Answers: P5.8 - Resultant forces

Connection

1 Backwards
Upwards
Downwards
Forwards

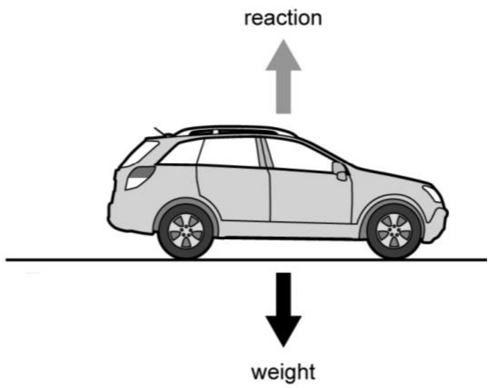
2 Object is stationary
Object moves with constant velocity

Demonstration

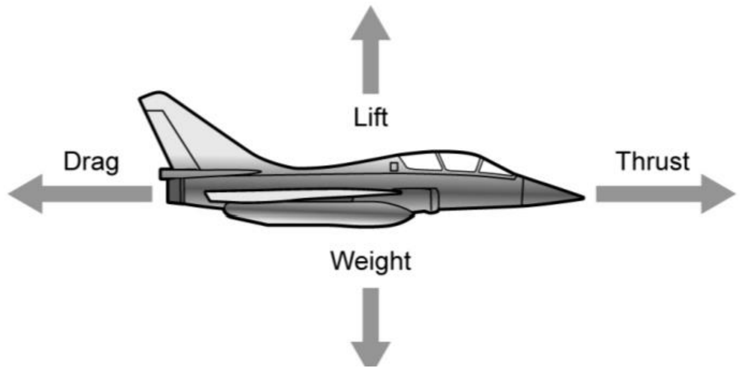
1 Gemma and Alan produce a total force of 40 + 40 = 80 N. So the resultant force is 80 – 50 = 30 N.

2 Total force opposing the motion = 1000 + 500 = 1500 N. Total forward force = 1500 N so the forces are balanced and the resultant force = 0 N.

3



4



5 13N at an angle of 670 above the horizontal.

6 Draw a scale diagram where e.g. 1cm represents a force of 1N. Start with an arrow pointing to the right that is 12cm long. At the head of this arrow join the tail of a 16cm arrow that is pointing downwards. The third force needs to end up where the 12cm arrow started so that there is no distance between the starting and ending points on the scale diagram (so there is no resultant force). Therefore, draw the third arrow from the head of the 16cm arrow to the tail of the 12 cm one. Measure the length of this arrow (= 25 cm). So the size of the force needed = 25 N.

7 Draw a scale diagram with a line 14.1 cm long at an angle of 450 (using a protractor to measure the angle). Form a triangle with one side vertical and the other side horizontal. The lengths of the sides represent the magnitudes of the components. Both components are 10N.

8 The horizontal components of the two forces are both 10N to the right, so the total horizontal component = 20N. The vertical components are both 10N but one points upwards and the other points downwards so they cancel out. Therefore, the resultant force is 20N to the right

Lesson 9: P5.9 – Forces and acceleration

Connection

Q1. A bike is accelerating on a flat, straight road. How would the free-body diagram represent this?

Q2. What two things does a free-body diagram tell us about the forces acting on a body? .

Q3. A child is learning to ride a bike while her mum runs alongside, pushing and keeping her upright. How would you calculate the resultant force on the bike?

Activation

LI: Explain what happens to an object when the resultant force is not zero

1. Make a note of the title and the LI
2. https://www.youtube.com/watch?v=fRwq8cRCko0
3. Read pages 158-159
4. Write the meanings of the keywords “gravitational mass” and “inertia”
5. Draw and label Fig 5.27 on page 158
6. Write out Newton’s Second law in the form of an equation linking Force, mass and acceleration

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

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: P5.9 - Forces and acceleration

Connection

1 The arrow representing forward thrust would be longer than the sum of the lengths of the arrows representing air resistance and friction

2 Their direction, Their magnitude

3 Thrust of child + thrust of mum - air resistance - friction

Demonstration

1. In Figure 5.26 the resultant force is to the left; in figure 5.27a the resultant force is to the right and in figure 5.27b there is no resultant force so there is no direction.

2 The resultant force rises from zero and it acts to the left.

3 $a = F / m = 4200 / 1200 = 3.5\ m/s^2$

4 $m = F / a = 1 / 10 = 0.1$ kg.

5 $F = ma = 4000 \times 2 = 8000$ N. However this is the resultant force. The resultant force = the force needed – the weight of the rocket. So 8000 = force needed – 40 000 Force needed = 8000 + 40 000 = 48 000N

6 Inertia is a measure of how difficult it is to change the velocity of an object (a reluctance to change motion). Inertial mass is calculated by dividing the force by the acceleration.

7 Inertial mass is a measure of how much force the object needs in order to get it to change its motion (accelerate) whereas gravitational mass is a measure of how strongly the object feels the force of gravity. More massive objects need a bigger force to accelerate them (due to their inertial mass) and they have a bigger weight (due to their gravitational mass).

8 Both inertial and gravitational mass = 2kg. For inertial mass, this is a measure of its reluctance to change its motion; for gravitational mass, this is a measure of how strongly it feels the force of gravity

Lesson 10: P5.10 – Required Practical Investigation the acceleration of an object

Connection

Q1. In terms of forces what is required for a car to accelerate?

Q2. What quality of an object is a measure of how difficult it is to change its velocity?

Q3. What is the acceleration of an object of mass 48 g when it experiences a forward force of 0.372 N and a backward force of 0.084 N?

Activation

LI: plan an investigation to explore an idea

1. https://www.youtube.com/watch?v=ugzjeggjznw&feature=emb_logo
2. Make a note of the title and the LI
3. Read pages 160 - 161
4. Define the key term "inverse proportion"
5. From the bottom of page 161 complete this sentence: Newton's Second Law states that if an object accelerates, its acceleration is ________ proportional to the applied force and _________ proportional to the mass of the object.
6. https://www.youtube.com/watch?v=MW152L4fFzI&feature=emb_logo

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: P5.10 - Required Practical:

Connection

1 The forward force must be greater than the air resistance and friction combined (or labelled force diagram)

2 mass

3. a = (0.372 – 0.084)N / 0.048 kg

= 6 N/kg or 6 m/s^2

Demonstration

1 The trolley will accelerate (at a constant rate) to the right.

2 The weight of the falling masses makes the trolley accelerate. This force remains constant as the trolley is moving.

3 You could change the mass of the falling mass.

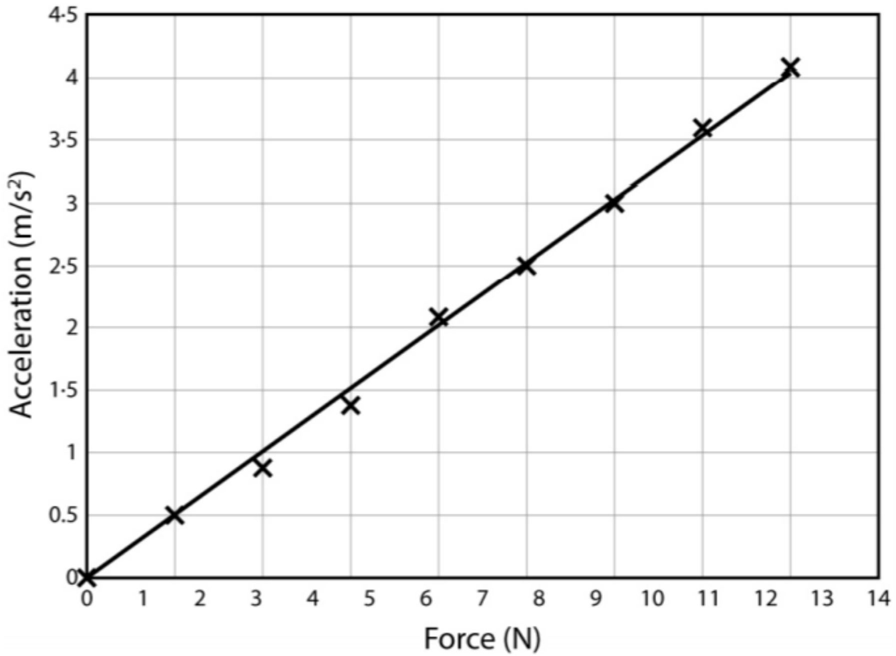
4 You can use the remaining masses in the trolley to add to the falling mass. This changes the force acting on the trolley but keeps the mass the same.

5 You could remove some of the remaining masses but not add them to the falling mass.

6 He should find that the acceleration increases as the force increases.

7 Yes they do.

8



Answers: P5.10 - **Required Practical cont.**

9 This shows that acceleration is directly proportional to the force.

10 As the mass is increasing the acceleration is decreasing

11 The graph would have a negative gradient and it would be curved.

12 A graph of acceleration against force gives a straight line through the origin. If you look at the table with mass and acceleration you can see that if you double the mass (e.g. from 20 g to 40 g) the acceleration halves (e.g. from 5.0 m/s^2 to 2.5 m/s^2). This shows that acceleration is inversely proportional to the mass.

13 $a = F / m$. If F is tripled then the acceleration is tripled. However, if m is doubled then the acceleration is halved. The combined effect is that the acceleration is 3/2 = 1.5 times bigger.

Lesson 11: P5.11 – Newton's Third Law

Connection

Q1. Students performed an experiment where a constant force was applied to different masses and the acceleration was measured. They then plotted acceleration on the y-axis against mass on the x-axis. Assuming their results are valid, what is the shape of the graph?

Q2. In an experiment where a constant force was applied to a mass and its acceleration was measured using ticker tape, which of the following variables on its own would make reliable measurements more difficult?

Activation

LI: Understand and be able to apply Newton's third law

1. https://www.youtube.com/watch?v=y61_VPKH2B4
2. Make a note of the title and the LI
3. Read pages 162-163
4. Find and write the meanings of the key term "Newton's third Law"
5. Write down the sub-heading **Force Pairs** and list one example from the three bullets
6. Write down the three bullet points under the car diagram with the sub-heading: **Features of force pairs**

Demonstration

Attempt questions 1-10
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: P5.11 - **Newton's third law**

Connection

1 A straight line with a negative gradient

2 High acceleration

Demonstration

1 They have the same magnitude but act in the opposite direction.

2 The road pushes on the tyres (due to friction).

3a They move apart.

3b There is a force pair. One person pushes on the other person with a force and the other person pushes on the first person with an equal force in the opposite direction.

4 Ben's body exerts a 50N force acts on Kim in the opposite direction. They move apart.

5a The resultant force will be the same on each vehicle (but acting in opposite directions) as the forces are a Newton's third law pair.

5b Since F = ma and the force is the same on each vehicle then the Lorry will decelerate at a smaller rate than the car as its mass is bigger.

6 Throw the backpack away from the ship. The backpack will exert an equal and opposite force on her which will push her back to the ship.

7a It is a gravitational force.

7b Since the Earth is pulling on the cat with a gravitational force downwards, the other force in the force pair is the cat pulling on the Earth with a gravitational force upwards.

Answers: P5.11 contd. - **Newton's third law**

DEMONSTRATION

8a The same as in question 7. The other force in the force pair is the gravitational force the cat exerts upwards on the Earth.

8b The force that the cat exerts downwards on the table and the force that the table exerts upwards on the cat (they're a pair of electrostatic forces).

9 The cat exerts a gravitational force upwards on the Earth (see question 7). This means the Earth will accelerate upwards towards the cat. The acceleration is very small though since the mass of the Earth is extremely large.

10 As you begin the jump, you push down onto the Earth. This means that the Earth will push upwards onto you. As you are in mid-air the Earth exerts a gravitational force on you and your body is exerting a gravitational force on the Earth. When you hit the ground you exert a force on the Earth and the Earth exerts an equal and opposite force on you, which decelerates you to rest.

Lesson 12: P5.12 – Momentum

Connection

Apply Newton's third law to explain the following example of an adventure loving elephant:

The elephant stood on a strong trampoline. The trampoline sank a good deal but did not break and the elephant remained upright.

Activation

LI: Apply ideas about rate of change of momentum to safety features in cars

1. https://www.youtube.com/watch?v=F8DnNqBhUfQ
2. Make a note of the title and the LI
3. Read pages 164 -165
4. Write out the meaning of "momentum" and "crumple zone"
5. State the Law of conservation of momentum
6. Write out the symbol equation for momentum including units.
7. https://www.youtube.com/watch?v=ZU6rJQTz7FI
8. Explain how to derive the equation relating force applied to the rate of change of momentum.

Consolidation

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

Demonstration

Attempt questions 1-7
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

Extension

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

Answers: P5.12 – **Momentum**

Connection

Trampoline: The elephant's weight pushes on the trampoline, making it stretch out of shape, but the trampoline pushes the elephant back with equal and opposite force so that the elephant remains standing.

Demonstration

1 $p = mv = 1000 \times 20 = 20\ 000$ kg m/s.

2 $v = p/m = 240 / 60 = 4$ m/s.

3 Force = change of momentum / time. The change of momentum is the same whether the air bag is there or not, but the air bag increases the time it takes to change momentum. Therefore, the force acting on the passenger is less and so there is less chance of harm

4 If the car stops suddenly, the passengers in the back will continue moving forward (since there is no force to change their momentum). Therefore, they will crash into the back of the driver and the front seat passenger who will be crushed between them and the front of the car

5 $F = m\Delta v / \Delta t$, so $\Delta t = m\Delta v / F = (800 \times 12) / 3000 = 3.2$ s.

6 Initial momentum = final momentum $(1200 \times 30) + (m \times 0) = (1200 \times 4) + (m \times 4)$
$36\ 000 = 4800 + 4m$ $4m = 31200$ $m = 7800$ kg.

7 Initial momentum = final momentum $(2 \times 8) + (6 \times 0) = (2 + 6)\ v$
$16 = 8\ v$; $v = 2$ m/s

Lesson 13: P5.13 – Keeping safe on the road

Connection

Q1. Superman's mass is 85 kg and he is cruising at 54 km/h. What is his momentum?

Q2. He spots an injured bird of mass 400 g stranded on top of a building. He picks it up and keeps flying at the same speed. What effect will this have on his momentum?

Q3. Suddenly, Lex Luther appears with a large lump of kryptonite. Superman loses all forward momentum and starts to plummet to earth (thankfully releasing the bird which flaps painfully away). What is Superman's momentum after 15 seconds?

Activation

LI: Explain the factors that affect stopping distance. Explain the dangers caused by large deceleration

1. https://www.youtube.com/watch?v=drMKdcMq3o0
2. Make a note of the title and the LI
3. Read pages 166-167
4. Write the meanings of "reaction time", "braking distance", "thinking distance" and "stopping distance"
5. Draw and label figure 5.38 to reinforce/describe the key terms
6. Write the equation linking stopping distance to braking distance and thinking distance.
7. List two factors that can affect thinking distance and two factors that affect braking distance.

Demonstration

Attempt questions 1-7
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: P5.13 – **Keeping safe on the road**

Connection

1. 54 km/h = 54 000 ÷ 3600 m/s = 15 m/s p = mv = 85 kg × 15 m/s

= 1275 kg m/s

02. p = mv =

85.4 kg × 15 m/s = 1281 kg m/s.

Momentum increases by 6 kg m/s

03. F = ma = 85 kg × 10 m/s^2 = 850 kg m/s^2 = difference in momentum ÷ time

p = 850 kg m/s^2 × 15 s = 12 750 kg m/s

Demonstration

1a 18 m/s 1b 24 m 1c 18 + 24 = 42 m

2 At 22 m/s the thinking distance = 15 m (to the nearest m) and the braking distance is 36 m. Therefore the stopping distance = 15 + 36 = 51 m

3 The braking distance increases as the speed increases at an increasing rate.

4 The braking distance increases at a given speed because there is less friction. Therefore, to keep the same, safe braking distance the car needs to go slower.

5 Estimate the following values: Mass of car = 1250 kg Speed of car = 25 m/s Braking distance = 50m Kinetic energy of the car before stopping = ½ mv^2 = 0.5 × 1250 × 252 = 390 625 J . Therefore work done stopping the car = 390 625 J

Force × distance = 390 625 So F = 390 625 / 50 = 7810 N (to three significant figures).

6 When the car decelerates rapidly, the brakes heat up. This can damage the brakes which then become worn. Worn out brakes cannot decelerate the car with as much force so the braking distance increases.

7 This increases the time that it takes for the child to change its speed. Therefore, the deceleration is less. Since F = ma then the force on the child becomes less and there is a smaller chance of harm

Lesson 14: P5.14 – Moments (T)

Connection

Q1. Identify a car safety feature designed to reduce momentum

Q2. What effect will new car tyres have on the braking distance?

Q3. A car decelerates from 64.8 km/h to zero in 5 seconds. What is the braking distance?
Hint: use the formula v 2 – u 2 = 2as

Activation

LI: Explain and use the principle of moments

1. Make a note of the title and the LI
2. Read pages 168-169
3. Write down the meanings of 2center of mass” and “pivot”
4. Define a moment
5. https://www.youtube.com/watch?v=p7QS4cz-Avs
6. Write out the equation to calculate moment and the units of a moment
7. https://www.youtube.com/watch?v=R8A-R-fm7iY

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
https://www.youtube.com/watch?v=pjK_3RuiCXk
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:P5.14– **Moments**

Connection

1 seat belt/airbag/crumple zone

2 reduces braking distance

3 45 m

Demonstration

1a 4 × 1.2 = 48 Nm

1b You could increase the force or you could increase the distance. 2 5 × 1.5 = 7.5 Nm

3 If the distance is large, you only need a small force to produce a big moment so the door handle is easier to turn.

4 Clockwise moment: 1 × 60 = 60 Ncm Anticlockwise moment: 2 × 30 = 60 Ncm The total anticlockwise moment is equal to the total clockwise moment so the beam is balanced.

5 X × 20 = 300 × 40 20X = 12 000 X = 12 000 / 20 = 600 N

6 6 × 20 = F2 × 40 120 = 40F2 F2 = 3 N

7 F2 and the 10N force both provide moments clockwise. F1 provides a moment anticlockwise. Therefore: (F2 × 40 cm) + (10 N × 10 cm) = (6N × 20 cm) So 40F2 + 100 = 120 40F2 = 20 F2 = 0.5 N

8 It is in the middle of the ruler because all of the clockwise moments and the anticlockwise moments from the gravitational forces on the particles in the ruler cancel out at that point.

9 You can consider the weight of the vase as a single force that acts on the centre of mass. This force creates an anticlockwise moment about the pivot and this turns the vase so it falls over

Lesson 15: P5.15 – Levers and Gears (T)

Connection

Q1. Ella was trying to unscrew a nut using a spanner, but she was having a tough time. How could she increase the moment she was applying?

Q2. Calculate the moment in the following example: **Force: 5 N; perpendicular distance** from pivot: **60 cm**

Q3. What is the centre of mass? .

Activation

LI: describe how levers and gears can be used to transmit the rotational effect of a force.

1. https://www.youtube.com/watch?v=kk6T0m9wmnU
2. Make a note of the title and the LI
3. Read pages 170 -171
4. Define “lever” and “gear”
5. Describe how a lever uses a moment of a force (paragraph 1) including the equations for work done on the load and work done by the effort force.
6. https://www.youtube.com/watch?v=s9XHTL93MTs
7. https://www.youtube.com/watch?v=1nL-RfKudhA

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 1-5
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: P5.15 – **Levers and gears**

Connection

1 Apply force at the end of the spanner furthest from the nut

2 Moment: 3.0 Nm (Did you remember to change the distance units from cm to m?)

3 A point in the object where its whole weight can be considered to act

Demonstration

1. It acts in the same way as in Figure 5.45. The lid of the bottle is like the load that is being picked up and the pivot is the edge of the bottle.
2. The distance between the load force and the fulcrum is bigger than the distance between the effort force and the fulcrum. When the wheelbarrow is balanced, the moments are the same and so the effort force is less than the load force. Therefore, it is easier to pick up the handles of the wheelbarrow than it is to pick up the load directly.
3. They increase the distance that the cyclist pedals which reduces the amount of force that is needed.
4. The pedals rotate faster than the wheels. So if the wheels are rotating quickly then the pedals would rotate too fast for the cyclist to keep cycling.
5. It changes the direction of rotation without changing the force needed.

Lesson 16: P5.16 Pressure in a fluid (T)

Connection

Q1. State three things that gears can do

Q2. When a wheelbarrow is loaded, its centre of mass is 60 cm from the centre of its wheel and the handlebars are 120 cm from it. The mass of the wheelbarrow is 7 kg. If the effort force is 130 N what is the mass of the load?

Activation

LI: Explain how pressure acts in a fluid. Calculate pressure at different depths in a liquid

1. https://www.youtube.com/watch?v=P08-lYPy1hI
2. Make a note of the title and the LI
3. Read pages 172-173
4. Define “density”, “pascal”, “pressure” and “upthrust”
5. Draw and label fig 5.49
6. Write down the equation for pressure in words and symbols with units

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 C5 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: P5.16 Pressure in a fluid

Connection

1 Increase force, Increase speed, Change direction of the rotation

2 (156Nm – 42Nm)/6 = 19 Kg
Steps to use:
use the fact that
clockwise moments = anticlockwise moments
use g = 10 m/s2
Equations:
(the weight of the wheelbarrow + the weight of the load *L*) × the distance between the centre of mass and the wheel produces one moment
(70N + 10*L*) x 0.6 m = 42 Nm + 6*L*

the force required to lift the handlebars × the distance from the end of the handle bars to the wheel produces the opposing moment.
130 N x 1.2 m = 156 Nm

Demonstration

1. The pressure at the lower holes is greater so the water comes out faster.
2. The pressure squashing the can will increase. Eventually it will become so large that the can is crushed.
3. pressure due to the petrol = height of column × density × g = 5 × 800 × 9.8 = 39 200 Pa
4. pressure due to the water = height of column × density × g = 3 × 1000 × 9.8 = 29 400 Pa
5. Lead
6. ice / air/ petrol
7. No, ice is denser than petrol so it would sink
8. For most substances solids are denser than liquids, which are denser than gases. Ice (a solid) is not denser than water (a liquid), however, but this is unusual.

Answers contd.: P5.16 Pressure in a fluid

9a $p = h\rho g = 10 \times 1000 \times 10 = 100\,000$ Pa

9b Top of cube is 9m below the surface of the water. $p = h\rho g = 9 \times 1000 \times 10 = 90\,000$ Pa.

9c The water is trying to squash the cube. Therefore, the pressure acts upwards on the base of the cube and downwards at the top of the cube. The pressure upwards is bigger than the pressure downwards so there is an upthrust.

9d The force acting on the base of the cube due to the pressure of the water = $p \times A = 100\,000 \times 1 = 100\,000$ N. The force acting at the top of the cube = $90\,000 \times 1 = 90\,000$N. Therefore, the upthrust = $100\,000 - 90\,000 = 10\,000$ N. This is smaller than the weight of the cube (= 12 000 N) so the cube will sink. (you could also work out the density of the cube = mass / volume = 1200 kg/m3 . This is larger than the density of water so the cube will sink)