2013 EM Paper 2. V 1.0

1(a)(i) $s = ut + \frac{1}{2}at^2$.

when $u=0$, $a=0.6$ and $t=15$.

$s = (0)(15) + \frac{1}{2}(0.6)(15)^2$

$= 67.5$ #

(ii) $s = ut + \frac{1}{2}at^2$

$2s = 2ut + at^2$.

$a = \frac{2s-2ut}{t^2}$ #

b (i) $18p^2 - 8 = 2[9p^2 - 4]$

$= 2(3p-2)(3p+2)$.

(ii) $\frac{18p^2-8}{6p^2-14p-12} = \frac{2(3p-2)(3p+2)}{2(3p+2)(p-3)}$

$= \frac{3p-2}{p-3}$. #

(c) $\frac{6}{3-2x} - \frac{4}{2-x}$.

$= \frac{6(2-x) - 4(3-2x)}{(3-2x)(2-x)}$

$= \frac{12-6x-12+8x}{(3-2x)(2-x)}$

$= \frac{2x}{(3-2x)(2-x)}$ #

2(a)(i) Amt of deposit $= \frac{1}{5} \times 78500 = \$15700$

Amt of 36 monthly payments $= 1900 \times 36 = \$68400.$

Total Amt for the car $= \$15700 + \$68400 = \$84100$ #

(ii) Value of Car after End 1 Yrs $= 0.9 \times 78500$
$= \$70,650$

Value of Car after End 2 Yrs $= 0.9 \times 70650$
$= \$63585$

Value of Car after End 3 Yrs $= 0.9 \times 63585$
$= \$57226.50$

Beg Yr 0
End 1 Yr
Beg Yr 1
End 2 Yr
Beg Yr 2.
End 3 Yr
Beg Yr 3.

Amt reduced $= 78500 - 57226.50$
$= \$21273.50$

% reduction $= \frac{21273.50}{78500} \times 100 = 27.1\%$ #

(b) Amt need to spend on fuel one year $= \frac{12000}{100} \times 4.5 \times 1.95$
$= \$1053$ #

(c) If he pays total amt at the start of the year,
then monthy payment $= \frac{565}{12} = \$47.0833 \approx \$47.83$ #

If he make 12 equal monthly payment,
then monthly payment $= \frac{565 \times 1.07}{12} = \$50.379 \approx \$50.38$ #

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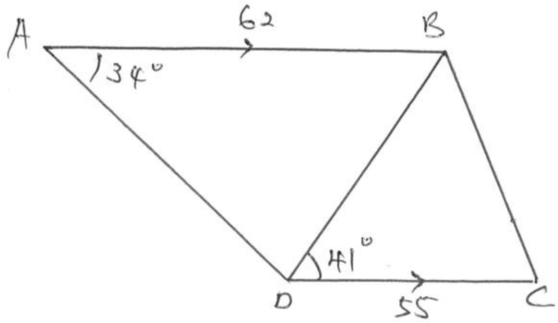
3(a) (i)



$\angle BAD + \angle BDC + \angle ADB = 180°$ (Int $\angle$s)

$\therefore \angle ADB = 180° - 34 - 41$

$= 105°$

(ii) In $\triangle ADB$, using sine Rule:

$$\frac{BD}{\sin \angle DAB} = \frac{AB}{\sin \angle ADB}$$

$$\frac{BD}{\sin 34°} = \frac{62}{\sin 105°}$$

$$BD = \frac{62}{\sin 105°} \times \sin 34°$$

$= 35.892$

≈ 35.9 mm (cor to 3 sig fig)

(iii) In $\triangle ABD$,

$\angle ABD = \angle BDC = 41°$ (alt $\angle$s)

Area of trapezium ABCD

$= $ Area of $\triangle ABD$ + Area of $\triangle BDC$.

$= \frac{1}{2}(AB)(DB) \sin \angle ABD + \frac{1}{2}(BD)(CD) \sin \angle BDC$

$= \frac{1}{2}(62)(35.892) \sin 41° + \frac{1}{2}(35.892)(55) \sin 41°$.

$= 1377.5$

≈ 1380 mm^2 (cor to 3 sig fig) #

(b) Let A_E be the area of the enlarged logo.

Then $\frac{A_E}{\text{Area of trapezium}} = \left(\frac{88}{55}\right)^2$

$$A_E = \left(\frac{88}{55}\right)^2 \times 1377.5$$

$= 3526.4$

≈ 3530 mm^2 (cor to 3 sig fig).

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4(a) (i) $T_4 = 4^2 + 8 = 24$

(ii) $T_1 = 1^2 + 2 = 1^2 + 2(1)$
$T_2 = 2^2 + 4 = 2^2 + 2(2)$
$T_3 = 3^2 + 6 = 3^2 + 2(3)$

$\therefore T_n = n^2 + 2n$

(iii) $T_{50} = 50^2 + 2(50) = 2600.$

(b) Given $-5, -1, 3, 7$

$\Rightarrow -9+4(1), -9+4(2), -9+4(3), -9+4(4).$

$\therefore P_n = -9+4n.$

(c) Given $\frac{P_n}{T_n} = \frac{1}{5}.$

$\frac{-9+4n}{n^2+2n} = \frac{1}{5}.$

$-45+20n = n^2+2n.$

$n^2 - 18n + 45 = 0.$

$(n-15)(n-3) = 0.$

$\therefore n = 3, 15$ #

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5 (a). $h = 80 + 16t - 5t^2$.

when $t = 6$

$h = 80 + 16(6) - 5(6)^2$

$= -4$.

c(i) Maximum height $= 92.8$ m.

(ii) When $h = 85$, $t = 0.35$s, 2.8s.

length of time for the stone to be more than 85 m above sea level $= 2.8 - 0.35$

≈ 2.45 s #

(iii) Time taken for the stone to hit the water (when $h = 0$)

≈ 5.9 s.

(d) Gradient of the curve at $(4, 64)$

$= \dfrac{100 - 20}{2.53 - 5.87}$

$= -23.95$

≈ -24.0 ((corr to 3 sig fig)

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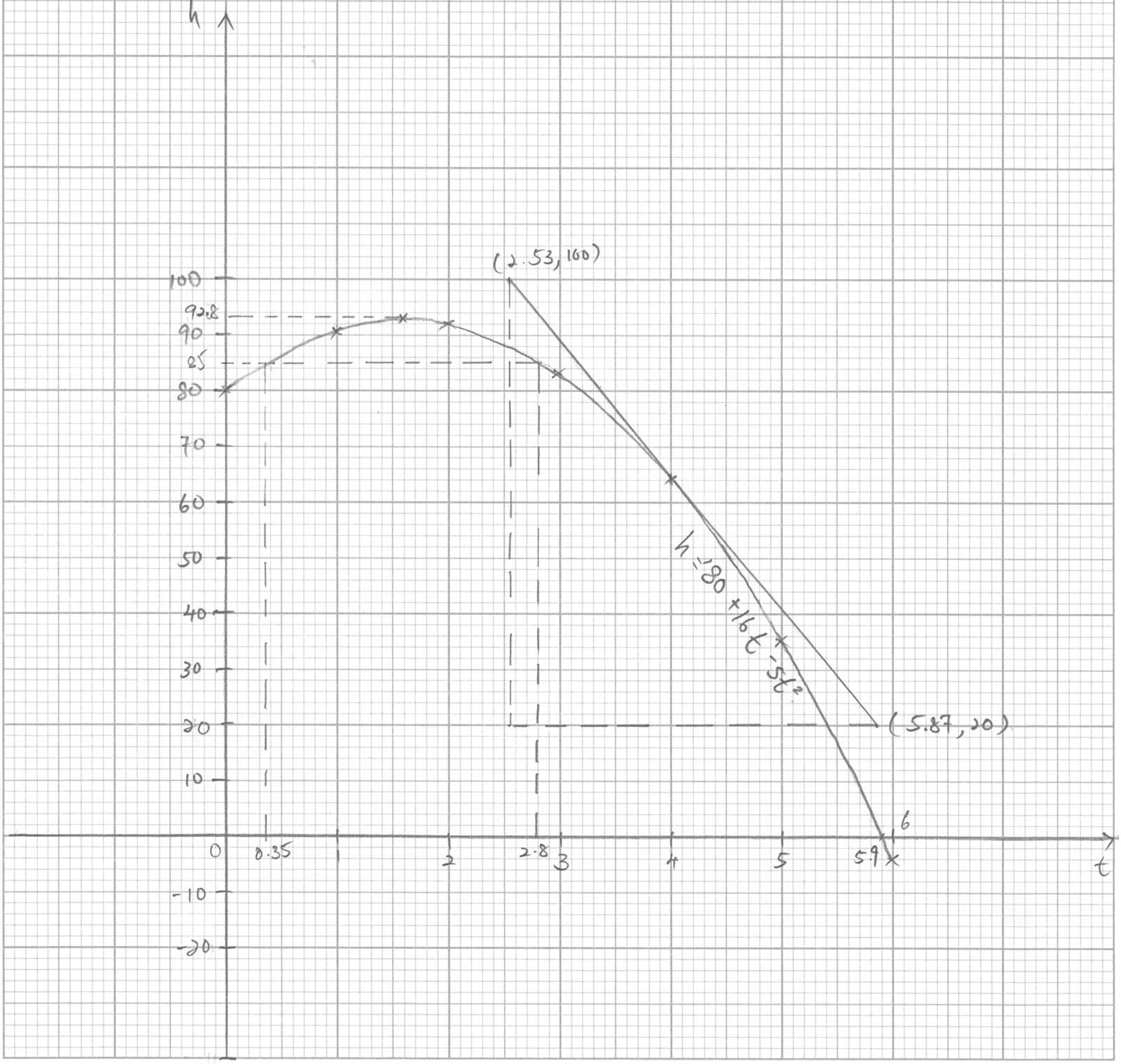
Scale: 2cm represent 1 sec
1 cm represent 10m



2 MM - SQUARE 20 CM X 24 CM 40 S

2013 EM Paper 2 V1.0

6(a). $\vec{OL} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$. ($L(3,2)$)

(i) Then $\vec{OM} = \vec{OL} + \begin{pmatrix} -6 \\ 4 \end{pmatrix}$

$= \begin{pmatrix} 3 \\ 2 \end{pmatrix} + \begin{pmatrix} -6 \\ 4 \end{pmatrix}$

$= \begin{pmatrix} -3 \\ 6 \end{pmatrix}$

$\therefore$ Coordinates of M is $(-3, 6)$.

(ii). Gradient LM $= \dfrac{6-2}{-3-3} = \dfrac{4}{-6} = -\dfrac{2}{3}$.

$y = -\frac{2}{3}x + c$.

sub $x = 3$, $y = 2$.

$2 = -\frac{2}{3}(3) + c$

$c = 4$.

$\therefore$ Equation of LM : $y = -\frac{2}{3}x + 4$

(iii) Given $\vec{MN} = 2\vec{ML}$

$\vec{ON} - \vec{OM} = 2(\vec{OL} - \vec{OM})$.

$\vec{ON} - \vec{OM} = 2\vec{OL} - 2\vec{OM}$

$\vec{ON} = 2\vec{OL} - \vec{OM}$

$= 2\begin{pmatrix} 3 \\ 2 \end{pmatrix} - \begin{pmatrix} -3 \\ 6 \end{pmatrix}$

$= \begin{pmatrix} 9 \\ -2 \end{pmatrix}$

$\therefore$ Coordinates of N is $(9, -2)_{\#}$

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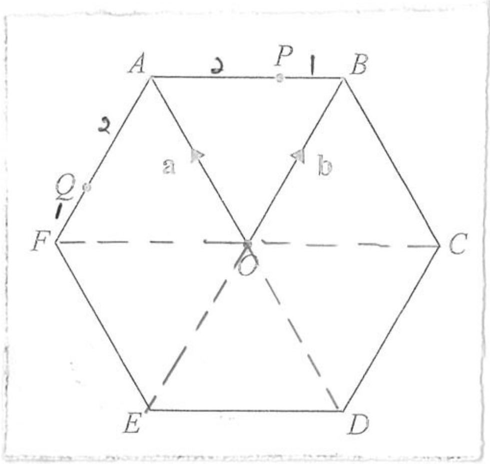
6(b) (i) (a). Given $AP : PB = 2:1$

$$\frac{AP}{PB} = \frac{2}{1} \quad \text{—— (A)}$$

and $AQ : QF = 2:1$

$$\frac{AQ}{QF} = \frac{2}{1} \quad \text{—— (B)}$$



$$\vec{AB} = \vec{OB} - \vec{OA} = \underset{\sim}{b} - \underset{\sim}{a}.$$

(b)
$$\begin{aligned}\vec{OP} &= \vec{OA} + \vec{AP} \\ &= \vec{OA} + \tfrac{2}{3}\vec{AB} \quad \{\text{from (A)}\} \\ &= \underset{\sim}{a} + \tfrac{2}{3}(\underset{\sim}{b} - \underset{\sim}{a}) \\ &= \tfrac{1}{3}\underset{\sim}{a} + \tfrac{2}{3}\underset{\sim}{b} \\ &= \tfrac{1}{3}(\underset{\sim}{a} + 2\underset{\sim}{b})\end{aligned}$$

(c) Since ABCDEF is a regular hexagon,
$\triangle OAB$, $\triangle OBC$, $\triangle OCD$, $\triangle ODE$, $\triangle OEF$, $\triangle OFA$ are equilateral $\triangle$.

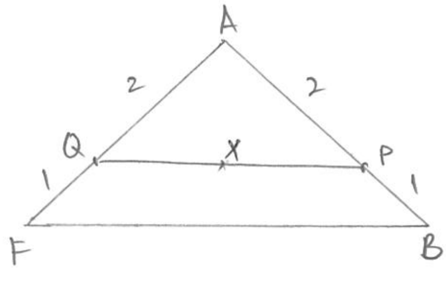
$\therefore$ OFAB is rhombus.

$$\vec{AF} = \vec{BO} = -\underset{\sim}{b}$$
$$\vec{AQ} = \tfrac{2}{3}\vec{AF} \quad \{\text{from (B)}\}.$$
$$= -\tfrac{2}{3}\underset{\sim}{b}.$$

(b) (ii) In $\triangle AQP$ and $\triangle AFB$.
$\measuredangle A$ is common.

$$\frac{AQ}{AF} = \frac{AP}{AB} = \frac{2}{3}$$

$\therefore \triangle AQP$ is similar to $\triangle AFB$



$$\vec{FB} = \vec{FA} + \vec{AB} = \underset{\sim}{b} + \underset{\sim}{b} - \underset{\sim}{a} = 2\underset{\sim}{b} - \underset{\sim}{a}.$$

$$\therefore \vec{QP} = \tfrac{2}{3}\vec{FB} = \tfrac{2}{3}(2\underset{\sim}{b} - \underset{\sim}{a}) = \tfrac{4}{3}\underset{\sim}{b} - \tfrac{2}{3}\underset{\sim}{a}$$

$$\therefore \vec{QX} = \tfrac{1}{2}\vec{QP} = \tfrac{1}{2}\left[\tfrac{4}{3}\underset{\sim}{b} - \tfrac{2}{3}\underset{\sim}{a}\right]$$
$$= \tfrac{2}{3}\underset{\sim}{b} - \tfrac{1}{3}\underset{\sim}{a}.$$

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7(a) (i). ext ∡ of a regular 20 sided polygon $= \frac{360°}{20} = 18°$.

∴ Interior ∡ of a 20 sided polygon $= 180° - 18°$
$= 162°$

(ii) Sum of interior ∡s $= (n-2) \times 180°$.

$4 \times 120 + (n-4)p = (n-2)180$

$480 + (n-4)p = 180n - 360$

$(n-4)p = 180n - 840$

$p = \frac{180n - 840}{n-4}$

(b) (i). $\triangle OAE \equiv \triangle ODE$

OR

$\triangle OAX \equiv ODX$

OR

$\triangle AXE \equiv \triangle DXE$

(ii) (a) ∡AOE = 180° − ∡OAE − ∡OEA (Sum of ∡s in △OAE)
$= 180° - 90° - 23°$
$= 67°$

(b). △OAD is isos (OA = OD = radius)

∡DOX = ∡AOE = 67°.

∴ ∡ODA $= \frac{180° - 67 \times 2}{2}$ (sum of ∡s in △OAD).
$= 23°$.

(c). ∡AOD $= 67 \times 2 = 134°$

∡ACD $= \frac{1}{2}$ ∡AOD (∡ at center = 2∡ at O^{ce}).
$= \frac{1}{2} \times 134$
$= 67°$.

∡ADC = 180° − ∡OAX − ∡OAC − ∡ACD (Sum of ∡s in △ACD)
$= 180° - 23° - 26° - 67°$
$= 64°$.

(d) ∡ABC = 180 − ∡ADC (∡s in Opp Segment)
$= 180 - 64° = 116°$

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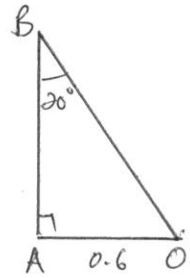
8(a) (i). Given window frame is symmetrical

$OA = OD = \frac{1.2}{2} = 0.6\,m$



In Δ OAB,

$\sin 20^\circ = \frac{0.6}{OB}$

$OB = \frac{0.6}{\sin 20^\circ} = 1.7542$

$\approx 1.75\ m$ (Corr to 3 sig fig).

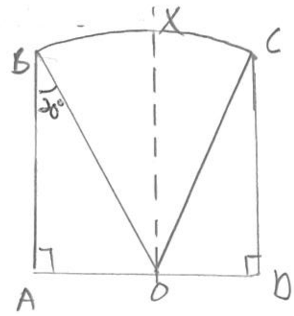
(ii) $\angle BOX = 20^\circ$ (alt $\angle$ AB // OX)

$\angle BOC = 20^\circ \times 2$ (symmetrical)

$= 40^\circ$

$= \frac{40}{180} \times \pi$

$= \frac{2}{9}\pi$ radians.



(iii) In Δ OAB,

$\tan 20^\circ = \frac{OA}{AB}$.

$AB = \frac{0.6}{\tan 20^\circ}$

Total Perimeter $= BA + AD + DC + \text{Arc } CB$.

$= \frac{0.6}{\tan 20^\circ} + 1.2 + \frac{0.6}{\tan 20^\circ} + \frac{40}{360} \times 2\pi \left(\frac{0.6}{\sin 20^\circ}\right)$.

$= 5.72169$

$\approx 5.72\ m$ (Corr to 3 sig fig).

Area of window frame = Area of Δ OAB $\times 2$ + Area of sector OBC

$= \frac{1}{2}(0.6)\left(\frac{0.6}{\tan 20^\circ}\right) \times 2 + \frac{40}{360} \times \pi \left(\frac{0.6}{\sin 20^\circ}\right)^2$

$= 2.063344\ m^2$.

Cost of manufacturing this window $= 2.063344 \times 78.5$

$= 161.9725$

$\approx \$161.97$ (Corr to 2 dec pl)

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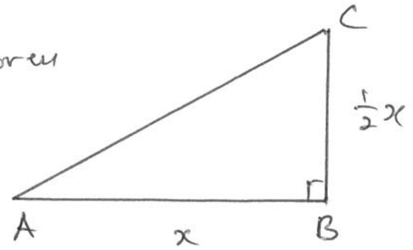
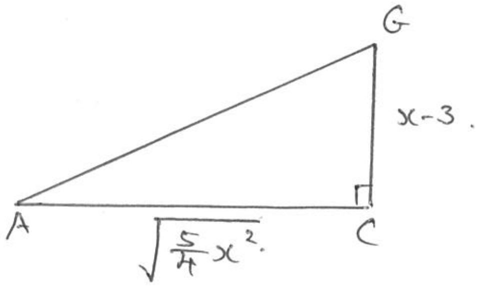
9(a). Width of the cuboid = $\frac{1}{2}x$ cm.
height of the cuboid = $(x-3)$ cm.

(b) In Δ ABC, using phythagoras theorem



$$AC^2 = AB^2 + BC^2$$
$$= x^2 + \left(\tfrac{1}{2}x\right)^2$$
$$= x^2 + \tfrac{1}{4}x^2$$
$$= \tfrac{5}{4}x^2 \text{ (shown)}$$

(c) In Δ ACG, using phythagoras theorem.



$$AG^2 = AC^2 + CG^2$$
$$12^2 = \left(\tfrac{5}{4}\right)x^2 + (x-3)^2.$$
$$4 \times 144 = 5x^2 + 4(x^2 - 6x + 9)$$
$$9x^2 - 24x + 36 = 576.$$

$$9x^2 - 24x - 540 = 0.$$
$$3x^2 - 8x - 180 = 0 \text{ (shown)}.$$

(d)
$$x = \frac{-(-8) \pm \sqrt{(-8)^2 - 4(3)(-180)}}{2(3)}$$
$$= \frac{8 - \sqrt{2224}}{6} \text{ or } \frac{8 + \sqrt{2224}}{6}$$
$$= -6.52655 \text{ or } 9.19321$$
$$\approx -6.527 \text{ cm or } 9.193 \text{ cm (cor to 3 dec pl)}$$

$\therefore$ length of the cuboid = 9.193 cm.

(e) Volume of the cuboid $= 9.19321 \times \frac{1}{2}(9.19321) \times (9.19321 - 3)$
$= 261.7099$
≈ 262 cm³ (cor to 3 sig fig)

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10(a) (i)

	1	2	3	4	5
1		1, 2	1, 3	1, 4	1, 5
2	2, 1		2, 3	2, 4	2, 5
3	3, 1	3, 2		3, 4	3, 5
4	4, 1	4, 2	4, 3		4, 5
5	5, 1	5, 2	5, 3	5, 4	

(ii)(a) P(both counters have nos less than 3) $= \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4} = \frac{1}{10}$ #

(b) P(neither counter has an even nos) $= \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4} + \frac{1}{5} \times \frac{1}{4}$

$= 0.3$ #

(c) P(sum of the nos is 10) $= 0$ # {largest sum $= 9$}

(d) P(product less than 6) $= \frac{1}{5} + \frac{1}{5} \times \frac{1}{4} \times 4$

$= \frac{2}{5}$ #

10(b) (i). Nos of students less than 170 cm tall = 6

% of student who are less than 170 cm $= \frac{6}{14} \times 100$

$= 42.857$

$\approx 42.9\%$ (corr to 3 sig fig)

(ii) Median height $= \frac{171 + 172}{2} = 171.5$ cm.

(iii).

x	f	fx	fx^2
156	1	156	$(156)^2$
160	1	160	$(160)^2$
162	1	162	$(162)^2$
164	1	164	$(164)^2$
167	1	167	$(167)^2$
168	1	168	$(168)^2$
171	1	171	$(171)^2$
172	2	344	$(172)^2 \times 2$
174	1	174	$(174)^2$
178	1	178	$(178)^2$
181	1	181	$(181)^2$
183	1	183	$(183)^2$
190	1	190	$(190)^2$
Sum	14	2398	411908

$$S = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$

$$= \sqrt{\frac{411908}{14} - \left(\frac{2398}{14}\right)^2} = 9.1216 \approx 9.12$$

(corr to 3 sig fig)

(iv) The median height will be lowered while the std deviation remains unchanged.