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Answers and Mark Schemes

Chapters 1 to 8 and the examination 341

Name: _____ Class: _____ Date: _____

SECONDARY 2 · SCIENCE · FORCES AND ENERGY

Forces and Energy

Theory and worked examples

Forces: pushes and pulls

A force is a push or a pull. We cannot see a force, but we can see what it does to an object. The SI unit of force is the newton (N). A force can be large or small, and it always acts in a direction.

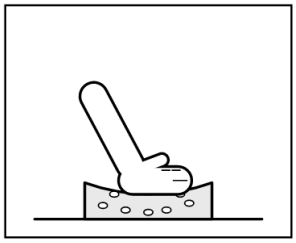
KEY IDEA

A force can change the state of rest or motion of an object, or change its size or shape.

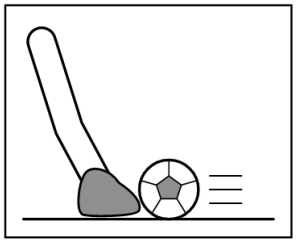
- A force can make a resting object start to move (kicking a football).
- A force can make a moving object speed up, slow down, stop or change direction (a goalkeeper stopping a ball).
- A force can change the size or shape of an object (squeezing a sponge, stretching a rubber band).
- Forces in nature can be very destructive: earthquakes, tsunamis, volcanic eruptions and tropical cyclones involve huge forces that can wreck buildings and harm people.
- A force can give an object a turning effect (turning a door handle) or press on a surface (pressure, see later).

WORDS TO KNOW

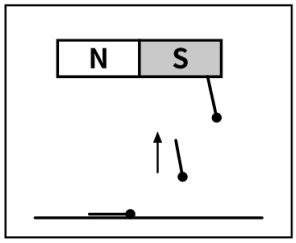
force	a push or a pull on an object; measured in newtons (N)
newton (N)	the SI unit of force
state of rest or motion	whether an object is staying still or moving, and how fast and in which direction



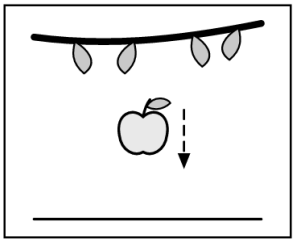
A



B



C



D

WORKED EXAMPLE

A cyclist squeezes the brake levers and the bicycle slows down. The tyres are also squashed slightly where they touch the road. State two effects of forces in this situation.

1. Slowing down means the state of motion of the bicycle has changed: a force changed its speed.
2. A squashed tyre has changed its shape: a force changed the shape of an object.

The force changed the state of motion of the bicycle (it slowed down). The force changed the shape of the tyre (it was squashed).

TRY THIS

A girl catches a fast-moving ball. State the effect of the force from her hands on the ball.

Answer: The force makes the moving ball stop (changes its state of motion).

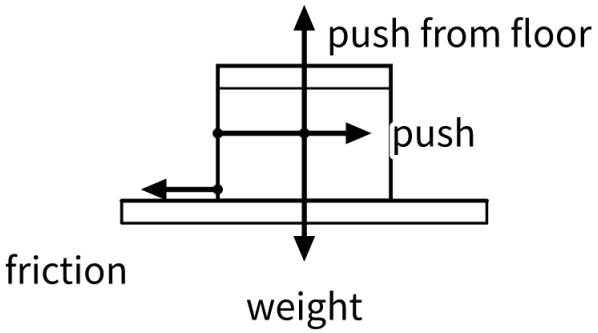
Contact forces and non-contact forces

A contact force acts only when two objects touch. A non-contact force acts across a gap, with no touching. Weight is the pull of the Earth on an object, so it is a non-contact force even when the object rests on a table.

WORDS TO KNOW

contact force	a force that acts only when two objects are touching
non-contact force	a force that acts without the objects touching
friction	a force that opposes the movement (or the attempt to move) between two surfaces in contact

Contact forces	Non-contact forces
friction between two surfaces	gravitational force (the pull of the Earth, which gives weight)
a push or pull from a hand (applied force)	magnetic force (a magnet on iron, or on another magnet)
tension (the pull of a stretched string or rope)	electrical force (a charged comb picks up small bits of paper)
the upward push of a table or floor on an object	
air resistance (the force of air against a moving object)	



WORKED EXAMPLE

A magnet picks up a steel paper clip from 2 cm away. A student then pushes the clip across a desk. Name one non-contact force and one contact force in these two situations.

1. The magnet pulls the clip without touching it, so that is a non-contact force: magnetic force.
2. The student's finger touches the clip when pushing it, so that is a contact force. Friction between the clip and the desk is another contact force.

Non-contact force: magnetic force. Contact force: the push from the student's finger (or friction between the clip and the desk).

TRY THIS

Is the weight of a book lying on a table a contact force or a non-contact force? Give a reason.

Answer: Non-contact force. The Earth pulls the book without touching it (gravitational force).

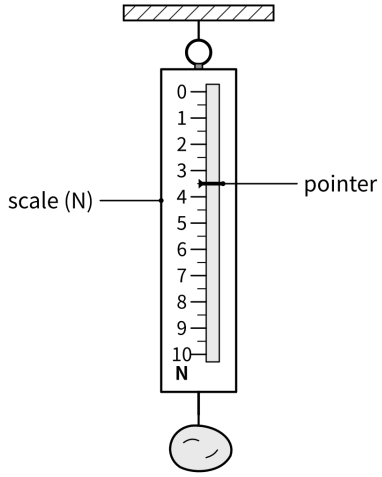
Measuring force with a spring balance

A spring balance measures force in newtons. The more the spring stretches, the larger the force. Hold the balance so the hook hangs freely, wait for the pointer to stop, and read the scale at eye level. Check the pointer reads zero before use. If it does not, the balance has a zero error, and every reading is wrong by that same amount.

- A spring stretches by the same extra length for each extra 1 N of force, as long as it is not overstretched.
- An overstretched spring does not go back to its original length.

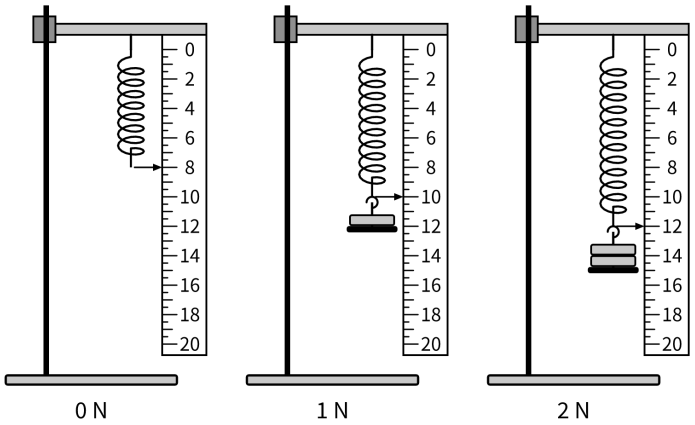
WORDS TO KNOW

spring balance	an instrument that measures force; a spring stretches and a pointer moves along a scale marked in newtons
extension	how much longer a spring becomes: stretched length – original length
zero error	the pointer does not read zero when no force acts; subtract the error (or add it if the pointer is below zero)



WORKED EXAMPLE

A student hangs slotted masses on a spring. Each mass has a weight of 1 N. The original length of the spring is 8.0 cm.
Force on spring (N): 0, 1, 2, 3, 4, 5
Length of spring (cm): 8.0, 10.0, 12.0, 14.0, 16.0, 18.0
(a) Find the extension when the force is 3 N.
(b) Describe the pattern in the results.
(c) Predict the length of the spring when the force is 6 N.
(d) State one variable the student kept the same.



1. (a) Extension = new length − original length = 14.0 cm − 8.0 cm = 6.0 cm.
2. (b) Each extra 1 N adds 2.0 cm. Use the numbers: the spring gets 2.0 cm longer for every 1 N added.
3. (c) Follow the pattern: 18.0 cm + 2.0 cm = 20.0 cm.
4. (d) A fair test changes only the force. The spring, the starting length and the way the length is measured stay the same.

(a) 6.0 cm. (b) The spring stretches by 2.0 cm for every extra 1 N of force. (c) 20.0 cm. (d) The same spring was used (or the same ruler, or the same original length).

TRY THIS

A spring balance reads 0.2 N when nothing hangs on it. A stone makes it read 2.5 N. What is the weight of the stone?

Answer: 2.5 N – 0.2 N = 2.3 N

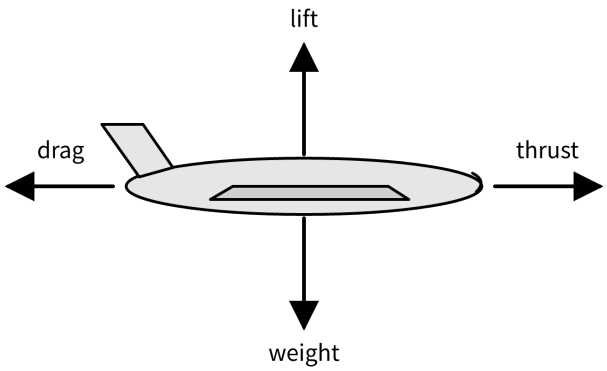
Balanced and unbalanced forces

Several forces can act on one object at the same time. If two forces are equal in size and opposite in direction, they are balanced forces and cancel out. Then an object at rest stays at rest, and a moving object keeps moving at the same speed in a straight line. If the forces are unbalanced, the object speeds up, slows down or changes direction.

WORDS TO KNOW

balanced forces	forces that are equal and opposite so that they cancel out; the state of motion does not change
unbalanced forces	forces that do not cancel out; the object speeds up, slows down or changes direction
thrust	the forward force on an aircraft from its engines
lift	the upward force on an aircraft from air flowing over its wings
drag (air resistance)	the force of air that opposes the motion of an object through it

Situation	Forces	What happens
aircraft flying level at a steady speed	lift = weight; thrust = drag	no change in speed or height
aircraft speeding up while level	lift = weight; thrust > drag	speeds up
car braking	friction (backwards) bigger than the engine force	slows down



CHAPTER 1

Practice Questions

Part 2: Forces and Energy



In the practice questions

27 questions, 81 marks. For each multiple-choice question, write the letter of the correct option in the brackets. Write your other answers on the lines given. The answers are on page 342.

- Section A: Multiple-Choice Questions: 18 questions, 18 marks
- Section B: Structured Questions: 7 questions, 43 marks
- Section C: Free-Response Questions: 2 questions, 20 marks

Name: _____ Class: _____ Date: _____

SECONDARY 2 · SCIENCE · FORCES AND ENERGY

Forces and Energy

INSTRUCTIONS

- 27 questions, 81 marks in total.
- Answer all questions in the spaces provided.
- For multiple-choice questions, write the letter of the correct option in the brackets.
- Write your other answers on the lines given, in full sentences.

Section A: Multiple-Choice Questions

1 Which of the following is a non-contact force? ( ) [1]

(A) the friction between a shoe and the floor
(B) the tension in a rope pulling a boat
(C) the pull of the Earth on a falling coconut
(D) the push of a girl on a swing

2 Which instrument and SI unit are used to measure a force? ( ) [1]

(A) beam balance, newton
(B) spring balance, newton
(C) spring balance, kilogram
(D) measuring cylinder, joule

3 An astronaut has a mass of 60 kg on the Earth, where the gravitational field strength is 10 N/kg. On the Moon the gravitational field strength is 1.6 N/kg. Which row shows her mass and weight on the Moon? ( ) [1]

	Mass on the Moon	Weight on the Moon
A	60 kg	600 N
B	60 kg	37.5 N
C	9.6 kg	96 N
D	60 kg	96 N

(A) A (B) B (C) C (D) D

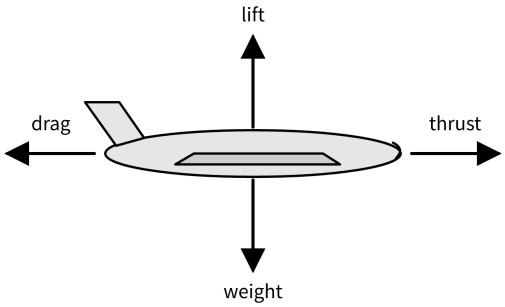
4 Which of the following can a force change?
1: the shape of an object
2: the direction in which an object moves
3: the mass of an object ( ) [1]

Ⓐ 1 and 2 only Ⓑ 1 and 3 only Ⓒ 2 and 3 only Ⓓ 1, 2 and 3

5 Which of the following reduces unwanted friction? ( ) [1]

Ⓐ cutting deep grooves in the soles of football boots
Ⓑ putting a rough rubber mat on a wet floor
Ⓒ wrapping rough tape round a racket handle
Ⓓ putting oil on a bicycle chain

6 The diagram shows the forces on an aircraft that is flying level at a steady speed. Which statement is correct? ( ) [1]

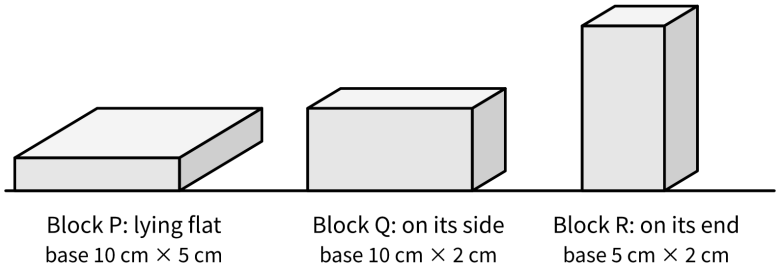


Ⓐ Lift is greater than weight, and thrust equals drag.
Ⓑ Lift equals weight, and thrust is greater than drag.
Ⓒ Lift equals weight, and thrust equals drag.
Ⓓ Lift is less than weight, and thrust is less than drag.

7 Before a stone is hung on a spring balance, its pointer reads 0.4 N. With the stone hanging, the pointer reads 3.1 N. What is the weight of the stone? ( ) [1]

Ⓐ 3.1 N Ⓑ 2.7 N Ⓒ 3.5 N Ⓓ 0.4 N

8 The diagram shows the same block resting on a table in three positions, P, Q and R. In which position does the block exert the greatest pressure on the table? ( ) [1]



(A) P
(B) Q
(C) R
(D) The pressure is the same in all three.

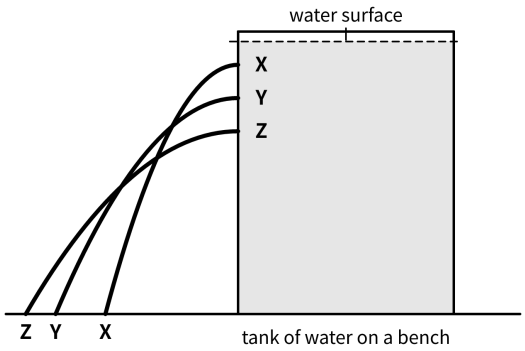
9 A crate of weight 360 N stands on a floor. It touches the floor over an area of 0.12 m². What is the pressure on the floor? ( ) [1]

(A) 3000 Pa (B) 43.2 Pa (C) 0.00033 Pa (D) 30 Pa

10 Which of the following does NOT depend on atmospheric pressure? ( ) [1]

(A) a suction cup holding on to a tile
(B) drinking juice through a straw
(C) a dropper drawing up liquid
(D) a sharp knife cutting an apple

11 Water leaks from three holes in the side of a tank. The jet from hole Z goes the furthest. What does this show? ( ) [1]



(A) Water pressure decreases with depth.
(B) Water pressure increases with depth.
(C) Water pressure is the same at all depths.
(D) Water pressure acts only downwards.