quantities include:

* force, eg 20 newtons (N) to the left
* displacement, eg 50 kilometres (km) east
* velocity, eg 11 metres per second (m/s) upwards
* acceleration, eg 9.8 metres per second squared (m/s²) downwards
* momentum, eg 250 kilogram metres per second (kg m/s) south west

Task 1: Put a tick in the box stating if the below Scalar or Vector ?

|  |  |  |
| --- | --- | --- |
| **Quantity** | **Scalar** | **Vector** |
| Weight |  |  |
| Distance |  |  |
| 6m West |  |  |
| 125 J |  |  |
| 68 Kg |  |  |
| Force |  |  |
| Displacement |  |  |
| 750 N Down |  |  |
| Speed |  |  |
| 30 m/s at 30° from North |  |  |
| Mass |  |  |

**Vector Information**

* Vectors have both size and direction. We represent them using arrows.
* The **length** of the arrow represents the magnitude.
* An arrow twice as long will have a magnitude twice as big. If possible draw the length to scale.
* The **direction** of the arrow represents the direction.
* The direction of a vector can be given in several ways:
* Compass bearing e.g. 45m m/s East or 12 m/s at 133o
* Arrow with a value e.g. à 20m/s
* Using a sign convention e.g. positive for upwards and negative for downwards

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**A picture containing text, font, screenshot, number

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**Classifying forces (push / pull, contact / non-contact).**

Forces can cause three effects on objects. They can:

1. Change their speed.
2. Change their direction.
3. ****Change their shape



We can classify forces depending on how they interact with objects. They can be classified as push or pull forces. We can also classify forces as contact forces and non-contact forces (or fields). Contact forces act when objects or surfaces touch. For example, friction is a contact force that might exist between your feet and the floor (if it didn’t, the floor would be very slippery). Other contact forces include normal contact force, tension and air resistance.

Non-contact forces act through space. For example, gravity can attract other objects without it having to touch them. Also, magnets can attract or repel other magnets without touching them. The non-contact forces are formally called gravitational force, electrostatic force and magnetic force.

All forces are vector quantities because they have a magnitude and a direction.

**Describing interactions.**

When two or more objects interact, all of the objects experience forces. E.g, when you kick a ball, the ball experiences a force so it moves. You also experience a force on your foot (you feel the pressure of the ball pushing against your foot).

The forces are equal and opposite. We call the pairs of forces, interaction pairs.

**Questions:**

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1. Describe the unit of measurement of forces and name the piece of equipment we use to measure forces?

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1. Describe the difference between a scalar and a vector quantity?

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1. Explain why we use arrows to represent forces?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Explain the effect applying a force has on an object?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Explain the difference between a contact and a non-contact forces and give examples of each?

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**Answers**

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2. Newtons, Newton meter

3. Scalar has a magnitude, vector has a magnitude and direction

4. To show the varying directions forces are acting, forces work in pairs

5. A force can, change the speed, direction and shape of an object

6. A contact force has to have direct contact on it to work, a non-contact does not need to be touching an object for it to effect it. It can work at a distance.

**Lesson 2: Gravity, Mass and Weight**

**Objective: You are learning about mass and weight and how they are related.**

**Do It Now**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**I wasn’t there, but I still care**

Define Scalar: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Define Vector:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

State 2 examples of a scalar and vector quantity:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

State the difference between a scalar and a vector quantity:

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Connect**

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Suggest reasons why weight is different on different planets but mass remains constant. Write in full sentences and use at least two connectives in your answer.

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**Notes:**

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**Gravitational field strength**

On Earth, the downward force of gravity on a 1 kg mass is 10 N.

This is called the gravitational field strength (g).

Gravitational field strength g = 10 N/kg (some questions will ask you to use 9.81 N/kg).

The relationship between the weight of an object in N, its mass in kg and the gravitational field strength N/kg is given by the equation:

**weight W in N = mass m x gravitational field strength g**

W = mg

W = weight in N

m = mass in kg

g = gravitational field strength in N/kg

g = 10 N/kg

A mass of 1 kg has a weight of 10 N.

A mass of 6 kg has a weight of 60 N.

Mass is a measure of how much matter is in an object. The mass of an object is constant, when the object is on Earth, Mars or even in the middle of space it’s mass will be the same. **The units of mass are the kilogram (kg). We measure mass using a balance.**

Weight is a measure of the force pulling an object down due to gravity. This can change due to the strength of gravity. **The unit of Weight is the Newton (N). Weight is measured using a calibrated Newton meter.** The weight of an object appears to act from a point called the **center of mass.**

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**Teacher Modelling:** Calculate the weight of a student whose mass is 72kg.

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**1 tonne (t) = 1000 kg**

**Questions 1 to 5 are asking about weight on earth, assume the gravitational field**

**strength on earth is 9.81 N/kg**

1. Calculate the weight of a student whose mass is 72kg

2. Calculate the weight of a wheelbarrow of concrete, total mass 105 kg

3. Calculate the weight of a pillow, total mass 0.5 kg

4. Calculate the weight of a 25g sachet of pickling spice

5. Calculate the weight of a 44t lorry (1 tonne = 1000 kg)

**In all the questions below g stands for “gravitational field strength”.**

6. Calculate the weight of a 25 kg sack of potatoes on earth, assume g = 9.8 N/kg

7. Calculate the weight of a 25 kg sack of potatoes on the moon where g = 1.6 N/kg

8. Calculate the weight of a 25 kg sack of potatoes on mars where g = 3.8 N/kg

9. Calculate the weight of a 1.5 tonne landing vehicle on mars (g = 3.8 N/kg )

10. Calculate the weight of 20 g of moon dust on earth (g = 9.8 N/kg )

11. Calculate the mass of a rover which weighs 500N on the moon where g = 1.6 N/kg

12. Calculate the mass of an astronaut whose weight is 400N on mars (g = 3.8 N/kg )

13. Calculate the mass of space dust whose weight is 4N on jupiter (g = 26.9 N/kg )

14. Calculate the mass of space dust whose weight is 89 mN on on Venus (g = 8.9 N/kg )

15. Convert the answer to Question 19 into grams.

16. If 1 kg has a weight of 2N on the planet zog, what is the value of g on the planet zog?

17. If a 25 kg lander weighs 110 N on the exoplanet proxima b what is the value of g on proxima b?

18. If a 450 t meteorite weighs 1350 kN, what is the value of g?

19. What would a 0.5 g paracetamol tablet weigh on mars (g = 3.8 N/kg )

20. If a 0.5 g paracetamol tablet weighs 0.8 mN, where might it be? (work out the value of g first...)

21. Using the answers to questions 11 to 13 above, on which of earth, mars and the moon does a 10kg

object weigh the most? Is this true for an object of any mass?

|  |  |  |
| --- | --- | --- |
| **Object**  **Using the Newton meters calculate the weight of various everyday objects. You must show your calculations.** | **Mass (kg)** | **Weight (N)** |
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| **Show your working out below:**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  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**Lesson 3: Resultant forces acting in a straight line**

**Objective: You are learning to calculate the resultant of forces acting in a straight line.**

**Do It Now**

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| Answer | | PA / SA |
| 1 |  |  |
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**I wasn’t there, but I still care.**

Recall the difference between mass & weight.

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Description automatically generated

**Connect**

Identify which arrow represents which force.

Conclude what overall effect the forces have on the car?



**Notes:**

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**Isaac Newton’s 3rd Law states:​**

* ***Each action has an equal and opposite reaction*​**

**​**

* In other words, if you exert a force on an object, the object exerts a force of the same magnitude back​

​

* E.g., a boxer who punches a punch bag with a force of 100N experiences an equal and opposite force of 100N from the bag​

These can be shown by force diagrams. Examples of force diagrams include:

A picture containing screenshot, table, design

Description automatically generated

A picture containing screenshot, text, diagram, graphic design

Description automatically generated

A picture containing transport, air travel, plane, vehicle

Description automatically generated

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**Task 1:**

A orange rectangular object with wheels

Description automatically generated with low confidence

1. What is the **magnitude** (size) of the **resultant force**?
2. What is the **direction** of the **resultant force**?
3. How could this be represented?
4. Because the resultant force has direction AND size it means that force is a…?

**Task 2**: Resolve the resultant forces

A picture containing screenshot, diagram, text, number

Description automatically generated

Free body diagrams

Show the forces acting on an object in a free body diagram. The arrows represent the size and direction of the forces acting. When drawing a force diagram:

A picture containing diagram, line, font, rectangle

Description automatically generated

* represent the object with a small box or dot
* draw the arrows with a pencil and ruler
* draw the arrows from the centre of the box or dot
* label the arrow with the name of the force and the size of the force

**Task3:**

A picture containing text, diagram, plan, technical drawing

Description automatically generated

Answers

0N 50N down 50N up

0N 0N 19N right

**Task4:**

For each question:

a) Draw a free body diagram in your book showing all the forces acting on the object

b) State the size and direction of the resultant force

Remember for free body diagrams:

• The length of the arrow represents the size of the force.

• The direction of the arrow represents the direction of the force.

• Represent the object by a box.

• Draw the arrow from the centre or edge of the box outward in the direction the force is acting.

1. A car drives along a road, travelling to the right. The driving force from the engine is 8000 N. The force of air resistance is 2000 N.

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2. A Skydiver falls through the air and opens their parachute. Their weight is 700 N and the air resistance is 1000 N.

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3. An egg with a weight of 5 N is falling with no air resistance.

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4. A book with a weight of 10 N is at rest on a table. (Hint: there is a second force to think about).

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**Lesson 4: resultant forces acting at angles to each other (HT)**

**Objective: You are learning to use vector diagrams to resolve resultant forces acting at angles to one another.**

**Do It Now**

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| Answer | | PA / SA |
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**I wasn’t there, but I still care.**

1.What is meant by resultant force?

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2.Determine the resultant force on the object below.

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Description automatically generated

3. **Draw a free body diagram** that shows the forces acting on an aeroplane that weighs 2500N. It has 3000N of thrust from the engines, 700N of air resistance and experiences 3000N of lift. **Determine the resultant force** on the aeroplane and **describe its motion.**

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**Connect**

A picture containing text, wheel, diagram, vehicle

Description automatically generated

**Notes:**

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**I do:**

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**Task 1:**

**Resultant Forces at angles**

**Draw free body diagrams for the following situations.**

**Then draw the vectors again head-to-tail (make sure they are to scale!)**

**Measure the resultant vector and describe the direction.**

**Use square paper to help you**

1. **A box is pushed to the right with a force of 60 N.   
   at the same time it is being pushed downwards with a force of 100 N**

**Use the scale 1 cm : 10 N**

1. **What is the size of the resultant force?**
2. **Use a protractor to find the direction of the resultant force.**

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1. **A man jumps up with an overall force of 500 N  
   The wind is blowing him right with a force of 100 N**

**Use the scale 1 cm : 100 N**

1. **What is the size of the resultant force?**
2. **Use a protractor to find the direction of the resultant force.**

A picture containing pattern, line, square

Description automatically generated

1. **The weight of a submarine is 20000 N**

**It is driving to the left with a force of 8000 N**

**Use the scale 1 cm : 2000 N**

1. **What is the size of the resultant force?**
2. **Use a protractor to find the direction of the resultant force.**

A picture containing pattern, line, rectangle, square

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**A diagram of forces with red and blue arrows

Description automatically generated with low confidence**

**A picture containing text, screenshot, font, line

Description automatically generated**

A picture containing pattern, line, rectangle, square

Description automatically generated

A picture containing text, cable

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**Task 2:**

(a)     A fisherman pulls a boat towards land.

The forces acting on the boat are shown in **Diagram 1**.

The fisherman exerts a force of 300 N on the boat.  
The sea exerts a resistive force of 250 N on the boat.

**Diagram 1**

A picture containing line, design

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(i)      Describe the motion of the boat.

………………………………………………………………………………………………………………

……………………………............................................................................................................ (2)

(ii)     When the boat reaches land, the resistive force increases to 300 N.  
 The fisherman continues to exert a force of 300 N.

Describe the motion of the boat. Tick (✓) **one** box.

|  |  |  |
| --- | --- | --- |
|  | Accelerating to the right |  |
|  | Constant velocity to the right |  |
|  | Stationary |  |

(1)

(iii)    Explain your answer to part **(a)(ii)**.

………………………………………………………………………………………………………………

…………………………............................................................................................................... (2)

(iv) Another fisherman comes to help pull the boat. Each fisherman pulls with a force of 300 N, as shown in **Diagram 2**.

**Diagram 2** is drawn to scale.

Add to **Diagram 2** to show the single force that has the same effect as the two 300 N forces.

Determine the value of this resultant force.

**Diagram 2**

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Resultant force = .................................... N (4) **(Total 9 marks)**

**To be used for part (iv) of Task 2.**

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**Lesson 5:**

**Objective: You are learning to how work is done in a scientific context.**

**Do It Now**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**I wasn’t there, but I still care.**

**Define resultant force:**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Complete the sentences using the words listed.**

**Push. Pull. Add. Subtract. Physically touching. Physically separated.**

When forces act in the same direction, we \_\_\_\_\_\_\_them together.

When forces act in the opposite direction to each other we \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_them.

A force is either a \_\_\_\_\_\_\_ or a \_\_\_\_\_\_\_\_\_\_\_

Contact forces are when objects are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Non-contact forces are when objects are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Connect**

**What have all the following got in common? What do they all involve?**

A work-out

Housework

Going to work

Horse work

Hard work

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Notes:**

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**Using physics textbooks, look up the following key words. Then write down one example of it or something that contains it.**

**Work**

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**Energy store**

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**Force**

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**Friction**

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**Thermal energy**

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**Kinetic energy store**

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**Gravitational energy store**

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**How do we keep fit**?

Lifting weights, biking, walking, running? Any or all of these involve us moving something. When we move something, we apply a force. **The work you do causes a transfer of energy.**

**Complete the sentence:**

Energy cannot be \_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ just \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_between energy stores. This principle tells us that energy is conserved (the total amount of energy in the Universe is a constant).

**Examples of energy transfers.**

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I do – using an accounting diagram to show the results of work being done**.**

**Transferring energy**

In each of these examples, energy is transferred by one of the following four types of energy transfer:

* **Mechanical work** - a force moving an object through a distance.
* **Electrical work** - charges moving due to a potential difference.
* **Heating** - due to temperature difference caused electrically or by chemical reaction.
* **Radiation** - energy transferred as a wave, e.g. light and infrared - light radiation and infrared radiation are emitted from the sun

Doing 'work' is the scientific way of saying that energy has been transferred. For example, a grazing cow, a firing catapult and a boiling kettle are all doing 'work', as energy is being transferred from one store to another.

**Something POWERFUL does a lot of work in a short time. That means it transfers energy quickly.**

**What have you got at home that is powerful?**

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Power just measures how quickly work is done or energy is transferred. The units are Watts (W) or (KW). We use this formula to work out the power/

Power (W) = Energy Transferred (J)

Time(s)

Energy accounting models show the energy before and after transfers.

**Modelling**. Your teacher will model some examples and then you can have a go at some others.

Remember energy at the start must equal energy at the end. It will just be in a different store.

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Your teacher will model how energy is transferred not lost using these accountancy diagrams.

Remember energy is not lost or gained but transferred from one store to another.

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Chemical Elastic Thermal

Chemical Elastic Thermal

A person stretches a spring. In the process of doing this, 100J of work is done. 100J of the energy in their chemical energy store is transferred. 80J is transferred to the elastic energy store of the spring. 20J is transferred to the thermal energy store of the surroundings.

**Represent this on the accounting diagram above.**

**YOU DO**

Chemical Kinetic Thermal

Chemical Kinetic Thermal

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A person carries a box of exercise from one desk to another. 200 J of work is done. 200 J of energy is transferred from the persons chemical energy store. 140 J is transferred to the kinetic energy store of the book box. 60 J is transferred to the thermal energy store of the surroundings.

**Represent this on the accounting diagram above.**

**Work is done on an object when a force makes the object move.**

Energy transferred = work done. We use the formula:

W = F x s

W = work done (Joules, J)

F = The force (Newtons, N)

s = The distance moved (Metres, M)

One joule of work is done when a force of 1N causes an object to move by 1m in the direction of the force.

**Worked example:**

A builder pushed a wheelbarrow a distance of 10 m across the ground. He used a force of 50 N. How much work did the builder do?

Solution:

Work done = Force x distance moved

Work done = 50N x 10m

Work done = 500J

**You Do task:**

How much work is done if a lorry was pulled by Britain’s strongest man over 40m using a pull force of 2000N.

**Set out the answer like the one above.**

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**TOP TIP:**

**If you calculate the work done this is the same as the energy transferred.**

**The force must move to do work so, a person lifting a box does work but, when they stand still, just holding the box, they do not do any work as no energy is transferred.**

**Energy transferred = work done**

Any work you do causes you to transfer energy. When an object is moved by a force, work is done by the force. Energy is transferred to the object from the force. The amount of energy is equal to the work done.

If you raise an object you need to overcome the force of gravity which holds it down. If the work you do on the object is 20J then the energy transferred must be 20 J. As we are increasing the height of this object its gravitational potential energy has increased by 20J

**We work out Gravitational potential energy using the formula:**

**E= m x g x f**

**E = Gravitational potential energy (Joules)**

**m = Mass (Kgs)**

**g = Gravitational field strength (9.8 N/Kg rounded to 10Kg)**

**h = Height (M)**

Gravitational Potential energy (GPe) store of an object increases when you it moves up and decreases when it moves down. It increases when it moves up because work must be done to lift it to overcome the force of gravity.

**TOP TIP:**

**If an object goes up a slope you need to make sure you look at the height gained NOT the distance along the slope**

**Worked example.**

A student lifts some heavy books onto a shelf 5M high. The books weigh 10Kg. Calculate the Ep.

Ep = m x g x h

Ep = 10 x 10 x 5

Ep = 500 joules.

**You do.**

What is the gravitational potential energy gained by a 6kg rabbit that is lifted 0.5 m by its owner.

Set out as shown in the previous example**.**

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**Friction and work.**

**Work done to overcome friction is transferred as heat.**

If you rub your hands together, they get warm. Your muscles are doing work to overcome the friction between your hands. The work you do is transferred as energy that warms your hands.

**I do**

**Using physics textbook page 9, explain using force and energy transfers, how brake pads get hot if the brakes are kept on too long.**

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**You Do**

**Explain using the following terms how we see meteorites (shooting stars)**

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**Lesson 6:**

**Objective: To demonstrate understanding of elasticity and the difference between elastic and inelastic deformation. This will inform your required practical for lesson 7.**

**Do It Now**

|  |  |  |
| --- | --- | --- |
| Answer | | PA / SA |
| 1 |  |  |
| 2 |  |  |
| 3 |  |  |
| 4 |  |  |
| 5 |  |  |

**I wasn’t there, but I still care.**

Write out the formula for calculating work done.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

List three situations where work is done (in a scientific sense).

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**Connect:**

Every day you do work. Describe the work you have done since last evening and the energy store changes that have been made in doing that work. Think of all the appliances that you have also used and the work they have done in transferring energy.

Use key words from the last lesson.

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**Notes:**

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Forces can stretch things as well as make them move or change direction. When you apply a force to an object you can cause it to BEND, STRETCH or COMPRESS. To do this you need more than one force acting on the object in opposing directions. Otherwise, the object would just move in the direction of the applied force instead of changing its shape.

An object has been ELASTICALLY DEFORMED if it CAN go back to its original shape and length after the force has been removed. We say objects like this are ELASTIC e.g. springs, rubber bands, hair bobbles.

An object has been INELASTICALLY DEFORMED if it CANNOT go back to its original shape and length e.g. old springs, old rubber bands.

Work is done when a force stretches or compresses an object and causes energy to be transferred to the ELASTIC POTENTIAL ENERGY store.

**Extension of a spring.**

**The extension of a spring is directly proportional to the force applied to it. That means as the force or mass increases so does the extension of the spring. Extension is the change in length from the original length to the stretched length with the mass/force applied.**

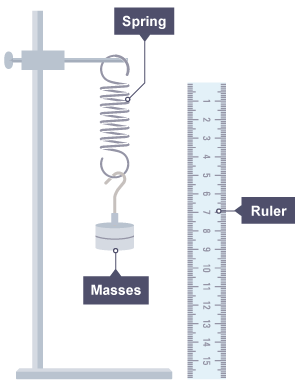
If we support a spring at the top and apply a mass or force at the bottom it will stretch. The extension is directly proportional to the mass or force, and we use this equation,

F = k x e

F = Force (N) k = Spring Constant (N/m) E = Extension (m)

The spring constant depends on the material the spring is made from. A stronger spring has a higher spring constant than a softer spring.

spring constant will vary depending on the material the spring is made from, for example a stiff spring will have a greater spring constant than a softeer spring.

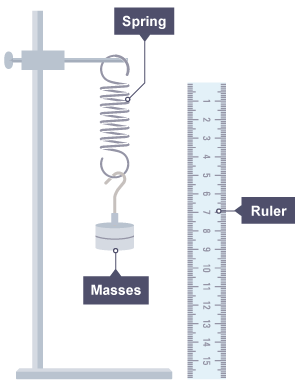


**I do**

A spring is fixed at one end and has a force of 1N applied at the other extends by 2 cm. Calculate the spring constant of this spring.

Remember to convert the units for extension; standard units are metres.

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**Hooke’s Law Problems**

***Take g = 10 m/s2 and use F = ke   
(don’t forget Weight (force) = mass x g)***

1. A spring extends by 10 cm when a mass of 100 g is attached to it. What is the spring constant? (Calculate your answer in N/m)

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2. What will be the extension of this spring if the load is a) 4N and b) 75 g?

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3. If an identical spring were connected in parallel (do a sketch), what mass would need to be attached to produce an extension of 15 cm?

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4. What mass would be needed if two of these springs were placed in series (do a sketch) and an extension of 30 cm was required?

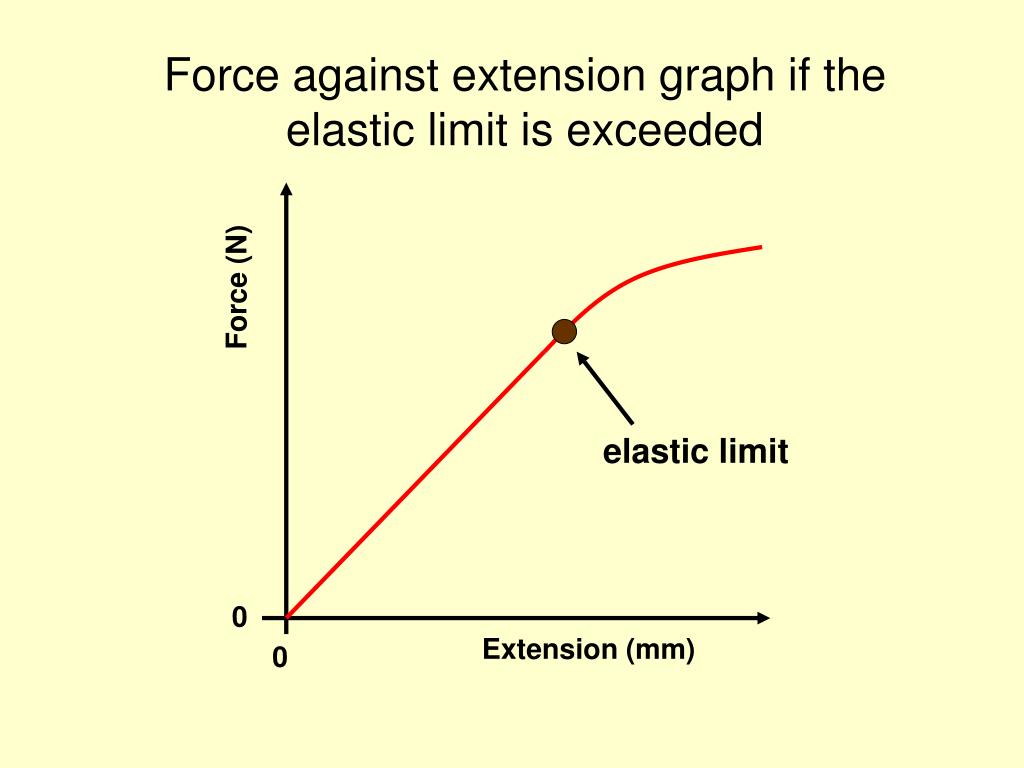
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5. Under a 3N force, two identical springs in parallel stretch12.5cm. What is the spring constant for one of these springs?

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Sometimes though this doesn’t work like this. This happens if the force is too great, and the extension doesn’t increase proportionally. There is a limit to the force you can apply.

The graph is a straight line until the LIMIT of PROPORTIONALITY has been reached and then it begins to curve. Shown by black dot.



Providing a spring is not stretched PAST its LIMIT of PROPORTIONALITY the work done in stretching the spring or compressing it can be found using:

Ee = ½ x k x e2

Elastic Potential Energy (Ee) (Joules)

Spring Constant (k) (N/m)

Extension (e) (m)

This formula can be used to calculate the energy stored in a springs elastic energy store store. It is also the amount of energy transferred to the spring as it deforms or as it returns to its original shape.

YOU DO:

A spring with a constant of 40N/m extends elastically by 2.5 cm. what is the energy store in its Ee store.

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Description automatically generated**

**Notes:**

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