

Surname	Centre Number	Candidate Number
Other Names		0



GCSE

3420U20-1



S19-3420U20-1

WEDNESDAY, 22 MAY 2019 – AFTERNOON

PHYSICS – Unit 2:
Forces, Space and Radioactivity

FOUNDATION TIER

1 hour 45 minutes

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	4	
2.	5	
3.	5	
4.	7	
5.	10	
6.	7	
7.	9	
8.	13	
9.	13	
10.	7	
Total	80	

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

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

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 at the back of the booklet.

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 7(b).



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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 $\times$ acceleration	$F = ma$
weight = mass $\times$ gravitational field strength	$W = mg$
work = force $\times$ distance	$W = Fd$
force = spring constant $\times$ extension	$F = kx$
momentum = mass $\times$ velocity	$p = mv$
force = $\frac{\text{change in momentum}}{\text{time}}$	$F = \frac{\Delta p}{t}$
u = initial velocity v = final velocity t = time a = acceleration x = displacement	$v = u + at$ $x = \frac{u + v}{2} t$
moment = force $\times$ distance	$M = Fd$

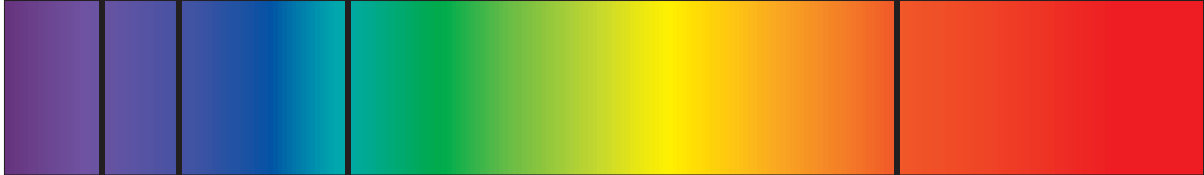
SI multipliers

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



Answer all questions.

1. Absorption spectra can be used to provide information about stars and galaxies. The diagram below shows a simplified absorption spectrum from our Sun.



- (a) Place a tick (✓) in the box next to the **three** correct statements below. [3]

The dark lines in the spectra from distant galaxies are blue shifted.

☐

The further away a galaxy is the longer the wavelength of the dark lines.

☐

The dark lines in the spectra from distant galaxies are green shifted.

☐

The dark lines can be used to identify the elements present in the star / galaxy.

☐

The dark lines in the spectra from distant galaxies are red shifted.

☐

The further away a galaxy is the shorter the wavelength of the dark lines.

☐

- (b) The shift of the absorption lines in spectra from distant galaxies provides evidence for the Big Bang model of the creation of the Universe. State another piece of evidence supporting the Big Bang. [1]

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2. A car is travelling at 10 m/s along a flat road. A driving force of 50 000 N acts on the car for a distance of 20 m causing it to accelerate.

(a) (i) Use an equation from page 2 to calculate the work done by the 50 000 N force. [2]

Work done = J

(ii) The car gains 600 000 J of kinetic energy as it accelerates. Calculate how much energy is transferred in other ways. [1]

Energy transfer = J

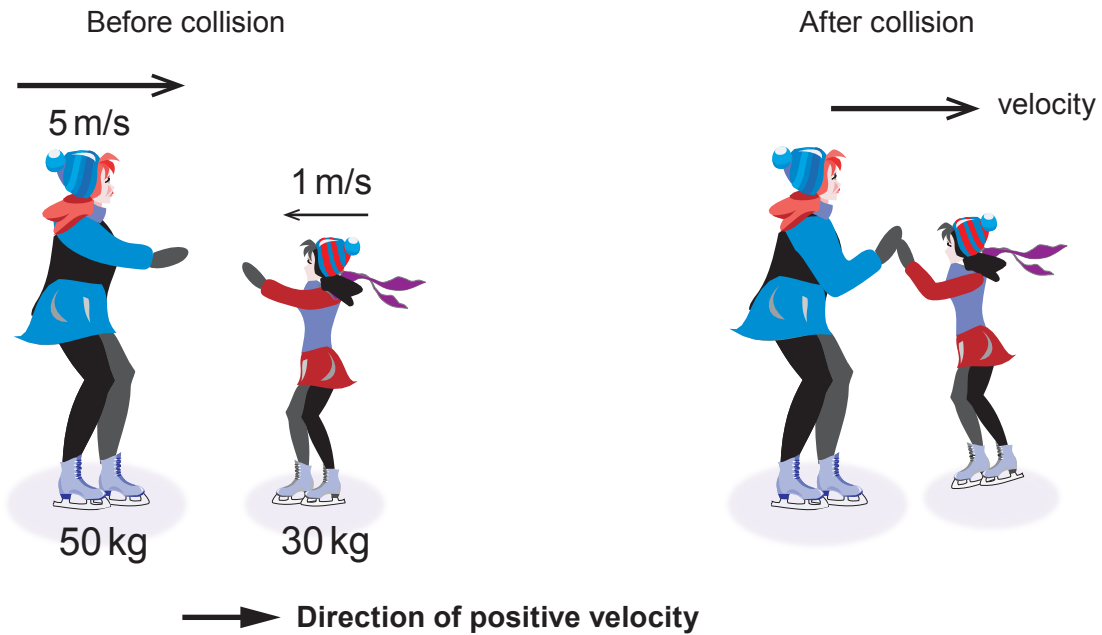
(b) State **two** ways that the **design** of the car could be changed to improve its efficiency. [2]

1.

2.



3. An ice skater of mass 50 kg and travelling with a velocity of 5 m/s to the right collides with a skater of mass 30 kg travelling with a velocity of 1 m/s **to the left**.



- (a) Use an equation from page 2 to calculate the total momentum of the skaters **before** the collision. [3]

Total momentum = kg m/s

- (b) After they collide the skaters move off together with a common velocity to the right. Use the equation:

$$\text{velocity} = \frac{\text{momentum}}{\text{mass}}$$

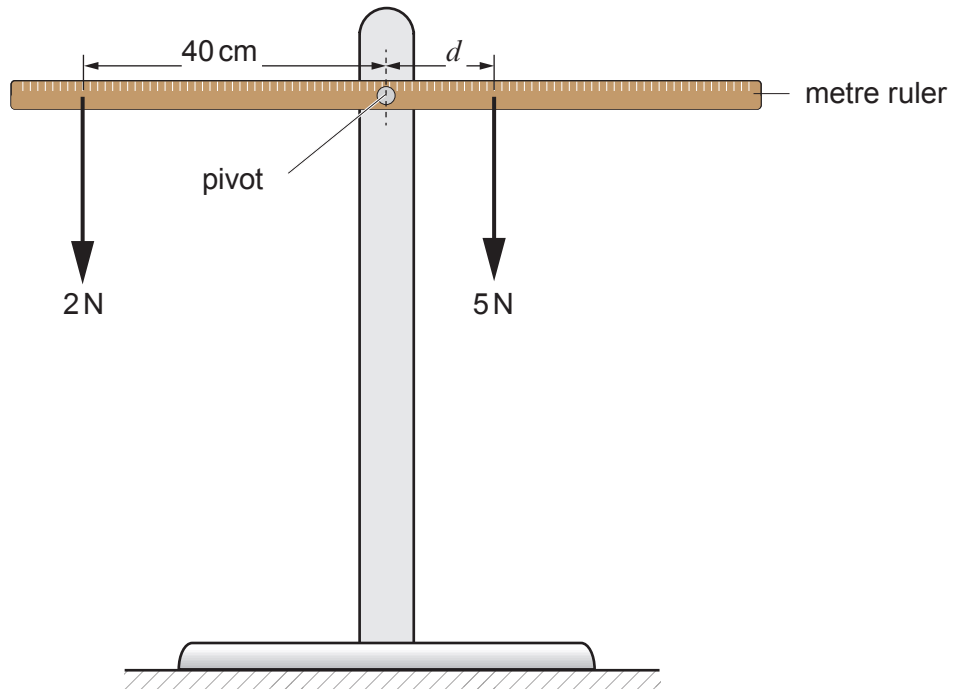
to calculate their velocity.

[2]

Velocity = m/s



4. Some students are investigating the principle of moments. They use a metre ruler and some different weights. The ruler is pivoted at its centre. To begin with they set up their experiment as shown below. They vary the position of the 5 N weight until the ruler is balanced.



- (a) (i) State the principle of moments. [1]

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- (ii) Use an equation from page 2 to calculate the moment of the 2 N weight about the pivot. Give your answer in N cm. [2]

Moment = N cm



(iii) Use the equation:

$$\text{distance} = \frac{\text{moment}}{\text{force}}$$

to calculate the distance that the 5 N weight must be from the pivot in order to balance the ruler. [2]

Distance = cm

(b) The students replace the 2 N weight with a 4 N weight. Jade suggests that to balance the ruler they will have to halve the distance that the 5 N weight is from the pivot. Explain whether you agree with her suggestion. [2]

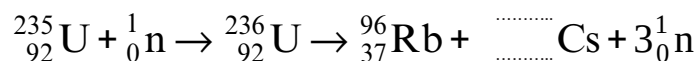
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5. Nuclear power in the U.K. provides around one sixth of our total electricity. It is important as it provides a constant and reliable source of electricity to help supply the base load demand for the National Grid. The incomplete nuclear equation below shows one possible fission reaction of uranium, U.



- (a) **Complete** the nuclear equation above. [2]

- (b) (i) Name the particle that is absorbed by the uranium-235 nucleus. [1]

- (ii) In a nuclear reactor on average two of the three particles, ${}_0^1\text{n}$, which are produced in one fission are absorbed by the **control rods**. Explain why this allows the nuclear reactor to operate safely. [2]

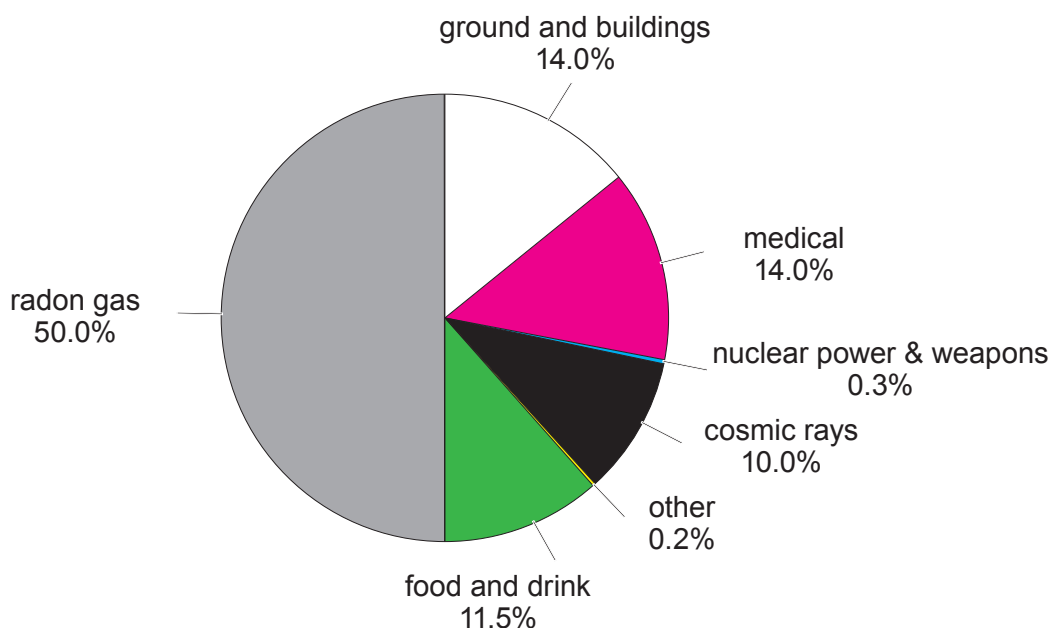
- (c) The use of nuclear power is controversial and some people believe that we should not build any new nuclear power stations because of the radioactive waste that they produce. State **two** properties of nuclear waste which makes storage a problem. [2]

1.

2.



- (d) The pie chart below shows the sources of background radiation near a nuclear power station.



- (i) State how the pie chart suggests that nuclear power is a safe source of electricity. [1]

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- (ii) Students measure the background radiation in counts per minute. One group takes a measurement for one minute. A second group measures the counts for 10 minutes and divide the value by 10. Explain which method is better. [2]

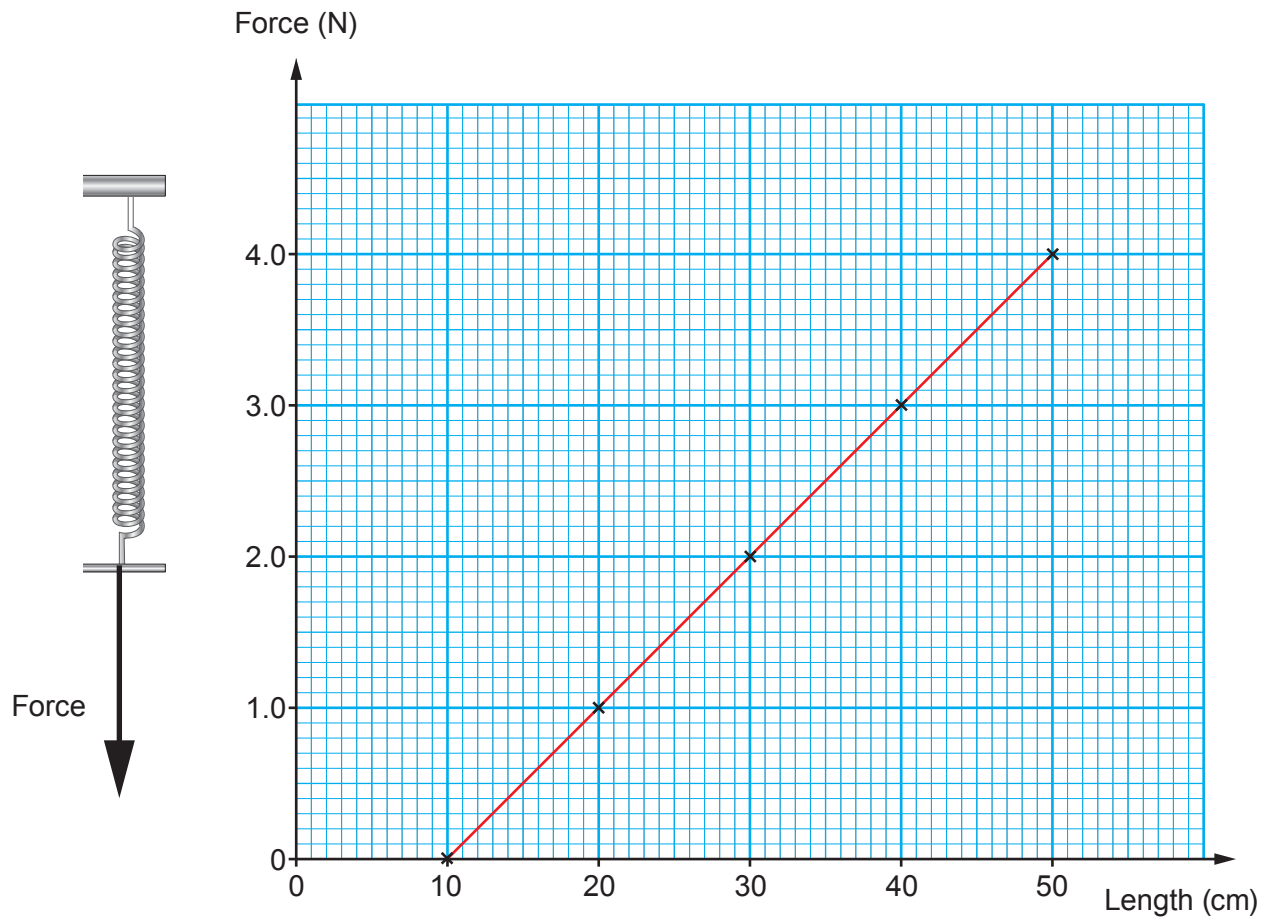
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6. A group of students are investigating how a spring stretches when forces are applied to it. They measure the length of the spring and plot their results on a graph.



- (a) (i) Use the graph to determine the unstretched length of the spring. [1]

Unstretched length = cm

- (ii) Use the graph and your answer to (i) to calculate the **extension** of the spring when a force of 2.5 N is applied to it. [2]

Extension = cm



- (iii) Use **your answer to (ii)** and the equation:

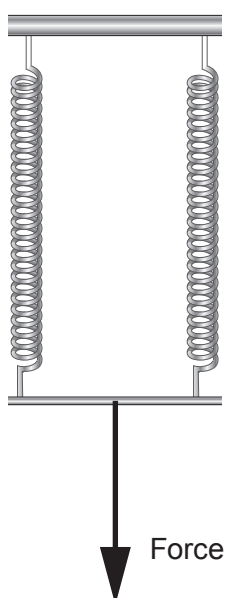
$$\text{spring constant} = \frac{\text{force}}{\text{extension}}$$

to calculate the spring constant in **N/m**.

[2]

Spring constant = N/m

- (b) The students add another identical spring in parallel with the first one as shown in the diagram.

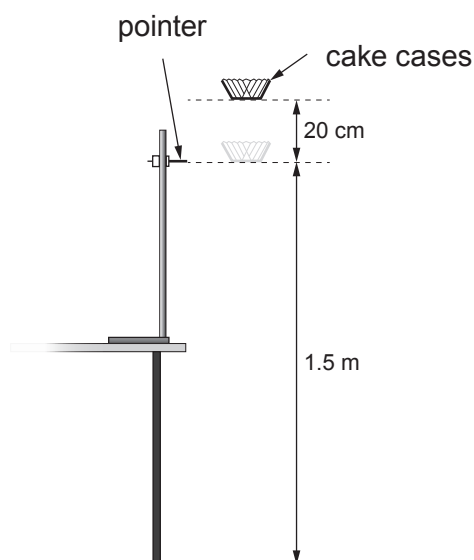


They find that the spring constant is now doubled. **Add a line on the graph** to show their results. [2]



- The Sun produces heat and light by fusing **(hydrogen / carbon / helium)** to make **(hydrogen / carbon / helium)**. The Sun is currently stable because the gravitational force is **(less than / balanced with / greater than)** the combination of gas and radiation pressure.

8. A class carries out an investigation into the relationship between the terminal speed of paper cake cases and their mass. They let the cake cases drop from about 20 cm above a pointer which is 1.5 m above the floor. They time how long they take to drop from the pointer to the floor. They assume that after 20 cm the cake cases will be travelling at terminal speed.



- (a) Explain, in terms of two named forces, why the cake cases travel at terminal speed. [2]

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- (b) The students take some trial readings to help them determine the number of repeat readings they need to take. Here are their results for 1 cake case.

Mass (g)	Time for cake case to travel 1.5 m (s)							
	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6	Trial 7	Trial 8
0.5	1.16	1.19	1.17	1.29	0.72	1.22	1.24	1.15

- (i) **Circle** the anomalous result. [1]
- (ii) Calculate the mean time. [2]

Mean time = s

- (iii) Use an equation from page 2 to calculate the mean speed. [1]

Mean speed = m/s

- (c) The students then carry out their experiment. First they measure a height of 1.5 m with two metre rulers and set their pointer. They drop 1 cake case and record the time taken to drop using a stopwatch. This is repeated 5 times. They then repeat the experiment with 2, 3, 4 and 5 cake cases in a stack to vary the mass of the cake cases.

- (i) State the independent variable in this experiment. [1]

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- (ii) State **one** controlled variable in this experiment. [1]

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- (iii) Explain how the data could be measured more accurately. [2]

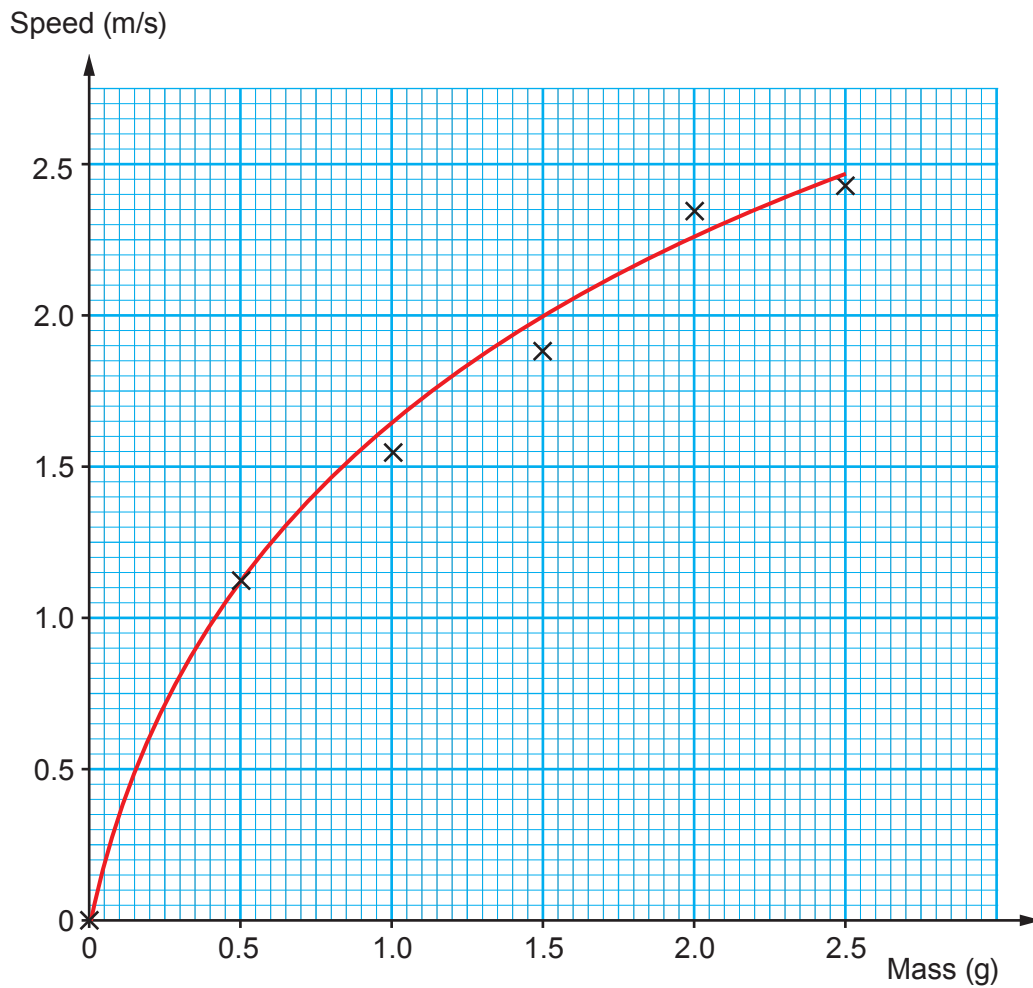
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(d) The results from one group are shown on the graph below.



Angus concludes that when the mass doubles, the speed is always 1.5 times bigger. Explain whether the results support his conclusion. Use data from the graph to support your answer. [3]

Space for calculations.

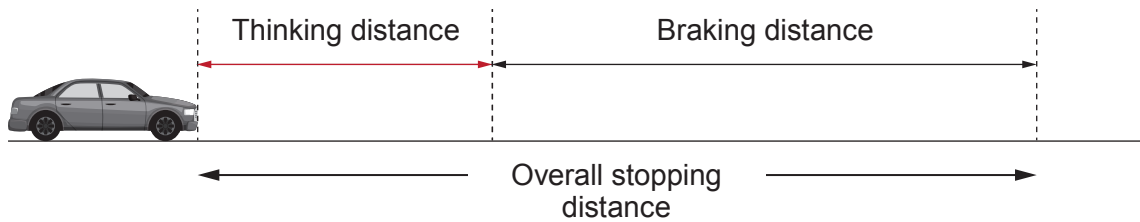
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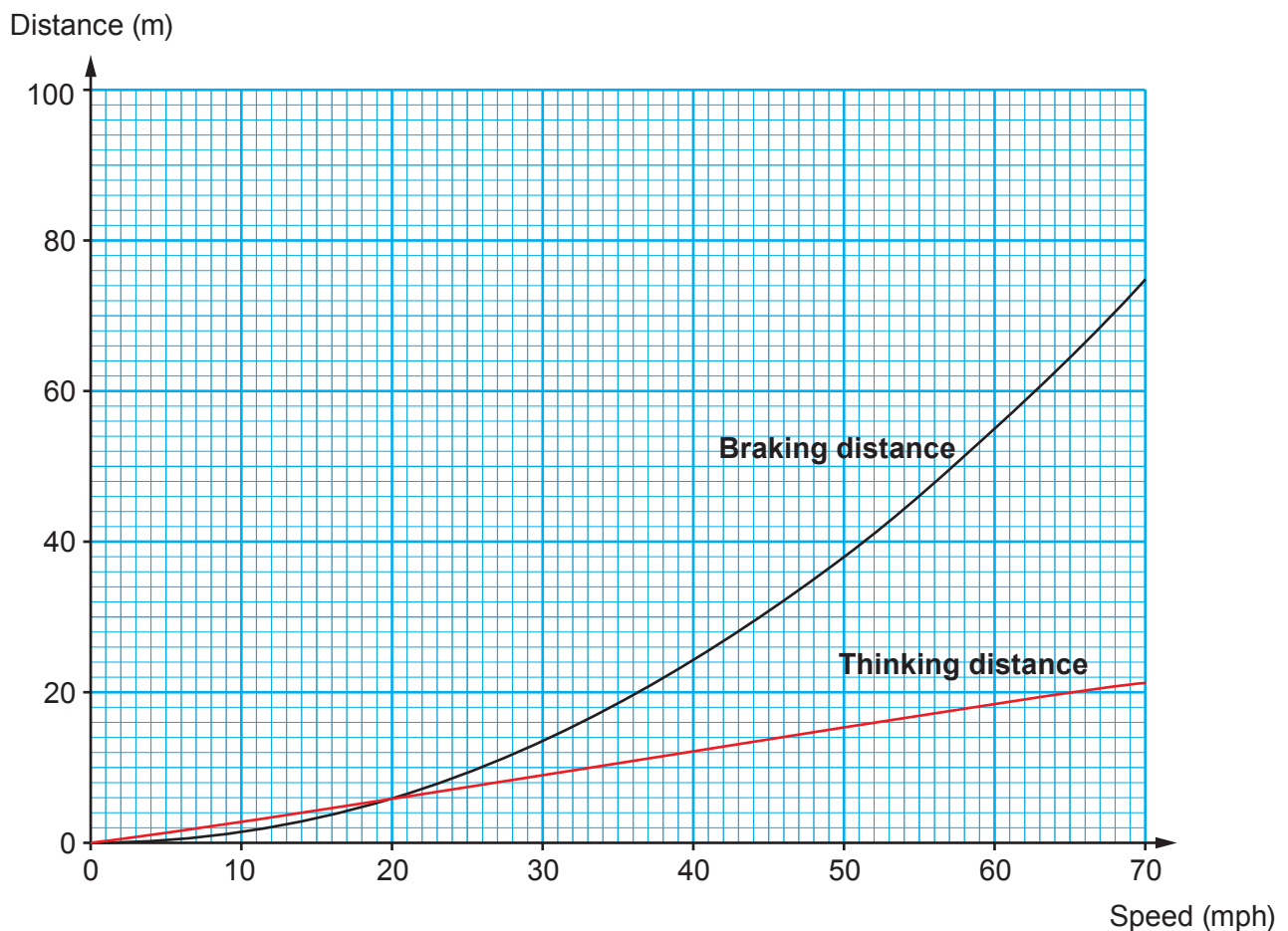
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9. The overall stopping distance of a car is made up of two parts:
- the distance that the car travels when the driver is reacting (thinking distance)
 - the distance that the car travels after the brakes have been applied (braking distance).



The graph below shows how the thinking distance and braking distance depend on the speed of a vehicle under good conditions.



The table below shows the conversion from mph into m/s.

Speed (mph)	20	40	60	70
Speed (m/s)	9	18	27	31



- (a) (i) It is suggested that both thinking distance and braking distance are directly proportional to speed. Explain whether this suggestion is true. [2]

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- (ii) Use information on page 16 and the equation:

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

to calculate the **thinking** time of the driver when travelling at 40 mph. [3]

Thinking time = s

- (iii) Use the information on the graph to complete the table below. [2]

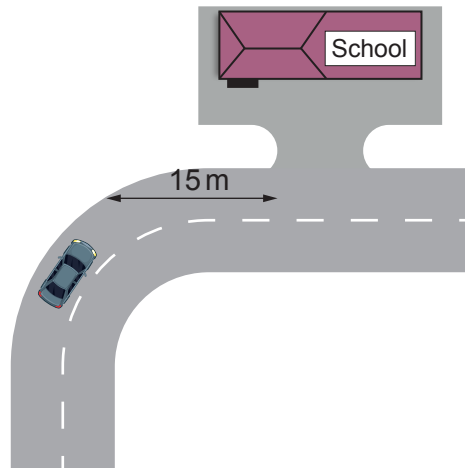
Speed (mph)	0	20	30	40	60	70
Overall stopping distance (m)						

- (iv) Use the data in the table to **plot** the points on the grid opposite **and draw a line** to show how the overall stopping distance depends on speed. [3]



- (b) The speed limit along a road outside a school in Cardiff was 30 mph. The council decided to reduce this to 20 mph in 2017.

The entrance to the school is situated 15 m after a bend in the road.



Explain how the change in speed limit affects the chance of children getting knocked down as they cross the road outside the school entrance. Use data to support your answer. [3]

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10. Radiotherapy is used to treat cancer. Three types of radiotherapy are described below.

Brachytherapy is a type of internal radiotherapy. It involves putting a sealed radiation source inside the cancerous growth. The radioisotope used emits low energy gamma rays. An isotope of iodine (iodine-125) can be used to treat prostate cancer.

Unsealed source radiotherapy also uses radioactive substances to treat cancer. These are introduced into the body by injection or ingestion. Iodine-131 is injected into a patient to treat thyroid cancer.

External radiotherapy is different from the methods described above. It is given as a series of short, daily treatments in the radiotherapy department using high energy gamma rays.

Information about some isotopes of iodine is given below.

Iodine-123 has a half-life of 13 hours and emits gamma.

Iodine-125 has a half-life of 59 days and emits gamma.

Iodine-128 has a half-life of 25 minutes and emits beta.

Iodine-129 has a half-life of 15 000 000 years and emits beta and gamma.

Iodine-131 has a half-life of 8 days and emits beta and gamma.

- (a) Explain why iodine-123 is unsuitable to treat prostate cancer. [2]

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- (b) Explain why iodine-131 is more suitable to treat thyroid cancer than iodine-128. [2]

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- (c) Patients are told that, after treatment with iodine-131, small amounts of radiation from their body may trigger radiation monitors until the activity has dropped to one thousandth $\left(\frac{1}{1000}\right)$ of its initial value. The patients are told this will occur 80 days after treatment. Explain with the aid of a calculation whether 80 days is long enough. [3]

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