

Random variables, distributions, pobability and proportions

Probability: For any event  $A$  and its complement  $A$ , and event  $B$

$$P(A) + P(\bar{A}) = 1$$
$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$
$$P(A \cap B) = P(A) P(B|A) = P(B) P(A|B)$$

In a Bernoulli trial:  $\bar{x}$  is the sample proportion  $\hat{p}$ ,  
Mean  $\mu = p$  and standard deviation  $\sigma = \sqrt{p(1-p)}$

$$P(X = x) = \binom{x}{n} p^x (1-p)^{n-x}$$
$$\text{Mean } \mu = np \text{ and standard deviation } \sigma = \sqrt{np(1-p)}$$

Expected value: If  $X$  is a discrete random variable,  
 $E(x) = \sum p_i x_i$ , where  $x_i$  are the possible values of  $X$  and  $p_i = P(X = x_i)$

If  $X$  is a continuous random variable,  
 $E(x) = \int_{-\infty}^{\infty} xp(x)dx$ , where  $p(x)$  is the probability density function of  $X$ .

Variance: If  $X$  is a discrete random variable,  
 $Var(x) = \sum p_i (x_i - \mu)^2$ , where  $\mu = E(X)$  is the expected value

If  $X$  is a continuous random variable,  
 $Var(x) = \int_{-\infty}^{\infty} (x - \mu)^2 p(x)dx$ .

A confidence interval for the proportion,  $p$ , of a population is:

$$\left( \hat{p} - z \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}, \hat{p} + z \sqrt{\frac{\hat{p}(1-\hat{p})}{n}} \right)$$

where  $\hat{p}$  is the sample mean,  
 $n$  is the sample size and  
 $z$  is the cut-off value on the standard normal distribution corresponding to the confidence level.

Margin of error:  $E = z \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$  is the half-width of the confidence interval

Note: Any additional formulas identified by the examination panel as necessary will be included in the body of the particular question.

MATHEMATICS METHODS  
ATAR COURSE  
FORMULA SHEET  
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Measurement

Circle:	$C = 2\pi r = \pi D$ , where $C$ is the circumference, $r$ is the radius and $D$ is the diameter $A = \pi r^2$ , where $A$ is the area
Triangle:	$A = \frac{1}{2}bh$ , where $b$ is the base and $h$ is the perpendicular height
Parallelogram:	$A = bh$
Trapezium:	$A = \frac{1}{2}(a + b)h$ , where $a$ and $b$ are the lengths of the parallel sides
Prism:	$V = Ah$ , where $V$ is the volume and $A$ is the area of the base
Pyramid:	$V = \frac{1}{3}Ah$
Cylinder:	$S = 2\pi rh + 2\pi r^2$ , where $S$ is the total surface area $V = \pi r^2h$
Cone:	$S = \pi rs + \pi r^2$ , where $s$ is the slant height $V = \frac{1}{3}\pi r^2h$
Sphere:	$S = 4\pi r^2$ $V = \frac{4}{3}\pi r^3$

Exponentials

Index laws:	For $a, b > 0$ and $m, n$ real,
	$a^m b^n = (a b)^m$ <span style="margin-left: 100px;"><math>a^m a^n = a^{m+n}</math></span> <span style="margin-left: 100px;"><math>(a^m)^n = a^{mn}</math></span>
	$a^{-m} = \frac{1}{a^m}$ <span style="margin-left: 100px;"><math>\frac{a^m}{a^n} = a^{m-n}</math></span> <span style="margin-left: 100px;"><math>a^0 = 1</math></span>
	For $a > 0$ and $m$ an integer and $n$ a positive integer, $a^{\frac{m}{n}} = \sqrt[n]{a^m} = (\sqrt[n]{a})^m$

Logarithms

For $a, b, y, m$ and $n$ positive real and $k$ real:	
$1 = a^0 \Leftrightarrow \log_a 1 = 0$	$y = a^x \Leftrightarrow \log_a y = x$
$\log_a mn = \log_a m + \log_a n$	$a = a^1 \Leftrightarrow \log_a a = 1$
$\log_e x = \ln x$	$\log_a (m^k) = k \log_a m$

Calculus

Differentiation:	If $f(x) = y$ then $f'(x) = \frac{dy}{dx}$	If $f(x) = \ln x$ then $f'(x) = \frac{1}{x}$
	If $f(x) = x^n$ then $f'(x) = nx^{n-1}$	If $f(x) = \sin x$ then $f'(x) = \cos x$
	If $f(x) = e^x$ then $f'(x) = e^x$	If $f(x) = \cos x$ then $f'(x) = -\sin x$
Product rule:	If $y = f(x) g(x)$ then $y' = f'(x) g(x) + f(x) g'(x)$	or If $y = uv$ then $\frac{dy}{dx} = \frac{du}{dx} v + u \frac{dv}{dx}$
Quotient rule:	If $y = \frac{f(x)}{g(x)}$ then $y' = \frac{f'(x) g(x) - f(x) g'(x)}{(g(x))^2}$	or If $y = \frac{u}{v}$ then $\frac{dy}{dx} = \frac{du}{dx} v - u \frac{dv}{dx} \over v^2$
Chain rule:	If $y = f(g(x))$ then $y' = f'(g(x)) g'(x)$	or If $y = f(u)$ and $u = g(x)$ then $\frac{dy}{dx} = \frac{dy}{du} \times \frac{du}{dx}$
Powers:	$\int x^n dx = \frac{x^{n+1}}{n+1} + c, n \neq -1$	
Exponentials:	$\int e^x dx = e^x + c$	
Natural logarithm:	$\int \frac{1}{x} dx = \ln  x  + c$	and $\int \frac{f'(x)}{f(x)} dx = \ln (f(x)) + c$
Trigonometry:	$\int \sin x dx = -\cos x + c$	and $\int \cos x dx = \sin x + c$
Fundamental Theorem of Calculus:	$\frac{d}{dx} \left( \int_a^x f(t) dt \right) = f(x)$	and $\int_a^b f'(x) dx = f(b) - f(a)$
Incremental formula:	$\delta y \approx \frac{dy}{dx} \delta x$	
Exponential growth and decay:	If $\frac{dy}{dt} = ky$ , then $y = Ae^{kt}$	