

Chapters 1-4

EDITION • Volum • STUDENT

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Chapter 1: Length, Time, Mass, Volume, and Density

- 1 The period of the vertical oscillations of a mass hanging from a spring is known to be constant.
 - (a) A student times single oscillations with a stopwatch. In 10 separate measurements, the stopwatch readings were:

1.8s, 1.9s, 1.7s, 1.9s, 1.8s, 1.8s, 1.9s, 1.7s, 1.8s, 1.8s.

What is the best value obtainable from these readings for the time of one oscillation? Explain how you arrive at your answer.

		best value =
		explanation
		[1]
	(b)	Describe how, using the same stopwatch, the student can find the period of oscillation more accurately.
		[4]
		[Total: 5]
2	(c)	Explain, in terms of their molecules, why the density of the oil is greater than that of air.
		[1]
3	(a)	Define density.
		[1]

2

0)		minium foil varies, but is much less than	The thickness of a rectangular sheet of 1 mm.
	A st	tudent wishes to find the average thicknes	ss. She obtains the following measurements.
		mass of sheet = 60.7g length of sheet = 50.0 cm width of sheet = 30.0 cm	
	Calc	culate the student's values for	
	(i)	the volume of the sheet,	
	(ii)	the average thickness of the sheet.	olume =[2]
		thic	kness =[2]
(c)	thic	other student, provided with a means of	cutting the sheet, decides to find its average nent. Assume the surfaces of the sheet are
	(i)	Name a measuring instrument she cou	ıld use.
			[1]
	(ii)	Describe the procedure she should average thickness of the sheet.	follow to obtain an accurate value of the
		Details of how to read the instrument a	are not required.
			[3]
			[Total: 9]

4	An	archaeologist digging at an ancient site discovers a spoon.
	(b)	The archaeologist hopes that, by determining its density, she will be able to identify the metal.
		Describe a method for determining the density of the metal from which the spoon is made.
		[4]
5	A st	tudent wishes to determine the density of a small, irregularly shaped stone.
	(a)	With the aid of a labelled diagram, describe an experiment to determine the volume of the stone.
		[4]

(b)	(i)	State the other quantity, apart from the volume, that must be measured in order to determine the density.
		[1]
	(ii)	State the formula that is used to calculate the density.
		[1]
(c)		e student now wishes to determine the volume of a small, irregularly shaped piece of wood floats in water. He notices that a small lead weight tied to the wood makes it sink in water.
		scribe how the student can adapt the experiment in (a) to determine the volume of the od. You may draw a diagram.
		4,07
		[2]
		[Total: 8]

6 A surveyor measures the dimensions of a room of constant height. Fig. 2.1 is a top view of the room and shows the measurements taken.

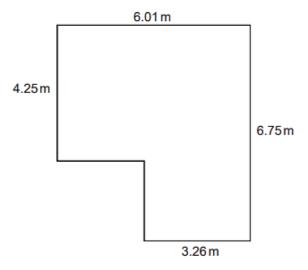


Fig. 2.1

		. 19. 2. 1
	(a)	State an instrument that would be suitable to take these measurements.
		[1]
7		tudent has a large number of coins of different diameters, all made of the same metal. She hes to find the density of the metal by a method involving placing the coins in water.
	(a)	State the formula needed to calculate the density.
		To.
		[1]
	(b)	Describe how the measurements of the required quantities are carried out.

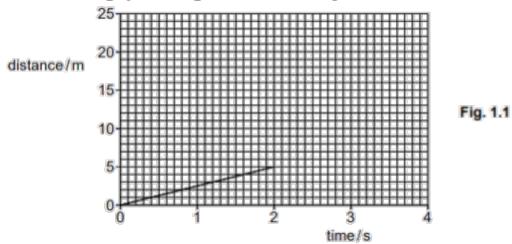
	(0)		ult is as accurate as possible.
			[1]
В	(a)	The	[Total: 7] weight of water in cylinder A is 80 kN.
		Cal	culate the mass of water in cylinder A.
			mass =[2]
	(b)	The	e density of water is 1000 kg/m ³ .
		Cal	culate the volume of water in cylinder A.
			volume =[2]
)	A s	tude 80 kg	nt has 500 identical, rectangular sheets of paper. The mass of 1.0 m ² of the paper is j.
	(a)		ng a metre rule, she measures the length of one sheet of paper and its width. The length is $0.0\mathrm{m}$ and the width is $0.210\mathrm{m}$.
		(i)	Calculate the mass of one sheet of paper.
			mass =[1]
		(ii)	The student makes a single pile of the 500 sheets of paper.
		(11)	
			With a metre rule, she measures the height of the pile. The height of the pile is 0.048 m.
			Calculate the density of the paper.

	(D)	A S	econd student has only 5 sheets of the same type of paper.
		_	gest how this student determines the density of the paper to a similar accuracy. Additional aratus may be used.
			[2]
10			[Total: 6] It wishes to find the volume of a piece of wood of irregular shape. Her experiment requires of a small brass object of mass 200 g.
	(a)	Cal	culate the volume of the brass object. The density of brass is 8.4g/cm ³ .
			volume =[2]
	(b)	wat	ind the volume of the piece of wood, the student has a measuring cylinder, a supply of er and the brass object in (a) . The piece of wood and the brass object are small enough to blaced in the measuring cylinder.
		(i)	The piece of wood does not sink in water.
		V-3	(,0)
			Suggest why.
			[1]
		(ii)	Describe what the student does to find the volume of the piece of wood, stating the measurements that she makes and any calculations required.
			[4]

[Total: 7]

Chapter 2: Motion

1 Fig. 1.1 is a distance/time graph showing the motion of an object.



(a) (i) Describe the motion shown for the first 2s, calculating any relevant quantity.

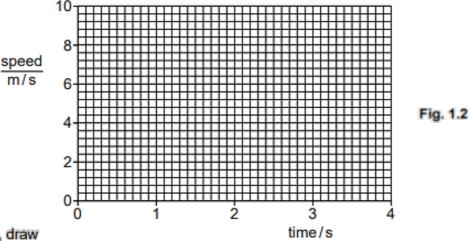
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(ii) After 2s the object accelerates.

On Fig. 1.1, sketch a possible shape of the graph for the next 2s.

(b) Describe how a distance/time graph shows an object that is stationary.

(c) Fig. 1.2 shows the axes for a speed/time graph.



On Fig. 1.2, draw

(i) the graph of the motion for the first 2s as shown in Fig. 1.1,

(ii) an extension of the graph for the next 2s, showing the object accelerating at 2 m/s².

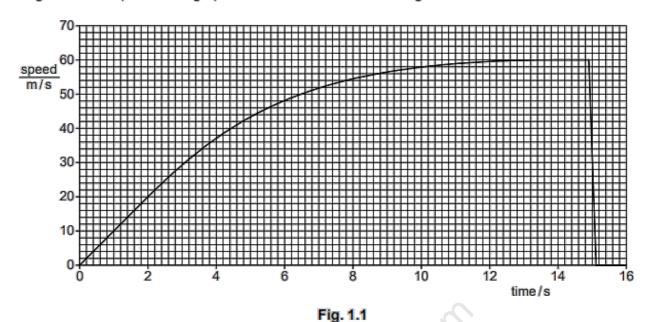
[3]

[1]

(d) Describe how a speed/time graph shows an object that is stationary.
.4411004113004113004113004113004113004113004113004113004113004113004113004113004113004113004113004113004113004
[2] [Total: 9]
2 A girl rides her bicycle along a straight level road. Fig. 2.1 shows a graph of her distance moved against time.
Fig. 2.1
300 - 300 -
0 10 20 30 40 50 60 (a) Describe her motion time/s
(i) from A to B,
(iii) from C to D
(i) her average speed from A to D, average speed =
maximum speed =[3] [Total: 8]

3 A brick is dropped from the top of a very tall building as it is being constructed.

Fig. 1.1 is the speed/time graph for the brick as it falls to the ground.



(a)	State a	time a	at which	the	acceleration	of	the	brick	is
-----	---------	--------	----------	-----	--------------	----	-----	-------	----

(i) zero,

(ii) constant but not zero,

(iii) not constant.

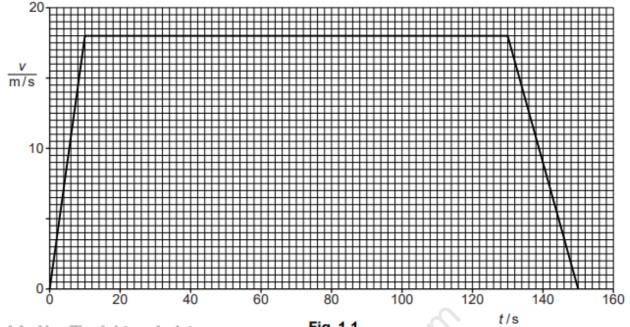
(b) Explain in terms of the forces acting on the brick why, between 0 and 14.0 s, its speed varies in the way shown by the graph.

......[4

(c) State the direction of the resultant force acting on the brick at time 15.0 s.

.....[1]

4 Fig. 1.1 shows the graph of speed *v* against time *t* for a train as it travels from one station to the next.



(a) Use Fig. 1.1 to calculate

Fig. 1.1

(i) the distance between the two stations,

(ii) the acceleration of the train in the first 10s.

(b) The mass of the train is 1.1×10^5 kg.

Calculate the resultant force acting on the train in the first 10 s.

(c)	The force generated b	y the engine of the	train is called the	driving force.
-----	-----------------------	---------------------	---------------------	----------------

Write down, in words, an equation relating the driving force to any other forces acting on the train during the period t = 10 s to t = 130 s.

[Total: 9]

5 On a windy day, a parachutist of mass 85 kg jumps from an aeroplane.

Fig. 3.1 shows the parachutist falling through the air at a constant vertical velocity of 8.4 m/s downwards.

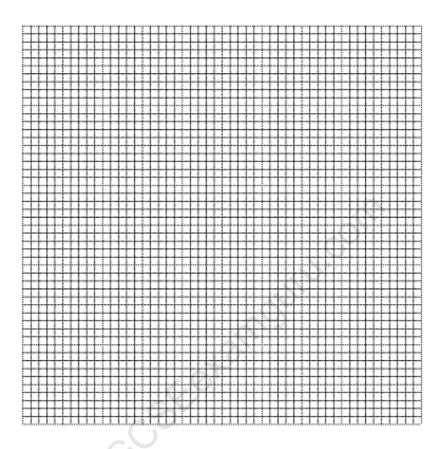


Fig. 3.1

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- (b) As the parachutist falls, the wind is moving him towards the right of the diagram, at a horizontal velocity of 6.3 m/s.
 - (i) On Fig. 3.1, draw an arrow to show the horizontal velocity of the parachutist. [1]
 - (ii) On the grid below, draw a vector diagram to determine graphically the size and direction of the resultant velocity of the parachutist.



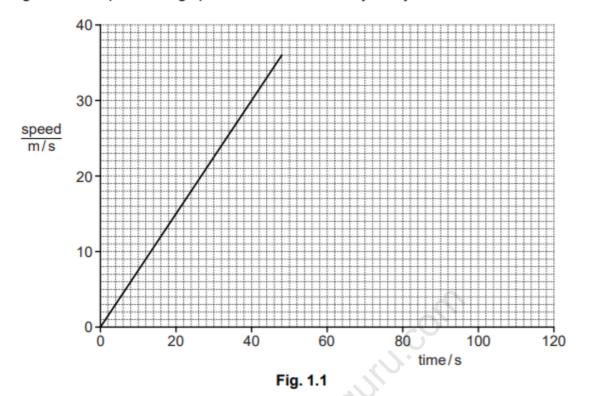
size =	
direction =	 [4]

(iii) Calculate the kinetic energy of the parachutist.

kinetic energy =[3]

6 A train is at rest in a railway station. At time t = 0, the train starts to move forwards with an increasing speed until it reaches its maximum speed at time $t = 48 \, \text{s}$.

Fig. 1.1 is the speed-time graph for the first 48s of the journey.



a)	(i)	State how the graph shows that, during	g the	first 48s	of the j	journey, t	he accele	ration
		of the train is constant.						

/ (/1)
X./[1]

(ii) Calculate the acceleration of the train during the first 48s of the journey.

(b) After time $t = 48 \, \text{s}$, the train continues at its maximum speed for another 72 s.

(i) On Fig. 1.1, sketch the speed-time graph for the next 72s of the journey. [1]

(ii) Determine the total distance travelled by the train in the 120s after it starts moving.

7 A rocket, initially at rest on the ground, accelerates vertically.

It accelerates uniformly until it reaches a speed of 900 m/s after 30 s.

After this period of uniform acceleration, the rocket engine cuts out. During the next 90 s, the upward speed of the rocket decreases uniformly to zero.

(a) On Fig. 4.1, plot a speed-time graph for the rocket for the first 120s of its flight.

speed m/s

(b) Using the graph,

Fig. 4.1

time/s

[4]

(i) calculate the acceleration during the first 30s,

acceleration =[2]

(ii) determine the height reached by the rocket after 120 s.

height reached =[2]

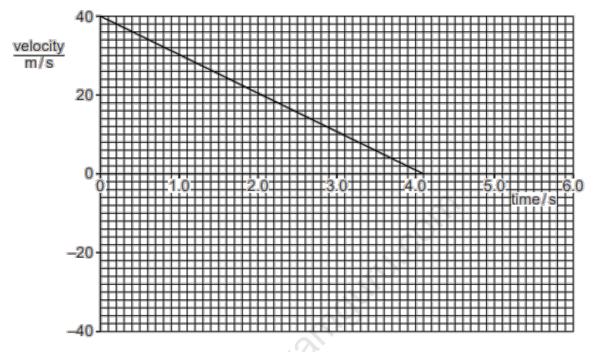
[Total: 8]

8 (a) Underline the vectors in the following list of quantities.

density energy force mass velocity volume [2]

(b) A small metal ball is projected into the air with a velocity of 40 m/s vertically upwards.

The graph in Fig. 2.1 shows how the velocity changes with time until the ball reaches its maximum height.



Use the graph to find,

Fig. 2.1

(i) the time at which the ball reaches its maximum height,

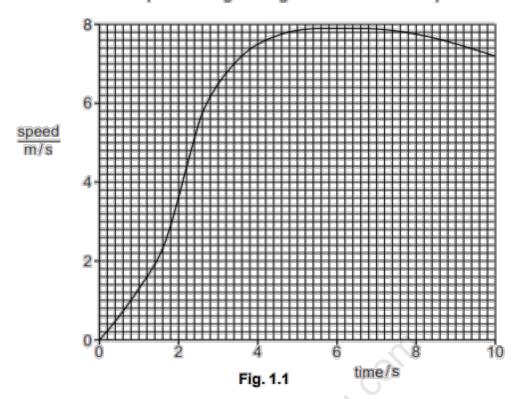
(ii) the deceleration of the ball,

(iii) the maximum height reached by the ball.

(c) On Fig. 2.1, add a line to the graph to show how the velocity of the ball changes after it reaches its maximum height. Your line should extend to time 6.0s. [1]

[Total: 8]

9 A school athlete does a sprint training run. Fig. 1.1 shows how her speed varies with time.



(a) Explain how the graph in Fig. 1.1 can be used to determine the distance she runs.

ne ne n
 1

(b) Determine her maximum acceleration. Show clearly on the graph how you obtained the necessary information.

(c) She runs a distance of 62 m.

Calculate her average speed.

[Total: 7]

10 Fig. 2.1 shows a model fire engine used by a student to take measurements of force and motion.

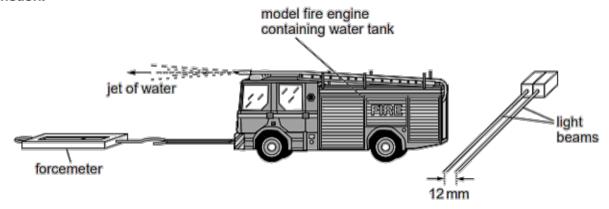


Fig. 2.1

The model projects a jet of water forwards. The forcemeter holds the model stationary. It indicates a force of 0.060 N acting on the model.

The forcemeter is now disconnected and the model accelerates to the right at 0.030 m/s².

(a) The back of the model breaks a pair of light beams and the time to pass between them is measured electronically. The beams are 12mm apart and the second beam is broken 0.080s after the first.

The student times with a stopwatch how long it takes from the release of the model until the beams are cut.

Calculate the time he measures.

time measured =

11 Fig. 1.1 shows a distance-time graph for a moving object.

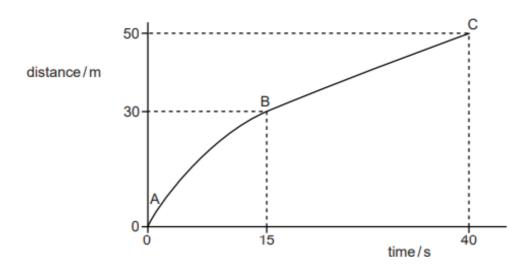


Fig. 1.1

(a)	Describe	the	speed	of	the	object	between	points
-----	----------	-----	-------	----	-----	--------	---------	--------

(i)	A and B,	

(ii) B and C.

[2]

(b) State whether the acceleration of the object is zero, negative or positive, as shown on the graph between points

(i) A and B,

.....

(ii) B and C.

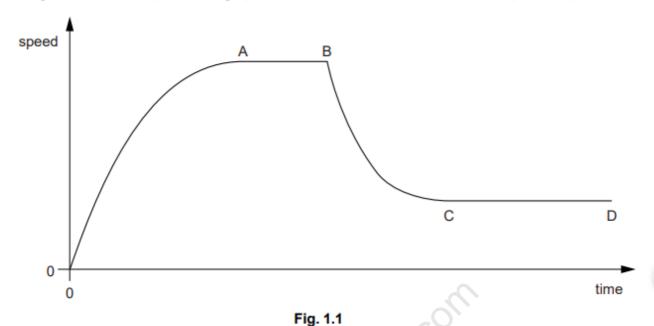
[2]

(c) Calculate the average speed of the object during the 40 seconds.

[Total: 6]

12 A free-fall parachutist jumps from a helium balloon, but does not open his parachute for some time.





(a) (i) State the value of the gradient of the graph immediately after time t = 0.

	gradient =[1]
	(ii) Explain why the gradient has this value.
	Z.O'
	[1]
(b)	State how Fig. 1.1 shows that the acceleration decreased between time $t=0$ and the time to A.
	[1]
(c)	Explain, in terms of forces, what is happening in section AB of the graph in Fig. 1.1.

(d) A second parachutist of the same size and mass jumps from the balloon with a larger parachute. He also opens his parachute at point B.

On Fig. 1.1, sketch a possible speed-time graph for his fall after he opens his parachute. [3] [Total: 8]

13 Fig. 2.1 shows a tanker lorry full of liquid.

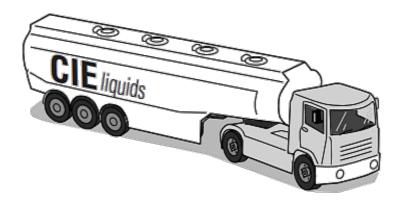


Fig. 2.1

The tanker delivers the liquid and drives away empty.

(a)	(i)	Compare the acceleration of the empty tanker with the acceleration of the full tanker for the same resultant force. Tick one box.
		acceleration of full tanker is less than acceleration of empty tanker
		acceleration of full tanker is the same as acceleration of empty tanker
		acceleration of full tanker is more than acceleration of empty tanker
	(ii)	Explain your answer.
		[2]
		empty tanker has a weight of 50 000 N. The forward force is 6000 N and the total resistive e is 2000 N.
	Cald	culate the acceleration.
		acceleration =[3]
		[Total: 6]

14 Fig. 3.1 shows the speed-time graph of a firework rocket as it rises and then falls to the ground.

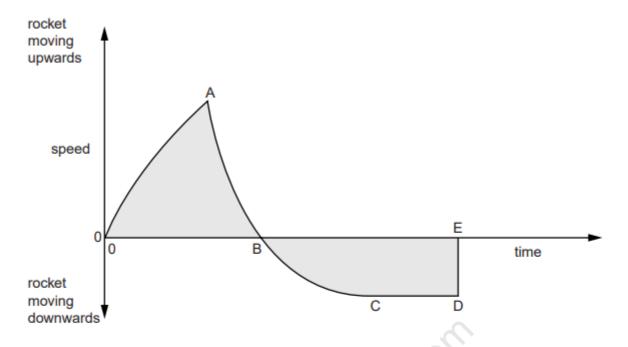


Fig. 3.1

The rocket runs out of fuel at A. It reaches its maximum height at B. At E it returns to the ground.

- - [3]
- (c) Another rocket, of the same size and mass, opens a parachute at point B.
 - On Fig. 3.1, sketch a possible graph of its speed from B until it reaches the ground. [3]

[Total: 8]

15 (a) Fig. 1.1 shows the distance-time graphs for three different objects A, B and C.

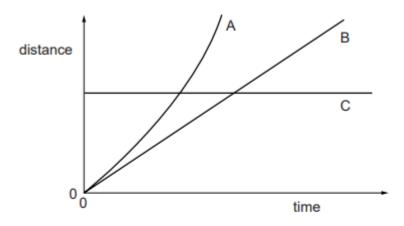
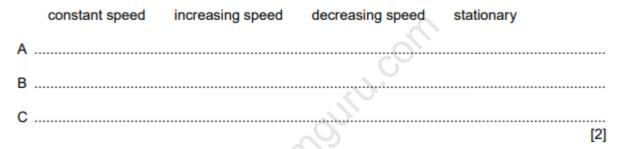


Fig. 1.1

Describe the motion of each of the objects A, B and C by selecting the appropriate description from the list below.



(b) Fig. 1.2 shows the speed-time graphs for three more objects D, E, and F.

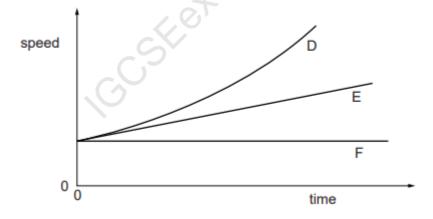


Fig. 1.2

Describe the motion of each of the objects D, E and F by selecting the appropriate description from the list below.

constant speed	constant acceleration	increasing acceleration	stationary
D			
E			
F			
			[2]

(c) Fig. 1.3 shows a person bungee-jumping from a bridge. The person is attached to a long elastic rope.

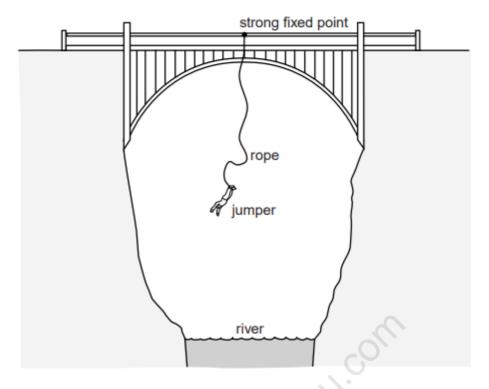


Fig. 1.3

(i) In 1.5s the speed of the jumper increases from zero to 10.5 m/s.

Calculate her average acceleration during this time.

acceleration =		[2]	
----------------	--	-----	--

- (ii) At one point during the fall, she reaches her maximum speed.
 - State her acceleration at this point.

2. What can be said about the forces acting on her at this point?



[Total: 8]

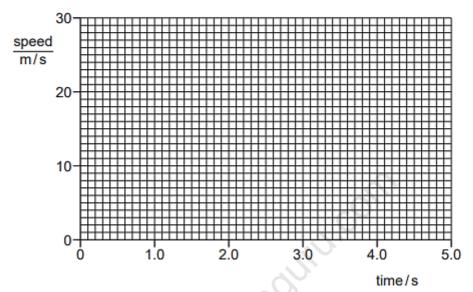
16 At a sports event, a champion runner and a car take part in a race.

(a) The runner runs at a constant speed of 10 m/s from the start of the race. During the first 5.0s of the race, the car's speed increases from 0 m/s to 25 m/s at a uniform rate.

On Fig. 1.1, draw

(i) a graph to show the motion of the runner, [1]

(ii) a graph to show the motion of the car.



Fia. 1.1

[1]

(b) Use your graphs to determine

(i) the distance travelled by the runner in the 5.0s,

distance =[1]

(ii) the distance travelled by the car in the 5.0 s,

distance =[2]

(iii) the time at which the car overtakes the runner.

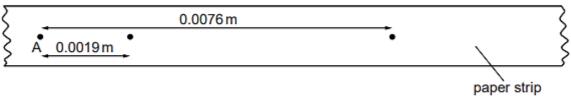
time =[2]

[Total: 7]

17 An experiment is carried out to find the acceleration of free fall.

A strip of paper is attached to a heavy object. The object is dropped and falls to the ground, pulling the paper strip through a timer. The timer marks dots on the paper strip at intervals of 0.020 s.

Fig. 1.1 shows a section of the paper strip with the first three dots marked. The first dot on the paper strip, labelled A, is marked at the instant the object is dropped.



	paper strip
	Fig. 1.1 (not to scale)
a)	State how the dots on the paper strip show that the object is accelerating.
	[1]
b)	Calculate the average speed of the object
	(i) in the first 0.020s after the object is dropped,
	Letal.
	average speed =
	(ii) in the second 0.020s after the object is dropped.
	average speed =[3]
c)	Use the results from (b) to calculate the acceleration of the falling object.

[Total: 7]

acceleration =[3]

18 (a) Figs. 1.1 and 1.2 show speed-time graphs for two objects, each moving in a straight line.

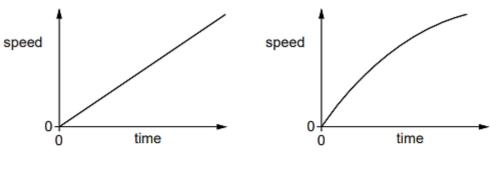


Fig. 1.1 Fig. 1.2

(i)	Describe the motion of the object shown by the graph in Fig. 1.1.
(ii)	Describe the motion of the object shown by the graph in Fig. 1.2.

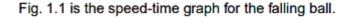
(b) On a day with no wind, a large object is dropped from a tall building. The object experiences air resistance during its fall to the ground.

during its f	all.	the lorces acting	, now the acceler	ation of the obj	ect valles
					[4]

[Total: 7]

[3]

19 A plastic ball is dropped from the balcony of a tall building and falls towards the ground in a straight line.



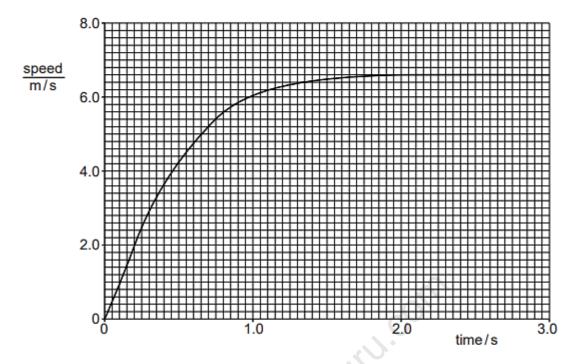


Fig. 1.1

(a)	t=2	te and explain, in terms of forces, what is happening to the speed of the ball between times 2.0 s and $t = 3.0$ s.	
(b)	On	Fig. 1.1, mark a point P on the line where the acceleration of the ball is not constant. [1]
(c)	Usi	ing Fig. 1.1,	
	(i)	calculate the acceleration of the ball between $t = 0$ s and $t = 0.25$ s,	
		acceleration =[
		acceleration =	2]
	(ii)	estimate the distance that the ball falls in the first 3.0 s.	
		distance =[2]

[Total: 7]

20 A comet, travelling in space, enters the atmosphere of a planet.

Fig. 1.1 is the speed-time graph for the comet from time t = 0 s.

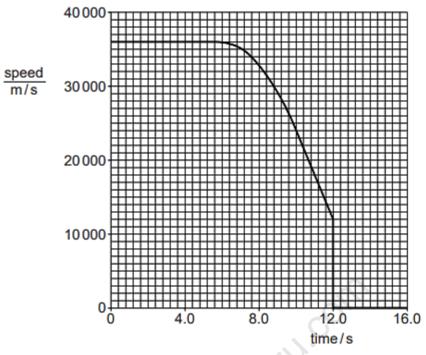


Fig. 1.1

(a)	(i)	During the period $t = 0$ s to $t = 6.0$ s,	both the speed of the comet and the velocity	of the
		comet remain constant.		

State what this suggests abo	ut the motion of the comet.
6	[1]

(ii) Determine the distance travelled during the period t = 0s to t = 6.0s.

	distance =	[2
(b)	Explain what the graph shows about the motion of the comet during the period $t = 6.0$ $t = 10.0$ s.)s to

(c) Determine the acceleration of the comet at $t = 11.0 \, \text{s}$.

	acceleration =[2]
(d)	Suggest what happens to the comet at $t = 12.0 \mathrm{s}$.
	[1]
	[Total: 8]

21 Fig. 1.1 shows a rocket-powered sled travelling along a straight track. The sled is used to test components before they are sent into space.

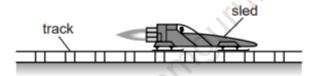


Fig. 1.1

Fig. 1.2 is the speed-time graph for the sled from time t = 0 s.

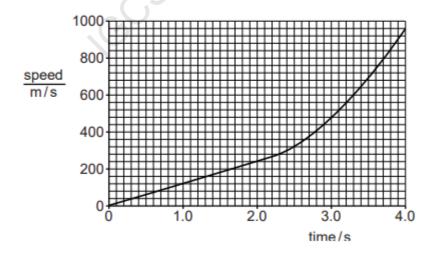


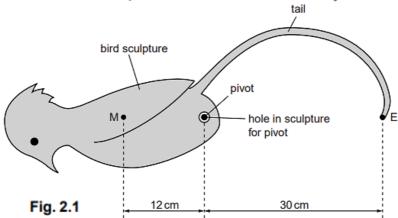
Fig. 1.2

(a) On Fig. 1.2, mark a point labelled P to indicate a time when the acceleration of the sled is not constant.
[1]

(b)	(1)	Calculate the acceleration of the sled at $t = 1.0$ s.
		acceleration =[2]
	(ii)	Determine the distance travelled by the sled between $t = 1.0 \mathrm{s}$ and $t = 2.0 \mathrm{s}$.
		distance =[2]
(c)	The	resultant force acting on the sled remains constant during the test.
	Sug	gest why the acceleration of the sled is not constant.
		[1]
		T-t-t-0
		[Total. 6]
		[lotal: 6]

Chapter 3: Forces

1 Fig. 2.1 shows a mobile bird sculpture that has been created by an artist.



M is the centre of mass of the bird sculpture, including its tail (but not including the counter-weight that will be added later). The mass of the bird and tail is 1.5 kg.

The bird sculpture is placed on a pivot.

The artist adds the counter-weight at the end E of the tail so that the bird remains stationary in the position shown.

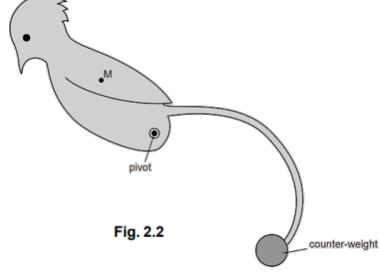
(a) Calculate the mass of the counter-weight.

mass =[2]

(b) The centre of mass of the sculpture with counter-weight is at the pivot. Calculate the upward force acting at the pivot.

force =[1]

(c) The sculpture is rotated clockwise to the position shown in Fig. 2.2. It is held still, then carefully released.



		(1)	rotate back anticlockwise.
		(ii)	Explain your answer to (i).
			[3]
			[Total: 6]
2			is full of oil. The total mass of the bucket of oil is 5.4kg and the gravitational field is 10 N/kg.
	(a)	Calo	culate the total weight of the bucket of oil.
			weight =[1]
	(b)		bucket of oil is hung from a spring of unstretched length 20 cm. The limit of ortionality of the spring is not exceeded and its length increases to 35 cm.
		(i)	State what is meant by the limit of proportionality.
			[1]
		(ii)	The oil is poured into a measuring tank. The empty bucket stretches the spring to a length of 25 cm.
			Calculate
			1. the force that stretches the spring to a length of 25 cm,
			force =[3]

		mass =	[2]
((iii)	The volume of the oil in the measuring tank is 0.0045 m ³ . Calculate the oil.	he density of
		density =	[2]
(c)	Exp	oplain, in terms of their molecules, why the density of the oil is greater that	
		CO'	[Total: 10
		Fig. 3.1	
Afte	er 26	26s it reaches a speed of 65 m/s.	
(a)	Ca	alculate	
	(i)) the acceleration of the aeroplane,	
		acceleration =	[2
	(ii)	the resultant force on the aeroplane.	
		force =	[9

2. the mass of the oil in the measuring tank.

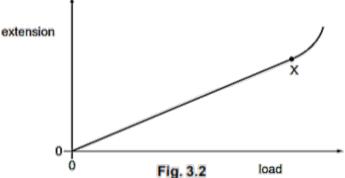
3

	(c)	When the aeroplane reaches its maximum height, it starts to follow a curved path at a constant speed.
		State the direction of the resultant force on the aeroplane.
		[1]
4		[Total: 9] 2.1 is a head-on view of an airliner flying at constant speed in a circular horizontal path. centre of the circle is to the left of the diagram. Fig. 2.1
	(a)	On Fig. 2.1, draw the resultant force acting on the airliner. Explain your answer.
		[3]
	(b)	The weight of the airliner is 1.20×10^6 N and there is an aerodynamic lift force of 1.39×10^6 N acting at 30° to the left of the vertical.
		By drawing a scale vector diagram, or otherwise, show that the resultant of these two forces is in the same direction as the resultant force you drew in (a).

	(c)	The speed is constant as the airliner flies in this circular path.
		State and explain what is happening to the velocity.
		[2]
5	(a)	[Total: 8] State the factors which completely describe a vector quantity.
		[1]
	(b)	An aeroplane is flying towards the east in still air at 92 m/s. A wind starts to blow at
	(2)	24 m/s towards the north.
		Draw a vector diagram to find the resultant velocity of the aeroplane. Use a scale of 1.0 cm = 10 m/s.
		1.0 cm = 10 m/s.
		10,
		() () () () () () () () () ()
		c,S ^v
		resultant speed =
		angle between resultant and easterly direction =[5]

[Total: 6]

6 (c) The trampoline springs are tested. An extension-load graph is plotted for one spring. Fig. 3.2 is the graph.



(i) State the name of the point X.

11.

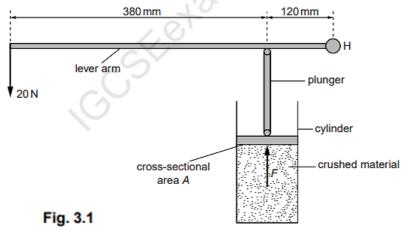
(ii) State the name of the law that the spring obeys between the origin of the graph and point X.

	[1]
[Total:	9

7 (a) A stationary body is acted upon by a number of forces. State the two conditions which must apply for the body to remain at rest.

1.	
2	
۷.	

(b) Fig. 3.1 shows a device used for compressing crushed material.



The lever arm rotates about the hinge H at its right-hand end. A force of 20 N acts downwards on the left-hand end of the lever arm. The force F of the crushed material on the plunger acts upwards. Ignore the weight of the lever arm.

(i) Use the clockwise and anticlockwise moments about H to calculate the upward force F which the crushed material exerts on the plunger. The distances are shown on Fig. 3.1.

[2]

(ii)	The cross-sectional area A of the plunger in contact with the crushed material is
	0.0036 m ² . Calculate the pressure exerted on the crushed material by the plunger.

pressure	=	 	 -	•••				[2	2]									
												г	Т	'n	ts	ıl.	7	71

8 A large crane has a mass of 8500 kg. Fig. 4.1 shows the crane on a muddy building-site.

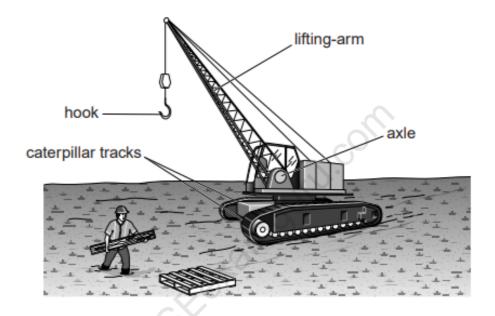


Fig. 4.1

- (c) When the crane lifts a heavy load with its hook, the load exerts a moment on the lifting-arm about the axle.
 - (i) Explain what is meant by moment of a force.

 [1]

 (ii) Despite the moment exerted on the lifting-arm, the crane remains in equilibrium.

 State the two conditions required for any object to be in equilibrium.

[Total: 8]

9 Fig. 2.1 shows the extension-load graph for a spring.

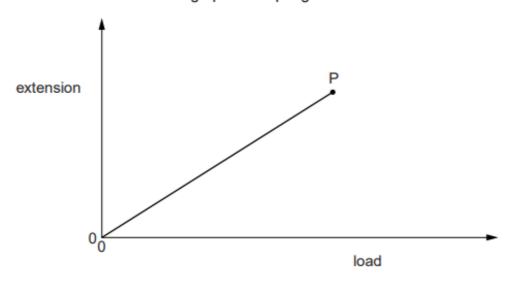


Fig. 2.1

Point P is the limit of proportionality.

(a)	(i)	Name the law obeyed by the spring from the origin to P.
		[1]
	(ii)	Describe two features of the graph which show that the law is obeyed.
	` '	
		1
		[2]

(b) On Fig. 2.1, sketch a possible continuation of the graph when the spring is loaded beyond the limit of proportionality. [1]

[Total: 4]

10 (a) Underline the vectors in the following list of quantities.

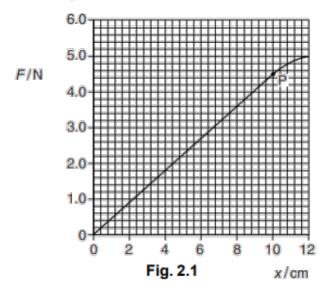
density energy force mass velocity volume [2]

11 A spring S is suspended from a clamp stand in a school laboratory.

A student hangs various masses from the end of S and determines the extension x produced by each mass.

(a) Calculate the weight of a 250 g mass.

(b) The student plots a graph of the force *F* applied to the spring against the extension *x*. Fig. 2.1 is the student's graph.



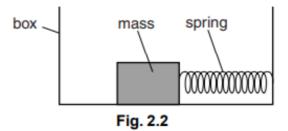
At point P on the graph, the line begins to curve.

(i) State the name given to point P.

[1]

(ii) Use the section of the graph where spring S obeys Hooke's law (F = kx) to determine the spring constant k of the spring.

(c) Fig. 2.2 shows a mass of 0.12 kg resting on the bottom of a box.



A spring that is identical to S connects the mass and one side of the box. Ignore friction between the mass and the box.

(i) The box and the mass are at rest.

State the resultant force acting on the mass.

	(ii)	The box is firmly attached, in a horizontal position, to the body of a racing car.
		As the car accelerates the spring stretches by 2.0 cm.
		1. Using Fig. 2.1, determine the tension in the spring.
		tension =
		acceleration =[2]
12	Fig. 2.1 motion.	shows a model fire engine used by a student to take measurements of force and model fire engine containing water tank
	~	jet of water light beams forcemeter

The model projects a jet of water forwards. The forcemeter holds the model stationary. It indicates a force of 0.060 N acting on the model.

Fig. 2.1

The forcemeter is now disconnected and the model accelerates to the right at 0.030 m/s².

(a) The back of the model breaks a pair of light beams and the time to pass between them is measured electronically. The beams are 12mm apart and the second beam is broken 0.080s after the first.

The student times with a stopwatch how long it takes from the release of the model until the beams are cut.

Calculate the time he measures.

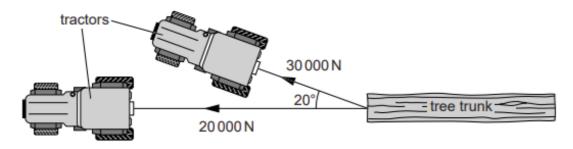
time	measured =	 [4	j

12 mm

(b)	This experiment is carried out with the water tank in the model nearly full.
	Calculate the mass of the model including the water in the tank.

		mass =[2]
(c)		e student repeats the experiment with the same force but with the water tank nearly npty.
	Sta	ate and explain how the acceleration will compare to that of the first experiment.
		[2]
		[Total: 8]
13 (a)	(i)	State one similarity and one difference between vector and scalar quantities.
		similarity
		difference[2]
	(ii)	Give an example of each quantity.
		vector quantity

(b) Fig. 3.1 is an overhead view of two tractors pulling a tree trunk.



scalar quantity[2]

Fig. 3.1

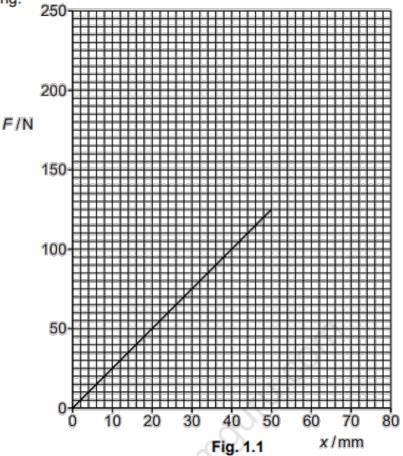
The force exerted by each tractor is indicated in the diagram.

In the space below, carefully draw a scale diagram to determine the resultant force on the tree trunk. State the scale you use.

Write down the magnitude of the resultant force **and** the angle between the resultant force and one of the original forces.

	GCSF.examound.com
	magnitude of resultant force =
	direction of resultant force =[4]
	[Total: 8]
14 (a)	State Hooke's law.
	[1]

(b) Fig. 1.1 shows a graph of the stretching force F acting on a spring against the extension x of the spring.



(i) State the features of the graph that show that the spring obeys Hooke's law.

[1]

(ii) Calculate k, the force per unit extension of the spring.

(iii) The limit of proportionality of the spring is reached at an extension of 50 mm.

Continue the graph in Fig. 1.1 to suggest how the spring behaves when the stretching force is increased to values above 125 N. [1]

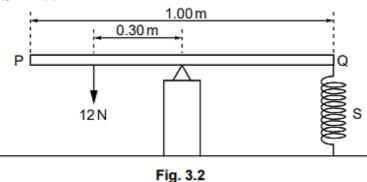
(iv) Another spring has a smaller value of k. This spring obeys Hooke's law for extensions up to 80 mm.

On the grid of Fig. 1.1, draw a possible line of the variation of F with x for this spring. [1]

[Total: 7]

15	A tr	ain	has a total mass of 7.5 × 10 ⁵ kg.	
((a)		e train accelerates from rest at a constant rate along a straight, horizontal traeaches a speed of 24 m/s in 60 s.	ack.
		Cal	culate	
		(i)	the train's acceleration,	
		(ii)	acceleration = the resultant force acting on the train.	
16 (a)) (i		force =	[2] end,
		:	2	
			3	
	(ii	i) l	Fig. 3.1 shows a uniform rod AB acted upon by three equal forces <i>F</i> . Fig. 3.1 State two reasons why the rod is not in equilibrium.	[2]
		2	2	
				[2]

(b) Fig. 3.2 shows a uniform rod PQ, supported at its centre and held in a horizontal position. The length of PQ is 1.00 m.



A force of 12N acts at a distance of 0.30m from the support. A spring S, fixed at its lower end, is attached to the rod at Q.

(i) Calculate the force exerted on PQ by the spring.

	force =[2]
ii)	Explain why it is not necessary to know the weight of PQ.
	[1]
	[Total: 7]

17 A metre rule balances when the 50 cm mark is directly above a pivot.

balanced at the 50 cm mark.

(a) State where in the rule its centre of mass is located.

(b) Fig. 3.1 shows an apple and a 0.40 N weight placed on the rule so that the rule remains

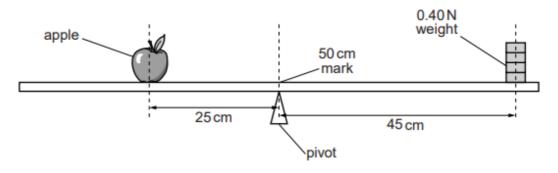


Fig. 3.1 (not to scale)

The centre of mass of the apple is 25 cm from the pivot and the centre of mass of the weight is 45 cm from the pivot. Calculate (i) the weight of the apple, weight =[2] (ii) the mass of the apple. (c) The apple is not moved. The weight is removed from the rule and the pivot is moved to the left until the rule balances as shown in Fig. 3.2. 50 cm pivot Fig. 3.2 (not to scale) Explain why the arrangement in Fig. 3.2 balances.

(ii) The pivot in Fig. 3.2 is closer to the 50 cm mark than to the centre of mass of the apple.

Compare the weight of the rule to the weight of the apple.

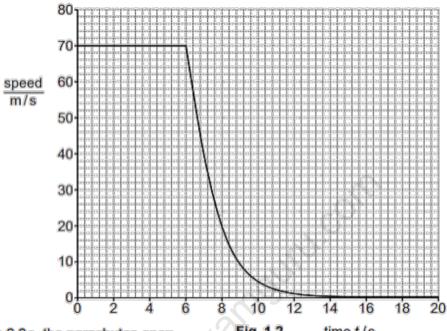
[1]

[Total: 7]

Fig. 1.1 shows the racing car, of total mass 750 kg, slowing down by using parachutes.



Fig. 1.2 is the speed-time graph for 20s after the car reaches full speed.



At time t = 6.0s, the parachutes open.

Fig. 1.2 time t/s

- (a) On Fig. 1.2,
 - (i) mark a point, labelled A, where the car is moving at constant speed,
 - (ii) mark a point, labelled B, where the car is decelerating at a uniform rate,
 - (iii) mark a point, labelled C, where the car is decelerating at non-uniform rate.
- (b) Calculate

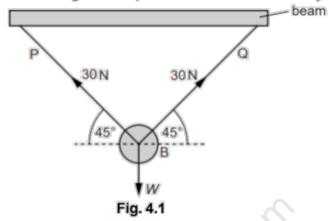
[3]

(i) the deceleration of the car at time t = 6.5 s,

(ii) the resultant force acting on the car at this time.

(c)	Explain why there is no resultant force acting on the car at time $t = 4.0 \mathrm{s}$.								
	[1]								
	[Total: 8]								

19 Fig. 4.1 shows a heavy ball B of weight W suspended from a fixed beam by two ropes P and Q.



P and Q are both at an angle of 45° to the horizontal. The tensions in P and Q are each 30 N.

(a) In the space below, draw a scale diagram to find the resultant of the tensions in P and Q. Use a scale of 1.0 cm to represent 5.0 N. Label the forces and show their directions with arrows.

		resultant =	. [4]
(b)	State the direction of the resultant.		. [1]
(c)	State the magnitude of W.	magnitude of W =	. [1]
		[Tota	ıl: 6]

20 Fig. 2.1 shows a uniform, rectangular slab of concrete ABCD standing upright on the ground. The slab has height 0.60 m, width 0.30 m and mass 18 kg. A force of 40 N acts horizontally to the left at B. 40 N 0.60 m D $0.30 \, \text{m}$ Fig. 2.1 (a) (i) Calculate the weight W of the concrete slab. (b) (i) On Fig. 2.1, draw and label an arrow to show the weight W of the slab acting at its centre of mass. [1] (ii) Calculate 1. the moment of the 40 N force about point D, moment = 2. the moment of W about point D.

(iii) The ground is rough so that the slab does not slide.

State and explain what happens to the slab as the horizontal force at B is gradually increased.

[2]

[7]

[7]

[7]

[7]

21	(a)	State the two conditions necessary for a system of forces acting on a body to be in equilibrium.						
		2						
		[2]						
	(b)	Fig. 1.1 shows a loaded wheelbarrow held in equilibrium by a gardener. The wheel of the wheelbarrow is in contact with the ground at point C.						
		Fig. 1.1						
		In Fig. 1.1, there are three vertical forces acting on the wheelbarrow.						
		 P is the upward force applied by the gardener. Q is the upward force of the ground on the wheel at point C. W is the weight of the wheelbarrow and its contents. 						
		Explain why the force P is less than the force W						
		(i) by considering the forces P, Q and W,						
		[2]						
		(ii) by considering the moments of the forces P and W about point C.						

(c) Fig. 1.2 shows a kitchen cupboard resting on a support and attached to a wall by a screw.

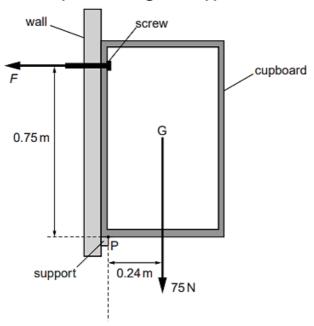


Fig. 1.2

The weight of the cupboard and its contents is 75 N. G is the position of the centre of mass of the cupboard.

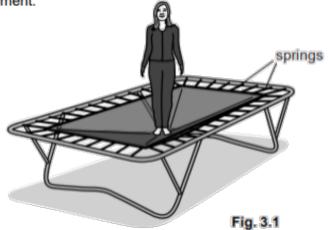
The clockwise and anticlockwise moments about point P are equal.

Calculate the force F exerted by the screw.

F	=	 	 	 [3]	
				[Total: 9)]

22 An athlete of mass 64 kg is bouncing up and down on a trampoline.

At one moment, the athlete is stationary on the stretched surface of the trampoline. Fig. 3.1 shows the athlete at this moment.



upw	stretched surface of the trampoline begins to contract. The athlete is pushed vertically vards and she accelerates. At time t , when her upwards velocity is 6.0m/s , she loses tact with the surface.
(i)	Calculate her kinetic energy at time t.
(ii)	kinetic energy =[2] Calculate the maximum possible distance she can travel upwards after time t.
	maximum distance =[3]
(iii)	In practice, she travels upwards through a slightly smaller distance than the distance calculated in (ii). Suggest why this is so.
	[1]
23 Fig. 3.	1 shows part of the extension-load graph for a spring.
	extension/cm 3.0
The sp	In the second se
(a) (i) (ii)	
	55

(b) The average value of the load between A and B is 6.0 N.

Calculate the work done in extending the spring from A to B.

work done =[2]

(c) The spring has an unstretched length of 4.0 cm.

An object is hung on the spring and the spring length increases from 4.0 cm to 6.0 cm.

(i) Calculate the mass of the object.

mass =[3]

(ii) The object is immersed in a liquid but remains suspended from the spring.

The liquid exerts an upward force on the object and the length of the spring decreases to 5.0 cm.

Calculate the upward force exerted on the object by the liquid.

upward force =[2]

[Total: 9]

24 (a) Fig. 4.1 shows a top view of a tourist vehicle in a game park and two elephants pushing against the vehicle. The two forces indicated are at right angles to each other.

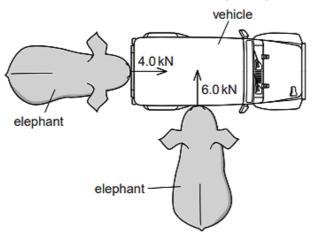


Fig. 4.1

		magnitude of resultant force =[3]
o)		4.2 shows another elephant pushing horizontally against a vehicle with a force of 11 kN at stance 1.8 m above the ground. Point M is the centre of mass of the vehicle.
		elephant
	(i)	Fig. 4.2 Calculate the moment about point A of the force exerted by the elephant.
	(ii)	moment =[2] The mass of the vehicle is 1900 kg, and it does not slide when pushed by the elephant.
	(")	Determine whether the elephant tips the vehicle over. Show your working.
		calculation

In the space below, draw a scale vector diagram to determine the magnitude of the resultant force. Label the two forces applied and the resultant, and clearly state the scale you use.

[Total: 7]

25 (a) (i) Mass is a scalar quantity.

State another scalar quantity.

(ii) Force is a vector quantity.

State another vector quantity.

(b) A boat is floating on still water.

The mass of the boat is 290 000 kg. A resultant force of 50 kN acts on the boat.

Calculate the acceleration of the boat.

acceleration =[3

(c) Fig. 2.1, not to scale, shows the view from above of the boat, now on a fast-flowing river. The boat accelerates.

Two forces are shown acting on the boat. The resultant of these forces is at right angles to the river banks.

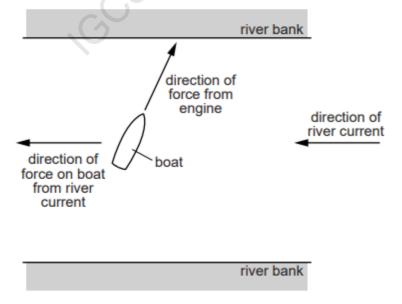


Fig. 2.1 (not to scale)

[2]

Fig. 2.2 is an incomplete vector diagram of the forces acting on the boat.

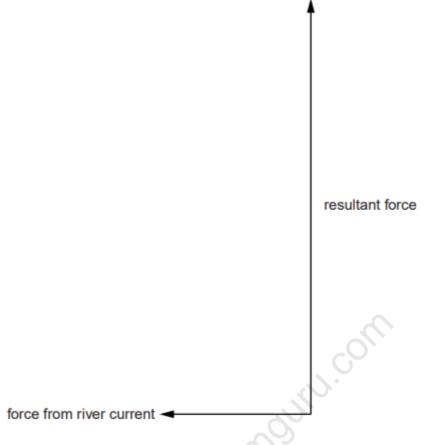


Fig. 2.2

The force from the river current is 80 kN.

(i)	Determine	the	scale	that	has	been	used	in	the	vector	diagram
-----	-----------	-----	-------	------	-----	------	------	----	-----	--------	---------

scale is

(ii) On Fig. 2.2, complete the vector diagram to determine the magnitude and direction of the force from the engine. Measure the angle between the direction of the current and the force from the engine.

> > [Total: 9]

[4]

Chapter 4: Momentum

42/FM/16 [Q2]

1 Fig. 2.1 shows a hammer being used to drive a nail into a piece of wood.

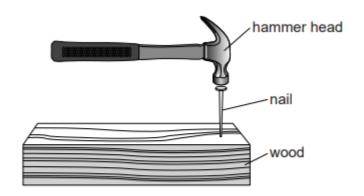


Fig. 2.1

The mass of the hammer head is 0.15kg.

The speed of the hammer head when it hits the nail is 8.0 m/s.

The time for which the hammer head is in contact with the nail is 0.0015 s.

The hammer head stops after hitting the nail.

(a) Calculate the change in momentum of the hammer head.

	change in momentum =	[2]
(b)	State the impulse given to the nail.	
	impulse =	[1]
(c)	Calculate the average force between the hammer and the nail.	

[Total: 5]

43/ON/16 [Q3]

2	(a)	(i)	State how a <i>vector</i> quantity differs from a <i>scalar</i> quantity.
		(ii)	State and explain whether <i>momentum</i> is a vector quantity or a scalar quantity.
			[1]
	(b)		pacecraft of mass 35 kg is travelling in a straight line at a velocity of 1200 m/s. Assume no ernal forces act on the spacecraft.
		Cal	culate
		(i)	the momentum of the spacecraft, momentum = [2]
		(ii)	the kinetic energy of the spacecraft. kinetic energy =
	(c)		rocket fuel stored in the moving spacecraft in (b) explodes and the spacecraft splits into sections. One section speeds up and the other section slows down.
		(i)	State what happens to the total momentum.
		(ii)	Predict and explain what happens to the total kinetic energy.
			[2]
			[Total: 9]

43/N	IJ/17 [Q2]		
3 (a)	State the word equation the	hat defines <i>momentun</i>	ı.
(b)		g in a straight line at	4.0 m/s on a smooth surface, collides with a shows the two metal blocks A and B before
	before collision	3.2 kg A 4.0 m/s	1.6 kg B at rest
	after collision		A 1.5 m/s B V
		Fig. 2.1	colu.
	The mass of A is 3.2kg. T After the collision, the velo		
	Calculate		2)
	(i) the momentum of A b	pefore the collision,	
		momentu	ım =[2]
	(ii) the velocity v of B aft	er the collision.	

v =[3]

(c)	In the collision that occurre	ed in (b) , block A and block E	3 are in contact for 0.050 s.	
	Calculate the average force	e that is exerted on B during	the collision.	
		average force =		[2]
(d)	After the collision in (b), t	he total kinetic energy of t		
(-,	energy of block A before th			
	Suggest one reason for thi	s.		
				[1]
				[Total: 9]
42/N	J/17 [Q3]		G	
(a)	Underline the pair of quant	ities which must be multiplie	ed together to calculate imp	oulse.
	force and mass	force and velocity	mass and time	
	time and velocity	weight and velocity	force and time	[1]
(b)	Fig. 3.1 shows a collision b	etween two blocks A and B	on a smooth, horizontal su	rface.
	Α	B	А В	
	2.4 kg 3.0 m/s	1.2 kg	V	
	before collision		after collision	
		Fig. 3.1		
	Before the collision, block at rest.	A, of mass 2.4 kg, is moving	at 3.0 m/s. Block B, of mas	ss 1.2kg, is
	After the collision, blocks A	and B stick together and m	ove with velocity v.	
	(i) Calculate			
	1. the momentum of	f block A before the collision	,	
		momentum =		[2]

																											,	۷	/E	е	lc	00	i	ty	y	:	=																												.[2	2]
		3.		t	ne	i	m	рι	ıls	se	e	X	pe	er	rie	en	nc	е	d	1	b	y	b	olo)(C	k		E	3	(dı	uI	ri	ir	1	g	t	he	е	С	Ю	ll	is	o	n.																				
																											i	r	r	ı	p	u	ls	66	е	:	=																				•••								[2	2]
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