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The Normal Distribution

(Haf 2006)

3. The weights of adult dogs of a certain breed may be assumed to be normally distributed. For male dogs, the mean weight is 30 kg and the standard deviation is 2 kg. For female dogs, the mean weight is 25 kg and the standard deviation is 1.8 kg.
- (a) (i) Find the probability that a randomly chosen male dog weighs between 28 kg and 34 kg.
- (ii) Determine the weight that is exceeded by 1% of female dogs. [8]
- (b) Find the probability that the weight of a randomly chosen male dog exceeds the weight of a randomly chosen female dog. [5]

(Haf 2007)

3. The weights of apples may be assumed to be normally distributed with mean 75 grams and standard deviation 5 grams.
- (a) (i) Find the probability that a randomly chosen apple weighs less than 80 grams.
- (ii) Find the upper quartile of the weights of apples. [6]
- (b) The weights of plums may be assumed to be normally distributed with mean 56 grams and standard deviation 4 grams. Calculate the probability that the combined weight of 3 plums exceeds the combined weight of 2 apples. [6]

(Haf 2008)

3. A farm produces chicken eggs. The weights of these eggs may be assumed to be normally distributed with mean 50 grams and standard deviation 2 grams.
- (a) (i) Find the probability that the weight of a randomly chosen egg is less than 49 grams.
- (ii) Six eggs are chosen at random. Find the probability that exactly three of these eggs weigh less than 49 grams. [6]
- (b) The farm also produces quail eggs whose weights may be assumed to be normally distributed with mean 18 grams and standard deviation 1.2 grams. Calculate the probability that the weight of a randomly chosen chicken egg is more than three times the weight of a randomly chosen quail egg. [5]

(Haf 2009)

2. Roger is a tennis player. When he serves, the speed of the ball may be assumed to be an independent normally distributed random variable with mean 140 km/h and standard deviation 8 km/h.
- (a) He serves three times. Calculate the probability that
- (i) the speed of the first serve exceeds 150 km/h,
 - (ii) the speed of all three serves exceeds 150 km/h. [5]
- (b) Andy is another tennis player. When he serves, the speed of the ball may be assumed to be an independent normally distributed random variable with mean 145 km/h and standard deviation 6 km/h. Andy and Roger each serve once. Calculate the probability that the speed of Roger's serve is greater than the speed of Andy's serve. [5]

(Haf 2010)

1. A large batch of tomatoes is delivered to a packing station. The weights of these tomatoes may be assumed to be independent and normally distributed with mean 106 grams and standard deviation 8 grams.
- (a) Find the probability that the weight of a randomly selected tomato exceeds 120 grams. [3]
- (b) A pack contains 10 randomly selected tomatoes. Find the probability that the total weight of these 10 tomatoes is less than 1 kilogram. [6]

(Haf 2011)

1. The time taken by Alan to drive to work may be assumed to be normally distributed with mean 28 minutes and standard deviation 2 minutes.
- (a) Find the probability that,
- (i) on a particular day, he takes more than 30 minutes to drive to work,
 - (ii) in a particular 5-day week, the mean time taken to drive to work is less than 30 minutes. [8]
- (b) The time taken by Brenda to drive to work may be assumed to be normally distributed with mean 25 minutes and standard deviation 3 minutes. Find the probability that, on a particular day, Brenda takes longer to drive to work than Alan. [5]

(Haf 2012)

2. The weights X kg of male birds of a certain species are normally distributed with mean 4.4 kg and standard deviation 0.2 kg.
- (a) (i) Find the probability that the weight of a randomly selected male bird exceeds 4.5 kg.
- (ii) Determine the 95th percentile of X . [5]
- (b) The weights Y kg of female birds of the same species are normally distributed with mean 2.6 kg and standard deviation 0.15 kg.
- (i) Find the mean and variance of $2Y - X$.
- (ii) Find the probability that the weight of a randomly chosen male bird is more than twice the weight of a randomly chosen female bird.
- (iii) Two male birds and three female birds are placed on a weighing machine whose maximum permissible weight is 16 kg. Find the probability that the maximum weight is exceeded. [13]

(Haf 2013)

1. The random variable X is normally distributed with mean 10 and standard deviation 2.
- (a) (i) Evaluate $P(X \leq 10.5)$.
- (ii) Given that $P(X \geq x) = 0.1$, find the value of x . [5]
- (b) The independent random variable Y is normally distributed with mean 12 and standard deviation 3.
- (i) Evaluate $P(X + 2Y < 36)$.
- (ii) Given that X_1, X_2, X_3 is a random sample from the distribution of X and Y_1, Y_2 is a random sample from the distribution of Y , evaluate
- $$P(X_1 + X_2 + X_3 < Y_1 + Y_2). \quad [11]$$

(Haf 2014)

2. The weights of the oranges sold on a market stall are normally distributed with mean 248 grams and standard deviation 8 grams. The weights of the lemons sold on the market stall are normally distributed with mean 85 grams and standard deviation 1.5 grams.
- (a) Find the upper quartile of the weights of the lemons. [2]
- (b) Ann buys 8 oranges. Calculate the probability that the total weight of her oranges is less than 2000 grams. [5]
- (c) Bethan buys 1 orange and 1 lemon. Calculate the probability that the weight of her orange is more than three times the weight of her lemon. [7]

(Haf 2015)

1. Jim is a tennis player. His serve has a mean speed of 120 miles per hour (mph). He buys a new racket and he wishes to investigate whether or not using this racket changes the mean speed of his serve. He therefore goes to a tennis centre where he hits 10 serves and the measured speeds are as follows (mph).

121.2 119.1 118.3 120.1 117.9 118.3 119.4 119.6 120.3 117.8

You may assume that this is a random sample from a normal distribution with a standard deviation of 1.2.

- (a) State suitable hypotheses for his investigation. [1]
- (b) Determine the p -value of these results and state your conclusion in context. [8]
2. In a certain population, the weights of the men are normally distributed with mean 82 kg and standard deviation 2.5 kg. The weights of the women are normally distributed with mean 65 kg and standard deviation 2 kg.
- (a) Calculate the 95th percentile of the men's weights. [2]
- (b) Determine the probability that the weight of a randomly chosen woman lies between 64 kg and 68 kg. [6]
- (c) One morning, 3 men and 4 women hire a boat which has a safety limit of 500 kg. Calculate the probability that their combined weight exceeds the safety limit. You may assume that the weights of the 3 men and 4 women are independent. [6]

(Haf 2016)

3. For a certain breed of dog, the weights of the males are normally distributed with mean 40 kg and standard deviation 2.5 kg. The weights of the females are normally distributed with mean 32 kg and standard deviation 1.5 kg.
- (a) Calculate the upper quartile of the weights of male dogs of this breed. [2]
- (b) A random selection is made of 3 males and 2 females of the breed. Calculate the probability that
- (i) the combined weight of the 5 dogs exceeds 185 kg,
- (ii) the combined weight of the 3 males is less than twice the combined weight of the 2 females. [12]

(Haf 2017)

3. A grocer sells apples and pears. The weights of the apples may be assumed to be normally distributed with mean 110 grams and standard deviation 14 grams. The weights of the pears may be assumed to be normally distributed with mean 160 grams and standard deviation 16 grams.
- (a) Find the 90th percentile of the weights of the apples. [2]
 - (b) George buys 10 apples. Find the probability that the total weight of his 10 apples is less than 1000 grams. [6]
 - (c) Sue buys 3 apples and 2 pears. Find the probability that the combined weight of her 3 apples is more than the combined weight of her 2 pears. [7]

(Haf 2018)

2. The weights of hens may be assumed to be normally distributed with mean 2.6 kg and standard deviation 0.15 kg. The weights of cockerels may be assumed to be normally distributed with mean 4.2 kg and standard deviation 0.25 kg.
- (a) Find the probability that the weight of a randomly chosen cockerel is more than twice the weight of a randomly chosen hen. [7]
 - (b) If 2 cockerels and 5 hens are chosen at random, find the probability that their total weight is more than 21 kg. [6]