Paper 1: [20 marks]
Answer all the questions in the OTAS provided.

1 Which of the following shows the correct S.I. units for the various quantities?

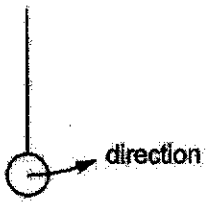
	mass	time	weight	moment
A	gram	minute	kilogram	newton centimetre
B	gram	second	newton	newton metre
C	kilogram	minute	kilogram	newton centimetre
D	kilogram	second	newton	newton metre

2 A voltage of 50 millivolts is applied across a resistor causing a current of 800 microampere to flow.

Which row gives the voltage in volts and the current in ampere?

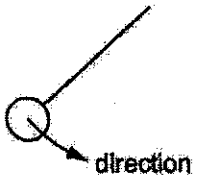
	voltage / V	current / A
A	0.00005	0.0008
B	0.00005	0.0000008
C	0.05	0.0008
D	0.05	0.0000008

3 A pendulum has a period of 1.0 s.
A stopwatch is started when the pendulum is vertical and is moving to the right as shown.

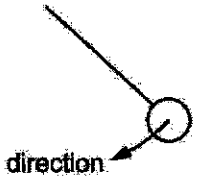


Which diagram shows the position and direction of the pendulum 5.75 s later?

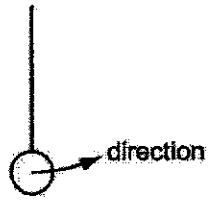
A



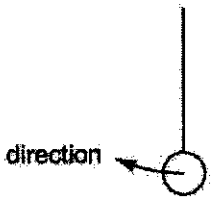
B



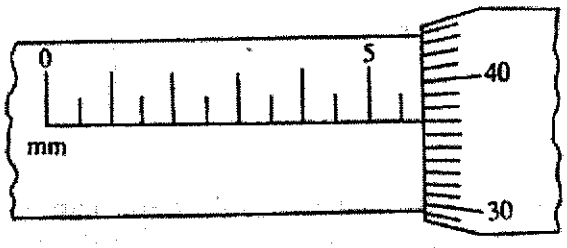
C



D



4 The diagram below shows the reading of a micrometer screw gauge when it is used to measure an object of length 5.62 mm.



What is the zero error of the micrometer screw gauge?

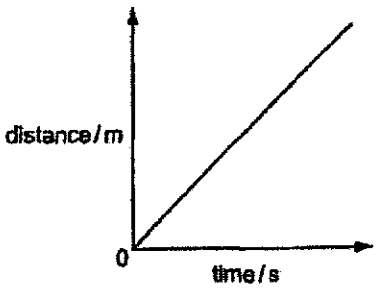
A - 0.25 mm
B + 0.25 mm
C - 0.75 mm
D + 0.75 mm

5 Which is a scalar quantity?

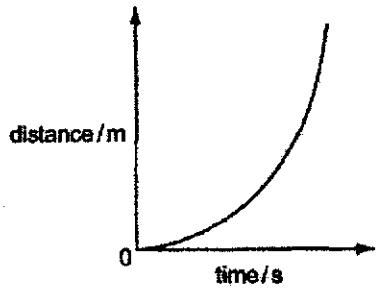
A acceleration
B weight
C speed
D displacement

6 The following are distance-time graphs. Which graph shows an object at rest?

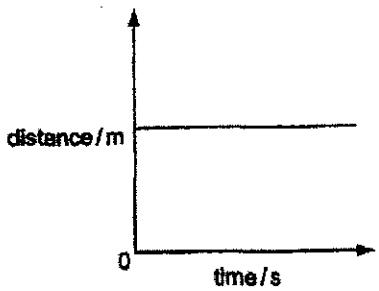
A



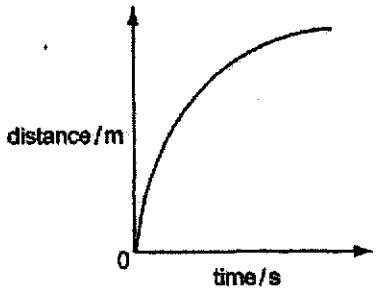
B



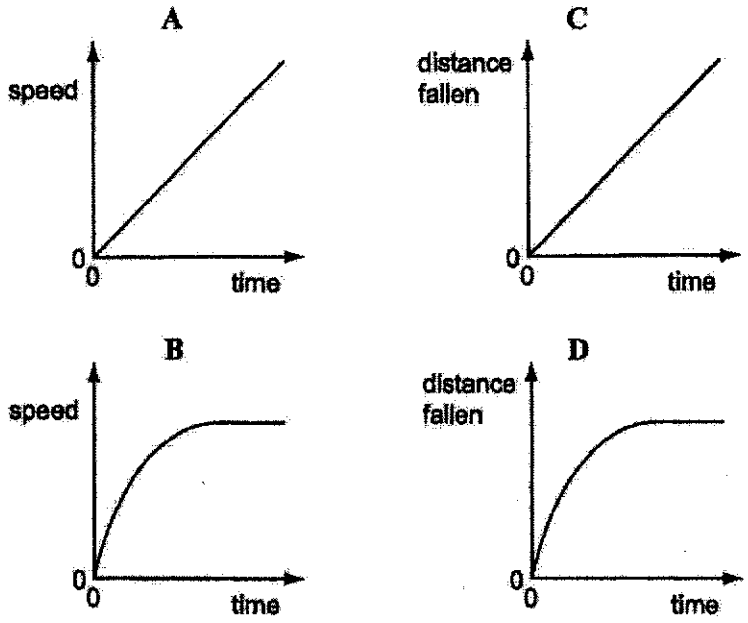
C



D



7 Which graph shows the motion of a heavy object falling from a height of 80 m (Neglect air resistance).



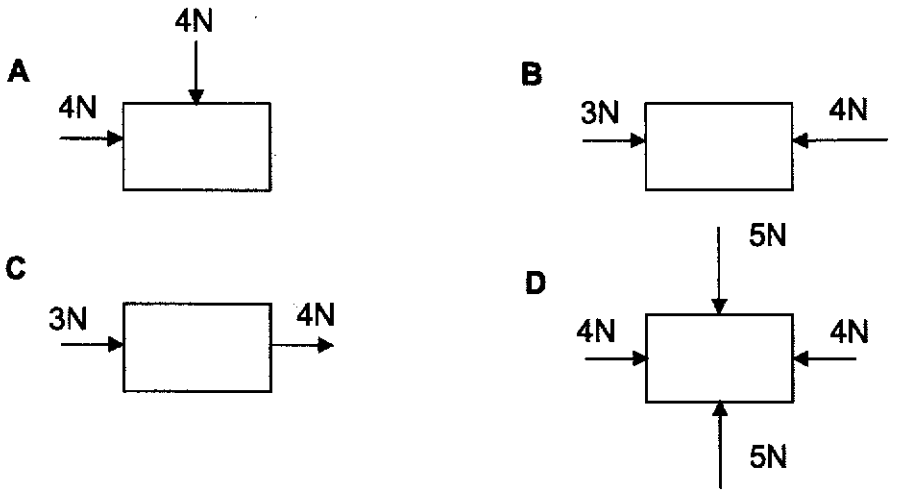
8 A car travels 80 m due North in 12.0 s. The car then turns around and travels 30 m due South in 8.0 s.

What is the magnitude of the resultant velocity of the car during this 20 second interval?

A 1.5 m / s **B** 2.5 m / s
C 4.0 m / s **D** 5.5 m / s

9 The diagrams below show four bricks with forces applied on them.

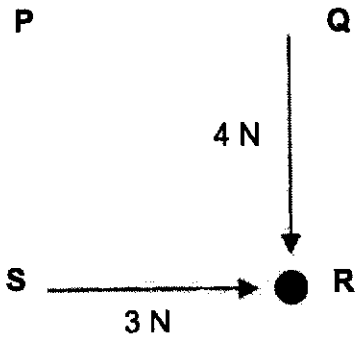
Which brick will move with the greatest acceleration when the forces are applied?



10 When two equal and opposite forces act on an object moving with constant velocity, what will happen to the moving object?

A The object will move faster as it was already moving.
B The object will move slower due to the equal and opposite forces.
C The object will stop immediately as there is no resultant force.
D The object will continue to move with the same velocity.

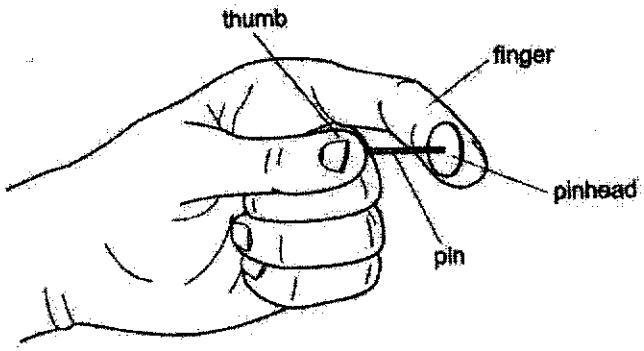
11 The diagram below shows two forces acting at right angle on a ball.



What is the magnitude and direction of the resultant force acting on the ball?

	magnitude / N	direction
A	5	**PR**
B	5	**RP**
C	7	**PR**
D	7	**RP**

12 A pin is squeezed between the finger and thumb as shown below.



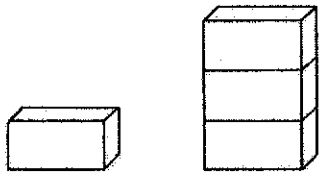
Which statement is correct?

A The force of the pin is larger on the finger than on the thumb.
B The force of the pin is larger on the thumb than on the finger.
C The pressure of the pin is larger on the finger than on the thumb.
D The pressure of the pin is larger on the thumb than on the finger.

13 Which property of a block of metal remains constant when it is heated?

A volume **B** mass
C density **D** surface area

14 The diagram below shows a single brick and a stack of three bricks. All the bricks are identical.



Compared to the single brick, the stack of bricks has

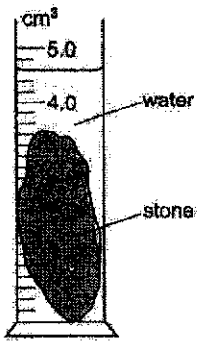
A three times the mass, volume and density.
B the same mass but three times the volume and density.
C the same density but three times the mass and volume.
D the same volume but three times the mass and density.

15 The weight of a meteorite on Earth is 680 N and on Mars is 252 N.
The gravitational field strength on Earth is 10 N / kg.

What is the gravitational field strength on Mars?

A 0.27 N / kg **B** 0.37 N / kg
C 2.70 N / kg **D** 3.71 N / kg

16 The diagram shows a measuring cylinder that contains water and a stone.

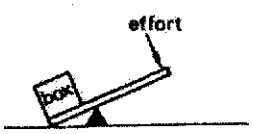


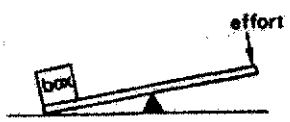
The initial volume of water in the measuring cylinder is 2.0 cm^3 and the mass of the stone is 3.0 g.

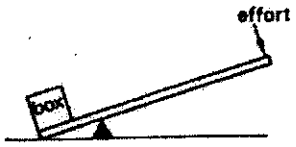
What is the density of the stone?

A 0.65 g / cm^3 **B** 0.87 g / cm^3
C 1.15 g / cm^3 **D** 1.53 g / cm^3

17 Four methods of lifting a heavy box using a lever are shown below.
Which method would most effort be needed to lift the box?

A 

B 

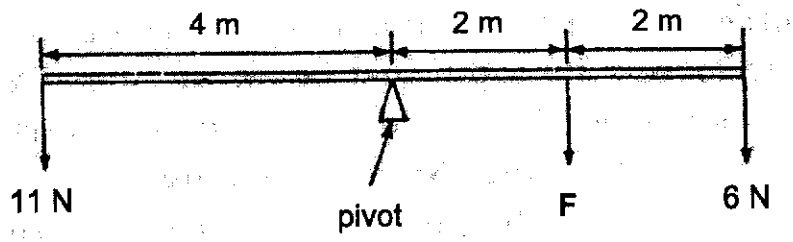
C 

D 

18 The centre of gravity of a body hanging freely is located _____.

A vertically below the pivot
B vertically above the pivot
C at the right of the pivot
D at the left of the pivot

19 A uniform beam, 8 m long, is pivoted at the centre.
Two forces of 6 N and 11 N are applied to the beam as shown below.



What is the value of force **F** needed to balance the beam?

A 10 N
B 16 N
C 20 N
D 32 N

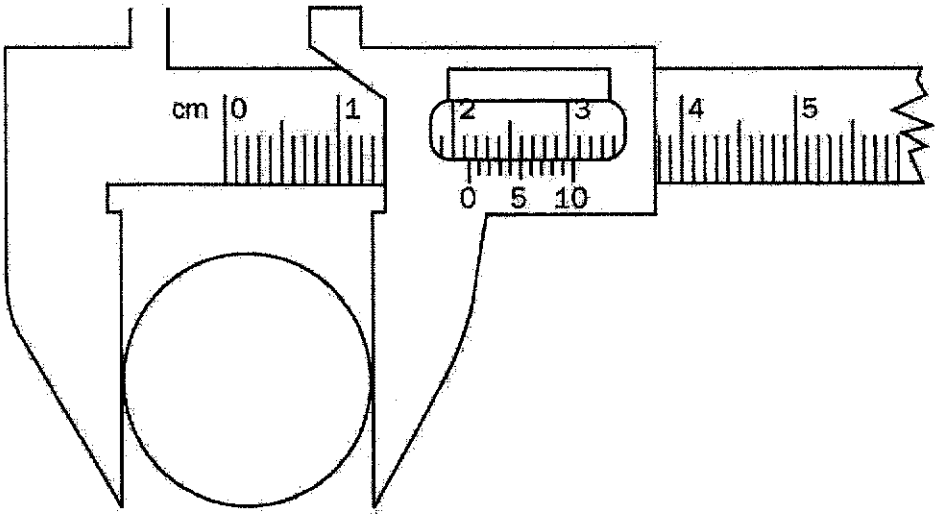
20 A pendulum is raised at the side and set oscillating. After some time, the pendulum returned to its original rest position. What kind of equilibrium is this illustrating?

A unstable equilibrium
B stable equilibrium
C neutral equilibrium
D none of the above

Section A

Answer **all** the questions in the spaces provided.

1 **(a)** A student measures the diameter of a metal ball bearing using a pair of vernier calipers as shown below.



(i) State the reading shown on the vernier calipers.

..... [1]

(ii) Describe two precautions one should take before using the vernier calipers to perform measurement.

.....

.....

..... [2]

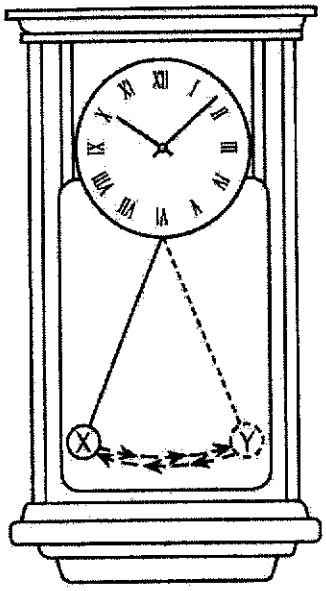
(iii) Describe how the student can improve the accuracy of the above results.

.....

.....

..... [2]

(b) A student checks the accuracy of a grandfather's clock by using a digital stopwatch to find the period of its oscillation.



(i) State what is meant by period of oscillation?

..... [1]

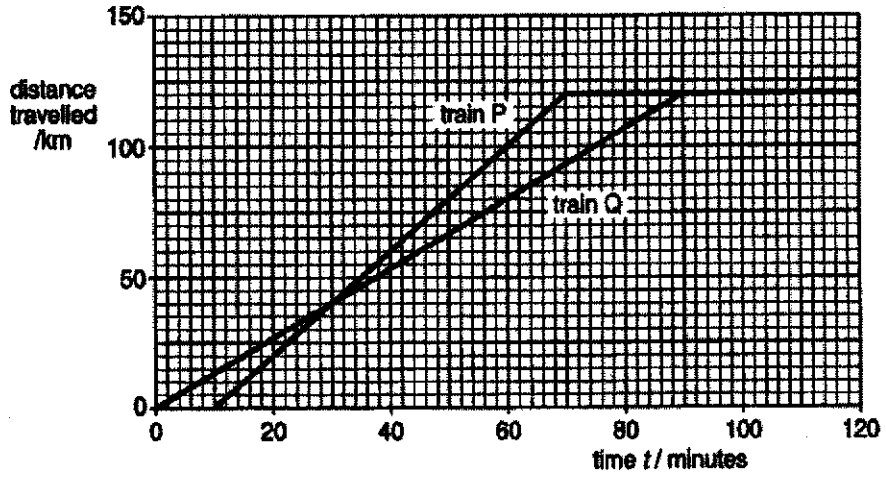
(ii) His timings for three separate measurements of 20 oscillations are 27.01 s, 26.24 s and 27.15 s respectively.
Calculate the average period of the grandfather's clock.

average period = ... s [2]

(iii) The timing from the grandfather's clock is found to be slower, state what needs to be done to make the timing faster.

..... [1]

2 Two trains **P** and **Q** travel between the same two stations on parallel tracks. The graph below shows the distance-time graph of the two trains.



Train **Q** starts its journey at time t = 0 minutes and train **P** starts its journey at t = 10 minutes.

(a) Explain how the above graph shows that train **P** has a greater speed than train **Q**.

..... [1]

(b) From the graph, state the distance when train **P** will overtake train **Q**.

..... [1]

(c) Calculate the speed of train **Q** giving your answers in km / h.

speed = ... km / h [2]

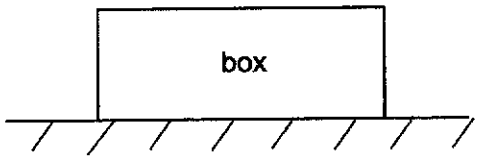
(d) Calculate the average speed of train **P**.

average speed = ... km / h [2]

(e) Another train **R** makes the same journey. It travels at the same speed as train **P**. Train **R** leaves 40 minutes later than train **P**. On the same graph, draw the distance-time graph for train **R**. [2]

3 A box is pushed to the left by a force of 80 N and a frictional force of 35 N acts from the ground.

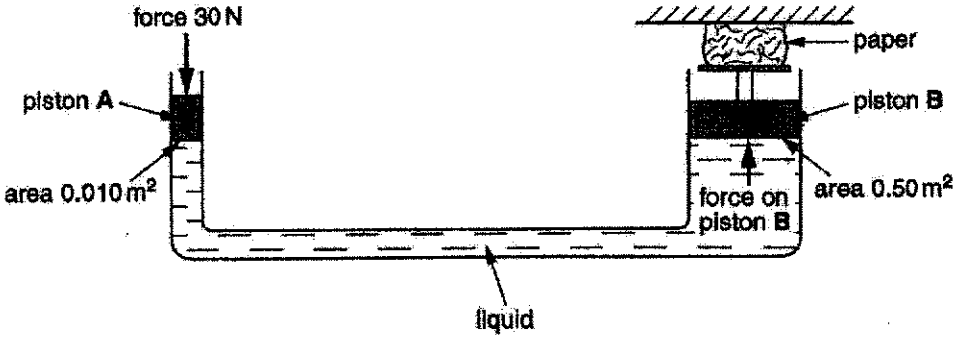
(a) Draw the forces, with magnitude, acting on the box. [2]



(b) Calculate the mass of the box if the acceleration is 5 m / s^2.

mass = ... kg [2]

4 The diagram below shows a hydraulic device that is used to compress paper in a waste disposal site.



A force of 30 N applied at piston **A** exerts a pressure. The liquid transmits this pressure to piston **B** which then causes a force to be exerted on the paper.

The area of piston **A** is 0.010 m^2 and the area of piston **B** is 0.50 m^2.

(a) Calculate the pressure exerted by piston **A**.

pressure exerted = ... N / m^2 [2]

(b) Calculate the force exerted on piston **B**.

force exerted = ... N [2]

(c) Suggest how the distance moved by piston **B** compares with the distance moved by piston **A**. Explain your answer.

.....

.....

..... [2]

5 **(a)** What is inertia?

.....

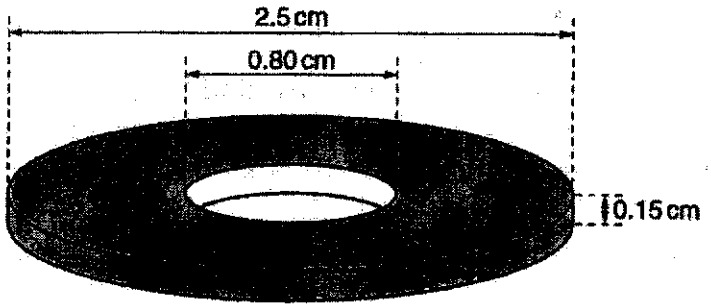
..... [1]

(b) State the effect on inertia if the mass of an object is decreased.

.....

..... [1]

6 The diagram below shows a metal washer of mass 6.5 g.
The washer is 0.15 cm thick. The internal and external diameters are marked as shown below.



(a) Calculate the volume of metal in the washer, given that the volume of a cylinder = $\pi r^2 h$.

volume of metal = ... cm^3 [2]

(b) Calculate the density of the metal.

density of metal = ... g / cm^3 [2]

(c) State the effect on the density of the metal if the metal washer is cut into two halves.

..... [1]

7 An allow is a mixture of two or more metals. One alloy is made by melting 4 cm^3 of a metal of density 5 g / cm^3 with 8 cm^3 of another metal of density 6 g / cm^3.
Assuming there are no changes in the volume as the alloy is made, calculate

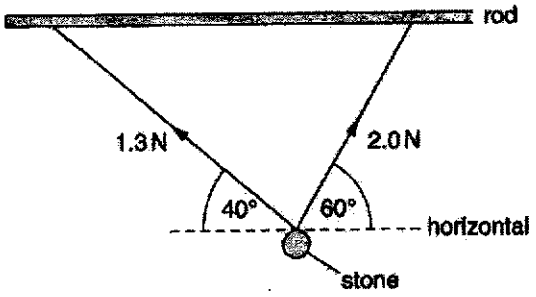
(a) the mass of the alloy,

mass of alloy = ... g [2]

(b) the density of the alloy.

density of alloy = ... g / cm^3 [2]

8 The diagram shows a stone supported by two strings that hang from a rod. The tensions in the strings are 2.0 N and 1.3 N as shown below.

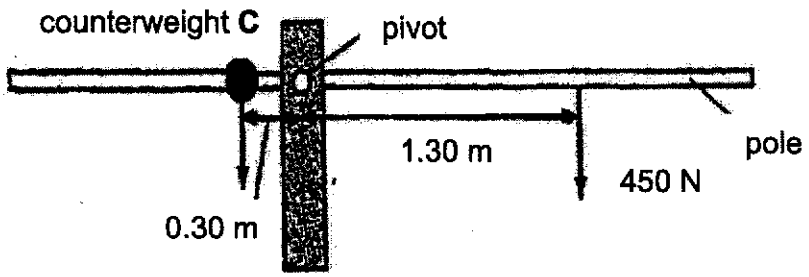


In the space below, draw a labelled vector diagram to determine the size of the resultant force.

scale used =

resultant force = ... N [4]

9 The diagram below shows a barrier found in most carparks. The barrier is in equilibrium. The weight of the pole is 450 N and the centre of gravity of the pole is 1.30 m away from the pivot. The centre of the counterweight is positioned 0.30 m from the pivot.



(a) Calculate the weight of the counterweight **C** needed to balance the pole.

weight of counterweight **C** = ... N [2]

(b) Suggest one practical way in which this system can be modified so that a smaller downward force from the counterweight can be used to overcome the weight of the pole.

.....

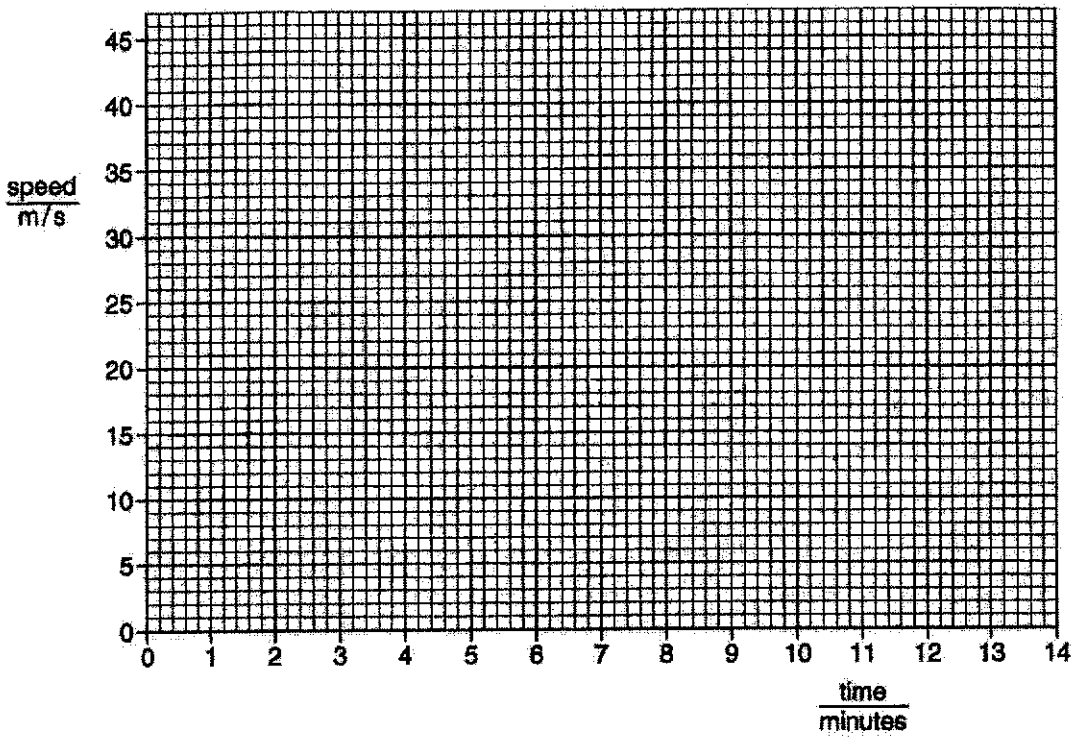
..... [1]

Section B

Answer any **two** questions in the spaces provided.

10 A car travels at 20 m / s for 3 minutes. It then accelerates uniformly to a speed of 35 m / s in 3 minutes. It then travels at this uniform speed for another 5 minutes before decelerating uniformly to rest in 2 minutes.

(a) Using the grid below, plot a graph to show the variation with time of the speed of the car. [3]



(b)(i) Calculate the acceleration of the car as it increases speed from 20 m / s to 35 m / s.

acceleration = ... [2]

(ii) Calculate the **total** distance moved by the car when it is travelling at uniform speed.

total distance = ... [2]

(c)(i) State what is meant by uniform acceleration.

.....

..... [1]

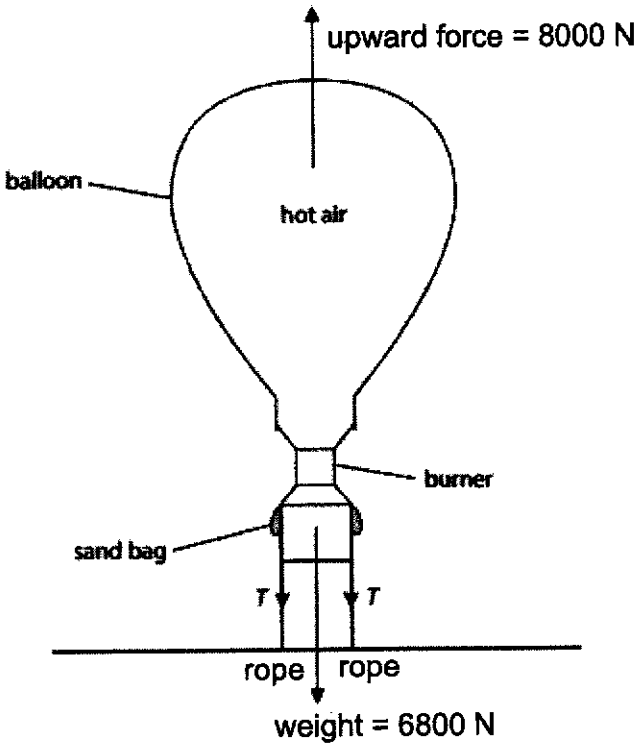
(ii) What is the acceleration of the car when it is moving at uniform speed? Explain your answer.

.....

.....

..... [2]

11 A hot air balloon is tied to the ground by two ropes. The diagram below shows the forces acting on the balloon.



The ropes are untied and the balloon starts to move upwards.

(a) What is the tension **T** in the rope before the ropes are untied?

tension = ... [2]

(b) State the value of the force acting downwards immediately after the ropes are untied.

..... [1]

(c) Calculate the initial acceleration of the balloon when the ropes are untied. Show clearly the formulae used.

acceleration = ... [3]

(d) Draw the free body diagram of the balloon with the forces acting on it when it is tied to the ground. [2]

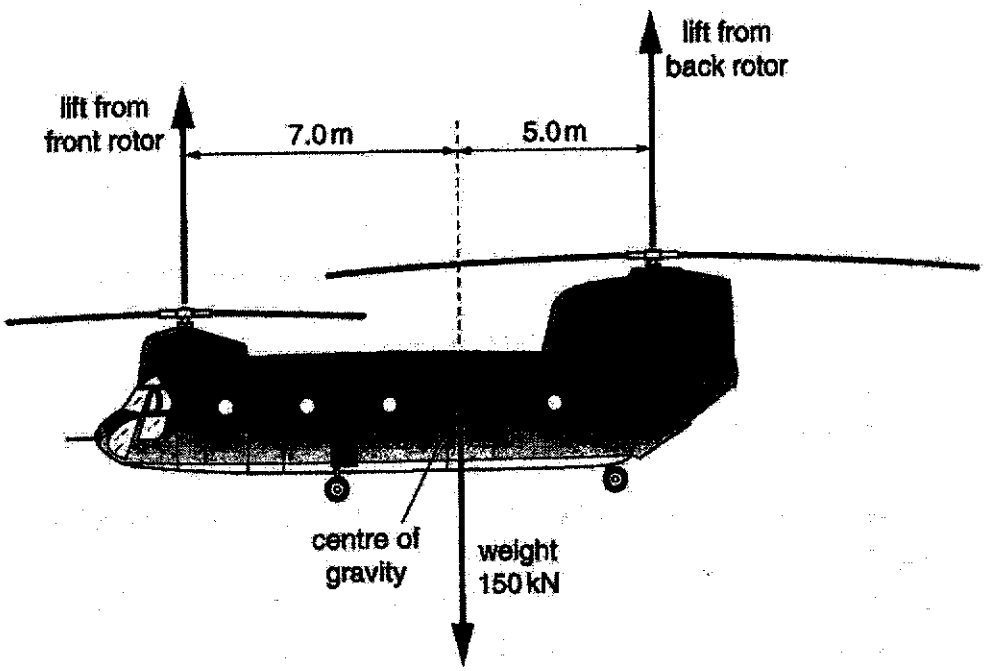
(e) When the balloon is still accelerating, the pilot pours some sand away from the bags. Explain how this affects the upward acceleration of the balloon.

.....

.....

..... [2]

12 The diagram below shows a helicopter stationary in the air.
Vertical forces are produced by the front rotor and the back rotor.



The weight of the helicopter is 150 kN and the horizontal distances are marked above as shown. The gravitational field strength g is 10 N / kg.

(a)(i) State two differences between mass and weight.

.....

.....

..... [2]

(ii) Determine the mass of the helicopter.

mass of helicopter = ... [2]

(b)(i) State the principle of moments.

.....

.....

..... [2]

(ii) By taking moments about **X**, calculate the lift force from the front rotor required to keep the helicopter in equilibrium.

lift force = ... [2]

(iii) By taking moments about **X**, what is the moment produced by lift force from the back rotor? Explain your answer.

.....

.....

..... [2]

End of Paper 2

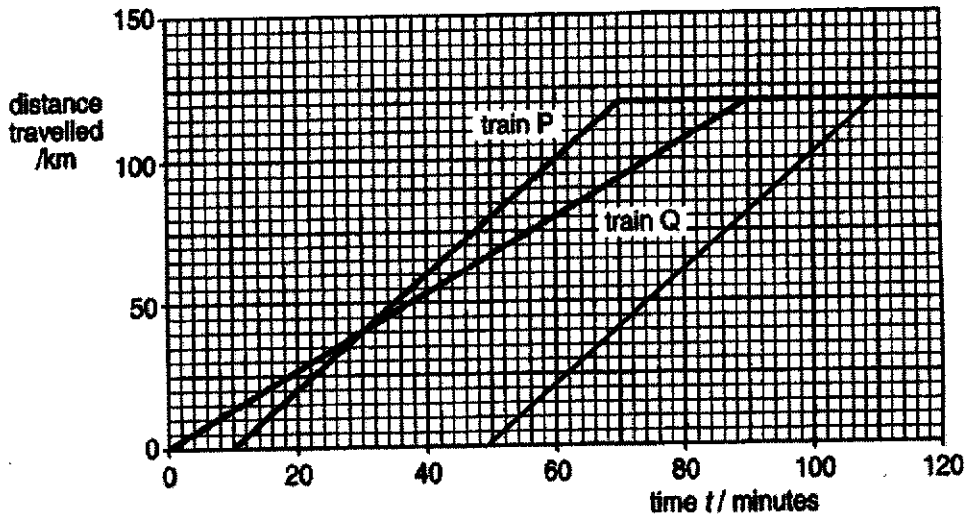
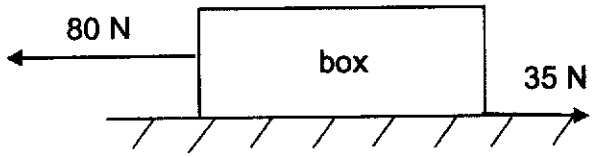
3E Science Physics (MYE) Answers
Paper 1 [20 marks]

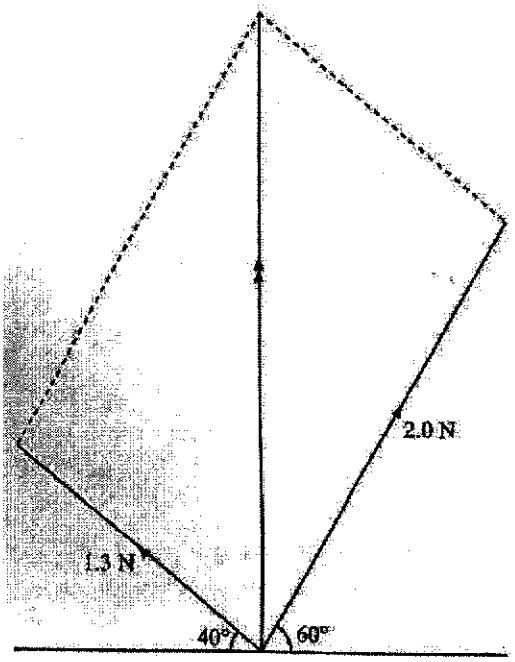
1	D	11	A
2	C	12	D
3	A	13	B
4	B	14	C
5	C	15	D
6	C	16	C
7	A	17	D
8	B	18	A
9	C	19	A
10	D	20	B

Paper 2

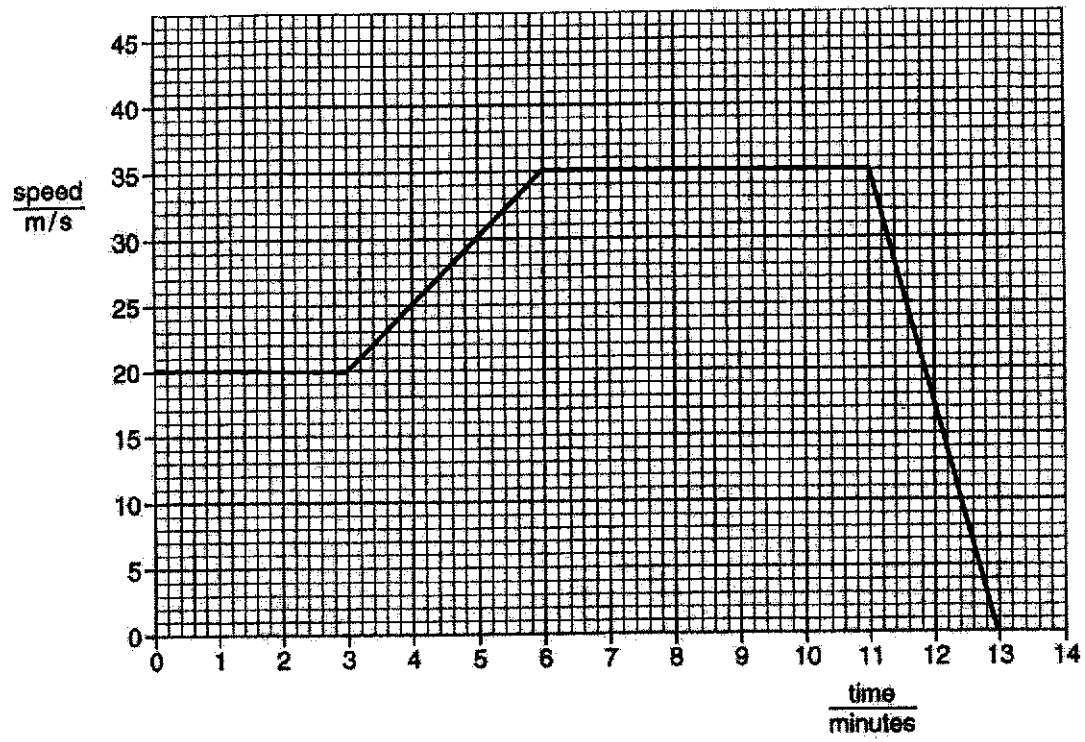
Section A: [45 marks]

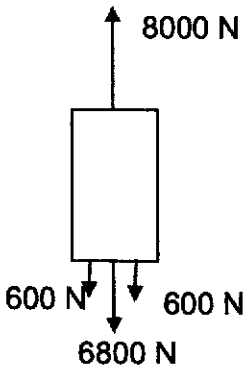
No.	Answer	Marks
1(a) (i)	2.14 cm	B1
(ii)	- Check the vernier calipers for any zero error. - Grip the object gently using the outside jaws of the vernier calipers.	B1 B2
(iii)	Obtain several readings of the diameter [1] by taking measurements at various points. Then, calculate the average value of the readings [1].	B1 B2
1(b) (i)	Period of oscillation refers to the time taken for one complete oscillation.	B1
(ii)	Average time for 20 oscillations = (27.01 + 26.24 + 27.15) / 3 = 26.80 s Average period = 26.80 / 20 = 1.34 s	M1 A1
(iii)	Shorten the length of the pendulum.	B1
2(a)	Gradient of train P, which represents the speed, is greater than train Q / Train P took a shorter time to reach the same destination than train Q.	B1
(b)	40 km	B1
(c)	Speed of train Q = gradient = 120 km / (90 / 60) h = 80 km / h	M1 A1
(d)	Average speed = total distance / total time = 120 km / (60 / 60) h = 120 km / h (to 3 sf)	M1 A1

(e)	 1 mark if the graph starts at t = 50 minutes 1 mark if the line has the same gradient as train P.	
3(a)		1 mark for correct 80 N and 1 mark for correct 35 N forces drawn. Note: 1 mark will be deducted if 80 N force is not longer than 35 N force.
(b)	Using F – f = ma => 80 – 35 = m x 5 m = 9 kg	M1 A1
4(a)	Using P = F / A = 30 / 0.010 = 3000 N / m^2	M1 A1
(b)	Using F = P x A = 3000 x 0.50 = 1500 N	M1 A1
(c)	Piston B should move a shorter distance [1] compared to piston A because for the volume of liquid pushed down by piston A, the same volume of liquid will be pushed up but spread over a bigger area [1].	B1 B2
5(a)	Inertia refers to the reluctance of the object to changes its state of motion, due to its mass.	B1
(b)	decreases	B1
6(a)	Using V = A x h = [π(1.25)^2 – π(0.40)^2] x 0.15 = 0.661 cm^3	 M1 A1
(b)	Using density = mass / volume = 6.5 / 0.661	Allow ecf M1 A1

	= 9.83 g / cm^3 (to 3 sf)	
(c)	No effect on density	B1
7(a)	Using mass = density x volume = (5 x 4) + (6 x 8) = 68 g	 M1 A1
(b)	Using density = total mass / total volume = 68 / (4 + 8) = 5.67 g / cm^3 (to 3 sf)	 M1 A1
8	scale used = 1 cm : 0.2 N  resultant force = 2.6 N → A1	1 mark for scale 1 mark for correct parallelogram drawn with dotted lines 1 mark for double arrow resultant force 1 mark for correct answer within range of 2.4 – 2.8 N
9(a)	Using anti-clockwise moment = clockwise moment F x 0.30 = 450 x 1.30 F = 1950 N	 M1 A1
(b)	The counterweight can be shifted further away from the pivot [1] OR use a lighter pole [1] so that a smaller downward force can be used to overcome the weight of the pole.	B1

Section B: [20 marks]

10 (a)	 1 mark will be deducted for any wrong section of the graph.	
(b) (i)	Using a = v – u / t = 35 – 20 / (3 x 60) = 0.0833 m / s^2 (to 3 sf)	M1 A1 Note: 1 mark will be deducted if student did not convert the time to seconds.
(ii)	Total distance = (20 x 180) + (35 x 300) = 14 100 m	M1 A1 Note: 1 mark will be deducted if student did not convert the time to seconds.
(c) (i)	Uniform acceleration is the constant rate of change of velocity.	B1
(ii)	The acceleration of the car is zero [1] because there is no change in the speed [1].	B1 B2
11 (a)	T = (8000 – 6800) / 2 = 600 N	M1 A1
(b)	6800 N	B1
(c)	Resultant force = 8000 – 6800 = 1200 N	M1

<table>
<tr><td></td><td>Using a = F / m = 1200 / 680 → M1
= 1.76 m / s^2 (to 3 sf) → A1</td><td>B1 for formula
A1</td></tr>
<tr><td>(d)</td><td> 
</td><td>1 mark for correct upward force drawn
1 mark for all correct downward forces drawn
Note: 1 mark will be deducted for any missing forces.</td></tr>
<tr><td>(e)</td><td>The acceleration of the balloon increases [1] as the weight of the balloon decreases / resultant force upwards increases [1]</td><td>B1

B2</td></tr>
<tr><td>12
(a)
(i)</td><td><table>
<tr><td>Mass</td><td>Weight</td></tr>
<tr><td>amount of matter in a body</td><td>a gravitational force</td></tr>
<tr><td>scalar quantity</td><td>vector quantity</td></tr>
<tr><td>SI unit: kg</td><td>SI unit: N</td></tr>
<tr><td>independent of gravitational field strength</td><td>dependent on gravitational field strength</td></tr>
</table></td><td>B2</td></tr>
<tr><td>(ii)</td><td>Using m = W / g = 150 000 / 10
= 15 000 kg</td><td>M1
A1</td></tr>
<tr><td>(b)
(i)</td><td>The principle of moment states that when a body is in equilibrium, the sum of clockwise moments about the pivot is equal to the sum of anti-clockwise moments about the same pivot.</td><td>B2
Note: 1 mark is deducted for any missing key points.</td></tr>
<tr><td>(ii)</td><td>F x 12.0 = 150 000 x 5.0
F = 62 500 N</td><td>M1
A1</td></tr>
<tr><td>(iii)</td><td>The moment produced by the lift force from the back rotor is zero [1] as the distance between the force and the pivot is zero [1].</td><td>
B1
B2</td></tr>
</table>