HILLGROVE SECONDARY SCHOOL
END OF YEAR EXAMINATION 2019
SECONDARY THREE (EXPRESS)

CANDIDATE NAME ( ) CLASS -

CENTRE NUMBER S INDEX NUMBER

PHYSICS 6091

8 Oct 2019

2 hours 15 minutes

9.45 AM to 12.00 PM

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on the work you hand in.
You may use an HB pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

Section A
Answer **all** questions. For each question there are four possible answers A, B, C and D.
Choose the one you consider correct and record your choice in soft pencil on the separate Answer Sheet.

Section B and C
Answer **all** questions.
Write your answers in the space provided on the question paper.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section	**Marks**
A	**/ 30**
B and C	**/ 70**
TOTAL	**/ 100**

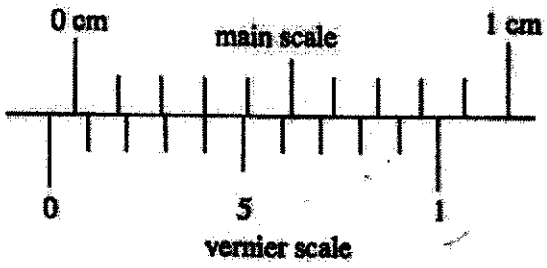
Parent's/ Guardian's Signature: _____

Setter: Mr. Jonathan Ho

This document consists of 31 printed pages.

Section A: Multiple Choice Questions [30 marks]

1 The diagram shows the reading of a vernier caliper when its jaws are closed.



What is the zero error shown?

A -0.06 cm

B -0.04 cm

C 0.04 cm

D 0.06 cm

2 Fig. 2.1 shows the reading of the zero error of the micrometer screw gauge. Fig. 2.2 shows the reading of the same instrument when it is used to measure the width of an object.

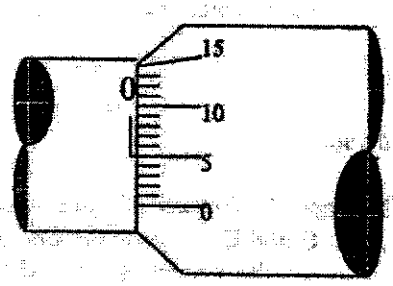


Fig. 2.1

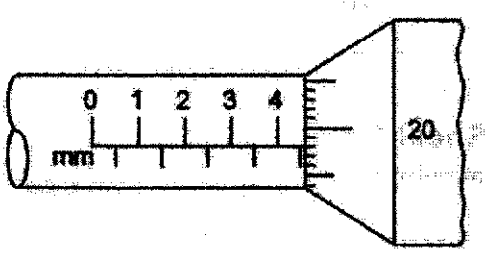


Fig. 2.2

What is the actual width of the object?

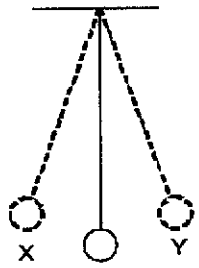
A 4.63 mm

B 4.73 mm

C 4.83 mm

D 4.85 mm

3 The diagram shows a simple pendulum. It takes 36.0 s for the pendulum to swing from X to Y and back again to X twenty times. What is the period of the pendulum?



A 0.9 s

B 1.8 s

C 9.0 s

D 18 s

4 A plumber measures, as accurately as possible, the length and internal diameter of a straight copper pipe. The length is approximately 80 cm and the internal diameter is approximately 2 cm.

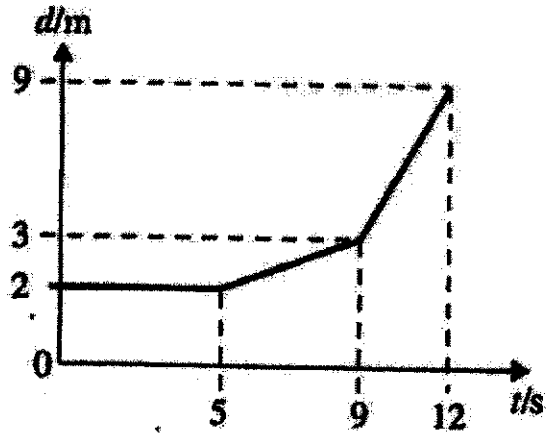
What is the best combination of instruments for the plumber to use?

	internal diameter	length
A	rule	rule
B	rule	tape
C	Vernier calipers	rule
D	Vernier calipers	tape

5 Which row correctly lists one scalar and one vector quantity?

	scalar quantity	vector quanttiy
A	displacement	work
B	energy	force
C	force	acceleration
D	velocity	mass

6 The distance-time graph of a car is shown below.



When was the car travelling at 2 m/s?

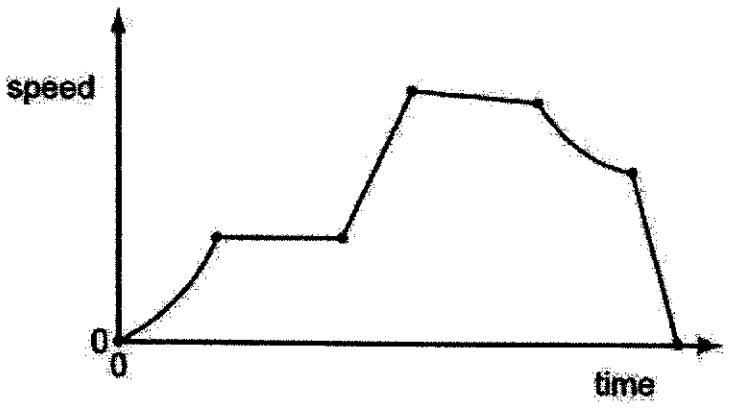
A 2.5 s

B 5.0 s

C 8.0 s

D 10.5 s

7 The speed-time graph represents the journey of a car. The dots separate different sections of the journey. There are six different sections.



How many sections represent the car moving with non-uniform acceleration?

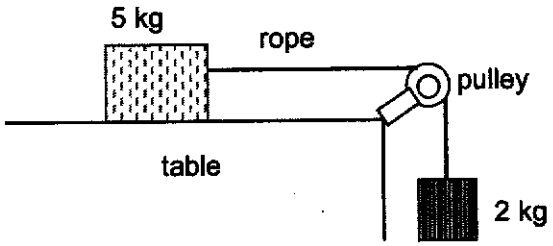
A 0

B 1

C 2

D 3

8 A 5 kg mass on a table is connected to a 2 kg mass by a rope which passes over a smooth pulley.



If the acceleration of the 5 kg mass is 2.0 m/s^2, find the friction between the 5 kg mass and the table.

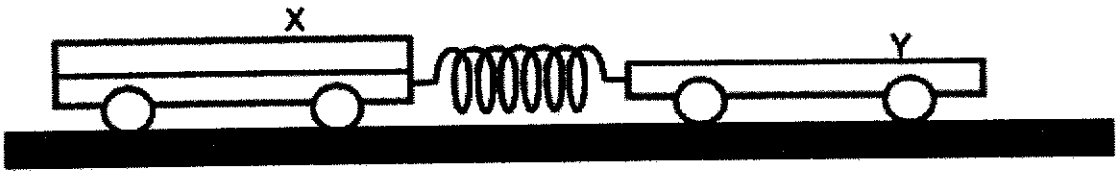
A 6 N

B 10 N

C 14 N

D 20 N

9 Trolley X and trolley Y are joined together by a compressed spring. The mass of trolley X is twice that of trolley Y. Both trolleys are initially at rest. When the trolleys are released, trolley Y accelerates to the right at 1.0 m/s^2.



What is the acceleration of trolley X?

A 0.50 m/s^2 to the left

B 0.50 m/s^2 to the right

C 2.0 m/s^2 to the left

D 2.0 m/s^2 to the right

10 Which statement about gravitational fields is correct?

A It is the gravitational force per unit mass.

B It is the region in which a mass experiences a force due to gravity.

C It is the amount of gravitational force acting on an object.

D It is the amount of force acting on an object.

11 What is inertia a measure of?

A ability for objects to move

B ability for objects to stop

C initial mass of bodies

D reluctance for objects to start moving and stop moving

12 What would happen to a space craft travelling in empty space if its engine were turned off?

A It would continue to move with constant acceleration.

B It would continue to move with constant deceleration.

C It would continue to move with constant velocity.

D It would stop moving.

13 A crown is made of a mixture of gold and silver.

Given that the mass of crown = 1000 g, the volume of crown = 64.8 cm^3, the density of gold is 19.3 g/cm^3, and the density of silver is 10.5 g/cm^3, find the percentage mass of gold and silver in the crown.

	% of Gold	% of Silver
A	29.9	70.1
B	35.2	64.8
C	64.8	35.2
D	70.1	29.9

14 Ice of mass 10 g, volume 11 cm^3 and temperature -3°C is added to water of mass 20 g, volume 20 cm^3 and temperature 30°C in a cup. The ice melted and all the water returns to 30°C. What is the final density of the water?

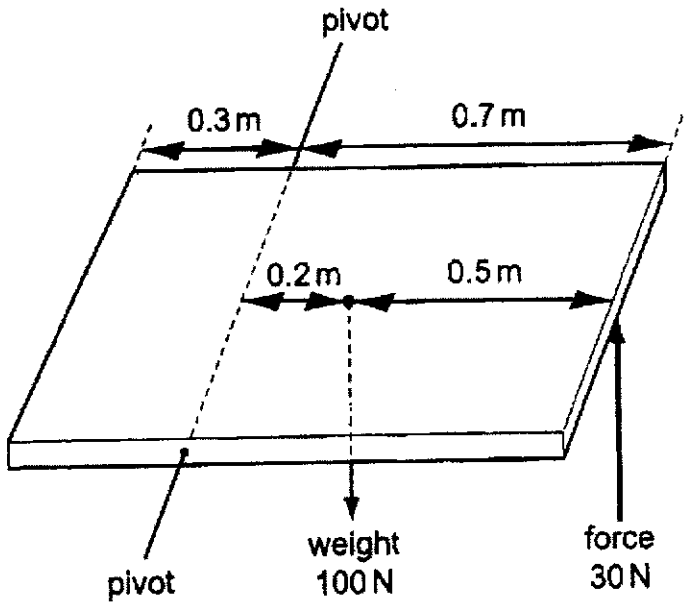
A 0.91 g cm^{-3}

B 0.95 g cm^{-3}

C 0.97 g cm^{-3}

D 1.00 g cm^{-3}

15 A pivoted window of weight 100 N is opened with a force of 30 N as shown.



What is the magnitude of the resultant moment about the pivot?

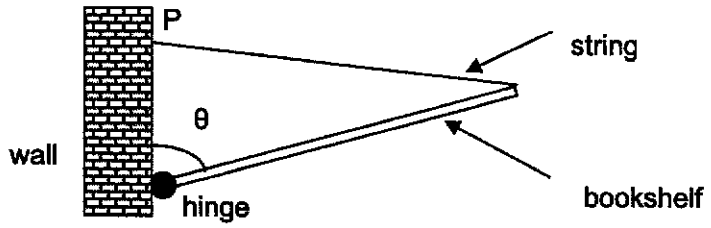
A 1 Nm

B 5 Nm

C 35 Nm

D 41 Nm

16 A string is tied to the wall at a fixed point P to help to secure a bookshelf.



Which of the following will help minimise the tension in the string in order to help it last longer?

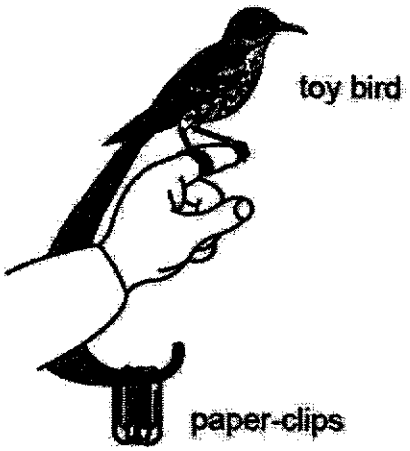
A decrease the angle of θ

B have a longer bookshelf

C less friction at hinge

D use steel bookshelf instead of light wooden one

17 A girl uses paper-clips to balance a toy bird on her finger as shown.



What is the effect of the paper-clips?

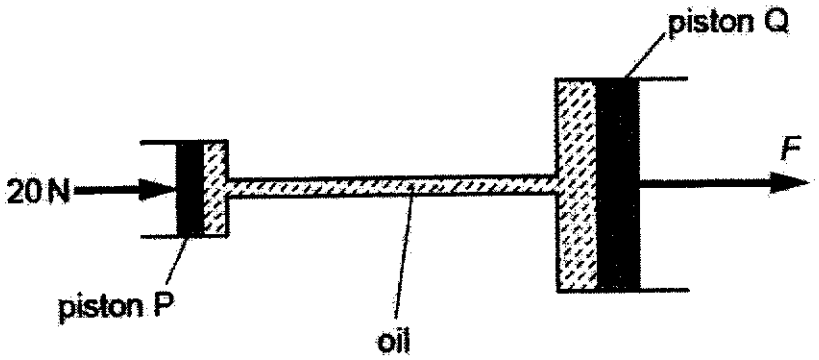
A They help to raise the centre of gravity above her finger.

B They help to raise the centre of gravity to her finger.

C They help to lower the centre of gravity below her finger.

D They do not affect the centre of gravity but increase the weight.

18 The diagram shows a simple model of the braking system of a car. A force of 20 N is applied to piston P. As a result, there is a force F on piston Q.



Piston P has an area of 5.0 cm^2 and piston Q has an area of 25 cm^2.

What is the force F?

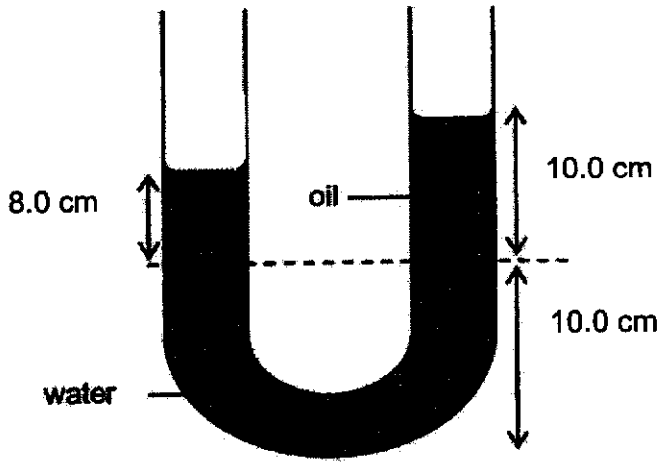
A 4.0 N

B 20 N

C 100 N

D 500 N

19 The diagram shows a U-tube containing some oil and also some water of density 1.00 g/cm^3.



What is the density of the oil?

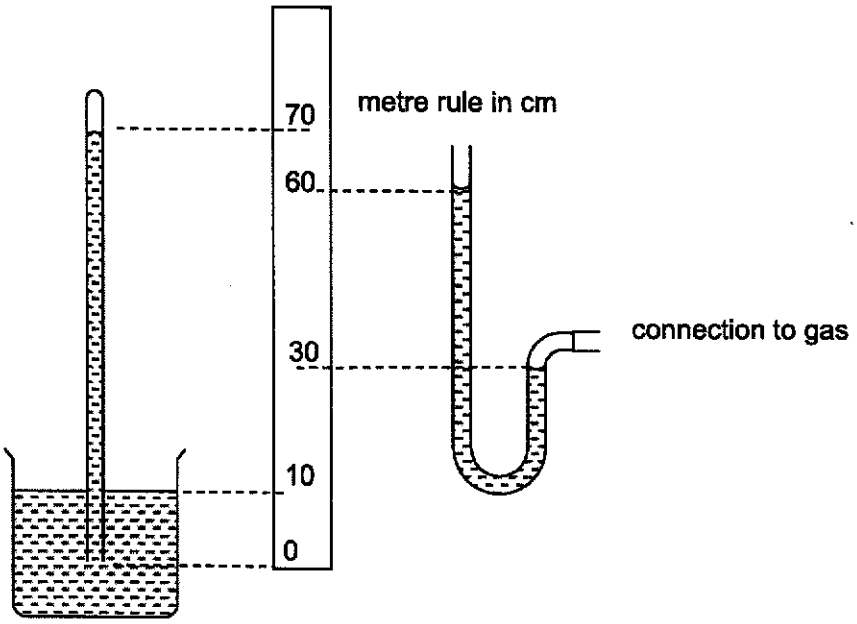
A 0.80 g/cm^3

B 0.90 g/cm^3

C 1.11 g/cm^3

D 1.25 g/cm^3

20 A mercury barometer and a mercury manometer are placed in the same room which is on a hill top. The manometer is connected to a gas container.



What is the pressure of the gas?

A 15 cm Hg

B 40 cm Hg

C 75 cm Hg

D 90 cm Hg

21 Below are three actions that a barometer manufacturer could take to modify a barometer.

- insert the opening of the tube deeper into the trough of liquid
- use a glass tube of larger inner diameter
- use a longer glass tube

How many of the above stated actions will not affect the height of the liquid level above the liquid surface in the column of a barometer?

A 0

B 1

C 2

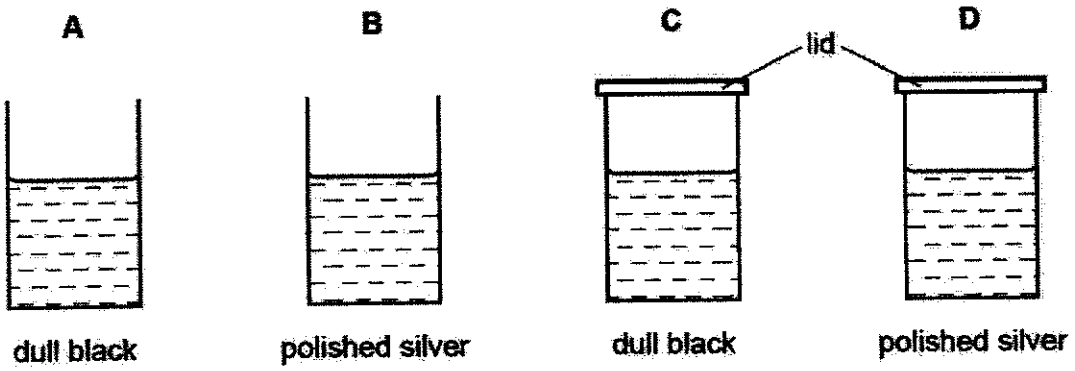
D 3

22 Which row correctly describes the kinetic energy of a substance in decreasing order of magnitude?

	decreasing order of magnitude →
A	gas, liquid, solid
B	gas, solid, liquid
C	solid, liquid, gas
D	solid, gas, liquid

23 The diagrams show four identical cans with their outside surfaces painted either dull black or polished silver. Each can contains the same volume of water, initially at 80 °C.

After five minutes in a cool room, which can contains the coolest water?



24 When calibrating a liquid-in-glass thermometer, which step is not needed?

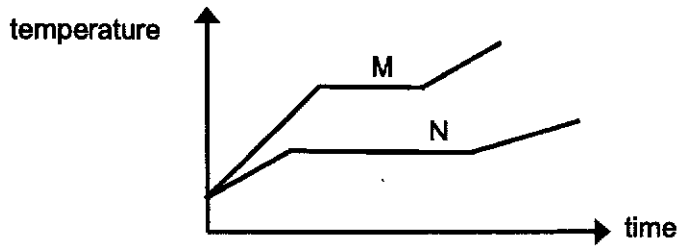
A Choosing two fixed points.

B Choosing a thermometric property that varies uniformly.

C Ensuring that the room temperature is kept constant.

D Ensuring that the thermometer is calibrated at one atmospheric pressure.

25 Two solids M and N are heated separately by identical heaters under identical conditions. The changes in temperature with time for the two solids are shown in the diagram.



If M and N are of the same mass, which of these statement(s) is/are correct?

1 Freezing point of N is lower than that of M.
2 Solid N has a higher specific heat capacity than solid M.
3 The specific latent heat of fusion of N is higher than that of M.

A 1 only

B 1 and 2 only

C 1 and 3 only

D 1, 2 and 3

26 Which statement about temperature is NOT correct?

A Temperature can be measured easily because the movement of the molecules in the system can be easily predicted.

B Temperature is a measure of scalar quantity.

C Temperature of an object tells us how much average kinetic energy the molecules in the object carry.

D Temperature of an object tells us how hot or how cold the object is.

27 The resistance of a piece of platinum wire in melting ice (273 K) and boiling water (373 K) are 800 Ω and 910 Ω respectively. What is the temperature reading in Kelvin when the resistance has a value of 1000 Ω?

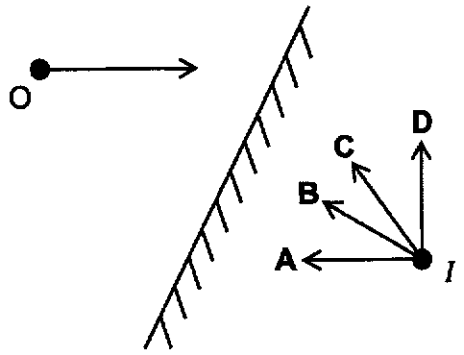
A 328 K

B 383 K

C 455 K

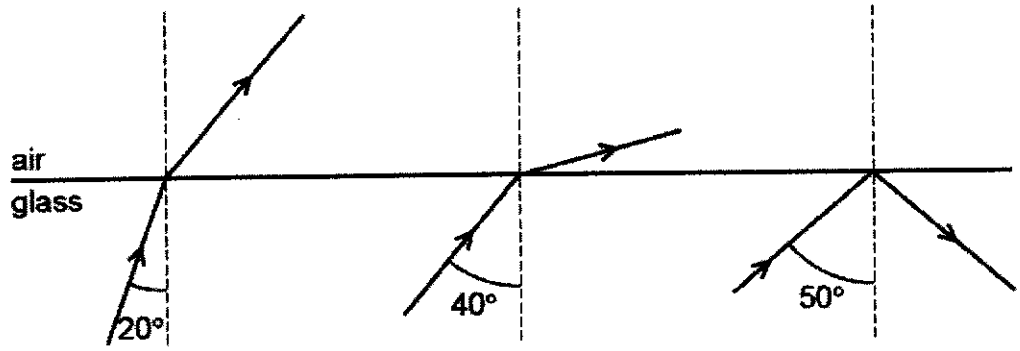
D 495 K

28 An object placed in front of a plane mirror at O produces an image at I.



If the object moves towards the mirror in the direction shown, in which direction does the image move?

29 Three rays of light are incident on the boundary between a glass block and air. The angles of incidence are different.



What is a possible critical angle for light in the glass?

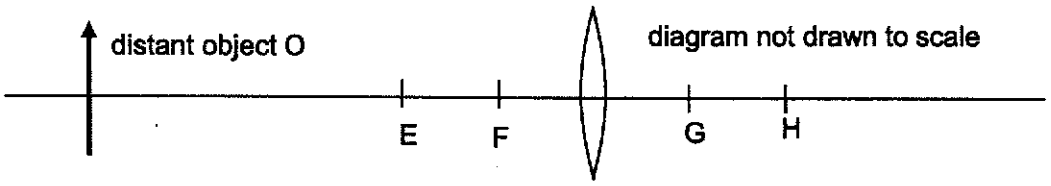
A 15°

B 30°

C 45°

D 60°

30 In the diagram, an object is located at O and is assumed to be faraway from the converging lens. Point E, F, G and H are points equally spaced along the axis of the lens. A real, inverted image of the object O is found at point G.



When the object is moved from E to F, what will happen to the image?

A It moves away from point G towards a point between G and H.

B It moves away from point H towards a point beyond H.

C It remains inverted at point G but becomes bigger.

D It remains inverted at point G but becomes smaller.

Section B: Short Structured Questions [40 marks]

1 Fig. 1.1 shows a man pushing a block across a road. After pushing for 8.0 s across road surface P, he enters a road surface Q. Throughout the entire journey, the man exerts a constant forward pushing force of 500 N. Assume that the air resistance is negligible.

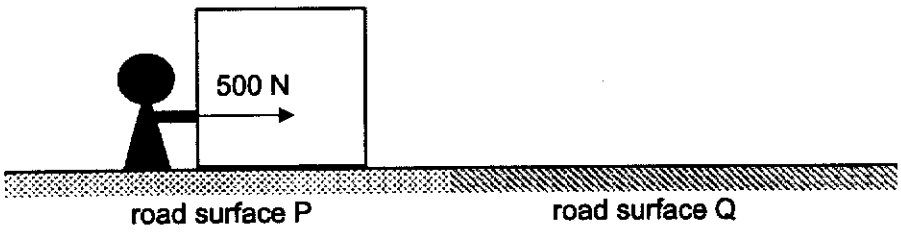


Fig. 1.1

Fig. 1.2 shows the graph of the resultant force acting on the block against time.

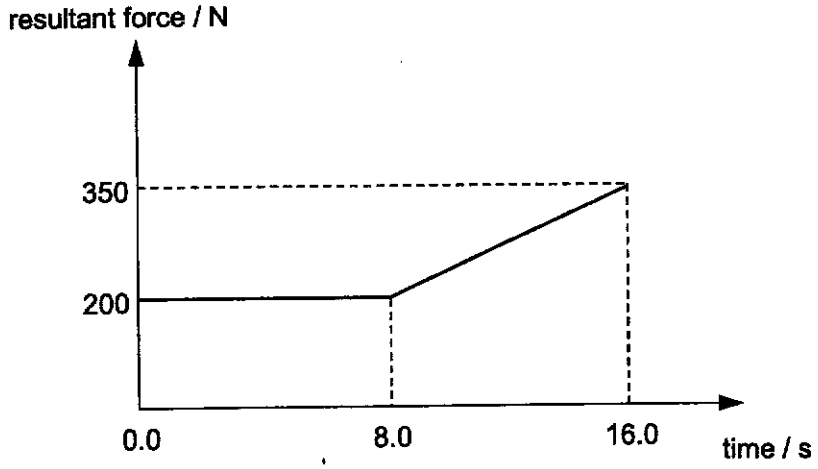


Fig. 1.2

(a) Calculate the effective resistive force that acts backwards on the block when it is on road surface P.

resistive force = ... [2]

(b) Explain, in terms of the condition of the road surface Q, why the resultant force increases from time $t = 8.0$ s to $t = 16.0$ s as shown in Fig. 1.2.

.....

.....

..... [2]

(c) The block has a mass of 100 kg.

Calculate the acceleration of the block at time $t = 4.0$ s.

acceleration = ... [2]

2 A uniform rod **AB** of length 2.00 m and weight 200 N is held horizontally by two light vertical wires. One of the wires is attached to end **A** of the rod and the other to point **X** on the rod, 0.50 m from **B** as shown in Fig. 2.1.

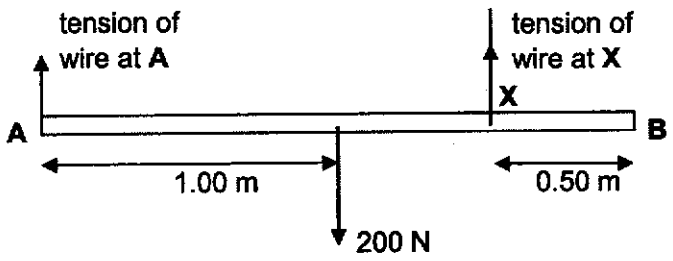


Fig. 2.1

(a) Define centre of gravity of a body.

.....

..... [1]

(b) Explain why the distance between **A** and the line of action of the weight of the rod in 1.00 m.

.....

.....

..... [1]

(c) By taking moments about **A** as the pivot, calculate the tension of the wire at **X**.

tension of the wire at **X** = ... [2]

(d) Calculate the tension of the wire at **A**.

tension of the wire at **A** = ... [2]

(e) A weight of 100 N is now hung from the rod, between **A** and **X**, and its position is adjusted such that the tensions in the two wires are of equal magnitude.

State the new tension in each of the two wires **A** and **X**.

..... [1]

3 Fig. 3.1 shows a diver working below the surface of a lake. The diver inflates a balloon with air at a depth of 15 m and attaches the balloon to a tray of objects.

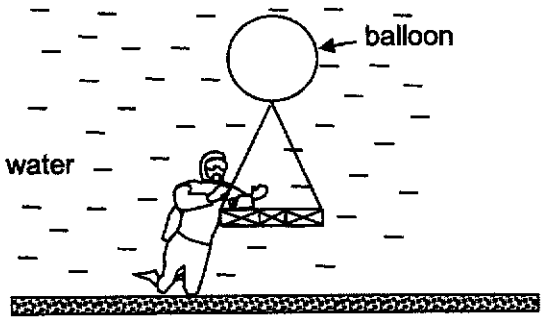


Fig. 3.1

(a) At a depth of 15 m below the water, the air pressure inside the balloon is more than if the balloon was at the surface of the lake.

Explain, in terms of the air molecules inside the balloon, why the pressure is more at a depth of 15 m. State any assumption(s) made.

.....

.....

.....

..... [2]

(b) State two differences between the arrangement and movement of the molecules of water in the lake, compared to the molecules of air in the balloon.

.....

.....

.....

..... [2]

4 Fig. 4.1 shows a liquid-in-glass thermometer that is NOT calibrated.

Fig. 4.1

The glass contains 0.30 kg of mercury at a temperature of 28 °C.
The heat capacity of the glass is 5 J/°C.
The specific heat capacity of mercury is 140 J/(kg°C).

(a) Describe the procedure to obtain the lower fixed point for the thermometer.
You should include a diagram in your answer.

.....

.....

.....

.....

..... [4]

(b) The thermometer is now placed into a cup of hot water as shown in Fig. 4.2.

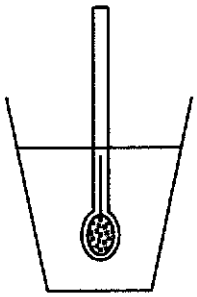


Fig. 4.2

Describe how the thermal energy is transferred from the hot water to the mercury in the thermometer.

.....

.....

..... [2]

5 Fig. 5.1 shows the boiler of a coal-fired power station. Air going into the boiler is heated up by the burning coal, and thermal energy is transferred from the hot gases to the water inside the metal pipes.

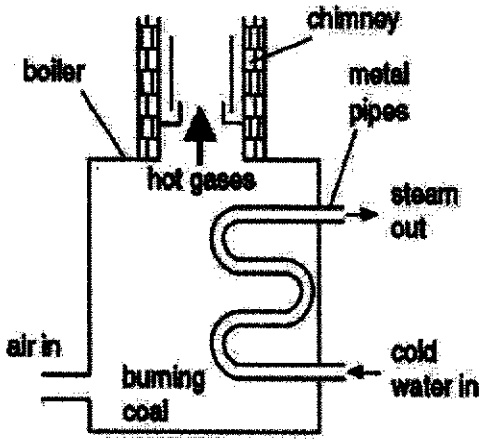


Fig. 5.1

(a) Explain why the hot gases rise.

.....

.....

.....

..... [2]

(b) Suggest one method to increase the rate of heat transfer to the water.

.....

..... [1]

6 Fig. 6.1 shows an object, O, placed in front of a thin lens. A ray of light from the top of the object when reaching P on the lens is refracted as shown.

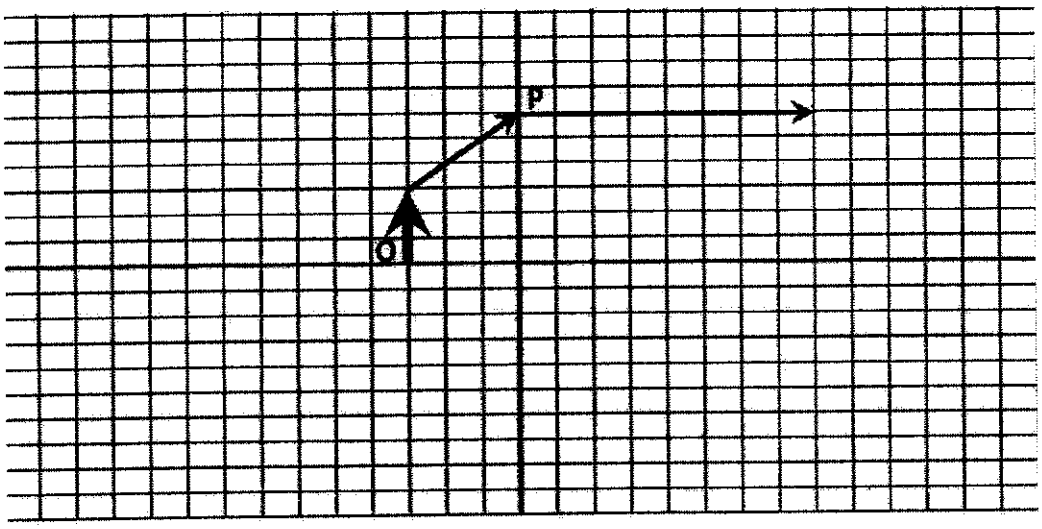


Fig. 6.1
(drawn to scale)

(a) Determine if the lens is a converging or diverging lens.

..... [1]

(b) **(i)** On Fig. 6.1, draw more rays from object O to locate the image of O. Draw the image, and label it as **I**. [2]

(ii) State two different qualities of this image.

.....

..... [2]

(c) Define the term focal length.

.....

..... [1]

(d) Find the focal length of this lens.

focal length = ... [1]

(e) State an application of this setup.

.....

..... [1]

7 Fig 7.1 shows a reservoir of water located a height *h* above a small water turbine that generates electricity.

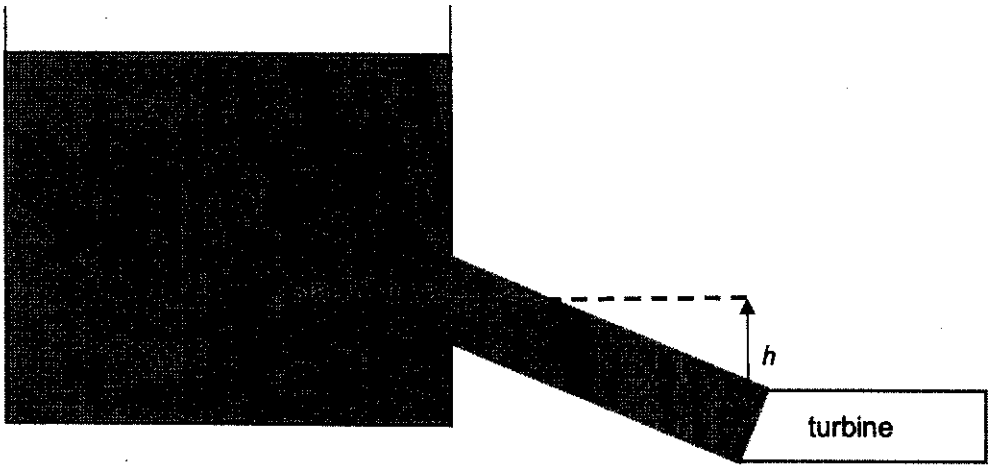


Fig 7.1

Fig 7.2 shows the specifications of the water turbine.

Useful electrical power output from turbine / W	height h of water at the start of the tube from the reservoir / m	flow rate / m^3/s
5000	20.0	0.0350

Fig 7.2

Take the density of water to be 1000 kg/m^3, and the gravitational strength to be 10.0 N/kg.

(a) Calculate the effective gravitational potential energy that the 0.0350 m^3 of water possesses at height *h* above the entrance of the turbine.

gravitational potential energy = ... [2]

(b) The 0.035 m^3 of water exits the reservoir at the start of the tube with a speed of 10.0 m/s.

Using your answer from **(a)**, calculate the speed of 0.035 m^3 of water when it reaches the entrance of the turbine. Assume negligible energy lost to friction when the water flows from the start of the tube to the entrance of the turbine.

speed = ... [3]

(c) Using the useful electrical power output from the turbine, calculate the energy efficiency of the water turbine, given that the kinetic energy of the water at the turbine reaches 12500 J. Assume negligible energy lost to friction when the water flows from the start of the tube to the entrance of the turbine.

efficiency = ... [1]

Section C: Long Structured Questions [30 marks]

8 In an experiment using a datalogger, a ball M is released from rest at a certain height *h* above the ground and its speed *v* is measured.

Some air is then released from ball M and the altered ball is renamed ball L.

The experiment is then repeated with ball L released from rest at the same height above the ground.

Fig. 8.1 shows the results obtained with the ball M (fully pumped with air) and ball L (deflated with much less air).

Time: *t* / s	0.0	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80
Ball 1: *v* / m/s	0.0	1.0	2.0	3.0	4.0	0.0	-1.5	-0.5	0.0
Ball 2: *v* / m/s	0.0	1.0	2.0	3.0	4.0	2.0	0.0	-0.5	0.0

Fig. 8.1

(a) Plot the above data for balls 1 and 2 and label correctly the two graphs as ball M and ball L in Fig. 8.2. [4]

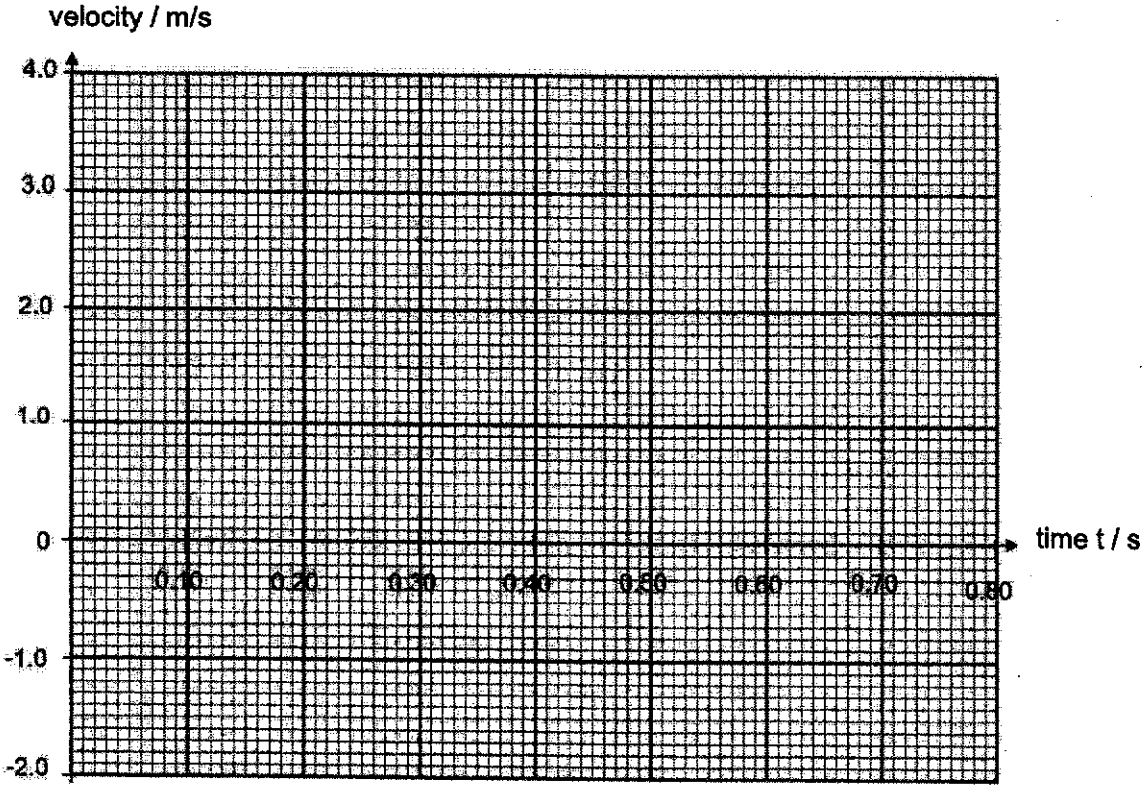


Fig. 8.2

(b) State which graph (ball 1 or ball 2) is represented by ball M. Explain your choice.

.....

..... [1]

(c) With reference to Fig. 8.2, calculate the acceleration of the balls at t = 0.2 s.

acceleration = ... [2]

(d) Given that air resistance is negligible, and the maximum speed that the balls reached is 4.0 m/s, determine from the graph, h, the height from the ground at which the balls were initially released.

height = ... [3]

9 Fig. 9.1 shows a microwave oven that heats and cooks food by exposing it to microwave radiation. The energy from the microwaves is absorbed by water molecules in the food causing it to heat up.

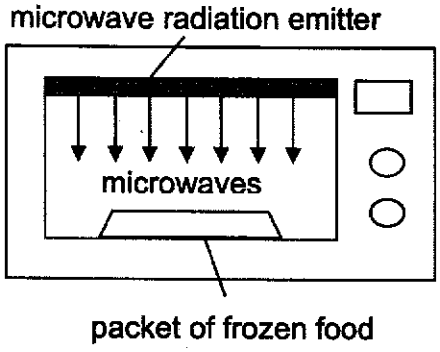


Fig. 9.1

A 250 g packet of ice at –10°C was placed in the microwave oven, which was switched on.

The specific heat capacity of ice is 2 kJ/(kg °C) and the specific latent heat of fusion of ice is 340 kJ/kg.

(a) **(i)** Calculate the minimum amount of thermal energy required to completely melt all the ice from –10°C to water.

energy = ... [3]

(ii) All the ice at –10 °C melts to water in exactly 10 minutes. Calculate the useful power output of the microwave oven.

time = ... [2]

(iii) The electrical power input into the microwave is 1000 W. Based on your answers in part **(b) (i)** and **(b) (ii)**, calculate the energy conversion efficiency of the microwave oven.

efficiency = ... [2]

(b) State three factors that increase the rate of absorption of radiation.

.....

.....

..... [3]

10 The Hare's apparatus is a device used for comparing the densities of two different liquids. As shown in Fig. 10.1, the equipment consists of a three-limbed E-shaped glass tube. The two longer limbs at the side are dipped into the beakers containing the liquids, X and Y.

One of the liquids is chloroform and the other is methyl isobutyl ketone. The central limb has a tap which allows air to be pumped out. When the tap is closed after air is pumped out, the densities of the liquids can be compared by measuring and comparing the column heights in the two long limbs.

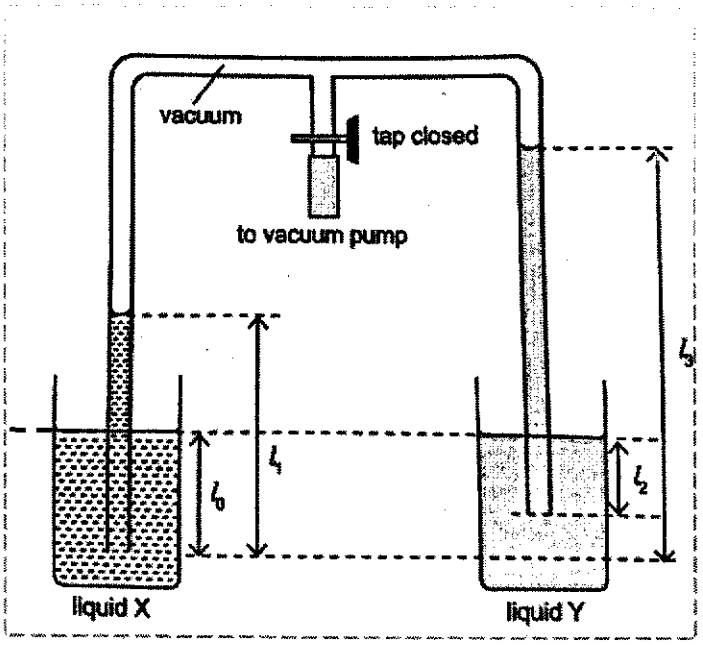


Fig. 10.1

The table shows the densities of the two liquids.

liquid	density / kg/m^3
chloroform	1490
methyl isobutyl ketone	801

(a) Explain, in terms of the air molecules inside and outside the Hare's apparatus, why the liquid levels in the two limbs increase after the air is pumped out.

.....

.....

.....

.....

..... [3]

(b) State which liquid (X or Y) is chloroform. Explain your answer.

.....

.....

..... [2]

(c) On Fig. 10.1, mark out a point P in liquid Y which has the same pressure as point O. [1]

(d) Given that l_0 = 5.0 cm, l_1 = 26.5 cm and l_2 = 3.0 cm, calculate l_3.

l_3 = ... [2]

(e) This experiment is repeated at a mountain top where the atmospheric pressure is lower.

State and explain how your answer in **(d)** will be affected.

.....

.....

.....

..... [2]

END OF PAPER

Hillgrove Secondary School
Sec 3 Pure Physics End Of Year Examination / 2019

MCQ

1	**A**	6	**D**	11	**D**	16	**A**	21	**D**	26	**A**
2	**A**	7	**C**	12	**C**	17	**C**	22	**A**	27	**C**
3	**B**	8	**A**	13	**D**	18	**C**	23	**A**	28	**C**
4	**C**	9	**A**	14	**D**	19	**A**	24	**C**	29	**C**
5	**B**	10	**B**	15	**A**	20	**D**	25	**D**	30	**B**

Structured Questions

Qn	Answers	Marks	Remarks (All units to be correct and included for full marks)
1a	500 – 200 = 300 N	1 1	
1b	Condition of road surface Q becomes [redacted] as the block travels further As the [redacted]	1 1	
1c	a = F/m = 200/100 = 2 ms^{-2}	1 1	
2a	Point at which the entire weight of the body appears to act	1	
2b	It is a [redacted] rod and so the weight of the rod acts on its centre of mass, the centre of the rod.	1	
2c	F1d1 = F2d2 200 x 1 = F2 x 1.5 F2 = 133 N	1 1	
2d	200 – 133 = 67 N OR 133/2 =66.5 N	1 1	
2e	(200 + 100) / 2 = 150 N each	1	
3a	There is [redacted] around it when the balloon is underwater Assume [redacted], as the volume is smaller when at the surface The [redacted]. (any 2 of 4)	1 1 1 1	
3b	The arrangement of water molecules are next to one another, but air molecules are far apart. The movement of water molecules [redacted] but the movement of air molecules are [redacted]	1 1	

	[redacted], colliding with each other and the walls of the container,		
4a	The drawing of placing the thermometer bulb in the middle of melting ice (1) in a funnel system that drains the excess melted water out (1) Description: Place the bulb of the thermometer in the middle of ice that is melting. Wait until the mercury thread has stopped moving. Make a marking at the height of the mercury thread. This is the lower fixed point of the thermometer.	1 1 1 1	
4b	[redacted] from the hot water to the glass to the mercury The hot water particles [redacted] in the glass, making them vibrate faster. In turn, they make the adjacent particles in the glass vibrate faster, until the glass particles next to the mercury particles transfers kinetic energy to them.	1 1	
5a	The air at the bottom is heated, [redacted], [redacted] than the surrounding cooler air, and rises.	1 1	
5b	There could be more length of the metal pipes in the boiler, to allow more time for energy transfer from the gases to the metal pipes. OR Paint pipes black to absorb more radiation from the burning coal	1	
6a	converging	1	
6bi	Step 1: extend the diagonal arrow on the left of the lens backwards, so that it goes through the principal axis. This shows that the focal length of the lens is 6 rectangular units. The focal length of the lens is the same on either side. So the focal length is also 6 units on the right side. Indicate this. Now, draw a line through from the arrowhead through the middle of the lens. Next, draw a line parallel to the principal axis, to the lens, and then from the lens to the focal point on the right. This shows that the image should be on the left, as a virtual and upright image. Extend the light lines backwards to the left, and they should meet at 6 units to the left, and 6 units high. The image arrow should be drawn as a dashed line, and labelled as I.	1 1	
6bii	ecf allowed from 6bi virtual, upright, same side of lens as object (any 2 of 3) If there is no image drawing, give the point if correct anyway If image is drawn, use the ecf.	1,1	
6c	Distance between centre of a lens and its focus / focal point	1	
6d	The length of 6 horizontal units in cm (measurement on printed paper is 3.1 cm, accept 3.0 cm to 3.2 cm)	1	
6e	Magnifying glass	1	

7a	m = dv = 1000 x 0.035 = 35 kg GPE = mgh = 35 x 10 x 20 =7000 J	1 1	
7b	KE at start = ½ mv^2 = ½ x 35 x 10^2 = 1750 J Total KE at the end = 7000 + 1750 = 8750 J 8750 = ½ x 35 x v^2 v = 22.4 m/s	1 1 1	
7c	5000/12500 = 0.4 = 40%	 1	
	Section C		
8a	All plots correct for M All plots correct for L M labelled correctly L labelled correctly	1 1 1 1	
8b	Ball M is fully pumped and should bounce higher, therefore it is Ball 1 as it reaches a higher negative velocity.	1	
8c	Acceleration = gradient of graph = 4 / 0.4 = 10 ms^{-2}	1 1	
8d	Distance travelled = area under graph from 1 to 0.4 s = 4 x 0.4 / 2 = 0.8 m OR ½ mv^2 = mgh ½ m 4^2 = m x 10 x h 8 = 10 h h = 0.8 m	1 1 1	
9ai	Q = mcT + mL Q = m(cT + L) = 0.25 ([2000 x 10] + 340,000) = 90,000 J	 1 1 1	
9aii	P = E / t = 90000 / 600 = 150 W	1 1	
9aiii	150 / 1000 = 15%	1 1	
9b	Black color, rough surface, high surface area, high temperature (any 3 of 4)	1 1 1	
10a	There are [redacted] when they are sucked out [redacted] Exerts less force per unit area, [redacted] the Hare's Apparatus, pushes down on the surface of the liquid outside, liquid levels rise. (any 3 of 4)	1 1 1 1	

10b	X [redacted], so the height of the column is lower.	1 1	
10c	It should be at the surface of the liquid.	1	
10d	Length of column X = 26.5 – 5 = 21.5 cm Pressure at liquid x = hpg = 21.5 x 1490 x 10 = 320,350 Pa Pressure at liquid y = 320,350 Pa 320350 = h x 801 x 10 h = 40 cm l_3 = 40 + 5 (any 1 of 3) = 45 cm	1 1 1 A1	
10e	Height of L3 will be lower. [redacted].	1 1	