YISHUN SECONDARY SCHOOL

We Seek, We Strive, We Soar

MID-YEAR EXAMINATION

Name : _____ **Reg. No :** _____ **Class:** _____

Sec 3 Express **Date: 14 May 2019**

PHYSICS (6091)

PAPER 1 and 2 **Duration: 2 hours 10 minutes**

MAX MARKS: 90

Additional Materials: OTAS Sheet

READ THESE INSTRUCTIONS FIRST:

Write your name and class on the work you hand in.
Do not use staples, paper clips, glue or correction fluid.

Paper 1

Write in soft pencil.
Write your name and register number on the **OTAS** Sheet provided.
There are **twenty** 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 OTAS Sheet.
Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Paper 2

There are 2 sections in this paper. Write your answers in the spaces provided.

Section A

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

Section B

Answer **all** questions. Question 10 has a choice of parts to answer.

The number of marks is given in brackets [ ] at the end of each question or part question.
All quantitative answers should include appropriate units.
Show all working in a clear and orderly manner.
Submit answers to Paper 1 and Paper 2 separately.
The use of an approved scientific calculator is expected, where appropriate.
Take g = 10 m/s^2 or 10 N/kg where appropriate, unless otherwise stated.

This document consists of **20** printed pages including the cover page.

[Turn Over

Paper 1 (20 marks)

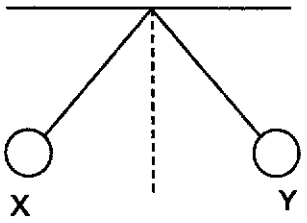
1 Which instrument can be used to measure directly the volume of a ball bearing?

A micrometer screw gauge **B** ball bearing
C measuring cylinder **D** ruler

2 What is the order of magnitude of the length of a football field?

A 10^{-2} m **B** 10^{2} m **C** 10^{3} m **D** 10^{6} m

3 The time taken for a pendulum to swing from position X to its position Y is 0.5 s. Both X and Y are at maximum displacements.



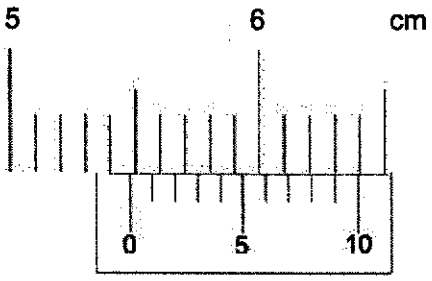
The pendulum is modified and makes 80 complete swings in a minute.

Which of the following is a possible modification?

A decreasing the length
B increasing the length
C decreasing the mass
D increasing the mass

4 The diagram shows the calipers reading when the jaws are closed over a golf ball.

If the zero error is +0.01 cm, what is the radius of the golf ball?



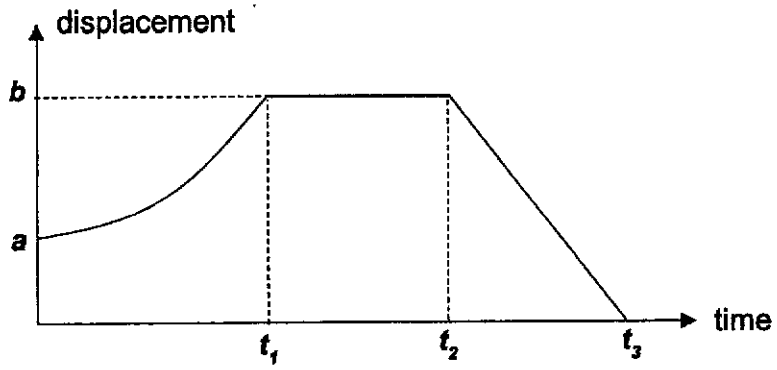
A 2.68 cm **B** 2.69 cm **C** 2.73 cm **D** 2.74 cm

5 A car travels a distance of 50 km followed by 30 km.

Which **cannot** be the displacement of the car?

A 20 km **B** 40 km **C** 70 km **D** 90 km

6 The graph represents the movement of a trolley.



How far does the trolley travel at zero acceleration?

A	b	**B**	$b\,(t_2 - t_1)$
C	$\frac{1}{2}\,b\,(t_3 - t_2)$	**D**	$\frac{1}{2}\,b\,(t_2 + t_3 - 2t_1)$

7 An average speed camera calculates the average speed of a car over a 10 km zone. To avoid being fined, all cars must travel within the zone with an average speed of no more than 60 km/h.

A driver enters the zone and travels at 105 km/h for the first 7 km before he realizes his mistake. Which option below shows the fastest speed he can travel at for the rest of the distance and yet avoid being fined?

A 20 km/h **B** 30 km/h **C** 40 km/h **D** 50 km/h

8 An object falls through vacuum.
Which row describes the acceleration and the velocity of the object?

	acceleration	velocity
A	constant	increasing
B	decreasing	increasing
C	constant	constant
D	decreasing	constant

9 A metal block of mass 2 kg is thrown vertically upwards with a force of 25 N. The gravitational field strength g is 10 N/kg.

What is the initial acceleration of the block?

A 12.5 ms^{-2} **B** 10 ms^{-2} **C** 5.0 ms^{-2} **D** 2.5 ms^{-2}

10 A car of mass 2000 kg is moving at a constant velocity of 1.0 ms^{-1}. The frictional force acting on the car is 1000 N.

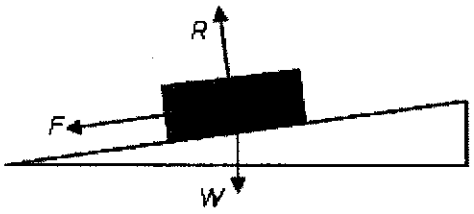
What is the driving force of the engine of the car?

A 3000 N **B** 2000 N **C** 1000 N **D** 0 N

11 An object of weight *W* is positioned on an inclined plane and is slowly sliding downwards. The object experiences friction *F* and a normal reaction force *R*.

Which diagram correctly shows the direction of these forces on the object?

A



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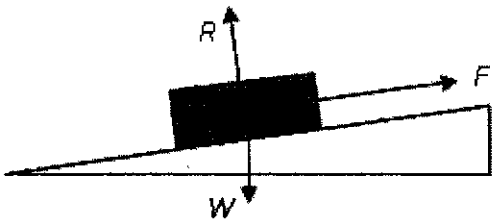
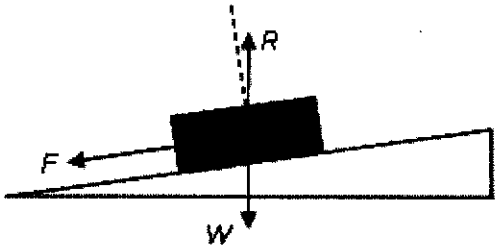
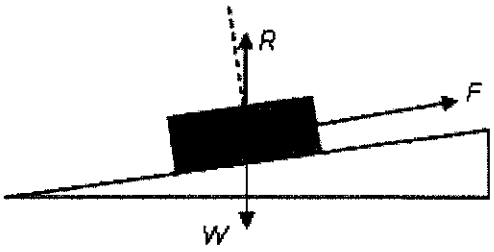


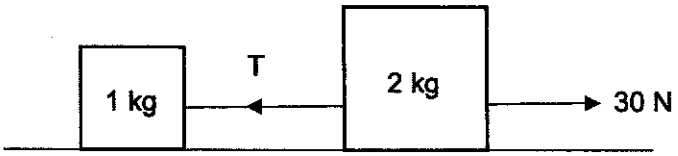
C



D



12 A 30 N force acts on a 1 kg mass and 2 kg mass on a frictionless surface as shown.



What is the size of tension T and the resultant force on the 1kg mass?

	T / N	resultant force on 1kg mass/ N
A	20	10
B	20	20
C	10	10
D	10	20

13 The inertia of a body resists changes to its motion.

Which property of the body is responsible for this resistance?

A gravitational potential energy **B** weight
C density **D** mass

14 A bottle is filled with 5.15 N of seawater. The density of seawater is 1.03 g / cm^3.

What is the volume of the container?

A 500 cm^3 **B** 50 cm^3 **C** 5 cm^3 **D** 0.5 cm^3

15 Object A has a weight of 20 N on Earth.

Object B is twice the volume of object A and is made of a material that is twice as dense.

What is the weight of object B on a planet with one-fifth the gravitational field strength of Earth?

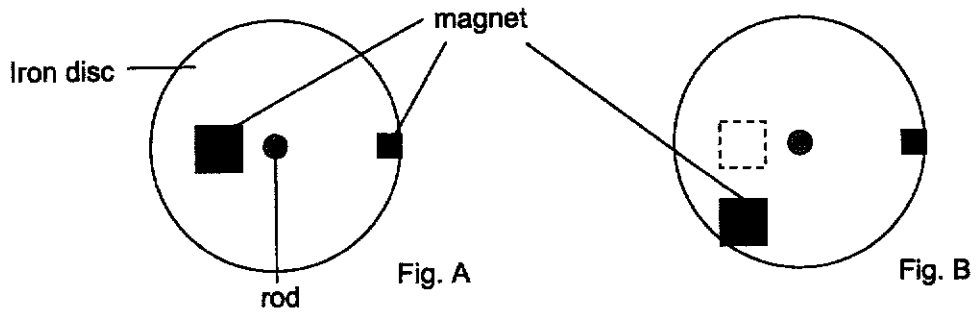
A 32 N **B** 16 N **C** 8 N **D** 4 N

16 A piece of rock approaches Earth from space.

As it approaches Earth, what is the effect on the weight and acceleration of the rock?

	weight	acceleration
A	constant	increasing
B	increasing	increasing
C	constant	constant
D	increasing	constant

17 A freely rotating circular iron disc is supported by a thin rod through the centre of the disc. When 2 magnets of differing masses are attached, the disc reaches equilibrium in the position shown in Fig. A.



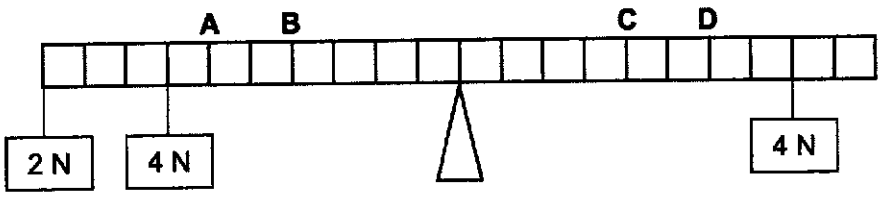
What is the effect of lowering one of the magnets vertically downwards to the position shown in Fig. B?

A The disc will rotate clockwise until it reaches equilibrium.
B The disc will rotate anti-clockwise until it reaches equilibrium.
C The disc will remain in the same position.
D The disc will rotate continuously.

18 The diagram shows a beam. Without any weights, the beam balances at its centre.

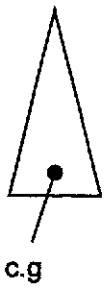
Three weights are hung as shown.

At which point does a 4 N upward force balance the beam?

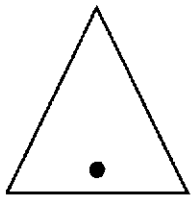


19 Four cones rest on the table.
Which cone is the most stable?

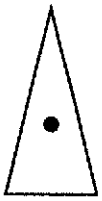
A



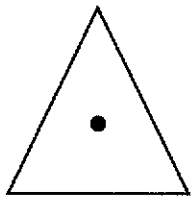
B



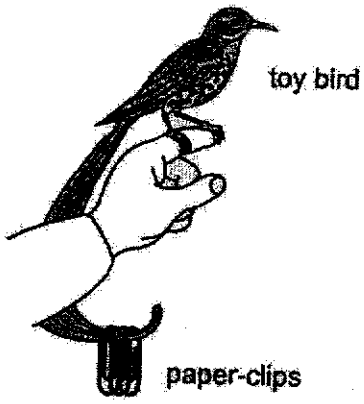
C



D



20 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 mass.

End of Paper 1

Paper 2 (70 marks)

Section A (40 marks)

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

1 Convert the physical quantities below to the given units.

(a) 3.5 GHz = ... Hz [1]

(b) 1.2 m^2 = ... mm^2 [1]

(c) A micrometer screw gauge is used to measure the thickness of a stack of paper.

Fig. 1.1 shows the reading when the jaws are closed.
Fig. 1.2 shows the reading when the jaws are closed around the stick.

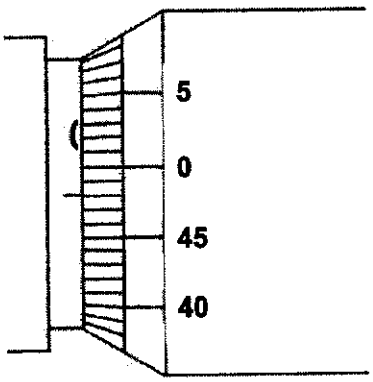


Fig. 1.1

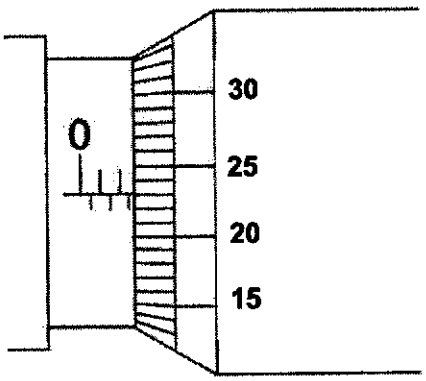


Fig. 1.2

(i) Determine the thickness of the stack of paper.

thickness = ... [2]

(ii) The paper manufacturer states that the paper has an average thickness of 100 μm. Estimate the number of sheets of paper in the stack.

number of sheets of paper = ... [2]

2 Fig. 2.1 shows the velocity-time graph of an object.

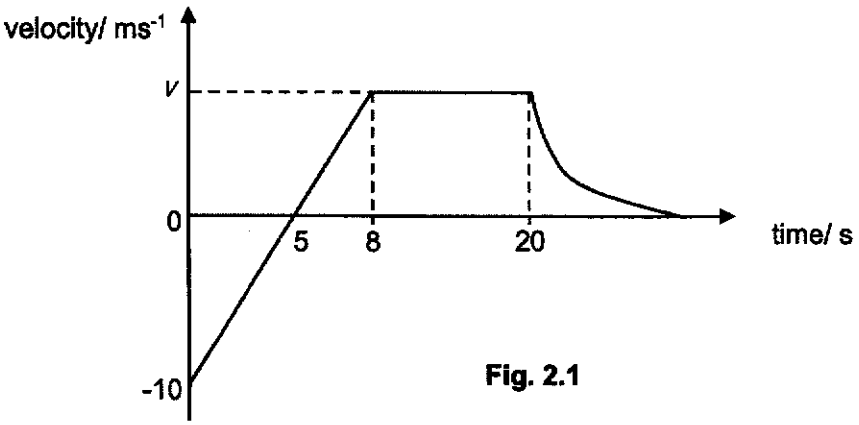


Fig. 2.1

(a) Describe the acceleration/ deceleration of the object between the following times.

(i) 0 – 5 seconds: ..... [1]

(ii) After 20 seconds: ..... [1]

(b) Determine *v*, the velocity achieved in 10 seconds.

v = ... [2]

(c) Calculate the average speed of the object in the first 5 seconds.

average speed = ... [2]

3 **(a)** State the difference between displacement and distance.

.....

..... [1]

(b) A cyclist travels a distance of 20 km in 1 hour. He takes a 30 min break before cycling another 15 km in another hour.

(i) Calculate the averge speed of the cyclist.

average speed = ... [1]

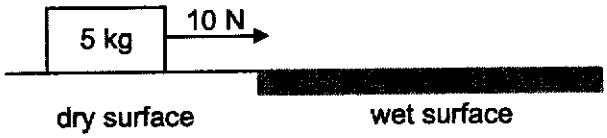
(ii) Calculate the difference between the magnitude of the maximum and minimum displacement of the cyclist. Explain clearly how you derived your answer.

.....

.....

..... [2]

4 A student drags a heavy box with a mass of 5 kg, across the hall with a force of 10 N. The box moves at a constant speed of 0.5 ms^{-1}.



(a) State the friction acting on the box. Explain your answer.

.....

..... [2]

(b) When the box was dragged across a wet surface, the box's velocity increased to 0.6 ms^{-1} in one second.

If there was no change in the pushing force, calculate the friction of the wet surface.

friction = ... [3]

(c) Draw a free-body diagram of the box when it is moving across the wet surface. Show the values of all horizontal and vertical forces ($g = 10\ N\ kg^{-1}$).

[2]

5 Fig. 5.1 shows a flower pot supported by two ropes from the ceiling.

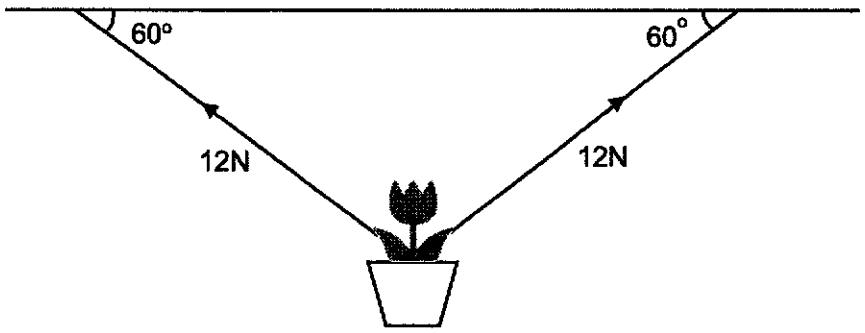


Fig. 5.1

The tension in each rope is 12 N.

(a) In the space below, draw a labelled vector diagram to show the resultant of the two tensions.

Determine the size of the resultant force and its direction.

resultant force = ...

direction = ... [4]

(b) Using your answer to **(a)**, determine the mass of the flower pot if the gravitational field strength is 10 N kg^{-1}.

mass = ... [1]

6 A wooden plank is fabricated from pulp made from a combination of cork and plywood. The combination by <u>volume</u> is 20% cork and 80% plywood.

Given the densities of cork and plywood, calculate the average density of the wooden plank.

ρ_{cork} = 240 kg m^{-3}
$\rho_{plywood}$ = 900 kg m^{-3}

average density = ... [3]

7 Fig 7.1 shows a stationary, uniform wooden plank of length 1 m between two supports, R and S.

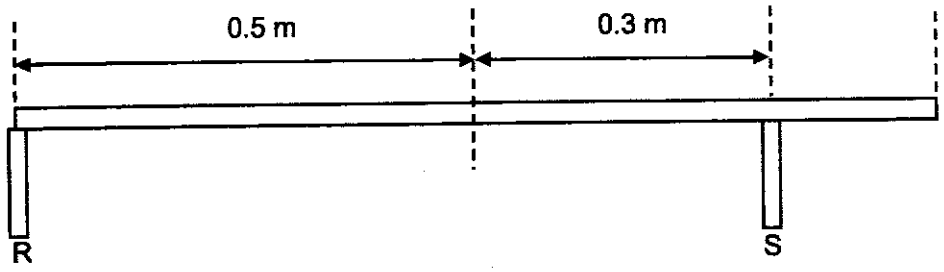


Fig. 7.1

(a) Determine the weight of the plank if the mass is 4 kg.
Assume the gravitational field strength is 10 N kg^{-1}.

W = ... [1]

(b) In Fig. 7.1, draw the position and the direction of all forces acting on the wooden plank.

[2]

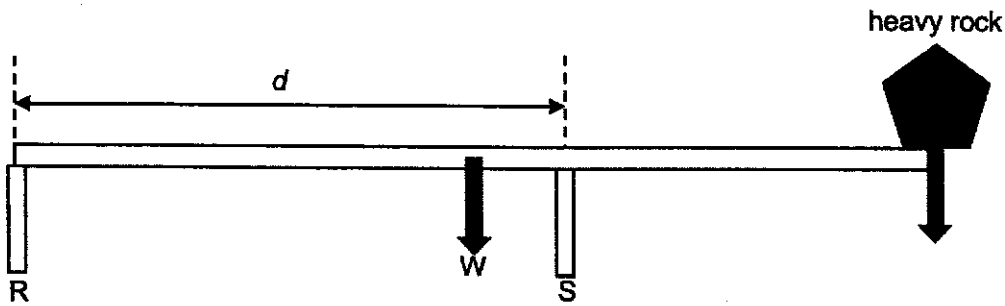
(c) By taking moments about R, calculate the force exerted by support S.

force exerted by S = ... [2]

(d) Calculate the force exerted by support R.

force exerted by R = ... [1]

(e) A heavy rock of mass 8 kg is now placed at the end of the plank.
Support R is kept in place while Support S is shifted.



Determine *d*, the new distance of S from R such that the plank just lifts off R but remains stationary.

d = ... [3]

Section B (30 marks)

Answer **all** the questions in this section.
Answer **only one** of the two alternative questions in **Question 10.**

8 In an experiment, a ping-pong ball was released from rest under two different conditions and its speed was measured at different times *t*.

Table 8.1 shows the results obtained under both conditions A and B.

Table 8.1

t/s	speed in A, v_A/ m s^{-1}	speed in B, v_B/ m s^{-1}
0.1	1.0	1.0
0.2	2.0	2.0
0.3	2.9	3.0
0.4	3.7	4.0
0.5	4.4	5.0
0.6	4.9	6.0
0.7	5.2	7.0
0.8	5.4	8.0
0.9	5.4	9.0
1.0	5.4	10.0

(a) Explain how the data can be used to determine which experiment was conducted in vacuum.

.....

..... [1]

(b) **(i)** On Fig. 8.2, draw both graphs of v_A and v_B against *t*. Label each graph. [2]

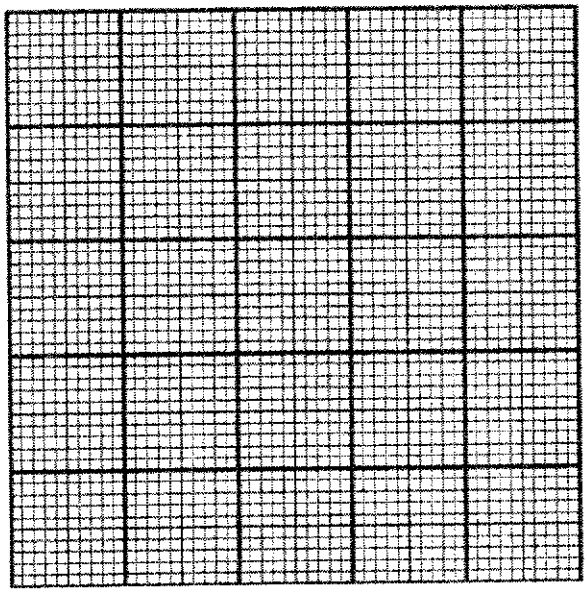


Fig. 8.2

(ii) State the terminal velocity of the ping-pong ball.

terminal velocity = ... [1]

(iii) Using the data in Fig. 8.1, estimate the difference in the distance travelled by the ping-pong ball in B and A during the 1 s.

distance = ... [3]

(c) (i) Explain, in terms of forces acting on the ping-pong ball in condition A, the motion between 0 to 0.7 seconds.

.....

.....

.....

.....

..... [2]

(ii) The experiment now uses a much heavier golf ball instead of a ping-pong ball. Compare the terminal velocities achieved between the golf ball and ping-pong ball.

.....

..... [1]

9 A standard kilogram mass is brought to the International Space Station (ISS) to calibrate the electronic scale. The ISS is located in space, orbiting around Earth.

The ISS electronic scale works similarly to the household electronic scale.

Fig. 9.1 shows an electronic scale.

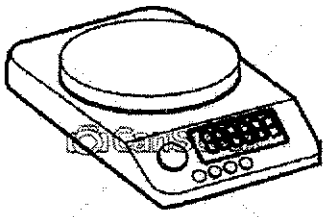


Fig. 9.1

(a) The standard kilogram mass is made of a corrosion-resistant alloy. The dimensions of the mass are shown in Fig. 9.2.

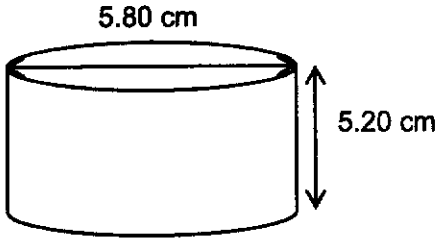


Fig. 9.2

(i) State the measuring instrument likely used in measuring the dimensions of the mass.

..... [1]

(ii) Determine the density of the alloy in g cm^{-3}.
[Volume of a cylinder = $\pi r^2 h$]

density = ... [2]

(b) **(i)** Calculate the weight of the standard kilogram mass on the ISS.
Assume the gravitational field strength on Earth is 10 N kg^{-1} and the gravitational field strength on the ISS is one-quarter of Earth's.

weight = ... [1]

(ii) When the standard kilogram mass is placed on the electronic scale on Earth, the display shows "1.00 kg".

Determine the display if the electronic scale remains uncalibrated after being brought to the ISS when the standard kilogram mass is placed on the scale. Explain your answer.

.....

.....

..... [2]

(c) On the ISS, the standard kilogram mass is placed on a slanted lever as shown in Fig. 9.3. The weight of the slanted lever is not shown in the figure.

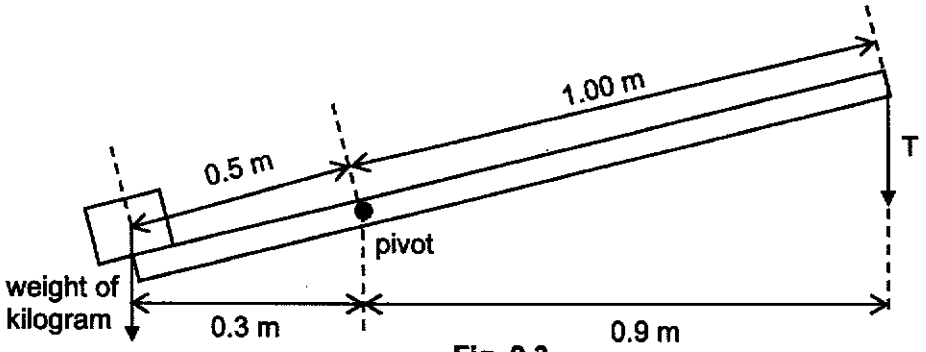


Fig. 9.3

(i) The weight of the lever does not contribute to any moments. State what you can conclude about the position of the pivot with this information. Explain your answer.

.....

.....

.....

..... [2]

(ii) If the lever is in equilibrium, calculate the magnitude of T.
Assume the gravitational field strength is 2.5 N kg^{-1}.

T = ... [2]

10 EITHER

Fig. 10.1 shows the velocity-time graph of a car and a traffic police car on an expressway.

The traffic police car started from 15 ms^{-1} at 0 seconds and is trying to catch up with the car that is speeding.

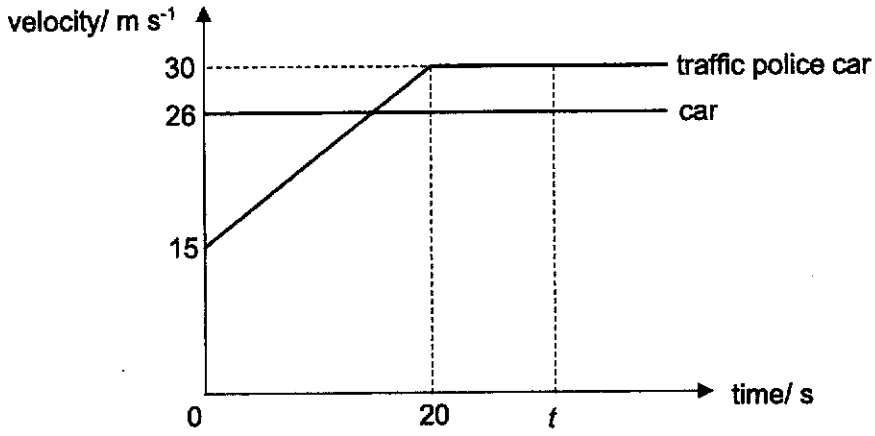


Fig. 10.1

(a) (i) Calculate the velocity of the car in km h^{-1}.

velocity = ... [2]

(ii) Calculate the acceleration of the traffic police car.

acceleration = ... [2]

(b) The combined resistance acting on the traffic police car due to friction and air resistance is 5000 N.

Determine the forward force generated by the engine during the first 20 seconds if the mass of the traffic police car is 3000 kg.

forward force = ... [2]

(c) After 20 seconds, both cars are travelling at constant velocity.

Assume both cars are the same make and model, explain why the traffic police car engine must be generating more force than the other car.

.....

.....

.....

..... [2]

(d) Determine the time t when the police car is just able to take over the car.

t = ... [2]

OR

Fig. 10.2 shows a simple toy is made of two cube blocks connected by a thin rope. The figure is not drawn to scale but the relative sizes depicted is accurate.

The masses of the blocks are 500 g and 300 g.

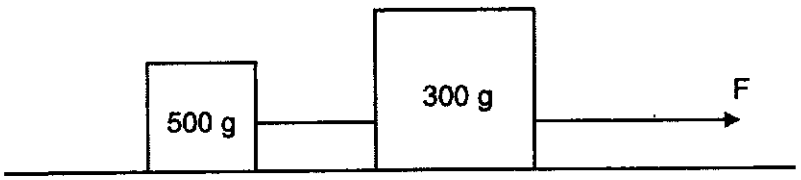


Fig. 10.2

(a) The blocks are each made of different materials. Explain how the information given allows you to determine which block is made from a less dense material.

.....

.....

..... [1]

(b) A child pulls the toy along with a force of 2 N across a polished surface.

(i) Determine the acceleration of the toy.

acceleration = ... [2]

(ii) Calculate the velocity achieved by the toy after 0.5 s assuming the toy starts from rest.

velocity = ... [1]

(c) State Newton's third law of motion.

.....

..... [1]

(d) Using your answer from **(b)(i)**, draw the free-body diagram for both the 500 g and 300 g block. Show the horizontal forces only.

[2]

(e) Explain how your answer in **(d)** illustrates Newton's third law.

.....

.....

..... [1]

(f) The child dismantles the toy and glues both blocks together as shown in Fig 10.3.

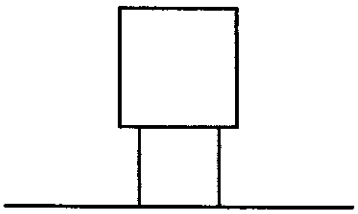


Fig. 10.3

(i) Comment on the stability of the toy.

.....

..... [1]

(ii) When tilted as shown in Fig. 10.4, the toy is just about to topple over.
On Fig. 10.4, indicate the centre of gravity of the toy with a "×". Show any relevant working lines.

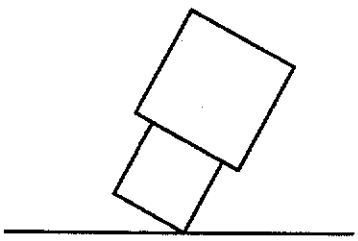


Fig. 10.4

[1]

End of Paper 2

Marking Scheme for Sec 3 Pure Physics MYE (6091)

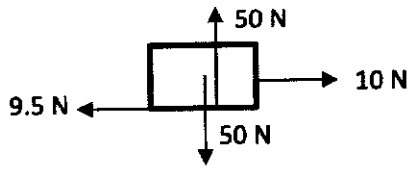
Section A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10
C	B	A	C	D	A	B	A	D	C

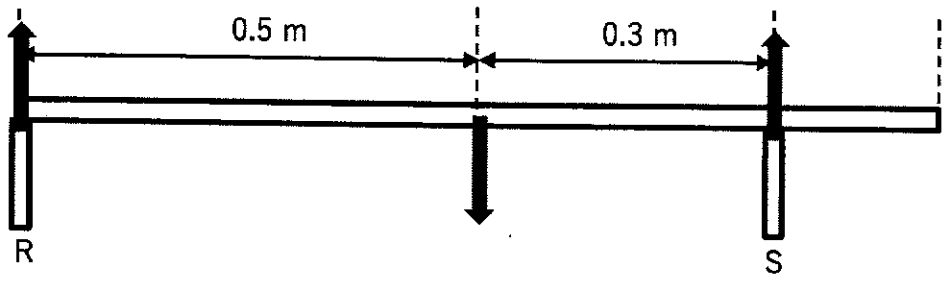
Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20
B	C	D	A	B	B	C	B	B	C

Section B

1a	3.5×10^9 / 3 500 000 000	B1
1b	$1.2\ (1000^2) = 1.2 \times 10^6$ / 1 200 000	B1
1ci	Zero error = -0.02 mm Reading = 2.73 mm Thickness = 2.73 – (-0.02) = 2.75 mm	C1 for either zero error or reading A1
1cii	Number = 2.75 mm / 0.1 mm = 27.5 =~28	C1 for dividing by same units A1 (must be whole no.)
2ai	**Constant deceleration** in the opposite direction	B1
2aii	**Decreasing deceleration**	B1 (non-uniform not accepted)
2b	v/3 = 10/5 v = 6	C1 A1
2c	Distance travelled = 0.5 x 10 x 5 = 25 m Average speed = 25/5 = 5 m/s	C1 A1

3a	Displacement is a vector/ involves direction as well as magnitude	B1 (any reasonable answer)
3bi	Average speed = 35/2.5 = 14 km/h	A1
3bii	Max displacement = 20+15=35 km Min displacement = 20-15 = 5 km Difference = 35 – 5 = 30 km	A1 (either max or min calculation) B1
4a	Friction = 10 N Acceleration is zero, hence, resultant force is zero.	A1 B1
4b	$a = 0.1\ ms^{-2}$ F = ma = 5 x 0.1 = 0.5 N Friction = 10-0.5 = 9.5 N	C1 C1 A1
4c		B1 for direction and relative length B1 for magnitude
5a	Appropriate scale Correct drawing Range of resultant force: 17 – 22 N Direction: 30° clockwise from 12 N / vertically upwards	B1 B1 B1 B1
5b	Based on answer in 5a/ 10	B1
6a	Assume 10 m^3 of wooden plank has 2 m^3 of cork and 8 m^3 of plywood.	C1
	Total mass = (2 x 240)+(8 x 900) = 7680 kg.	C1
	Avg density = total mass/total vol = 7680/10 = 768 kg/m^3	C1
7a	W = mg = 40 N	A1

7b



B1 for correct direction
B1 for location of weight
Need not include magnitude.

7c Sum of c.w. moments = sum of a.c.w. moments
$40 \times 0.5 = S \times 0.8$ C1
$S = 25$ N A1

7d $R + S = W$
$R = W - S = 40 - 25 = 15$ N A1

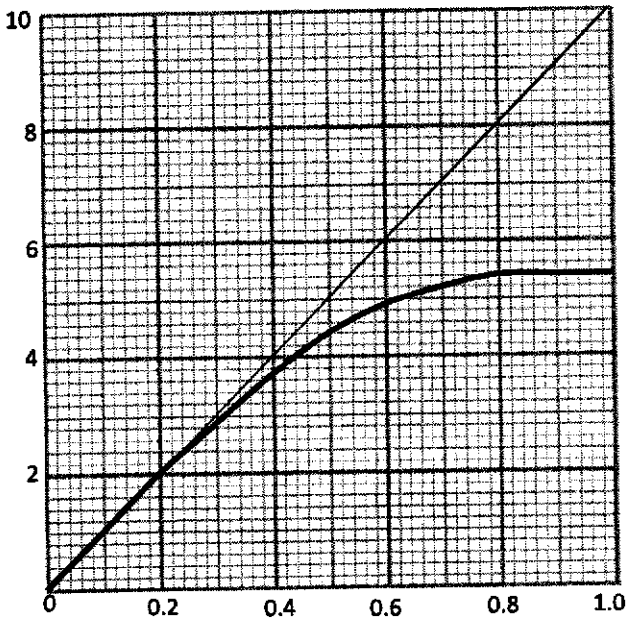
7e Force by $S = 40 + 80 = 120$ N C1

Taking moments about R,

$W \times 0.5 + 80 \times 1 = S \times d$ C
$d = (20+80)/120 = 0.833$ m A1

8a Find out which data has a constant increase in speed throughout B1

8bi



B1 for plotting of points
B1 for smooth curve
-1 if graph is too small

8bii	5.4 m/s	B1
8biii	Distance travelled by B = 0.5 x 10 x 1 = 5 m Distance travelled by A = 3.8 m (counting sq) Difference = 5 – 3.8 = 1.2 m	C1 C1 A1
8ci	Betw 0 – 0.2 s, <u>weight</u> is the only force acting, hence <u>acceleration is constant</u>.	B1
	Betw 0.2 – 0.7s, the <u>air resistance is increasing</u> and the resultant force is decreasing, hence the acceleration is decreasing.	B1
8cii	Terminal velocity of the heavier golf ball will be greater.	B1
9ai	Vernier calipers	B1
9aii	Volume = pi x $(5.8/2)^2$ x 5.2 = 137.388 cm^3 Density = mass/vol = 1000g/137.388 = 7.28 g/cm^3	C1 A1

9bi	W=mg = 1 x (10/4) = 2.5 N	A1
9bii	0.25 kg The electronic scale actually measures weight and the weight of the mass is 0.25 of Earth's on the ISS.	B1 B1
9ci	Pivot is at the same position as the c.g. The weight of the lever passes through the pivot, the perpendicular distance from the line of action of the force to the pivot is zero.	B1 B1
9cii	By principles of moments, Sum of c.w. moments = sum of a.c.w. moments 2.5 x 0.3 = 0.9 x T T = 0.833 N	 C1 (practice ecf) A1
Either		
10 ai	26 m/s = (26/1000)/(1/3600) = 93.6 km/h	A1
10aii	a = v-u/t = (30-15)/20 = 0.75 m/s^2	C1 A1
10b	F = ma = 3000 x 0.75 = 2250 N Forward force = 2250 + 5000 = 7250 N	C1 A1
10c	Since the police car is moving faster, air resistance is greater in the police car.	M1
	Since they are travelling at constant speed, the forward force must be equal to air resistance, which is greater for police car.	A1
10d	Distance travelled by police = 0.5 x 20 x (30+15) = 450 m Distance travelled by car = 26 x 20 = 520 m Difference = 520 – 450 = 70 m t = 20 + (70/4) = 37.5 s	C1 for either distance calculation A1
OR		
10a	The block with the larger volume and smaller mass has the less dense material	B1

10bi Total mass = 800 g = 0.8 kg C1

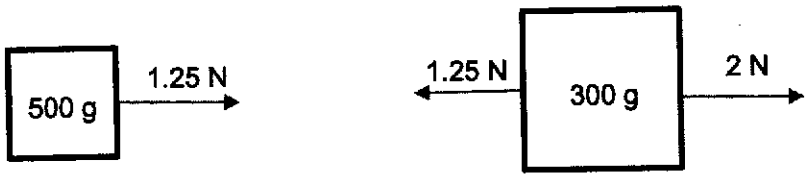
F = ma

$a = F/m = 2/0.8 = 2.5\ m/s^2$ A1

10bii $v = 2.5 \times .5 = 1.25\ m/s$ A1

10c For every action, there is an equal and opposite reaction. B1

10d

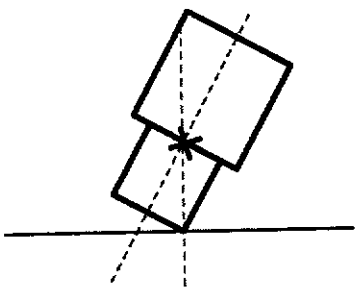


B1 force on 500 g
B1 forces on 300 g

10e The 1.25 N force acting on the 300 g mass is the same in magnitude as the force on the 500 g mass but in the opposite direction and different body. B1

10fi The toy is stable as the c.g. is lowered due to the heavier mass below. B1 for any valie explanation

The toy is unstable as the base is narrow.

10fii  A1 for cross
e.c.f. if working lines are shown but position is slightly off.