

Candidate Name	Centre Number				Candidate Number			
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GCSE

PHYSICS

**UNIT 2: FORCES, SPACE and
RADIOACTIVITY**

FOUNDATION TIER

SAMPLE ASSESSMENT MATERIALS

(1 hour 45 minutes)

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	7	
2.	9	
3.	7	
4.	9	
5.	13	
6.	7	
7.	8	
8.	9	
9.	11	
Total	80	

ADDITIONAL MATERIALS

In addition to this paper you will require a calculator.

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.

INFORMATION FOR CANDIDATES

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

Question **4(b)** is a quality of extended response (QER) question where your writing skills will be assessed.

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. Read the information below.

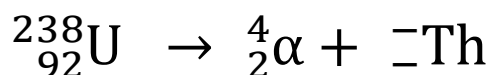
The first 92 elements in the periodic table occur naturally on the Earth. Other elements have been created by mankind, usually inside nuclear reactors. The atoms of some elements exist in different forms which are called isotopes. Isotopes of the same element all have the same number of protons. However isotopes of different elements may have the same nucleon number, some of which are shown in the table below.

Isotope	Proton number	Nucleon number
americium (Am)	95	238
uranium (U)	92	238
thorium (Th)	90	238
californium (Ca)	98	238

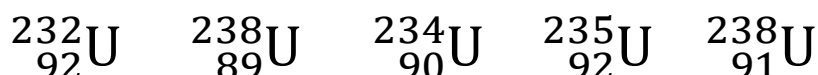
- (a) Read the statements below and tick (✓) the correct statements. [3]

Statement	
Atoms of all of these isotopes have the same number of protons in their nuclei.	
An atom of uranium has 92 neutrons in its nucleus.	
An atom of californium has the greatest number of protons in its nucleus.	
An atom of californium has the smallest number of neutrons in its nucleus	
Uranium is not a naturally occurring element.	
An atom of uranium has 92 protons in its nucleus.	

- (b) Complete the decay equation of uranium-238 into thorium in the equation below. [2]



- (c) Circle the two correct isotopes of uranium from the list below. [2]



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2. The distances between objects in space are mind boggling. Even the distances between planets in our solar system are so enormous that it takes space vehicles from Earth a very long time to get to them, many years in some cases. For example, the space craft called New Voyager that passed Pluto in 2015 was launched from Earth in January 2006 and despite it being the fastest vehicle that has ever been sent from Earth, it took over 9 years to reach Pluto.

Fortunately there is one thing that travels so fast that we can express the vast distances of space in terms of how far it travels in 1 second or even for huge distances, the distance it travels in 1 year. This is of course light. Light travels 300 000 kilometres in 1 second and even at that speed light takes 500 s to travel to us from the Sun. We could say that the Sun is 500 light seconds away. The nearest star to our Sun is about 4 light years away, others are even millions of light years away from us.

Some of the distances used in astronomy are:

1 astronomical unit (AU) is the distance between the Earth and the Sun

1 light second is the distance travelled by light in 1 second = 300 000 km

- (a) (i) What is a meant by a light year? [1]

.....

- (ii) The sun is 500 light seconds away from Earth.
 Use the equation:

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

to calculate this distance in km. [2]

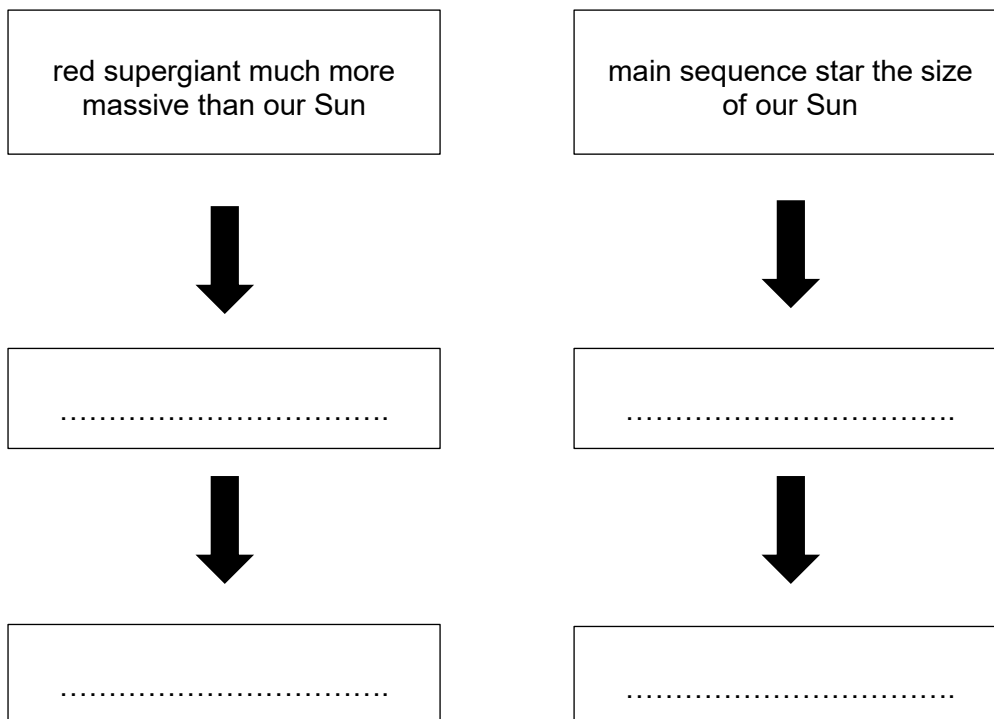
$$\text{distance} = \dots\dots\dots\text{km}$$

- (iii) The radius of Saturn's orbit is 9 AU. Use your answer to (ii) above to calculate the radius of its orbit in km. [2]

$$\text{radius} = \dots\dots\dots\text{km}$$

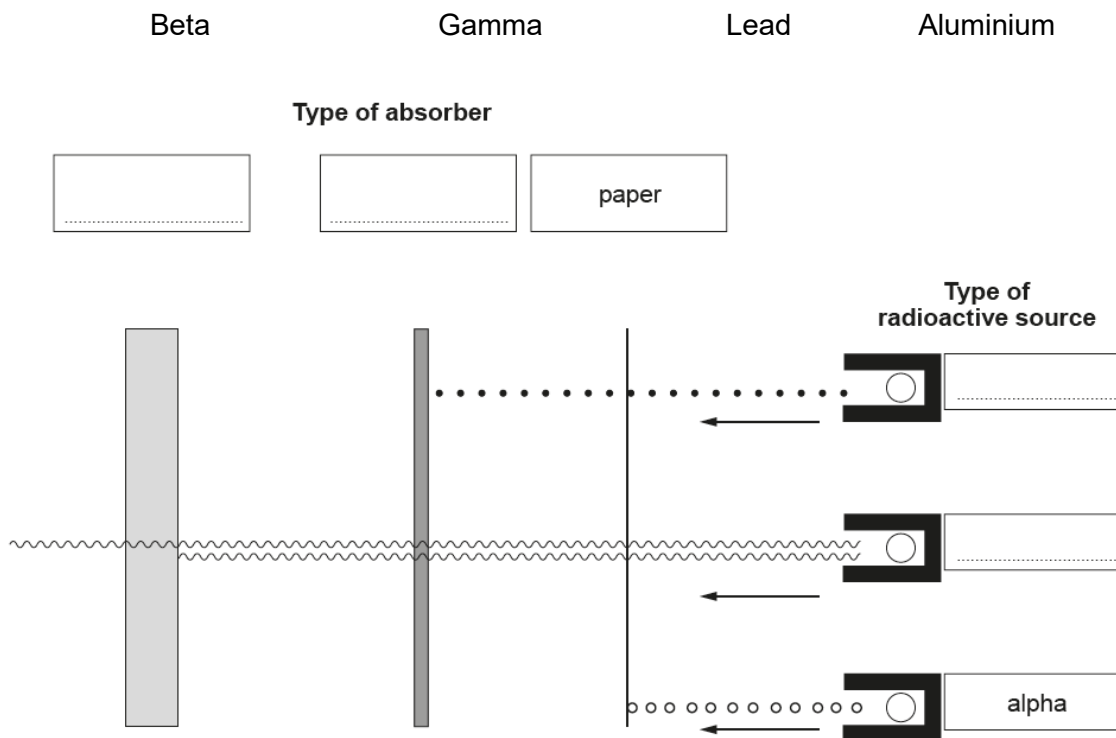
- (b) When main sequence stars come to the end of their “lives” they go through stages which depend on their mass. Choose words or phrases from the box **to complete the diagram** that follows. [4]

red giant black dwarf white dwarf supernova neutron star



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3. (a) The diagram shows the three types of nuclear radiations being absorbed by different materials. Use the words below to complete the 4 boxes on the diagram. [3]



- (b) The table shows the background count rate (in counts/min) taken in a laboratory at five different times.

	Measurement 1	Measurement 2	Measurement 3	Measurement 4	Measurement 5
Activity (counts/min)	20	22	18	19	21

- (i) State why the readings are different. [1]

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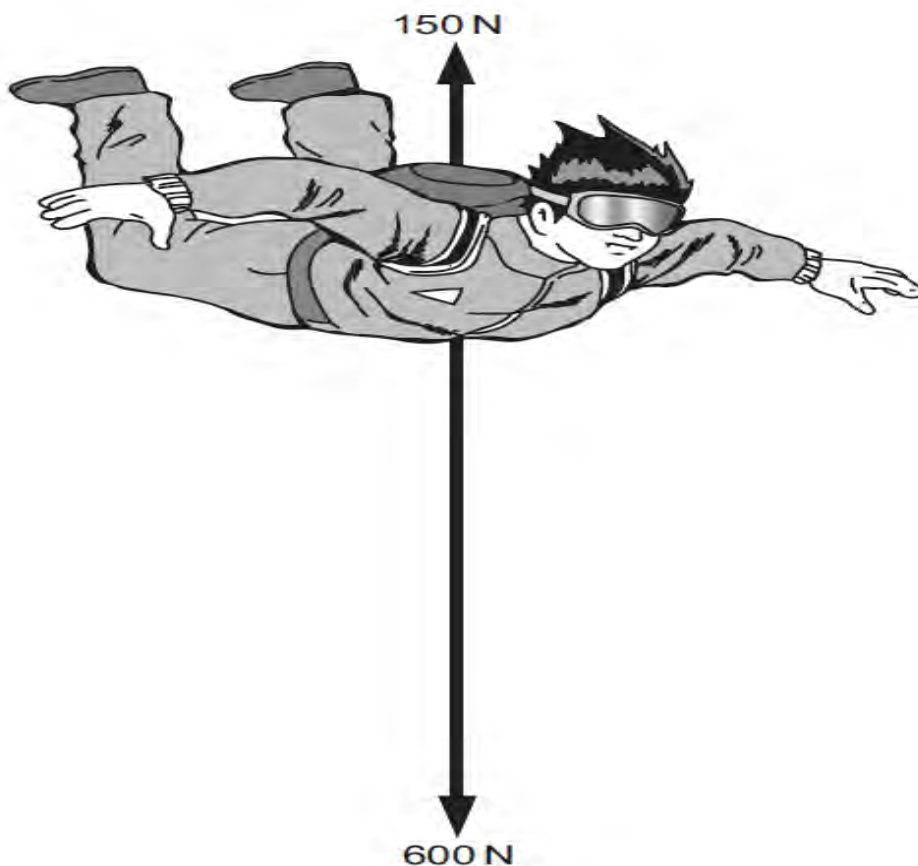
- (ii) Calculate the mean activity for the background radiation and convert your answer from counts per minute to counts per second (counts/s). [2]

mean activity = counts/s

- (iii) Name one **natural** source of background radiation. [1]

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4. A skydiver of mass 60 kg weighs 600 N. The diagram below shows the forces acting on the skydiver **at one point** in her fall.



- (a) (i) Calculate the resultant force acting on the skydiver. [1]

resultant force = _____ N

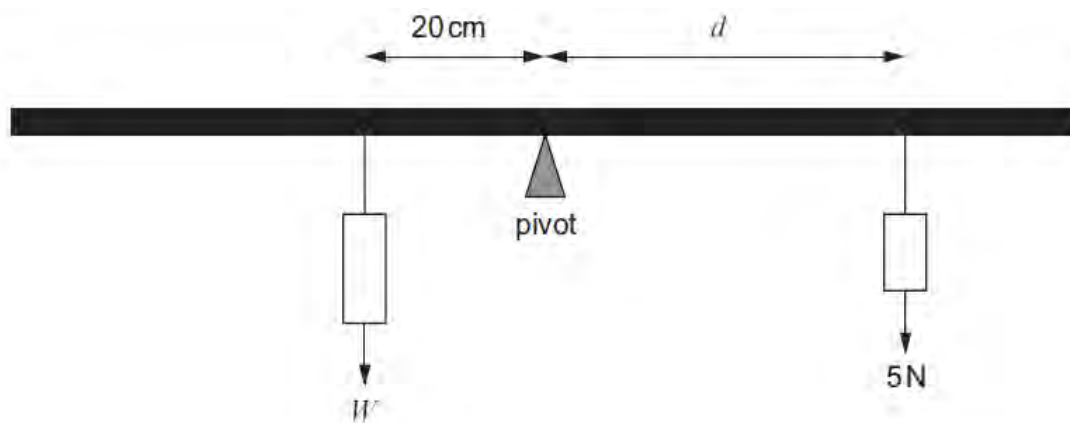
- (ii) Use the equation:

$$\text{acceleration} = \frac{\text{resultant force}}{\text{mass}}$$

to calculate the acceleration produced by this resultant force [2]

acceleration = m/s²

5. See-saws, tower cranes and even simple levers are all things that rely on an understanding of balance and moments in their design. For objects not to topple, the moments must balance. A class of students studying moments carried out the following experiment. They set up a **metre rule** to balance at its mid-point and then placed weights at different distances from the centre to get it to level. One of the weights was kept the same throughout at 5 N but its distance, d , from the pivot (centre of the rule) could be changed. The other balancing weight, W , could be varied but its distance from the pivot was kept constant at 20 cm. This is shown below.



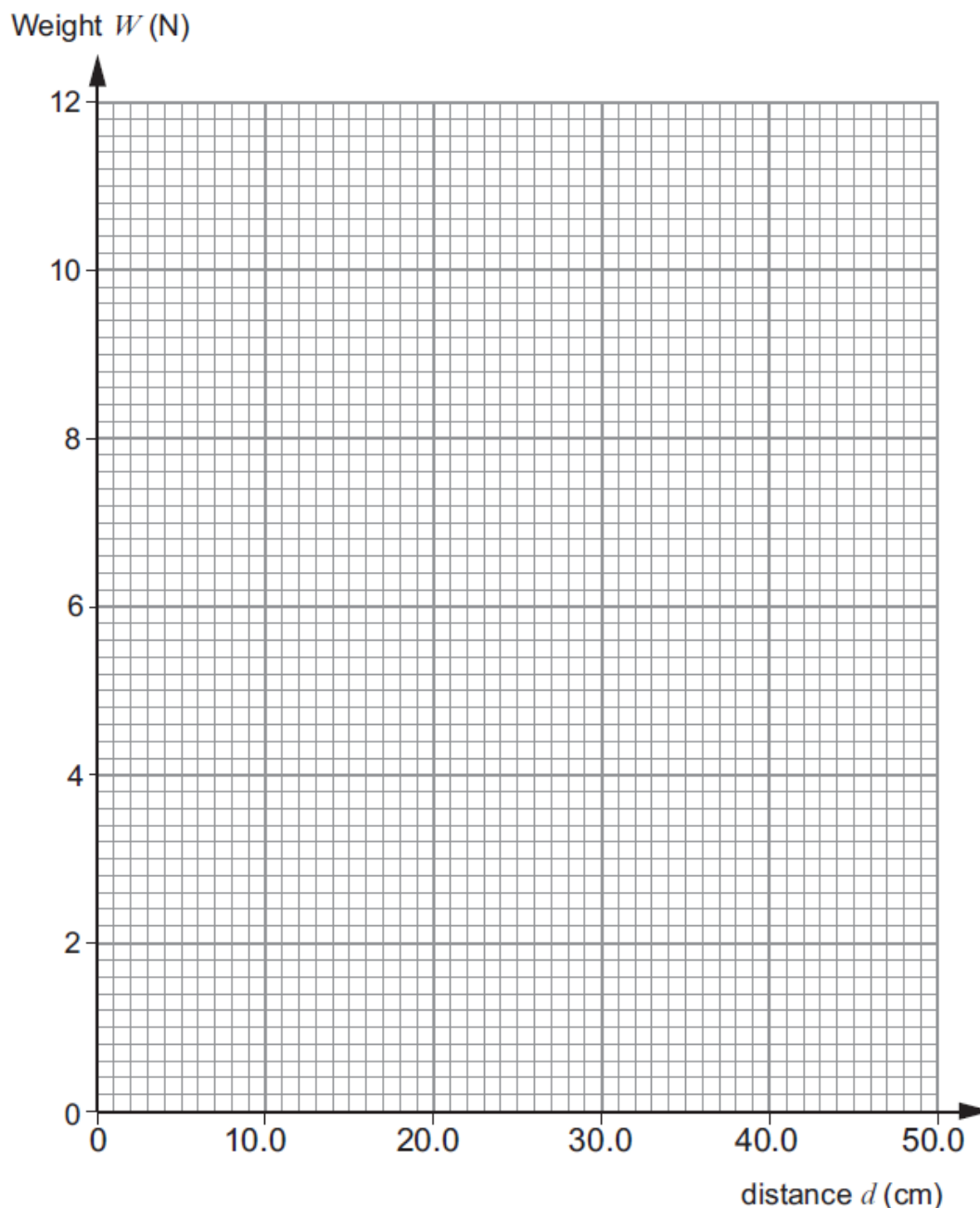
- (a) (i) **Complete** the moments equation for the situation shown above. [1]

$$W \times \dots\dots\dots = 5 \times d$$

The results from one group are shown below.

Left side		Right side	
W (N)	Distance (cm)	Weight (N)	d (cm)
3	20.0	5	12.0
4	20.0	5	16.0
5	20.0	5	20.0
8	20.0	5	32.0
10	20.0	5	40.0
12	20.0	5	48.0

- (ii) Plot a graph of the values of W from the left side against values of d from the right side on the grid below. [3]



- (iii) Give the value of the weight, W , that would balance at a distance, d , of 10 cm. [1]

force = N

- (iv) Give the value of d that would balance a weight, W , of 6 N. [1]

d = cm

(v) Describe how the weight, W , changes as the distance, d , changes. [2]

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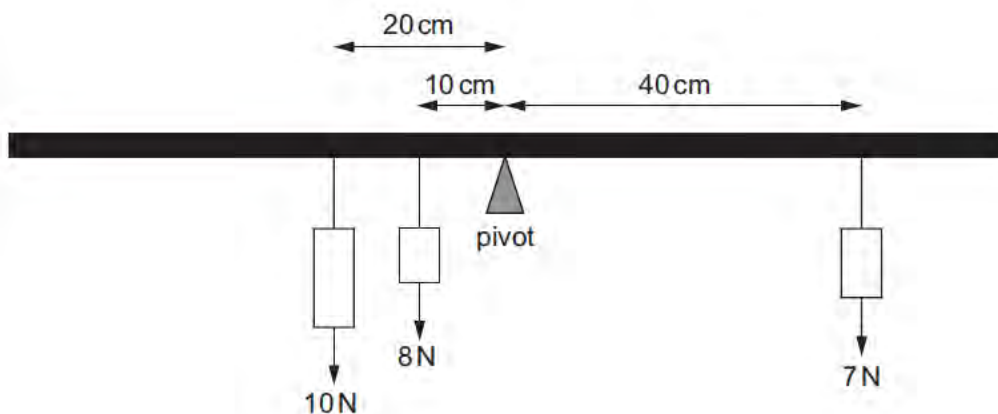
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(vi) Use your graph to explain whether further readings should have been taken in this experiment. [2]

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(b) The metre rule shown below is supported at its midpoint. A student suggests that it is balanced. Use the principle of moments to investigate this claim. [3]



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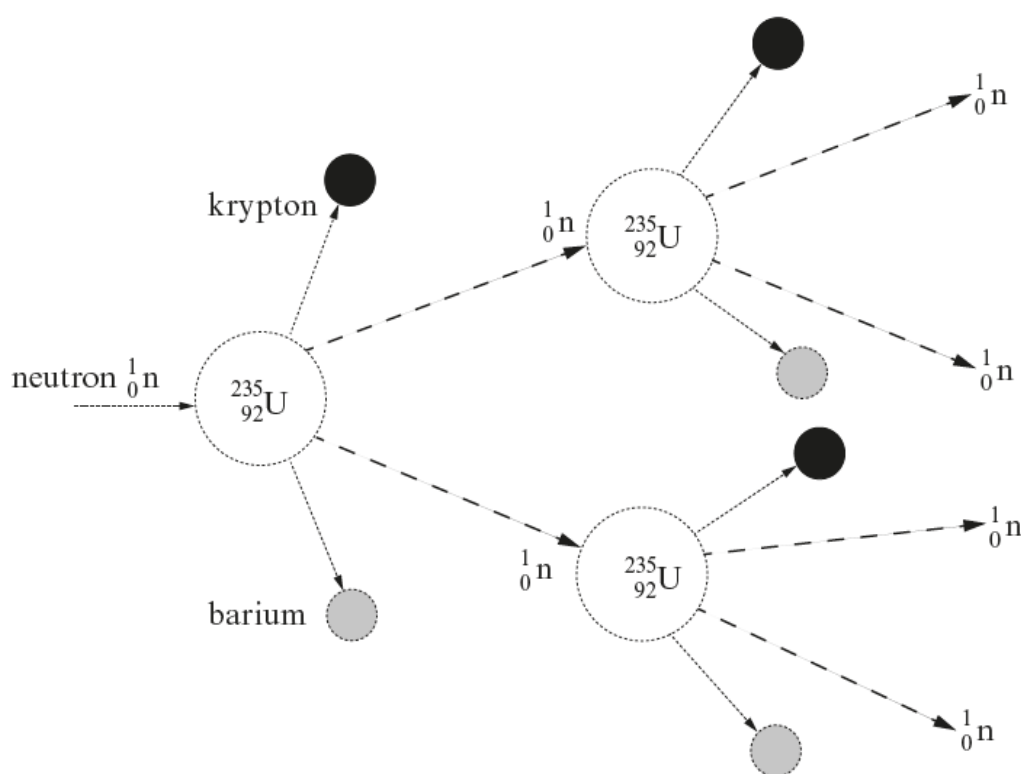
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6. (a) Underline the word or phrase in brackets to complete each sentence about nuclear reactors. [3]
- (i) The function of the moderator is to (**slow down the neutrons** / provide channels for the cooling gas / speed up the reaction).
 - (ii) The function of the control rods is to (**absorb neutrons** / provide channels for the cooling gas / contain the fuel rods).
 - (iii) The function of the steel and concrete container is to (**stop a nuclear explosion** / absorb radiation / contain the plasma).
- (b) The following nuclear reaction can take place in a nuclear reactor. Use the diagram to help you answer the questions that follow.



- (i) Write down the name of this type of reaction. [1]

- (ii) Name **one** waste product of this reaction. [1]

(c) Give **two** reasons why the safe storage of waste materials from nuclear reactors is controversial. [2]

1.

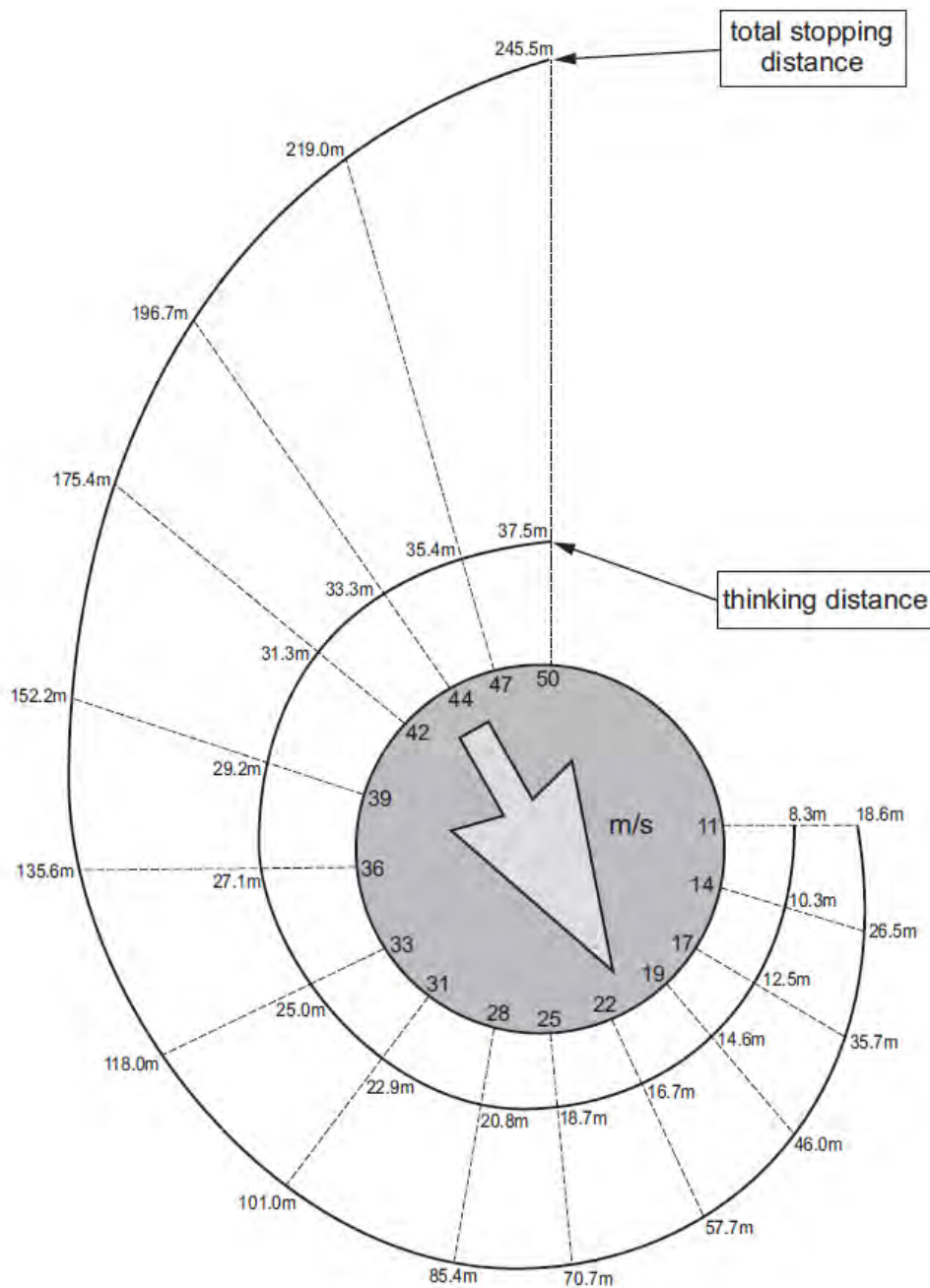
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7. The diagram below shows how the thinking distance (m) and total stopping distance (m) for a vehicle on a dry road and with good brakes depends on the vehicle's speed (m/s).



- (a) A car driver is travelling along a road when he sees a child step on to the road ahead. The driver's **thinking distance** is 10.3 m at a particular speed.
- (i) Use the diagram above to write down the speed of the car. [1]

speed =m/s

- (ii) Use the diagram to write down the total stopping distance for this speed. [1]

stopping distance = m

- (b) The car now travels at a speed of 25 m/s.

- (i) Use the equation:

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

to calculate the **thinking time** for the driver at this speed. [2]

thinking time = s

- (ii) Use information from the diagram to calculate the **braking distance** when the car travels at 25 m/s. [2]

braking distance = m

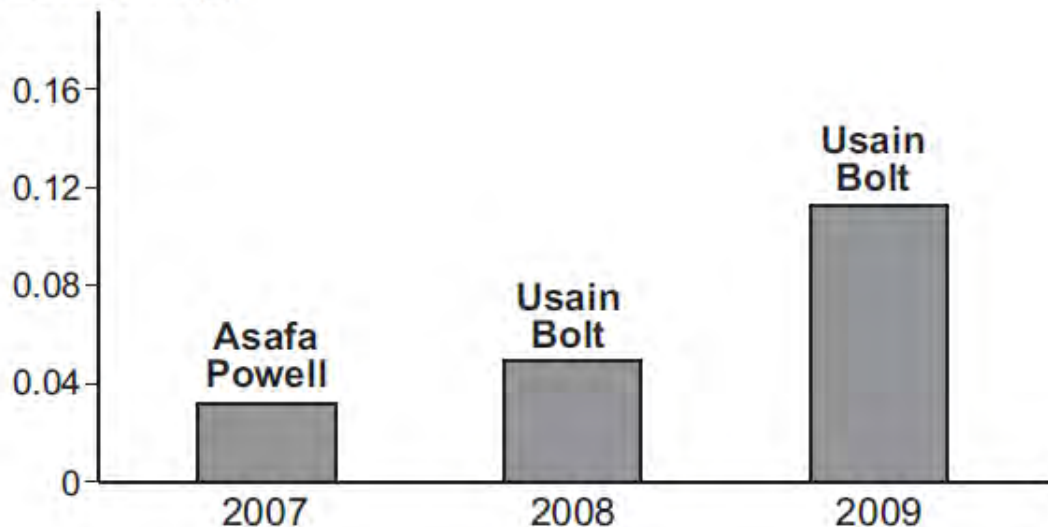
- (c) (i) State one factor that would increase the **braking distance**. [1]

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- (ii) **Draw on the diagram** on page 84 a line to show how the **thinking distance** changes for a driver who has been drinking alcohol. [1]

8. Usain Bolt was born in Jamaica in August 1986 and is the fastest man alive. He has run the 100 m in record breaking times as shown in the following chart of world record breakers since 2006.

reduction in time
for 100 m sprint (s)



Though good running form is useful in increasing speed, fast and slow runners have been shown to move their legs at nearly the same rate – it is the force exerted by the leg on the ground that separates fast sprinters from slow. Top short-distance runners exert as much as four times their body weight on the running surface. For this reason, muscle mass in the legs, relative to total body weight, is a key factor in achieving a high speed.

Usain Bolt reached his top speed of 12.4 m/s at 60 m and only maintained it for 20 m in the Berlin world championships' 100 m race.

The following list shows the top times achieved in a 100 m race in the 10 years up to 2015.

Year	Athlete	Time (s)
2005	Asafa Powell	9.77
2006	Asafa Powell	9.77
2007	Asafa Powell	9.74
2008	Usain Bolt	9.69
2009	Usain Bolt	9.58
2010	Tyson Gay	9.78
2011	Usain Bolt	9.76
2012	Usain Bolt	9.63
2013	Usain Bolt	9.77
2014	Justin Gatlin	9.77
2015	Justin Gatlin	9.74

(Source: IAAF)

After the Berlin race of 2009, Bolt made the following statement following his world record time of 9.58 s.

“When I clocked 9.72 seconds to set the world 100 m record in New York (May 2008), I knew I could do better; when I ran 9.69 to win gold at the Olympics, I knew there was a lot more to come; and now, having run 9.58 in Berlin, I believe I can go even faster.”

- (a) What is the total time that Usain Bolt has improved on Asafa Powell’s world record of 2007? [1]

time = s

- (b) Use an equation from page 2 to calculate Usain Bolt’s mean speed when he ran his final record time. Give the unit of speed with your answer. [3]

mean speed =
unit =

- (c) Explain why top sprinters need to be physically strong. [2]

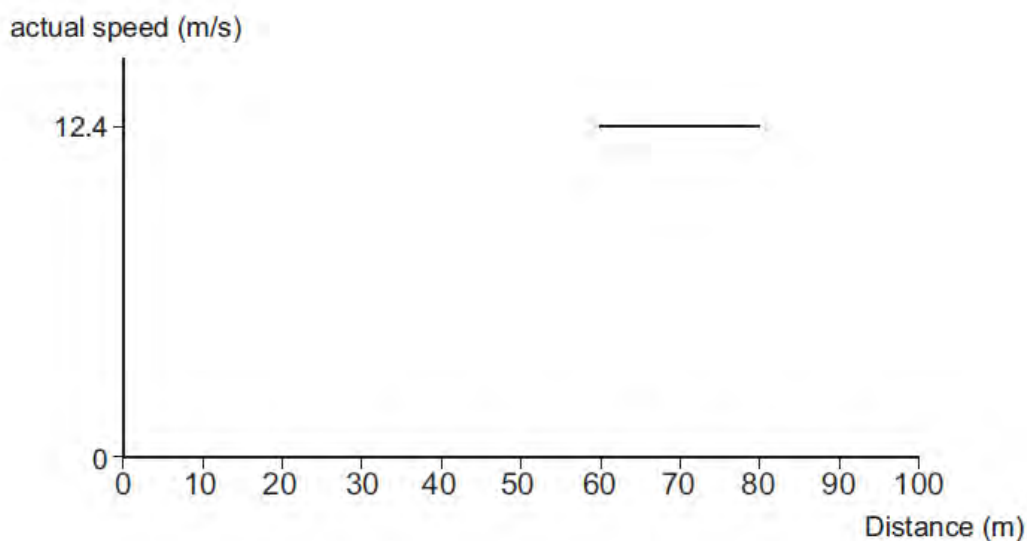
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- (d) The graph below shows part of the race in which Bolt set the fastest time ever for the 100 m sprint in the Berlin world championships in 2009.

Draw lines before and after the one shown to show how you think his speed would have changed over the 100 m distance. [3]



9. (a) Explain the motion of a cricket ball that is hit high in to the air by a batsman and falls to a fielder. [3]

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- (b) A cricketer catches and stops a ball of mass 0.16 kg which is moving at a speed of 40 m/s.



- (i) Use the equation:
- momentum = mass × velocity
- to calculate the change in momentum of the ball. [2]

momentum change = kg m/s

- (ii) Use an equation from page 2 to calculate the force applied by the cricketer if the ball is stopped in 0.4 seconds. [2]

force = N

- (iii) If the cricketer halves the time taken to stop the ball, state the size of the force. [1]

force = N

- (c) Using the ideas involved in this question, state what advice you would give a parachutist when landing and explain the physics behind your answer. [3]

Advice:

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Physics behind the advice:

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