4-5 Forces – Physics

1.0 The distance taken for a car to stop after an emergency depends on two things:

The thinking distance: how far the car travels while the driver processes the information.

The braking distance: how far the car travels after the driver presses the break.

1.1 Each distance is affected by different factors.

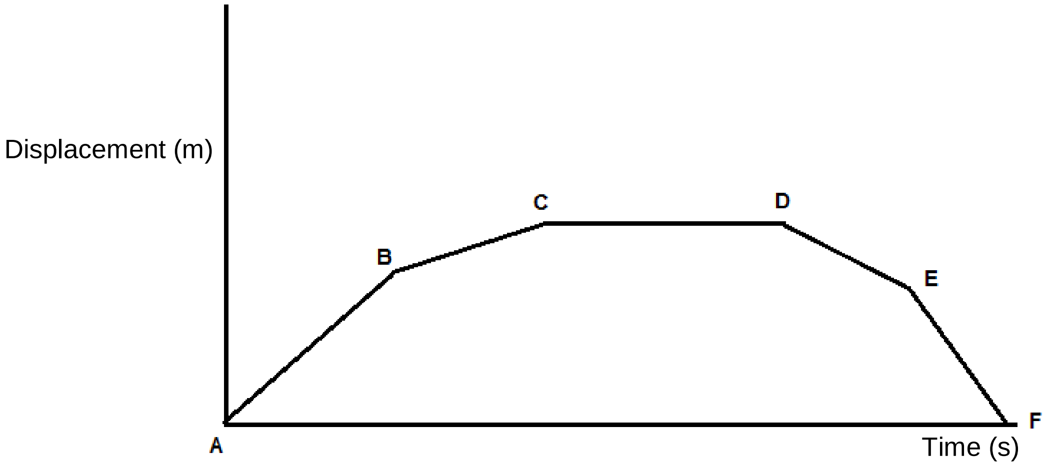
Tick the boxes to show whether each factor affects the thinking distance, the braking distance or both.

[2 marks]

Factor	Thinking distance	Braking distance	Both
Speed of car			
Water on road			
Driver's tiredness			
Driver's alcohol consumption			
Condition of car's brakes			

1.2 **Figure 1** shows part of a displacement-time graph of a car journey.

Figure 1



Complete the gaps with letters from the diagram.

[4 marks]

The car was moving forwards between ____ and ____.

The car was stationary between ____ and ____.

The car is moving slowest between ____ and ____.

The car was moving backwards between ____ and ____.

1.3 What is the difference between speed and velocity?

Put ticks in the boxes.

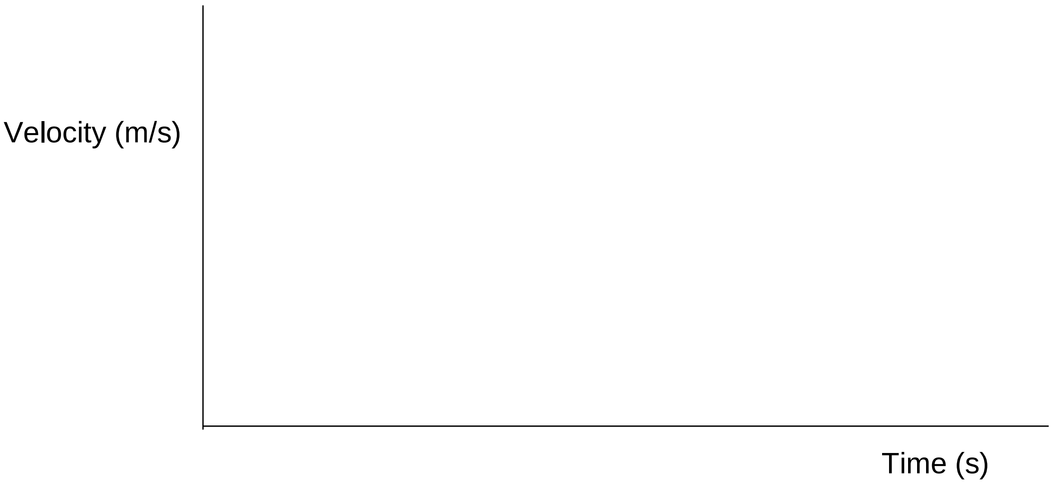
[2 marks]

	Speed	**Velocity**
Has size		
Has direction		
Scalar		
Vector		

1.4 On the axes below, draw a **velocity-time** graph for a car that:

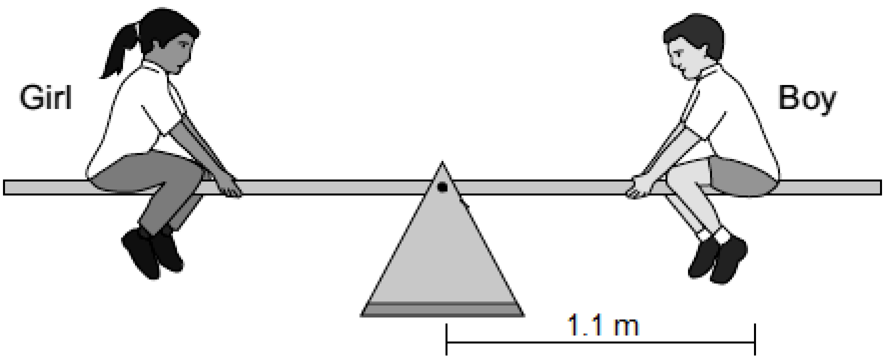
- Moves at constant velocity
- Slows down
- Stops

[3 marks]



2.0 **Figure 2** shows a girl and a boy on a see saw.

Figure 2



2.1 The boy has a mass of 27 kg.

Calculate the boy's weight.

The acceleration due to gravity is 9.8 m/s^2.

Give your answer to 2 significant figures.

[2 marks]

Boy's weight = ________ N

2.2 The see-saw is balanced.

Calculate the girl's moment about the pivot of the see-saw.

Give your answer in newton-metres.

[3 marks]

Moment = ________ Nm

2.3 Use the idea of moments to explain what happens when another child sits behind the girl.

[3 marks]

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2.4 State one similarity and one difference between a see-saw and a lever.

[2 marks]

Similarity____

____

Difference____

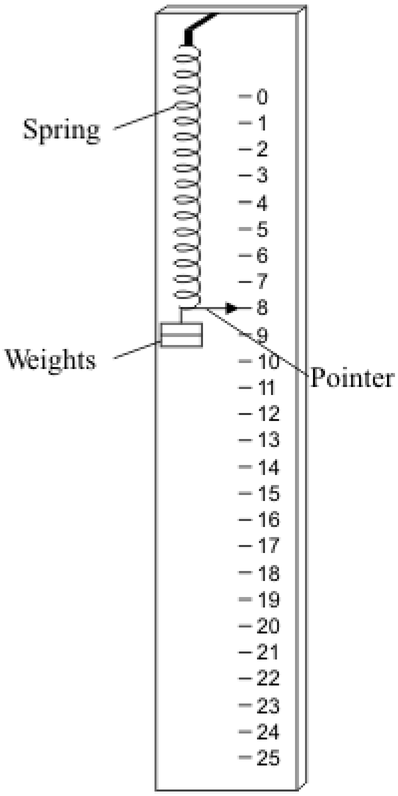
____

3.0 A student wants to measure the spring constant of a spring.

The equipment she uses is shown in **Figure 3.**

The scale measures distance in cm.

Figure 3



3.1 Explain why the mark for 0 cm is slightly below the top of the spring in the **Figure 3**.

[1 mark]

____

____

3.2 As the student carries out the experiment, her head moves slightly up and down when taking readings.

State the type of error this movement would have caused.

[1 mark]

____

3.3 How does the pointer make the measurement of length more **accurate**?

[1 mark]

____

____

3.4 Explain how the student could use the equipment in **Figure 3** to measure the spring constant of the spring.

[4 marks]

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3.5 The spring constant of the spring was 15.6 N/m.

Calculate the extension of the spring if the energy stored in it was 1.95 J.

Give your answer to 2 significant figures.

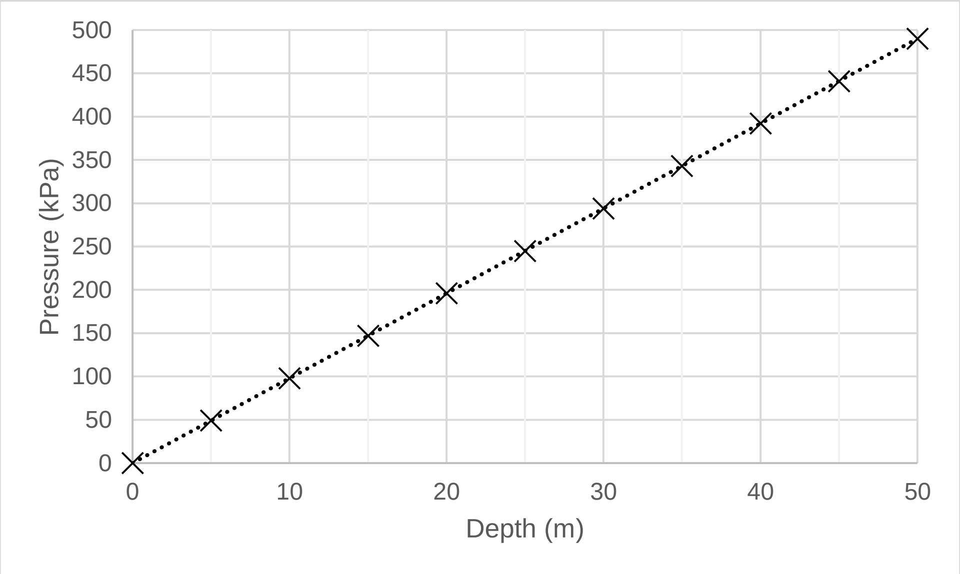
[3 marks]

Extension = _________ cm

4.0 A boy wanted to try scuba diving.

He found **Figure 4** on a website.

Figure 4



4.1 Explain why the pressure increases with depth.

[2 marks]

____

____

4.2 A typical scuba diving mask has an area of 0.015 m^2.

The world record for scuba diving is 332 m.

Calculate the force on a scuba diving mask at this depth.

The acceleration due to gravity, g, is 9.8 m/s^2 and the density of water is 1000 kg/m^3.

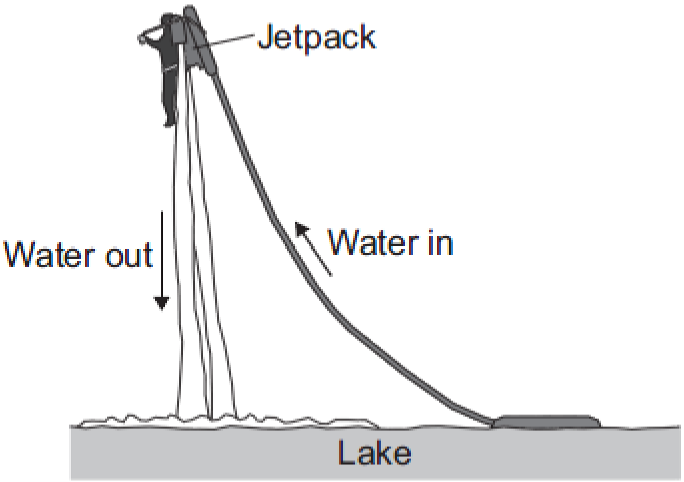
Give your answer in standard form to 2 significant figures.

[4 marks]

Force = ____________________ N

5.0 **Figure 5** shows a person using a device called a jetpack. Water is forced downwards from the jetpack and produces an upwards force on the person.

Figure 5



5.1 Explain why the jetpack moves upwards when water is forced downwards.

Include reference to the relevant law of physics in your answer.

[3 marks]

___

___

___

___

5.2 Read the following information.

Combined mass of jetpack and person	84 kg
Force water ejected from jet pack	1900 N
Starting velocity of person	0.0 m/s
Acceleration due to gravity, *g*	9.8 m/s^2

Calculate the maximum speed the person reaches after moving 5 m upwards.

In your answer:

- Calculate the combined weight of the jetpack and person
- Calculate the resultant force on the jetpack
- Calculate the acceleration of the jetpack and person
- Use $v^2 = u^2 + 2as$ to calculate the maximum velocity of the person.

Use two significant figures at each step in your calculation.

Show your working.

[6 marks]

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Maximum velocity = ________ m/s

MARK SCHEME

<table>
<tr><th>Qu No.</th><th></th><th>Extra Information</th><th>Marks</th></tr>
<tr><td>1.1</td><td>
<table>
<tr><th>Factor</th><th>Thinking distance</th><th>Braking distance</th><th>Both</th></tr>
<tr><td>Speed of car</td><td></td><td></td><td>✓</td></tr>
<tr><td>Water on road</td><td></td><td>✓</td><td></td></tr>
<tr><td>Driver's tiredness</td><td>✓</td><td></td><td></td></tr>
<tr><td>Driver's alcohol consumption</td><td>✓</td><td></td><td></td></tr>
<tr><td>Condition of car's brakes</td><td></td><td>✓</td><td></td></tr>
</table>
</td><td>Allow ticks in Thinking distance and Braking distance instead of both.

All five ticks correct: 2 marks
3 or 4 ticks correct: 1 mark</td><td>2</td></tr>
<tr><td>1.2</td><td>A and C
C and D
B and C
D and F</td><td>Both points required for each mark.</td><td>1
1
1
1</td></tr>
<tr><td>1.3</td><td>
<table>
<tr><th></th><th>Speed</th><th>Velocity</th></tr>
<tr><td>Has size</td><td>✓</td><td>✓</td></tr>
<tr><td>Has direction</td><td></td><td>✓</td></tr>
<tr><td>Scalar</td><td>✓</td><td></td></tr>
<tr><td>Vector</td><td></td><td>✓</td></tr>
</table>
</td><td>1 mark for Speed
1 mark for Velocity</td><td>2</td></tr>
<tr><td>1.4</td><td>Horizontal line above the x axis
Line drops to x axis
Line continues along x axis</td><td>
Allow curved or straight line.
Do not allow vertical line</td><td>1
1
1</td></tr>
</table>

Qu No.		Extra Information	Marks
2.1	W = mg = 27 x 9.8 = 260 (N)	If answer 264.6 (N) given, award one mark.	1 1
2.2	Recognition that girl's moment = boy's moment Moment = 260 (N) x 1.1 (m) = 286 (Nm)	May be implicit in calculation below. Allow 264.6 (N) x 1.1 (m) Allow 291(.06) (Nm)	1 1 1
2.3	The anticlockwise moment increases Making it more than the clockwise moment So the children on the left / the girl moves downwards Or The boy moves upwards	 Accept so moments are no longer balanced	1 1 1

2.4	Similarity One from: • Includes a pivot • Idea of rotation • Idea of clockwise on one side, anticlockwise on the other Difference Idea that lever is a force multiplier / seesaw should be balanced forces	Ignore size and for play / work	1 1

Qu No.		Extra Information	Marks
3.1	To allow for size of spring / to measure extension of the spring		1
3.2	Random error		1
3.3	Easier to read the scale / smaller parallax		1
3.4			
Level 2:	A detailed and coherent description of how to measure the spring constant. Answer includes multiple measurements and uses the gradient of a graph.		3-4
Level 1:	A simple description of how to measure the spring constant. Likely to only include one reading and make reference to F = kx.		1-2
	No relevant content		0
Indicative content			
	Change weight on spring Measure extension for each weight Reference to table of results Plot graph of extension (y-axis) against weight (x-axis) (or vice versa) Gradient is 1/spring constant (or gradient is spring constant if axes swapped) Reference to F = kx / Hooke's law		
3.5	$x = \sqrt{\frac{E}{0.5\,k}}$ $= \sqrt{\frac{1.95}{7.8}}$ = 0.5 m / 50 cm	Allow **2** marks for an answer of 0.25 m / 25cm (student has forgotten to square root) Award **2** marks for 50 cm Award **2** marks for correct answer to more than 2 significant figures.	1 1 1

Qu No.		Extra Information	Marks
4.1	Water molecules colliding with a surface create pressure At increasing depth more molecules (above a surface)		1 1
4.2	Pressure at depth = h ρ g = 332 × 1000 × 9.8 = 3253600 Force = pressure × area = 3253600 x 0.015 = 48,804 N = 4.9×10^4 N.	Allow ecf from first marking point.	1 1 1 1

Qu No.		Extra Information	Marks
5.1	Newton's third law Jetpack forces the water down So water exerts an equal (magnitude) and opposite (direction) force on the jetpack (so it moves up)		1 1 1
5.2	Combined weight = 84 × 9.8 = 820 N Resultant force = 1900 – 820 = 1100 N Acceleration = F/m = 1100 / 84 = 13 m/s^2 $v^2 = u^2 + 2as$ = 0 + 2 x 13 x 5 = 130 v = 11 m/s		1 1 1 1 1 1