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**ASSUMPTION ENGLISH SCHOOL  
MID-YEAR EXAMINATION 2019**

**PHYSICS 6091  
BOOKLET A**



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LEVEL: Sec 3 Express

DATE: 13 May 2019

CLASS: Sec 3/2

DURATION: 2 hours 30 minutes  
(for Booklets A and B)

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 Additional Materials provided: 1 sheet of OAS paper
 

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**INSTRUCTIONS TO CANDIDATES**

Do not open this booklet until you are told to do so.

Write your NAME and INDEX NUMBER at the top of this page and on the OAS paper. **Shade your index number on the OAS paper.**

This paper consists of 3 sections.

**BOOKLET A:****SECTION A – MULTIPLE CHOICE QUESTIONS (30 marks)**

There are 30 questions in this section. Answer all questions. For each question, there are four possible answers A, B, C and D. **Record your choice in pencil on the OAS paper provided. DO NOT fold or bend the OAS paper.**

**BOOKLET B:****SECTION B – SHORT STRUCTURED QUESTIONS (40 marks)**

Answer all questions. Write your answers in the spaces provided on the question paper.

**SECTION C – FREE RESPONSE QUESTIONS (30 marks)**

Answer all questions. Answer only one of the two alternative questions in **Question 12**. Write your answers in the spaces provided.

At the end of the examination, hand in your OAS paper, Booklets A and B separately.

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 This Question Paper consists of **11** printed pages including this page.

[Turn over

## 2

**Section A – Multiple Choice Questions (30 marks)**

Answer all questions on the OAS paper provided.

1 Which of the following represents the longest length?

- A  $1.5 \times 10^{-9}$  Mm                      B  $1.5 \times 10^7$  mm  
 C  $1.5 \times 10^7$   $\mu$ m                      D  $1.5 \times 10^8$  nm

2 Which row correctly shows one scalar and one vector quantity?

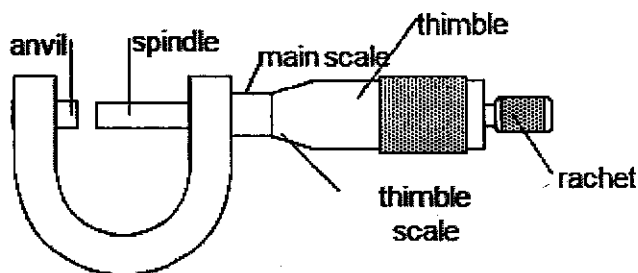
	scalar	vector
<b>A</b>	displacement	distance
<b>B</b>	mass	weight
<b>C</b>	moment	speed
<b>D</b>	velocity	acceleration

3 A pendulum clock is running too fast, what is the correct way of increasing the period of the pendulum?

- A decrease the amplitude of the pendulum  
 B decrease the length of the pendulum  
 C increase the amplitude of the pendulum  
 D increase the length of the pendulum

3

- 4 A student measures the thickness of a coin using a micrometer screw gauge.



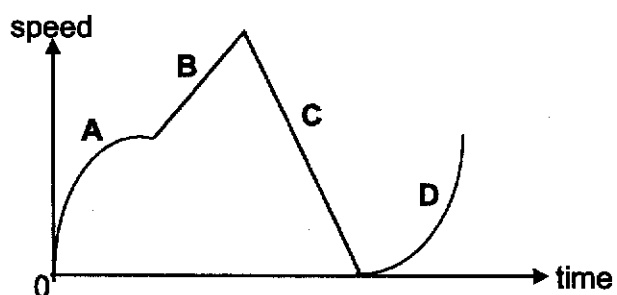
The following steps are carried out but are in the wrong order.

1. Turn the ratchet until a 'click' is heard.
2. Take the reading on the thimble.
3. Place the coin between the anvil and the spindle.
4. Take the reading on the main scale.
5. Turn the thimble to close the anvil and the spindle.

What is the correct order?

- A 1 → 5 → 3 → 2 → 4  
 B 3 → 1 → 5 → 4 → 2  
 C 3 → 5 → 1 → 4 → 2  
 D 5 → 3 → 1 → 2 → 4

- 5 The speed-time graph of an object is shown.

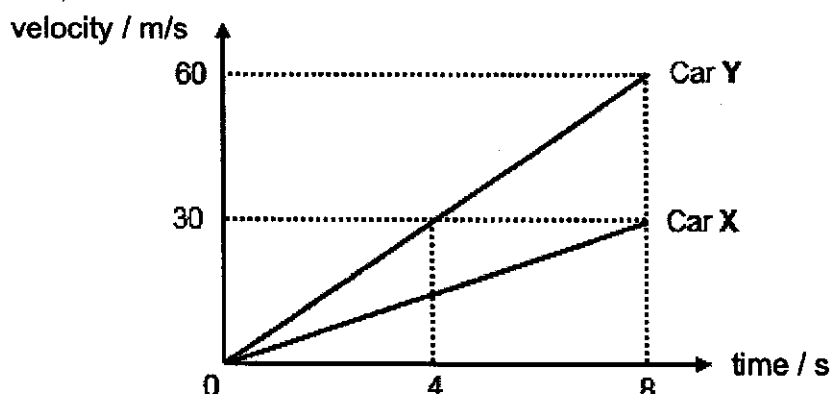


Which labelled section, A, B, C or D, shows the object moving with increasing acceleration?



5

- 9 The velocity-time graph of two cars is shown below.



Which statement is true?

- A Cars X and Y have the same acceleration.
  - B Cars X and Y will pass each other after 4 s.
  - C Car X travels a total distance of 30 m and car Y travels a total distance of 60 m.
  - D The acceleration of car X is half that of car Y.
- 10 Which of the following **must** be changing when a body is accelerating uniformly?
- A the force acting on the body
  - B the mass of the body
  - C the speed of the body
  - D the velocity of the body
- 11 When a block of wood of mass 2 kg was pushed along a horizontal flat surface of a bench, the friction force measured was 4 N. If the block was pushed along the same bench with a force of 10 N, which statement is correct?
- A constant acceleration of  $3 \text{ m/s}^2$
  - B constant acceleration of  $5 \text{ m/s}^2$
  - C constant speed of 3 m/s
  - D constant speed of 5 m/s







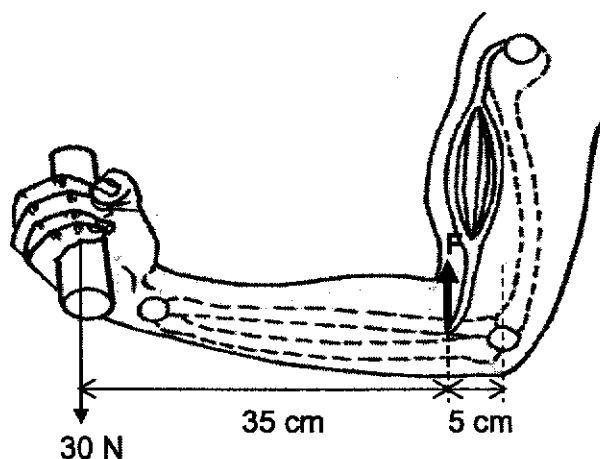
9

- A Less force is needed to be exerted by the user.
- B Less friction is present.
- C Less turning effect is required on the spanner.
- D Less work is done by the user.

23 Which item has every point on its surface equidistant to its centre of gravity?

- A a cubic box
- B an egg
- C a cylinder
- D a table-tennis ball

24 The diagram shows Jensen using one hand to hold a 30 N object.



What is the force  $F$ , exerted by Jensen's bicep muscle in order to hold the object in the position?

- A 21 N
- B 30 N
- C 210 N
- D 240 N

25 Which device is designed to convert electrical energy to sound energy?

- A bulb
- B generator
- C loudspeaker
- D motor

26 An apartment block receives water from a nearby reservoir. A pump is necessary to lift the water into a storage tank at the top of the building.



11

- A 13 m/s                      B 18 m/s  
C 25 m/s                      D 630 m/s

30 At what rate is energy transformed when a man of mass 50 kg and carrying a 5 kg mass went up 8 m-high flight of stairs in 20 s? The gravitational field strength is 10 N/kg.

- A 20 W                      B 22 W  
C 200 W                    D 220 W

– END OF BOOKLET A –



**Section B – Short Structured Questions (40 marks)**

Answer all the questions in this section.

1 Complete the table below. Give the missing prefixes, symbols and value.

prefix	symbol	value
milli	m	$10^{-3}$
		$10^{-6}$
	n	
mega	M	$10^6$

[2]

2 A pair of vernier calipers was used to measure the diameter of a coin as shown in Fig. 2.2. The vernier calipers had a zero error as shown in Fig. 2.1.

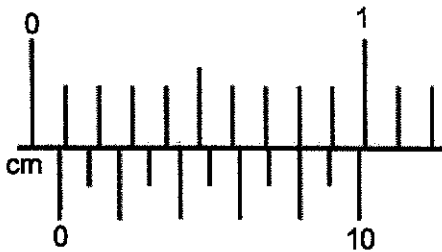


Fig. 2.1

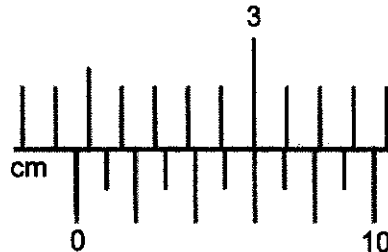


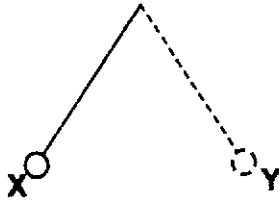
Fig. 2.2

Calculate the actual diameter of the coin.

diameter = ..... [2]

3

3 The figure below shows a simple pendulum oscillating between positions X and Y. The period of the pendulum is 0.50 s.



(a) Explain what is meant by the *period of a pendulum*.

.....  
 .....

[1]

(b) Calculate the time taken for the pendulum to travel from X to Y.

time = ..... [1]

(c) State any change(s), if any, to the period of oscillation if

(i) the length of pendulum was to be decreased, ..... [1]

(ii) a heavier pendulum bob was used instead. .... [1]

4

- 4 Fig. 4.1 shows a micrometer screw gauge with its jaws closed when there is no object placed between the spindle and anvil. Fig. 4.2 shows the same micrometer when a small ball bearing is placed between the spindle and anvil.

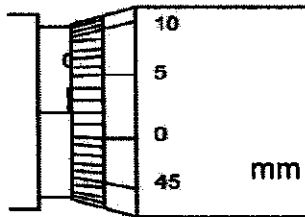


Fig. 4.1

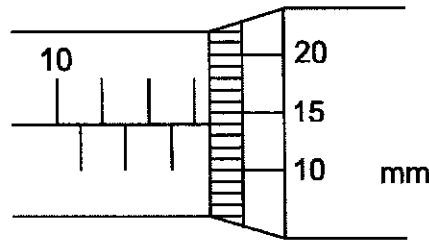


Fig. 4.2

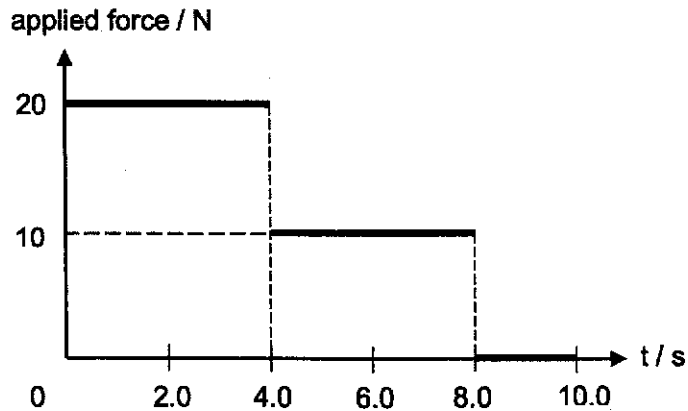
- (a) State the zero error shown in Fig. 4.1.

zero error = ..... [1]

- (b) Calculate the actual diameter of the ball bearing.

diameter = ..... [1]

- 5 The figure below represents a force-time graph for the force applied to a 3.0 kg box pushed over a rough surface. Assume the frictional force to be constant.



- (a) Given that the box initially accelerates at a uniform rate of  $5.0 \text{ m/s}^2$ , calculate the frictional force acting on the box.

frictional force = ..... [2]

5

- (b) Assuming that the box was initially at rest, calculate the speed of the box at  $t = 4.0$  s.

speed = ..... [2]

- (c) State and explain the motion of the box from  $t = 8.0$  s to 10.0 s.

.....  
.....  
..... [2]

- 6 (a) State what is meant by the *density of a substance*.

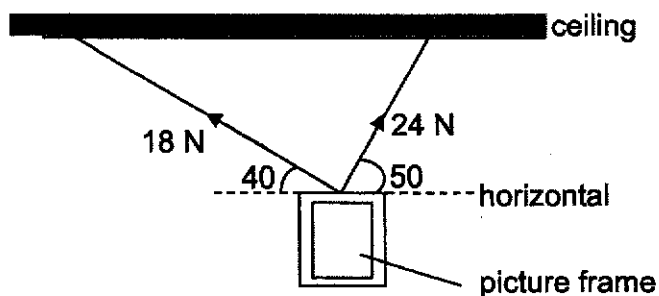
.....  
..... [1]

- (b) A block of sides 3.0 cm each has a density of  $7.0 \text{ g cm}^{-3}$ . A hole having the volume of  $1.0 \text{ cm}^3$  is drilled into the cube. A substance of mass 3 g is used to fill the hole completely. Calculate the density of the composite cube.

density = ..... [3]

6

- 7 The figure below shows a hanging picture frame supported by two strings that hang from a ceiling.



The tensions in the strings are 18 N and 24 N.

- (a) In the space below, draw a labelled vector diagram to show the resultant of the two tensions. Determine the size and direction of the resultant force.

resultant force = .....

direction = ..... [4]

- (b) Hence, determine the mass of the picture frame. The gravitational field strength is 10 N/kg.

mass = ..... [2]

- 8 Fig. 8.1 shows a uniform wooden block, **ABCD** resting on a table with a pushing force exerted on it from the right. Fig. 8.2 shows the block **ABCD** being tilted at an angle of  $40^\circ$ .

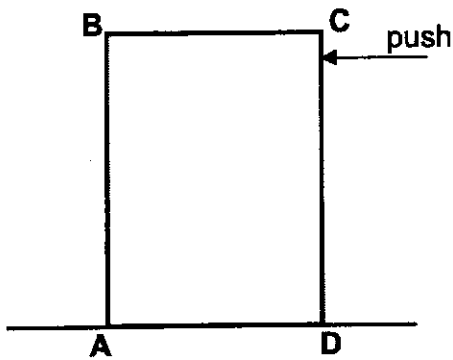


Fig. 8.1

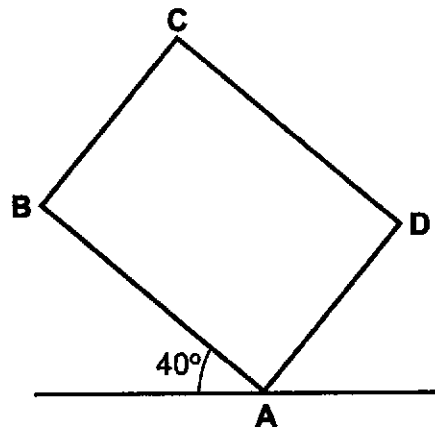


Fig. 8.2

- (a) Define *centre of gravity*.

.....  
 ..... [1]

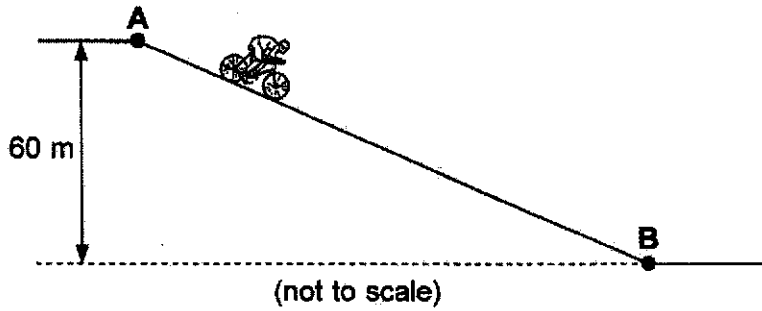
- (b) On Fig. 8.2, draw appropriate lines to show how you would locate the centre of gravity of the block accurately. Label the point **CG**. [1]

- (c) On Fig. 8.2, draw and label the arrow, **W** to represent the weight of the block. [1]

- (d) State the side (**AB** or **AD**) on which the block will fall on. Explain your answer clearly.

.....  
 .....  
 .....  
 .....  
 ..... [2]

9 The figure below shows a cyclist travelling downhill on a race track.



The cyclist starts from rest at **A** and rolls down the hill to **B**, through a vertical distance of 60 m. He does not brake or use the pedals. The speed of the cyclist at **B** is 12 m/s. The total mass of the cyclist and bicycle is 90 kg. The acceleration of free fall,  $g$ , is  $10 \text{ m/s}^2$ .

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

.....  
 .....  
 ..... [2]

(b) Calculate

(i) the loss in gravitational potential energy between **A** and **B**,

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

(ii) the increase in kinetic energy as the cyclist travels from **A** to **B**.

increase in kinetic energy = ..... [2]

(c) Suggest why the loss in gravitational potential energy and increase in kinetic energy are different and explain how the law of conservation of energy applies to this situation.

.....  
.....  
.....

[2]

(d) Suggest two ways how this loss in gravitational potential energy can be reduced.

method 1 .....

method 2 .....

[2]

**Section C – Free Response Questions (30 marks)**

Answer all questions from this section. Answer only one of the two alternative questions in **Question 12**. Write your answers in the spaces provided.

- 10** In an Olympic 100 m finals, the table below shows the breakdown in terms of distance,  $d$  and time,  $t$  for two athletes **G** and **A**.

$d / \text{m}$	0	10	20	30	40	50	60	70	80	90	100
Athlete <b>G</b> $t_G / \text{s}$	0	2.00	3.09	4.09	5.04	5.97	6.89	7.80	8.71	9.62	10.53
Athlete <b>A</b> $t_A / \text{s}$	0	2.02	3.13	4.15	5.11	6.07	7.01	7.96	8.91	9.87	10.83

- (a) Explain how the data shown in the table above for athlete **G** suggests that the speed is increasing at  $d = 20 \text{ m}$ .

.....  
 ..... [1]

- (b) On Fig 10.1, draw a best fit curve graph of  $d$  against  $t$  for athlete **G**.

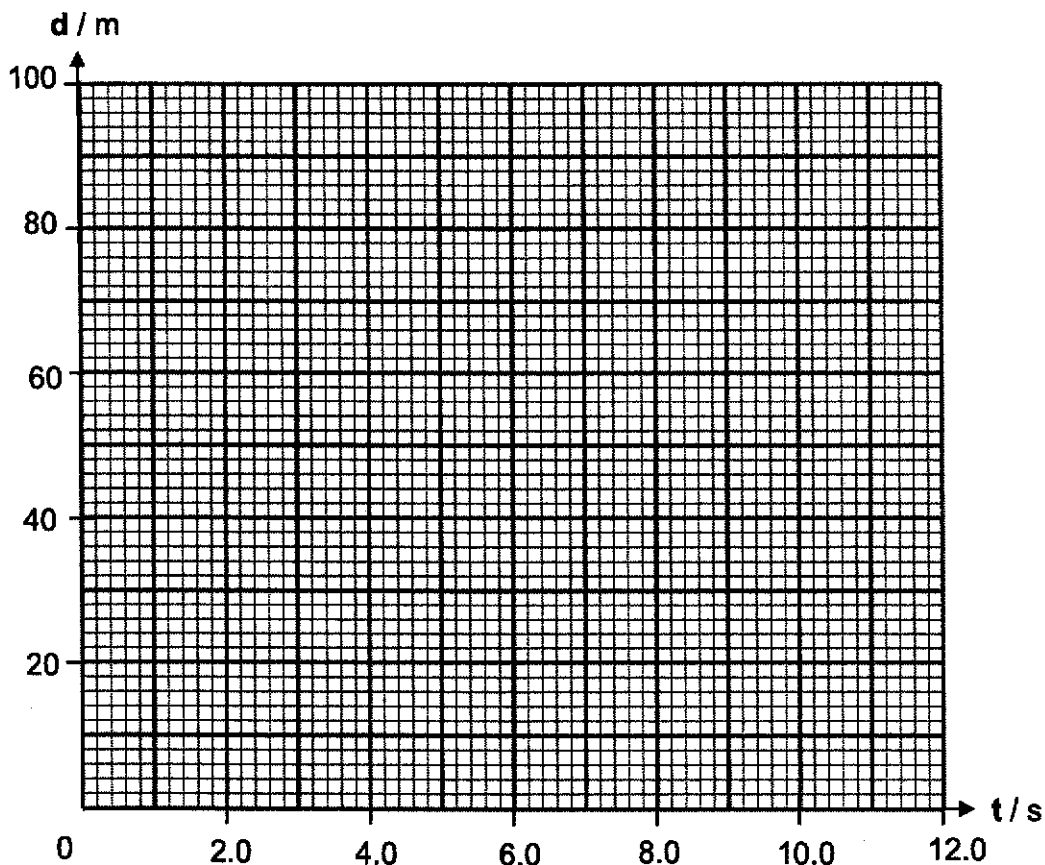


Fig. 10.1

[2]

(c) Explain how the graph shows that athlete G reaches her maximum speed.

.....  
.....

[1]

(d) Use your graph to determine the magnitude of the maximum speed of G.

maximum speed = ..... [2]

(e) Fig. 10.2 shows the position of athlete G at the 50 m mark on the track. The force applied by the muscles for a forward motion is known as the propulsion force, P.

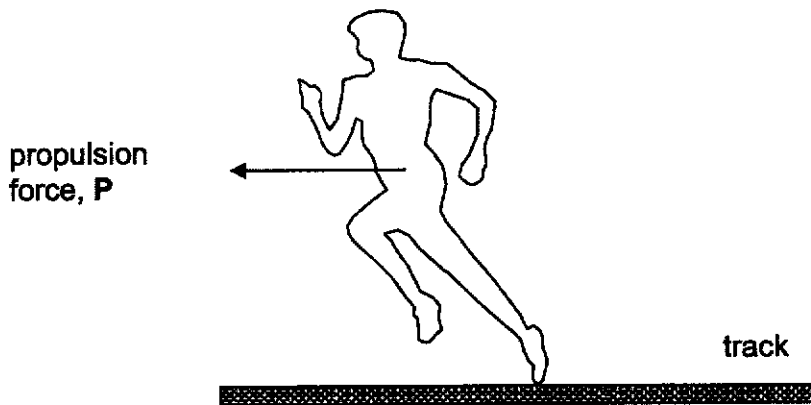


Fig. 10.2

(i) Label on Fig.10.2, the rest of the forces acting on athlete G.

[2]

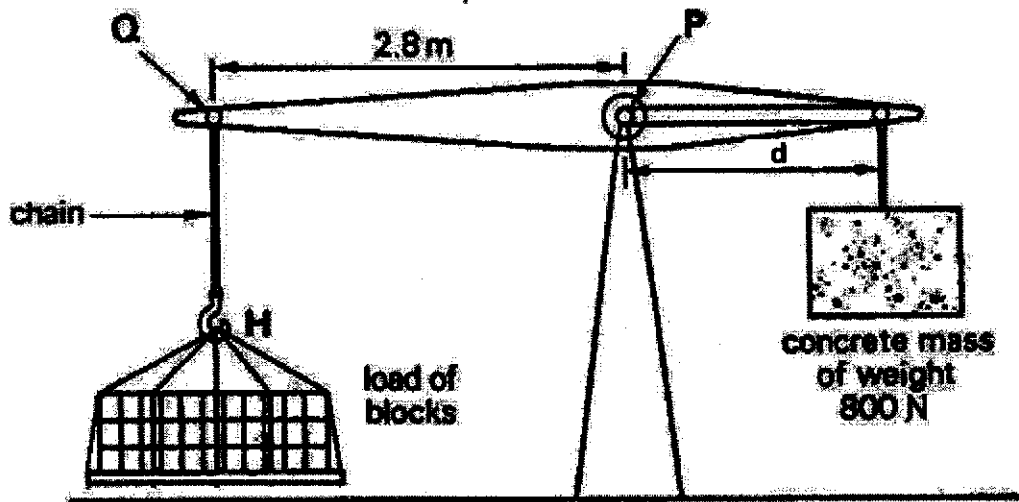
(ii) Explain how the position of the athlete in Fig. 10.2 helps the athlete reach her maximum speed.

.....  
.....  
.....  
.....

[2]

12

- 11 The figure below shows the essential features of a simple crane used for lifting blocks which are attached to the hook H.



- (a) With no blocks suspended from H, the crane arm balances horizontally when the position of the concrete mass is adjusted so that  $d$  is 0.6 m.

Calculate the moment of the weight of the concrete mass about the pivot P.

moment = ..... [2]

- (b) A mechanism on the right-hand side moves the concrete mass away from the pivot P until the blocks are lifted from ground. Calculate the weight of the blocks when  $d = 1.7$  m.

weight = ..... [3]

(c) An electric motor is fitted at Q which, by shortening the chain, increases the height to which the blocks can be raised.

(i) State, with a reason, whether or not raising the height of the blocks increases the moment of the weight of the blocks about the pivot P.

.....  
.....  
.....

[2]

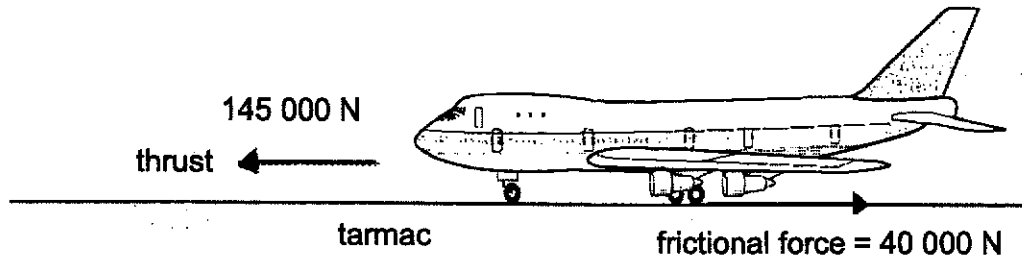
(ii) What would be the effect of the weight of this electric motor on the operation of the crane? Explain in terms of moment.

.....  
.....  
.....  
.....  
.....

[3]

## 12 EITHER

An aircraft of mass 60 000 kg makes its take-off run from rest. The engines produce a constant thrust of 145 000 N which is directed parallel to the ground. The frictional force on the tarmac is 40 000 N.



- (a) Calculate the initial acceleration of the aircraft along the horizontal runway just as the plane started its take-off run.

acceleration = ..... [2]

- (b) (i) Calculate the time taken for the take-off run if the aircraft becomes airborne at a speed of 60 m/s.

time = ..... [2]

- (ii) Hence, calculate the distance of the take-off run.

distance = ..... [2]

15

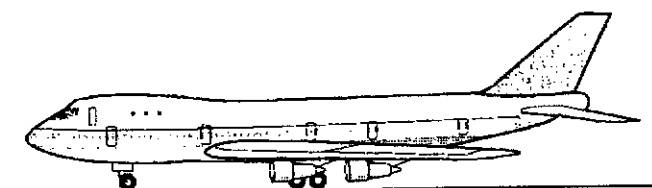
(c) Apart from thrust from engine and friction from tarmac, in real life, air resistance is also exerted on the plane when it is moving.

(i) When the sum of air resistance and frictional force is equal to 145 000 N, what is the acceleration of the plane? Explain how you obtain the answer.

.....  
.....  
.....  
.....  
.....

[2]

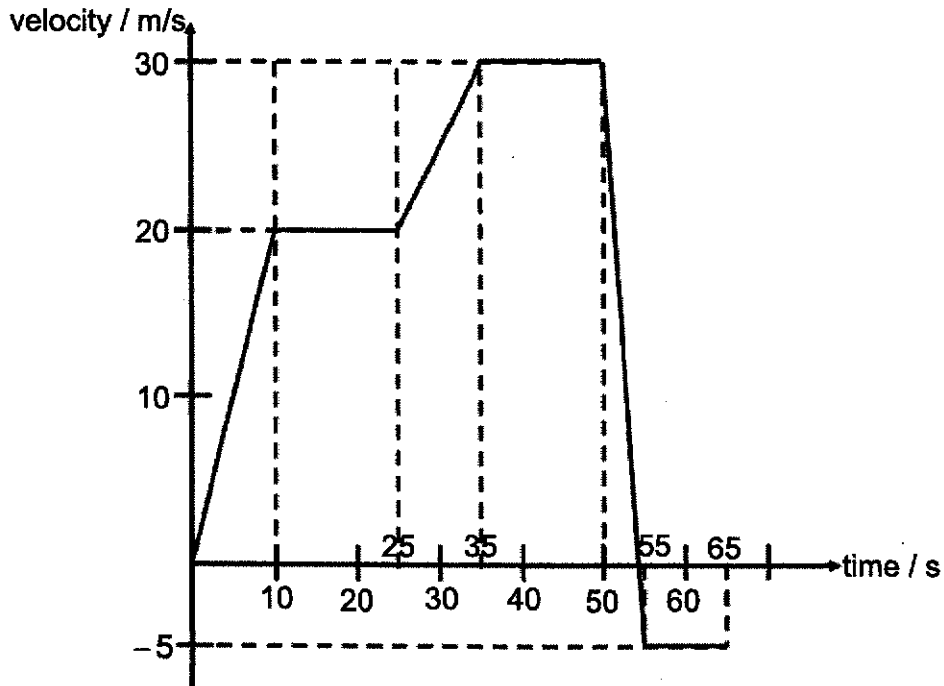
(ii) Based on the real-life scenario in (d)(i), draw a free body diagram to show the forces acting on the plane as it is about to take off.



[2]

12 OR

The figure below shows the velocity-time graph of a car.



(a) (i) State all the time intervals where the resultant force acting on the car is zero.

.....  
 ..... [1]

(ii) Explain your answer in (a)(i).

.....  
 ..... [1]

(b) Calculate the acceleration of the car in the first 10 s of the journey.

acceleration = ..... [2]

17

- (c) Calculate the total displacement travelled in the first 50 s of the journey.

displacement = ..... [2]

- (d) Calculate the average velocity of the car for the first 50 s of the journey.

average velocity = ..... [2]

- (e) Describe the motion of the car from  $t = 50$  s to  $t = 55$  s.

.....  
.....  
.....  
..... [2]

**– END OF BOOKLET B –**

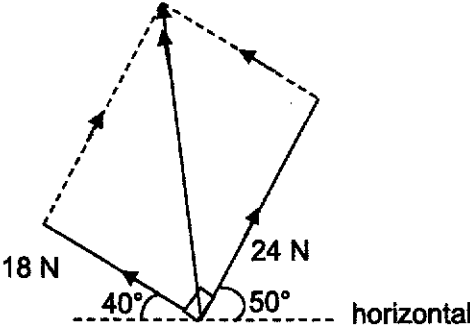
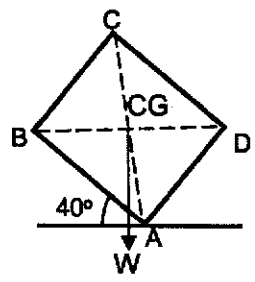


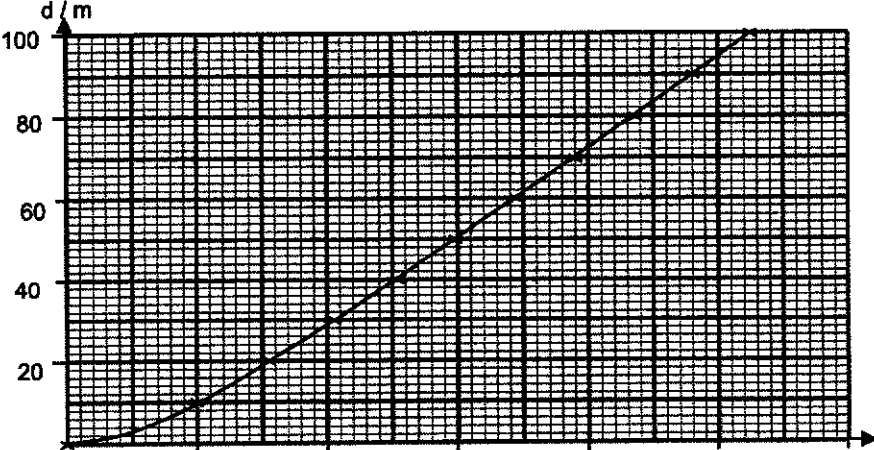
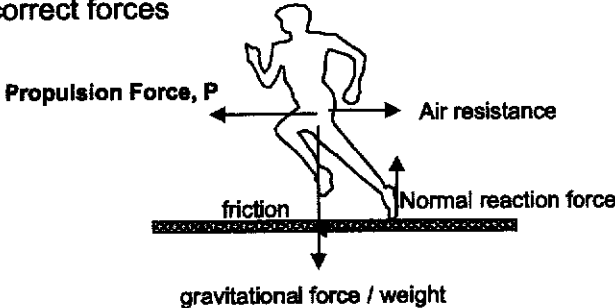
**3Pure (Physics) MYE Marking Scheme 2019****Section A[30 m]**

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

**Section B[40 m]**

1		prefix	symbol	value	
		milli	m	$10^{-3}$	
		micro	$\mu$	$10^{-6}$	
		nano	n	$10^{-9}$	B1
		mega	M	$10^6$	B1
		1 mark for every 2 correct answers			
2		Zero error = 0.08 cm			B1
		$2.46 - 0.08 = 2.38$ cm			B1 ECF
3	a	Period is the time taken for one oscillation / for the bob to travel from X to Y and back to X.			B1
	b	$\frac{0.50}{2} = 0.25$ s			B1
	ci	decrease			B1
	cii	no change			B1
4	a	Zero error = +0.02 mm			B1
	b	Diameter = 13.12 mm			B1
5	a	Resultant force = $3 \times 5.0 = 15$ N 20 – friction = 15 friction = 5.0 N			C1 A1
	b	$a = (v-u)/t$ $5 = (v - 0)/4$ $v = 20$ m/s			C1 A1
	c	Box <b>moves with constant deceleration</b> as there is a <b>resultant force acting opposite to the direction of motion</b> of the box.			B1 B1

6	a	Density is the amount of mass per unit volume of a substance.	B1
	b	mass of block = $7.0 \times 27 = 189 \text{ g}$ mass of drilled block = $7.0 \times 1.0 = 7.0 \text{ g}$ new mass of block = $189 - 7 = 182 \text{ g}$ mass of composite = $3.0 + 182 = 185 \text{ g}$ density = $185 / 27 = 6.9 \text{ g/cm}^3$	C1 C1 C1
7	a	 <p>Accept either parallelogram or tip-to-toe method.                      Appropriate scale: at least 1 cm : 5 N.                      18 N and 24 N drawn according to specified scale <u>and</u> labelled.                      Resultant force = <math>30 \text{ N} \pm 2 \text{ N}</math>                      Angle = <math>90^\circ \pm 2^\circ</math></p>	B1 B1 B1 B1
	b	Weight = $m \times g$ $m = W / g$ $= 30 \text{ N} / 10$ $= 3.0 \text{ kg}$	C1 A1 ECF
8	a	a point from which the weight of a body or system may be considered to act.	B1
	b	 <p>Dotted construction line for CG and correct position</p>	B1
	c	Arrow from CG and labelled as W	B1
	d	Side AB As the <u>line of action of the weight</u> through the CG of the block <u>lies outside the base area</u> , it causes an <u>anti-clockwise moment</u> about point A, causing the block to topple on side AB.	B1 B1 B1
9	a	The principle of conservation of energy states that energy in a system cannot be created or destroyed. It can only be converted from one form to another without any loss in total energy.	B1 B1
	bi	Loss in GPE = $mgh = 90 \times 10 \times 60 = 54\,000 \text{ J}$	C1 A1

	<b>bii</b>	Gain in KE = $\frac{1}{2}mv^2 = \frac{1}{2}(90)(12^2)$ = 6480 J	<b>C1</b> <b>A1</b>
	<b>c</b>	Increase in KE is lower than loss in GPE as work is done against frictional forces on the slope and against air resistance. Applying the law of conservation of energy, the work done in overcoming resistive forces added to the increase in kinetic energy should be equal to the loss in gravitational potential energy.	<b>B1</b> <b>B1</b>
	<b>d</b>	1. Smoother tyres 2. Streamlining (any other acceptable answer in reducing effects of friction/air resistance)	<b>B1</b> <b>B1</b>
<b>Section C</b>			
<b>10</b>	<b>a</b>	From the table, 1.09 s taken for the 20-30m distance interval < 1.00 s taken for the 10-20 m distance interval. As speed = distance / time, speed is inversely proportional to time for a constant distance. The speed increases when the time interval is smaller / shorter time interval to travel the same distance	<b>B1</b>
	<b>b</b>	Points plotted correctly, best fit curve 	<b>B1</b> <b>B1</b>
	<b>c</b>	The gradient (=velocity) is a constant and maximum after 60 m mark	<b>B1</b>
	<b>d</b>	Maximum speed = gradient = $100 - 60 / (10.53 - 6.89) = 10.989$ = 11 m/s	<b>C1</b> <b>A1</b>
	<b>ei</b>	Any two correct forces 	<b>B1</b> <b>B1</b>
	<b>eli</b>	The forward inclined position of the athlete body with the line of action of the weight to the left of the pivot (toe) allows the turning effect of the weight about the pivot (toe) to topple him forward. The bend position of the body helps to streamlined his body to reduce the air resistance he encounters when he runs.	<b>Any</b> <b>2</b> <b>B1</b>  <b>B1</b> <b>Or</b>

		The bend arms and bend leg swing and creates the pendulum effect where a shorter length of pendulum enables it to swing faster and thus increases the speed running.	
11	a	moment = $F \times d$ = $800 \times 0.6$ = $480 \text{ N m}$	C1 A1
	b	Total clockwise moment = $800 \times 1.7 = 1360 \text{ N m}$ Moment due to blocks = $1360 - 480 = 880 \text{ N m}$  Total clockwise moment = Total anticlockwise moment $880 = \text{weight} \times 2.8$ Weight = $314 \text{ N}$	C1 A1
	ci	No Perpendicular distance from line of action of weight to pivot remains the same	B1 B1
	cii	Motor's weight causes <b>anticlockwise moment</b> about P Use of formula for moments to explain less blocks can be lifted / how the position of block (or concrete mass) should be adjusted to maintain balance	B1 B1 B1
12 E	a	Resultant force, $F_R = 145\,000 - 40\,000 = 105\,000 \text{ N}$  $a = \frac{F_R}{m} = \frac{105\,000}{60\,000} \quad (\text{formula and working})$ = $1.75 \text{ m/s}^2$	C1 A1
	bi	$v = 60 \text{ m/s}$ $u = 0 \text{ m/s}$  $a = \frac{v - u}{t}$ $1.75 = \frac{60 - 0}{t} \quad (\text{formula and working})$ $t = 34.3 \text{ s}$	C1 A1
	bii	Distance = $\frac{1}{2}(60)(34.3)$ = $1029 \text{ m}$	C1 A1
	ci	When the thrust force of $145\,000 \text{ N}$ is similar to sum of air resistance and frictional force, there will be <u>no resultant force</u> on the plane as both opposing forces have same magnitude.  As such there is <u>no acceleration</u> by the plane and it moves at constant velocity.	B1 B1

	cii	<p>1 mark for each correct pair</p>	B1 B1
12 O	ai	10 s – 25 s, 35 s – 50 s and 55 s to 65 s	B1
	aii	<p>During these intervals, the car is moving with <u>constant velocity</u>. By Newton's first law, car will move with <u>constant speed in a straight line</u> when <u>resultant force is zero</u>.</p> <p>Or</p> <p>During these intervals, the car is moving with <u>constant speed</u>. By Newton's second law, <math>F = ma</math>, <u>resultant force is zero</u> when <u>acceleration is zero</u>.</p>	B1
	b	$a = \frac{20 - 0}{10}$ $= 2.0 \text{ m/s}^2$	C1 A1
	c	<p>Displacement</p> $= \left[ \frac{1}{2} \times (15 + 25) \times 20 \right] + \left[ \frac{1}{2} \times (20 + 30) \times 10 \right] + (15 \times 30)$ $= 1100 \text{ m}$	C1 A1
	d	$\text{Avg vel} = \frac{1100}{50}$ $= 22 \text{ m/s}$	C1 A1
	e	From $t = 50$ s, the car <b>decelerates uniformly</b> until it is momentarily at <b>rest</b> . It then <b>accelerates uniformly in the opposite direction</b> till it reaches a speed of 5.0 m/s at $t = 55$ s.	B1 B1