# Statistics and Probability\_P\_3\_MS

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

## Markscheme

 (goodness of fit)       ***A1***

***[1 mark]***

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

## Markscheme

***EITHER***

because aim is to measure improvement

***OR***

because the students may be of different ability in the two schools      ***R1***

***[1 mark]***

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

## Markscheme

0.1875 (accept 0.188, 0.19)       ***A1***

***[1 mark]***

**1d.** *[2 marks]*

## Markscheme

2.46        ***(M1)A1***

**Note:** Award ***(M1)A0*** for 2.63.

***[2 marks]***

**1e.** *[4 marks]*

## Markscheme

 : there has been no improvement

 : there has been an improvement       ***A1***

attempt at a one-tailed paired -test     ***(M1)***

-value = 0.423       ***A1***

there is no significant evidence that the students have improved       ***R1***

**Note:** If the hypotheses are not stated award a maximum of ***A0M1A1R0***.

***[4 marks]***

**1f.** *[5 marks]*

## Markscheme

 : there is no difference between the schools

 : school B did better than school A       ***A1***

one-tailed 2 sample -test     ***(M1)***

-value = 0.0984       ***A1***

0.0984 > 0.05 (not significant at the 5 % level) so do not reject the null hypothesis      ***R1A1***

**Note:** The final ***A1***cannot be awarded following an incorrect reason. The final ***R1A1***can follow through from their incorrect -value. Award a maximum of ***A1(M1)A0R1A1*** for -value = 0.0993.

***[5 marks]***

**1g.** *[1 mark]*

## Markscheme

sample too small for the central limit theorem to apply (and -tests assume normal distribution)     ***R1***

***[1 mark]***

**1h.** *[3 marks]*

## Markscheme

 : 

 :         ***A1***

**Note:** Allow hypotheses to be expressed in words.

-value = 0.00157        ***A1***

(0.00157 < 0.01) there is a significant evidence of a (linear) correlation between effort and improvement (so it is reasonable to assume a linear relationship)        ***R1***

***[3 marks]***

**1i.** *[1 mark]*

## Markscheme

(gradient of line of regression =) 6.6      ***A1***

***[1 mark]***

**1j.** *[6 marks]*

## Markscheme

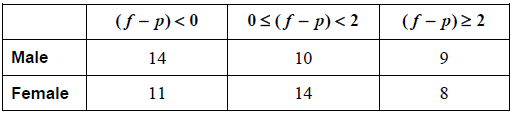
 : improvement and gender are independent

 : improvement and gender are not independent        ***A1***

choice of  test for independence        ***(M1)***

groups first two columns as expected values in first column less than 5        ***M1***

new observed table

        ***(A1)***

-value = 0.581        ***A1***

no significant evidence that gender and improvement are dependent        ***R1***

***[6 marks]***

**1k.** *[2 marks]*

## Markscheme

*For example:*

larger samples / include data from whole school

take equal numbers of boys and girls in each sample

have a similar range of abilities in each sample

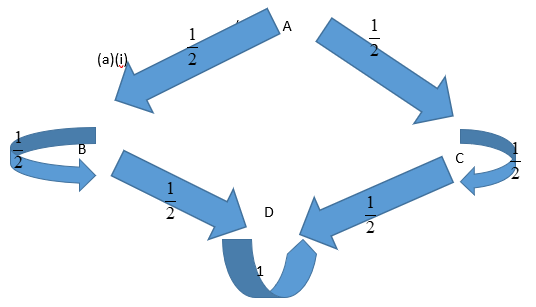
(if possible) have similar ranges of effort                      ***R1R1***

**Note:** Award ***R1***for each reasonable suggestion to improve the validity of the test.

***[2 marks]***

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

## Markscheme

    ***M1A2***

***[3 marks]***

**2b.** *[1 mark]*

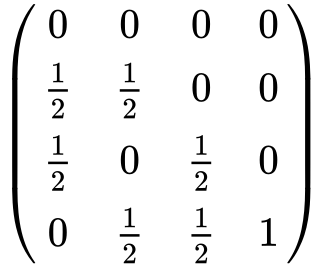
## Markscheme

You must leave the state along one of the edges directed out of the vertex.   ***R1***

***[1 mark]***

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

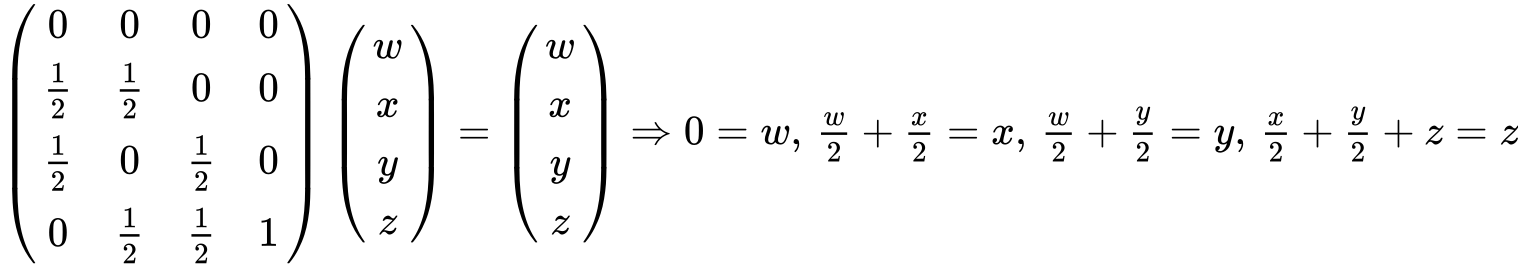
## Markscheme

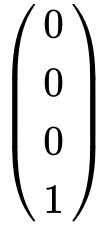
      ***M1A2***

***[3 marks]***

**2d.** *[4 marks]*

## Markscheme

     ***M1***

  since    so steady state vector is  .     ***A1R1A1***

***[4 marks]***

**2e.** *[1 mark]*

## Markscheme

There is a loop with probability of 1 from state D to itself.    ***A1***

***[1 mark]***

**2f.** *[2 marks]*

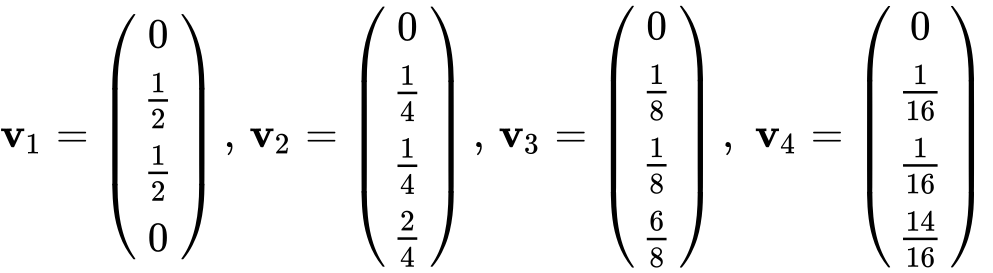
## Markscheme

Let the steady state probability vector be **s** then **Ms** = 1**s** showing that (\lambda  = 1\) is an eigenvalue with associated eigenvector of **s**.    ***A1R1***

***[2 marks]***

**2g.** *[4 marks]*

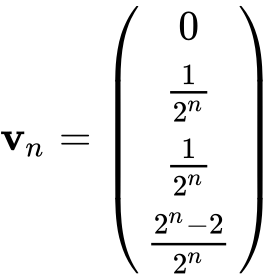
## Markscheme

          ***A1A1A1A1***

***[4 marks]***

**2h.** *[2 marks]*

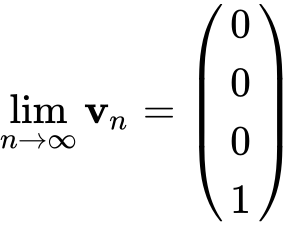
## Markscheme

         ***A2***

***[2 marks]***

**2i.** *[2 marks]*

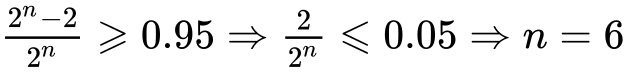
## Markscheme

 the steady state probability vector       ***M1R1***

***[2 marks]***

**2j.** *[4 marks]*

## Markscheme

Require  (e.g. by use of table)      ***R1M1A2***

***[4 marks]***

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

## Markscheme

Area          ***M1A1***

Area = 156 units2          ***A1***

***[3 marks]***

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

## Markscheme

The graph is concave up,         ***R1***

so the trapezoidal rule will give an overestimate.         ***A1***

***[2 marks]***

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

## Markscheme

         ***M1A2***

***[3 marks]***

**3d.** *[1 mark]*

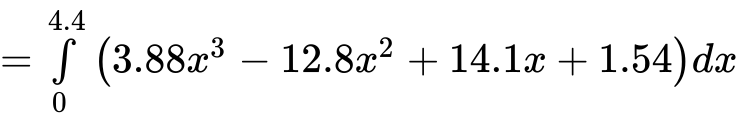
## Markscheme

        ***A1***

***[1 mark]***

**3e.** *[2 marks]*

## Markscheme

Area         ***A1A1***

***[2 marks]***

**3f.** *[2 marks]*

## Markscheme

Area = 145 units2    (Condone 143–145 units2, using rounded values.)      ***A2***

***[2 marks]***

**3g.** *[2 marks]*

## Markscheme

      ***M1***

      ***A1***

      ***AG***

***[2 marks]***

**3h.** *[1 mark]*

## Markscheme

Plot  against .      ***R1***

***[1 mark]***

**3i.** *[5 marks]*

## Markscheme

Regression line is        ***M1A1***

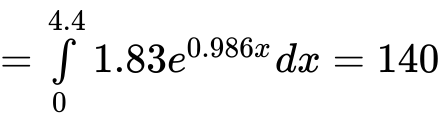
So  gradient = 0.986    ***R1***

       ***M1A1***

***[5 marks]***

**3j.** *[2 marks]*

## Markscheme

Area  units2     ***M1A1***

***[2 marks]***

**4a.** *[1 mark]*

## Markscheme

52.8     ***A1***

***[1 mark]***

**4b.** *[2 marks]*

## Markscheme

      ***M1A1***

***[2 marks]***

**4c.** *[3 marks]*

## Markscheme

      ***M1A1***

      ***M1***

= 31.5       ***AG***

***[3 marks]***

**4d.** *[8 marks]*

## Markscheme

use of a  goodness of fit test      ***M1***

 and       ***A1A1***

      ***A1***

*p*-value = 0.569       ***A2***

Since 0.569 > 0.05        ***R1***

Insufficient evidence to reject . The scores follow a normal distribution.      ***A1***

***[8 marks]***

**4e.** *[2 marks]*

## Markscheme

     ***M1A1***

***[2 marks]***

**4f.** *[6 marks]*

## Markscheme

use of a *t*-test     ***M1***

 and       ***A1***

p-value = 0.180       ***A2***

Since 0.180 > 0.05       ***R1***

Insufficient evidence to reject . There is no difference between males and females.      ***A1***

***[6 marks]***

**4g.** *[6 marks]*

## Markscheme

use of test for proportion using Binomial distribution    ***M1***

 and       ***A1***

 and     ***M1***

So the critical region is       ***A1***

Since 5 < 7        ***R1***

Insufficient evidence to reject . It is not easier to achieve a distinction on the new exam.      ***A1***

***[6 marks]***

**4h.** *[3 marks]*

## Markscheme

using     ***M1***

    ***M1A1***

***[3 marks]***

**4i.** *[3 marks]*

## Markscheme

using     ***M1***

   ***M1A1***

***[3 marks]***

**5a.** *[3 marks]*

## Markscheme

     ***M1A1A1***

***[3 marks]***

**5b.** *[3 marks]*

## Markscheme

       ***A1***

number of new people infected = 247 – 140 = 107     ***M1A1***

***[3 marks]***

**5c.** *[2 marks]*

## Markscheme

use of graph or table      ***M1***

day 9    ***A1***

***[2 marks]***

**5d.** *[1 mark]*

## Markscheme

9.7782(1.7125)1      ***M1***

= 16.7 people    ***AG***

***[1 mark]***

**5e.** *[2 marks]*

## Markscheme

2 parameters ( and ) were estimated from the data.     ***R1***

     ***M1***

= 2    ***AG***

***[2 marks]***

**5f.** *[5 marks]*

## Markscheme

 data is modeled by  and  data is not modeled by      ***A1***

p-value = 0.893    ***A2***

Since 0.893 > 0.05     ***R1***

Insufficient evidence to reject . So data is modeled by     ***A1***

***[5 marks]***

**5g.** *[2 marks]*

## Markscheme

vaccine or medicine might slow down rate of infection     ***R1***

People become more aware of disease and take precautions to avoid infection     ***R1***

*Accept other valid reasons*

***[2 marks]***

**5h.** *[2 marks]*

## Markscheme

1060      ***M1A1***

***[2 marks]***

**5i.** *[1 mark]*

## Markscheme

108      ***A1***

***[1 mark]***

**5j.** *[1 mark]*

## Markscheme

0.560     ***A1***

***[1 mark]***

**5k.** *[2 marks]*

## Markscheme

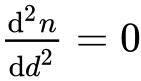
As        ***M1***

      ***A1***

***[2 marks]***

**5l.** *[3 marks]*

## Markscheme

sketch of  or solve         ***M1***

      ***A1***

Day 8      ***A1***

***[3 marks]***