Lesson 17: P5.17 – Atmospheric Pressure (T)

Connection

Q1 What is the unit for pressure?

Q2 A 15 cm tall can is submerged in water so that the top of the can is 20 cm below the surface of the water. What is the difference in pressure between the top and bottom of the can?

Water density is 1000 kg/m^3 .
pressure = height of the column × density of the liquid × gravitational field strength
gravitational field strength = 10 m/s^2

Activation

LI: Show that the atmosphere exerts a pressure. Explain variations in atmospheric pressure with height

1. https://www.youtube.com/watch?v=s8C2RktZtbM
2. Make a note of the title and the LI
3. Read pages 174-175
4. Draw and label Fig 5.52
5. Use key terms in paragraph 1 to explain why the can gets crushed.

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P5 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Demonstration

Attempt questions 1-8
In 15 mins answer as many questions as you can.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Answers: P5.17 – **Atmospheric Pressure**

Connection

1. Pa
2. 1500 Pa

Demonstration

1a The pressure outside the bag is larger than the pressure inside the bag. Therefore, the bag will crush.

1b The sides have been pushed in by the atmospheric pressure outside the bag.

2a The helium atoms inside the balloon.

2b Atmospheric pressure.

3 There is a smaller height of air above you.

4 The air has a weight and the force of gravity pulls it downwards.

5 The helium balloon rises upwards. Therefore, atmospheric pressure gets less as the balloon rises but the pressure inside the balloon due to the helium is not affected. This means there is a bigger pressure inside the balloon than outside so the balloon expands.

6 Its molecules collide with the walls of its container. This creates a force when they rebound which creates a pressure.

7 The molecules in the atmosphere are colliding with the outside walls of the can and therefore create a force inwards. There is no force to balance this out (since there is a vacuum inside the can) so the can collapses inwards.

8 The air particles create a pressure by colliding with the suction cup. There are no air particles between the wall and the suction cup so the only pressure acting is on the outside of the cup. This creates a force which pushes the suction cup onto the wall. So the man is held onto the wall purely by lots of air particles colliding with the suction cup.

Lesson 18: P5.18 – Forces and energy in springs

Connection

Q1. What causes air pressure?

Q2. If the air was sucked out of a plastic bottle, what would happen and why?

Q3. T or F

i) Changes in atmospheric pressure at any point are due to changes in the density of the air.

ii) Atmospheric pressure at any point is caused by the action of gravity on the mass of air above that point.

Activation

LI: Explain why you need two forces to stretch a spring. Describe the difference between elastic and inelastic deformation

1. https://www.youtube.com/watch?v=FAHOI32oAns
2. Make a note of the title and the LI
3. Read pages 176-177
4. Write the meanings of “elastic deformation” and “extension”
5. Draw a free-body diagram for the spring in fig 5.54 labelling the two forces acting on a spring at rest or equilibrium. (HINT : Read the first paragraph again)

Demonstration

Attempt questions 1-9

In 15 mins answer as many questions as you can.

Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:

Green questions to GCSE Level 3

Blue questions to GCSE Level 6

Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P5 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers: P5.18 – Forces and energy in springs

Connection

1 Particles colliding with container walls

2 The bottle would collapse because outside air pressure was greater than inside air pressure.

3 Both are true

Demonstration

1 0N – there is no resultant force

2 3N

3 It would end up thinner than it was before it was used.

4 6.0 – 4.8 = 1.2 cm

5 k = F/e = 4/0.08 = 50 N/m

6 Compression, e = 10 – 4 = 6cm = 0.06m. F = ke = 2000 × 0.06 = 120N

7 $E_e = \frac{1}{2} ke^2 = \frac{1}{2} \times 30 \times 0.022 = 0.006$J

8 Work done = the gain of elastic potential energy

$E_e = \frac{1}{2} ke^2$. So $0.2 = \frac{1}{2} \times 10 \times e^2$

$0.2 / 5 = e^2$ so $0.04 = e^2$ so $e = 0.2$ m

9 Assume that the limit of proportionality has not been exceeded.

10g = 0.01 kg, 10cm = 0.1m.

Gravitational potential energy of the spring at 1m = mgh = 0.01 × 10 × 1 = 0.1J. Therefore elastic potential energy stored before the spring is released is 0.1J. $E_e = \frac{1}{2} ke^2$ so $k = 2E_e / e^2 = 2 \times 0.1 / 0.12 = 20$ N/m.

Lesson 19: P5.19 – Required Practical Investigate the relationship between force and the extension of a spring

Connection

Q1. Before the limit of proportionality is reached, what is the relationship between elastic potential energy and the extension or compression of a spring?

Q2. When does the equation $E_e = \frac{1}{2}ke^2$ apply?

Q3. What key term is defined as the force divided by the extension of a spring within the limit of.

Activation

LI: Interpret graphs to form conclusions. Apply the equation for a straight line to the graph.

1. https://www.youtube.com/watch?v=jQAt3e6Bz7U
2. Make a note of the title and the LI
3. Read pages 178-179

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P5 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Demonstration

Attempt questions 1-9 Watch the video again if you need help.
Self mark the questions you have done making any necessary corrections in blue pen

Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Answers: P5.19 – Required Practical

Connection

1 It is proportional to the square of the extension or compression

2 Before the limit of proportionality is reached

3 Spring constant

Demonstration

1 She could either use a spring balance / newton meter or she could hang known masses off the springs and calculate their weight.

2 She could use a ruler to measure the starting length of the spring. Then she could measure the total length of the spring when a force is added. The extension would be the total length – the starting length for each force that she uses.

3 She added all of the repeat readings together and then divided this total by the number of readings.

4 Yes – for Spring 1 at 20N the 20mm extension is very different from the other two readings and at 30N the 30 mm extension is very different from the other two readings.

5 Yes – if the anomalies are discarded and further repeat readings are taken. When you find a mean value, the random errors become smaller since the readings that are slightly too big tend to balance out the readings that are slightly too small.

6 It shows that the extension is directly proportional to the weight in this region.

7 The spring has inelastically deformed.

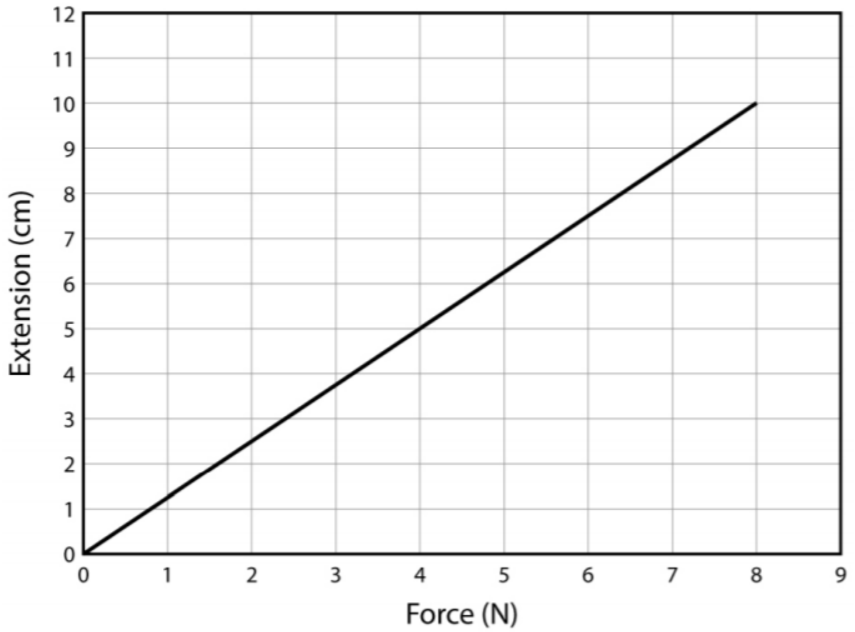
8 The extension was directly proportional to the force up to a point called the elastic limit but after that it was not proportional.

Answers contd.: **P5.19 – Required Practical**

9 Spring B: m = 10 / 8 = 1.25 Spring C: m = 6 / 8 = 0.75

10 Spring B: k = 8 / 10 = 0.8 N/cm Spring C: k = 8 / 6 = 1.33 N/cm Spring C is the stiffest as it needs the greater force to stretch it by a certain amount.

11 e.g. for spring B



Gradient of this line = 8 / 10 = 0.8 N/cm, which agrees with the previous calculation.

12a Area under line A = a triangle = ½ × base × height = ½ × 8 × 0.16 = 0.64 Nm.

12b k = F / e = 8 / 0.16 = 50 N/m Ee = ½ke2 = ½ × 50 × 0.162 = 0.64 J 12c The answers are the same. This is because the area = ½ × F × e but F = ke. Therefore, area = ½ × ke × e = 1/2 ke2 . So the area = the elastic potential energy

Lesson 20: P5.20 – Key Concept Forces and acceleration

Connection

An experiment is set up to measure the extension of a suspended spring when weights are hung from one end of it. Which of the following will have an impact on the extension measured?

i)The mass of the spring
ii) The mass of the weight
iii) The material the spring is made from
iv) The material the weight is made from

Activation

LI: **A**pply ideas about speed and acceleration to explain sensations of movement

1. https://www.youtube.com/watch?v=sPZ2bjW53c8
2. Make a note of the title and the LI
3. Read pages 180-181
4. List the key terms in the KEY WORD box

Demonstration

Attempt questions 1-9 Watch the video again if you need help.
Self mark the questions you have done making any necessary corrections in blue pen
https://www.youtube.com/watch?v=sPZ2bjW53c8
Challenge yourself to answer as many as you can:
Green questions to GCSE Level 3
Blue questions to GCSE Level 6
Purple questions to GCSE Level 9

Consolidation

Complete and self assess the relevant past paper question for this topic - From the P5 DIP file

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Answers:

Connection	**Demonstration**
The first three	1 The acceleration increases.
	2 The roller coaster would decelerate but the passengers would continue to move forward at their original speed (and so come out of their seats).
	3 You would fly off at a tangent to the circle.
	4 The direction is changing to the velocity is changing. An acceleration is equal to the change in velocity / time rather than the change of speed.
	5 Velocity includes a direction but speed doesn't.
	6 The riders feel the force when the roller coaster accelerates and decelerates. This force is designed to make the ride a thrilling experience.
	7 $F = ma = 2500 \times 10 = 25\,000$ N
	8 They would experience an acceleration of – 0.5g = -5 m/s2 (taking g to be 10 m/s2 in this question).
	9 The water accelerates due to gravity towards the ground at 10 m/s2 as normal. However the bottle is also accelerated at this rate as part of the ride. Therefore, the water remains in the bottle even though the bottle is upside down.

Revision

Connection

Making estimations

Q1. **Estimate the volume of an average GCSE text book. Show your working and assumptions.**

Q2. **Estimate the running speed for a typical adult over a distance of 500 m. Show your working and assumptions.**

Activation

LI: Create a topic summary sheet

1. Fold an A3 sheet so it is divided into 8 sections
2. Look back over your lessons and group them into 8 main headings
3. Summarise the key points into each section, use keywords and diagrams and symbols rather than sentences

Consolidation

Look though the relevant past paper questions for this topic - From the P5 DIP file – see if you can complete any additional questions

Demonstration

Test yourself by working with the person sitting next to you by talking though each box on your summary sheet and seeing how many key facts you can remember.

Extension

Make a note of one thing you think you understand well and one thing that you would like to ask your teacher

Connection Answers

1 E.g. Volume of this book is about 20 cm × 30 cm × 2 cm = 1200 cm3 ≈ 1000 cm^3

2 E.g. A typical adult would take about 2 minutes to run 500 m. So their running speed would be about 500 m / 120 s ≈ 4 m/s

DART P5 – Dangerous Driving

Whenever two objects touch there are always two forces involved. If a car crashes into a bollard, the car applies a force to the bollard called the action force. The bollard also exerts a force back onto the car known as the **reaction force**, which is what does the damage. The forces are always **equal** in size and **opposite** in direction. These ideas are used in car safety testing to predict what might happen and to improve car design.

Which make of car saves most lives in a crash?

All car manufacturers test their cars to make sure they are as safe as possible. The tests include front, side and pedestrian impact tests. Dummies are used in place of the driver and passengers, and the cars are crashed in various ways. **Sensors** on the dummies measure the forces acting on them and this data can help predict what might happen in a real accident. **Crumple zones** and air bags are two very successful car design features that reduce injuries if a car is involved in an accident.

An **air bag** inflates automatically on impact. It cushions the head of the driver or passenger. This causes much less injury than if they were to hit the hard surface of the steering wheel or dashboard. Crumple zones in cars work in a similar way to air bags. Parts of the front and sides of the car are designed to crumple on impact. This reduces the forces on the people in the car. However, even for a small impact, the car can look very badly damaged.

An air bag reduces the risk of damage to the head and neck.

Whenever anything stops, its momentum is removed. This can require very large forces. Both air bags and crumple zones work by increasing the time it takes for the car or passenger to come to a halt, reducing the forces involved and risk of injury. Exactly the same idea is used when fast moving roller coasters come to a halt at the end of the ride. They are slowed down gradually so that you do not feel a strong jolt.

Crumple zones reduce the risk of injury by absorbing momentum.

Reference:

https://www.buyautoinsurance.com/car-physics-and-newtons-laws-of-motion/

Questions

1a Are the action and reaction forces always equal in size?

1b What is always different about the action and reaction forces?

1c Give an example of where these ideas are used in car design.

2a Name three types of impact tests carried out on new cars.

2b Explain how the forces involved in the crash test are measured

2c Describe how crumple zones and air bags work as safety features.

3a Explain why roller coasters are designed not come to a sudden halt at the end of the ride.

3b Describe the science behind car safety features.

3c Write a promotional leaflet for a new car, advertising its safety features. Try to make it as persuasive as possible using the science behind each feature as described in the article.

DART P5

Answers

1a Action reaction forces are always equal in size.

1b Action reaction forces are always opposite in direction.

1c These ideas are used in designing safety features in cars

2a. Front, side and pedestrian impact tests

2b. Dummies are used in place of people, cars are crashed in various ways and sensors measure the forces and their effects.

2c. Air bags cushions the head of the driver or passenger. This causes much less injury than if they were to hit the hard surface of the steering wheel or dashboard. Crumple zones: Parts of the front and sides of the car are designed to crumple on impact. This reduces the forces on the people in the car causing fewer injuries.

3a. They are slowed down gradually so that you do not feel a strong jolt which could lead to which lash or more serious injury.

3b. Using Newton's third law which states that every action has an equal and opposite reaction, car manufactures place dummies as passengers and crash the car in various ways to test the impact of the forces and then design features such as crumple zones and safety belts to reduce the forces acting on the dummy passenger resulting in little or no injury to the 'passenger'.

3c. Students to use the article to make a leaflet explaining safety design features. (Should include all the points in the answers above as creatively as possible – e.g. Draw a model of the car or use the images included in their own poster/leaflet, detailing/abelling all the safety features and how they work.)

Attainment Band :	P5 Forces (AQA) **Knowledge and Understanding**
Yellow Plus/ Yellow	Represent vector quantities by arrows. Calculate acceleration from change in velocity/time taken. Determine the instantaneous speed from the tangent to a distance–time graph of an accelerating object. Determine total distance travelled from a velocity–time graph. Rearrange the equation for uniform motion. Determine the components of a force. Explain what is meant by inertia. Explain what is meant by inertial mass. Relate the ideas of weight and mass to Newton's second law. Explain how Newton's third law applies. Interpret a graph that relates speed to stopping distance for different vehicles Calculate braking forces using ideas of stopping distance and energy transfer. Explain vehicle safety features in terms of the rate at which momentum is reduced Apply the principle of conservation of momentum to collisions. Apply the idea of moments to contexts such as the balancing of a seesaw. Explain how a partially (or totally) submerged object experiences upthrust and why atmospheric pressure decreases with height. Describe the factors which influence floating and sinking.
Blue	Explain the difference between contact and non-contact forces. Know that acceleration is the rate at which speed changes. Interpret a journey represented on a distance–time graph. Interpret a journey represented on a velocity–time graph. Apply the equation for uniform motion. Calculate the resultant force acting on an object. Link Newton's first law to the idea of a zero resultant force. Use F = ma to determine force, mass or acceleration. Explain the difference between weight and mass. Apply Newton's third law to simple equilibrium situations. Describe factors that affect a driver's reaction time and a vehicle's braking distance Explain why the temperature of a vehicle's brakes increases during braking. Relate measures to increase road safety to ideas about forces and kinetic energy, and to rate of change of momentum. Calculate the size and direction of a moment Explain how gears and levers transmit the rotational effect of a force. Calculate pressure at any depth in a fluid and explain what causes atmospheric pressure.
Green	Know that forces are vectors and have magnitude and direction. Understand that average speed = distance/time. Explain the significance of the gradient of a distance–time graph. Explain the significance of the gradient of a velocity–time graph. Recall the equation for uniform motion. Draw a free-body diagram to represent forces acting on an object. Apply Newton's first law to a stationary object and an object moving in a straight line at a constant speed. State Newton's second law and recall the equation F = ma. Recognise that weight and mass are not the same. State Newton's third law. State that vehicle speed and reaction time affect the stopping distance of a vehicle. Identify measures to increase road safety Explain what is meant by momentum. Explain that a moment is the turning effect of a force. Describe how a fluid exerts a pressure on a surface Describe how pressure varies with depth in a fluid.
White	Some elements of the above have been achieved