Centre Number

Candidate Number

ADVANCED SUBSIDIARY (AS)
General Certificate of Education

Mathematics

Assessment Unit AS 2

Assessing

Applied Mathematics

[SMT21]

PRACTICE PAPER

TIME

1 hour 15 minutes

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 outside the boxed area on each page or on blank pages or tracing paper.
Complete in black ink only. **Do not write with a gel pen**.
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 down the right-hand side of pages indicate the marks awarded to each question or part question.
Answers should include diagrams where appropriate and marks may be awarded for them.
Take $g = 9.8 ms^{-2}$, 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 $\ln z \equiv \log_e z$

Answer all questions

SECTION A

Mechanics

1. At time $t = 0$ seconds a stone is thrown vertically upwards from a point O with a speed of 9.8 ms^{-1}

   Find the length of time for which the stone is at least 1.3 m above O. [5]

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2. **R** is the resultant of two forces $\mathbf{F_1}$ and $\mathbf{F_2}$

$\mathbf{F_1} = (9\mathbf{i} - 2\mathbf{j})$ N and

$\mathbf{F_2} = (-4\mathbf{i} + b\mathbf{j})$ N where b is a constant scalar.

R acts in the same direction as the vector $\mathbf{i} + 3\mathbf{j}$

(i) Find the value of b. [4]

R acts on a particle of mass 0.2kg which at time $t = 0$ s, passes through a fixed point O with a velocity of $(-25\mathbf{i} - 5\mathbf{j})\text{ms}^{-1}$

At time $t = T$ seconds the displacement vector of the particle from O acts in the direction of the unit vector **j**

(ii) Find T. [5]

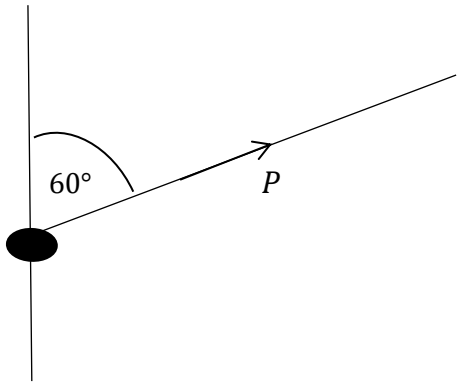
3. A bead of mass $2m$ kg is threaded onto a fixed rough vertical rod.

To prevent the bead from slipping down the rod a force P, acting at 60° to the upward vertical, is applied to the bead.

The coefficient of friction between the bead and the rod is $\frac{\sqrt{3}}{9}$

The bead is on the verge of slipping down the rod.

(i) Complete the force diagram below showing all the forces acting on the bead.



[2]

(ii) Find P in terms of m and g. [6]

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4. **Fig.1** below shows a box A, mass 5 kg, sitting on the rough roof of a shed.
The roof is inclined at an angle $\alpha = \sin^{-1}\left(\frac{3}{5}\right)$ to the horizontal.

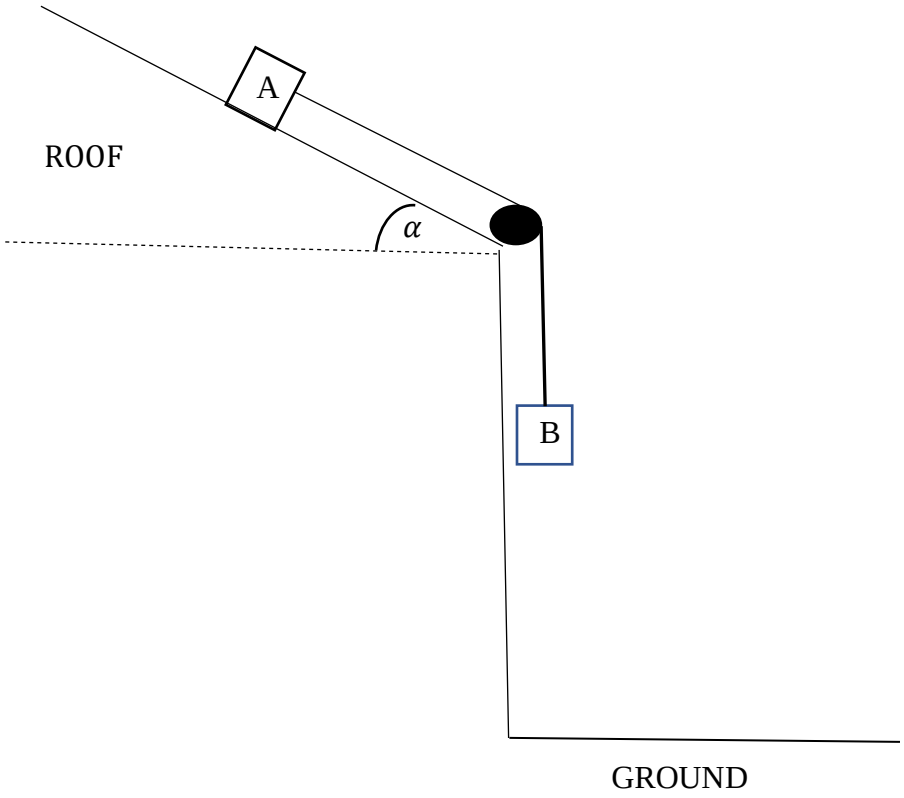

Fig.1

Box A is 0.5m from a smooth pulley which is fixed at the end of the roof.

A light inelastic string is attached to A and it passes over the pulley.

A box B, mass 1kg, is attached to the other end of the string and hangs vertically 0.6m above the ground.

The system is released from rest and a resistance of R newtons acts on A.

(i) Show that the acceleration a ms^{-2} of the system can be expressed as

$$a = \frac{1}{6}(4\text{g} - R)$$ [9]

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Box A hits the pulley with a speed of $\frac{7}{\sqrt{10}}\text{ms}^{-1}$

(ii) Find the value of R. [4]

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SECTION B

Statistics

5. **Fig. 2** below shows a scatter graph of Net Run Rate against points in a cricket league for the top ten teams.

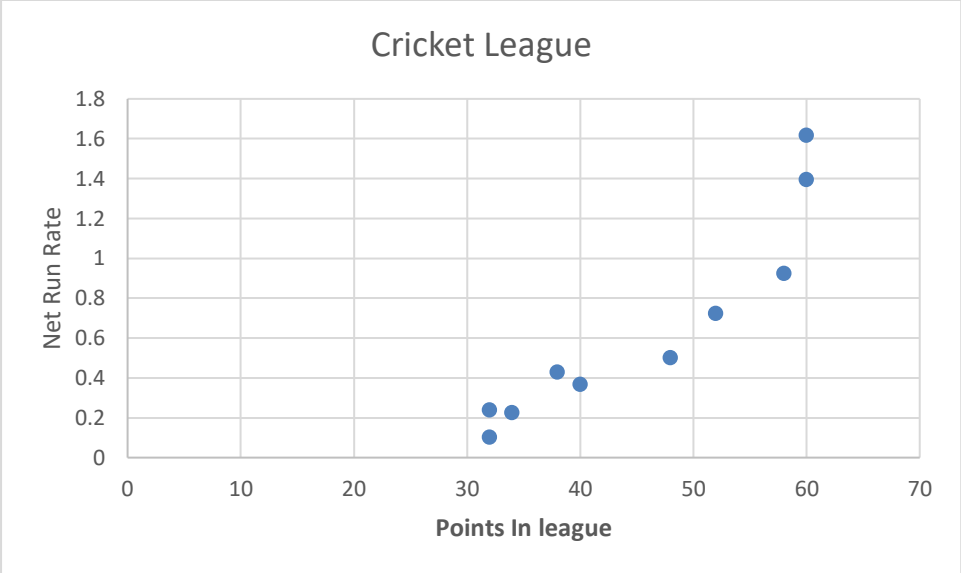

Fig. 2

The product moment correlation coefficient $r = 0.914$

(i) Describe the relationship between the league points and net run rate of the cricket teams. [2]

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June believes that the point (60, 1.618) on **Fig.2** suggests that 1.618 is an outlier for Net Run Rate (y) for the teams.

(ii) Given the following summary statistics

$$n = 10 \quad \sum y = 6.53 \quad \sum y^2 = 6.6858$$

and using the definition of an outlier to be the mean ± 2 standard deviations, decide whether June is correct, clearly explaining your answer. [6]

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6. **Fig. 3** below shows a histogram of mass (grams) of apples picked by a farmer on Tuesday in his orchard.

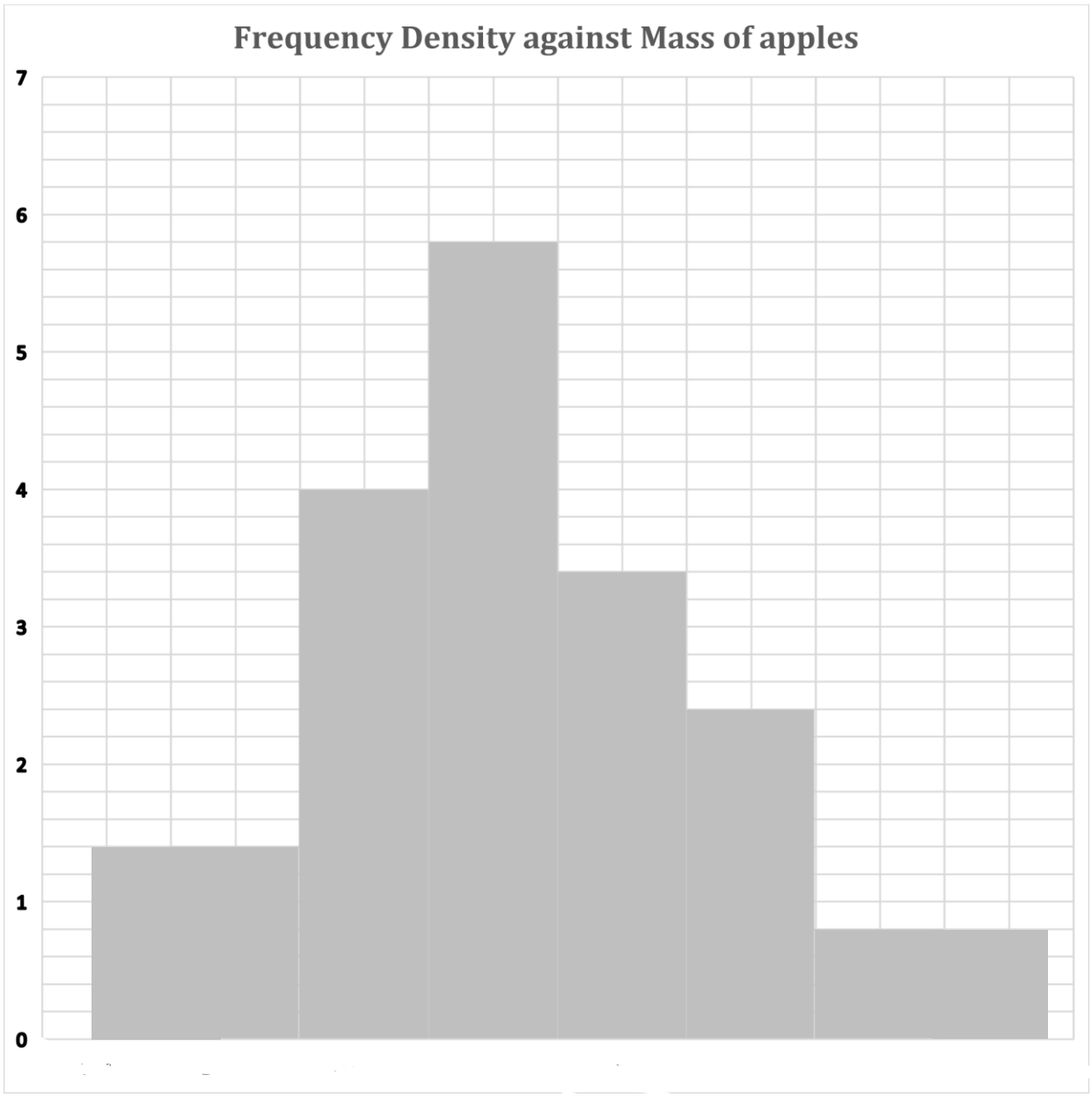

Fig. 3

(i) Show that the farmer picked two hundred apples. [2]

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The farmer does not sell apples weighing less than 168 grams.

(ii) Estimate what percentage of his total crop of apples picked on Tuesday he would not consider selling as they are too light. [4]

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The farmer also does not sell apples which are bruised.
The probability that an apple picked on Tuesday is bruised is 0.2

An apple being bruised and an apple being too light to sell are not mutually exclusive events.

The probability that an apple selected at random is sellable is 0.55

(iii) Find the probability that an apple selected at random from the apples picked on Tuesday is both bruised and too light to sell. [4]

7. The staff in all of the council's leisure centres consists of:

200 Leisure Centre Attendants.
20 Senior Leisure Centre Attendants.
8 Duty managers and
22 Admin staff.

The council wishes to carry out a survey to obtain views on salaries. They decide to sample 50 people.

(i) State one advantage and one disadvantage of stratified sampling. [2]

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(ii) Explain how you would obtain this sample of 50 employees, clearly stating how many employees are to be sampled from each stratum. [5]

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8. The probability that it rains on any day in February is 0.3

(i) Find the probability that it rains on most of the days in a week in February. [4]

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(ii) Find the probability that in two of the four weeks in February it rains on most of the days in each week. (Assume February is not a leap year.) [3]

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On a day in February the probability that is snows is less than the probability that it rains.

The probability of both raining and snowing on a particular day in February is 0.12

Based on the information given Peter suspects that the event of snowing and the event raining on any day in February could be independent events.

(iii) Is Peter's suspicion, correct? Show clearly, your working. [3]

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THIS IS THE END OF THE PAPER

ADVANCED

General Certificate of Education

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[SMT21]

PRACTICE PAPER

MARK SCHEME

	AVAILABLE MARKS

SECTION A

MECHANICS

1.

$$s = ut + \frac{1}{2}at^2 \qquad \text{M1}$$

$$1.3 = 9.8t - \frac{1}{2}(9.8)t^2 \qquad \text{W1}$$

$$4.9t^2 - 9.8t + 1.3 = 0$$

$$49t^2 - 98t + 13 = 0$$

$$(7t - 1)(7t - 13) = 0$$

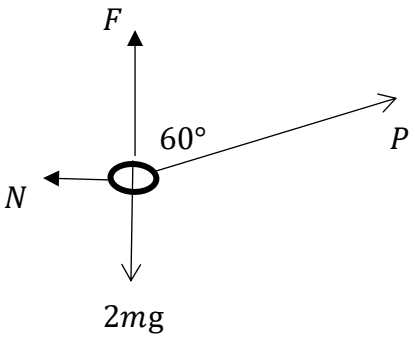
$$t = \frac{1}{7},\ \frac{13}{7} \qquad \text{MW2}$$

$$\text{Time} = \frac{12}{7}\text{s} \qquad \text{W1} \qquad 5$$

		AVAILABLE MAR KS
2.(i) Resultant $= (\ 9\mathbf{i} - 2\mathbf{j}\ ) + (-4\mathbf{i} + b\mathbf{j}\ )$	M1	
$= [5\mathbf{i} + (b-2)\mathbf{j}\ ]$ N	W1	
Resultant is parallel to $\mathbf{i} + 3\mathbf{j}$		
Hence $5\mathbf{i} + (b-2)\mathbf{j} = k(\ \mathbf{i} + 3\mathbf{j})$	M1	
$k = 5 \Rightarrow b - 2 = 5 \times 3$		
$b = 17$	W1	
(ii) $\mathbf{F} = m\mathbf{a}$		
$5\mathbf{i} + 15\mathbf{j} = 0.2\mathbf{a}$		
$\mathbf{a} = 25\mathbf{i} + 75\mathbf{j}$	MW1	
$\mathbf{s} = \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$	M1	
$\mathbf{s} = (-25\mathbf{i} - 5\mathbf{j})T + \frac{1}{2}(25\mathbf{i} + 75\mathbf{j})T^2$	W1	
$\mathbf{s} = (-25T + 12.5T^2)\mathbf{i} + (-5T + 37.5T^2)\mathbf{j}$		
s in the direction of the **j** vector implies $-25T + 12.5T^2 = 0$	M1	
$12.5T^2 - 25T = 0$		
$T(T-2) = 0$		
$T = \not{0},\ 2$ s	W1	9

AVAILABLE MAR KS

3(i)



MW2

(ii) Consider forces on bead

Resolve vertically

$$F + P\cos 60° = 2mg \qquad \text{M1}$$

$$2F + P = 4mg \qquad (1) \qquad \text{W1}$$

Resolve horizontally

$$N = P\cos 30° \qquad \text{MW1}$$

$$N = \frac{\sqrt{3}P}{2} \qquad (2)$$

$$F = \mu N$$

$$F = \frac{\sqrt{3}}{9}N \qquad (3) \qquad \text{MW1}$$

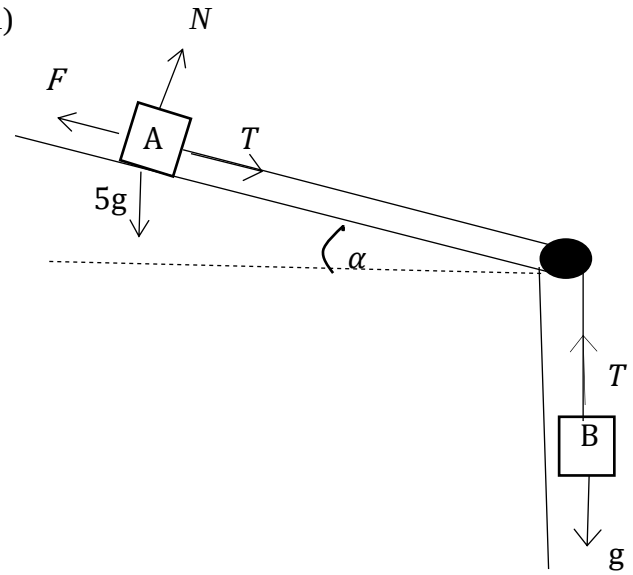
Substituting (2) and (3) into (1)

$$2F + P = 4mg \qquad \text{M1}$$

$$2 \times \frac{\sqrt{3}}{9} \times \frac{\sqrt{3}P}{2} + P = 4mg$$

$$P = 3mg \qquad \text{W1}$$

8

		AVAILABLE MARKS
4(i) 	MW2	
$T + 5\text{g}\sin\alpha - R = 5a$	M1W1W1	
$\text{g} - T = a$	MW1	
$T + 5\text{g}\sin\alpha - R = 5a$	M1	
$\text{g} - T = a$		
$5\text{g}\sin\alpha - R + \text{g} = 6a$	W1	
$6a = 3\text{g} - R + \text{g}$		
$a = \frac{1}{6}(4\text{g} - R)$	W1	
(ii) $v^2 = u^2 + 2as$	M1	
$\left(\frac{7}{\sqrt{10}}\right)^2 = 2a \times 0.5$		
$a = 4.9$	W1	
$4.9 = \frac{1}{6}(4\text{g} - R)$	M1	
$4\text{g} - R = 29.4$		
$R = \text{g} = 9.8$ N	W1	13

SECTION B

STATISTICS

AVAILABLE MARKS

5.(i) There is a strong positive correlation between the net run rate and the points in the league. MW2

(ii) $\sigma = \sqrt{\frac{\sum y^2}{n} - \left(\frac{\sum y}{n}\right)^2}$ M1

$\sigma = \sqrt{\frac{6.6858}{10} - \left(\frac{6.53}{10}\right)^2}$

$\sigma = 0.4921$ W1

Mean = $\frac{6.53}{10} = 0.653$ MW1

Outlier top boundary = mean + $2 \times \sigma$ M1

$= 0.653 + 2 \times 0.4921 = 1.6372$ W1

The run rate of 1.618 is lower than the upper boundary for the outlier and therefore is not an outlier. June is incorrect in her belief. MW1 8

AVAILABLE MARKS

6.

(i)

Weight	F.D	Frequency
140-160	1.4	28
160-170	4	40
170-180	5.8	58
180-190	3.4	34
190-200	2.4	24
200-220	0.8	16

Total = 28 + 40 + 58 + 34 + 24 + 16 = 200 MW2

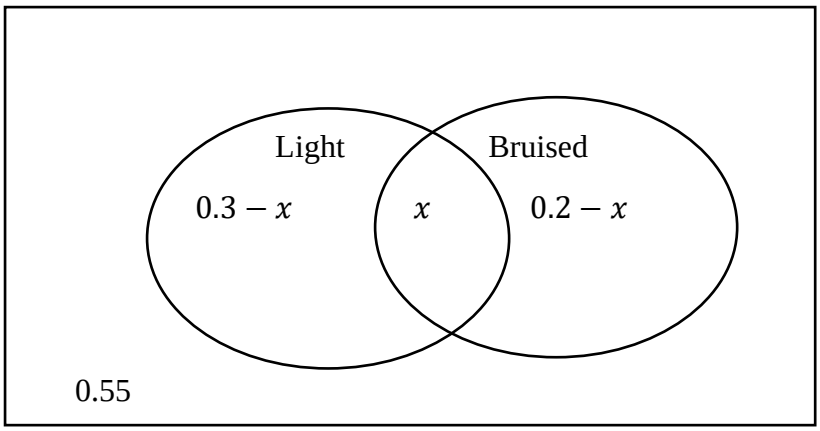
(ii) 168 is $\frac{8}{10}$ the way along the second class of width 10 MW1

The number of apples less than 168 g $= 28 + \frac{8}{10} \times 40$ M1W1

$= 60$ apples

Percentage of the total crop less than 168 is $\frac{60}{200} \times 100 = 30\%$ W1

(iii)



M1W1

$0.3 - x + x + 0.2 - x + 0.55 = 1$ M1

$1.05 - x = 1$

$x = 0.05$ W1 10

AVAILABLE MARKS

7. (i) Advantages:

1. We can find an accurate reflection of the population.
2. Different groups(strata) represent the population in the correct proportion.

Disadvantages:

1. It must be possible to take each member of the population and place them into a distinct stratum.

MW2

(ii)

LA	SLA	DM	AD
200	20	8	22

1. Total is 250 MW1
2. Proportion is $\frac{50}{250}$ MW1
3. Calculate the number of employees in each stratum to select

LA	SLA	DM	AD
200	20	8	22
40	4	2 (1.6 rounded up)	4 (2.4 rounded down)

MW2

4. Take a simple random sample from each group by numbering each person in the sample and generating random numbers using calculator.

MW1 7

			AVAILABLE MARKS
8(i)	Let X be the random variable "the number of days it rains"		
	$X = \text{Bin}(7, 0.3)$	M1	
	$\text{P}(X \geq 4) = 1 - \text{P}(X \leq 3)$	M1	
	Calculator Use: Binomial Probability Cumulative function with		
	$n = 7, p = 0.3$		
	$\text{P}(X \leq 3) = 0.873964..$	MW1	
	$\text{P}(X \geq 4) = 1 - \text{P}(X \leq 3) = 0.126036 = 0.126$ (3sf)	W1	
(ii)	$X = \text{Bin}(4, 0.126036)$	M1	
	Calculator Use: Binomial Probability Cumulative function with	M1	
	$n = 4, x = 2,\ p = 0.126054$		
	$\text{P}(X = 2) = 0.07281716 = 0.0728$	W1	
(iii)	$\text{P}(S \cap R) = 0.1 \quad \text{P}(R) = 0.3$		
	$\text{P}(S) < \text{P}(R)$		
	To be independent $\text{P}(S \cap R) = \text{P}(S)\text{P}(R)$	M1	
	$0.12 = \text{P}(S)0.3$		
	$\text{P}(S) = 0.4$	W1	
	However, $\text{P}(S)$ must be less than $\text{P}(R) = 0.3$ Hence the two events could not possibly be independent. Peter's statement is incorrect.	MW1	10