Write your name here

| Surname | Other names |
|---|---|
| | |

**Pearson Edexcel GCE**

| Centre Number | Candidate Number |
|---|---|
| | |

# Physics

## Advanced Subsidiary
## Unit 1: Physics on the Go

Tuesday 23 May 2017 – Morning
**Time: 1 hour 30 minutes**

Paper Reference
**6PH01/01**

**You must have:**
Ruler and protractor

Total Marks

### Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

### Information

- The total mark for this paper is 80.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- Questions labelled with an **asterisk** (*) are ones where the quality of your written communication will be assessed
  – *you should take particular care with your spelling, punctuation and grammar, as well as the clarity of expression, on these questions.*
- The list of data, formulae and relationships is printed at the end of this booklet.
- Candidates may use a scientific calculator.

### Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

P53489A



1/1/1/1/1/1/

P 5 3 4 8 9 A 0 1 2 4

Pearson

## SECTION A

**Answer ALL questions.**

**For questions 1–10, in Section A, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.**

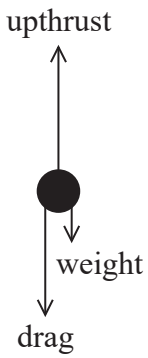
**1** Quantities are either vector or scalar.

Which row of the table correctly states a vector and a scalar?

| | Vector | Scalar |
|---|---|---|
| ☒ **A** | force | displacement |
| ☒ **B** | time | force |
| ☒ **C** | mass | time |
| ☒ **D** | displacement | mass |

**(Total for Question 1 = 1 mark)**

**2** A bubble moves upwards through a fluid at a steady speed. The forces acting on the bubble are as shown.




Which equation correctly describes the forces acting on the bubble?

☒ **A** drag + upthrust = weight

☒ **B** weight + upthrust = drag

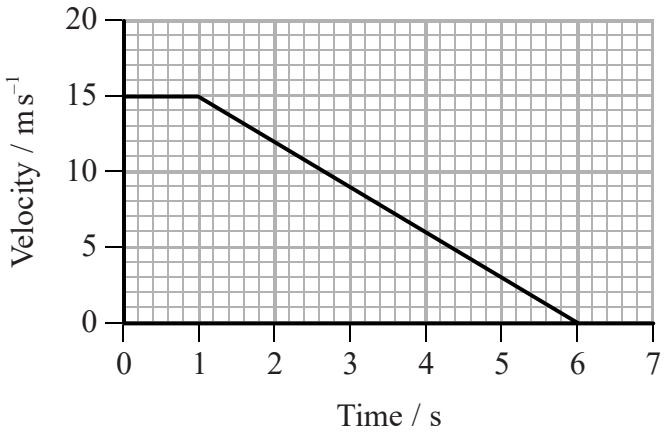
☒ **C** drag + weight – upthrust = 0

☒ **D** weight – drag + upthrust = 0

**(Total for Question 2 = 1 mark)**

**3** A car is moving at a constant velocity of $15\,m\,s^{-1}$. The driver applies the brakes and the car decelerates to rest at a constant rate.

The velocity-time graph for the final six seconds of the car's journey is shown.




The distance the car travels while braking is

☒ **A** 38 m

☒ **B** 45 m

☒ **C** 53 m

☒ **D** 75 m

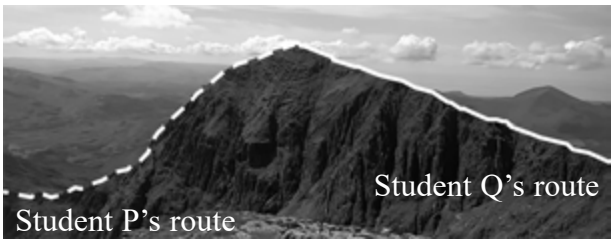
**(Total for Question 3 = 1 mark)**

**4** Select the row from the table that correctly describes the SI prefixes.

| | Pico (p) | Giga (G) |
|---|---|---|
| ☒ **A** | $10^{-9}$ | $10^{9}$ |
| ☒ **B** | $10^{-12}$ | $10^{9}$ |
| ☒ **C** | $10^{-9}$ | $10^{6}$ |
| ☒ **D** | $10^{-12}$ | $10^{6}$ |

**(Total for Question 4 = 1 mark)**

**5** Two students, P and Q, of equal mass climb to the top of a mountain. They both start their climb from the same vertical height.




Student P takes two hours to climb a shorter, steeper route. Student Q takes three hours to climb a longer, less steep route.

Which row of the table correctly describes the gain in gravitational potential energy and power developed by student P compared to student Q?

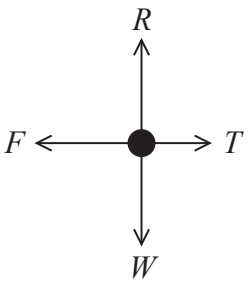
| | Gain in gravitational potential energy | Power developed |
|---|---|---|
| ☒ **A** | greater for P than Q | greater for P than Q |
| ☒ **B** | greater for P than Q | less for P than Q |
| ☒ **C** | same for P and Q | greater for P than Q |
| ☒ **D** | same for P and Q | less for P than Q |

**(Total for Question 5 = 1 mark)**

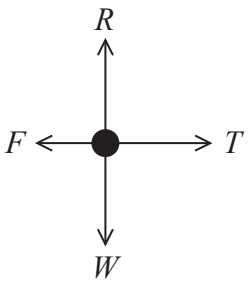
**6** A car pulls a caravan at a slow but increasing velocity along a horizontal road.


The four forces acting on the car are weight $W$, reaction force $R$ of the road on the car, tension $T$ in the tow-bar and friction $F$ between the car tyres and the road.

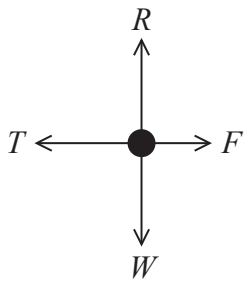
Which of the following could be the free-body force diagram for the car?



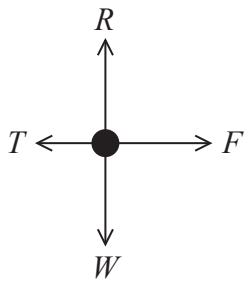

☒ **A**




☒ **B**




☒ **C**

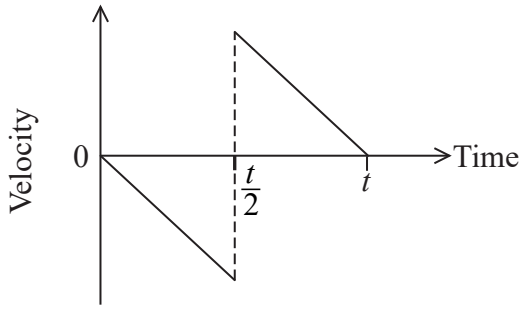



☒ **D**

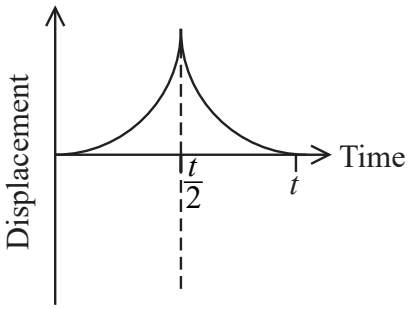
**(Total for Question 6 = 1 mark)**

**7** A ball is dropped, bounces once at time $\frac{t}{2}$ and is then caught at time $t$.

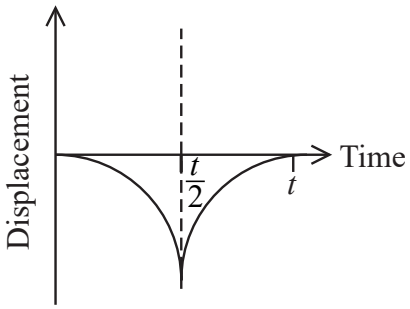
The velocity-time graph for the motion of the ball is shown.



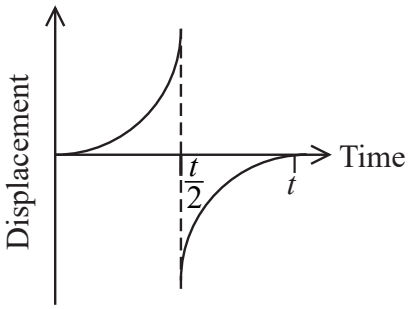

Assuming that the initial displacement of the ball is 0, which is the correct displacement-time graph for the motion of the ball?



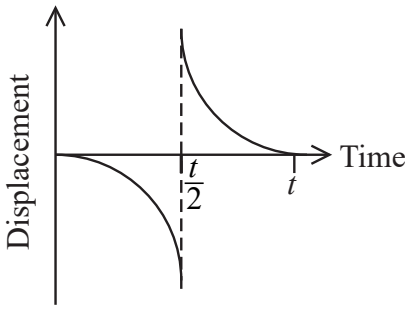

☒ **A**




☒ **B**




☒ **C**




☒ **D**

**(Total for Question 7 = 1 mark)**

**8** The flow of water in a pipe is turbulent.

Which statement correctly describes turbulent flow?

☒ **A** Speed and direction at a point remain constant.

☒ **B** The layers are parallel.

☒ **C** The layers do not mix.

☒ **D** There are sudden changes in speed and direction.

**(Total for Question 8 = 1 mark)**

**9** A person stands on some bathroom scales in a stationary lift. The lift begins to move upwards with a constant acceleration.

The reading on the scales will

☒ **A** increase but then remain constant.

☒ **B** increase at a constant rate.

☒ **C** decrease but then remain constant.

☒ **D** decrease at a constant rate.

**(Total for Question 9 = 1 mark)**

**10** On a guitar two strings are tightened to the same tension. The diameter of one string is double the diameter of the other.

The stress in the thicker string is $\sigma$.

What is the stress in the thinner string?

☒ **A** $4\sigma$

☒ **B** $2\sigma$

☒ **C** $\frac{\sigma}{2}$

☒ **D** $\frac{\sigma}{4}$

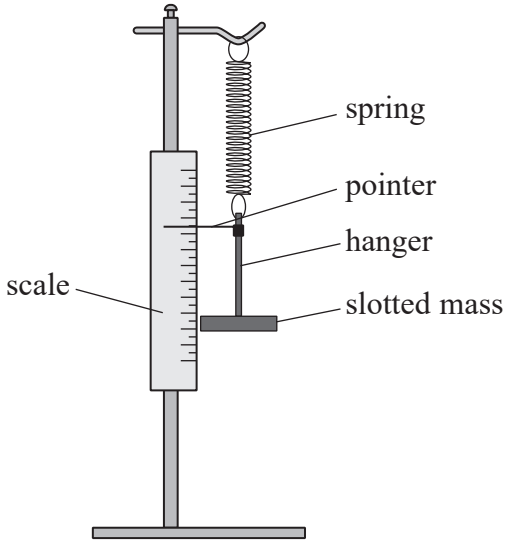
**(Total for Question 10 = 1 mark)**

**TOTAL FOR SECTION A = 10 MARKS**

## SECTION B

**Answer ALL questions in the spaces provided.**

**11** A student carried out an experiment to determine the spring constant of a spring. The diagram shows the arrangement of the equipment used.




Each time a slotted mass was added to the hanger, the position of the pointer was recorded and the extension of the spring calculated.

(a) Describe how the student could use a graphical method to determine the spring constant of the spring.

**(3)**

(b) State **two** ways in which this method contributes to an accurate value for the spring constant.

**(2)**

.....

.....

.....

.....

**(Total for Question 11 = 5 marks)**

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

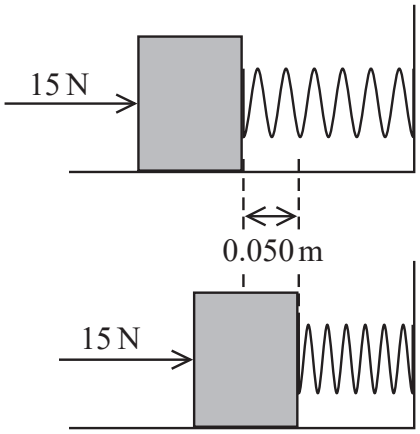
***12** A mobile phone falls to the floor. The glass screen shatters while the aluminium frame remains intact.

Explain why this happens in terms of the properties of glass and aluminium.

**(4)**

**(Total for Question 12 = 4 marks)**

**13** A spring is attached to a wall. A constant force of 15 N pushes a block of mass 0.40 kg along a frictionless surface, compressing the spring by 0.050 m, as shown.




(a) A student suggests that the work done on the block is $\Delta W = 15\,\text{N} \times 0.050\,\text{m}$.

Explain why this suggestion is **not** correct.

**(2)**

(b) When the spring is compressed by 0.060 m the tension in the spring is 18 N.
The mass is held in this position and then released.
The block now moves along the frictionless surface, losing contact with the spring once the spring has reached its original length.

Calculate the velocity of the block after it loses contact with the spring.

**(3)**

Velocity of the block = .....

**(Total for Question 13 = 5 marks)**

**14** Magma consists of molten rock and gas and is found beneath the surface of the Earth. During a volcanic eruption the magma rises to the surface and pours through an opening in the Earth's crust. As the magma rises, the pressure decreases and bubbles of gas expand and rise through the magma.

(a) Explain why the bubbles rise faster through the magma as they start to expand.

**(3)**

(b) The table shows three types of magma: basaltic, andesitic and rhyolitic.

| Magma type | Viscosity |
|---|---|
| basaltic | low |
| andesitic | medium |
| rhyolitic | high |

Explain through which magma type the bubbles will rise with the greatest velocity.

**(2)**

(c) The magma cools as it reaches the surface of the Earth.

State how cooling affects the magma.

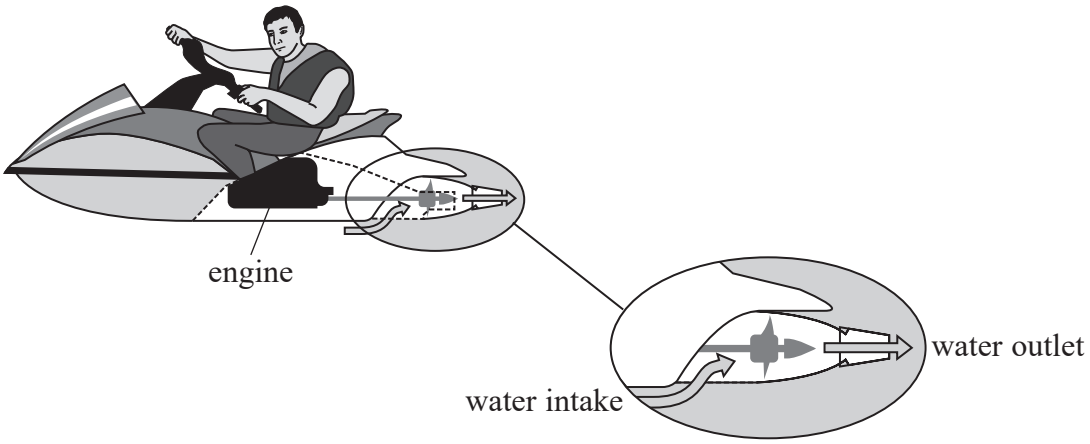
**(1)**

.....

.....

**(Total for Question 14 = 6 marks)**

**15** A jet ski is a jet-propelled vehicle that moves across the surface of water.




(a) To propel the jet ski forwards, water is drawn through an intake and then ejected through a water outlet at high speed.

(i) Explain why the cross-sectional area of the water outlet is smaller than the cross-sectional area of the water intake.

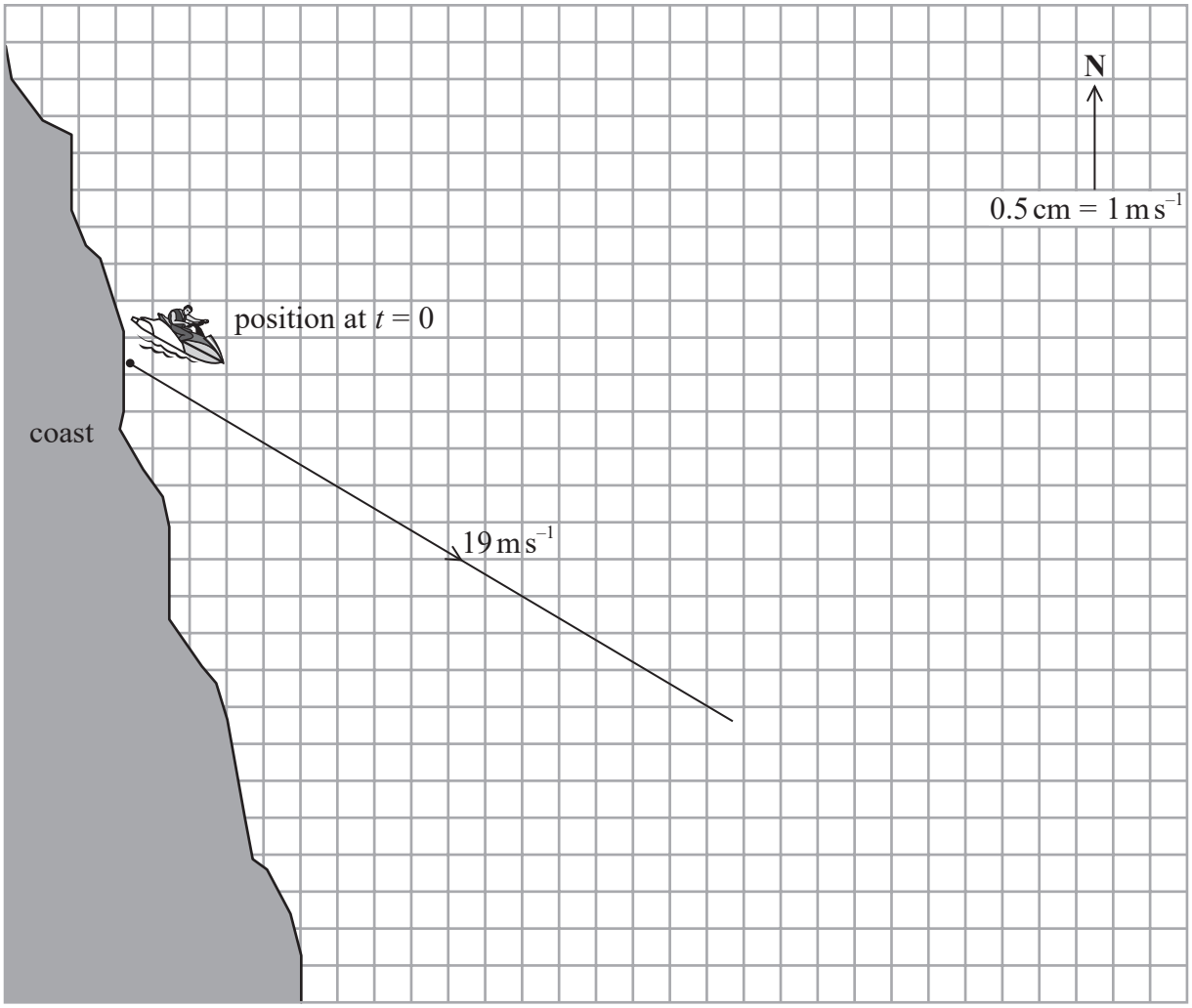
**(2)**

(ii) Explain, using Newton's laws of motion, how the ejection of water at high speed results in the forward propulsion of the jet ski.

**(3)**

(b) A man on a jet ski is heading away from the coast at a speed of $19\,m\,s^{-1}$ in a direction 30° south of east, as shown. There is a current in the water of $6\,m\,s^{-1}$ due north.

The velocity of the jet ski has been drawn to scale on the vector diagram below (with a scale of $1\,m\,s^{-1} = 0.5\,cm$).




Complete the vector diagram and determine the resultant velocity of the jet ski.

**(5)**

Resultant velocity of jet ski = .....

Direction of jet ski = .....

**(Total for Question 15 = 10 marks)**

**16** (a) The picture shows a machine to launch tennis balls, used by tennis players when training.

The following information appears on the manufacturer's website.

> The launcher features an adjustable trajectory from –20° to 80°, a ball speed range from 5 m s$^{-1}$ to 38 m s$^{-1}$ and a ball capacity of 225 balls.

*(i) The launcher is initially set to release balls at a speed of 30 m s$^{-1}$ at an angle of 25° to the horizontal.

State and explain **two** ways in which the launcher can be adjusted to increase the time of flight of the ball.

**(4)**

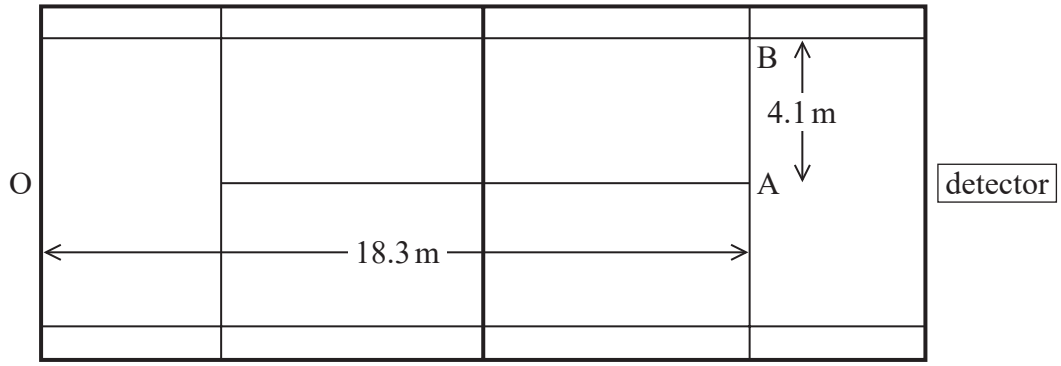
(ii) Calculate the maximum power output of the launcher.

time taken to release a tennis ball = 0.90 s
mass of a tennis ball = 0.058 kg

**(3)**

Maximum power output = .....

(b) The diagram shows a plan view of a tennis court.
During a tennis match, detectors placed on the court can record the speed of a player's serve.
A detector placed at the end of the court, in line with OA as shown, measures the speed of the ball towards the detector.




A tennis ball is served by a player from the position O in the direction OB.

(i) Explain why the detector records a velocity that is less than the actual velocity.

**(2)**

.....

.....

.....

.....

.....

(ii) Using the values given in the diagram, calculate the percentage error in the recorded velocity.

**(3)**

.....

.....

.....

.....

.....

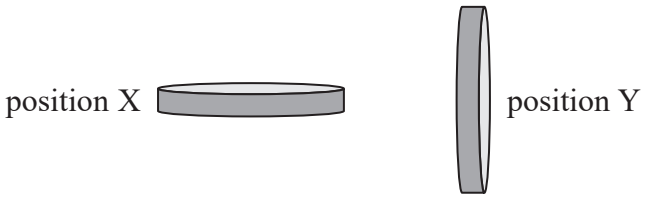
.....

.....

Percentage error in the recorded velocity = .....

**(Total for Question 16 = 12 marks)**

**17** A coin is dropped from the top of a tall building. The coin may fall in either position X or position Y, landing a time $t$ after being released.




The drag force $D$ acting on the coin is given by

$$D = \frac{1}{2} C\rho A v^2$$

Where:

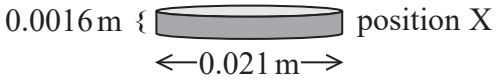
$C$ = a constant called the drag coefficient
$\rho$ = density of air
$A$ = cross-sectional area of the coin perpendicular to the direction of travel
$v$ = terminal velocity.

At terminal velocity the magnitude of the drag force is equal to the weight of the coin.

(a) Explain which position of the coin, X or Y, would result in the smaller terminal velocity.

**(3)**

(b) (i) The coin falls in position X as shown.




Show that the terminal velocity of the coin is about $15\,m\,s^{-1}$. Assume that the upthrust on the coin is negligible.

$C = 1.1$
$\rho = 1.2\,kg\,m^{-3}$
weight of coin = 0.048 N

**(3)**

(ii) A second identical coin is pushed horizontally off the top of the building with an initial velocity of $0.60\,m\,s^{-1}$.

Calculate the distance from the base of the building that this coin will land. Assume that this coin also falls in position X and reaches terminal velocity almost instantly.

height of building = 305 m

**(3)**

Distance from base of building = .....

(c) A student claims that a small coin, if dropped from a tall building, can cause serious injury were it to land on a person.

A second student claims that this would only be the case had the coin been falling through a vacuum.

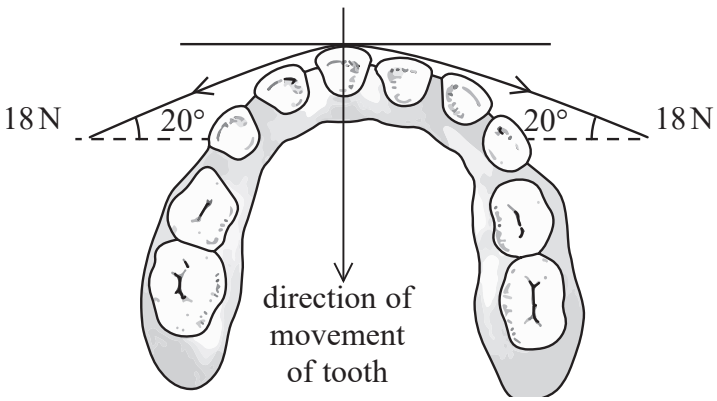
Show that a coin falling through a distance of 305 m through a vacuum would reach the ground at a speed over 5 times faster than a coin falling this distance through air in position X.

**(3)**

**(Total for Question 17 = 12 marks)**

**18** Orthodontists use braces to straighten a patient's teeth. The force required to move the teeth and the distance the teeth need to move both depend on the individual patient. One type of brace consists of a wire under tension placed across the teeth, held in place by a bracket on each tooth.


A brace is fitted to a patient and tightened. The tension in the wire is 18 N.




(a) (i) Calculate the total force of the wire on the tooth to move the tooth in the direction shown.

**(2)**

.....

.....

.....

.....

Total force of wire on tooth = .....

(ii) Explain why the wire will not produce any movement of the tooth perpendicular to the direction shown.

**(2)**

.....

.....

.....

.....

.....

(b) The wire is already under tension when it is inserted into the brackets.

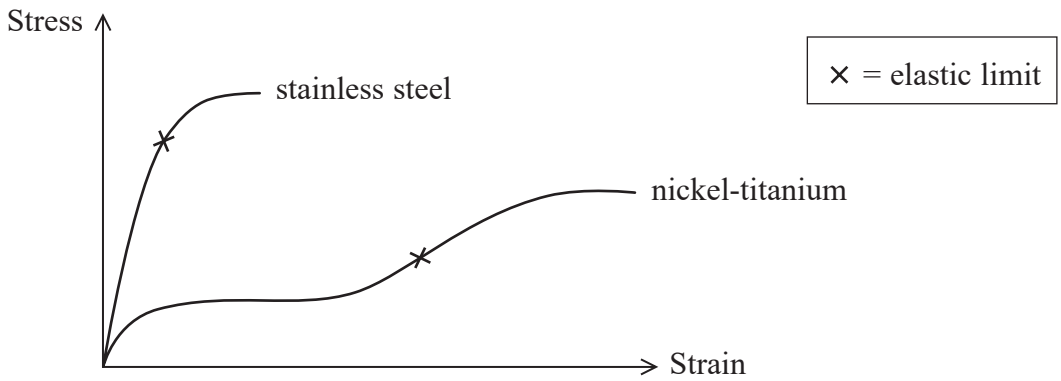
Calculate the extension of a nickel-titanium wire when under a tension of 18 N.

Young modulus of nickel-titanium = $7.5 \times 10^{10}$ Pa
original length of wire = $8.4 \times 10^{-2}$ m
cross-sectional area of wire = $7.1 \times 10^{-8}$ m$^2$

**(3)**

Extension = .....

(c) Both nickel-titanium and stainless steel wires are used in braces. The stress-strain graphs for nickel-titanium and stainless steel, up to fracture, are shown.




(i) Complete the table to compare the properties of the two metals, using evidence from the graph. The first line has been completed for you.

**(6)**

| Comparison of property | Evidence from graph |
|---|---|
| steel is stiffer | steeper gradient |
| | |
| | |
| | |

(ii) Suggest how the type of wire the orthodontist uses depends on the individual patient.

**(3)**

**(Total for Question 18 = 16 marks)**

**TOTAL FOR SECTION B = 70 MARKS**
**TOTAL FOR PAPER = 80 MARKS**

## List of data, formulae and relationships

| | | |
|---|---|---|
| Acceleration of free fall | $g = 9.81\ \text{m s}^{-2}$ | (close to Earth's surface) |
| Electron charge | $e = -1.60 \times 10^{-19}\ \text{C}$ | |
| Electron mass | $m_e = 9.11 \times 10^{-31}\ \text{kg}$ | |
| Electronvolt | $1\ \text{eV} = 1.60 \times 10^{-19}\ \text{J}$ | |
| Gravitational field strength | $g = 9.81\ \text{N kg}^{-1}$ | (close to Earth's surface) |
| Planck constant | $h = 6.63 \times 10^{-34}\ \text{J s}$ | |
| Speed of light in a vacuum | $c = 3.00 \times 10^{8}\ \text{m s}^{-1}$ | |

***Unit 1***

*Mechanics*

Kinematic equations of motion

$$v = u + at$$
$$s = ut + \tfrac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

Forces

$$\Sigma F = ma$$
$$g = F/m$$
$$W = mg$$

Work and energy

$$\Delta W = F\Delta s$$
$$E_k = \tfrac{1}{2}mv^2$$
$$\Delta E_{grav} = mg\Delta h$$

*Materials*

Stokes' law $F = 6\pi\eta rv$

Hooke's law $F = k\Delta x$

Density $\rho = m/V$

Pressure $p = F/A$

Young modulus $E = \sigma/\varepsilon$ where
Stress $\sigma = F/A$
Strain $\varepsilon = \Delta x/x$

Elastic strain energy $E_{el} = \tfrac{1}{2}F\Delta x$