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HSC Mathematics Revision Questions

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1. A chord in a circle of radius 8cm is subtended by an angle of 40° at the centre. Find (a) the length of the chord (b) the area of the minor segment.

2. Find the area of a sector bounded by radii of 15cm and arc of length 20cm.

3. Sketch the following for $0 \leq \theta \leq 2\pi$: (a) $4\sin(3\theta)$ (b) $2 - 2\cos(\theta)$

4. Differentiate: (a) $\sin(x^3 + 5x)$ (b) $\cos(\sqrt{x})$ (c) $\tan(\frac{1}{x})$

5. Find the indefinite integrals: (a) $\int 10\sin 5x\mathrm{d}x$ (b) $\int -2\cos(3x)\mathrm{d}x$ (c) $\int 6x^2\ \sec^2(x^3)\mathrm{d}x$

6. Solve (a) $\log_2 32 = x$ (b) $\log_5 x = -2$ (c) $\log_x 9 = 0.5$

7. Simplify (a) $\log_6 9 + \log_6 4$ (b) $\log_3 5 - \log_3 45$

8. If $\log_a 2 = 0.3562$ and $\log_a 3 = 0.5646$ find: (a) $\log_a \frac{2}{3}$ (b) $\log_a 72$
   (c) $\log_a 4a$ (d) $\log_a a^4$

9. Solve (a) $4^{2x-3} = 13$ (b) $5^{x^2} = 62$

10. What is the domain of $y = \ln(2 - x)$? Sketch the function.

11. Differentiate:(a) $x^2\mathrm{e}^{2x}$ (b) $\ln(\sqrt{x})$ (c) $\ln(x^2 + 1)$ (d) $e^{\sin x}$

12. Evaluate: (a)$\int_2^5 \mathrm{e}^{5x-2}dx$ (b) $\int_{-1}^{1} \frac{x^2}{x^3+6}dx$

13. Find the equation of the normal to $y = x\cos(x)$ at the point $x = \pi$.

14. Find the area bounded by $y = \cos 2\theta$, the θ-axis and the lines $\theta = \frac{\pi}{6}$ and $\theta = \frac{\pi}{3}$.

15. Find the volume when the curve $y = \frac{1}{2\sqrt{x}}$ is rotated around the x-axis from $x = 2$ to $x = 4$.

16. Find the stationary and inflexion points on the curve $y = \sin\ x + 2\cos\ x$. Determine the nature of the stationary point.

17. Differentiate: (a) $\ln(\cos\ x)$ (b) $\frac{\tan\ x}{\mathrm{e}^{2x}}$ (c) 2^x (d) $\log_{10} x^3$

18. Differentiate $x\ln(x)$ and hence find $\int \ln\ x dx$

19. Over a 10-year period commencing on 1 January 1995 the population $P(t)$ in a certain town was modelled by the equation

$$P(t) = \frac{1000}{1 + 0.02t}$$

where t is time in years, $0 \le t \le 10$.
Find: (a) the population on 1 January 1995 (b) the population on 31 December 2004 (c) the rate of change in the population on 1 January 2000

20. After a thunderstorm the rate of increase in water stored in a dam is given by $R(t) = \frac{500}{t+1}$ litres/day where t is in days.
(a) If the dam contained 2000 litres before the storm calculate the amount of water in the dam when $t = 6$.
(b) What is the maximum rate of flow and for what value of t does this occur?

21. The rate of growth in the number of bacteria is proportional to the number present. If the initial population of 100 grew to 200 after 3 hours find: (a) the population after 5 hours
(b) the population after 9 hours
(c) the time, to the nearest minute, for the population to reach 1000
(d) the rate of growth in the population after 5 hours

22. The half-life of a radioactive material is 50 years. How long will it take until only 10% of the original material is present, assuming exponential decay?

23. The rate of growth in the number of locusts in a colony is proportional to the population present. If there were 5000 locusts 2 days after observations began and 12000 after 5 days, calculate
(a) the number of locusts in the population when observations began
(b) the number of locusts after 10 days
(c) how long it will take for the population to reach 100000
(d) whether the model used to answer the previous questions is applicable over an extended period of time.

24. The displacement of a particle in metres at time t seconds is given by
$x = \ln(t^2 - 3t + 4)$. Find: (a) the initial displacement
(b) the initial velocity
(c) the direction in which the particle is initially moving
(d) whether the particle comes to rest and if so, its location
(e) the distance travelled in the first 2 seconds

(f) the acceleration at $t = 1$
(g) a description of the velocity as time increases.

25. Find the distance travelled by a particle between $t = \frac{\pi}{6}$ and $\frac{5\pi}{12}$ if the velocity is given by $v = \sin 4t$ cm/s.

26. The acceleration of a particle is given by $\ddot{x} = 6\cos 2t\ m/s^2$.
If the particle momentarily stopped at $x = \pi$ metres when $t = \frac{\pi}{4}$ sec, find the exact displacement at $t = \pi$ sec.

27. The displacement of a particle in metres is given by $x = 4t - 3\sin 2t$.
Find the maximum velocity of the particle.

28. The velocity, in metres/sec, of a body that is initially at the origin is given by

$$\dot{x} = \frac{e^{2t}}{9 + e^{2t}}$$

Find:
(a) an expression for acceleration
(b) an expression for displacement
(c) the initial velocity
(d) a full description the motion as time increases
(e) graph velocity against time