SERANGOON SECONDARY SCHOOL
END-OF-YEAR EXAMINATION
SECONDARY 3 EXPRESS

CANDIDATE NAME		CLASS	3	I	8
INDEX NUMBER					

PHYSICS

Paper 1 Multiple Choice

6091/01
13 Oct 2022
1 hour

Additional Materials: Multiple Choice Answer Sheet

Setter(s):

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. 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.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate

This document consists of **15** printed pages, including this cover page.

1 What is the approximate diameter of an atom?

A 0.1 nm

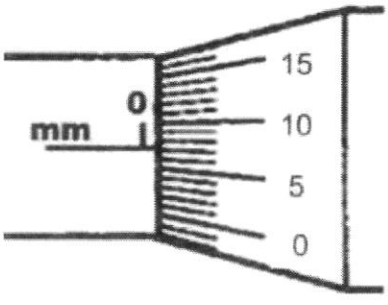
B 0.1 μm

C 0.1 mm

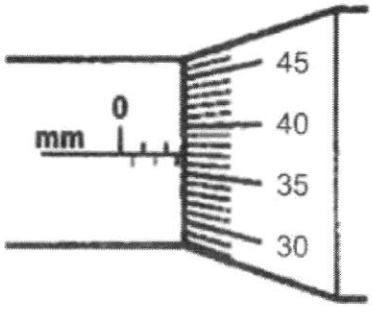
D 0.1 cm

2 The diagram on the left shows the zero error on a micrometer screw gauge while the diagram on the right shows the reading when it is used to measure the thickness of a pencil.

zero error



measured reading



What is the corrected reading of the diameter of the pencil?

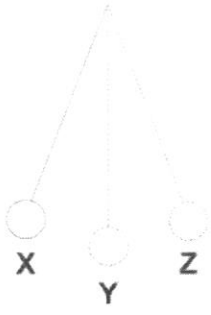
A 2.30 mm

B 2.37 mm

C 2.80 mm

D 2.87 mm

3 The diagram shows a pendulum with a period of 1.6 s. A stopwatch is started when the pendulum is released at point **X**.



What is the subsequent position and direction of motion of the pendulum 2.8 s later?

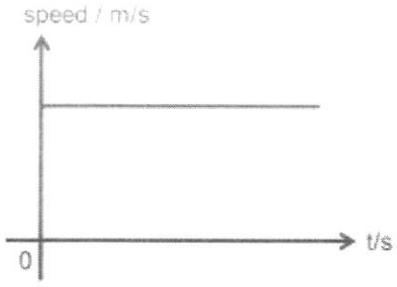
A At **X**, moving towards **Y**

B At **Y**, moving towards **X**

C At **Y**, moving towards **Z**

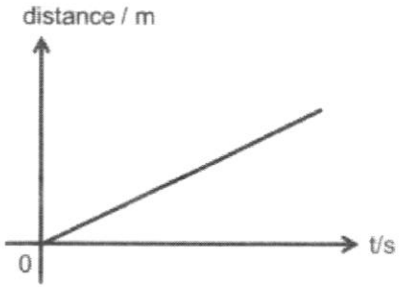
D At **Z**, moving towards **Y**

4 The diagram shows how the speed of a moving vehicle changes with time.

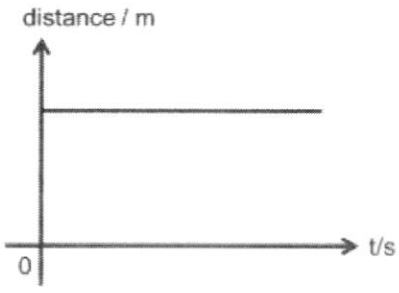


Which distance-time graph corresponds to the speed-time graph of the moving vehicle?

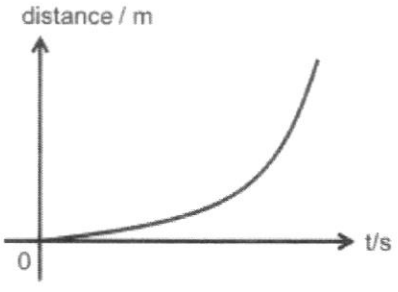
A



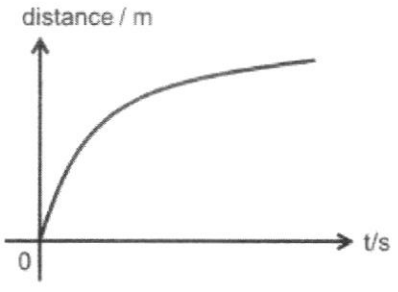
B



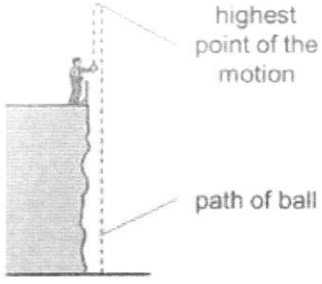
C



D



5 The diagram shows a person throwing a ball upwards near the edge of a cliff. It rises vertically for a short distance before falling to the bottom of the cliff.



Assuming that air resistance is negligible, which statement is correct?

A The acceleration of the ball at the highest point is 0 m/s^2.

B The direction of the acceleration of the ball is downwards as it is thrown up.

C The magnitude of the acceleration of the ball is lower when it moves upwards than when it falls.

D The speed of the ball remains constant as it falls.

6 A train is moving at a speed of 25 m/s when its brakes are applied suddenly. If the driver has a mass of 75 kg and it takes 5.0 s for the train to decelerate to a stop, what is the average resistive force acting on the driver during this period of time?

A 1.67 N

B 15.0 N

C 375 N

D 4690 N

7 A box of 20 kg is moving at a constant velocity of 2 m/s when it is pushed across a rough table with an applied force of 45 N.

What is the force required to push the box across the same table with an acceleration of 0.50 m/s^2?

A 10 N

B 40 N

C 45 N

D 55 N

8 A skydiver jumps from the helicopter and opens the parachute after some time.

Which statement is correct as the parachute is being opened?

A The air resistance is smaller than the weight and the skydiver decelerates. The air resistance will increase over time and the skydiver undergoes decreasing deceleration.

B The air resistance is smaller than the weight and the skydiver accelerates. The air resistance will increase over time and the skydiver undergoes increasing acceleration.

C The air resistance is larger than the weight and the skydiver decelerates. The air resistance will decrease over time and the skydiver undergoes increasing deceleration.

D The air resistance is larger than the weight and the skydiver decelerates. The air resistance will decrease over time and the skydiver undergoes decreasing deceleration.

9 A thick book is placed on the surface of a table. The table exerts an upward normal contact force is exerted on the book.

Which force will form an action-reaction pair with the normal contact force?

A The gravitational force on the earth exerted by the book.

B The gravitational force on the book exerted by the earth.

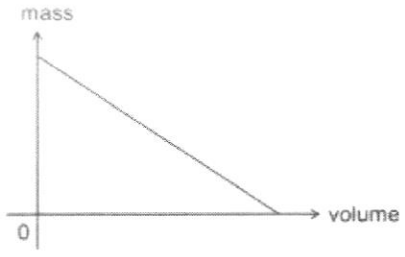
C The downward force on the table exerted by the book.

D The upward force on the book exerted by the table.

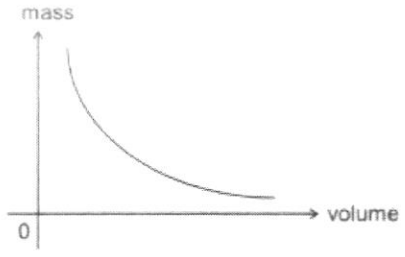
10 In order to determine the density of a piece of wood, the mass and volume of different sized samples of the same type of wood are measured.

Which graph correctly shows the results obtained?

A



B



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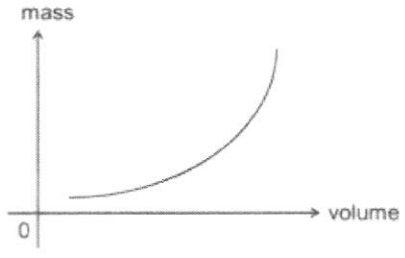
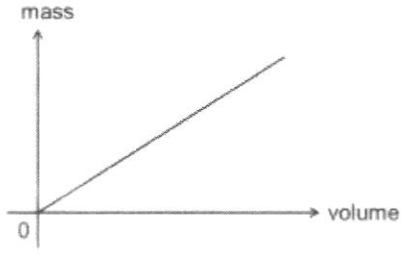


D



11 150 cm^3 of liquid A with density 1.0 g/cm^3 is mixed with 350 cm^3 of liquid B with density 2.0 g/cm^3.

Assuming there is no change in the total mass and volume of both liquids after mixing, what is the density of the mixture?

A 1.0 g/cm^3

B 1.5 g/cm^3

C 1.7 g/cm^3

D 2.0 g/cm^3

12 A solid is cut into three pieces X, Y and Z, such that the ratio of X:Y:Z is 3:2:1. Which statement is correct?

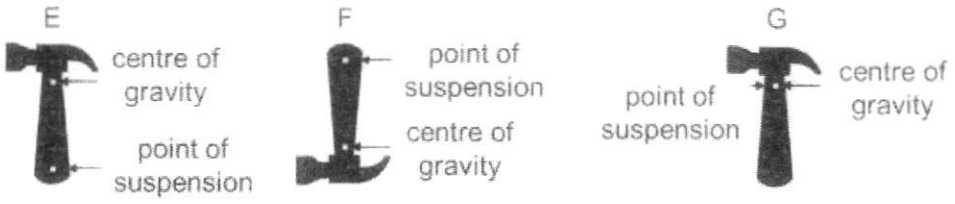
A All three pieces have the same density.

B Piece X has the highest density.

C Piece Z has the lowest density.

D The sum of the density of Y and Z is equal to the density of X.

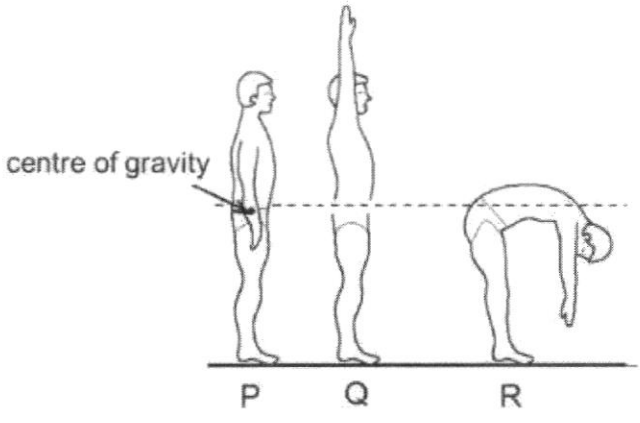
13 The diagram shows how a hammer can be suspended from three different positions E, F and G.



Which row correctly matches the position with its respective type of equilibrium?

	Unstable	Neutral	Stable
A	E	F	G
B	E	G	F
C	F	E	G
D	G	F	E

14 The diagram shows a diver with centre of gravity at his waist standing upright in position P, raising his arms in position Q and bending his body in position R.



Which statement is correct?

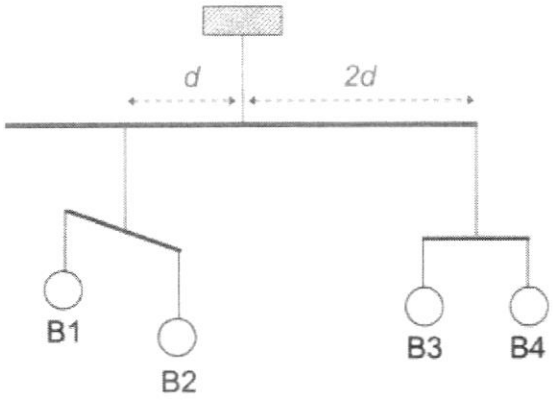
A The diver is the least stable in position R.

B The diver in position Q is less stable than in position R.

C The diver in position R is more stable than in position P.

D The stability of the diver remains the same for all positions P, Q and R.

15 Four balls of the same size, B1, B2, B3 and B4 are suspended from rods that are attached to one another. Each rod is suspended at its centre of gravity.



Given that the setup is stationary, which statement is correct?

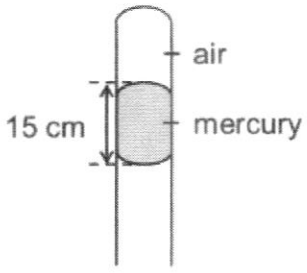
A The weight of B1 is equal to the weight of B2.

B The weight of B1 is twice the weight of B2.

C The total weight of B1 and B2 is equal to the total weight of B3 and B4.

D The total weight of B1 and B2 is twice the total weight of B3 and B4.

16 The diagram shows a column of air enclosed in a narrow capillary tube by a thread of mercury 15 cm in length.



Given that the atmospheric pressure is 76 cm Hg, what is the pressure of the trapped air?

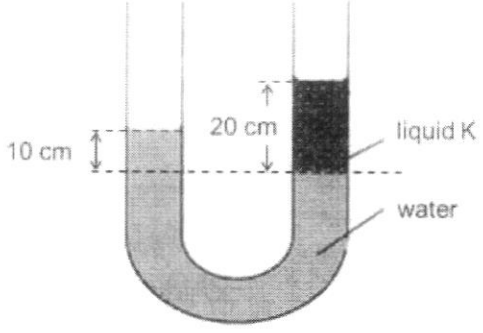
A 15 cm Hg

B 61 cm Hg

C 76 cm Hg

D 91 cm Hg

17 The diagram shows a manometer with a column of liquid K in one arm and water in the other.



Given that the density of water is 1000 kg/m^3, what is the density of liquid K? [g = 10 N/kg]

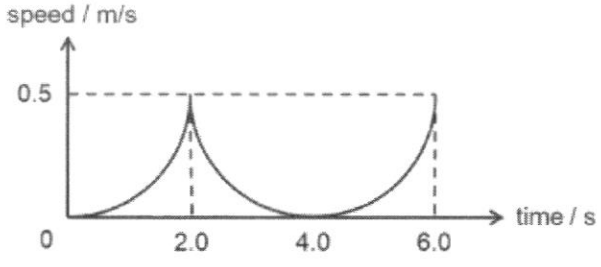
A 50 kg/m^3

B 500 kg/m^3

C 1000 kg/m^3

D 2000 kg/m^3

18 The diagram shows how the speed of an oscillating pendulum with a bob of mass 100 g changes with time.



What is the maximum possible gain in gravitational potential energy of the pendulum bob?

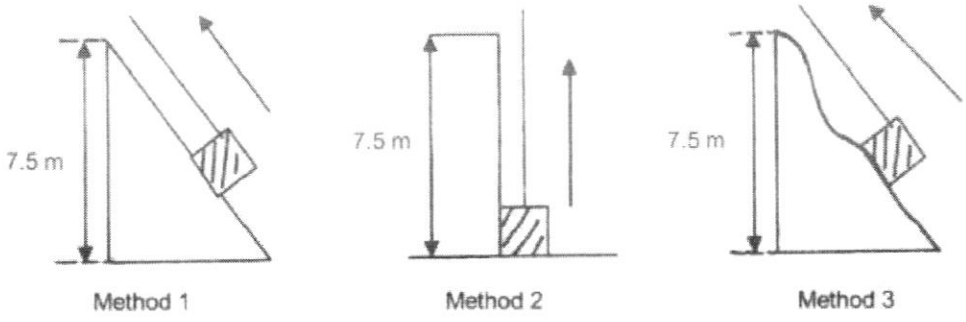
A 12.5 J

B 12.5 x 10^{-1} J

C 12.5 x 10^{-2} J

D 12.5 x 10^{-3} J

19 The diagram shows three different ways in which a box of mass 2.5 kg can be raised to a vertical height of 7.5 m.



Assuming that the friction on all the surfaces is negligible, which statement is correct?

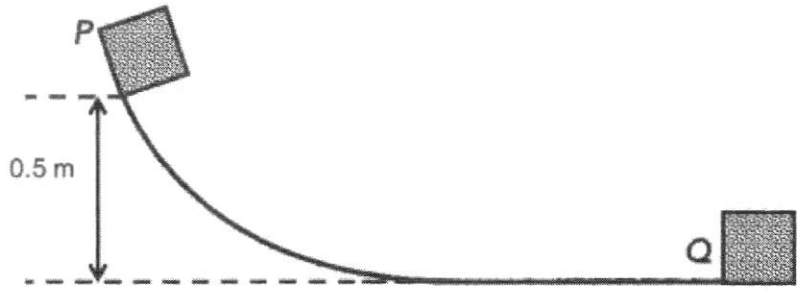
A All three methods require the same amount of work to be done to raise the box.

B Method 1 requires the most work to be done to raise the box.

C Method 2 requires the least work to be done to raise the box.

D Method 3 requires the most work to be done to raise the box.

20 The diagram shows a block of mass 2.0 kg being released from rest at point P. The block slid down the slope before coming to a stop at point Q.



Given that the length of the track PQ is 2.0 m, what is the average frictional force acting on the block when it is moving from P to Q? [g = 10 N/kg]

A 0.5 N

B 5.0 N

C 10 N

D 20 N

21 A gas is compressed while keeping its temperature constant.

Which statement is correct?

A The gas contracts and the gas molecules have more internal kinetic energy.

B The gas contracts and the rate of collision remains the same.

C The gas pressure increases as the gas molecules collide with the walls more frequently.

D The gas pressure increases as the gas molecules vibrate more vigorously.

22 A car is driven along a rough road. What causes the pressure in the tyres to increase?

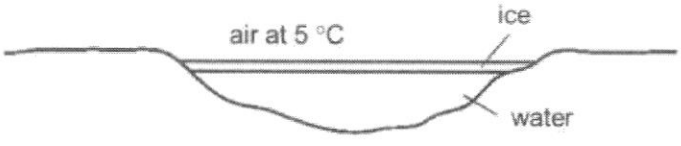
A The air molecules in the tyres expand with the rise in temperature.

B The magnitude of the force between the air molecules in the tyres increases.

C The speed of the air molecules in the tyres increases.

D The volume of the air molecules in the tyres increases.

23 The diagram shows a frozen lake with the surface of the ice melting as heat is absorbed from the warmer air above the lake.



Which is/are the method(s) of heat transfer from the warmer air to the ice?

A Conduction only.

B Conduction and radiation.

C Convection and radiation.

D Convection only.

24 Which method would not produce convection currents in a container filled with water at 30 °C?

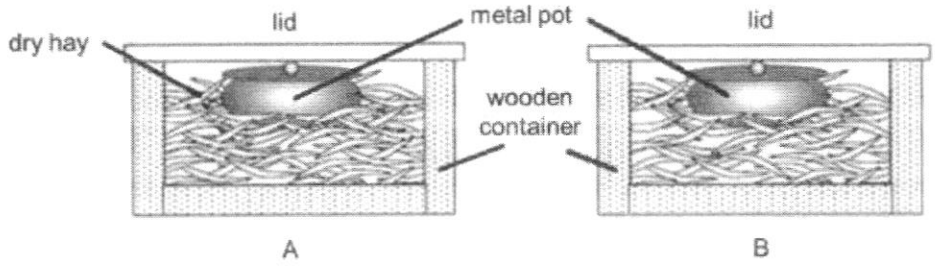
A Add in more water at 30 °C.

B Add in a piece of hot metal at the bottom of the container.

C Place a bunsen burner at the bottom of the container.

D Place a cooling unit at the top of the container.

25 The diagram shows how food in a metal pot can be kept warm in a container. The metal pot is surrounded with some dry hay, where container B has more loosely packed dry hay than that in container A. Both containers are closed with a lid.



Which statement is correct?

A The metal pot in container A will retain heat longer as there is more hay in container A.

B The metal pot in container A will retain heat longer as there is less trapped air in container A.

C The metal pot in container B will retain heat longer as there is more trapped air in container B.

D Both metal pots will lose heat at the same rate as they are kept in a container with the same material.

26 The length of the alcohol column in an alcohol-in-glass thermometer is 2.5 cm at −15 °C and 15.0 cm at 110 °C.

How long would the alcohol column be at 55 °C?

A 7.0 cm

B 7.5 cm

C 9.5 cm

D 11.3 cm

27 One junction of a thermocouple is placed in melting ice and the other in steam. The voltage reading registered is +2.50 mV. The junction is now removed from steam and placed in a liquid X. The voltage reading now shows −1.50 mV.

What is the temperature of liquid X?

A −160 °C

B −60 °C

C 60 °C

D 160 °C

28 The diagram shows the boiling and freezing points of three different liquids.

	liquid X	liquid Y	liquid Z
freezing point / °C	−40	−10	−50
boiling point / °C	150	120	100

Which liquid is suitable to be used in a thermometer that can measure temperatures between −15 °C and 110 °C?

A Liquid X

B Liquid Y

C Liquid Z

D None of the above

29 Which row correctly shows the changes, if any, in the internal kinetic energy and internal potential energy of the particles as a liquid boils?

	internal kinetic energy	internal potential energy
A	increases	stays the same
B	increases	increases
C	stays the same	increases
D	stays the same	stays the same

30 Which factor increases the rate of evaporation of a liquid?

A higher boiling point of the liquid.

B higher level of humidity across the liquid surface.

C lower atmospheric pressure.

D lower surrounding temperature.

END OF PAPER 1

SERANGOON SECONDARY SCHOOL
END-OF-YEAR EXAMINATION
SECONDARY 3 EXPRESS

CANDIDATE NAME		CLASS	3	I	8

INDEX NUMBER		

PHYSICS

Paper 2

6091/02
07 Oct 2022
1 hour 45 minutes

Candidates answer on the Question Paper.

Setter(s): Mr Lim Tong Yang

READ THESE INSTRUCTIONS FIRST

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

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

Section B
Answer **all** questions. Question 13 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

The number of marks is given in brackets [ ] at the end of each question or part question.

For examiner's use	
Section A	50
Section B	30
Total	80

Section A [50 marks]

Answer **all** the questions in this section.

1 **(a)** Complete the table. Give the missing prefixes, symbols and values.

prefix	symbol	value
deci	d	10^{-2}
milli		
		10^{6}
		10^{-9}

[3]

(b) Velocity is a vector quantity and speed is a scalar quantity.

Give one other example of:

(i) a vector quantity .....

(ii) a scalar quantity ..... [1]

2 A car of mass 1500 kg moves with a constant acceleration from rest to a speed of 15.0 m/s in 4.0 s. It then travels at a constant speed for 6.0 s. Lastly, a constant braking force brought it to rest in 2.0 s.

(a) On Fig. 2.1, sketch a speed-time graph to show how the speed of the car varies with respect to time. [2]

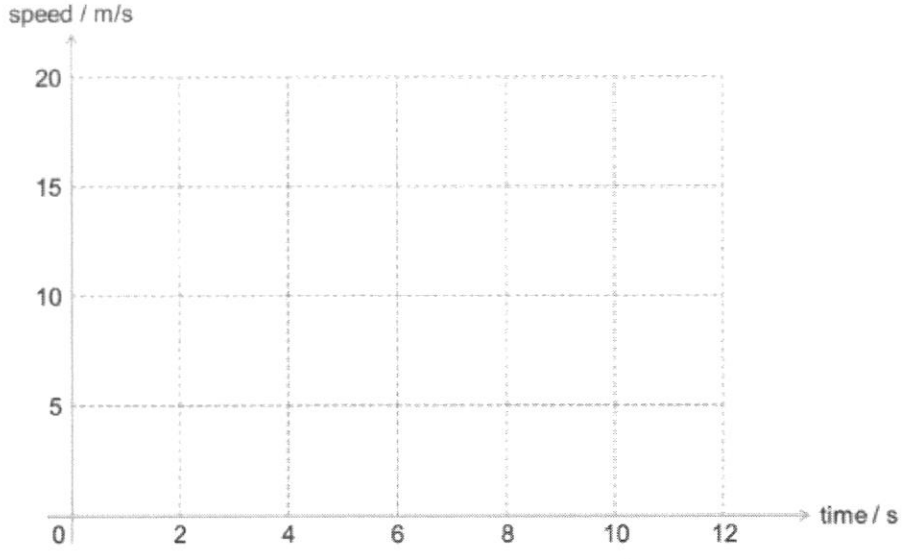


Fig. 2.1

(b) Calculate the average speed of the car for the whole journey.

average speed = ... m/s [2]

(c) On Fig. 2.2, sketch an acceleration-time graph to show how the acceleration of the car varies with respect to time. [2]

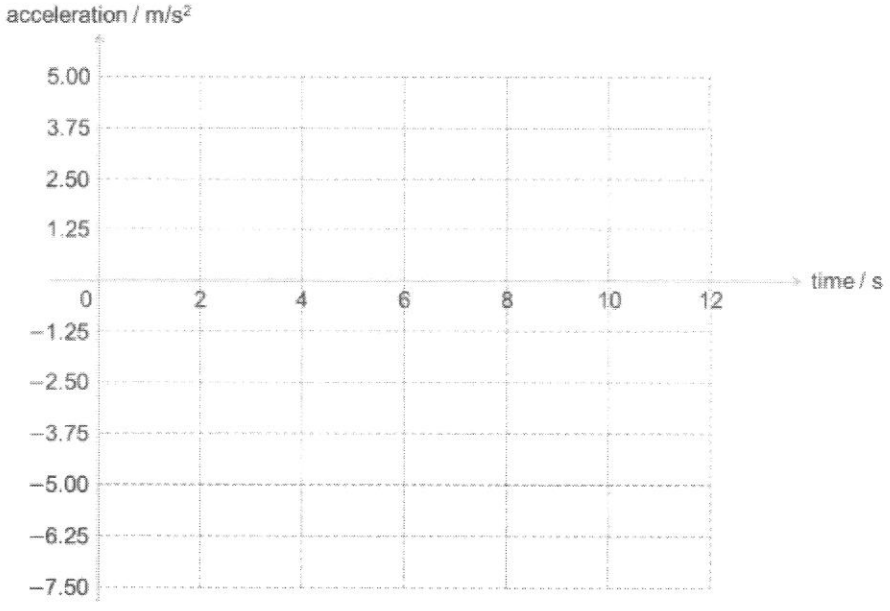


Fig. 2.2

3 Water droplets are observed to fall through a crack as shown in Fig. 3.1.

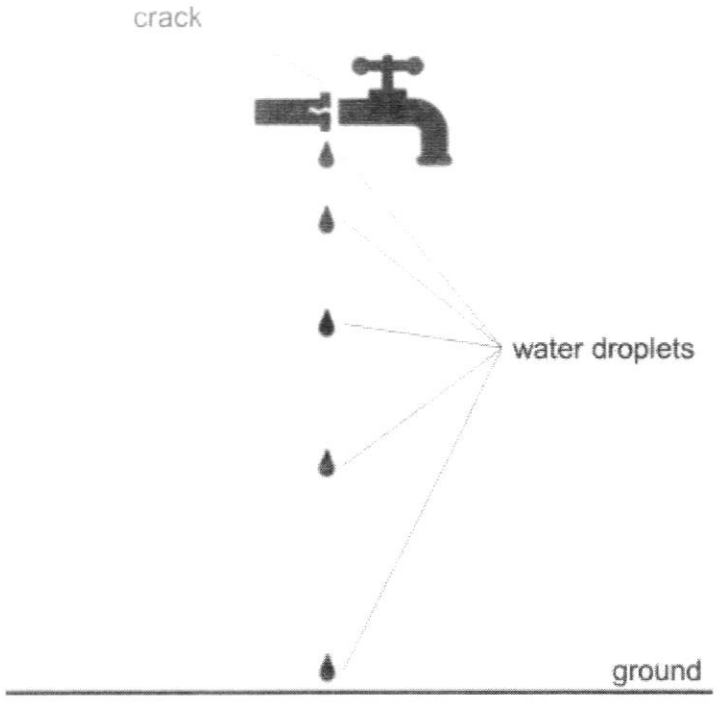


Fig. 3.1

An experiment is carried out to find the time interval between one water droplet and the next. A stopwatch is started when the first water droplet leaves the crack. The stopwatch is stopped when the 11th water droplet leaves the crack.

The reading on the stopwatch is 3.7 s.

(a) Assuming that the water droplets leave the crack at a constant rate, calculate the time interval between one water droplet and the next.

time interval = ... [1]

(b) Explain why it is more accurate to take the average of multiple intervals than taking the timing for 1 interval.

.....

.....

..... [1]

(c) Estimate the average time taken for a water droplet to fall from the crack to the ground.

time taken = ... [1]

(d) Explain why the water droplets become further apart as they fall further away from the crack.

.....

.....

..... [1]

4 Fig. 4.1 (not drawn to scale) shows the forces acting on a heavy parcel that is pulled by two ropes on a smooth and flat surface.

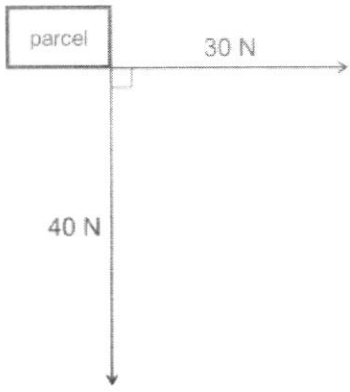


Fig. 4.1

Using an appropriate scale, draw a vector diagram in the space below to determine the magnitude and direction of the resultant force acting on the parcel.

scale: .....

magnitude of resultant force = ...

direction: ..... [3]

5 One of the methods of checking for the purity of a substance is by calculating its density. The mass of a gold ball bearing is measured to be 97.5 g while its volume is 5.0 cm^3.

(a) Calculate the weight of the ball bearing. [g = 10 N/kg]

weight = ... [2]

(b) Calculate the density of the ball bearing, leaving your answer in g/cm^3.

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

(c) The density of pure gold is 19.3 g/cm^3. State and explain whether the ball bearing is made of pure gold.

.....

.....

..... [1]

(d) State and explain what would happen to the gold ball bearing when it is placed in a beaker of oil with a density of 0.92 g/cm^3.

.....

.....

..... [1]

6 Fig. 6.1 shows a tightrope walker with a long and rigid curved pole balanced at midpoint M on a tightrope.

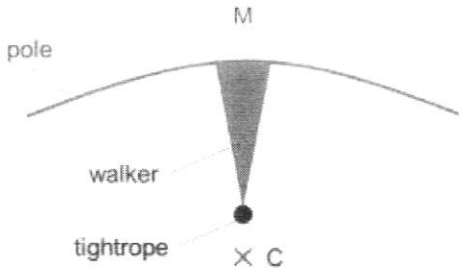


Fig. 6.1

The cross, labelled C, shows the position of the combined centre of gravity of the pole and the walker. The combined mass of the pole and the walker is 100 kg.

(a) Define centre of gravity.

.....

.....

..... [1]

(b) On Fig. 6.1, draw an arrow to show the direction of the combined weight of the pole and the walker. [1]

(c) Explain why it is important for the tightrope walker to be balanced at midpoint M.

.....

.....

.....

..... [2]

(d) Fig. 6.2 shows the right end of the pole pushed upwards by a 100 N force at a perpendicular distance of 4.0 m away from M such that the combined centre of gravity C lies 0.25 m to the left of midpoint M.

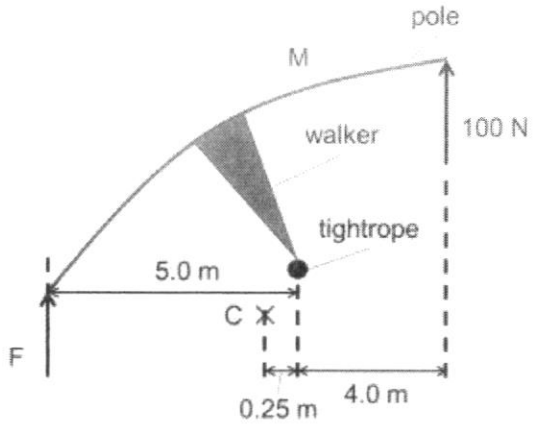


Fig. 6.2

(i) Calculate the moment due to the 100 N force.

moment = ... [2]

(ii) The left end of the pole is 5.0 m away from midpoint M. Calculate the magnitude of force F that has to be exerted at the left end of the pole to balance the walker on the tightrope.

magnitude of force = ... [2]

7 On a particular day, the atmospheric pressure at sea level is 103000 N/m^2.

At the same time, a mercury manometer is placed at the top of a mountain with a reading of 55 cmHg. Mercury has a density of 13600 kg/m^3.

(a) Determine the atmospheric pressure at the top of the mountain in N/m^2. [g = 10 N/kg]

atmospheric pressure = ... [2]

(b) Calculate the pressure difference between the top of the mountain and the sea level.

pressure difference = ... [1]

(c) If the density of the air between the top of the mountain and the sea levels is 1.4 kg/m^3, determine the height of the mountain top above sea level. Leave your final answer to the nearest whole number.

height of mountain = ... [2]

8 A suction cup holder is commonly used as tablet mounts because they can secure the device to a flat surface like the windscreen of a car. Fig. 8.1 shows a suction cup pressed against the windscreen. Most air is removed from the space between the suction cup and the windscreen.

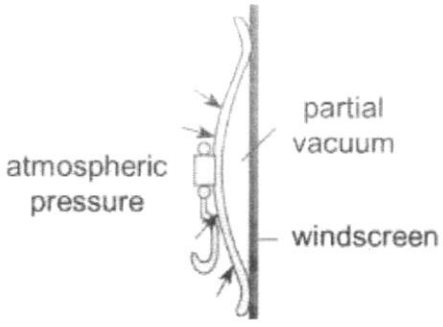


Fig. 8.1

(a) Using ideas about molecules, explain why the suction cup is able to stay attached to the windscreen.

.....

.....

.....

.....

.....

.....

..... [3]

(b) A suction cup holder may fall off after a long period of time under the sun. using ideas about molecules, explain why this phenomenon is observed.

.....

.....

.....

.....

..... [2]

9 Fig. 9.1 shows an experimental set up to observe the movements of small smoke particles moving around in a box of air when placed under a light microscope.

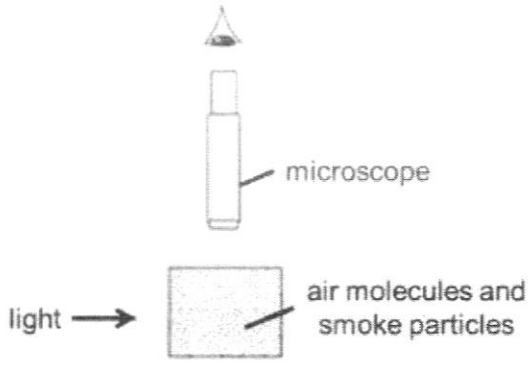
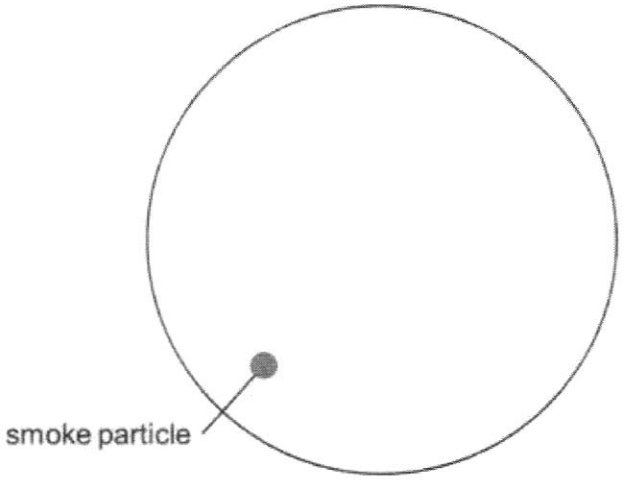


Fig. 9.1

(a) Draw the movement of a smoke particle observed through the light microscope.



[1]

(b) State two reasons why the smoke particles move in the manner observed through the light microscope.

.....

.....

.....

..... [2]

10 Fig. 10.1 shows two sets of apparatus used to investigate the effect of surfaces of different colour on the rate of absorption of thermal energy.

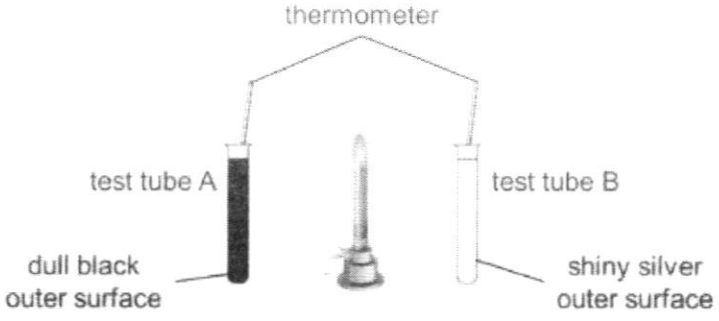


Fig. 10.1

Test tube A has a dull black outer surface while test tube B has a shiny silver outer surface. Both test tubes contain the same amount of water at 25 °C. A bunsen burner is placed in the middle of both test tubes to heat up the water for a period of time *t*. Temperature readings are taken at regular intervals to plot a heating curve.

(a) Fig. 10.2 shows the heating curve of the water in test tube B. In the space provided below, sketch the heating curve of the water in test tube A. Take the boiling point of water to be 100 °C.

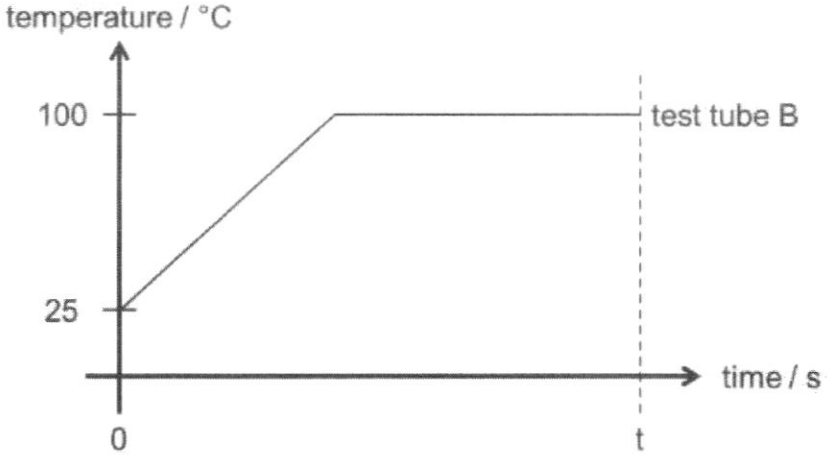


Fig. 10.2 [2]

(b) After a while, the bunsen burner is turned off to let the water in both test tubes to cool. State and explain which test tube would cool down faster.

.....

.....

..... [2]

(c) State two advantages of using a thermocouple thermometer for measuring temperatures of an object.

.....

.....

.....

.....

..... [2]

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 14.**

11 Fig. 11.1 shows the speed-time graph of a car travelling along a flat road. The brakes were applied at $t = 20$ s and the car comes to rest at $t = 30$ s.

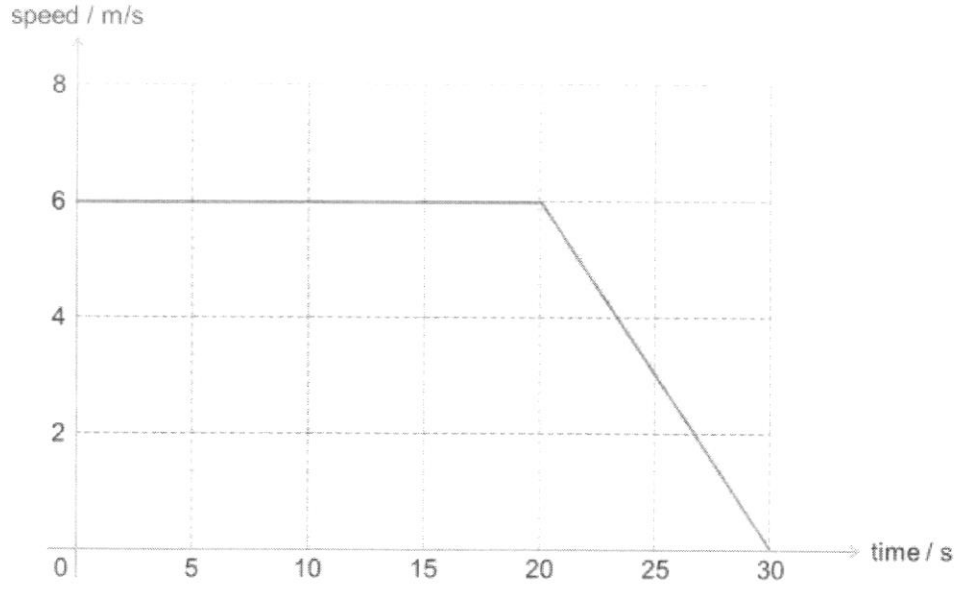


Fig. 11.1

The car has a mass of 750 kg and the forward driving force on the wheels is 1500 N.

(a) State what is meant by work done.

.....

.....

.....

..... [2]

(b) Calculate the distance travelled by the car in the first 20 s.

distance travelled = ... [2]

(c) Calculate the work done by the driving force in the first 20 s.

work done = ... [2]

(d) Calculate the power supplied by the driving force in the first 20 s.

power supplied = ... [2]

(e) Calculate the deceleration of the car in the last 4 s.

deceleration = ... [2]

12 (a) Fig. 12.1 shows a gymnast with mass 50 kg trying to swing on high bar. At B, the gymnast is momentarily at rest at the top of the swing. At this position, the centre of gravity of the gymnast is at a height of 1.0 m above the bar. [g = 10 N/kg]

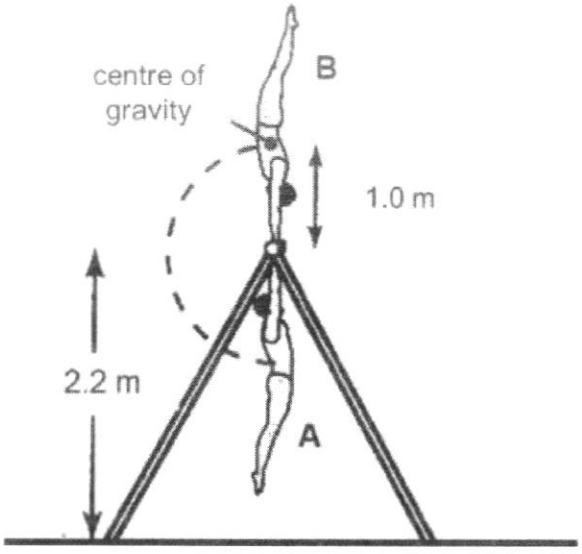


Fig. 12.1

(i) State the *principle of conservation of energy*.

.....

.....

.....

.....

..... [2]

(ii) Calculate the gain in gravitational potential energy of the gymnast, as he moves from A to B.

gain in gravitational potential energy = ... [2]

(iii) Assuming no energy loss to overcome resistive forces and the surroundings, calculate the speed of the gymnast at the bottom of the swing.

speed = ... [2]

(b) Wind and solar energy sources generate over 10% of global electricity in 2021. Based on Ember's Global Electricity Review in 2022, 21.7% of Australia's electricity was generated by wind and solar power.

Offshore wind turbines are a source of clean energy. Fig. 12.2 shows the design of a wind turbine with a blade length of 150 m.

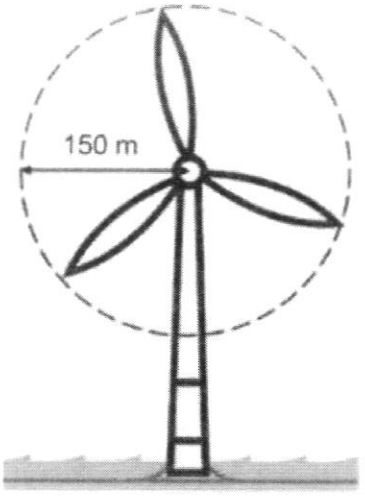


Fig. 12.2

At a wind speed of 12 m/s, the average volume of air passing through the blades is 4.5×10^5 m^3 in one second.

(i) Given that the density of air is 1.2 kg/m^3, determine the average mass of air that would pass through the blades in one second.

average mass = ... [2]

(ii) Calculate the energy output if the wind turbine operates with an efficiency of 35%.

energy output = ... [2]

13 **EITHER**

A heating coil is used to supply energy at a constant rate of 30 W to a 4.0 kg solid with an initial temperature of 5 °C. Fig. 13.1 shows the change in the temperature of the solid with respect to time. There was no energy loss to the surrounding.

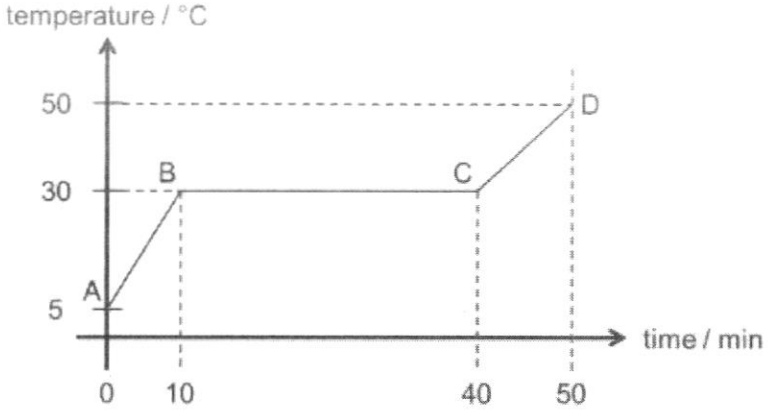


Fig. 13.1

(a) Explain what is meant by *specific latent heat of fusion*.

.....

..... [1]

(b) Calculate the specific latent heat of the fusion of the substance.

specific latent heat of fusion = ... [2]

(c) Explain why the temperature of the substance is constant in section BC.

.....

.....

.....

.....

..... [2]

(d) Describe the arrangement of the molecules of the substance in section CD.

.....

..... [1]

(e) Describe how thermal energy is transferred throughout the substance in section CD.

.....

.....

.....

.....

..... [2]

(f) Calculate the specific heat capacity of the substance in section CD.

specific heat capacity = ... [2]

13 OR

Chicken nuggets is a popular snack. To achieve the desired quality, the frozen nuggets need to be immersed in 2.0 kg of cooking oil at 130 °C. The deep-frying pan is placed over an electric induction stove of power rating of 1500 W. Assume no heat loss to the pan and the surroundings.

The specific heat capacity of cooking oil is 2000 J/(kg°C) while the specific heat capacity of the frozen nuggets is 3500 J/(kg°C).

(a) (i) Explain what is meant by *power rating of 1500 W*.

.....

.....

..... [1]

(ii) Given that the initial temperature of the cooking oil is 25 °C, determine how long it would take for the cooking oil to be ready for the first batch of nuggets.

time taken = ... [2]

(iii) Fig. 13.2 shows frozen nuggets at 1.0 °C added into the cooking oil at 130 °C. The induction stove was switched off thereafter.

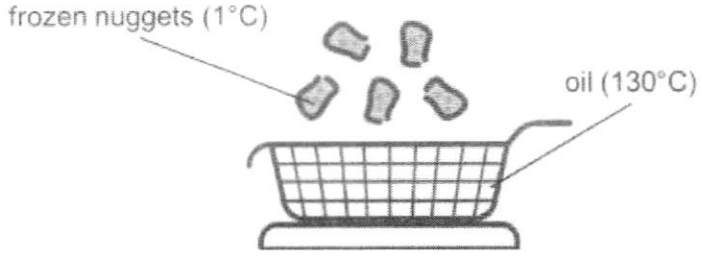


Fig. 13.2

Assuming that there is no loss or gain of heat to the surroundings and the heat absorbed by the stove is negligible, determine the mass of nuggets added to the cooking oil if the final temperature of the mixture was 80 °C.

mass of nuggets = ... [3]

(b) With the development of technology, the air fryer has become a more popular method of frying food.

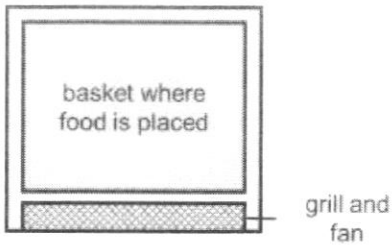


Fig. 13.3

Fig. 13.3 shows an air fryer that cooks by circulating hot air around the food. A grill heats up the air and a fan circulates the hot air around the food at high speeds. This will cook the food and produce a crispy layer.

(i) State the main process involved in the transfer of thermal energy in the air fryer and explain how this process helps to heat up the food.

.....

.....

.....

.....

.....

.....

..... [3]

(ii) Thermocouples are built into air fryers to detect temperature changes. State an advantage of using thermocouples in air fryers.

.....

.....

..... [1]

END OF PAPER 2

2022 SSS 3E EOY PHY P1 Marking Scheme

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

2022 SSS 3E EOY PHY P2 Marking Scheme

Section A

1 **(a)**

prefix	symbol	value
deci	d	10^{-1}
milli	m	10^{-3}
mega	M	10^{6}
nano	n	10^{-9}

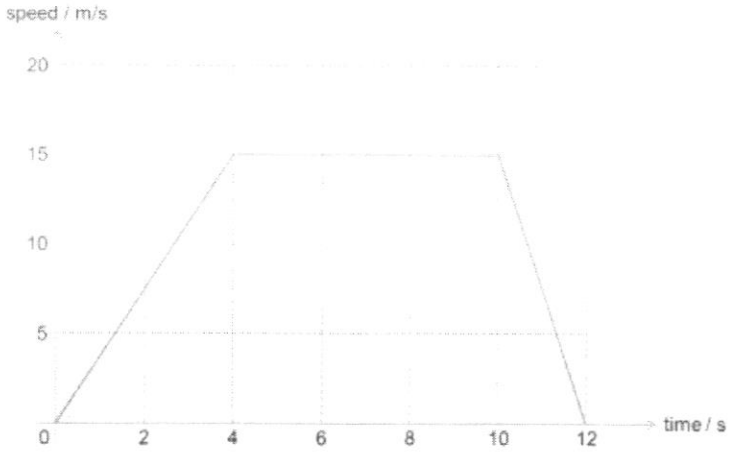
1m for each correct row (both boxes)

(b)

1m for both correct answers

(i) Vector: displacement / weight / force / acceleration
(ii) Scalar: distance / time / energy / temperature / mass

2 (a)



[1] straight lines to show constant acceleration and deceleration (both to be correct for this 1m)

[1] horizontal line to show constant speed

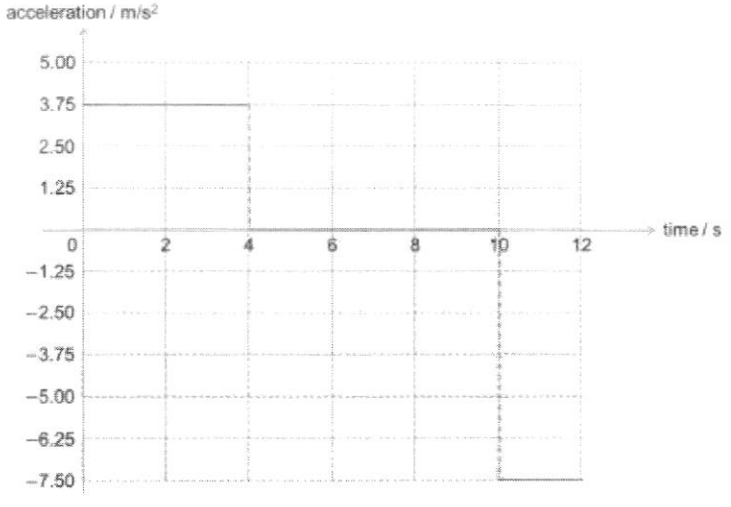
(b) Total distance = area under graph = ½ x (6 + 12) x 15 = 135 [1]

OR

Total distance = area under graph = (½ x 15 x 4) + (15 x 6) + ((1/2 x 15 x 2) = 135 [1]

Average speed = total distance / total time = 135 / 12 = 11.25 m/s = 11.3 m/s (3 s.f.) [1]

(c)



[2] all 3 horizontal lines to show constant speed (0), constant acceleration (3.75) and deceleration (-7.5)

3 **(a)** 10 intervals → 3.7 s

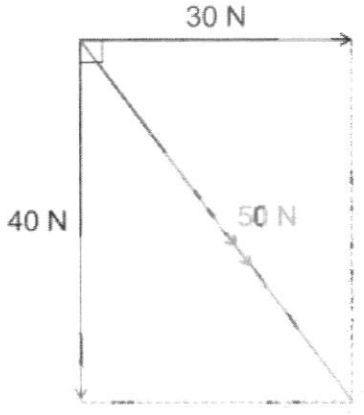
1 interval → 3.7 / 10 = 0.37 s [1]

(b) [1] Taking the average of multiple intervals **reduce the error due to human reaction time** which is larger when only 1 interval is taken.

(c) Total time taken = 0.37 x 4 = 1.48 s [1]

(d) [1] As the water droplets fall further away from the crack, they **accelerate due to gravity** and hence the water droplets become further apart.

4



1m --- correct scale: 1cm to 5N

1m --- magnitude of resultant force: 50 N

1m --- direction of resultant force: 37° to the 40 N force or 53° to the 30 N force

Deduct 1m if no / wrong arrowheads / wrong arrowhead direction (1 arrowhead for tension & 2 arrowheads for resultant force)

5 **(a)** $W = mg = (\frac{97.5}{1000})(10)$ [1]

$= 0.975$ N [1]

(b) Density $= \frac{m}{V} = \frac{97.5}{5.0}$ [1]

$= 19.5$ g/cm^3 [1]

(c) [1] It is not made of pure gold as its density is 19.5 g/cm^3 not 19.3 g/cm^3 (need to state values).

(d) [1] It will sink as it has a density of 19.5 g/cm^3 which is higher than 0.92 g/cm^3 (need to state values to give comparison).

6 **(a)** [1] The centre of gravity of an object is defined as the point through which its whole weight appears to act for any orientation of the object.

(b) [1] Weight must be drawn vertically downwards from C

(c) [1] By keeping balanced at midpoint M, the **line of action of the weight is within the base area** (tightrope).

[1] This will result in **no turning effect as there is no moment due to the weight**.

(d) **(i)** M = F x d = 100 x 4.0 [1]

= 400 Nm [1]

(ii) Taking moments about pivot M,

Sum of anticlockwise moments = sum of clockwise moments

(100)(4.0) + (1000)(0.25) = (F)(5.0) [1]

F = 130 N [1]

7 **(a)** $P = h\rho g = (0.55)(10)(13600)$ [1]

$= 74800\ N/m^2$ [1]

(b) Difference = 103000 – 74800 = 28200 N/m^2 [1]

(c) 28200 = 1.4 x 10 x h [1]

h = 2014.28571 = 2014 m (nearest whole number.) [1]

8 **(a)** [1] As the air is expelled, **the number of air molecules per unit volume between the suction cup and the windscreen decreases. The average force per unit area exerted by the air molecules decreases.**

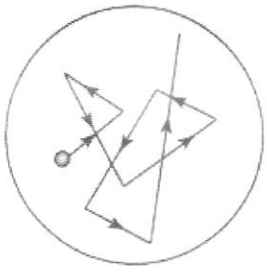
[1] As the **pressure within the suction cup and the windscreen is lower than the atmospheric pressure outside**,

[1] **there will be a net force exerted on the suction cup**, causing it to stay attached to the windscreen.

(b) [1] The air molecules in the suction cup **gain thermal energy and vibrate more vigorously**. The **frequency of collision** of the air molecules with the walls of the suction cup and windscreen **increases.**

[1] The **average force per unit area exerted on the walls increases till a point where it is greater than or equal to the atmospheric pressure**. Hence, the suction cup will fall off.

9 (a)



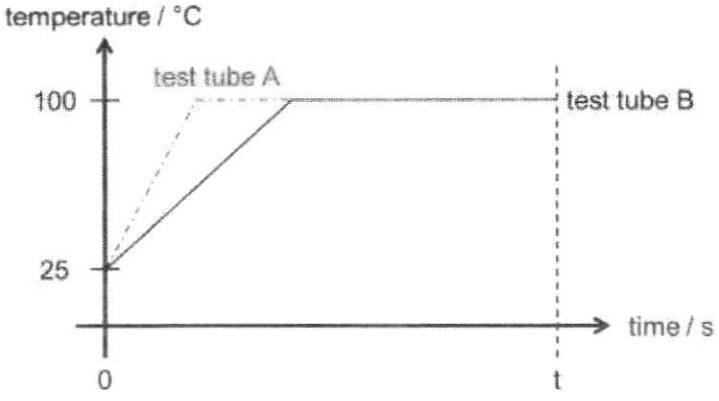
[1] zig zag motion of a smoke particle

(b)

[1] The air molecules are in constant random motion.

[1] The air molecules bombard the smoke particles randomly in all directions.

10 (a)



[1] test tube A will reach boiling point earlier than test tube B

[1] same boiling point

(b)

[1] Test tube A will cool down faster as

[1] the dull black outer surface is a good emitter of radiation / the shiny silver outer surface is a poor emitter of radiation.

DNA "good / poor absorber / reflector of radiation"

(c)

Responds very quickly to rapidly changing temperature OR

Measures a very large temperature range OR

Can measure temperature at specific point

1m each, max 2m

Section B

11 (a) [1] Work done is the product of the applied force and the distance

[1] travelled in the same direction as the force.

(b) Distance travelled = area under graph = 20 x 6 [1]

= 120 m [1]

(c) W = F x d = 1500 x 120 [1]

= 180 000 J [1]

(d) P = E / t = 180000 / 20 [1]

= 9000 W [1]

(e) $a = \frac{v-u}{t} = \frac{0-6}{10}$ [1]

= – 0.60 m/s^2

→ deceleration = 0.60 m/s^2 [1]

12 (a) (i) [1] Energy cannot be created or destroyed. Energy can only be converted from one form to another / transferred from one body to another.

[1] Total energy must remain constant.

(ii) GPE = mgh = (50)(10)(1.0 x 2) --- [1]

= 1000 J --- [1]

(iii) Gain in KE = Loss in GPE

½ mv^2 = 1000 --- [1]

v^2 = 40

v = 6.3245 m/s = 6.32 m/s (3 s.f.) --- [1]

(b) (i) mass = density x volume = (1.2)(4.5 x 10^5) --- [1]

= 540000 = 5.4 x 10^5 kg --- [1]

(ii) efficiency = $\frac{energy\ output}{energy\ input} \times 100\%$

$0.35 = \frac{energy\ output}{energy\ input} = \frac{energy\ output}{\frac{1}{2}(540000)(12^2)} = \frac{energy\ output}{38880000}$ --- [1]

energy output = 13608000 = 1.36 x 10^7 J (3 s.f.) --- [1]

13 E (a) [1] It is the amount of thermal energy required to change a unit mass of the solid to liquid without a change in temperature.

(b) Energy supplied = ml_f

$Pt = ml_f$

$(30)(30)(60) = (4)(l_f)$ --- [1]

$l_f = 13500$ J/kg --- [1]

(c) [1] The thermal energy gained was used to **overcome the attractive forces between the molecules**. Hence, the internal potential energy increased.

[1] However, there is **no change in the internal kinetic energy**, hence the temperature of the substance remains constant.

(d) [1] The liquid molecules are closely packed in an irregular manner.

(e) [1] The liquid closer to the heating coil gets heated up, expands, becomes **less dense** and rises while the cooler **denser** liquid further away sinks to take its place.

[1] This sets up a **convection current** which heats up the entire liquid.

(f) $E = Pt = mc\Delta\theta$

$c = \frac{Pt}{m\Delta\theta} = \frac{(30)(10\times60)}{(4)(50-30)}$ --- [1]

$c = 225$ J/(kg°C) --- [1]

13 O (a) (i) [1] The electric induction stove converts 1500 J of electrical energy to thermal energy in 1 s.

(ii) $E = Pt = mc\Delta\theta$

$(1500)(t) = (2.0)(2000)(130 - 25)$ --- [1]

$t = 280$ s --- [1]

(iii) Heat loss by oil = Heat gain by nuggets

$mc\Delta\theta$ (oil) = $mc\Delta\theta$ (nuggets)

[1] --- $(2.0)(2000)(130 - 80) = (m)(3500)(80 - 1)$ --- [1]

$m = 0.72332$ kg $= 723.32$ g

$m = 0.723$ kg $= 723$ g (3 s.f.) --- [1]

(b) (i) [1] The main process is **convection**.

[1] The air closer to the grill gets heated up, expands, becomes **less dense** and rises while the cooler **denser** air further away at the top sinks to take its place.

[1] This sets up a **convection current** which heats up the food.

(ii) [1] Thermocouples are able to measure high temperatures / detect rapidly changing temperatures.