# 4.6 Combined\_mutually exclusive\_conditional independence\_prob diagram\_P\_2

**1a.** *[3 marks]*

## Markscheme

use of formula or Venn diagram      ***(M1)***

0.72 + 0.45 − 1       ***(A1)***

= 0.17       ***A1***

***[3 marks]***

**1b.** *[1 mark]*

## Markscheme

0.72 − 0.17 = 0.55      ***A1***

***[1 mark]***

**1c.** *[1 mark]*

## Markscheme

200 × 0.45 = 90      ***A1***

***[1 mark]***

**1d.** *[3 marks]*

## Markscheme

let *X* be the number of customers who order cake

*X* ~ B(200,0.45)        ***(M1)***

P(*X* > 100) = P(*X* ≥ 101)(= 1 − P(*X* ≤ 100))    ***(M1)***

= 0.0681      ***A1***

***[3 marks]***

**1e.** *[1 mark]*

## Markscheme

0.46 × 0.8 = 0.368    ***A1***

***[1 mark]***

**1f.** *[4 marks]*

## Markscheme

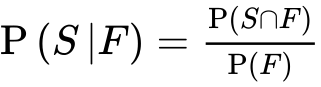
**METHOD 1**

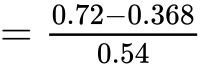
       ***M1A1A1***

**Note:** Award ***M1*** for an appropriate tree diagram. Award ***M1*** for LHS, ***M1*** for RHS.

     ***A1***

**METHOD 2**

       ***(M1)***

       ***A1A1***

**Note:** Award ***A1***for numerator, ***A1***for denominator.

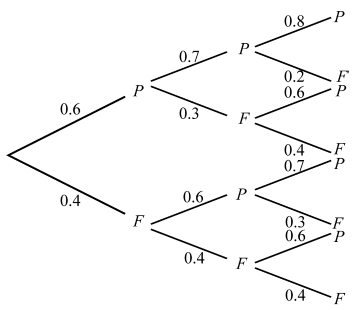
     ***A1***

***[4 marks]***

**2a.** *[3 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

***A1A1A1***

**Note:** Award ***A1*** for each correct column of probabilities.

***[3 marks]***

**2b.** *[2 marks]*

## Markscheme

probability (at least twice) =

**EITHER**

       ***(M1)***

**OR**

       ***(M1)***

**Note:** Award ***M1*** for summing all required probabilities.

**THEN**

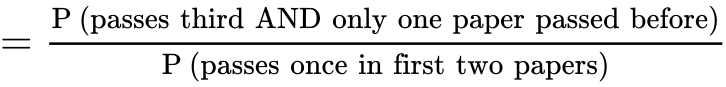
= 0.696***A1***

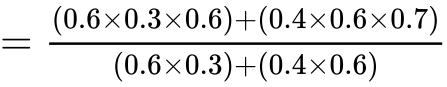
***[2 marks]***

**2c.** *[3 marks]*

## Markscheme

P(passes third paper given only one paper passed before)

      ***(M1)***

      ***A1***

= 0.657***A1***

***[3 marks]***

**3a.** *[2 marks]*

## Markscheme



    ***(M1)***

= 0.102     ***A1***

***[2 marks]***

**3b.** *[2 marks]*

## Markscheme

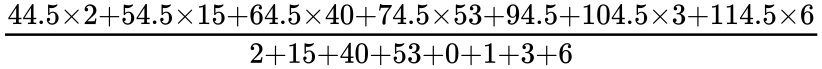
standard deviation =  (= 8.37)   ***(M1)A1***

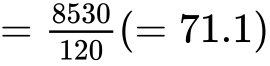
***[2 marks]***

**3c.** *[3 marks]*

## Markscheme

use of midpoints (accept consistent use of 45, 55 etc.)  ***(M1)***

   ***(M1)***

      ***A1***

**Note:** If 45, 55, etc. are used consistently instead of midpoints (implied by the answer 71.58…) award ***M1M1A0***.

***[3 marks]***

**3d.** *[2 marks]*

## Markscheme

13.9  ***(M1)A1***

***[2 marks]***

**3e.** *[1 mark]*

## Markscheme

valid reason given to include the examples below       ***R1***

variance is 192 which is not close to the mean (accept not equal to) standard deviation too high (using parts (a)(ii) and (b)(ii))

relative frequency of  ≤ 59 is 0.142 which is too high (using part (a)(i))

Poisson would give a frequency of roughly 14 for 80 ≤  ≤ 89

**Note:** Reasons which do not use values found in previous parts must be backed up with numerical evidence.

***[1 mark]***

**3f.** *[3 marks]*

## Markscheme



      ***(M1)***

attempt to solve a correct equation       ***(M1)***

*λ*= 20.1       ***A1***

***[3 marks]***

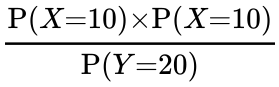
**3g.** *[5 marks]*

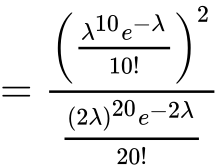
## Markscheme

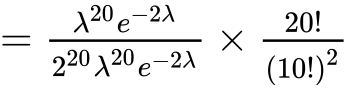
in 1 day, no of emails is *X* ~ Po(*λ*)

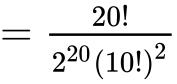
in 2 days, no of emails is *Y* ~ Po(2*λ*)       ***(A1)***

P(10 on first day | 20 in 2 days)        ***(M1)***

        ***(M1)***

     ***A1***

      ***A1***



which is independent of *λ*       ***AG***

***[5 marks]***

**4.** *[5 marks]*

## Markscheme

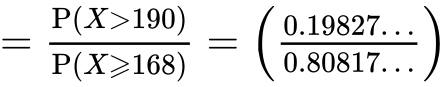
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

*X* is number of squirrels in reserve  
*X* ∼ Po(179.2)      ***A1***

**Note:** Award ***A1*** if 179.2 or 56 × 3.2 seen or implicit in future calculations.

recognising conditional probability     ***M1***

P(*X* > 190 | *X* ≥ 168)

       ***(A1)(A1)***

= 0.245      ***A1***

***[5 marks]***

**5.** *[7 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**METHOD 1**

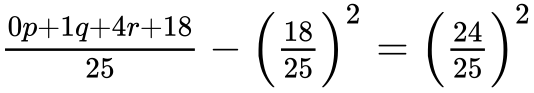
let *p* have no pets, *q* have one pet and *r* have two pets      ***(M1)***

*p* + *q* + *r* + 2 = 25      ***(A1)***

0*p* + 1*q* + 2*r* + 6 = 18      ***A1***

**Note:** Accept a statement that there are a total of 12 pets.

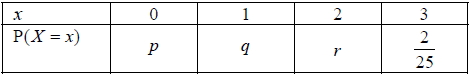
attempt to use variance equation, or evidence of trial and error       ***(M1)***

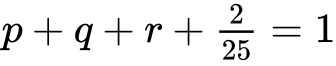
     ***(A1)***

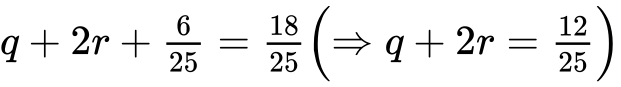
attempt to solve a system of linear equations ***(M1)***

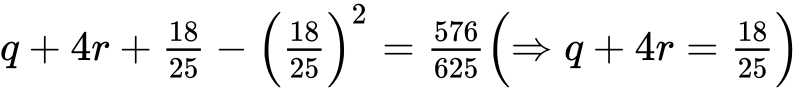
*p* = 14      ***A1***

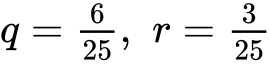
**METHOD 2**

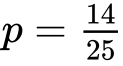
     ***(M1)***

     ***(A1)***

      ***A1***

      ***(M1)(A1)***

      ***(M1)***

       ***A1***

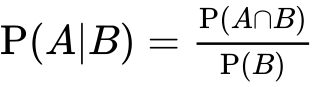
so 14 have no pets

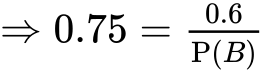
***[7 marks]***

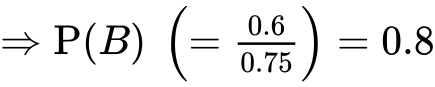
**6a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



     ***(M1)***

     ***A1***

***[2 marks]***

**6b.** *[2 marks]*

## Markscheme



     ***(M1)***

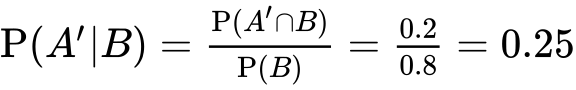
     ***A1***

***[2 marks]***

**6c.** *[2 marks]*

## Markscheme

**METHOD 1**

     ***A1***

     ***R1***

hence  and  are independent     ***AG***

**Note:**     If there is evidence that the student has calculated  by assuming independence in the first place, award ***A0R0***.

**METHOD 2**

**EITHER**

     ***A1***

**OR**

     ***A1***

**THEN**

 and  are independent     ***R1***

hence  and  are independent     ***AG***

**METHOD 3**

     ***A1***

     ***R1***

hence  and  are independent     ***AG***

***[2 marks]***

**7a.** *[3 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

use of      ***M1***

     ***A1***



     ***A1***

**Note:**     Do not award the final ***A1*** if two solutions are given.

***[3 marks]***

**7b.** *[3 marks]*

## Markscheme

use of  or alternative     ***(M1)***

     ***(A1)***

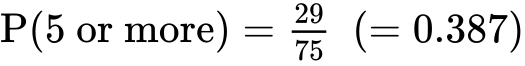
     ***A1***

***[3 marks]***

**8a.** *[2 marks]*

## Markscheme

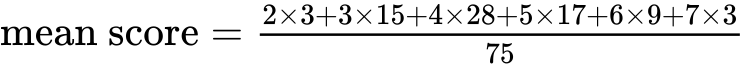
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

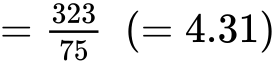
     ***(M1)A1***

***[2 marks]***

**8b.** *[2 marks]*

## Markscheme

     ***(M1)***

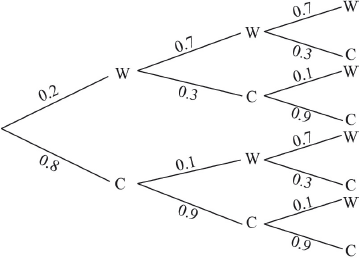
     ***A1***

***[2 marks]***

**9a.** *[3 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

     ***M1A2***

**Note:**     Award ***M1*** for 3 stage tree-diagram, ***A2*** for 0.8, 0.9, 0.3 probabilities correctly placed.

***[3 marks]***

**9b.** *[2 marks]*

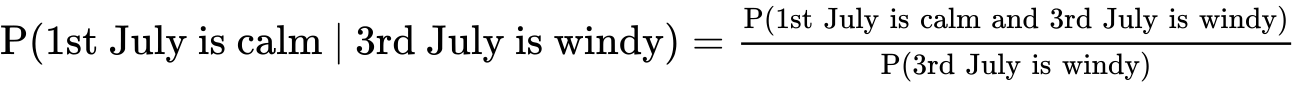
## Markscheme

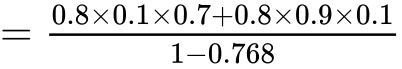
     ***(M1)A1***

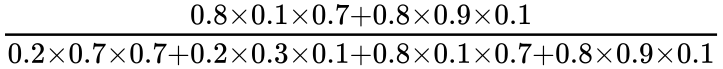
***[2 marks]***

**9c.** *[4 marks]*

## Markscheme

     ***(M1)***



**OR**

**OR**     ***(A1)(A1)***

**Note:**     Award ***A1*** for correct numerator, ***A1*** for correct denominator.

     ***A1***

***[4 marks]***

**10a.** *[3 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

    ***A1***

    ***AG***

    ***(M1)***

 (or equivalent)     ***A1***

    ***AG***

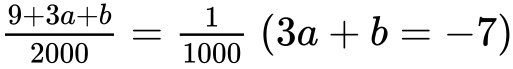
***[3 marks]***

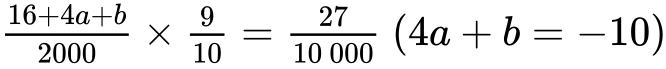
**10b.** *[5 marks]*

## Markscheme

**METHOD 1**

attempting to form equations in  and      ***M1***

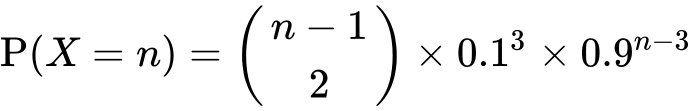
    ***A1***

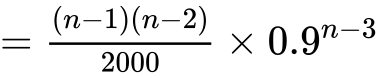
    ***A1***

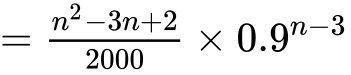
attempting to solve simultaneously     ***(M1)***

    ***A1***

**METHOD 2**

    ***M1***

    ***(M1)A1***

    ***A1***

    ***A1***

**Note:** Condone the absence of  in the determination of the values of  and .

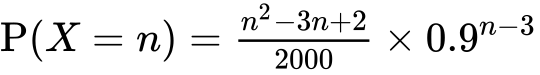
***[5 marks]***

**10c.** *[4 marks]*

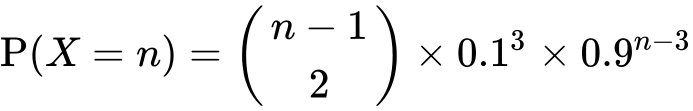
## Markscheme

**METHOD 1**

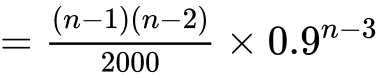
**EITHER**

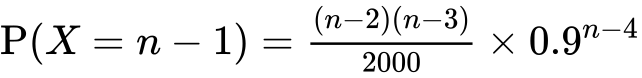
    ***(M1)***

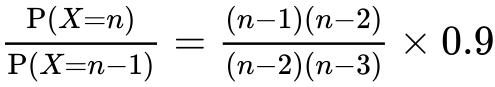
**OR**

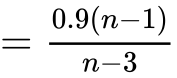
    ***(M1)***

**THEN**

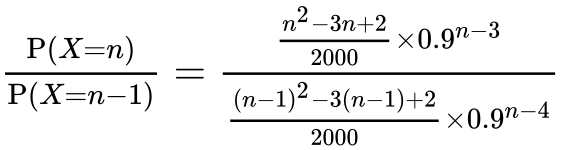
    ***A1***

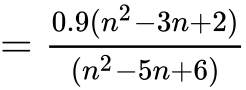
    ***A1***

    ***A1***

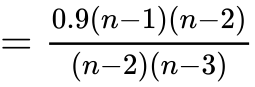
    ***AG***

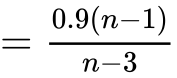
**METHOD 2**

    ***(M1)***

    ***A1A1***

**Note:** Award ***A1*** for a correct numerator and ***A1*** for a correct denominator.

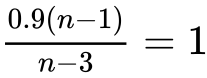
    ***A1***

    ***AG***

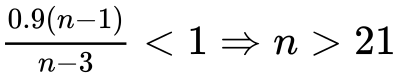
***[4 marks]***

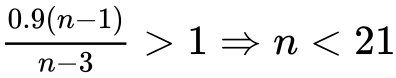
**10d.** *[5 marks]*

## Markscheme

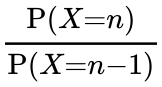
(i)     attempting to solve  for      ***M1***

    ***A1***

    ***R1***

    ***R1***

 has two modes     ***AG***

**Note:** Award ***R1R1*** for a clearly labelled graphical representation of the two inequalities (using ).

(ii)     the modes are 20 and 21     ***A1***

***[5 marks]***

**10e.** *[3 marks]*

## Markscheme

**METHOD 1**

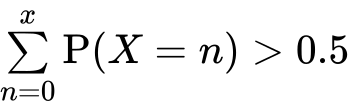
    ***(A1)***

attempting to solve  (or equivalent *eg* ) for      ***(M1)***

**Note:** Award ***(M1)*** for attempting to solve an equality (obtaining ).

    ***A1***

**METHOD 2**

    ***(A1)***

attempting to solve for      ***(M1)***

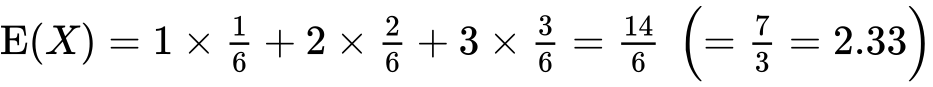
    ***A1***

***[3 marks]***

**11a.** *[2 marks]*

## Markscheme

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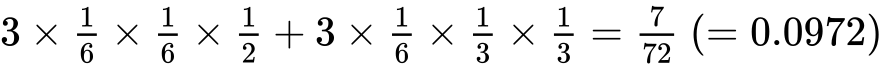
     ***(M1)A1***

***[2 marks]***

**11b.** *[3 marks]*

## Markscheme

     ***(M1)***

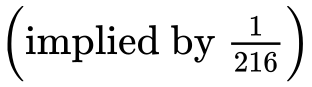
     ***A1***

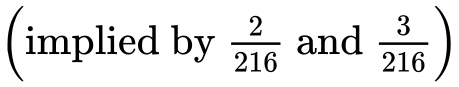
**Note:** Award ***M1*** for attempt to find at least four of the cases.

***[3 marks]***

**11c.** *[3 marks]*

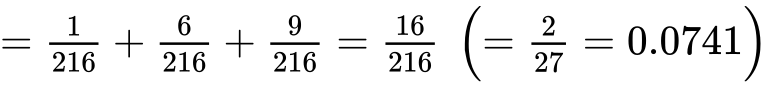
## Markscheme

recognising 111 as a possibility      ***(M1)***

recognising 112 and 113 as possibilities      ***(M1)***

seeing the three arrangements of 112 and 113     ***(M1)***

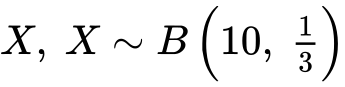


     ***A1***

***[3 marks]***

**11d.** *[3 marks]*

## Markscheme

let the number of twos be      ***(M1)***

     ***(M1)A1***

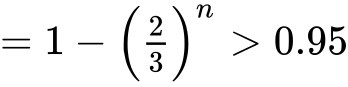
***[3 marks]***

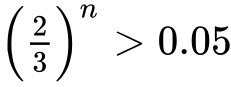
**11e.** *[3 marks]*

## Markscheme

let  be the number of balls drawn

     ***M1***

     ***M1***

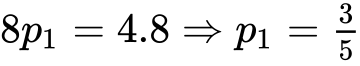


     ***A1***

***[3 marks]***

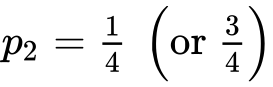
**11f.** *[8 marks]*

## Markscheme

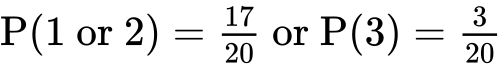
     ***(M1)A1***

     ***(M1)***

     ***(M1)***

     ***A1***

reject  as it gives a total greater than one

     ***(A1)***

recognising LCM as 20 so min total number is 20     ***(M1)***

the least possible number of 3’s is 3     ***A1***

***[8 marks]***

**12a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**Note:** In Section A, where appropriate, accept answers that correctly round to 2 sf except in Q2, Q5(a) (ii), Q5(b) and Q8(a).

     ***(M1)***

     ***A1***

***[2 marks]***

**12b.** *[2 marks]*

## Markscheme

     ***A1***

since  then  and  are independent     ***R1***

**Note:** Only award the ***R1*** if numerical values are seen. Award ***A1R1*** for a correct conditional probability approach.

***[2 marks]***

***Total [4 marks]***

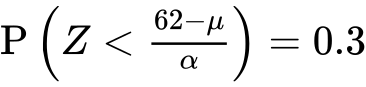
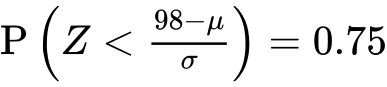
**13a.** *[6 marks]*

## Markscheme

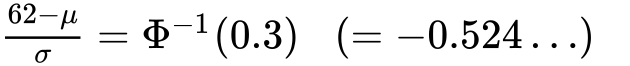
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

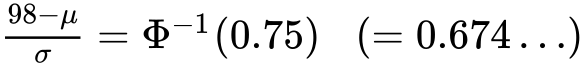
**Note:** In Section B, accept answers that correctly round to 2 sf.

(i)     let  be the weight of a worker and 

 and      ***(M1)***

**Note:** Award ***M1*** for a correctly shaded and labelled diagram.

and



or linear equivalents     ***A1A1***

**Note:** Condone equations containing the GDC inverse normal command.

(ii)     attempting to solve simultaneously     ***(M1)***

     ***A1A1***

***[6 marks]***

**13b.** *[1 mark]*

## Markscheme

**Note:** In Section B, accept answers that correctly round to 2 sf.

     ***A1***

***[1 mark]***

**13c.** *[2 marks]*

## Markscheme

**Note:** In Section B, accept answers that correctly round to 2 sf.

let  represent the number of workers over  kg in a lift of ten passengers

     ***(M1)***

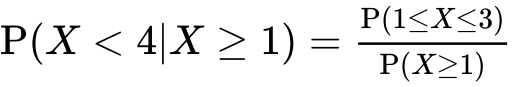
     ***A1***

***[2 marks]***

**13d.** *[3 marks]*

## Markscheme

**Note:** In Section B, accept answers that correctly round to 2 sf.

     ***M1(A1)***

**Note:** Award the ***M1*** for a clear indication of a conditional probability.

     ***A1***

***[3 marks]***

**13e.** *[3 marks]*

## Markscheme

**Note:** In Section B, accept answers that correctly round to 2 sf.

     ***(M1)***

     ***(M1)***

     ***A1***

***[3 marks]***

**13f.** *[3 marks]*

## Markscheme

**Note:** In Section B, accept answers that correctly round to 2 sf.

 workers require at least  elevators     ***(A1)***

     **(*M1)***

     ***A1***

***[3 marks]***

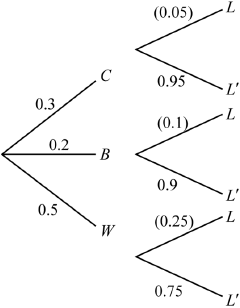
***Total [18 marks]***

**14.** *[6 marks]*

## Markscheme

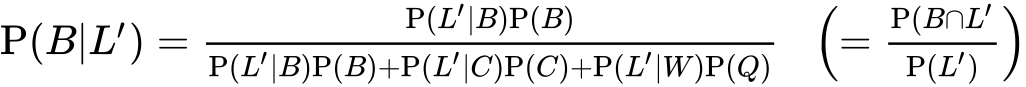
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

**EITHER**

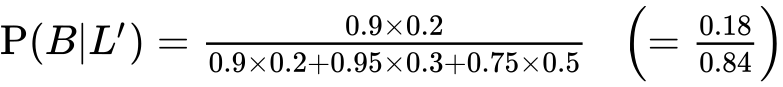
***M1A1A1***

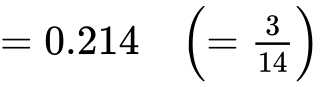
**Note:** Award ***M1*** for a two-level tree diagram, ***A1*** for correct first level probabilities, and ***A1*** for correct second level probabilities.

**OR**

     ***(M1)(A1)(A1)***

**THEN**

     ***M1A1***

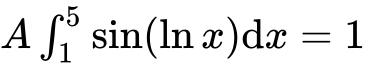
     ***A1***

***[6 marks]***

**15a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

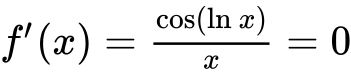
     ***(M1)***

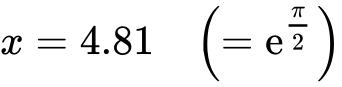
     ***A1***

***[2 marks]***

**15b.** *[2 marks]*

## Markscheme

either a graphical approach or      ***(M1)***

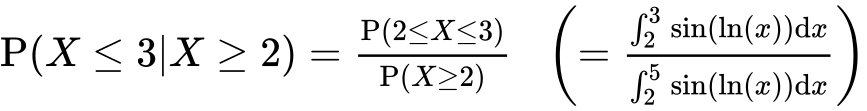
     ***A1***

**Note:** Do not award ***A1FT*** for a candidate working in degrees.

***[2 marks]***

**15c.** *[2 marks]*

## Markscheme

     ***(M1)***

     ***A1***

**Note:** Do not award ***A1FT*** for a candidate working in degrees.

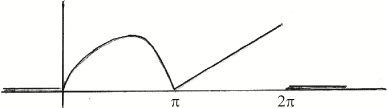
***[2 marks]***

***Total [6 marks]***

**16a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



Award ***A1*** for sine curve from  to , award ***A1*** for straight line from  to      ***A1A1***

***[2 marks]***

**16b.** *[2 marks]*

## Markscheme

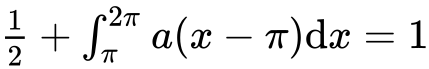
     ***(M1)A1***

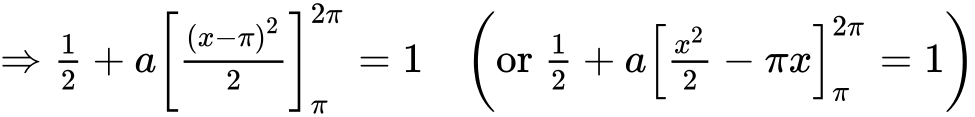
***[2 marks]***

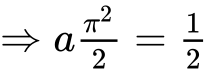
**16c.** *[3 marks]*

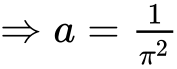
## Markscheme

**METHOD 1**

require      ***(M1)***

     ***A1***

     ***A1***

     ***AG***

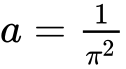
**Note:**     Must obtain the exact value. Do not accept answers obtained with calculator.

**METHOD 2**

     ***R1***

area of triangle      ***M1A1***

**Note:**     Award ***M1*** for correct use of area formula , ***A1*** for .

     ***AG***

***[3 marks]***

**16d.** *[1 mark]*

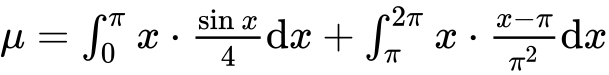
## Markscheme

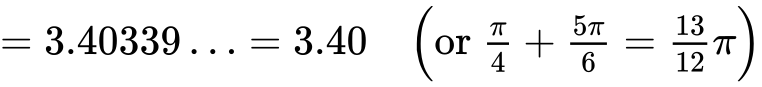
median is      ***A1***

***[1 mark]***

**16e.** *[3 marks]*

## Markscheme

     ***(M1)(A1)***

     ***A1***

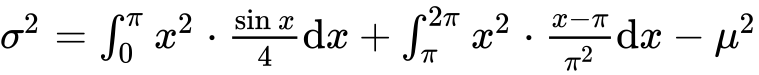
***[3 marks]***

**16f.** *[3 marks]*

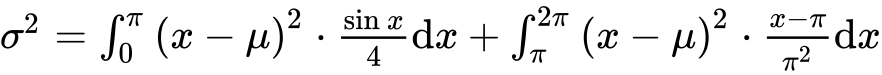
## Markscheme

For 

**EITHER**

     ***(M1)(A1)***

**OR**

     ***(M1)(A1)***

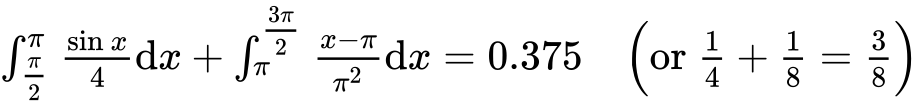
**THEN**

     ***A1***

***[3 marks]***

**16g.** *[2 marks]*

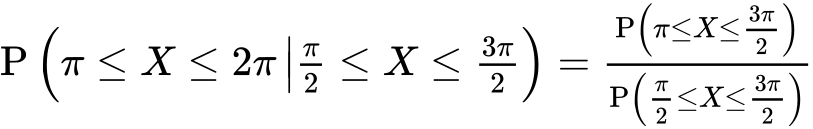
## Markscheme

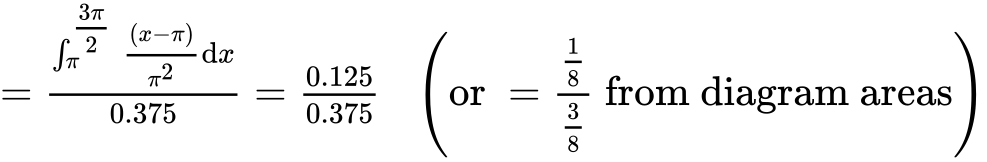
     ***(M1)A1***

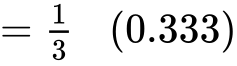
***[2 marks]***

**16h.** *[4 marks]*

## Markscheme

     ***(M1)(A1)***

     ***(M1)***

     ***A1***

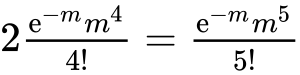
***[4 marks]***

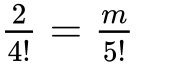
***Total [20 marks]***

**17a.** *[3 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

     ***M1A1***

or other simplification     ***M1***

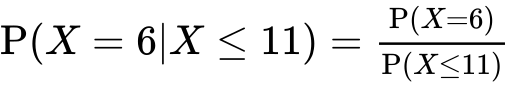
**Note:**     accept a labelled graph showing clearly the solution to the equation. Do not accept simple verification that  is a solution.

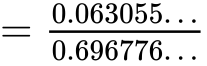
     ***AG***

***[3 marks]***

**17b.** *[4 marks]*

## Markscheme

     ***(M1) (A1)***

     ***(A1)***

     ***A1***

***[4 marks]***

***Total [7 marks]***

**18a.** *[6 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

(i)          ***(M1)A1***

**Note:**     Accept 

**Note:**     Award ***M1A0*** for  ()

(ii)          ***M1***

expected number of turnips      ***A1***

**Note:**     Accept .

(iii)     no of turnips weighing more than  is      ***M1***

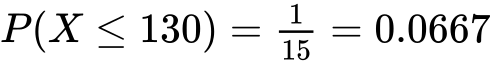
     ***A1***

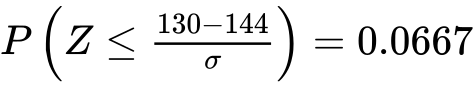
***[6 marks]***

**18b.** *[6 marks]*

## Markscheme

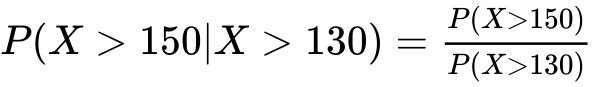
(i)     

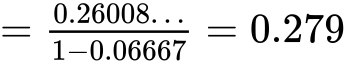
     ***(M1)***



     ***(A1)***

     ***A1***

(ii)          ***M1***

     ***A1***

expected number of turnips      ***A1***

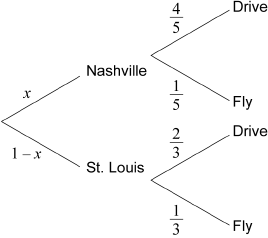
***[6 marks]***

***Total [12 marks]***

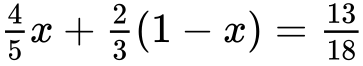
**19a.** *[3 marks]*

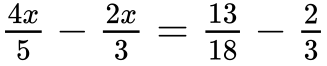
## Markscheme

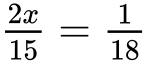
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.



attempt to set up the problem using a tree diagram and/or an equation, with the unknown      ***M1***

     ***A1***



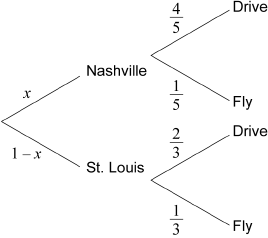


     ***A1***

***[3 marks]***

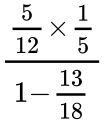
**19b.** *[3 marks]*

## Markscheme

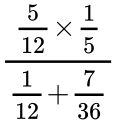


attempt to set up the problem using conditional probability     ***M1***

**EITHER**

     ***A1***

**OR**

     ***A1***

**THEN**

     ***A1***

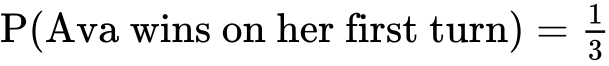
***[3 marks]***

***Total [6 marks]***

**20a.** *[1 mark]*

## Markscheme

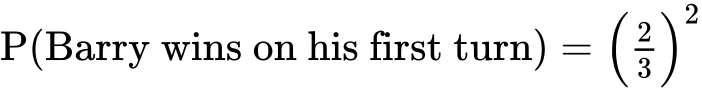
\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

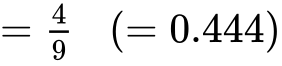
     ***A1***

***[1 mark]***

**20b.** *[2 marks]*

## Markscheme

     ***(M1)***

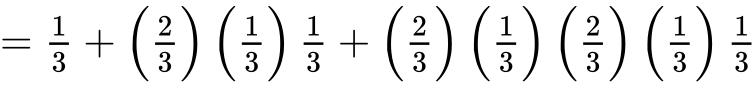
     ***A1***

***[2 marks]***

**20c.** *[4 marks]*

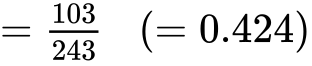
## Markscheme

(Ava wins in one of her first three turns)

     ***M1A1A1***

**Note:** Award ***M1*** for adding probabilities, award ***A1*** for a correct second term and award ***A1*** for a correct third term.

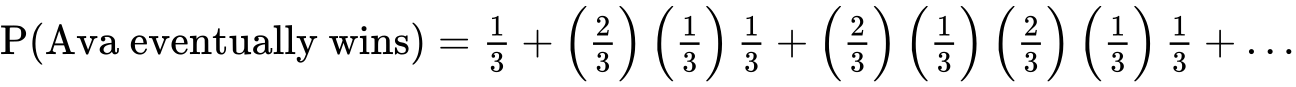
Accept a correctly labelled tree diagram, awarding marks as above.

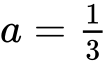
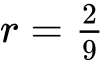
     ***A1***

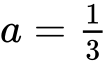
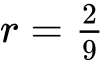
***[4 marks]***

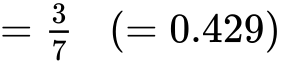
**20d.** *[4 marks]*

## Markscheme

     ***(A1)***

using  with  and      ***(M1)(A1)***

**Note:** Award ***(M1)*** for using  and award ***(A1)*** for  and .

     ***A1***

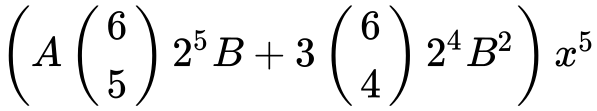
***[4 marks]***

***Total [11 marks]***

**21a.** *[4 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

     ***M1A1A1***

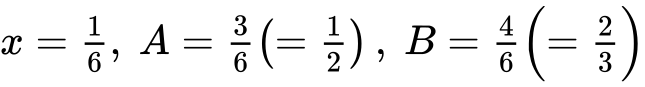
     ***A1***

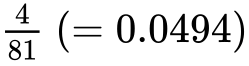
***[4 marks]***

**21b.** *[4 marks]*

## Markscheme

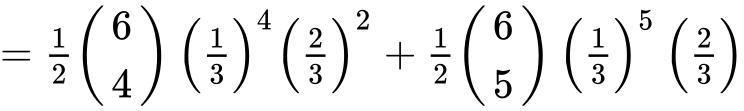
**METHOD 1**

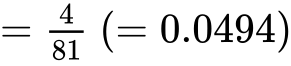
     ***A1A1A1***

probability is      ***A1***

**METHOD 2**

P (5 eaten) =P (M eats 1) P (N eats 4) + P (M eats 0) P (N eats 5)     ***(M1)***

     ***(A1)(A1)***

     ***A1***

***[4 marks]***

**22a.** *[2 marks]*

## Markscheme

\* This question is from an exam for a previous syllabus, and may contain minor differences in marking or structure.

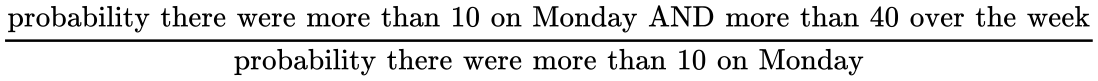
mean for week is 40.88     ***(A1)***

     ***A1***

***[2 marks]***

**22b.** *[5 marks]*

## Markscheme

     ***M1***

possibilities for the numerator are:

there were more than 40 birds on the power line on Monday     ***R1***

11 on Monday and more than 29 over the course of the next 6 days     ***R1***

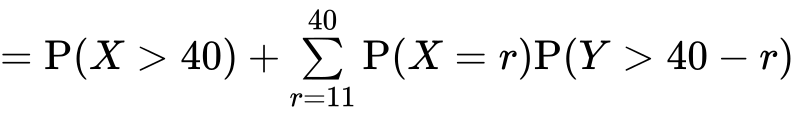
12 on Monday and more than 28 over the course of the next 6 days … until

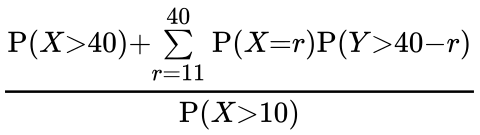
40 on Monday and more than 0 over the course of the next 6 days     ***R1***

hence if *X* is the number on the power line on Monday and *Y*, the number on the power line Tuesday – Sunday then the numerator is     ***M1***







hence solution is      ***AG***

***[5 marks]***

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