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ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2019

Centre Number

Candidate Number

Mathematics

Assessment Unit AS 2
assessing
Applied Mathematics

MV18

[SMT21]
WEDNESDAY 22 MAY, MORNING

Time

1 hour 15 minutes, plus your additional time allowance.

Instructions to Candidates

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write on blank pages or tracing paper.
Complete in black ink only. Questions which require drawing or sketching should be completed using an HB pencil.
Candidates must answer **all** questions from sections A and B.
Equal time should be spent on each section. Show clearly the full development of your answers.
Answers without working may not gain full credit.
Answers should be given to three significant figures unless otherwise stated.
You are permitted to use a graphic or scientific calculator in this paper.

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Information for Candidates

The total mark for this paper is 70. The total available mark for each section of this paper is 35.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
Answers should include diagrams where appropriate and marks may be awarded for them.
Take $g = 9.8\,\text{m}\,\text{s}^{-2}$, unless specified otherwise.
A copy of the **Mathematical Formulae and Tables booklet** is provided.
Throughout the paper the logarithmic notation used is $\ln z$ where it is noted that $\ln z \equiv \log_e z$

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(Questions start overleaf)

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Answer all questions.

Section A

Mechanics

1 **Fig. 1** below shows three forces acting on a particle.

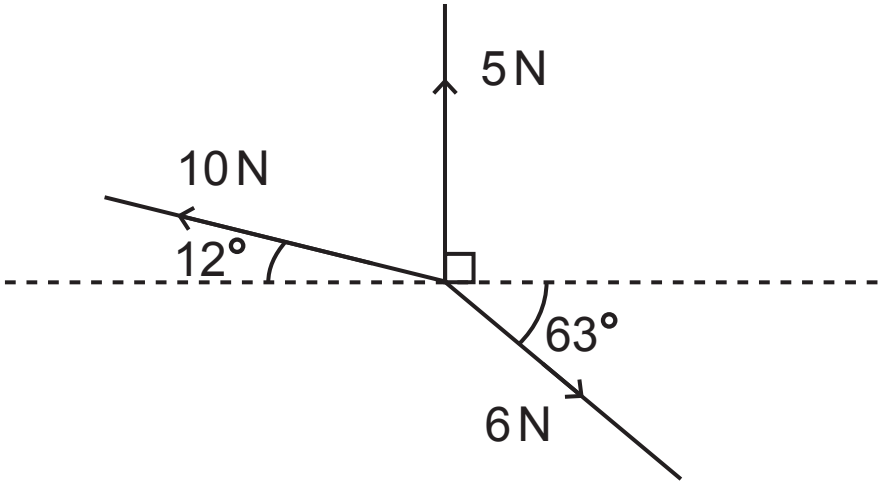

Fig. 1

Find the magnitude and direction of the resultant of these three forces. [6 marks]

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2 A drone is flown, with constant acceleration, in a horizontal plane.

When initially observed, at a point P, it has a velocity of $(2\mathbf{i} - 7\mathbf{j})\ \text{m s}^{-1}$

Four seconds later the drone is at a point Q and has a velocity of $(14\mathbf{i} + \mathbf{j})\ \text{m s}^{-1}$

(i) Find the acceleration of the drone in terms of **i** and **j**. [3 marks]

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(ii) Find the distance PQ. [5 marks]

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3 **Fig. 2** below shows the velocity–time graph for an athlete running a 100 m race in 11.8 seconds.

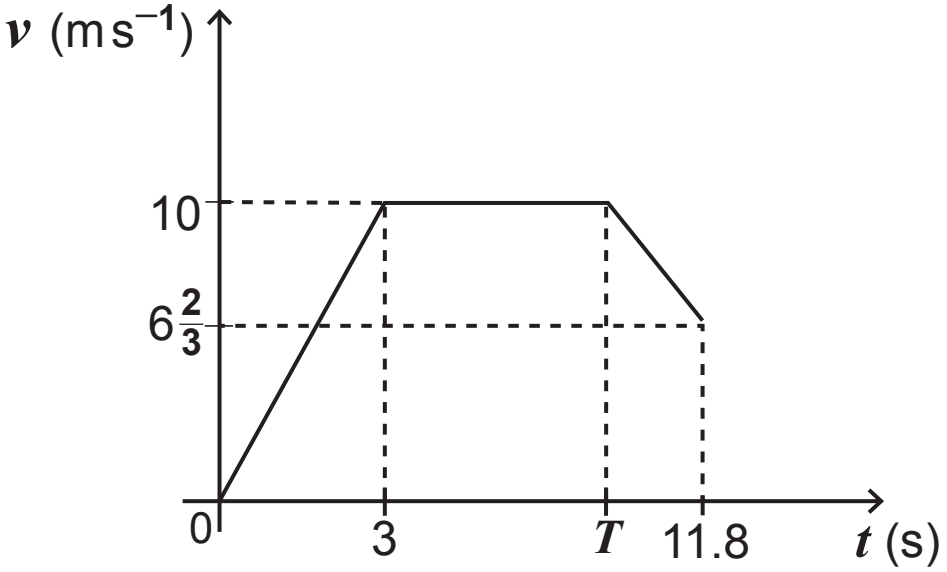

Fig. 2

(i) Describe the motion of the athlete between $t = 0$ and $t = 3$ [1 mark]

The athlete starts to decelerate at time T.

(ii) Find the value of T. [5 marks]

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4 **Fig. 3** below shows two boxes, A and B, connected by a rope passing over a smooth, light, fixed pulley.

Box A is held at rest on a rough horizontal table 5 m from the pulley.

Box B hangs 2.5 m vertically above the floor.

A and B have masses 8 kg and 6 kg respectively.

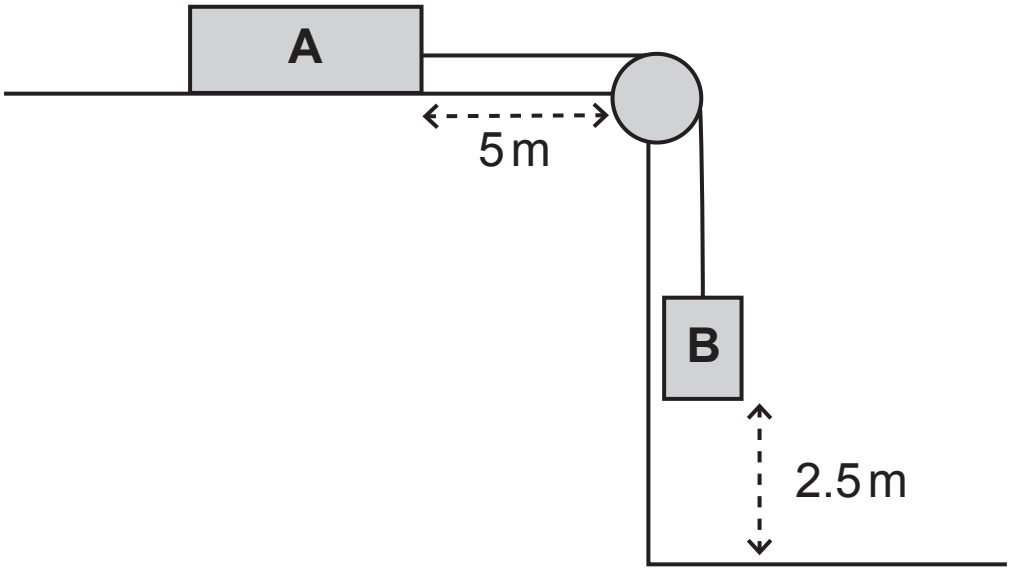
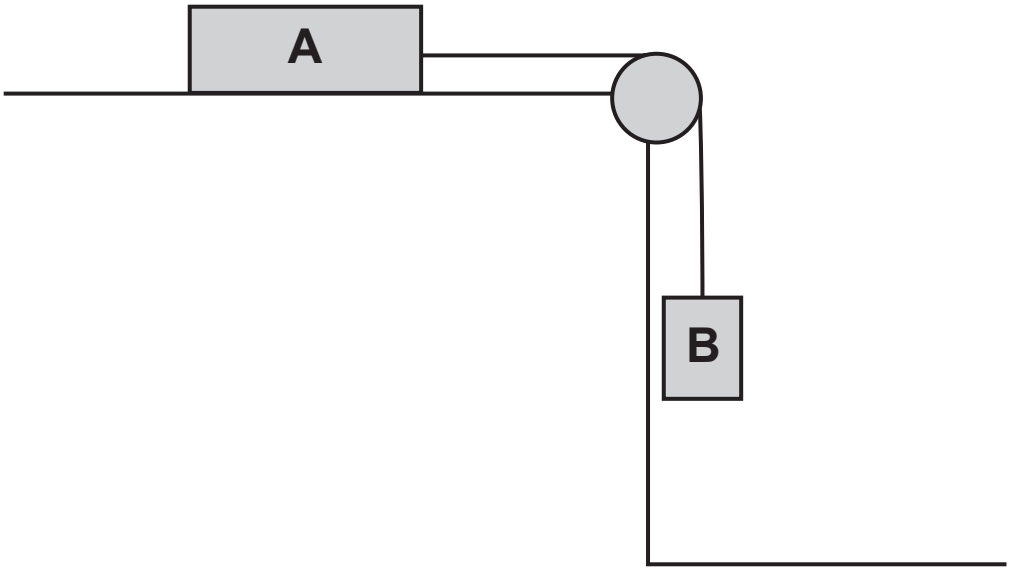


Fig. 3

Box A is released from rest.

(i) Complete the diagram below showing all the external forces acting on A and B. [2 marks]



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B hits the floor with a speed of $3.7\,m\,s^{-1}$

(ii) Find the value of the coefficient of friction between A and the table. [8 marks]

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(iii) Determine whether box A will collide with the pulley. [4 marks]

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(iv) State one modelling assumption you have made about the rope. [1 mark]

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Section B

Statistics

5 **(a)** Explain the difference between a census and a sample. [2 marks]

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(b) A market researcher is interested to find out the opinions of nurses living in Northern Ireland.

To get a random sample, he questions women that he meets entering the Royal Victoria Hospital on a Monday morning after 9 am.

Give two reasons to explain why this sampling procedure is not satisfactory. [2 marks]

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6 **(a)** The weekly incomes, rounded to the nearest pound, of households on a certain street in Belfast are given below:

221 248 251 255 259 263 264 272 291 297 374

(i) Calculate the mean and standard deviation for these weekly incomes. [4 marks]

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Outliers are defined to be
more than $1.5 \times (Q_3 - Q_1)$ above Q_3 or
more than $1.5 \times (Q_3 - Q_1)$ below Q_1

(ii) Show that **£**374 is an outlier. [3 marks]

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Further investigations suggested that the weekly income of £374 was recorded incorrectly and should in fact have been £347

Without carrying out any further investigation, state what effect, if any, this change would have on:

(iii) the standard deviation, [1 mark]

(iv) the interquartile range. [1 mark]

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(b) The histogram in **Fig. 4** below shows the weekly incomes, in **£**, of a random sample of households in a neighbourhood.

Histogram showing weekly incomes

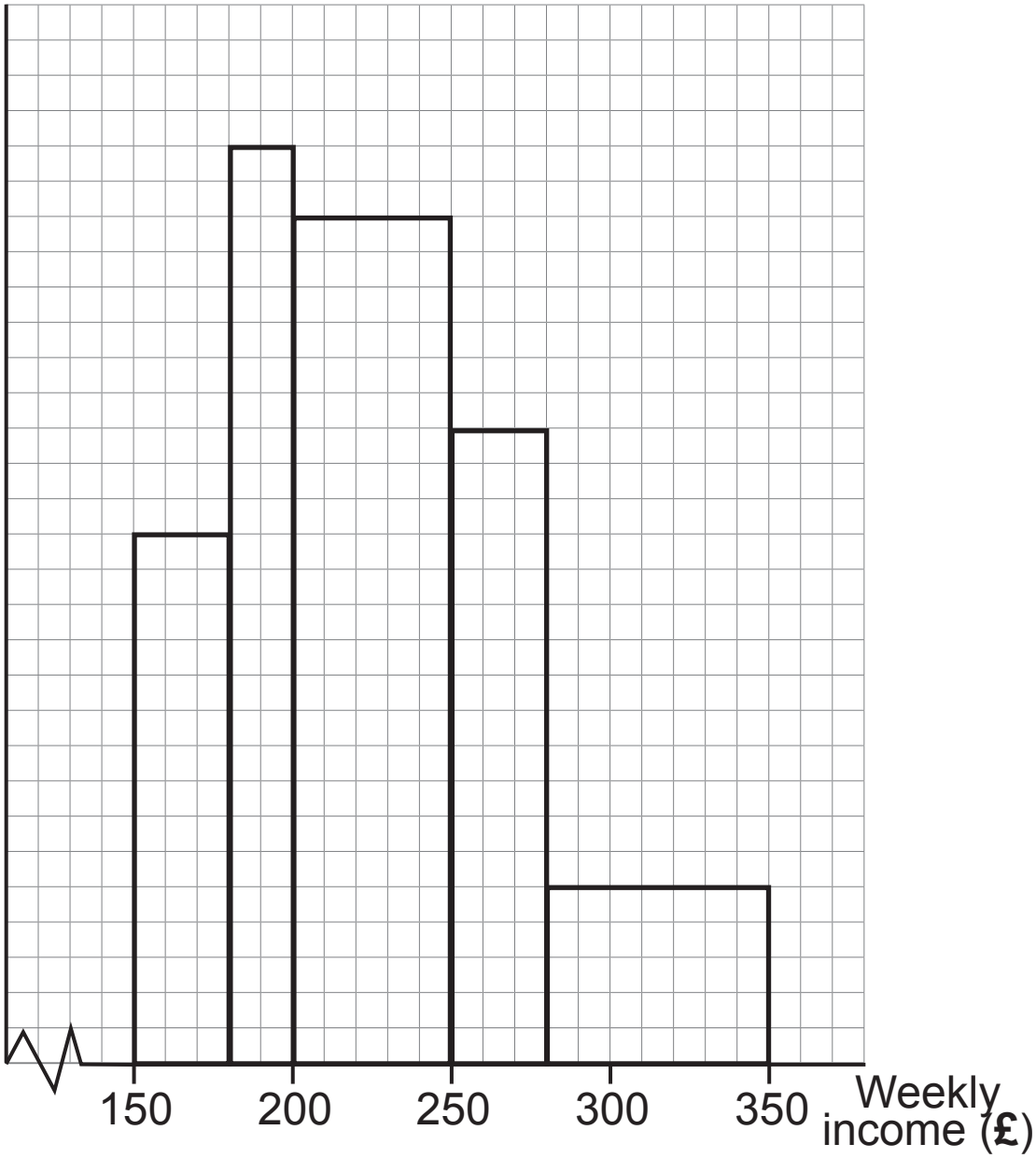

Fig. 4

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(i) Complete the table below. [1 mark]

Weekly incomes (£)	Number of households
150 –	45
180 –	52
200 –	120
250 –	
280 –	35
350 –	0

(ii) Estimate the probability that a household chosen at random received a weekly income of more than £230. [2 marks]

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7 The percentage unemployment rate (U) and percentage change in average wages (W) per year were recorded over a period of 10 years.

These are shown in **Table 1** below.

Table 1

% Unemployment Rate (U)	2.5	1.8	1.7	1.6	2.2	1.5	1.6	2.1	1.8	2.3
% Change in Wages (W)	3.2	3.6	4.6	4.4	2.7	3.5	4.3	2.7	4.1	2.9

(i) Calculate the product moment correlation coefficient between U and W. [5 marks]

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(ii) Comment on the value obtained in part **(i)**. [1 mark]

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8 A school sports club has 15 members. The probability of any member, chosen at random, being injured throughout the school year is p.

Let X be the random variable "the number of members injured throughout the school year".

(i) Find an expression, in terms of p, for $P(X = 1)$
[3 marks]

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It is known that P($X = 2$) = 3P($X = 1$)

(ii) Prove that $p = 0.3$ [4 marks]

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(iii) Hence find the probability that at least three members are injured throughout the school year. [6 marks]

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This is the end of the question paper

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Question Number	Marks
1	
2	
3	
4	
5	
6	
7	
8	
Total Marks	

Examiner Number

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