Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

3430U60-1

Z22-3430U60-1

WEDNESDAY, 8 JUNE 2022 – AFTERNOON

SCIENCE (Double Award)

Unit 6 – PHYSICS 2
FOUNDATION TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**11**	
2.	**7**	
3.	**10**	
4.	**6**	
5.	**11**	
6.	**7**	
7.	**8**	
Total	**60**	

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ADDITIONAL MATERIALS

In addition to this examination paper, you may require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question.

The assessment of the quality of extended response (QER) will take place in question **4**.

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Equations

speed = $\frac{\text{distance}}{\text{time}}$	
acceleration [or deceleration] = $\frac{\text{change in velocity}}{\text{time}}$	$a = \frac{\Delta v}{t}$
acceleration = gradient of a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
force = spring constant × extension	$F = kx$

SI multipliers

Prefix	Multiplier
m	1×10^{-3}
k	1×10^{3}
M	1×10^{6}

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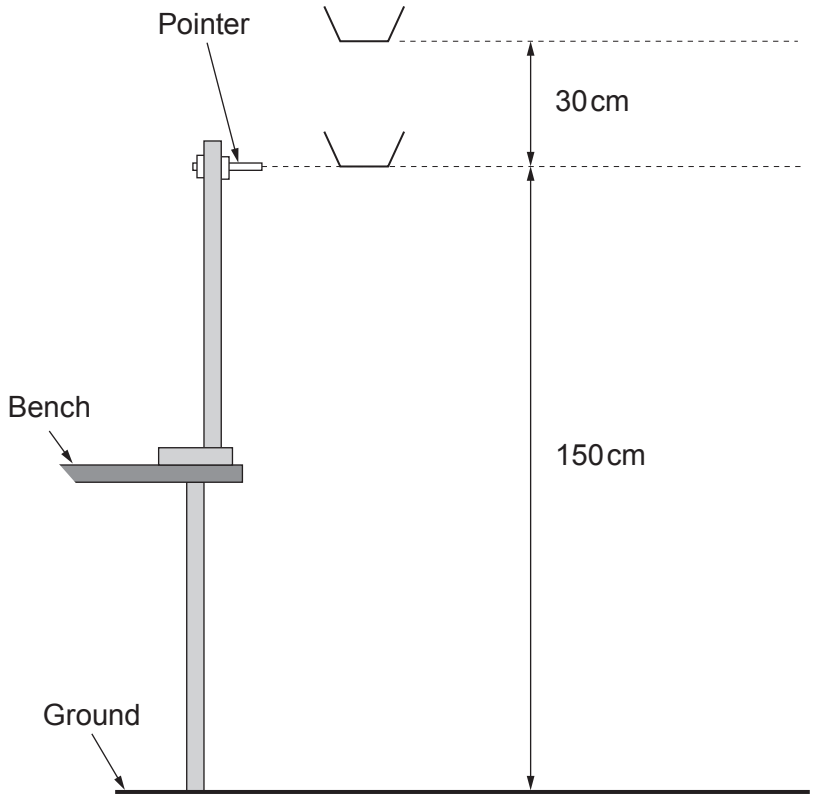
Answer **all** questions.

1. A group of students investigate the terminal speed of a number of cake cases.
They set up the following apparatus.
They drop the cake cases from rest at a point 30 cm above a pointer.
They measure the time taken for the different numbers of cake cases to fall 150 cm, from the pointer to the ground.



(a) Complete the sentences below by underlining the correct phrase in the bracket. [3]

(i) In this experiment, the independent variable is the
(number of cake cases / time of fall / height of pointer).

(ii) In this experiment, the dependent variable is the
(number of cake cases / time of fall / height of pointer).

(iii) During the first 30 cm of the fall, the cake cases
(speed up / slow down / fall at constant speed).

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(b) Five separate groups in the class carry out the same experiment.
Their results and calculated values are shown below.

Distance (cm)	Number of cake cases	Time of fall (s)						Terminal speed (m/s)
		Group A	Group B	Group C	Group D	Group E	Mean	
	0							0
150	1	0.86	0.88	0.91	0.90	0.85	0.88	1.7
150	2	0.72	0.72	0.67	0.65	0.66	0.68	2.2
150	3	0.60	0.59	0.62	0.60	0.61	0.60	2.5
150	4	0.55	0.56	0.55	0.75	0.58		2.7
150	5	0.50	0.55	0.51	0.54	0.50	0.52	2.9

(i) **Draw a circle** around the anomalous result when **4 cake cases** are dropped. [1]

(ii) Calculate the mean time for 4 cake cases to fall 150 cm. [2]

Mean time = ... s

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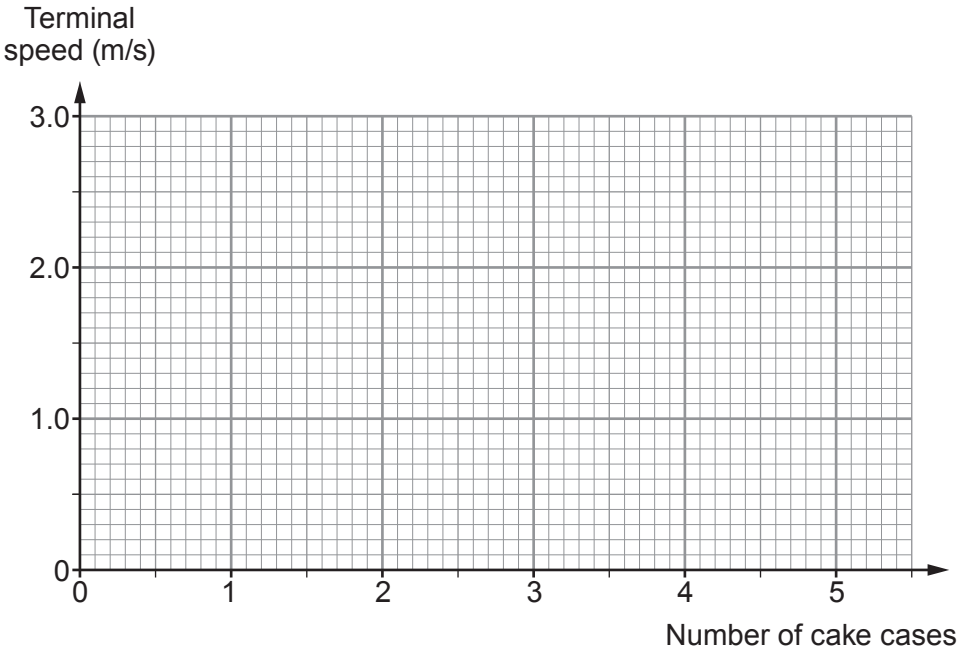
(c) (i) Use the table below to plot the data on the grid and draw a suitable curve of best fit. [3]

Number of cake cases	Terminal speed (m/s)
0	0
1	1.7
2	2.2
3	2.5
4	2.7
5	2.9



(ii) Complete the sentence below by underlining the correct phrase in each bracket. [2]

As the number of cake cases increases, the terminal speed **(increases / decreases / stays the same)** at **(an increasing / a decreasing / a constant)** rate.

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2. The total stopping distance for a moving car is given by the equation below:

total stopping distance = thinking distance + braking distance

(a) These distances may be affected by a number of factors.
Three of these factors are given in the table below.

Put a **tick** (✓) or a **cross** (**X**) in each box below to show whether the distance is affected by each factor. [3]

The first row has been done for you.

Factor	Thinking distance	Braking distance	Total stopping distance
Worn tyres	**X**	✓	✓
Drunk driver			
Wet road			

(b) At a speed of 13 m/s, the thinking distance of an alert driver is 9.1 m.

Use the equation:

$$\text{time} = \frac{\text{distance}}{\text{speed}}$$

to calculate the thinking time. [2]

Thinking time = ... s

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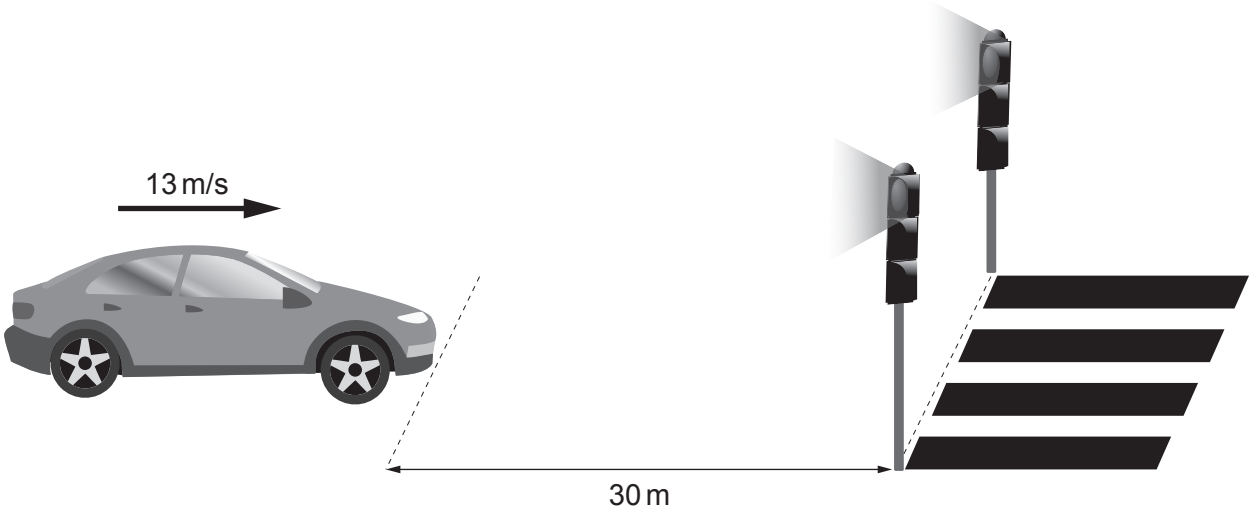
(c) A driver of a car travelling at 13 m/s sees traffic lights 30 m ahead when the lights turn to red.



The thinking distance = 9.1 m and the braking distance = 13.9 m at this speed.

Use the equation:

total stopping distance = thinking distance + braking distance

to explain whether the car would be able to stop before reaching the crossing. [2]

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Turn over.

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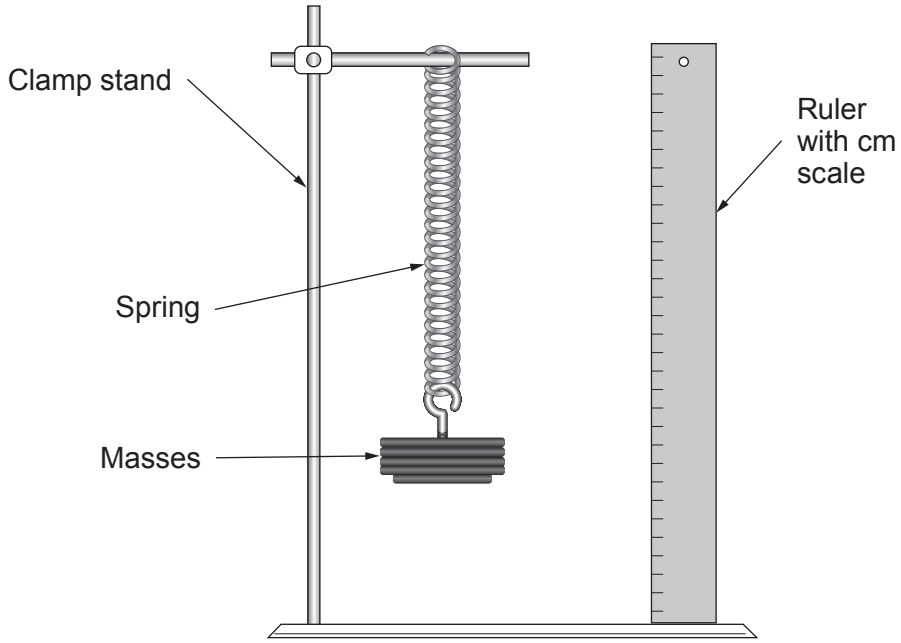
3. The diagram shows a spring being stretched by adding masses.
The spring is stretched within its elastic limit.



(a) Part of the method used for investigating the extension of the spring is shown below.

METHOD

1. Record the original length of the spring.

2. Suspend the spring from the clamp and attach the 100 g mass hanger.

3. .....

4. Add a further 100 g to the spring and record the new length.

5. .....

6. Remove all masses and repeat steps 1 – 5 once more.

7. .....

8. .....

Complete the method by writing the letters **A**, **B**, **C**, **D** from the table below into the correct gaps in the method above. [3]

A	Calculate the mean length for each mass added.
B	Record the new length of the spring.
C	Repeat step 4 until a total mass of 700 g has been added.
D	Calculate the mean extension for each mass added.

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(b) One source of inaccuracy in this experiment is measuring the length of the spring. State **two** ways this measurement could be improved. [2]

1. .....

2. .....

(c) The spring has an extension of 8 cm when a mass of 400 g is suspended from it.

(i) State the weight of the 400 g mass. [100 g weighs 1 N] [1]

Weight = ... N

(ii) Use the equation:

$$\text{spring constant} = \frac{\text{weight}}{\text{extension}}$$

to calculate the spring constant for an extension of **8 cm**. [2]

Spring constant = ... N/cm

(iii) John says that a mass of 200 g would stretch the spring by 2 cm. Explain whether his claim is correct. [2]

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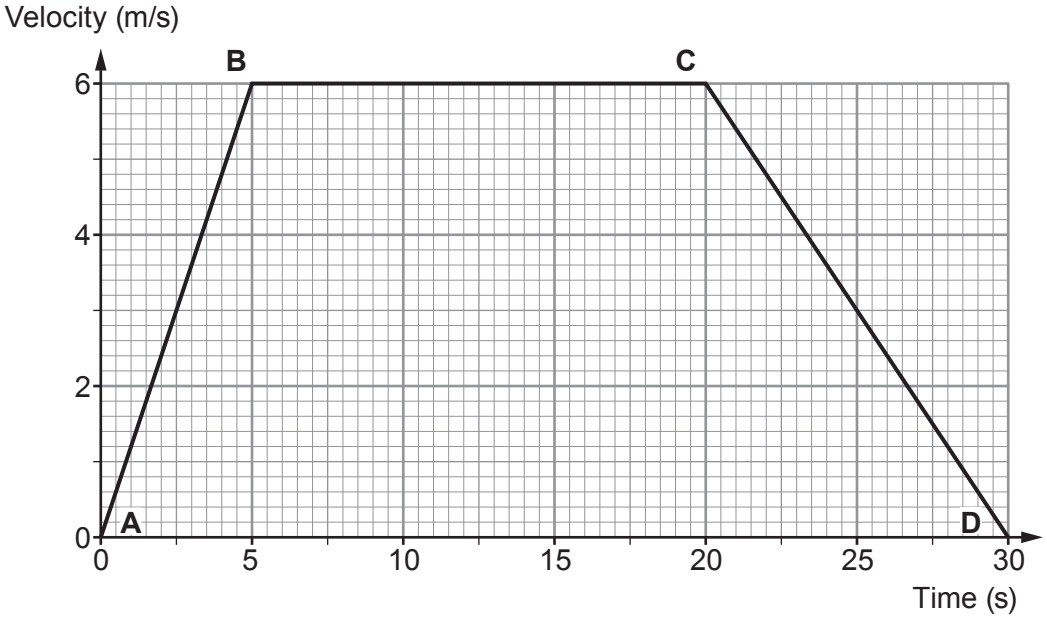
4. The velocity-time graph shows the motion of a car for a time of 30 s.



Use data from the graph to describe the motion of the car. [6 QER]
No calculations are required.

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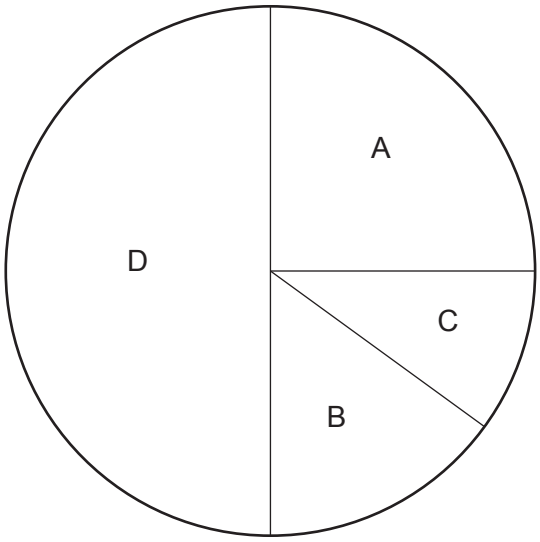
5. (a) The pie chart shows the percentages of background radiation from various sources for an area of Cornwall in the UK.

(i) Use the following information to **complete the key** for the pie chart. [3]

Around 50 % of background radiation comes from radon gas.
25 % comes from ground and buildings and medical together.
15 % comes from cosmic rays.
10 % comes from food and drink.



Key for pie chart

Source of background radiation	Letter on pie chart
Radon gas	.....
Food and drink	.....
Ground and buildings and medical	.....
Cosmic rays	.....

(ii) The background radiation from radon gas in Mid Wales **is smaller** than in Cornwall.
The background radiation from all other sources remains the same.

Alan states that the pie chart for Mid Wales would be the same as the one above.
Explain whether you think that Alan is correct. [2]

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(b) The isotope polonium-210 has a half-life of 140 days.
It is a source of alpha radiation.
200 g of polonium-210 is stored in a locked cupboard.

(i) The mass of the polonium-210 halves in 140 days.
State **one** other quantity that halves in that time. [1]

.....

(ii) **Complete the table** below to show how the mass of polonium remaining changes with time. [2]

Time (days)	Mass of polonium remaining (g)
0	200
140	100
280	.....
420	.....

(iii) **Complete the following table**, giving the numbers of particles in a nucleus of polonium-210 ($^{210}_{84}Po$). [3]

Name of particles	Number of particles in the nucleus
nucleons	.....
protons	.....
neutrons	.....

11

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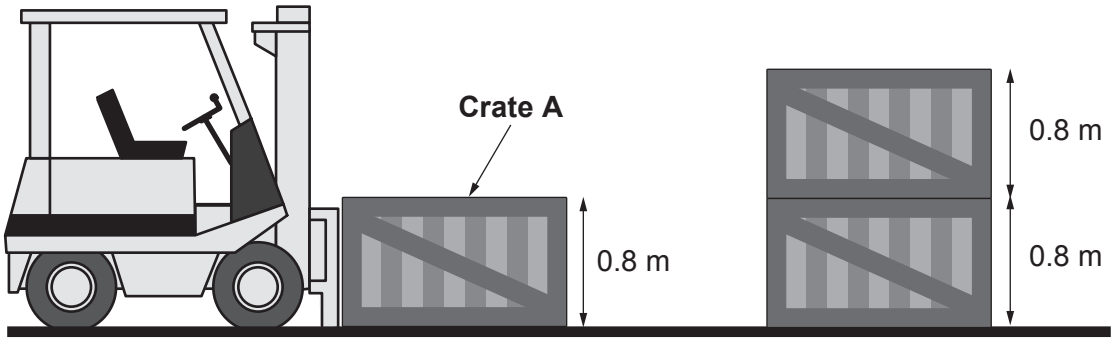
6. On a farm a fork-lift truck is used to stack wooden crates of Welsh apples.



(a) (i) Each crate of apples has a weight of 450 N and is 0.8 m high.
Use an equation from page 2 to calculate the work done in putting **crate A** on top of the **2 other** crates. [3]

Work done = ... J

(ii) State the gain in potential energy (PE) of the crate when lifted on to the stack. [1]

Gain in PE = ... J

(iii) Give a reason why the fork-lift truck uses more energy lifting crate A than the work done calculated in part (i). [1]

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(b) Each crate of apples has a weight of 450 N.
The mass of the empty crate is 12 kg.
Calculate the mass of apples contained in the crate.
(On Earth, an object of weight 10 N has a mass of 1 kg.) [2]

Mass of apples = ... kg

7

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7. Jupiter has 79 moons in orbit around it. The table shows data for 4 of its moons.

Name of moon	Mean diameter (km)	Mean temperature (°C)	Orbit radius (km)	Orbit time (days)
Io	3660	–163	421700	1.8
Europa	3120	–171	671000	3.6
Ganymede	5260	–163	1070400	7.2
Callisto	4820	–139	1882700	16.7

Use information from the table above to answer the following questions.

(a) (i) State which moon has the highest mean temperature. ..... [1]

(ii) For the solar system, as the orbit radius increases around the Sun, the mean temperature of the planets generally decreases.
Explain why the orbit radius of the moons around Jupiter does not affect their temperatures in the same way. [2]

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(iii) Peter states that as Callisto has the longest orbit time it must be the largest moon.
Determine whether Peter's claim is correct. [1]

.....

.....

(iv) Peter correctly notices that Ganymede has an orbit time that is exactly double Europa's.
Peter suggests that as the orbit time **doubles**, the orbit radius also **doubles**.
Use **only** the data for Ganymede and Europa to determine whether Peter's claim is true. [1]
Space for calculations.

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(b) (i) Two of the statements listed below are correct. One correct statement has already been ticked.
Tick (✓) **one more box** to show the other correct statement. [1]

An Astronomical Unit (AU) is the mean distance that separates the Earth and the Sun.	✓
A light year is a measurement of time.	
A light minute is the distance travelled by light in 60 seconds.	
A light year is smaller than a light second.	

(ii) Both Earth and Jupiter travel in elliptical paths around the Sun.
As they orbit the Sun the closest distance between Jupiter and Earth is 588 000 000 km. This is equivalent to 3.92 AU.

Calculate the distance, in km, that separates the **Earth and the Sun**. [2]
(1 AU = Earth to Sun distance)

Distance = ... km

8

END OF PAPER

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