6-5 Forces – Trilogy

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
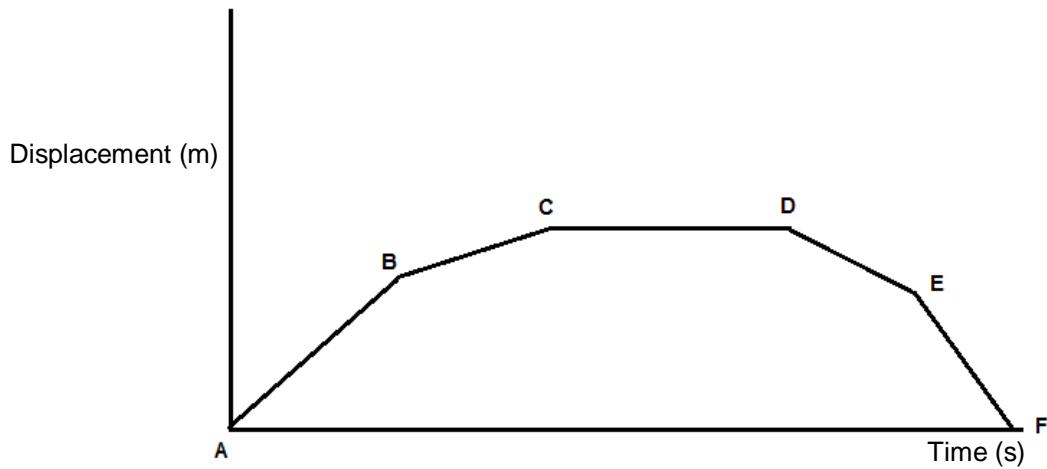
Complete the gaps with letters from the diagram.

[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?
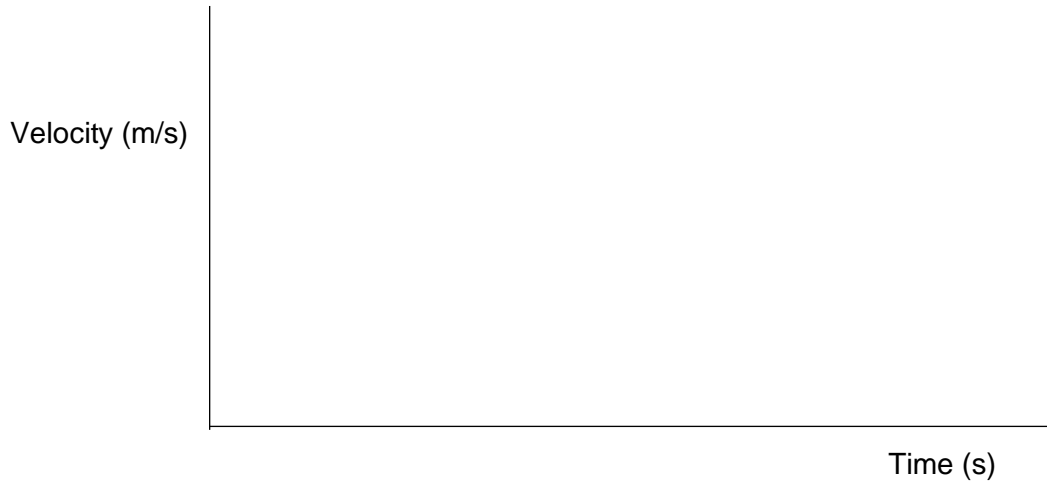
Put ticks in the boxes.

[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]

Velocity (m/s)

Time (s)

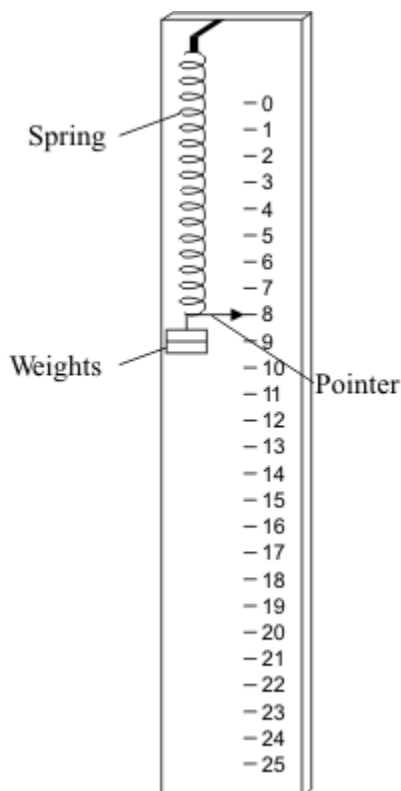NB This document may have been edited and can only be used in your school

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

The equipment she uses is shown in **Figure 2.**

The scale measures distance in cm.

Figure 2

2.1 Explain why the mark for 0 cm is slightly below the top of the spring in the **Figure 2**.

[1 mark]

_____

_____

2.2 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]

_____

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

[1 mark]

_____

_____

2.4 Explain how the student could use the equipment in **Figure 2** to measure the spring constant of the spring.

[4 marks]

_____

_____

_____

_____

_____

_____

_____

2.5 The student found that 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

3.0 **Figure 3** 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 3
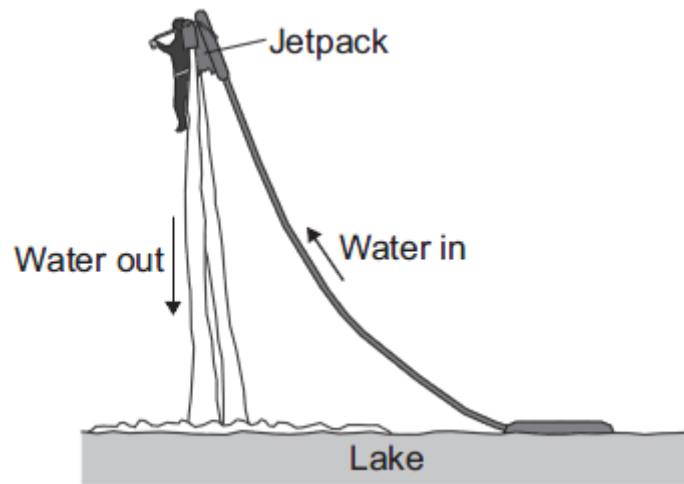
3.1 Explain why the jetpack moves upwards when water is forced downwards.

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

[3 marks]

_____

_____

_____

_____

3.2 Read the following information.

Combined mass of jetpack and person	84 kg
Upwards force from water	1900 N
Starting velocity	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]

_____

_____

_____

_____

_____

_____

_____

_____

_____

Maximum velocity = _____ m/s

MARK SCHEME

Qu No.		Extra Information	Marks
1.1		Allow ticks in Thinking distance and Braking distance instead of both.	2
	Factor | **Thinking distance** | **Braking distance** | **Both**		
	Speed of car → Both ✔	All five ticks correct: **2** marks	
	Water on road → Braking distance ✔	3 or 4 ticks correct: **1** mark	
	Driver's tiredness → Thinking distance ✔		
	Driver's alcohol consumption → Thinking distance ✔		
	Condition of car's brakes → Braking distance ✔		
1.2	A and C	Both points required for each mark.	1
	C and D		1
	B and C		1
	D and F		1
1.3		**1** mark for Speed	2
	Speed | **Velocity**	**1** mark for Velocity	
	Has size → Speed ✔, Velocity ✔		
	Has direction → Velocity ✔		
	Scalar → Speed ✔		
	Vector → Velocity ✔		
1.4	Horizontal line above the x axis		1
	Line drops to x axis	Allow curved or straight line.	1
	Line continues along x axis	Do **not** allow vertical line	1

Qu No.		Extra Information	Marks
2.1	To allow for size of spring / to measure extension of the spring		1
2.2	Random error		1
2.3	Easier to read the scale / smaller parallax		1
2.4			
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		
2.5	$x = \sqrt{\dfrac{E}{0.5\, k}}$		1
	$= \sqrt{\dfrac{1.95}{7.8}}$	Allow **2** marks for an answer of 0.25 m / 25cm (student has forgotten to square root)	1
	$= 0.5\text{ m} / 50\text{ cm}$	Award **2** marks for 50 cm Award **2** marks for correct answer to more than 2 significant figures.	1

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