1. Write your class, class number in the spaces provided on this cover.

2. This paper consists of TWO sections, A and B. Section A carries 80 marks, Section B carries 40 marks.

3. Attempt ALL questions in this paper. Write your answers in the spaces provided in this Question-Answer Book.

4. Unless otherwise specified, numerical answers should either be exact or correct to 3 significant figures.

5. All the working steps should be shown clearly.

6. The diagrams in this paper are not necessarily drawn to scale.

7. Total marks in this paper is 120.
SECTION A  Short Questions.  (80 marks)

1. (a) Simplify \( \frac{(2a^{-2})^3}{8a^3} \), and express the answer with positive indices \( \text{ (5 marks) } \)

\[
\frac{a^3 - 2b^3}{3a - 3b}
\]

\[
\text{(2) } \frac{4a^{-2}}{2a^{-3}} = \frac{1}{2} a \quad \text{1 M}
\]

\[
= \frac{1}{2} a^{-2} \quad \text{1 A}
\]

\[
= \frac{1}{2} a^{-1} \quad \text{1 A}
\]

\[
= \frac{2a^{-2}}{4} \quad \text{1 A}
\]

(b) Simplify \( \frac{a^2 - 6b^b}{3a - 6b} \)

\[
= \frac{a^2 - (2b)^2}{3(a - 2b)} \quad \text{1 A + 1 M}
\]

\[
= \frac{3(a + 2b)}{3(a - 2b)} \quad \text{1 M}
\]

\[
= \frac{a + 2b}{a - 2b} \quad \text{1 A}
\]
2. A man bought a car at $240000 in 2005 and paid $3500 to insure it for the first year. For each of the next four years, the insurance would cost him 10% less than for the previous year unless he made an insurance claim. If he made an insurance claim, the insurance would cost 20% more than for the previous year.

(a) Find the total cost for insurance for the first four years assuming that he did not make any claims.

(6 marks)

\[
\text{(a) The total cost for insurance:} \\
= 3500 + 3500(1-10\%) + 3500(1-10\%)^2 + 3500(1-10\%)^3 \\
= 3500 + 3150 + 2835 + 2428.5 \\
= 12036.5 \text{ or } 12000 \text{ (3 s.f.))} \\
\]

(6 marks)

(b) If he did make an insurance claim during the fourth year, find the cost of his insurance for the fifth year.

(6 marks)

\[
\text{(b) The cost of his insurance for the fifth year:} \\
= 3500 (1-10\%)^4 (1+20\%) \\
= 2214.8 \text{ (1 s.f.))} \\
= 3061.8 \text{ or } 3060 \text{ (2 s.f.))} \\
\]
3. At 1:00 p.m., a typhoon K is 100 km from a city C. In the direction of N30°E, K then moves in the direction of S45°W at a speed of 20 km/h, as shown in the figure. Find
(a) the compass bearing of K from C when K is closest to C. (6 marks)
(b) the shortest distance between K and C. (3 marks)
(c) the time at which this occurs. (3 marks)

(a) \[
\angle NKC = 12^\circ \\
\angle NCK' = 90^\circ - 12^\circ - 30^\circ \\
= 48^\circ
\]

\[\therefore \text{Compass bearing of } K \text{ from } C \text{ is } N48^\circ W.\]

(b) \[
\frac{CK'}{100} = \sin(45^\circ - 30^\circ) \\
CK' = 100 \times \sin 15^\circ \\
CK' = 25.9 \text{ km (3 sig. fig.)}
\]

\[\therefore \text{The shortest distance between } K \text{ and } C \text{ is } 25.9 \text{ km.}\]

(c) \[
KK' = 100 \cos 15^\circ \\
KK' = 96.6 \text{ km}
\]

Time taken = \[
\frac{96.6}{20} = 4.83 \text{ h (3 sig. fig.)}
\]

\[\therefore \text{The time would be at } 5:40 \text{ p.m.}\]
4. In the figure, B, A and O are three collinear points on the ground. OT is a tower. A person at A views T at an angle of elevation 45°. When he is at B, the angle of elevation of T is 30°. OT = h m and AB = 50 m
(a) Express OA and OB in terms of h.
(4 marks)

(b) Hence find the height of the tower.
(6 marks)

\[
\begin{align*}
(A) \quad \frac{OT}{OA} &= \tan 45° \\
OT &= OA \tan 45° \\
&= h \\
\therefore \quad OA &= OT \\
&= h \\
\therefore \quad OB &= OA + AB \\
&= h + 50 \\
\end{align*}
\]

(b) \[
\begin{align*}
\frac{h}{h + 50} &= \tan 30° \\
h &= (h \tan 30° + 50 \tan 30°) \\
&= \left( h \left(\frac{1}{\sqrt{3}}\right) + 50 \left(\frac{1}{\sqrt{3}}\right) \right) \\
&= \left( h \left(\frac{1}{\sqrt{3}}\right) + 50 \left(\frac{1}{\sqrt{3}}\right) \right) \\
&= \frac{h}{\sqrt{3}} + \frac{50}{\sqrt{3}} \\
\therefore \quad OA &= 68.3 \text{ m (3 sig. fig.)} \\
\end{align*}
\]

\[
\begin{align*}
\therefore \quad \text{The height of the tower is 68.3 m} \\
\end{align*}
\]
5. The figure shows a solid, whose upper part is a cone, and lower part is a hemisphere of same radius. It is given that the slant height of the cone is 13 cm and the base radius is 5 cm. Find the volume and the total surface area of the solid figure. Express the answers in terms of \( \pi \). (10 marks)

\[
\text{The height of the cone } = \sqrt{13^2 - 5^2} = 12 \text{ cm}
\]

\[
\text{Volume of the solid } = \frac{1}{3} \pi (5)^2 (12) + \frac{2}{3} \pi (5)^3
\]

\[
= 100 \pi + \frac{500}{3} \pi = \frac{500}{3} \pi \text{ cm}^3
\]

\[
\text{Total surface area } = \pi (5)(13) + 2 \pi (5)^2
\]

\[
= 115 \pi \text{ cm}^2
\]
6. The figure shows a rectangle based right frustum, where \( AB = 6 \) cm, \( BC = 8 \) cm, \( PQ = 3 \) cm and \( MX = 5 \) cm

(a) Find \( NY \). (3 marks)

(b) Find the volume of the frustum. (5 marks)

\[ \text{(a) } AR = \frac{8}{3} \text{ cm} \]

\[ NY = \sqrt{8^2 - (\frac{8}{3} - \frac{5}{2})^2} \]

\[ = \frac{131}{12} \] cm

\[ = 4.38 \text{ cm} \] (3 sig. fig.)

\[ \text{(b) } \frac{V_H}{\sqrt{V_H + xV}} = \frac{2}{4} \]

\[ 2V_H = \sqrt{V_H + 4.38} \]

\[ V_H = 4.38 \text{ cm}^3 \]

\[ \text{Volume of the frustum} \]

\[ = \frac{1}{3} (6 \times 8 \times 3.16 - \frac{1}{3} (3 \times 4) \times 4.38) \]

\[ = 128 \text{ cm}^3 \] (3 sig. fig.)
7. In the figure, ABCD is a parallelogram, AE//FC, and diagonal BD intersects AE and FC at M and N respectively.

(a) Show that AAMB ≅ ACND.  
(b) Write down 4 more pairs of congruent triangles.

(a) \[ \triangle AEM \cong \triangle CDM \]
\[ \triangle ABE \cong \triangle CDF \]
\[ \triangle ABM \cong \triangle CDN \]
\[ \triangle ABE \cong \triangle ADF \]

(b) \[ \triangle BNE \cong \triangle DNF \]
\[ \triangle BNC \cong \triangle DMA \]
\[ \triangle BDC \cong \triangle DRA \]
\[ \triangle BAE \cong \triangle DCF \]
8. (a) Solve the inequality \( \frac{3(x + 2)}{2} > \frac{x - 4}{3} \) (6 marks)

(b) Give the least integral solution satisfying \( \frac{3(x + 2)}{2} > \frac{x - 4}{3} \) (2 Marks)

\[
\begin{align*}
(a) & \quad \frac{3x + 6}{2} > \frac{x - 4}{3} \\
& \quad \frac{9x + 18}{2} > 2x - 8 \\
& \quad 9x - 2x > -8 - 18 \\
& \quad 7x > -26 \\
& \quad x > -\frac{26}{7} \\
& \quad 2M + 1A \\
& \quad 1A \\
& \quad 1A \\
& \quad 1A \\

(b) & \quad \text{The solution} - 3 \\
& \quad 2A
\end{align*}
\]
SECTION B  Long Questions.  (40 marks)

9. in the figure, ABCD is a quadrilateral. Given that \( AE \sim EC \) and \( BE = ED \).

\[ \begin{array}{c}
\text{Diagram}
\end{array} \]

(a) Find the coordinate of \( E \) and \( D \).  

\[ \text{Coordinate of } E = \left( \frac{4+9}{2}, \frac{5+7}{2} \right) \]
\[ = (4.5, 7) \]

\[ \text{Let } \text{Coordinate of } D \text{ be } (x, y) \]
\[ \begin{cases} 
  x + 3 = 4.5 \\
  y + 10 = 7 \\
  x = 6 \\
  y = 4 
\end{cases} \]
\[ \therefore \text{Coordinate of } D \text{ is } (6, 4) \]

(b) Find the equation of \( AD \).  (Express the answer in general form)

\[ \frac{y - 5}{x - 1} = \frac{5 - 8}{1 - 6} \]
\[ x - 1 = -3y + 25 \]
\[ x + 3y - 26 = 0 \]
(c) Find the slopes of AB, BC, CD and AD. Hence, show ABCD is a parallelogram. (4 marks)

\[
\begin{align*}
\text{Slope of AB} &= \frac{10-7}{1-1} = \frac{3}{1} \\
\text{Slope of BC} &= \frac{10-7}{1-2} = -\frac{3}{1} \\
\text{Slope of CD} &= \frac{7-4}{1-2} = 3 \\
\text{Slope of AD} &= \frac{1-7}{1-2} = 4 \\
\end{align*}
\]

2 A

\[
AB \parallel CD \quad \text{and} \quad BC \parallel AD \quad 1 M
\]

\[.\text{ABCD is a parallelogram} \quad 1 A
\]

(d) Join OA and OD. Using the result of (b), find the area of \(\triangle OAD\). (8 marks)

Let \((a,0)\) and \((0,b)\) be the points of \(x\)-intercept and \(y\)-intercept respectively.

\[
\begin{align*}
2a + 5(0) - 26 &= 0 \quad 1 M \\
2a &= 26 \\
\therefore a &= 13 \quad 1 A
\end{align*}
\]

\[
\begin{align*}
0 + 5(b) - 26 &= 0 \quad 1 M \\
b &= \frac{26}{5} \quad 1 A
\end{align*}
\]

\[
\text{Area of } \triangle OAD : \frac{1}{2} \left(13 \times \frac{26}{5}\right) - \frac{1}{2} \left(1 \times \frac{26}{5}\right) - \frac{1}{2} (26 \times 4) \quad 2 M
\]

\[
= 67.6 - 2.6 - 52 \quad 1 A
\]

\[
= 13 \quad \text{sq. units} \quad 1 A
\]

* No unit, 1 mark deducted.
10. In the figure, $ABFE$, $BCGF$ and $CDHG$ are 3 identical squares with sides equal to 1 cm. Let $\angle DEF = a, \angle DFG = b$ and $\angle DGH = c$.

(a) Find $EB$, $BD$, $FG$ and $DG$.

$$EB = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ cm}$$

$$BD = 2 \text{ cm}$$

$$FG = 1 \text{ cm}$$

$$DG = \sqrt{1^2 + 1^2} = \sqrt{2} \text{ cm}$$

(b) Show that $\triangle DFG \sim \triangle DEB$.

$$\angle DEB = \angle FGC \quad \text{(prop. of sq.)}$$

$$\therefore \angle DEB = 45^\circ$$

$$\angle DBF = 45^\circ \quad \text{(prop. of sq.)}$$

$$\therefore \angle DBF = 45^\circ$$

$$\therefore \angle DGF = \angle DBF$$

$$\frac{GF}{EB} = \frac{1}{2}$$

$$\frac{FG}{EB} = \frac{1}{2}$$

$$\therefore \triangle DFG \sim \triangle DEB \quad \text{(Ratio of 2 sides, inc. L)}$$

$$\therefore \angle DFG \sim \angle DEB$$

$$\therefore \angle DFB \sim \angle DEB$$
(c) Using the result of (b), show that $\angle BCE = a + b$.

\[ \angle DZE = \angle DEG \quad (\text{corr. } LS, \sim \angle A) \quad \text{[A + 1]} \]

\[ \therefore \angle DEF = 90^\circ \quad \text{[A]} \]

\[ \angle BEF = \angle DEE + \angle DZE \quad \text{[A]} \]

\[ \therefore \angle BEF = a + b \]


(d) Hence show that $a + b + c = 90^\circ$.

\[ \angle BEF = 45^\circ \quad (\text{prop. of } 45^\circ) \quad \text{[A + 1]} \]

\[ a + b = 45^\circ \]

\[ c = 45^\circ \quad (\text{prop. of } 45^\circ) \quad \text{[A]} \]

\[ \therefore a + b + c = 90^\circ \quad \text{[1]} \]

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End of Paper