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GCSE

SCIENCE (Double Award)

**UNIT 6: (Double Award) PHYSICS 2
HIGHER TIER**

SAMPLE ASSESSMENT MATERIALS

(1 hour 15 minutes)

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	15	
2.	11	
3.	9	
4.	17	
5.	8	
Total	60	

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

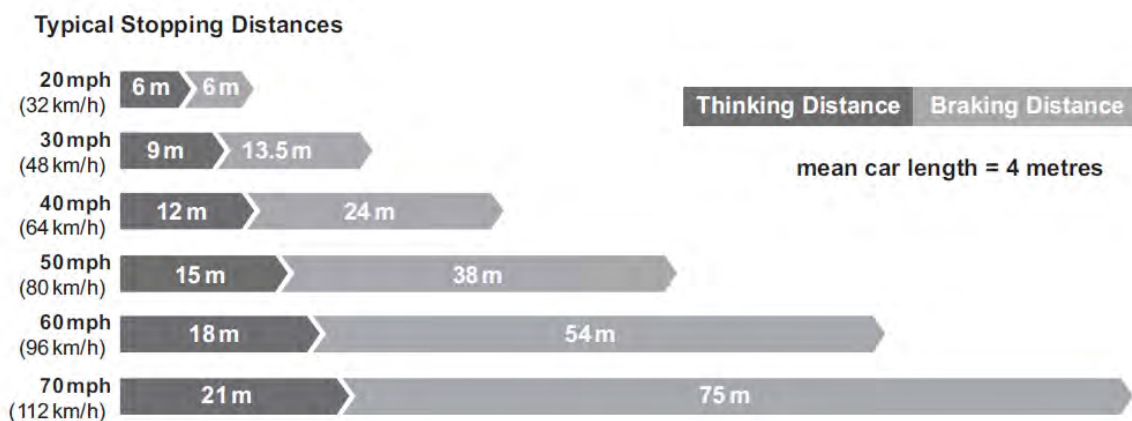
Answer **all** questions

1. Read the information below then answer the questions that follow.

Speed is a critical factor in all road traffic accidents (RTA). Driving is unpredictable and if something unexpected happens on the road ahead – such as a child stepping out from between parked cars – it is a driver's speed that will determine whether they can stop in time, and if they can't stop - the size of the impact force.

Hence reducing and managing traffic speeds is crucial to road safety. It has been estimated that for every 1 mph reduction in mean speeds, RTA rates fall by an average of 5%. Breaking the speed limit or travelling too fast for the road conditions is recorded as a contributory factor in more than one in four (28%) serious RTAs in the UK. Research has found that British drivers who regularly exceed the speed limit are nearly twice as likely to have been involved in a RTA.

Stopping distances include the distance travelled while the driver notices a hazard and applies the brakes (thinking distance), and while the vehicle comes to a full stop from its initial speed (braking distance). Typical minimum stopping distances for cars are shown below.



Source: Department for Transport, 2007

Technology such as anti-lock brakes and stability control are designed to enable greater control over the vehicle, not shorten stopping distances. There may be a very small reduction in braking distance with modern technology, but not enough to significantly affect overall stopping distance. Technology such as air bags is designed to reduce the harm to passengers in the event of a RTA. Whatever technology a vehicle has, the basic fact remains that the bigger the speed, the longer the stopping distance, and the less chance of stopping in time in an emergency.

Adapted from: <http://www.brake.org.uk/news/15-facts-a-resources/facts/1255-speed>

- (a) Read the following statements and tick (✓) the boxes next to the correct statements. [2]

A speed limit of 30 mph indicates that it is **always** safe to travel
at 30 mph in that area

Cars always have a braking distance of 24 m at 40 mph

Travelling twice as fast always doubles the thinking distance

The typical minimum overall stopping distance at 50 mph is
53 m

- (b) Explain in practice why actual stopping distances may differ from the minimum distances shown on the diagram. [3]

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- (c) Describe the relationship between speed and braking distance shown in the diagram. [2]

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- (d) Using the patterns shown in the data, calculate the overall stopping distance at 80 mph. [3]

stopping distance = m

- (e) (i) The text suggests that air bags reduce the harm to passengers in the event of an accident. Explain how they do this. [2]

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- (ii) Name another safety feature of cars other than air bags. [1]

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- (f) The text states that: "It has been estimated that for every 1 mph reduction in mean speed, crash rates fall by an average of 5%." Suggest measures that are taken to encourage people to drive more slowly. [2]

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2. A class of students used 50, 6-sided dice to model radioactive decay. Each of 8 groups gathered data which were added together to give the class results shown in the table below.

(a) Describe the method each group used to collect data. [3]

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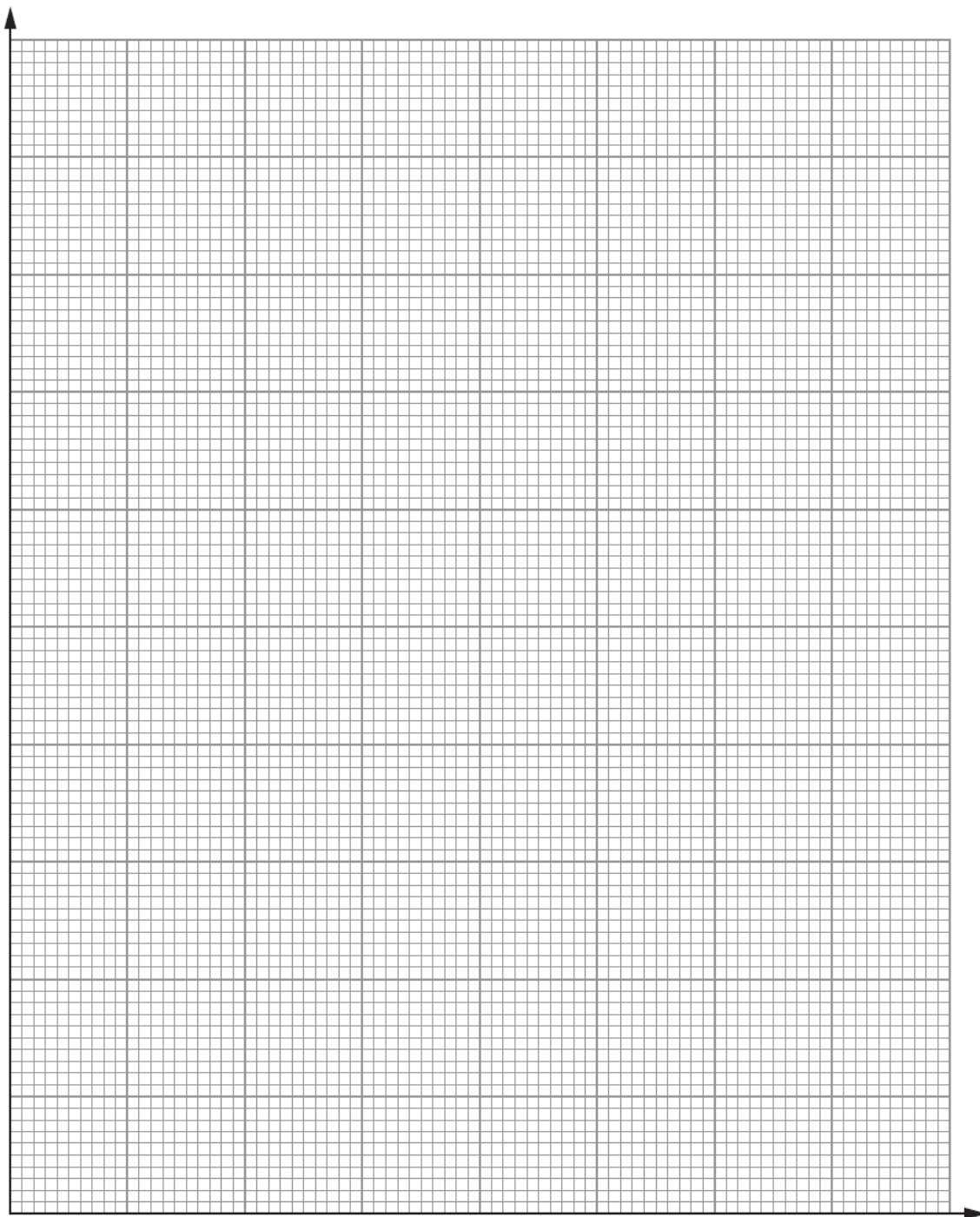
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The table shows the class results.

Number of rolls	Number of dice remaining
0	400
1	335
2	281
3	230
4	245
5	163
6	135
7	108
8	92

- (b) Plot a graph of the data on the grid below. [3]

Number of dice remaining



Number of rolls

- (c) (i) The experiment is modelling the process of radioactive decay. Which important quantity relating to radioactive decay can be estimated from the graph? [1]

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(ii) Use your graph to estimate this quantity. [2]

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(d) Explain how the results would be different if 12 sided dice were used instead. [2]

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3. Zeta Puppis is a main sequence blue star in the constellation of Puppis, also known by the traditional name Naos. It is the 62nd brightest star visible from the Earth and is approximately 1 090 light years away. It has a surface temperature of 42 400 °C and mass 22.5 times that of the Sun. This means that it will use up its fuel much more quickly than the Sun and move away from the main sequence.

(a) Describe and explain the remaining observable stages in the life cycle of the star Zeta Puppis. [6 QER]

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(b) Describe the formation of our solar system. [3]

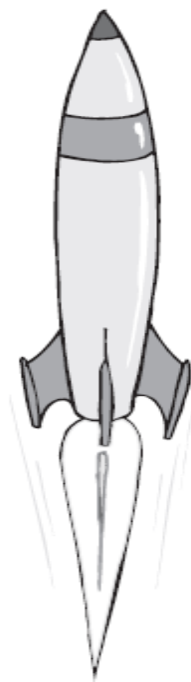
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4. A bottle rocket contains water and air which has been pressurised. When launched the air pushes water out of the bottle.



A rocket of total mass 0.5 kg is launched vertically.
(Gravitational field strength = 10 N/kg.)

- (a) (i) State Newton's third law. [2]

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- (ii) Explain how Newton's third law applies to the rocket. [2]

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- (b) At 1 m above the ground all the water has left the rocket. At this point the rocket has 5 J of potential energy and a velocity of 22 m/s. Use equations from page 2 to calculate the maximum height that could be reached by the rocket. Show your workings clearly. [5]

height = m

- (c) Explain why the rocket will not actually reach the height calculated in (b). [2]

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- (d) The initial acceleration of the rocket is 4 m/s^2 .

- (i) Use Newton's second law to calculate the initial resultant force acting on the rocket. [3]

initial resultant force = N

- (ii) Calculate the size of the initial thrust force. [2]

initial thrust force = N

- (iii) A student suggests that the resultant force increases as the rocket gains height. Give a reason why. [1]

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5. Read the information below then answer the questions that follow:

Dimitri Mendeleev predicted the existence of an element with atomic number 43 in 1871. Element 43, now known as technetium, was actually discovered in 1937. Technetium is the element in the periodic table with the lowest atomic number which has no stable isotopes. Technetium-99 is one isotope of technetium which has a half-life of 2.11×10^5 years. It decays by 'soft' beta decay – the electrons emitted are low energy electrons. Technetium-99m is a form of technetium which is used as a radioactive tracer; it decays to technetium-99 by gamma emission with a half-life of 6 hours. A patient is injected with the isotope and when a technetium-99m nucleus decays it emits gamma radiation which is easily detected outside the body. This technique is used to tell us about the function of parts of the body such as the heart, liver and lungs.

- (a) (i) State the number of protons in a nucleus of technetium. [1]

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- (ii) Two types of radioactive decay are mentioned in the text. Name the other type of radioactive decay and state what it is. [2]

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- (iii) The initial activity of a sample of technetium-99m is 5×10^4 Bq. Calculate the activity remaining after 2.5 days. [3]

activity = Bq

- (b) The isotope of technetium with the longest half-life is technetium-98. It has a half-life of 4.2 million years. In 1952 technetium-98 was detected in red giant stars [which are billions of years old]. Explain how the discovery of technetium-98 in these stars added support to the theory that heavier elements are produced within stars. [2]

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