

PHYSICS



EXAM QUESTION PACK

P8.1 PHYSICS ON THE MOVE

SCORE

/110

PERCENTAGE

%

STEMUP

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Gateway Physics A (9-1)

Physics on the move

Please note that you may see slight differences between this paper and the original.

Candidates answer on the Question paper.

OCR supplied materials:

Additional resources may be supplied with this paper.

Other materials required:

- Pencil
- Ruler (cm/mm)

Duration: Not set

Candidate
forename

Candidate
surname

Centre number

Candidate number

INSTRUCTIONS TO CANDIDATES

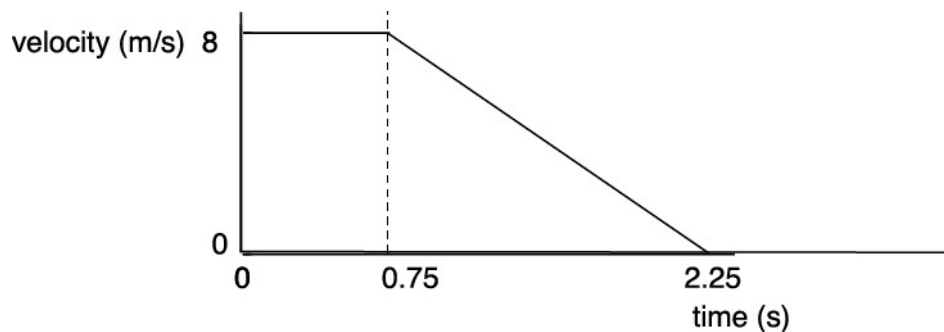
- Write your name, centre number and candidate number in the boxes above. Please write clearly and in capital letters.
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions, unless your teacher tells you otherwise.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Where space is provided below the question, please write your answer there.
- You may use additional paper, or a specific Answer sheet if one is provided, but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

- The quality of written communication is assessed in questions marked with either a pencil or an asterisk. In History and Geography a *Quality of extended response* question is marked with an asterisk, while a pencil is used for questions in which *Spelling, punctuation and grammar and the use of specialist terminology* is assessed.
- The number of marks is given in brackets [] at the end of each question or part question.
- The total number of marks for this paper is **110**.
- The total number of marks may take into account some 'either/or' question choices.

- 1 A car takes 6 m to brake when moving at 8 m/s.

Look at the graph of the car as it starts to brake and then stopping.



Use the graph to show that the braking distance is 6 m.

----- [2]

- 2 Jin drives her car at a steady speed.

Look at the situations in which she drives her car along a straight road at 60 km/hr.

- A with one passenger.
- B with one passenger and towing a caravan.
- C with one passenger and a roof rack on the car.
- D with one passenger and a cycle rack attached to the back of the car.

Which situation will give her the best fuel consumption?

Choose from A B C D

answer -----

[1]

- 3 The table shows the stopping distances for a car.

Speed of car (m/s)	Thinking distance (m)	Braking distance (m)	Total stopping distance (m)
4	3	1.5	4.5
8	6	6	12
16	12	24	36
32	24		

Use the data given to fill in the information missing at a speed of 32 m/s.

[2]

4 Look at the information about thinking distance and braking distance for cars travelling at 13 m/s.

Driver	Thinking distance in metres	Braking distance in metres
Sam	9	14
Chris	9	25
Jo	15	14
Ben	7	10

One of the drivers is tired after driving for several hours.

Suggest which driver is tired.

answer _____

Explain fully why you chose this driver.

One of the drivers was driving on an icy road.

Suggest which driver was driving on an icy road.

answer _____

Explain fully why you chose this driver.

[2]

5 A car is fitted with seatbelts.

Write about the risks and benefits of wearing a seat belt when travelling in a car.

[2]

6 Very old cars did not have seat belts.

The first seat belts were only fastened across the lap of the driver.

Modern seat belts pass over the shoulder and lap of all passengers.

This is one example of how the design of seat belts has been developed for cars.

Describe how scientists could collect data to compare and improve the design of seat belts.

----- [2]

7(a) There are other safety features in modern cars that reduce injuries. They work in a similar way to seat belts.

Write down two **other** safety features of modern cars that work in a similar way to seat belts.

1

2

[1]

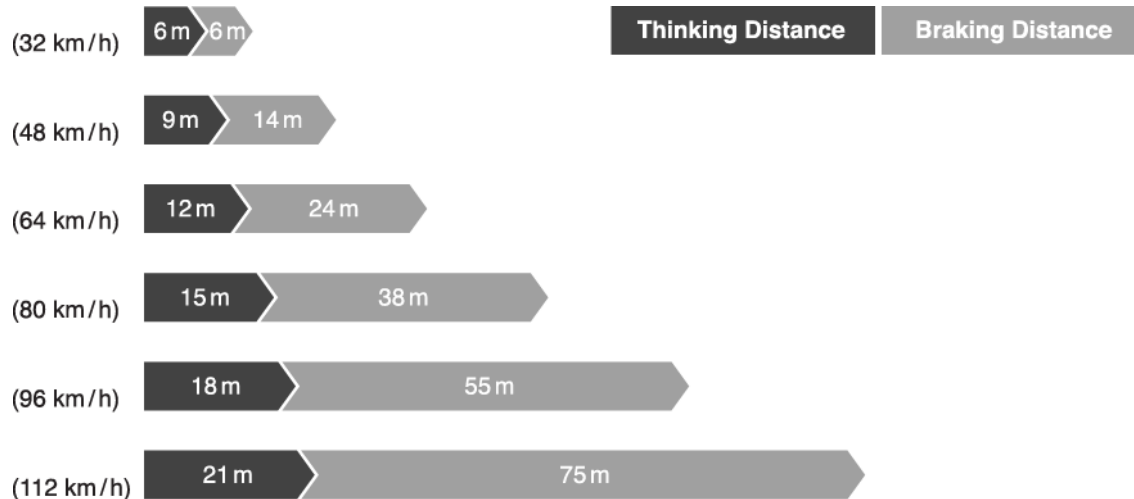
(b) Seat belts reduce injuries in a crash.

Explain how.

----- [2]

(c)

(i) Look at the data about stopping distances.



Ben says that “doubling the driving speed doubles the thinking distance”.

Chloe says “so, if I double the speed of my car, this will double the stopping distance”.

Is Chloe correct?

Explain your answer.

 ----- [2]

(ii) One factor which increases the **braking** distance of the car is higher speed.

Write down two other factors that increase braking distance.

1

 2

 [1]

8 Very old cars did not have seat belts.

The first seat belts were only fastened across the lap of the driver.

Modern seat belts pass over the shoulder and lap of all passengers.

This is one example of how the design of seat belts has been developed for cars.

Describe how scientists could collect data to compare and improve the design of seat belts.

----- [2]

9(a) Seat belts reduce injury by absorbing energy when the car stops suddenly.

Write about other safety features that absorb energy when the car stops suddenly.

----- [2]

(b) The seat belt exerts a force on the passenger when a car is stopping.

This force causes a change in momentum of the passenger.

Look at the table for four different passengers when their car stops.

Passenger	Change in momentum of passenger in kg m/s	Passenger stopping time in seconds
A	1440	4
B	1224	2
C	1200	3
D	1000	1

Which passenger experiences the greatest force from their seat belt?

Choose from: A B C D

answer _____

[1]

10 Look at the information about thinking distance and braking distance for cars travelling at 13 m/s.

Driver	Thinking distance in metres	Braking distance in metres
Sam	9	14
Chris	9	25
Jo	15	14
Ben	7	10

One of the drivers is tired after driving for several hours.

Suggest which driver is tired.

answer

Explain fully why you chose this driver .

One of the drivers was driving on an icy road.

Suggest which driver was driving on an icy road.

answer

Explain fully why you chose this driver.

[2]

11(a) Different factors can **increase** the thinking distance and the braking distance of a car.

(i) Write down one factor that increases **thinking distance**.

-----[1]

(ii) Write down one factor that increases **braking distance**.

-----[1]

(b) Explain what this warning means.

“you are driving inside the thinking distance of the car in front”

-----[1]

- 12 A car accelerates from 0 to 60 mph (miles per hour) in about 9 seconds.

Use the relationship: $1 \text{ m/s} = 2.24 \text{ mph}$

Estimate the acceleration for this car in m/s^2 .

- A 1 m/s^2
- B 3 m/s^2
- C 7 m/s^2
- D 15 m/s^2

Your answer

[1]

- 13 A student measures the time it takes for a bicycle to stop in an emergency.

She repeats the measurement to get three results.

The average time for her results is 2.72 s.

The first two results are 2.66 s and 2.60 s.

What is the value of her third result?

- A 2.63 s
- B 2.66 s
- C 2.72 s
- D 2.90 s

Your answer

[1]

- 14 An adult on a bicycle travels at 8 m/s on a level road. She sees a hazard and applies her brakes using full force.

Estimate the force of the brakes.

- A 5 N
- B 50 N
- C 500 N
- D 5000 N

Your answer

[1]

- 15(a) A scientist uses different drivers to test the stopping distances of the same car.

Look at the results.

Driver	Speed (m/s)	Thinking distance (m)	Braking distance (m)
A	8	6	6
B	16	13	24
C	32	24	96
D	16	12	22
E	8	5	6
F	32	30	120

Most of the drivers tested the car on a dry day, on a level road.

Which driver tested the car on an icy road?

Driver tested the car on an icy road.

[1]

(b) Which driver has the **quickest** reaction time?

Driver has the **quickest** reaction time.

Calculate their reaction time.

Answer = ... s [3]

(c) Give two drivers that have the **same** reaction time.

Drivers have the **same** reaction time.

Explain your answer.

.....

.....

..... [2]

(d) Driver **B** travels at 16 m/s on the road. The thinking distance is 13 m and the braking distance is 24 m.

Driver **B** now drives the car **uphill** at the same speed on the same road.

How will driving the car **uphill** affect thinking, braking and stopping distances?

The reaction time will stay the same.

Complete the sentences.

The **thinking distance** will -----

The **braking distance** will -----

The **stopping distance** will -----

[2]

16 Estimate the typical cruising speed of a jet airliner.

- A 25 m/s
- B 250 m/s
- C 2 500 m/s
- D 25 000 m/s

Your answer ☐

[1]

17 A student experiments with a model parachute and collects some results.

She drops the parachute from a height of 4 m three times and takes three results of the time taken.

The three results are:

3.25 s

3.00 s

3.08 s

What is the mean of the three results?

A 3.00 s

B 3.08 s

C 3.11 s

D 3.25 s

Your answer

[1]

18 Fig. 20.1 shows thinking, braking and stopping distances for the same car travelling at different speeds.

Speed (m/s)	Thinking distance (m)	Braking distance (m)	Stopping distance (m)
8	6	6	12
16	12	24	36
32	24	96	120

Fig. 20.1

Calculate the reaction time of the person driving the car.

Answer = ----- s [3]

Seatbelts in cars are made of a wide material that stretches in a crash.



(i) Explain why it is important that the material is **wide**.

----- [1]

(ii) Explain why it is important that the material is **stretchy**.

----- [1]

20 This question is about force, mass and acceleration.

A car starts from rest and accelerates at 3 m/s^2 .

Use the equation: Acceleration = Change in velocity $\div$ Time taken

Calculate the **velocity** of the car after 4 s.

Answer = ----- m/s [2]

Children in cars use special seats with their own seatbelts.



The seatbelts for children are narrower than adult seatbelts.

Why is it safe for children’s seatbelts to be **narrower** than adult seatbelts?

[2]

22 This question is about force, mass and acceleration.

A roller coaster car moves down a slope with an acceleration of 5 m/s².

The force on the roller coaster car is 4000 N.

Calculate the **mass** of the roller coaster car.

Answer = ----- kg [2]

23 A domestic wind turbine has a power rating which varies from 1.0 kW to 3.0 kW.

(i) The domestic wind turbine has an electrical resistance of 23 Ω .

It generates a current of 11 A on a windy day.

Calculate the **power** output in kW of the turbine on this day.

Answer = ----- kW [4]

(ii) Suggest why the manufacturer gives a range for the power rating of the wind turbine.

----- [1]

(iii) Using just **one** domestic wind turbine may be an unreliable source of power for a house.

State a reason why.

----- [1]

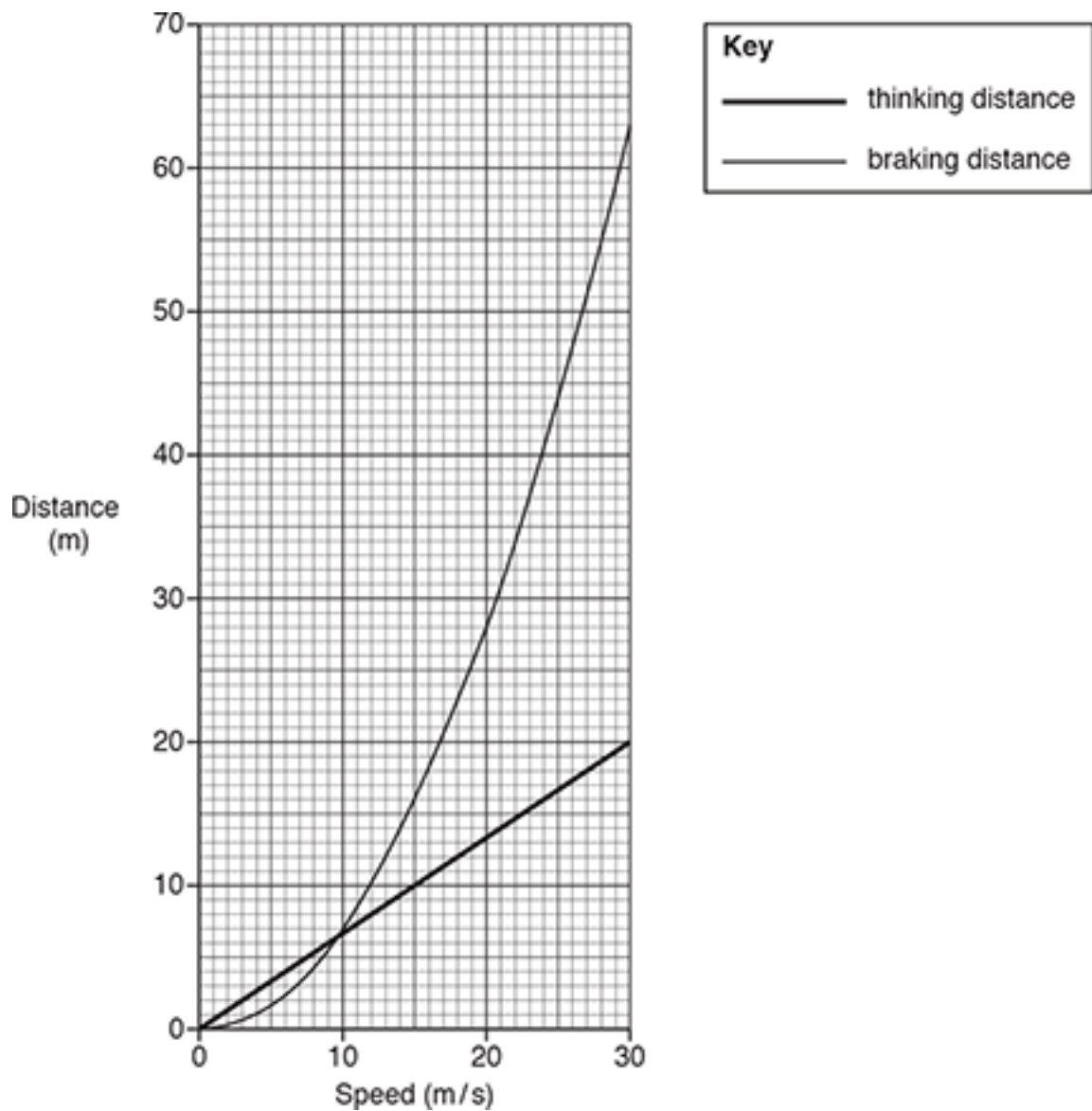
24 Which row in the table shows realistic speeds?

Speed (m / s)			
	Road cyclist	Gale force wind	Sound in air
A	40	12	1000
B	6	24	340
C	20	6	760
D	15	55	250

Your answer

[1]

25(a) The graph shows thinking and braking distances for a car at different speeds.



Describe how **thinking distance** varies with increasing speed.

Use data from the graph in your answer.

[2]

(b)

- (i) Use the graph to find the **thinking distance** at 24 m / s.

Thinking distance = ... m [1]

- (ii) Calculate the **thinking time** at 24 m / s.

Use your answer to (i) and the equation: distance travelled = speed $\times$ time

Give your answer to 2 decimal places.

Thinking time = ... s [3]

(c)

- (i) State **one** factor that could **increase** thinking distance.

----- [1]

- (ii) Calculate the **stopping distance** at 15 m / s.

Use the graph to help you.

Stopping distance = ... m [2]

(d) How does the speed affect the kinetic energy and braking distance of the car?

Use the graph in your answer.

[3]

26(a) Fig. 21.1 is a speed-time graph for car P.

The driver of car P reacts to a traffic light at time = 0.00 s, then presses the brakes at time = 0.50 s.

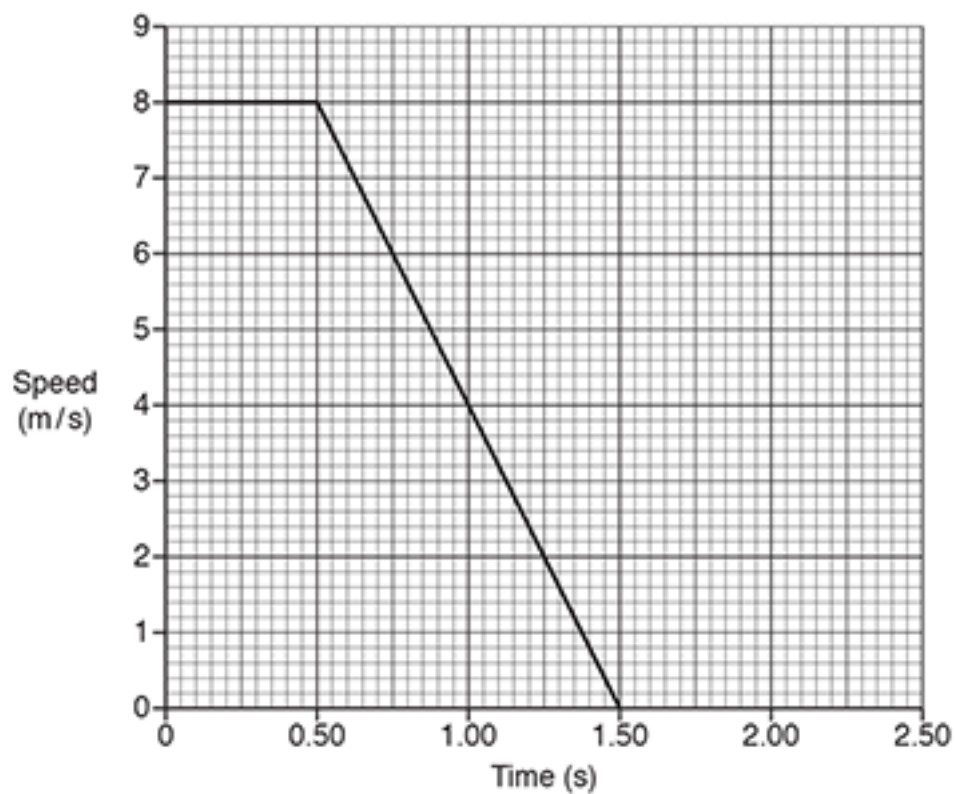


Fig. 21.1

- (i) The braking distance is the same size as the thinking distance.

Explain how the graph in Fig. 21.1 shows this.

[1]

- (ii) Add another line to the graph in Fig. 21.1 to show the journey of car Q.

- Car Q is travelling at 8 m / s.
- The driver of car Q reacts, then presses the brakes after 0.75 s.
- Car Q decelerates at the same rate as car P.

[2]

- (b) Driver **P** measures the reaction time of driver **Q** using a 30 cm ruler.

Driver **P** drops a 30 cm ruler vertically and driver **Q** catches it.

- (i) Explain how the ruler can be used to estimate reaction time.

----- [1]

- (ii) State **one** precaution they can use to get accurate results.

----- [1]

- (c) In the brakes of a car there are brake pads and a brake disc, as shown in Fig. 21.2.

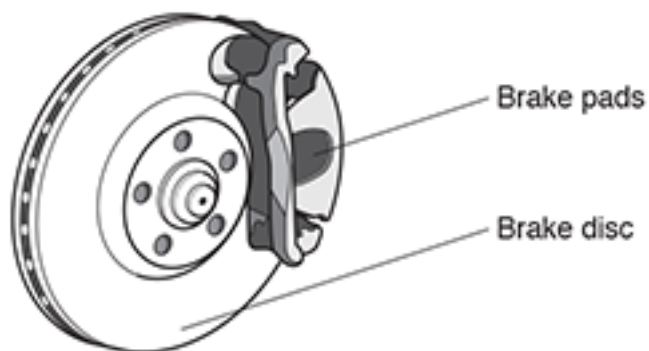


Fig. 21.2

When a car stops, energy transfers between stores.

The brake pads squeeze the brake disc and cause a friction force.

- (i) Explain how braking stops the car.

Include ideas about **energy stores** in your answer.

[2]

(ii) High speed cars have ventilated brakes with air holes in the disc, as shown in Fig. 21.3.

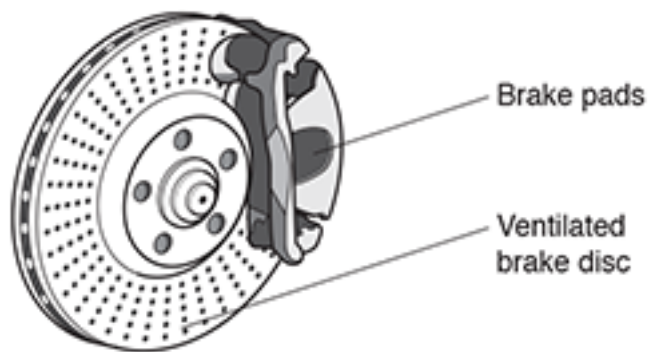


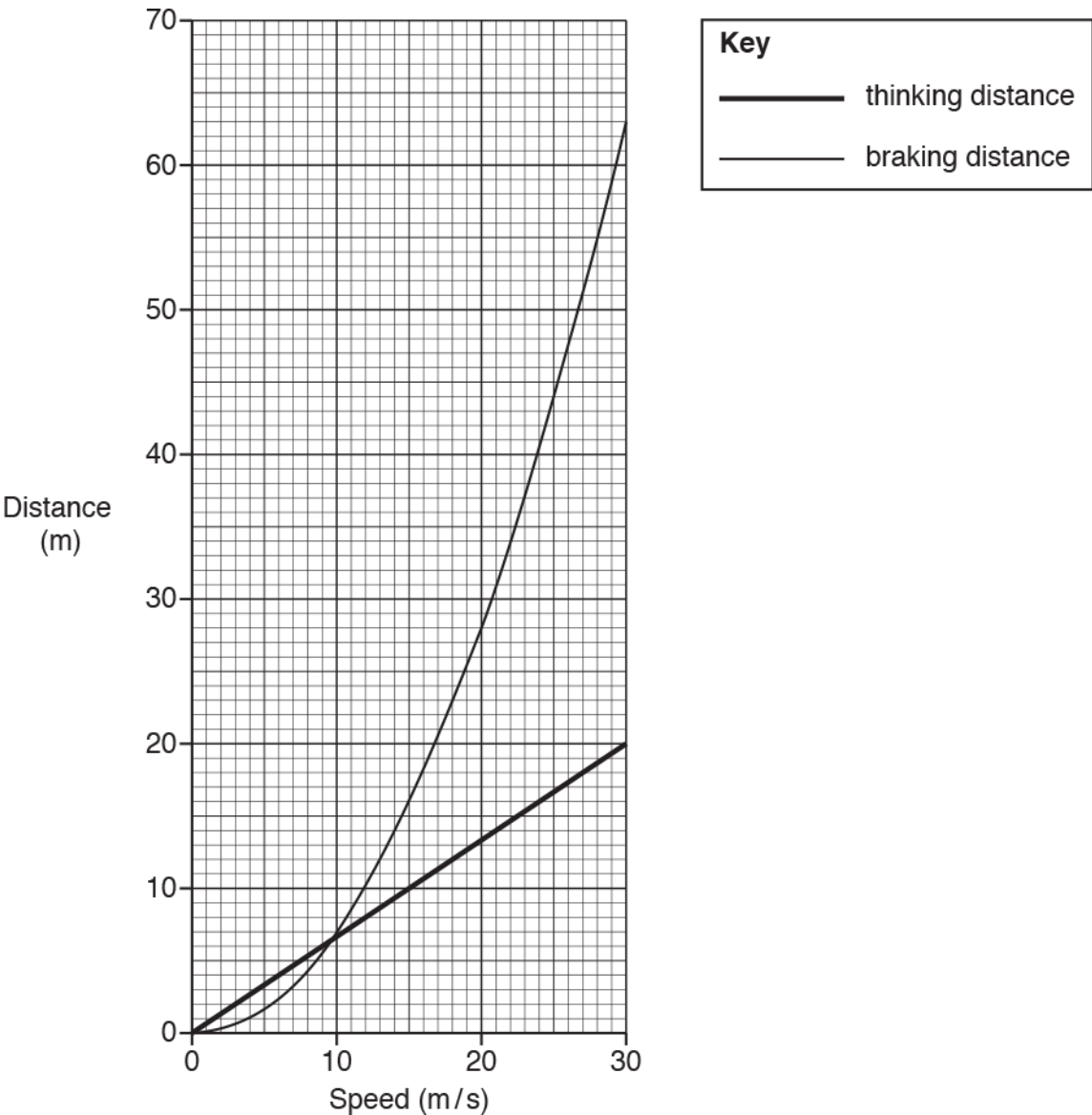
Fig. 21.3

The air holes allow more air to circulate around the disc.

Suggest how these brakes can reduce braking distances.

[1]

27(a) The graph shows thinking and braking distances for a car at different speeds.



(i) Use the graph to find the **thinking distance** at 24 m / s.

Thinking distance = ... m [1]

(ii) Calculate the **thinking time** at 24 m / s.

Use your answer to (i) and the equation: distance travelled = speed × time

Give your answer to 2 decimal places.

Thinking Time = ... s [3]

(b)

(i) State **one** factor that could **increase** thinking distance.

----- [1]

(ii) Calculate the **stopping distance** at 15 m / s.

Use the graph to help you.

Stopping distance = ... m [2]

(c) How does the speed affect the **kinetic energy** and **braking distance** of the car?

Use the graph in your answer.

----- [3]

28 A car travels at a speed of 60 mph (miles per hour).

1 mph = 0.45 m / s.

Convert 60 mph into m / s (metres per second).

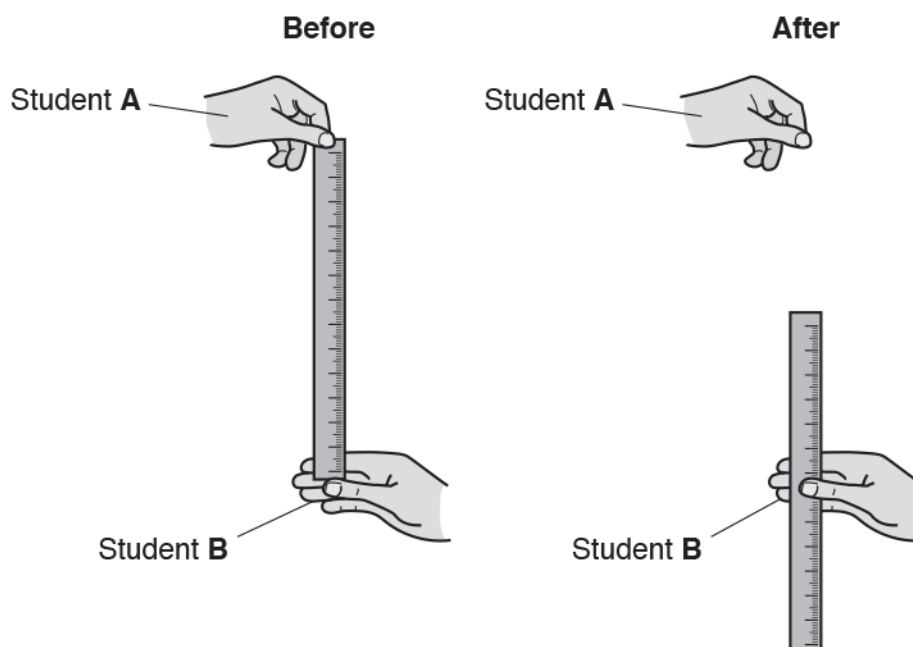
- A 0.45 m / s
- B 7.5 m / s
- C 27 m / s
- D 130 m / s

Your answer

[1]

29(a)

The diagram shows a ruler being used to estimate a student's reaction time.



(i) Describe how the ruler can be used to estimate student B's reaction time.

[2]

(ii) Why do the students repeat the experiment several times?

[1]

(iii) Student **B** is very tired when they try this experiment.

Suggest how this might affect student **B**'s reaction time.

[1]

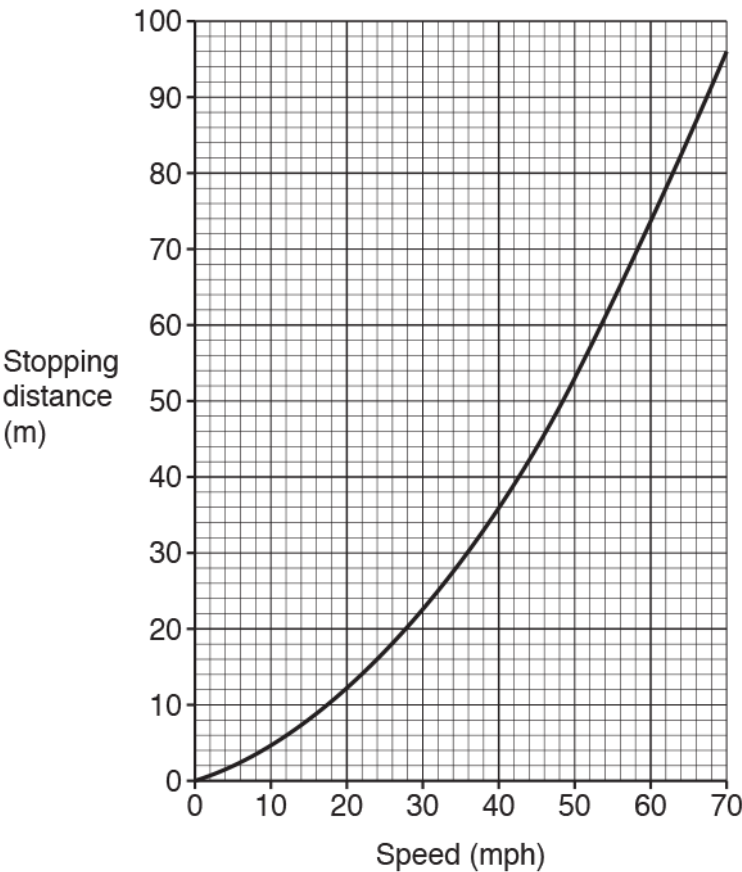
(b) The driver of a car makes an emergency stop.

The thinking distance is 9 m. The braking distance is 14 m.

(i) Calculate the total stopping distance of the car.

Stopping distance = ... m [1]

(ii) This graph shows how this driver's stopping distance changes with speed.



- A car is travelling at 50 mph.
- There is a barrier in the road 40 m in front of the car.

- The driver makes an emergency stop.

Use the graph to work out if the car hits the barrier.

Explain how you obtained your answer.

----- [2]

- (iii) State one factor, other than speed, that affects braking distance.

Explain how this factor changes braking distance.

Factor -----

Explanation -----

[3]

(c)

- (i) A car travels at a speed of 13 m / s. The car takes 4 s to stop after the brakes are applied.

Calculate the deceleration of the car.

Use the equation: acceleration = change in velocity ÷ time

Deceleration = ...m / s² [3]

- (ii) The braking system of the car in (i) is changed. The same car travelling at 13 m / s now takes 0.4 s to stop after the brakes are applied.

The driver says, 'The new braking system is ten times safer.'

Do you agree with the driver? Explain your answer.

Yes ☐

No ☐

----- [2]

- (iii) Suggest **one** safety feature in a car that can reduce injury in a crash.

----- [1]

30 A car travels at a speed of 70 mph (miles per hour).

1 mile is approximately 1600 metres.

Convert 70 mph into m / s (metres per second).

- A 2.6 m / s
- B 31 m / s
- C 112 m / s
- D 160 m / s

Your answer

[1]

END OF QUESTION PAPER

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																
1			Correct reference or attempt to use area under sloping part of graph (1) $\frac{8 \times 1.5}{2} = 6 \text{ (1)}$	2	ALLOW full marks for correct calculation as this implies correct use of area under sloping part of graph.																
			Total	2																	
2			A (1)	1	mark answer on line first allow answer ringed, underlined or ticked if no answer on the answer line <u>Examiner's Comments</u> The majority of candidates correctly identified A as the situation with the best fuel consumption.																
			Total	1																	
3			<table><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td></td><td></td><td></td><td></td></tr><tr><td>(32)</td><td>24</td><td>96 (1)</td><td>120 (1)</td></tr></table>													(32)	24	96 (1)	120 (1)	2	
(32)	24	96 (1)	120 (1)																		
			Total	2																	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
4			Jo (no mark) idea that Jo will have the longest thinking time / distance (1) Chris (no mark) largest braking distance / less friction, grip or traction (1)	2	answer must be Jo to score the mark for the explanation allow slowest reaction [1] Not slowest time or slowest reaction time answer must be Chris to score the mark for the explanation if no marks scored allow Jo (for tired) and Chris (for icy) (1) <u>Examiner's Comments</u> This question was answered well by the majority of candidates who realised that tiredness would increase the thinking distance and that slippery conditions would increase the braking distance.
			Total	2	
5			any two from risks could cause bruising / break ribs / friction burn / cut (1) could trap passenger (1) benefits holds passenger in seat / AW (1) reduces injury or named injury (1)	2	not just causes injury, injury must be stated eg. whiplash / choking <u>Examiner's Comments</u> About 90% of candidates gave correct answers as to the benefits and risks of using seat belts.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
6			Maximum of one for: compare injuries from (a variety of) crashes / compare effects on crash dummies / measure force / acceleration / stretch / momentum [1] for different materials / seatbelts [1] for different people [1] for different speeds [1] for seat positions [1]	2	eg. different types of seatbelt [1] old design of belt compared with new designs [1] lap belt compared to 3-point belt [1] eg. sizes Examiner's Comments This question was about car safety features. This question was common with the foundation paper (B751-01). Poor communication and use of English prevented many from scoring 2. Many said 'look at' accidents / tests but did not say what to do. Also common was 'with and without' seatbelts rather than different types of belt – e.g. Shoulder belt v lap belt or different materials for belts [1].
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
7	a		crumple zones and air bags [1]	1	Allow collapsible steering column / collapsible bumpers Examiner's Comments Many correct, but ABS was also seen many times. Crumple zone / air-bag / collapsible steering wheel were the most common correct responses. Bumpers, safety cages, seatbelts and good tyres were often given as answers [0].
	b		they change shape / stretch / get longer [1] (and therefore) absorb energy [1]	2	allow reduce pressure by spreading force over a larger area [1] allow the KE of driver is converted into elastic (potential) energy in the seat belt [1] allow higher level answers referring to eg. increased time / distance [1] eg. reduced force / acceleration [1] eg. decreased rate of change of momentum [2] allow prevents impact with steering wheel, windscreen or dashboard [1] Examiner's Comments Only more able candidates tended to score [2] marks here. Many failed to say that seatbelts stretch. Common to see though was the belt preventing passengers hitting part of car — e.g. Windscreen or dashboard [1]. Often higher level answers such as seatbelts stretch giving a longer time or distance to stop [1] and a reduced acceleration and force [1] were also seen quite often.
	c	i	(no) (no mark) doubling speed increases stopping distance [1] but	2	If yes answered [0] marks

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		i	doubling speed more than doubles the braking / stopping distance [2]		Allow anything more than double the affect Eg. doubling speed triples / quadruples braking or stopping distance [2] Allow correct calculation and comparison of two stopping distances, e.g. at 32km/h, stopping distance = 12m & at 64km/h it is 36m [2] Examiner's Comments In this question candidates had to use the data in the chart to comment. It was quite well answered and the 'quadrupling' of breaking distance was often seen and understood. Most realised at least that the braking distance would increase [1]. Most however went on the gain the second mark also for more than doubling.
		ii		1	
		ii	bald tyres / smooth tyres / faulty brakes		Allow worn tyres / worn brakes
		ii	wet road / ice on road		Allow reduced friction surface / slippery road [1] Ignore bad weather / tyre condition / road conditions
		ii	more load in car		Ignore merely mass / weight / number of passengers But allow more mass / weight / passengers
		ii	increased gradient / downhill [1]		Examiner's Comments In this question many failed to score because they did not specify the condition clearly. Commonly seen was 'the road condition' or 'the tyre condition' but did not say for example 'wet road' or 'bald tyres'. Often answers did not achieve the mark for this as they did not answer the question correctly by referring to things that <i>affected</i> the braking distance rather than things that <i>increased</i> it. As both answers were needed for the single mark this tended to reduce success on this simple recall question.
			Total	6	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
8			Maximum of one for: compare injuries from (a variety of) crashes / compare effects on crash dummies / measure force / acceleration / stretch / momentum [1] and maximum of one from for different materials / seatbelts [1] for different people [1] for different speeds [1] for seat positions [1]	2	Marking points are independent eg. different types of seatbelt [1] old design of belt compared with new designs [1] lap belt compared to 3-point belt [1] eg. sizes <u>Examiner's Comments</u> Most candidates correctly suggested dummies being used in crashes with different types of seat belts, which scored full marks.
			Total	2	
9	a		any two from crumple zones [1] air bags [1] collapsible steering wheel [1] side impact bars [1]	2	<u>Examiner's Comments</u> There were 2 marks for this question, but a large proportion of candidates were happy to give only one answer. To score full marks any two from crumple zones (often described as crumple zones – which was accepted), air bags or collapsible steering columns were needed.
	b		D [1]	1	allow correct answer circled, ticked or underlined if no answer on the answer line <u>Examiner's Comments</u> Tested the idea of force = rate of change in momentum. About half the candidates answered the question successfully.
			Total	4	

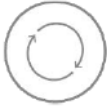
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
10			Jo (no mark) idea that Jo will have the longest thinking time / distance (1) Chris (no mark) largest braking distance / less friction, grip or traction (1)	2	answer must be Jo to score the mark for the explanation allow slowest reaction [1] NOT slowest time / slowest reaction time answer must be Chris to score the mark for the explanation if no marks scored allow Jo (for tired) and Chris (for icy) (1) <u>Examiner's Comments</u> The first question on section C module P1 was about speed and has 10 marks in total. This question on stopping distances was answered well with most gaining the 2 marks.
			Total	2	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
11	a	i	any one from: driver tiredness (1) influence of alcohol / drugs (1) greater speed (1) distractions (1) lack of concentration (1)	1	not just speed allow named distractions, e.g. radio / talking / mobile phone
		ii	any one from: wet / icy / slippery road conditions (1) worn brakes (1) worn / poor tyres (1) greater speed (1)	1	Not merely 'road conditions' Allow poor road conditions (1) allow poor brakes (1) not merely 'condition of brakes' not merely quality / condition of tyre not just speed Allow high speed (1) Allow more mass / heavier car (1)
	b		(Idea that) there is not enough reaction time or enough thinking distance to stop the car / AW (1)	1	Allow you will crash before you have reacted (1) Allow not (even) enough time to start braking (1) Ignore there is not enough time to think ignore 'you will crash' / 'you are too close'
			Total	3	
12			B ✓	1 (AO1.1)	<u>Examiner's Comments</u> This question required candidates to recall and apply the equation: <i>acceleration = change in velocity ÷ time</i> as well as use the relationship provided to convert m/s into mph. Most candidates were able to do this successfully.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
13			D ✓	1 (AO1.2)	
			Total	1	
14			C ✓	1 (AO2.2)	<u>Examiner's Comments</u>  Many candidates struggled to estimate the force of the brakes, often incorrectly choosing distractor B. Those candidates who correctly choose distractor C were often seen to write down their estimated values of the mass and acceleration.  AfL Candidates would benefit from being provided with opportunities to estimate, the speed, accelerations and forces involved for everyday road transport.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
15	a		F ✓	1 (AO3.3a)	<u>Examiner's Comments</u> Almost all candidates were able to answer this correctly.
	b		E ✓ FIRST CHECK THE ANSWER ON THE ANSWER LINE If answer = 0.6 (s) award 2 marks $5 \div 8$ ✓ = 0.6 (s) ✓	3 (AO3.1a) (AO1.2) (AO2.2)	ALLOW 0.625 or 0.63 (s) <u>Examiner's Comments</u> Most candidates were able to identify that driver E had the quickest reaction time. Only the higher ability candidates were then able to correctly calculate the reaction time. Calculations were sometimes shown and a common error made by candidates when calculating the reaction time was to use (<i>thinking distance + braking distance</i>) $\div$ speed.
	c		Any two from: A, C or D ✓ Thinking distance / reaction time is proportional to speed / AW ✓	2 (AO3.2b) (AO3.2b)	ALLOW as speed doubles, thinking distance doubles / ratio of speed:distance or distance:speed is the same / both have reaction time of 0.75 (s) <u>Examiner's Comments</u> This question required candidates to identify two drivers from A, C and D and explain why their reaction times are the same. Over half of the candidates correctly identified two of the drivers. Most of these candidates proceeded to explain why, usually by calculating the reaction time of 0.75 s. A significant number of candidates did not gain any credit. A common error candidates made was to choose drivers A and E or B and D due to their braking distances being almost the same.

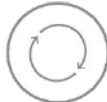
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
	d		(The thinking distance will) stay the same (The braking distance will) decrease (The stopping distance will) decrease All three correct ✓✓ Two correct ✓	2 (AO3.2b) (AO3.2b)	Examiner's Comments Higher ability candidates generally were credited with full marks for this question. However a third of the candidates did not provide any creditable response. .  AFL These 'thought experiment' type questions can be used as short starter activities to help students develop the habit of thinking about science. Candidates can also be encouraged to quickly sketch out the question. This can help candidates to visualise how the forces acting on the car have changed from moving along the flat road to moving uphill at a constant speed.
			Total	8	
16			B	1 (AO 1.1)	Examiner's Comments This question assessed P8.1a which includes the abilities to recall typical speeds of other transportation systems. Many candidates chose 2500 m/s (equivalent to 9000km/h), rather than 250 m/s, equivalent to 900 km/h (or about 560 mph). Candidates should have an idea of typical speeds of wind, sound as well as walking, running, cycling and other transportation systems such as trains.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance																				
17			C ✓	1 (AO 2.2)	Examiner's Comments Higher ability candidates added an extra column to the table to calculate the change in temperature. These candidates were also more likely to write down their workings, even for multiple choice questions. See exemplar 1 Exemplar 1 6 A student wants to find out which heater produces the largest temperature rise. Look at the results she collects and the calculations she makes. <table><tr><th>Heater</th><th>Starting temperature (°C)</th><th>Finishing temperature (°C)</th><th>Change in temperature (°C)</th></tr><tr><td>A</td><td>18</td><td>28</td><td>20</td></tr><tr><td>B</td><td>18</td><td>36</td><td>16</td></tr><tr><td>C</td><td>18</td><td>44</td><td>26</td></tr><tr><td>D</td><td>18</td><td>51</td><td>23</td></tr></table> Which heater has results that are correctly calculated? Your answer ☒ C	Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)	A	18	28	20	B	18	36	16	C	18	44	26	D	18	51	23
Heater	Starting temperature (°C)	Finishing temperature (°C)	Change in temperature (°C)																						
A	18	28	20																						
B	18	36	16																						
C	18	44	26																						
D	18	51	23																						
			Total	1																					
18			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.75 (s) award 3 marks Recall: (Reaction) time = (Thinking) distance ÷ Speed ✓ 6÷8 or 12÷16 or 24÷32 ✓ = 0.75 (s) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	IGNORE correct substitutions if NOT rearranged Examiner's Comments 10% of candidates recalled the speed equation and rearrange it as <i>reaction time = thinking distance ÷ speed</i>. The majority of the candidates were unable to interpret the data from the table and very few realised that the reaction time depended on the thinking distance before calculating the answer.																				
			Total	3																					

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
19		i	Reduces <u>pressure</u> / spreads the <u>force</u> / AW ✓	1 (AO 1.1)	Examiner's Comments Many candidates found it difficult to use appropriate technical language in their answers to this question (for example, force and pressure). Many candidates wrote vague responses such as 'it would cover more of the body' without explaining why this was important. Higher ability candidates used specific technical language such as 'reducing the pressure' or 'spreading the force'.  AfL The parts of a question form a story that develops a central theme. In part (a) looks at the pressure the car applies to the road, part (b) looks at the pressure that the force resulting from breaking applies to passengers, and part (c) applies this knowledge to the specific context of child safety seats. Where candidates follow these story lines, it helps them to improve the quality of their answers. However in (i) and (c) most candidates did not make the connection after they were asked to calculate pressure in (a).
		ii	Absorb energy (in a crash) ✓	1 (AO 1.1)	ALLOW higher level answers: eg. Reduces force / acceleration E.g. Increases time / distance to stop Examiner's Comments Higher ability candidates realised that the material was stretchy to absorb energy in a crash. Other responses referred to more generalised reasons such as allowing seatbelts 'to fit around different sized people.' Some candidates described the seat belt material as 'having a little give' or 'movement' without explicitly explain how this would increase time, reducing the rate of deceleration and thus the force exerted on the passenger.

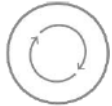
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
			Total	2	
20			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 12 (m/s) award 2 marks Rearrange formula - 4×3 ✓ 12 (m/s) ✓	2 (AO 2.1) (AO 2.1)	Examiner's Comments Higher ability candidates wrote out in a recognisable form that <i>change in velocity = acceleration × time</i> = $3 \times 4 = 12$ (m/s). A common misconception was to divide the acceleration by time taken (i.e. $3 \times 4 = 0.75$). Candidates should be encouraged to put the numbers into the given equation which will help them to identify if they will need to rearrange the formula.
			Total	2	
21			Mass / inertia of child is lower ✓ Less force is needed (for the same deceleration)✓	2 (AO 2.1) (AO 1.1)	ALLOW weight of child is lower/child is smaller Examiner's Comments Many candidates suggested that the narrower belts were needed because of child car seats are smaller.
			Total	2	
22			FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 800 (kg) award 3 marks Recall: force = mass × acceleration ✓ $4000 \div 5$ ✓ 800 (kg) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW 0.8 for two marks Examiner's Comments Some candidates divided their calculated answer by 1000 so that there answer was actually in tonnes rather than kilograms. Because the equation uses force in N and acceleration in m/s^2 the computed mass will be kilograms. Other candidates divided 4000 by 5^2 perhaps thinking that 5 m/s^2 implied it needed to be squared.
			Total	3	

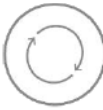
Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
23		i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 2.8 (kW) award 4 marks $(P =) I^2 \times R \checkmark$ $11 \times 11 \times 23$ or 112×23 or $121 \times 23 \checkmark$ $= 2783 \checkmark$ Conversion to kW = 2.8 (kW) $\checkmark$	4 (AO 1.2) (AO 2.1) (AO 2.1) (AO 2.1)	ALLOW 2.78 kW or 2.783 kW $\checkmark\checkmark\checkmark\checkmark$ ALLOW equation in any form ALLOW ecf candidates answer to 3rd marking point converted to kW Examiner's Comments Q23 is an overlap question with J249/04 and candidates found it very challenging with only a small number of the most able candidates being credited with any marks. From the stem of the question candidates knew that their answer needed to be between 1.0 kW and 3.0 kW. There were compensatory marks available where candidates wrote down the equation they were using and the different stages of their calculations. The most common workings shown were 11×23 or $23 \div 11$, rather than $112 \times 23 = 2.78\text{kW}$. .
		ii	Wind speed varies / AW $\checkmark$	1 (AO 2.1)	ALLOW it depends on the strength of the wind / how windy it is / AW IGNORE there might not be any wind / wind changes direction / AW Examiner's Comments Many candidates realised that the wind speed would vary, but most responses were vague statements about the 'weather'.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	(Idea of) not always enough wind / demand may exceed supply / AW ✓	1 (AO 2.1)	ALLOW (it) may not generate enough power / energy / AW <u>Examiner's Comments</u> Two thirds of the candidates reasoned that there may not be enough wind of the required speed or that a 3.0 kW wind turbine would not be sufficient to power a household.  AfL It is very important to show candidates how to focus their answers on the question that they are being asked. For example, this question was about whether 'just one wind turbine' could be a reliable source of power a house. However, many candidates answered a question about the impact of a domestic electrical supply failure, which would apply to any source of power to a house.
			Total	6	
24			B ✓	1 (AO 1.1)	<u>Examiner's Comments</u> Candidates are expected to be able to recall typical speeds such as cycling, wind and sound. Most candidates were able to do this successfully.
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
25	a		As speed increases, (thinking) distance increases / ORA ✓ BUT (thinking) distance is (directly) proportional to speed / as speed doubles, (thinking) distance doubles / linear relationship through the origin ✓✓	2 (AO 3.1a) (AO 3.2b)	ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10m but at 30 (m/s) td = 20(m). ALLOW numerical values from graph, e.g. at 15 (m/s), td = 10 (m) but at 30 (m/s) td = $2 \times 10 = 20$ (m) for 2 marks <u>Examiner's Comments</u> This AO3 question assessed candidates' ability to interpret the distance-speed graph and draw conclusions about how thinking distance varies with increasing speed. The question discriminated well. Most candidates were able to give a basic description that as speed increases, thinking distance increases but only the more able candidates were able to give a more detailed relationship, e.g. speed is proportional to thinking distance, for 2 marks.
	b	i	16 (m) ✓	1 (AO 3.1a)	
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.67 (s) award 3 marks Rearrangement to give Time = distance / speed ✓ Time = $16 / 24$ ✓ Time = 0.67 (s) (2 decimal places) ✓	3 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW ECF from (b)(i) ALLOW 0.6 or 0.7 or 0.66(6...) (s) for 2 marks ALLOW one mark for any calculated answer to 2dp <u>Examiner's Comments</u> There were many excellent responses for this question with the majority of candidates gaining full credit. A few candidates could not rearrange the equation correctly and therefore did not score any marks. About one fifth of candidates did not give their answers to 2 decimal places as requested.  AfL

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
					A number of candidates gave two possible versions of rearranging the equation leading to two different answers. Candidates should be aware that marks cannot be awarded when they do this, even if one of the versions is correct. Exemplar 1 (ii) Calculate the thinking time at 24 m/s. Use your answer to (b)(i) and the equation: distance travelled = speed × time Give your answer to <u>2 decimal places</u>. $\begin{aligned} \text{thinking time} &= \frac{\text{distance}}{\text{speed}} \\ &= \frac{16 \text{ m}}{24 \text{ m/s}} \\ &= 0.666... = 0.67 \\ \text{Thinking time} &= \dots\dots\dots 0.67 \dots\dots\dots \text{ s [3]} \end{aligned}$ This is an excellent example of how the response should be set out. The candidate has clearly rearranged the equation, before substituting the correct values for distance and speed and writing down the answer. This would allow compensatory marks to be awarded if the candidate had then made an error such as mis-entered numbers into the calculator. Finally, the candidate has underlined the instruction to give their answer to 2 decimal places so that they do not forget to do this.
	c	i	(Driver under influence of) alcohol / drugs / tired / (named) distraction / ill / <u>old</u> -age / intoxication / high(er) speed ✓	1 (AO 1.1)	IGNORE just age ALLOW increase in driver's reaction time <u>Examiner's Comments</u> Although the majority of candidates answered this question correctly, candidates should be aware that vague answers such as 'speed' or 'age' without any qualification will not gain credit.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 26 (m) award 2 marks (Stopping distance =) braking (distance) + thinking (distance) OR 16 OR 10 ✓ (sd =) 26 (m) ✓	2 (AO 2×2.2)	<u>Examiner's Comments</u> This question assessed candidates' ability to read the values of thinking distance and braking distance from the distance-speed graph. Most candidates scored 1 mark for reading at least 1 value correctly but many did not calculate the stopping distance by adding the thinking distance and braking distance together, with some multiplying or subtracting the values instead.
	d		Maximum 2 marks from: Higher speed increases braking distance ✓ BUT Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ Maximum 2 marks from: (Idea that) higher speed (car has) more KE ✓ BUT Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓✓	3 (AO 2.1) (AO 3.1x2) (AO 2.1) (AO 3.1x2)	ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 30 (m). ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 4×7.5 (= 30m) for 2 marks <u>Examiner's Comments</u> This question covered Assessment Objectives 2 and 3 and assessed candidates' ability to apply their knowledge of kinetic energy and braking distance as well as to interpret the graph. The majority of candidates scored 2 marks for linking a higher speed to increased kinetic energy and braking distance. Although some candidates recognised that the relationships were linked to a 'square factor' they could not express it clearly and therefore only the more able candidates gained full credit for recognising that speed is directly proportional to kinetic energy and/or braking distance.
			Total	12	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
26	a	i	Area (under line) for thinking (distance) is same as for braking (distance) / area under horizontal line = area under diagonal line / area of rectangle = area of triangle / AW ✓	1 (AO 3.1a)	ALLOW both areas show 4(m) <u>Examiner's Comments</u> This question was a good discriminator as only the more able candidates recognised that the braking distance and thinking distance could be calculated from the area under the graph and that both had the same value.
		ii	A line starting at (0.75, 8) ✓ Diagonal line drawn parallel to original line and finishing at the x axis ✓	2 (AO 2×1.2)	Mark independently
	b	i	(Idea of measuring) a length/distance on the ruler ✓	1 (AO 1.2)	<u>Examiner's Comments</u> The majority of candidates gave a correct response but it was also common to see incorrect explanations referring to using a stopwatch to time how long it took driver Q to catch the ruler.
		ii	Any one from: drop ruler from same height above hand ✓ (idea of) change the time taken before dropping the ruler each time ✓ make sure hand of catcher not moving / fingers are the same distance apart ✓	1 (AO 1.2)	ALLOW suitable answers that refer to reducing named random or systematic errors e.g. measure from same place on the ruler (relative to hand) ALLOW (idea of driver Q being) unaware of when ruler is being dropped ALLOW repeat and calculate mean
	c	i	(Store of) KE (in moving car) ✓ (transferred thermally) to (store of) thermal energy / heat (in brakes/pads/discs/tyres) ✓	2 (AO 2×2.1)	<u>Examiner's Comments</u> This question assessed candidates' ability to apply their knowledge of energy stores. Most candidates scored at least 1 mark for identifying either kinetic energy or thermal energy but it was generally only the more able candidates that identified both energy stores correctly.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	Any one from: (Idea of) heat dissipated/transferred (to air) more quickly ✓ KE is reduced more quickly ✓	1 (AO 2.1)	IGNORE to thermal energy of road/surroundings <u>Examiner's Comments</u> It was evident that most candidates found this question very challenging, with usually only the most able gaining 1 mark.
			Total	8	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
27	a	i	16 (m) ✓	1 (AO 3.1a)	<u>Examiner's Comments</u> This question was generally answered well.
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 0.67 (s) award 3 marks Rearrangement to give Time = distance / speed ✓ Time = 16 / 24 ✓ Time = 0.67 (s) (2 decimal places) ✓	1 (AO 1.2) (AO 2.1) (AO 2.1)	ALLOW ECF from (b)(i) ALLOW 0.6 or 0.7 or 0.66(6...) (s) for 2 marks ALLOW one mark for any calculated answer to 2dp <u>Examiner's Comments</u> Higher ability candidates rearranged the equation, substituted the numbers and wrote the answer as 0.66667 before rounding the answer to 0.67. A number of candidates wrote their answer exactly from the calculator as 0.66 which was not acceptable for two decimal places.
	b	i	(Driver under influence of) alcohol / drugs / tired / (named) distraction / ill / <u>old</u> -age / intoxication / high(er) speed ✓	1 (AO 1.1)	IGNORE just age ALLOW increase in driver's reaction time <u>Examiner's Comments</u> Many candidates correctly answered this question. The common factors were alcohol, drugs and tiredness. Some candidates did not score the mark for factors related to braking distances. Other candidates did not give an appropriate direction for the change, e.g. 'speed' was not credited but 'increasing speed' was credited.

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		ii	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 26 (m) award 2 marks (Stopping distance =) braking (distance) + thinking (distance) OR 16 OR 10 ✓ (sd =) 26 (m) ✓	2 (AO 2.2.2)	<u>Examiner's Comments</u> The majority of the candidates gained one mark for correctly reading off either the thinking distance or the braking distance. Many candidates did not read the question carefully to realise it was the stopping distance that was required. Higher ability candidates clearly showed both the values from the graph and the addition.
	c		Maximum 2 marks from: Higher speed increases braking distance ✓ BUT Double speed quadruples braking distance / braking distance is (directly) proportional to the speed squared AW ✓✓ Maximum 2 marks from: (Idea that) higher speed (car has) more KE ✓ BUT Double speed quadruples KE / KE is (directly) proportional to the speed squared / AW ✓	3 (AO 2.1) (AO 3.1a x2) (AO 2.1) (AO 3.1a x2)	ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 30 (m). ALLOW numerical values from graph, e.g. at 10 (m/s), bd = 7.5 (m) but at 20 (m/s) bd = 4×7.5 (= 30m) for 2 marks <u>Examiner's Comments</u> Many answers to this question were vague. This question again required candidates to indicate the direction of the change in speed, e.g. as the speed increases. A small minority of candidates realised that both the kinetic energy and the braking distance increased with increasing speed. Very few used their graph to show that as the speed doubled the braking distance and kinetic energy quadrupled.
			Total	10	
28			C ✓	1 (AO1.2)	
			Total	1	

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
29	a	i	Any two from: First student drops the ruler and second student catches as quick as possible ✓ Measure the distance on the ruler where it was caught ✓ Use look-up table/equation to find time to travel this distance ✓	2 (AO2 × 1.2)	1
		ii	Any one from: To check the precision or repeatability of the readings ✓ to find the uncertainty in the measurement ✓ to find an average or mean ✓	1 (AO3.3a)	
		iii	Student B's reaction times will be longer / increases ✓	1 (AO3.2a)	ALLOW B will be slower
	b	i	$(9 + 14) = 23 \text{ (m)}$ ✓	1 (AO2.2)	
		ii	Stopping distance at 50 mph = 53 m ✓ Stopping distance is greater than 40 m / Car hits the barrier ✓	2 (AO3.1a) (AO3.2a)	ALLOW 52-54m

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	Factor: larger mass (of car) ✓ Reason: Braking distance is increased ✓ because deceleration is less / larger KE to dissipate ✓ OR Factor: Poor quality brakes / tyres ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Icy / wet / slippery road ✓ Reason: Braking distance is increased ✓ Less friction / smaller deceleration ✓ OR Factor: Going uphill ✓ Reason: Braking distance is decreased ✓ Weight of car increases deceleration ✓ OR Factor: Going downhill ✓ Reason: Braking distance is decreased ✓ Weight of car decreases deceleration ✓	3 (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1) (AO1.1) (AO2 × 2.1)	DO NOT ALLOW distance for braking/thinking distance DO NOT ALLOW stopping distance
	c	i	FIRST CHECK THE ANSWER ON ANSWER LINE If answer = 3.25/3.3 (m/s²) award 2 marks 13 ÷ 4 ✓ = 3.3 (m/s²) ✓	2 (AO2 × 2.1)	ALLOW 3.25 (m/s²)
		ii	Any two from: Yes / No (no mark) (agree with driver) stopping distance is shorter ✓ Less likely to hit obstacles / safer ✓ Attempt to quantify, e.g. 4 s / 0.4 s = 10 ✓ OR (disagree with driver) ($F = ma$ / so) the force (acting on the people in the car) is 10x greater ✓ This can lead to injury / 10× more dangerous ✓ Other factors involved (so cannot quantify) ✓	2 (AO2.1) (AO2 × 3.1b) (AO2.1) (AO2 × 3.1b)	1

Mark Scheme

Question			Answer/Indicative content	Marks	Guidance
		iii	Seat belt / airbag / crumple zone ✓	1 (AO1.1)	
			Total	18	
30			B ✓	1 (AO1.2)	
			Total	1	