BEDOK SOUTH SECONDARY SCHOOL
END-OF-YEAR EXAMINATION 2021

3EXP

CANDIDATE NAME

CLASS

REGISTER NUMBER

SCIENCE (PHYSICS)

5076

30 September 2021

1 hour 30 minutes

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on the work you hand in.
Write in dark blue or black ink on both sides of the paper.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A [20 marks]
There are **twenty** questions in this section. 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 [35 marks]
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section C [20 marks]
Answer any **two** questions.
Write your answers in the spaces provided on the question paper.

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

For Examiner's Use	
Section A	20
Section B	35
Section C	20
TOTAL	75

Setter: Mdm Joanne Ng

This document consists of **23** printed pages.

Section A

Answer **all** questions.
Record your answers on the separate Multiple Choice Answer Sheet.

A1 Which of the following is a derived physical quantity?

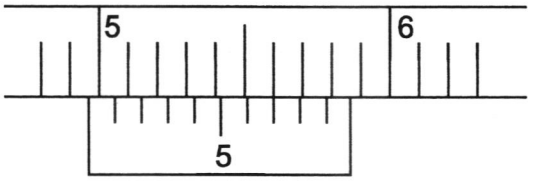
A length **B** mass **C** speed **D** time

A2 The length of a thin copper wire is approximately 35 cm and its diameter is about 2.10 mm.

Which instruments are the most appropriate to measure the length and diameter of the copper wire?

	length	diameter
A	metre rule	micrometer screw gauge
B	metre rule	vernier calipers
C	vernier calipers	micrometer screw gauge
D	vernier calipers	vernier calipers

A3 The diagrams show a pair of vernier calipers when it is used to measure the internal diameter of a pipe.

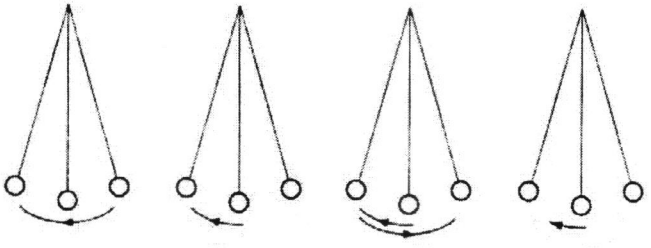


What is the correct internal diameter of the pipe?

A 4.47 cm **B** 4.97 cm **C** 5.07 cm **D** 5.57 cm

A4 A simple pendulum takes a fixed amount of time to complete one oscillation.

Which diagram shows that the pendulum is set to oscillate for half a period?

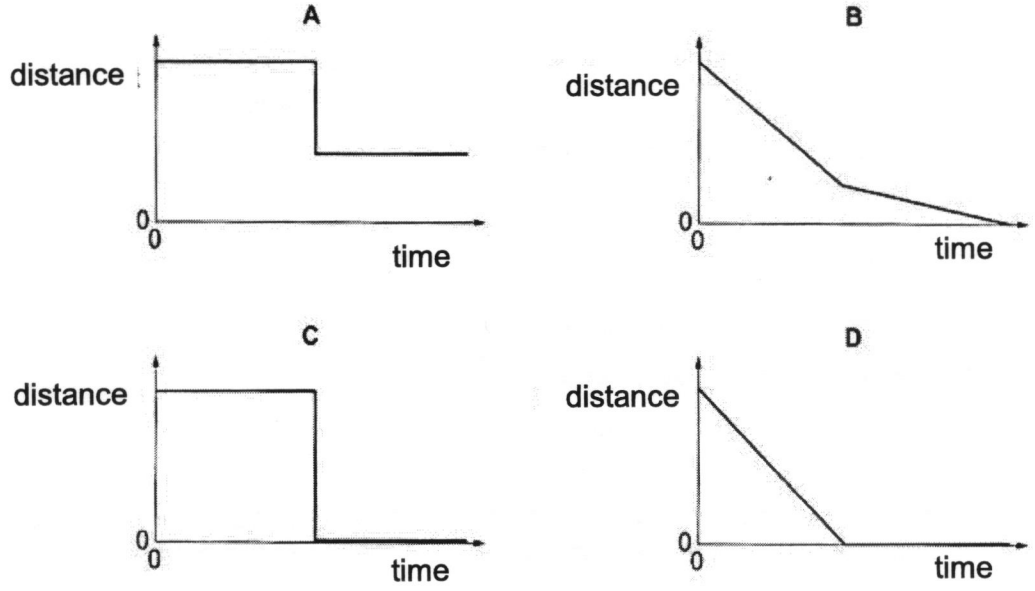


A **B** **C** **D**

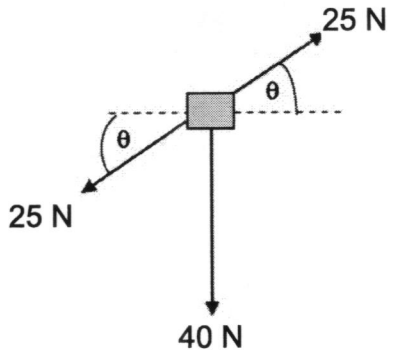
[Turn over

A5 A free-fall parachutist falls at a constant speed. He then opens his parachute and continues to fall to Earth at a lower, constant speed.

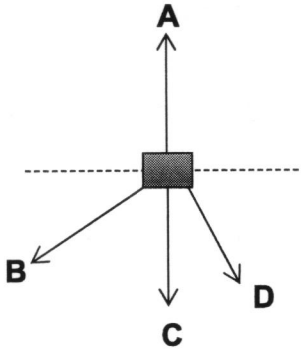
Which correctly shows the variation of the parachutist's distance from Earth with time?



A6 The diagram shows three forces acting on an object.

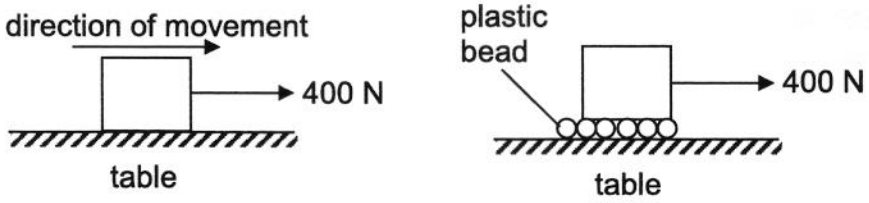


Which correctly shows the direction of the resultant force of the three forces?



[Turn over

A7 A wooden block moves across a table top with constant speed when a force of 400 N is applied to it.



What happens when the wooden block is pulled with the same force on the table top covered with plastic beads?

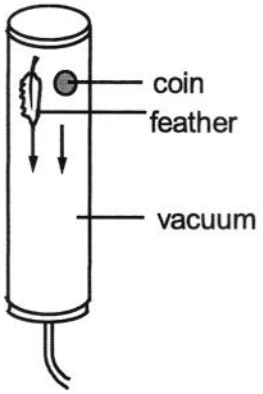
A It fails to move.

B It moves with constant acceleration.

C It moves with constant deceleration.

D It moves with constant speed.

A8 A coin and a feather are released from rest in vacuum as shown in the diagram. It is observed that both the coin and the feather reach the bottom of the cylinder at the same time.



Which of the following is/are correct deduction(s) from this experiment?

I The masses of the coin and the feather are identical in vacuum.

II The coin and the feather fall with the same acceleration in vacuum.

III The gravitational forces acting on the coin and the feather in vacuum are identical.

A I only **B** II only **C** II and III only **D** III only

[Turn over

A9 A boy is trapped on a lake that has frozen. A man rescues the boy by crawling across the ice rather than by walking across the ice.

What effect, if any, does crawling across the ice have on the force and the pressure on the ice, compared to walking?

	force	pressure
A	decreased	decreased
B	decreased	increased
C	unchanged	decreased
D	unchanged	increased

A10 A 10.0 kg block of iron is brought from Earth to the surface of a planet.

Given that the gravitational field strength of the planet is 3.90 N / kg, how will the properties of the iron block change?

	inertia that the block could experience	weight of the block
A	unchanged	decreased
B	unchanged	increased
C	decreased	decreased
D	decreased	increased

A11 The table shows the density of various substances.

substance	density in g / cm^3
kerosene	0.87
water	1.0
iron	7.9
copper	8.9
mercury	13.6

Which statement is correct?

A 1 cm^3 of mercury has a greater mass than 1 cm^3 of any other substance in the table.

B 1 cm^3 of water has a smaller mass than 1 cm^3 of any other substance in the table.

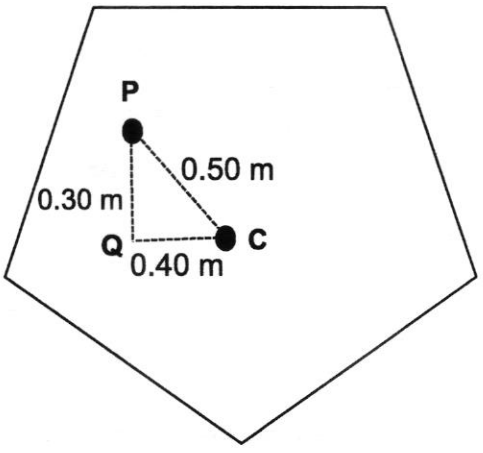
C 1 g of iron has a smaller volume than 1 g of copper.

D 1 g of mercury has a greater mass than 1 g of copper.

[Turn over

A12 A plane lamina is freely suspended from point **P**. The weight of the lamina is 3.0 N and the centre of gravity is at **C**.

The lamina is then displaced to the position shown in the diagram such that the points **P**, **Q**, and **C** forms a right angle triangle.



What is the moment that will cause the lamina to swing?

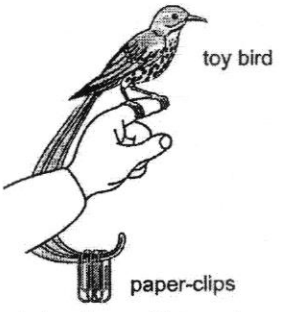
A 0.90 N m, clockwise

B 1.2 N m, clockwise

C 1.5 N m, clockwise

D 1.5 N m, anticlockwise

A13 A girl uses paper-clips to balance a toy bird on her finger as shown.



The toy bird will return to its original position when it is tilted out of place.

Where is its centre of gravity?

A directly above her finger

B directly at her finger

C directly below her finger

D not possible to tell

[Turn over

A14 A 6.0 kg object is moving at an initial speed of 7.0 m / s along a horizontal track. It loses 47 J of energy in overcoming friction by the end of the track.

What is the kinetic energy of the ball at the end of the track?

A 20 J **B** 60 J **C** 80 J **D** 100 J

A15 A stone enters a deep pool at high speed. It slows down as it moves towards the bottom of the pool.

What is the energy transformation as the stone moves downwards through the water?

A gravitational potential energy → kinetic energy + thermal energy (heat)

B gravitational potential energy → kinetic energy → thermal energy (heat)

C kinetic energy + gravitational potential energy → thermal energy (heat)

D kinetic energy → gravitational potential energy + thermal energy (heat)

A16 A gas in a sealed container is compressed to half its original volume.

Which is **incorrect** about the gas particles in the container?

A The distance between the gas particles decreases.

B The mass of the gas particles remains the same.

C The number of gas particles remains the same.

D The size of the gas particles decreases.

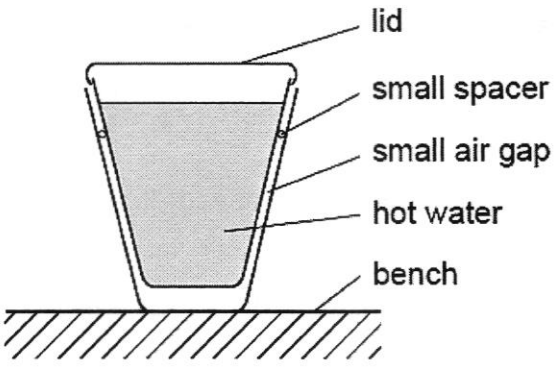
A17 The rate at which heat is conducted through a substance depends on its state.

Which correctly shows the rate at which heat is conducted from the lowest to the highest?

	lowest rate ⟶ highest rate		
A	solid	liquid	gas
B	solid	gas	liquid
C	liquid	gas	solid
D	gas	liquid	solid

[Turn over

18 Two plastic cups are placed one inside the other. Hot water is poured into the inner cup and a lid is placed on top as shown.



Which statement is correct?

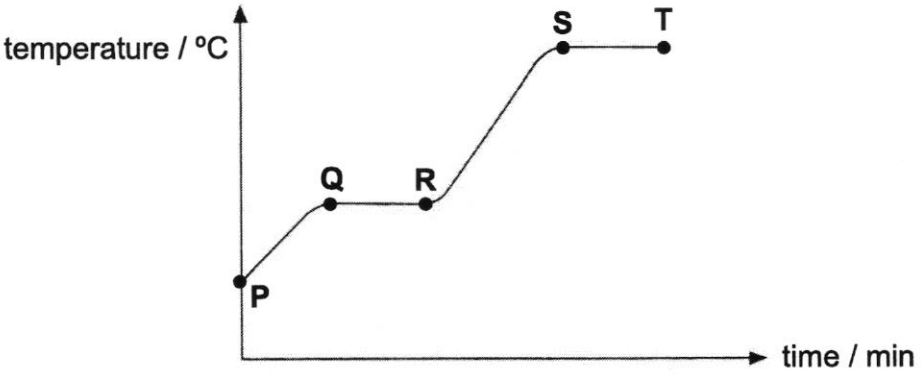
A Heat loss by radiation is prevented by the small air gap.

B No heat passes through the sides of either cup.

C The bench is heated by convection from the bottom of the outer cup.

D The lid is used to reduce heat loss by convection.

A19 Some ice cubes are placed in a beaker and heated above a Bunsen burner until it boils.



Between which two points on the graph does the substance in the beaker exist in two different states, ice and water, and water and steam?

	ice and water	water and steam
A	PQ	RS
B	RS	PQ
C	ST	QR
D	QR	ST

[Turn over

A20 A certain liquid evaporates rapidly.

Why does evaporation cause the remaining liquid to cool?

A Air molecules remove heat by contact with the liquid surface.

B Energy is lost by convection currents.

C Some of the most energetic molecules leave the liquid.

D The molecules have less room to move around.

Section B

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

For examiner's use

B1 **(a)** Convert the following using a correct prefix symbol.

759.2×10^{-6} g = 759.2 ..... g [1]

(b) Convert the following value to the required unit without any prefix.

0.04 km^2 = ... m^2 [1]

B2 A student uses a measuring cylinder to measure out 20.0 cm^3 of water.

(a) **(i)** The student ensures that his line of sight is perpendicular to the scale of the measuring cylinder.

State the error that could be prevented with this precaution.

..... [1]

(ii) The student put ten ball bearings made of brass into the water in a measuring cylinder. Fig. B2.1 shows the new reading on the measuring cylinder.

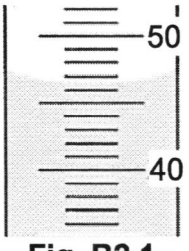


Fig. B2.1

Read and record the new reading shown by the measuring cylinder.

new reading = ... cm^3 [1]

(b) **(i)** Calculate the volume of one ball bearing.

volume of one ball bearing = ... cm^3 [1]

(ii) Explain why there is a need to measure the volume of ten ball bearings in **(a)(ii)** instead of only one.

.....

..... [1]

[Turn over

B3 A 1500 kg racing car accelerates uniformly from rest to 60 m / s in 10 s. It travels for 12 s at a constant speed of 60 m / s before decelerating uniformly to rest with a constant deceleration of 7.5 m / s^2.

For examiner's use

(a) Draw a graph of speed against time for the car's journey on Fig. B3.1. [3]

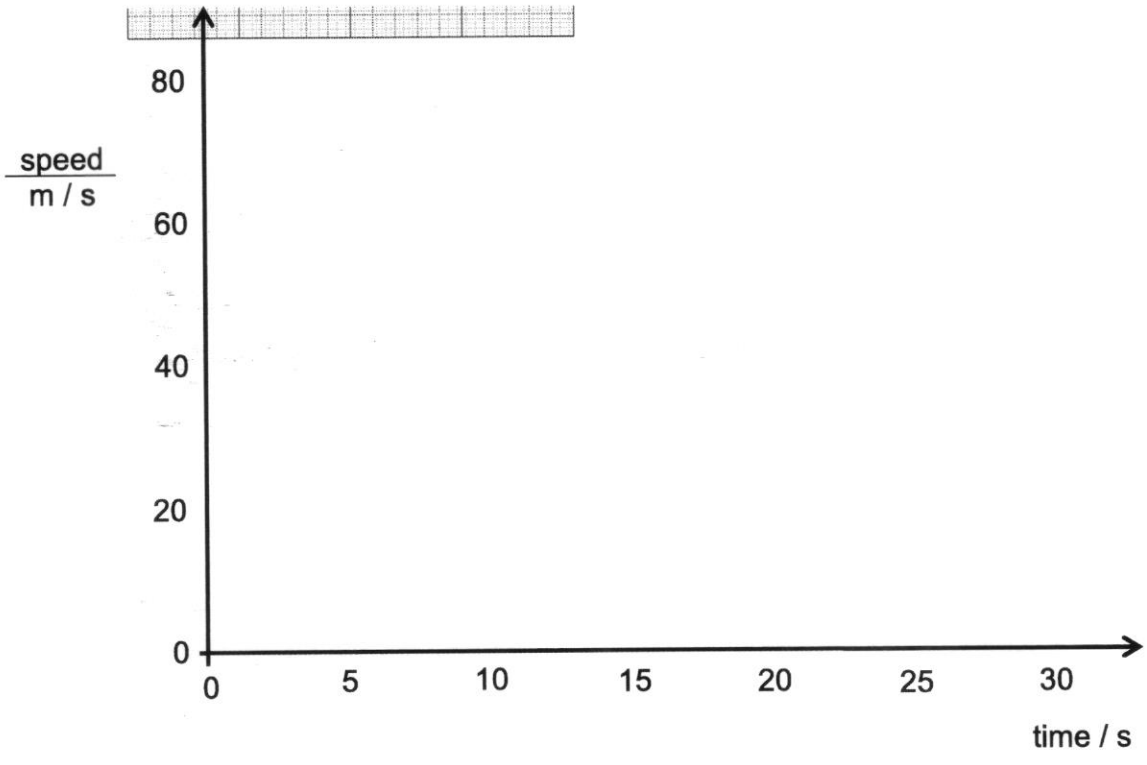


Fig. B3.1

(b) **(i)** Calculate the distance travelled by the car during its acceleration.

distance = ... m [2]

(ii) Determine the average speed of the car in the first 22 seconds of its journey.

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

[Turn over

For examiner's use

(c) The 1500 kg racing car and a 5000 kg lorry are travelling at the same speed of 60 m / s when both drivers stepped on the brakes at the same time.

State and explain which vehicle would come to a stop first, assuming that the braking force is the same for both vehicles.

.....

.....

.....

..... [2]

(d) Fig. B3.2 shows a racing car.

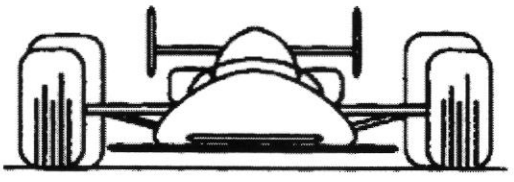


Fig. B3.2

State two features of the racing car that make it more stable than a normal passenger car.

1. .....

2. ..... [2]

[Turn over

B4 Fig. B4.1 shows two forces acting on an object. The 50 N acts at an angle of 45° to the vertical and the 20 N force acts southwards.

For examiner's use

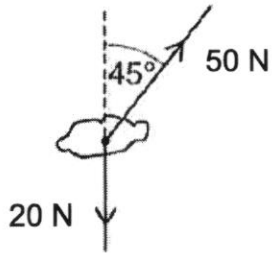


Fig. B4.1

Complete Fig. B4.2 to determine the magnitude of the resultant force.
Scale: One small grid square represents 1.0 N.

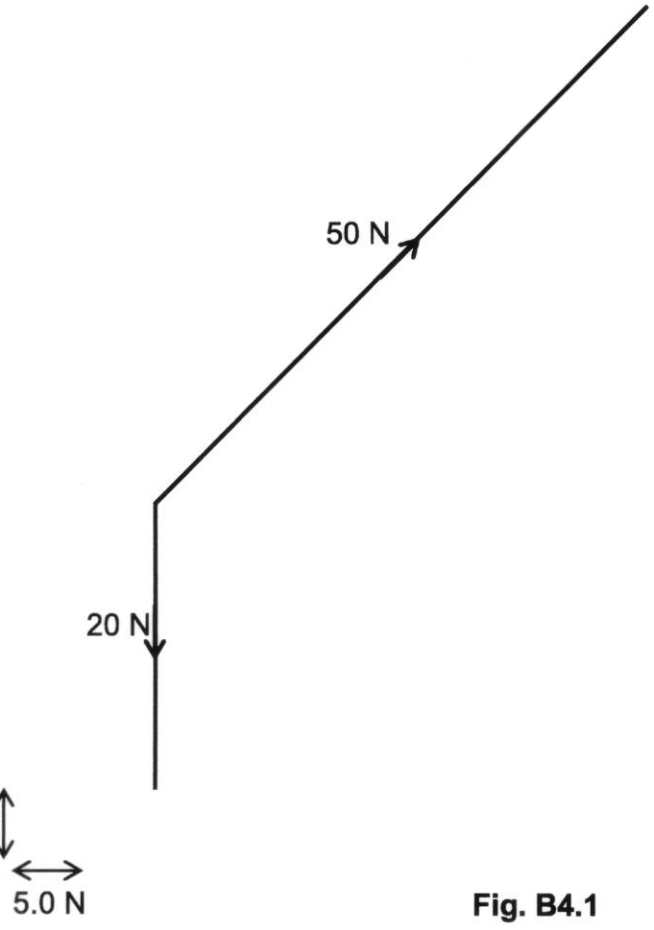


Fig. B4.1

magnitude of resultant force = ... N [3]

[Turn over

B5 Fig. B5.1 shows a 5.0 kg object placed on a plank at 0.70 m from the pivot. The object is balanced by a spring attached to the other end of the plank.

For examiner's use

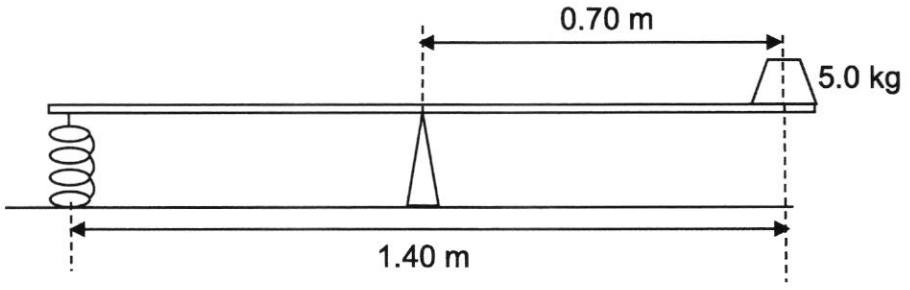


Fig. B5.1

(a) Explain why the pivot is placed exactly at the mid-point of the length of the plank.

.....

..... [1]

(b) Draw an arrow on Fig. B5.1 to show the force experienced by the spring. [1]

(c) State how the force experienced by the spring will change if the object is moved nearer to the pivot.

.....

..... [1]

[Turn over

For examiner's use

B6 Fig. B6.1 shows a hydraulic system.

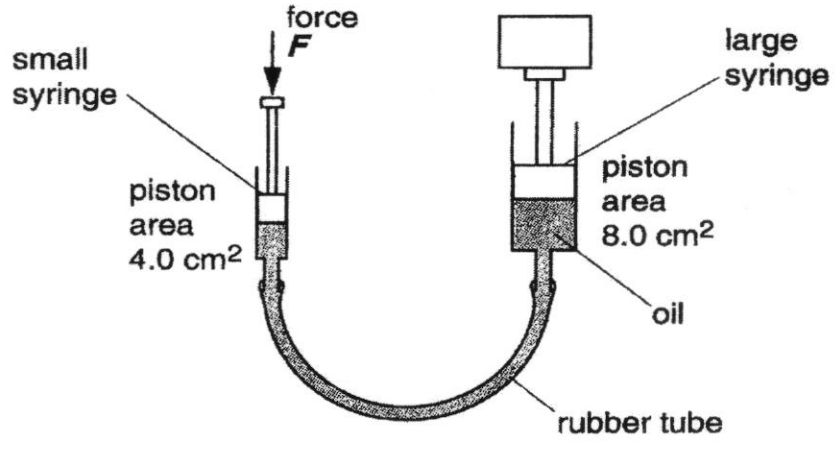


Fig. B6.1

(a) Calculate the pressure exerted on the oil at the small syringe when the force exerted *F* is 8.0 N.

pressure = ... N / cm^2 [2]

(b) The pressure at the small piston is equal to the pressure at the large piston.

Deduce whether the force at the large syringe will be greater, smaller, or equal to the force *F* exerted on the small syringe.

..... [1]

(c) State the physical property of oil that makes it suitable for use as a medium to transmit pressure in a hydraulic press.

..... [1]

[Turn over

B7 Fig. B7.1 shows an object of mass 6.0 kg suspended from a ledge with a rope. The rope snaps and the object falls through 4.2 m to reach the ground.

For examiner's use

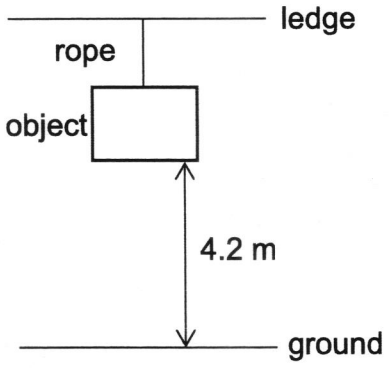


Fig. B7.1

The gravitational field strength g is 10 N / kg.

(a) Calculate the gravitational potential energy possessed by the object when it was suspended.

gravitational potential energy = ... J [2]

(b) Calculate the speed of the object at the instant it reaches the ground.

speed = ... m / s [2]

(c) State the assumption made in order to obtain the answer for **(b)**.

.....

..... [1]

[Turn over

For examiner's use

B8 Fig. B8.1 shows a plate warmer.

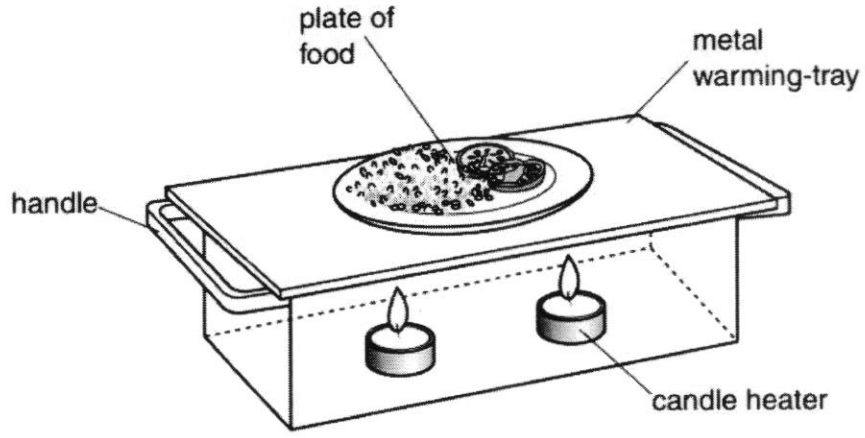


Fig. B8.1

(a) Explain, using the kinetic model of matter, why convection can only occur in fluids.

.....

..... [1]

(b) Describe how heat is transferred from the candle's flame to the warming tray by convection.

.....

..... [1]

(c) Suggest a suitable colour for the bottom of the warming tray to increase the rate of heat gain.

..... [1]

[Turn over

Section C

Answer any **two** questions in this section.
Write your answers in the spaces provided.

For examiner's use

C1 Fig. C1.1 shows a windsurfer on his surfboard. The wind exerts a forward force of 180 N on the sail of his board. The perpendicular distance between the line of action of the windsurfer's weight and the pivot P is *d*.

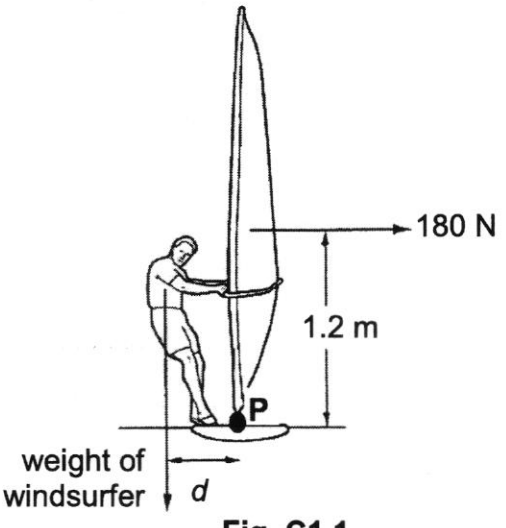


Fig. C1.1

(a) Given that the mass of the windsurfer is 54 kg, calculate his weight. Take gravitational field strength *g* to be 10 N / kg.

weight = ... [1]

(b) **(i)** State the *Principle of Moments*.

.....

.....

.....

..... [2]

(ii) Given that the windsurfer is in equilibrium about pivot P, calculate distance *d*.

distance *d* = ... [2]

[Turn over

For examiner's use

(c) The force exerted by the wind on the sail increases. So, the windsurfer adjusts his position to change the distance *d*.

State and explain whether distance *d* would increase, decrease, or remain the same.

.....

..... [2]

(d) Consider the surfboard and sail as one body.

The weight of the surfboard and sail does not produce a turning effect about pivot P.

On Fig. C1.1, mark the position of the centre of gravity of the surfboard and sail with an **X**. [1]

(e) The total mass of the windsurfer, surfboard, and sail is 84 kg. When the forward force by the wind is 180 N, the total resistive force is 150 N.

Calculate their acceleration.

acceleration = ... [2]

[Turn over

C2 Fig. C2.1 shows an electric motor used to pull a crate up a ramp.

For examiner's use

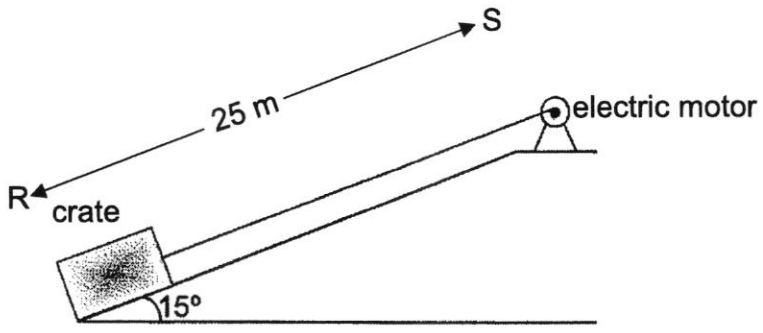


Fig. C2.1

(a) The crate moves at constant speed *v* from point R to S, through a distance of 25 m up the ramp in 35 s, against a constant frictional force of 40 N.

(i) Explain why there is no change in kinetic energy of the crate as it moves from point R to S up the ramp.

.....

..... [1]

(ii) Calculate the work done to overcome the frictional force.

work done = ... [2]

(iii) Hence, calculate the power generated by the electric motor to overcome the frictional force.

power = ... [2]

[Turn over

For examiner's use

(b) The crate is made of steel and it feels hot to touch when left in the sun.

(i) Describe how thermal energy is conducted from the outside to the inside of the crate in molecular terms.

.....

.....

.....

..... [2]

(ii) Explain why steel is a better conductor of thermal energy than wood.

.....

..... [1]

(iii) Similar bigger versions of the steel crate can hold double the volume of goods than the one in Fig. C2.1.

Compare and explain how the rate of heat absorbed by the big and small steel crates will be different.

.....

.....

.....

..... [2]

[Turn over

C3 Fig. C3.1 shows the variation of temperature with time of a liquid substance Y that is left to cool.

For examiner's use

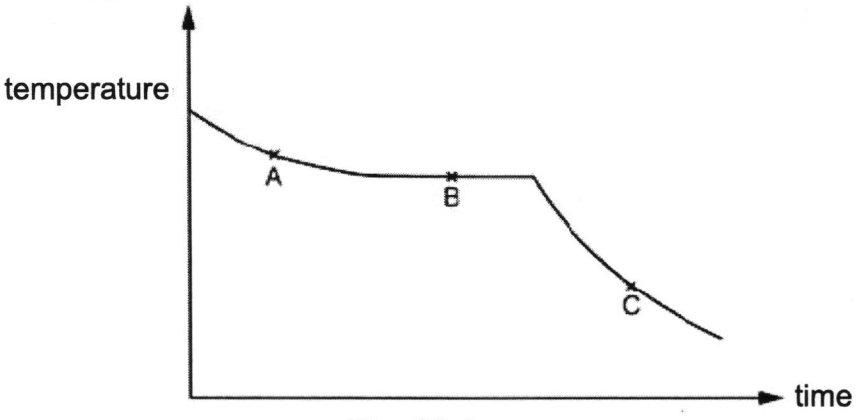


Fig. C3.1

(a) (i) State the process that occurs at point B.

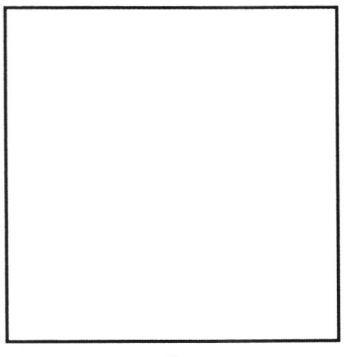
..... [1]

(ii) State whether the internal kinetic and potential energies increases, decreases, or remains the same at points A and B in the table below.

	point A	point B
internal kinetic energy		
internal potential energy		

[2]

(b) Draw the arrangement of the particles of substance Y at point C in the box provided below. [1]



[Turn over

For examiner's use

(c) Substance Y can exist in the solid, liquid, and gaseous states.

Explain why, in terms of forces and distances between the particles of Y,

(i) gas Y is compressible,

.....

..... [1]

(ii) liquid Y has a fixed volume, and

.....

..... [1]

(iii) more energy is needed to change substance Y from liquid to gas than to change it from solid to liquid.

.....

.....

.....

..... [2]

(d) Liquid Y can evaporate.
State one difference between evaporation and boiling.

.....

..... [1]

(e) Fig. C3.2 shows the movement of a pollen grain placed in liquid Y over some time.

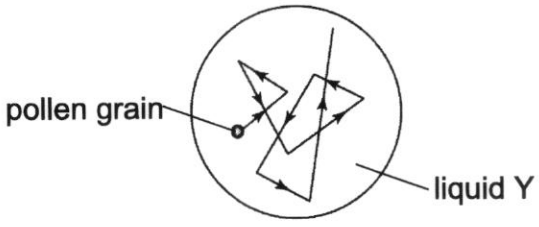


Fig. C3.2

Explain the movement of the pollen grain observed.

.....

..... [1]

End of paper

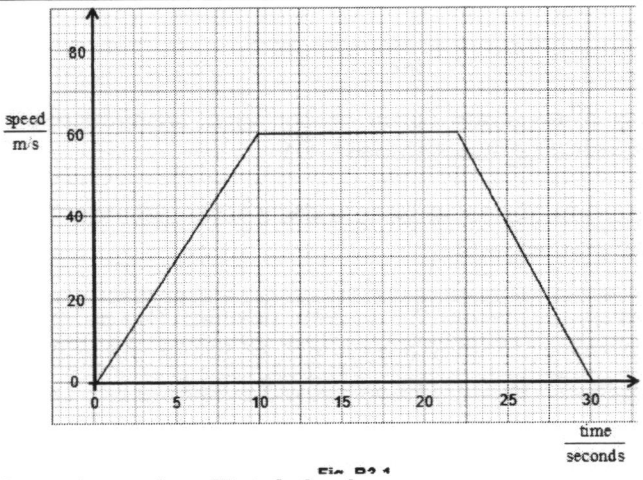
[Turn over

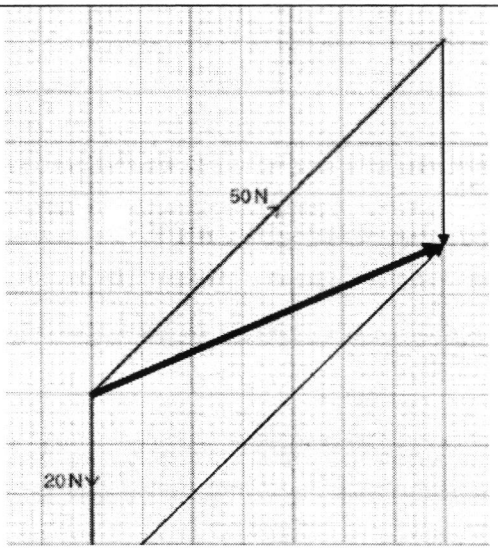
2021 Sec 3 Sc(Phy) EOY Mark Scheme

Section A

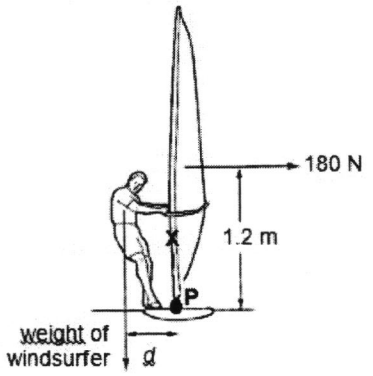
A1	A2	A3	A4	A5	A6	A7	A8	A9	A10
C	A	B	A	B	C	B	B	C	A
A11	A12	A13	A14	A15	A16	A17	A18	A19	A20
A	B	C	D	C	D	D	D	D	C

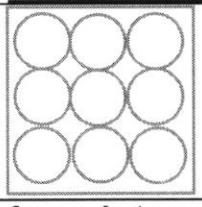
Sections B and C

Qn	Part	Solutions	Remarks
B1	(a)	**μ**	
	(b)	**40 000**	
B2	(a)(i)	**to prevent parallax error**	
	(a)(ii)	**46.5**	
	(b)(i)	**(46.5-20.0)/10 = 2.65**	
	(b)(ii)	Calculating the average volume of one ball bearing reduces the percentage error due to the **lack of precision of the measuring cylinder** in determining volume. – B1 OR There is error involved in measuring the volume of only one ball bearing at a time because **the volume of one ball bearing is too small.**	
B3	(a)	 **1 section – 1 m (Total: 3 m)** **Allow e.c.f.** **For example, part 2 needs to show 60 m/s for 12 s. But it may start from wrong timing due to part 1 error.** **Part 3 needs to have the correct gradient of 7.5 m/s^2.**	Allow e.c.f.

	(b)(i)	**distance = area under speed-time graph – M1** **= ½ (10) (60)** **= 300 m – A1**	Allow e.c.f.
	(b)(ii)	**average speed = total distance/ total time – M1** **= [300 m + (12)(60)] / 22 s** **= 46.4 m/s – A1**	
	(c)	The **racing car** will come to a stop first because – B1 it has a **smaller mass and lower inertia** than the lorry. – B1	
	(d)	**1. It has a low centre of gravity. – B1** **2. It has a wide base. – B1**	
B4		 **Magnitude of resultant force = 38.1 N – B1** **Correct drawing of resultant force on the grid, labelled using double arrow (excluding magnitude) – B1** **Correct working shown to draw parallelogram (accept both dotted lines and arrows) – B1**	
B5	(a)	**This is so that the pivot would be exactly beneath the centre of gravity of the plank such that the weight of the plank will not cause any turning effect/moment about the pivot.**	
	(b)		Accept arrow not on spring if it is clear and correct.
	(c)	**The force experienced by the spring will be smaller.**	

B6	(a)	**p = F/A – M1** **p = 8.0/4.0** **p = 2.0 N/cm^2 – A1**	
	(b)	**greater – B1**	
	(c)	**It is incompressible.**	
B7	(a)	**G.P.E. = mgh – M1** **= (6.0 kg) (10 N/kg) (4.2 m)** **= 252 J – A1**	
	(b)	**G.P.E. lost = K.E. gained** **252 J = ½ (6.0 kg) v^2 – M1** **84 = v^2** **v = 9.17 m/s (to 3 s.f.) – A1**	
	(c)	**Any 1.** **Energy is conserved.** **There is no loss of energy to overcome air resistance.** **There is no air resistance.** **All gravitational potential energy is converted to kinetic energy.**	
B8	(a)	**Fluid particles are able to slide over one another** **OR free to move around** so they can move due to difference in density.	
	(b)	The **hotter, less dense air near the candle flame rises.** **Note: Important to say "density".**	
	(c)	**black**	
C1	(a)	**W = 540 N** **(No Answer Mark for wrong/missing unit.)**	
	(b)(i)	**The Principle of Moments state that the sum of clockwise moments about a pivot equals the sum of anticlockwise moments about the same pivot – B1** **for an object in equilibrium.- B1**	
	(b)(ii)	**(180 N)(1.2 m) = (540 N)(d) – correct substitution – M1** **d = 0.40 m – A1** **Do not award M1 for stating equation as credit given in (b)(i).**	
	(c)	**d will increase – B1** **so that the moment produced by the windsurfer's weight can counterbalance the increased moment caused by the stronger wind – B1**	

	(d)	 **Accept X marked 2 mm above or below that shown in answer.**	
	(e)	**F_{net} = ma – M1** **180 N – 150 N = (84 kg)(a)** **a = 0.357 m/s^2 – A1**	
C2	(a)(i)	**The speed of the crate is constant from point R to S.**	
	(a)(ii)	**W = Fd – M1** **W = (40 N)(25 m)** **W = 1000 J – A1**	
	(a)(iii)	**P = W/t – M1** **P = 1000/35** **P = 28.6 W (to 3 s.f.) – A1**	
	(b)(i)	**The steel particles on the outside of the crate gains thermal energy first as it is exposed to the sun. They vibrate and rotate about their fixed positions more vigorously, - B1** **colliding with neighbouring particles and transferring the energy to the particles nearer to the inside of the crate, - B1** **in turn causing them to vibrate more vigorously so that the temperature of the steel on the inside of the plate also increases.** **OR** **free electrons on the outside of the crate gains thermal energy first as it is exposed to the sun – B1** **The free electrons move rapidly from the outer side to inner side of the crate, transferring thermal energy to particles at the cooler end. –B1**	
	(b)(ii)	**Free electron diffusion** can occur in steel and not wood due to the mobile valence electrons of metal atoms.	
	(b)(iii)	**The bigger steel crates have a bigger surface area exposed to the sun than the smaller crates. – B1** **The rate of heat absorbed by the bigger steel crates will be higher. – B1**	

<table>
<tr><td>C3</td><td>(a)(i)</td><td><u>freezing</u></td><td></td></tr>
<tr><td></td><td>(a)(ii)</td><td>
<table>
<tr><td></td><td>point A</td><td>point B</td></tr>
<tr><td>internal kinetic energy</td><td>decrease</td><td>remains the same</td></tr>
<tr><td>internal potential energy</td><td>remains the same</td><td>decrease</td></tr>
</table>
<u>2 blanks correct – B1</u>
<u>4 blanks correct – B2</u>
</td><td>No ½ mark.</td></tr>
<tr><td></td><td>(b)</td><td>  </td><td></td></tr>
<tr><td></td><td>(c)(i)</td><td><u>forces between particles are very weak</u>
<u>distances between particles are far apart</u>

<u>Or any reasonable phrasing</u></td><td>[B1]</td></tr>
<tr><td></td><td>(c)(ii)</td><td><u>forces between particles are strong</u>
<u>distances between particles are close</u>

<u>Or any reasonable phrasing</u></td><td>[B1]</td></tr>
<tr><td></td><td>(c)(iii)</td><td>To change Y from solid to liquid, <u>energy is only needed to overcome the forces of attraction between particles of Y</u>. – B1

However, to change Y from liquid to gas, energy is needed to overcome forces of attraction between particles of Y and also to <u>push against atmospheric pressure</u> so that more energetic particles can escape the surface of liquid Y. – B1

OR

<compare the distances in between particles>
<u>solid to liquid the force from very strong to strong and distance from very closely packed to closely packed so the difference is smaller as compared to liquid to gas, from strong force of attraction to weak and closely packed to far apart which the difference is much larger so that's why more energy is needed.</u>

<u>Or any reasonable phrasing</u></td><td>[B1]

[B2]

Note:
Accept if phrasing for non-underlined parts is not so exact.</td></tr>
<tr><td></td><td>(d)</td><td><u>Evaporation occurs at the surface of a liquid while boiling occurs throughout the liquid.</u>

Accept other correct answers.</td><td></td></tr>
<tr><td></td><td>(e)</td><td>According to the Kinetic Particle Theory, liquid Y particles move <u>continuously and randomly</u> so that they <u>collide</u> with the pollen grain, causing it to move continuously and randomly as well.</td><td></td></tr>
<tr><td></td><td></td><td><u>THE END</u></td><td></td></tr>
</table>