Surname	Centre Number	Candidate Number
Other Names		0

GCSE

3430UF0-1

S19-3430UF0-1

WEDNESDAY, 22 MAY 2019 – AFTERNOON

SCIENCE (Double Award)

Unit 6 – PHYSICS 2
HIGHER TIER

1 hour 15 minutes

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**15**	
2.	**10**	
3.	**9**	
4.	**13**	
5.	**13**	
Total	**60**	

3430UF01 01

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. 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 continuation page 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 **3*(a)***.

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	
distance travelled = area under a velocity-time graph	
resultant force = mass × acceleration	$F = ma$
weight = mass × gravitational field strength	$W = mg$
work = force × distance	$W = Fd$
kinetic energy = $\frac{\text{mass} \times \text{velocity}^2}{2}$	$\text{KE} = \frac{1}{2} mv^2$
change in potential energy = mass × gravitational field strength × change in height	$\text{PE} = mgh$
force = spring constant × extension	$F = kx$
work done in stretching = area under a force-extension graph	$W = \frac{1}{2} Fx$

SI multipliers

Prefix	Multiplier
p	1×10^{-12}
n	1×10^{-9}
μ	1×10^{-6}
m	1×10^{-3}

Prefix	Multiplier
k	1×10^{3}
M	1×10^{6}
G	1×10^{9}
T	1×10^{12}

Examiner only

Answer **all** *questions.*

1. *(a)* Pupils in a class were given 200 coins to use in an experiment to simulate radioactive decay.
They were asked to shake the coins in a bag, throw them out on the table then remove those showing “heads”. The number removed were counted and recorded in a table.
The remainder of the coins were put back in the bag and the process was repeated again and again.
Their results are shown in the table below.

Throw number	Total number of coins removed	Number of coins remaining
0	0	200
1	104	96
2	149	51
3	....	26
4	....	20
5	....	6
6	....	4

(i) **Complete the table.** [1]

(ii) After two throws, the number of coins remaining was 51. How many coins would you have **expected** to remain? [1]

....

(iii) After how many throws would the number of remaining coins fall to about **one eighth** of the original number? [1]

....

(b) Carbon-14 is a radioactive form of carbon that is present in all living material. Each nucleus of carbon-14 undergoes radioactive decay by emitting a beta particle to form nitrogen-14 according to the following decay equation, which is incomplete.

$$^{14}_{6}\mathrm{C} \longrightarrow {}^{\dots\dots}_{\dots\dots}\mathrm{N} + {}^{0}_{-1}\mathrm{e}$$

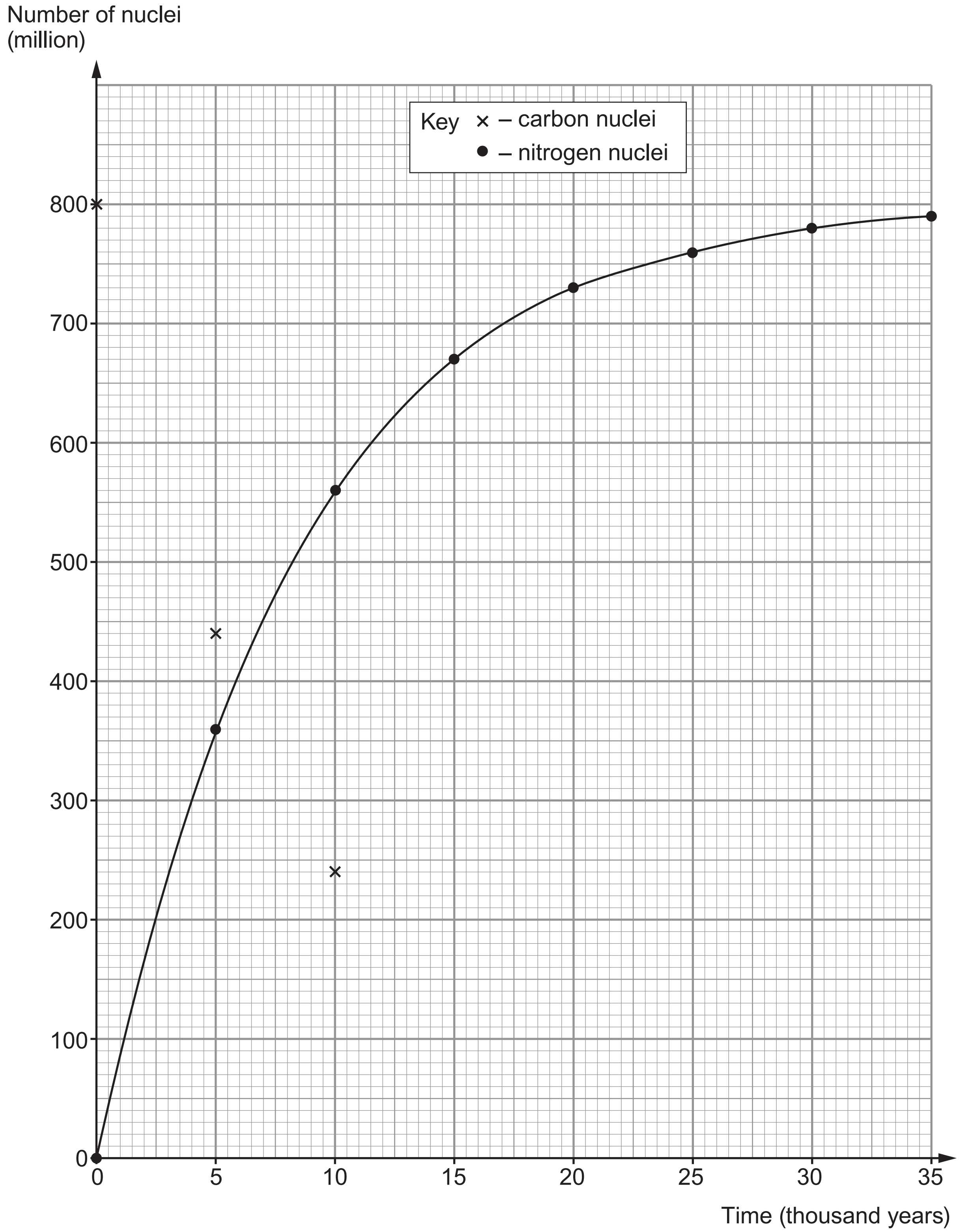
Complete the nuclear equation above. [2]

3430UF01 03

 (3430UF0-1) **Turn over.**

Examiner only

(c) A sample of 800 million carbon nuclei decays to create nuclei of nitrogen. The decrease in the sample creates an **increase** in the number of nuclei of nitrogen according to the following graph.



Examiner only

(i) **Complete the following table.** [2]

Time (thousand years)	Total number of nuclei (million)	Number of nitrogen nuclei (million)	Number of carbon nuclei (million)
0	800	0	800
5	....	360	440
10	....	560	240
15	....	670	....
20	....	730	....
25	....	760	....
30	....	780	....
35	....	790	....

3430UF01 05

(ii) On the grid opposite, plot points showing the **decay** of the carbon-14 nuclei. The first three crosses showing the numbers of carbon nuclei have been plotted for you.
Draw a suitable line. [3]

(d) (i) State the meaning of "the half-life" of a radioactive substance. [2]

....

....

....

(ii) Use the graph to determine the half-life of carbon-14. [1]

Half-life = ... thousand years

Examiner only

(e) Carbon dating is used to find the age of some ancient objects because carbon-14 is present in all once-living material. The process has been used to identify the age of the Turin shroud. This is a sheet of cloth that was claimed to be about 2000 years old. Three independent radiocarbon dating tests, carried out recently, attempted to identify the age of the cloth.

Out of **80 million** carbon-14 nuclei which were present in each sample of the original cloth, around 6 million have decayed into nitrogen. Use this information to explain whether the claim about its age is correct. [2]

....

....

....

....

15

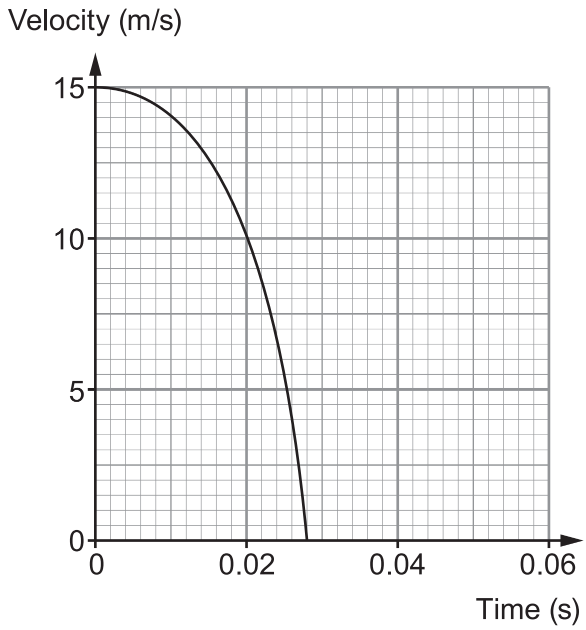
BLANK PAGE

PLEASE DO NOT WRITE
ON THIS PAGE

Examiner only

2. The safety of car drivers and passengers in the event of a collision has been the subject of an enormous amount of research in the last 50 years. As a result, the design of cars has developed to improve the safety of the occupants in the event of a head-on collision.

A crash dummy is positioned in the driving seat of a car, which is directed, under test conditions, into a solid concrete wall. The graph below shows the velocity of the dummy from the moment the car makes contact with the wall.



(a) State Newton's third law of motion and explain how it applies to the car and the wall in this collision. [3]

....

....

....

....

....

....

Examiner only

(b) (i) Use the graph opposite and equations from page 2 to calculate the mean resultant force on the dummy of mass 85 kg during the collision.
Give your answer to two significant figures. [3]

Mean resultant force = ... N

(ii) Use the graph opposite to explain whether the resultant force is constant during the collision. [2]

....

....

....

....

(c) Explain, **in terms of the work done**, how a crumple zone at the front of the car would improve the safety of the driver in a head-on collision. [2]

....

....

....

....

3430UF01
09

10

Examiner only

3. *(a)* Explain, in terms of forces and nuclear fusion, the life cycle of a high-mass star, from its position on the main sequence to its "death". [6 QER]

(b) The number of planets in our Solar System totals eight.
Briefly outline the difference between the structure of the inner and outer four planets and explain how they originated. [3]

9

Examiner only

4. Nuclear waste materials give out alpha, beta and gamma radiations and are classified according to their level of activity. They fall into three groups as follows:

Group	Information
Low level waste	Contain relatively low levels of activity and consist of alpha emitters and low activity beta and gamma emitters.
Intermediate level waste	Have higher levels of activity than low level waste but are not as dangerous as high level waste.
High level waste	Produce a significant temperature rise as a result of their high activity. This has to be considered when planning waste storage or disposal methods.

(a) Outline the dangers to people's health from each of alpha, beta and gamma radiations from sources that are external to the body. [3]

....

....

....

....

....

....

Examiner only

(b) Low level waste can, after some basic treatment, be dumped in approved local authority sites. However, intermediate and high level wastes pose a much larger threat to life. They must be stored or disposed of in a way that keeps them well away from life forms for a very long time, typically tens of thousands of years or more.

The table below gives some data about four countries that generate significant amounts of high level waste from nuclear power stations.

<table>
<tr><th>Country</th><th>U.K.</th><th>Sweden</th><th>U.S.A.</th><th>France</th></tr>
<tr><td>Land area (km^2)</td><td>241 930</td><td>407 310</td><td>9 147 420</td><td>547 557</td></tr>
<tr><td>Population</td><td>65 637 240</td><td>9 903 120</td><td>323 127 510</td><td>66 689 000</td></tr>
<tr><td>Mean population per km^2</td><td>271.7</td><td>24.3</td><td>35.3</td><td>121.8</td></tr>
<tr><td>Number of nuclear reactors</td><td>15</td><td>8</td><td>99</td><td>58</td></tr>
<tr><td>Volume of low level waste in storage (m^3)</td><td>30 100</td><td rowspan="3">No information available</td><td>52 800</td><td>87 000</td></tr>
<tr><td>Volume of intermediate level waste in storage (m^3)</td><td>99 000</td><td rowspan="2">416 060</td><td>40 000</td></tr>
<tr><td>Volume of high level waste in storage (m^3)</td><td>1960</td><td>2 700</td></tr>
</table>

(i) A person has suggested that for the U.K. and France, the volume of low level waste increases in proportion to the number of nuclear reactors in the country. Explain whether the suggestion is valid. [2]

Space for calculations.

....

....

Examiner only

(ii) Sweden, U.S.A. and France are well advanced in their planning for the long term storage of intermediate and high level wastes in deep underground storage facilities.

In 2010, the scientific director of the French authority for the long term storage of nuclear waste visited the U.S.A. storage site at Yucca Valley. Following his visit, he made the statement "There are far better sites in the U.S.A. than at Yucca mountain. When I went to the top of Yucca mountain and saw the volcanoes below, that worried me".
The development of the Yucca site has been stopped since around that time despite the spending of $10 billion on two decades of work. The Americans are still investigating an alternative site to Yucca Valley.

I. Explain the reason for concern over the choice of the Yucca Valley for the long term storage of nuclear waste. [2]

....

....

....

....

II. Use information in the table opposite to suggest a reason why a country such as the U.K. finds it difficult to agree on a site for a deep storage facility. [2]

....

....

....

....

(iii) The U.K. opened the world's first nuclear power station in 1956 in Calder Hall in Windscale amidst claims that, in the future, electricity would be free. The present view is that, with everything taken into account, electricity production from nuclear fuel is unacceptably expensive. Explain why there has been a change of view. [2]

....

....

....

....

(iv) Discuss an advantage and a disadvantage of **one** option, other than deep underground storage, for the long term disposal of dangerous nuclear waste. [2]

....

....

....

....

13

Examiner only

5. Springs are used in a wide variety of applications, ranging from those used in the suspension systems of heavy vehicles to those used in retracting ball-point pens.

The table below shows the properties of a number of springs that are available from a particular supplier.

Spring	Coil diameter (mm)	Wire diameter (mm)	Maximum load (N)	Unstretched length (mm)	Spring constant (N/mm)	Maximum length (mm)
A	16.00	0.165	1.252	6.350	0.17	13.716
B	16.00	0.165	1.031	6.350	0.14	13.716
C	16.00	0.165		6.350	0.12	17.050
D	16.00	0.165	1.257	9.524	0.09	23.495
E	16.00	0.230	1.768	7.950	0.24	14.016
F	16.00	0.230	1.524	7.950	0.12	20.650

(a) (i) Write down the spring that can withstand a maximum load of at least 1.2 N and has a maximum extension close to 14 mm. [1]

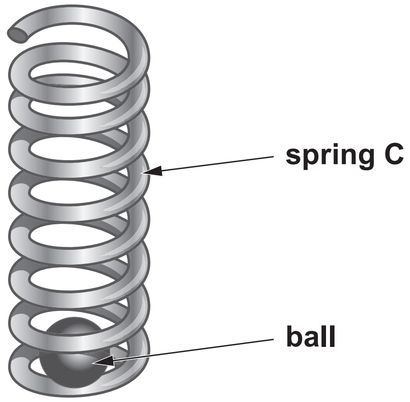
Spring = ...

(ii) Express the spring constant for **spring A** in standard units of N/m. [1]

Spring constant, k = ... N/m

Examiner only

(b) A group of students want to use a spring to project a small ball vertically upwards. They choose to use **spring C**. The bottom of their spring would hold the ball within it and the top of the spring would be fixed in position.
The bottom of the spring would be pulled down and released to project the ball vertically upwards.



(i) Use equations from page 2 to calculate the energy stored in the spring when it is stretched to its maximum length. [3]

Stored energy = ... J

(ii) Use an equation from page 2 to calculate the maximum theoretical height that the ball would reach given that its mass is 15 grams. [3]
(g = 10 N/kg)

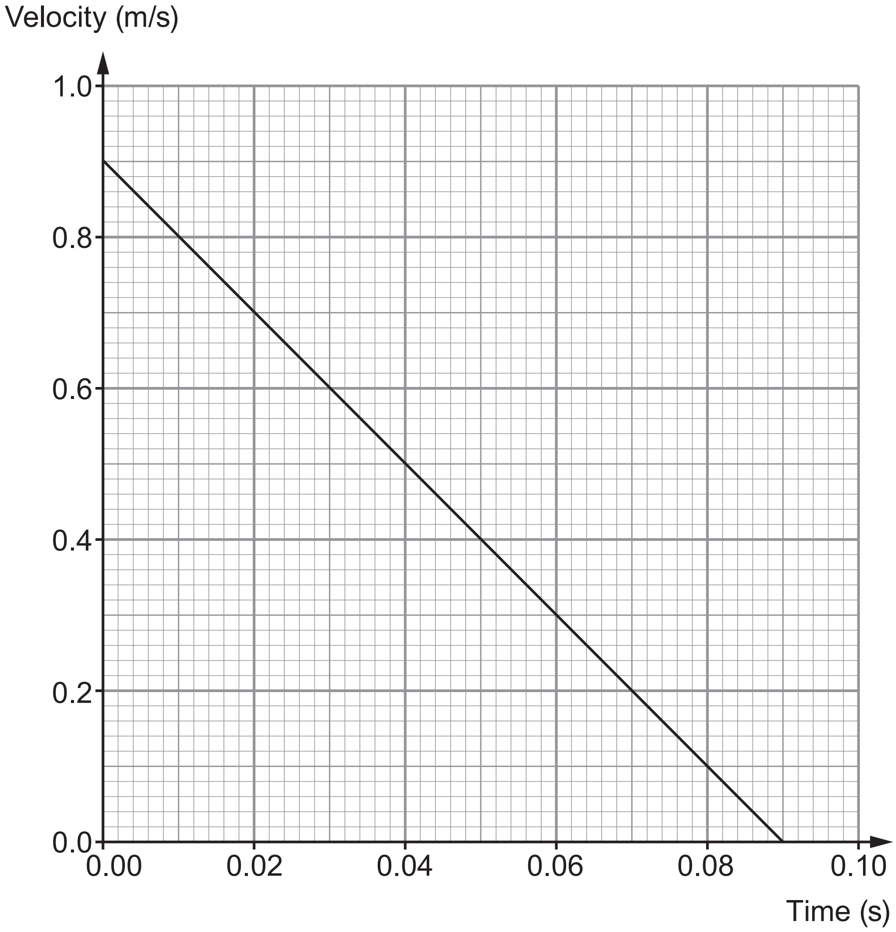
Height = ... m

THIS QUESTION CONTINUES ON PAGE 16

 (3430UF0-1) **Turn over.**

Examiner only

(iii) A data logger is then used to monitor the motion of the ball as it rises from the spring. A graph is automatically produced showing how the velocity of the ball changes with time. The graph is shown below.



I. One student states that the height reached by the ball is different from that which you have calculated in *(b)*(ii). Show that this statement is true. [2]
Space for calculation.

....

Examiner only

II. Explain why the height reached by the ball is different from the theoretical height. [2]

....

....

....

III. Suggest **one** change that could be made that would enable a ball to reach a greater height in this experiment. [1]

....

....

13

END OF PAPER

BLANK PAGE

PLEASE DO NOT WRITE ON THIS PAGE

Question number	Additional page, if required. Write the question number(s) in the left-hand margin.

Examiner only

BLANK PAGE

PLEASE DO NOT WRITE
ON THIS PAGE