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MARKING GUIDE, P425/2, APPLIED MATHEMATICS

(1)

	$P(T) = \frac{2}{3}$		$P(T) = \frac{1}{3}$	
$P(G) = 0.9$	$P(\bar{G}) = 0.1$		$P(G) = 0.6$	$P(\bar{G}) = 0.4$

both arms correct

(a) $P(G) = \frac{2}{3} \times 0.9 + \frac{1}{3} \times 0.6 = 0.8 = \frac{4}{5}$ (B1)(M1)(A1) — correct output

Correct substitution

(b) $P(T/G) = \frac{P(T \cap G)}{P(G)} = \frac{\frac{2}{3} \times 0.9}{0.8} = 0.75 = \frac{3}{4}$ (M1)(A1) — correct

(2)

horizontal motion	vertical motion
$u_x = 5 ms^{-1}$	$u_y = 0 ms^{-1}$
$a_x = 0 ms^{-2}$	$a_y = 10 ms^{-2}$
$S_x = x m$	$S_y = 80 m$
$t_x = t s$	$t_y = t s$

correct vertical resolution

(a) $S = ut + \frac{1}{2}at^2$, $80 = 0 \times t + \frac{1}{2} \times 10 \times t^2$ (B1)(M1) — correct substitution

$5t^2 = 80$, $t^2 = 16$ $\therefore t = 4s$. (M1)(A1) — correct output

(b) $x = 5 \times 4 + \frac{1}{2} \times 0 \times (4)^2 = 20 m$ (M1)(A1) — correct output

correct substitution

(3) let $P = \frac{xy}{z} = \frac{4 \times 16.2}{2.53} = 25.6126$

correct substitution

$P_{max} = \frac{x_{max} \, y_{max}}{z_{min}} = \frac{4.5 \times 16.26}{2.523} = 29.0012$ (M1)(B1) — correct

$P_{min} = \frac{x_{min} \, y_{min}}{z_{max}} = \frac{3.5 \times 16.14}{2.537} = 22.2665$ (B1) — correct output

$\Delta P = \frac{1}{2}(P_{max} - P_{min}) = \frac{1}{2}(29.0012 - 22.2665)$ (M1) — correct

$\Delta P = 3.36735$ (A1) — correct output

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(4) $H : T$

$2 : 1 \quad = 3$ — both p and q correct

$P(H) = \frac{2}{3} : P(T) = \frac{1}{3}$ (B1), $n = 6$ — Correct substitution
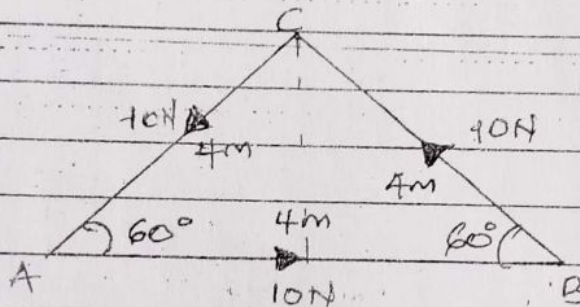
(a) $P(X_H \geq 5) = P(X_H = 5) + P(X_H = 6)$

$= {}^6C_5 \left(\frac{2}{3}\right)^5 \left(\frac{1}{3}\right)^1 + {}^6C_6 \left(\frac{2}{3}\right)^6 \left(\frac{1}{3}\right)^0 = \frac{256}{729} = 0.3512$ (M1)(A1)

(b) $P(X_T \leq 1) = P(X_T = 1) + P(X_T = 0)$

$= {}^6C_1 \left(\frac{1}{3}\right)^1 \left(\frac{2}{3}\right)^5 + {}^6C_0 \left(\frac{1}{3}\right)^0 \left(\frac{2}{3}\right)^6 = \frac{256}{729} = 0.3512$ (M1)(A1)

Correct substitution

(5)

(B1) — Correct force diagram with AB horizontal

$\rightarrow R_x = 10 - 10\cos 60° - 10\cos 60° = 0$ (M1) — correct R_x

$\uparrow R_y = 10\sin 60° - 10\sin 60° = 0$ (M1) — correct R_y

$R = \begin{pmatrix} 0 \\ 0 \end{pmatrix} N$

(A) $A.C.M = 4 \times 10\sin 60° = 20\sqrt{3} \, Nm$ (B1) — correct moment about any pt

Since $R = \begin{pmatrix} 0 \\ 0 \end{pmatrix} N$ and $A.C.M = 20\sqrt{3} \, Nm$ ∴ HS

a couple. (B1) — For conclusion (can be implied)

(6) (a)

60	C	40
150	170	200

(B1) — Location (variable)

$\dfrac{C - 60}{170 - 150} = \dfrac{40 - 60}{200 - 150}$ (M1) — correct substitution

$C = 52$ (A1) — output (exact)

(b)

100	90	75
S	50	100

$\dfrac{S - 50}{100 - 90} = \dfrac{50 - 100}{90 - 75}$ (M1) — correct substitution

$S = 16.6667 = \frac{50}{3}$ (A1) — output (≥ 0.d.p)

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(7)

x	$F(x)$	$P(x=x)$	$x\,P(x=x)$	$x^2 P(x=x)$
3	0.01	0.01	0.03	0.09
4	0.23	0.22	0.88	3.52
5	0.64	0.41	2.05	10.25
6	0.85	0.21	1.26	7.56
7	1	0.15	1.05	7.35

All correct (B1) $E(x) = 5.27$ (A1) $E(x^2) = 28.77$ (B1) – correct output

$$Var(x) = E(x^2) - (E(x))^2 = 28.77 - (5.27)^2 = 0.9971 \text{ (A1)}$$

(8)

$F = \dfrac{P}{V} = \dfrac{19.2 \times 10^3}{10}$

$= 1,920N$ (B1)

Force diagram with 4 force seen including weight

$900 \times 9 \cos 1.91° = 8,820N$ correct substitut

$1,920 - 360 - 294 = 900a$ (M1) (B1) – correct along the

$900a = 1,266$ (B1) – correct result (can be implied) f

$a = \dfrac{211}{150} \, ms^2 = 1.4067 \, ms$ (A1) – output

(9) (a)
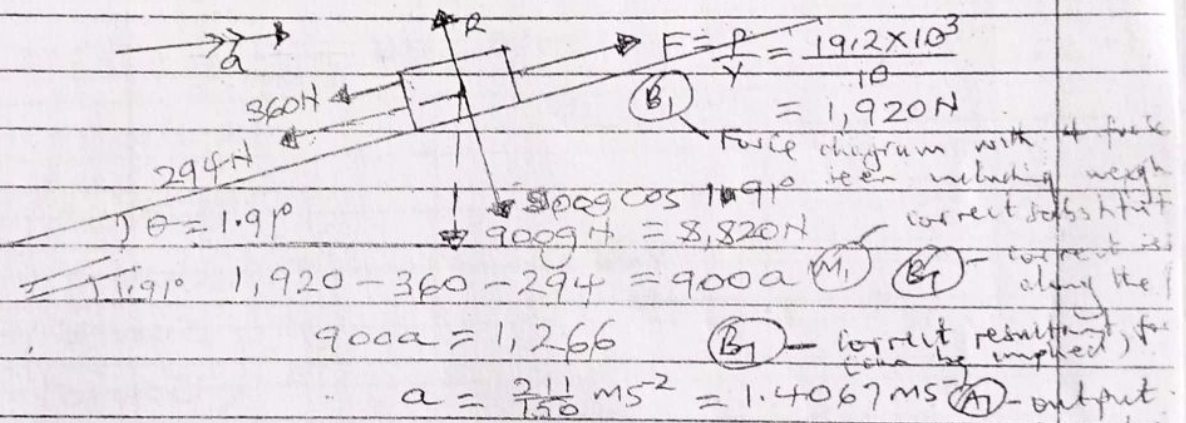
$$\int_a^5 \frac{1}{a(b-a)}\,dx = \frac{1}{4}$$ Correct integral and equated to ¼

$\left[\dfrac{x}{b-a}\right]_a^5 = \dfrac{1}{4}$ (M1) $\dfrac{5-a}{b-a} = \dfrac{1}{4}$ (B1) correct substitution limits $20 - 4a = b-a$

$3a + b = 20$, (*)

$$\int_a^9 \frac{1}{a(b-a)}\,dx = \frac{3}{4}$$ Correct integral equated to ¾

$\left[\dfrac{x}{b-a}\right]_a^9 = \dfrac{3}{4}$ (M1) $\dfrac{9-a}{b-a} = \dfrac{3}{4}$ (B1) correct substitution of $36 - 4a = 3b - 3a$

$a + 3b = 36$, (**) ×3 $3a + 9b = 108$, (−)

$3a + b = 20$, (*) $3a + b = 20$, (*) . (−)−(*)

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(correct method used (can be implied))

$8b = 88$ (M1) $b = 11$ (A1) — correct value of b

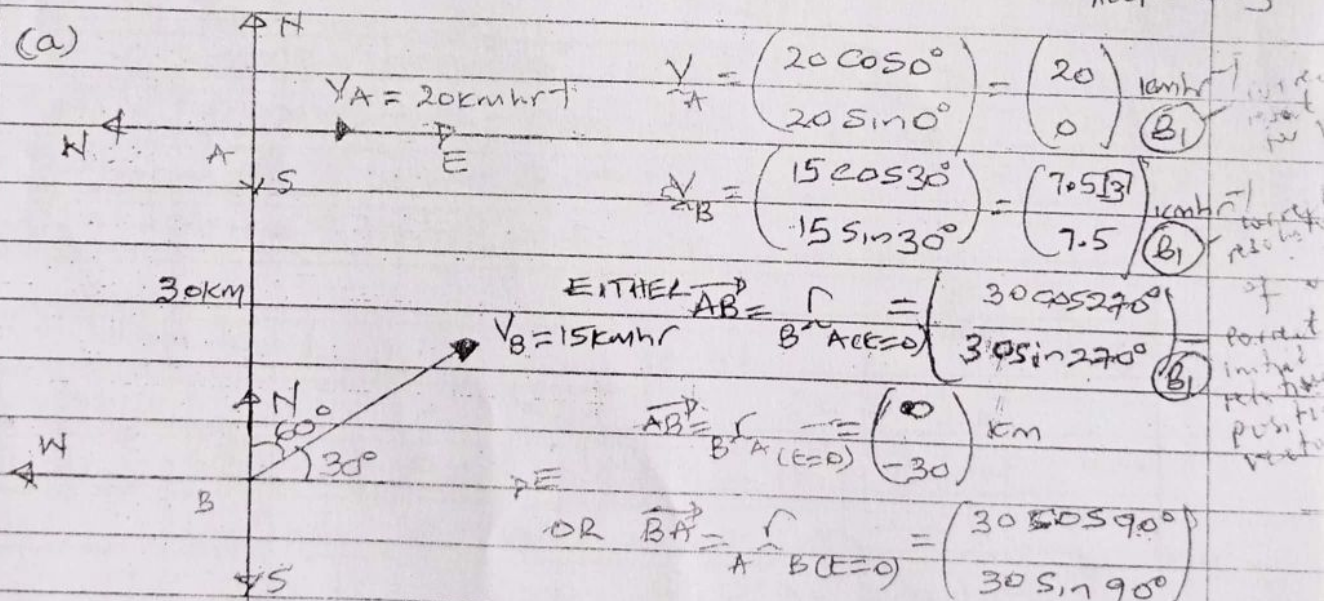from (—) $\quad a = 36 - 3 \times 11 = 3$ (A1) — correct value of a

$$f(x) = \begin{cases} \frac{1}{8} & ; \ 3 < x < 11 \\ 0 & ; \ \text{otherwise} \end{cases}$$

(b) $P(4 < x < 7) = \int_4^7 \frac{1}{8} \, dx = \left| \frac{x}{8} \right|_4^7 = \frac{7-4}{8} = \frac{3}{8}$ or 0.375 (M1) (A1) output (exa

(c) $E(x) = \frac{1}{2}(3 + 11) = 7$ (B1) — correct integral with h
correct output — correct subst

$Var(x) = \frac{1}{12}(11-3)^2 = \frac{64}{12} - \frac{16}{3} = 5.3333$ (M1) (A1) — correct output
(γ, 4 d.p.)
Accept $5\frac{1}{3}$

(10) (a)

$\underset{\sim}{V}_A = \begin{pmatrix} 20\cos 0° \\ 20\sin 0° \end{pmatrix} = \begin{pmatrix} 20 \\ 0 \end{pmatrix}$ kmhr^{-1} (B1)

$\underset{\sim}{V}_B = \begin{pmatrix} 15\cos 30° \\ 15\sin 30° \end{pmatrix} = \begin{pmatrix} 7.5\sqrt{3} \\ 7.5 \end{pmatrix}$ kmhr^{-1} (B1)

$Y_A = 20$kmhr^{-1}

30KM

$V_B = 15$kmhr

60°
30°

EITHER $\overrightarrow{AB} = \underset{B}{\overset{r}{\underset{A(t=0)}{}}} = \begin{pmatrix} 30\cos 270° \\ 30\sin 270° \end{pmatrix}$ (B1)

$\overrightarrow{AB} = \underset{B}{\overset{r}{\underset{A(t=0)}{}}} = \begin{pmatrix} 0 \\ -30 \end{pmatrix}$ km

OR $\overrightarrow{BA} = \underset{A}{\overset{r}{\underset{B(t=0)}{}}} = \begin{pmatrix} 30\cos 90° \\ 30\sin 90° \end{pmatrix}$

$\overrightarrow{BA} = \underset{A}{\overset{r}{\underset{B(t=0)}{}}} = \begin{pmatrix} 0 \\ 30 \end{pmatrix}$ km

$\underset{A}{\overset{r}{\underset{B(t=t)}{}}} = \underset{A}{\overset{r}{\underset{B(t=0)}{}}} + (\underset{\sim}{Y}_A - \underset{\sim}{Y}_B)t$

correct substitut
Attempt to find AB

$= \begin{pmatrix} 0 \\ 30 \end{pmatrix} + \begin{pmatrix} 7.5\sqrt{3} \\ 7.5 \end{pmatrix} t = \begin{pmatrix} 7.0096t \\ 30 - 7.5t \end{pmatrix}$ (M1) (B1)

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$A^r_B(t=t) \cdot {}_A X_B = 0$

$\begin{pmatrix} 7.0096t \\ 30-7.5t \end{pmatrix} \cdot \begin{pmatrix} 7.0096 \\ -7.5 \end{pmatrix} = 0$ (M₁) — correct substitution with dot symbol seen and equated to zero

— correct dot product (B₁)

$105.3848t - 225 = 0$ (B₁) — correct output

$t = 2.135hrs \approx 2.14hr = 2hrs \ 0.14 \times 60min, \ \therefore t = 14:08hrs$ (A₁) — correct time

(b) $A^r_B(t=2.14hr) = \begin{pmatrix} 7.0096 \times 2.14 \\ 30-7.5 \times 2.14 \end{pmatrix} = \begin{pmatrix} 15.0005 \\ 13.95 \end{pmatrix} km$ (M₁) (B₁) — correct substitution of t in to Attempt to find distance

$|A^r_B(t=2.14hr)| = \sqrt{(15.0005)^2 + (13.95)^2} = 20.48 km$ (A₁) — output with unit (≥ 2 d.ps)

11 (a) $h = \frac{6-1}{6} = \frac{5}{6}$ (B₁) — Attempt to find depth

x	$f(x) = x\ln x$	$f(x) = x\ln x$
1	0.0000	
$\frac{11}{6}$		1.1112
$\frac{8}{3}$		2.6156
$\frac{7}{2}$		4.3847
$\frac{13}{3}$		6.3549
$\frac{31}{6}$		8.4848
6	10.7506	
Sum (B₁)	10.7506 (B₁)	22.9502 (B₁)

correct extreme values — correct middle/intermediate values of y

$\int_1^6 x\ln x \, dx \approx \frac{5}{12}(10.7506 + 2 \times 22.9502) \approx 23.6036$ (M₁) — correct substitution

≈ 23.604 (3d.p.s) (A₁) — correct to exactly 3 d.ps

(b) $E.V = \int_1^6 x\ln x \, dx, \quad u = \ln x, \frac{du}{dx} = \frac{1}{x}$

$\frac{dv}{dx} = x, \quad v = \frac{x^2}{2}$

$= \frac{x^2}{2}\ln x - \int \frac{1}{x} \cdot \frac{x^2}{2} dx = \frac{x^2}{4}$ — correct integral with limits

$= \left|\frac{x^2}{2}\ln x - \frac{x^2}{4}\right|_1^6 = (18\ln 6 - 9) - (\frac{1}{2}\ln 1 - \frac{1}{4})$ (M₁) — correct substitution

$= 22.5017 \approx 22.5$ (3d.ps) (A₁) — correct output (3 d.ps only)

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Attempt to find A.E with magnitude sign seen

$$A.E = |E.V - A.V| = |23.502 - 23.605| = 0.103$$ (B)

correct A.E with magnitude

$$P.E = \frac{A.E}{E.V} \times 100 = \frac{0.103}{23.502} \times 100 = 0.438$$ (B) *correct P.E (≥2d.p)*

OR 0.44

Increase number of strips or sub-Intervals or ordinates. (B) — *correct if all the above II scored*

(12)(b)

R_x	R_y	d^2
4	3.5	0.25
9.5	8	2.25
7	3.5	12.25
6	7	1
2.5	5	6.25
9.5	9	0.25
1	1	0
2.5	2	0.25
8	10 *correct R_y*	4
5	6	1

correct R_x

(B) Sum (B) $\Sigma d^2 = 27.5$ (B) — *correct sum of d*

correct substitution

$$\rho_c = \left|1 - \frac{6\Sigma d^2}{n(n^2-1)}\right| = \left|1 - \frac{6 \times 27.5}{10 \times 99}\right| = 0.8333$$ (A) *correct output (≥2d.p)*

(M)

$$\rho_c = 0.8333 > \rho_T = 0.65, \therefore \text{Significant at } 5\%.$$ (B) *correct comment with comparison seen*

(13)(a)

$$\underline{v} = \begin{pmatrix} 3t \\ -4t \\ t^2 \end{pmatrix} ms^{-1}$$

correct integral with constant seen

i) $$\underline{r}_{(t+t)} = \int \underline{v}\, dt = \int \begin{pmatrix} 3t \\ -4t \\ t^2 \end{pmatrix} dt = \begin{pmatrix} \frac{3t^2}{2} \\ -2t^2 \\ \frac{1}{\cdots} \end{pmatrix} + \underline{c}$$ (M)

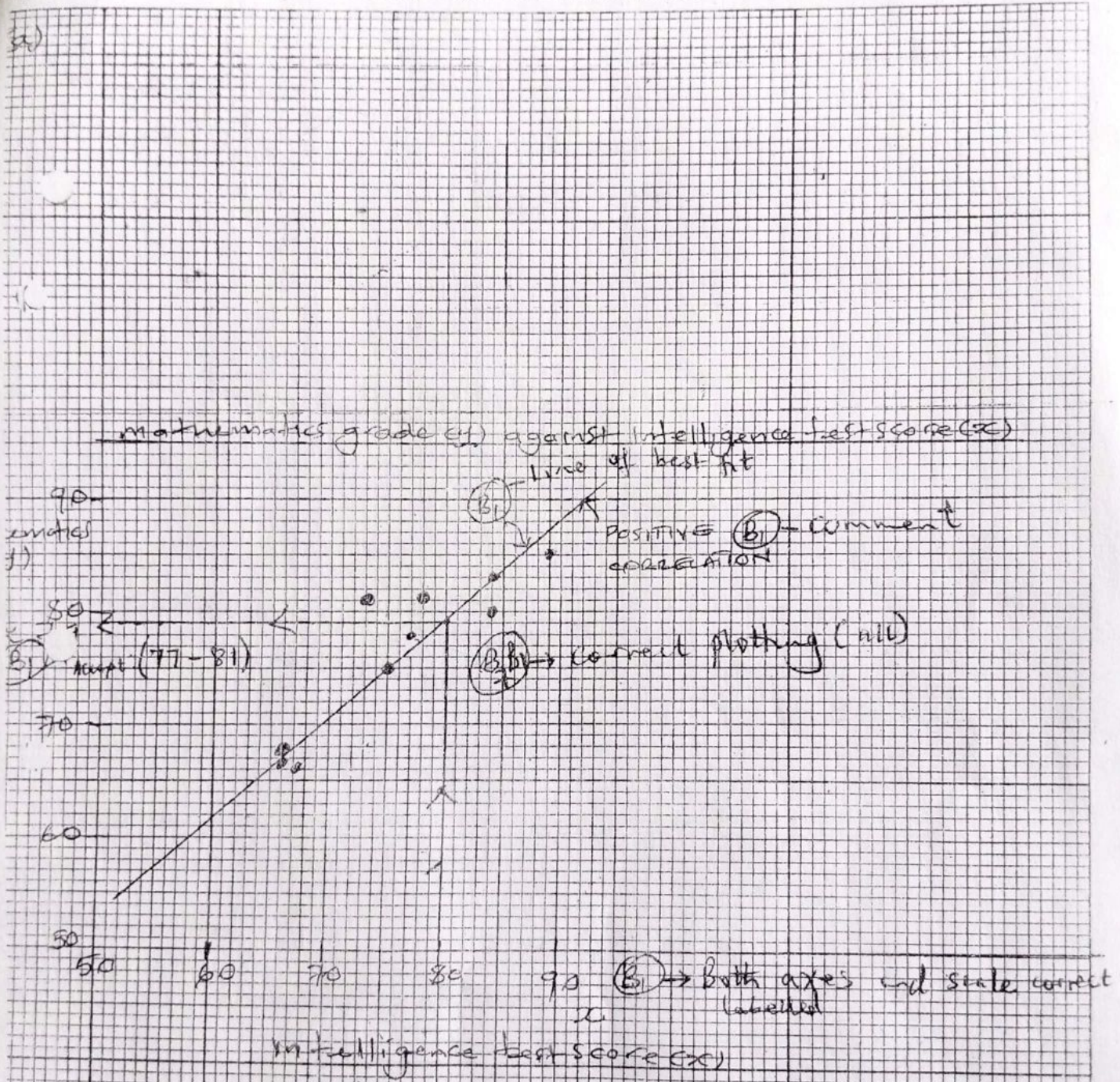# UGANDA NATIONAL EXAMINATIONS BOARD
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mathematics grade (y) against Intelligence test score (x)

B₁ → line of best fit

POSITIVE B₁ → comment
CORRELATION

B₁ → Accept (77 - 81)

8 B₁ → correct plotting (n₁₀)

B → both axes and scale correct labelled

intelligence test score (x)

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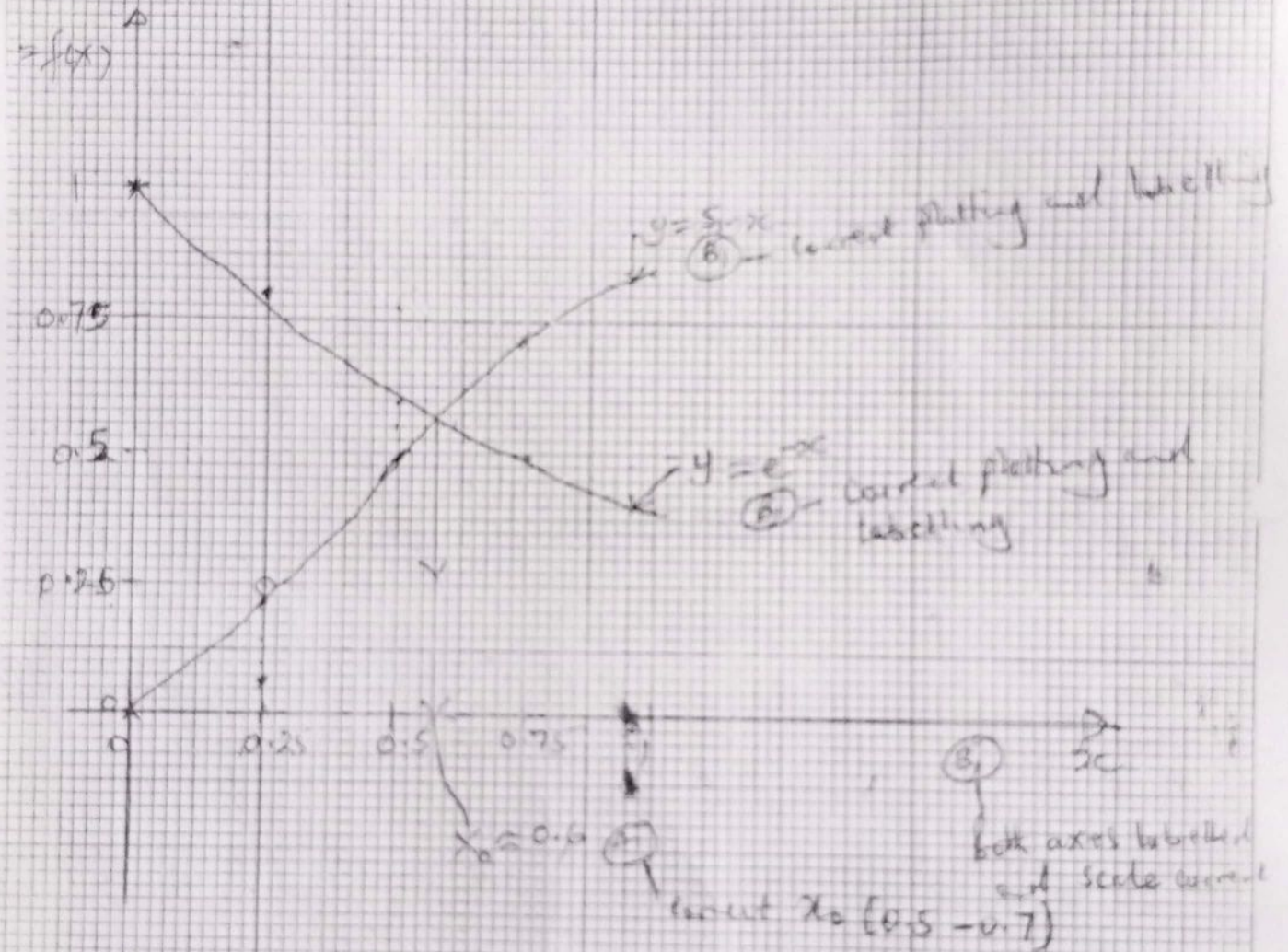gnature ....   Random No.
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14. (a)

x	0	0·25	0·5	0·75	1
$y = e^{-x}$	1	0.78	0·61	0·47	0·37
$y = \sin x$	0	0·25	0·48	0·68	0·84

$y = e^{-x}$ and $y = \sin x$ against x values.

$y = \sin x$ — correct plotting and labelling

$y = e^{-x}$ — correct plotting and labelling

$x_0 \simeq 0.6$ about x_0 (0.5 – 0.7)

both axes labelled and scale correct

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At $t=0$, $r_{(t=0)} = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$, $\begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 10 \end{pmatrix} + c$, $c = \begin{pmatrix} 1 \\ 0 \\ 1 \end{pmatrix}$ (B) — Attempt to find the constant

$r_{(t=t)} = \begin{pmatrix} \frac{3}{2}t^2+1 \\ -2t^2 \\ \frac{t^3}{3}+1 \end{pmatrix}$ m (B) — correct output with constant substituted or correct position vector at anytime t

$r_{(t=2s)} = \begin{pmatrix} \frac{3}{2}(2)^2+1 \\ -2(2)^2 \\ \frac{(2)^3}{3}+1 \end{pmatrix} = \begin{pmatrix} 7 \\ -8 \\ \frac{11}{3} \end{pmatrix}$ m (B) — correct displacement when correct substitution of $t=2$

$|r_{(t=2s)}| = \sqrt{(7)^2+(-8)^2+(\frac{11}{3})^2} = 11.2448$ m (A) — correct output with units [? , 2d.pl]

(M) — Attempt to find distance

11.24 m

(b)

$a_{(t=t)} = \frac{dv}{dt} = \begin{pmatrix} 3 \\ -4 \\ 2t \end{pmatrix}$ ms^{-2} (M) — correct derivative

$a_{(t=3s)} = \begin{pmatrix} 3 \\ -4 \\ 2\times3 \end{pmatrix} = \begin{pmatrix} 3 \\ -4 \\ 6 \end{pmatrix}$ ms^{-2} (B) — correct acceleration in vector form when $t=3s$

(M) — Attempt to find magnitude of a

$|a_{(t=3s)}| = \sqrt{(3)^2+(-4)^2+(6)^2} = 7.8102$ ms^{-2} (A) — correct output, units [? 2d.pl]

(c)

$F = ma = 3\begin{pmatrix} 3 \\ -4 \\ 6 \end{pmatrix} = \begin{pmatrix} 9 \\ -12 \\ 18 \end{pmatrix}$ N (M) (A) — correct output with units

— Correct substitution in correct form

$(9i - 12j + 18k)$ N

14) (b) $e^{-x} = \sin x$, $\sin x - e^{-x} = 0$, $f(x) = 0$

$f(x) = \sin x - e^{-x}$

$f'(x) = \cos x + e^{-x}$ (M) — correct derivative

$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)} = x_n - \left(\frac{\sin x_n - e^{-x_n}}{\cos x_n + e^{-x_n}}\right)$

$x_0 = 0.6$

$x_1 = 0.6000 - \left(\frac{\sin 0.6000 - e^{-0.6000}}{\cos 0.6000 + e^{-0.6000}}\right) = 0.5885$ (M) — correct subst

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Correct substitution with $x \geqslant 4 d$

$$x_2 = 0.5885 - \left(\frac{\sin 0.5885 - e^{-0.5885}}{\cos 0.5885 + e^{-0.5885}}\right) - 0.5885 \quad \text{M}_1$$

$|x_1 - x_2| = 0$ $\quad$ B$_1$ - Correct test of error

root x 0.589 (3d.p.s) $\quad$ A$_1$ - Correct output to

(15) (a)

$y = f(x)$

$P = 0.49$

$P = 0.45$

$\phi = 0.01$

$\phi = 0.05$

x $\quad X_2 = 185$ $\quad X_1 = 210$ correct z-value $\quad$ correct z-value

$-Z_{0.49} = -2.326$ B$_1$ $\quad Z_{0.45} = 1.645$ B$_1$ $\quad Z = \dfrac{X - \mu}{\delta}$

$$1.645 = \frac{210 - \mu}{\delta} \quad \text{M}_1 \text{ - Correct standardisation and equation to Z-value}$$

$1.645\delta + \mu = 210$

$$-2.326 = \frac{185 - \mu}{\delta} \quad \text{M}_1 \quad \text{correct standardisation and equating to Z-value}$$

$\mu - 2.326\delta = 185$ $\quad$ (=) $\quad$ cal $\quad \mu = 199.6437$

$\mu + 1.645\delta = 210$ $\quad$ (+) $\quad$ $\delta = 6.2956$

(+) - (=) $\quad 3.971\delta = 25$ $\quad$ M$_1$ - correct method to find $\bar{x}$ and μ

$\delta = 6.2956$ $\quad$ A$_1$ - Correct output to 3.4 d.p.

correct substitution

from (+) $\mu = 210 - 1.645 \times 6.2956 = 199.6437$ M$_1$ A$_1$

(b) $P(182 < X < 195)$

$$= P\left(\frac{182 - 199.6437}{6.2956} < Z < \frac{195 - 199.6437}{6.2956}\right) \quad \text{M}_1 \text{ correct standardy}$$

$= P(-2.8025 < Z < -0.7376) = P(Z < -0.7376) -$

$P(Z < -2.8025)$ $= 0.2304 - 0.0025 = 0.2279$ B M$_1$ A

.49746
.26962
.22784

OR $P(Z < 2.8025)$

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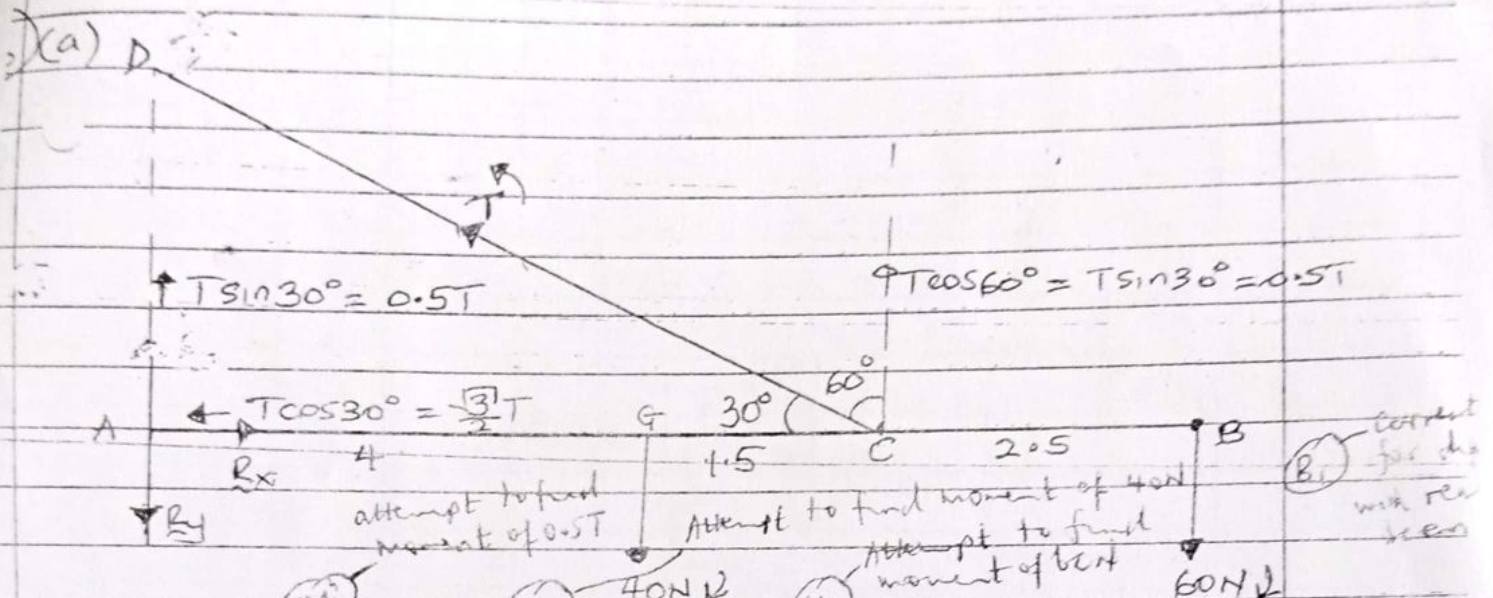
(a)

$T\sin 30° = 0.5T$

$T\cos 60° = T\sin 30° = 0.5T$

$T\cos 30° = \frac{\sqrt{3}}{2}T$

$A \qquad R_x \qquad 4 \qquad G \qquad 1.5 \qquad 30° \qquad C \qquad 2.5 \qquad B$

R_y

attempt to find moment of 0.5T (M1)

Attempt to find moment of 40N (M1)

Attempt to find moment of 60N (M1)

40N ↓   60N ↓

correct for the with rea tion

(B1)

A↻ $5.5 \times 0.5T = 4 \times 40 + 8 \times 60$ (B1) — Equating the moments

$T = 232.7273N$ (A1) — correct output with units (T/2)

(b) ↑ $0.5T = R_y + 40 + 60$ (B1) — vertical resolution

$R_y = 0.5 \times 232.7273 - 100 = 16.3636N$

→ $R_x = \frac{\sqrt{3}}{2}T = \frac{\sqrt{3}}{2} \times 232.7273 = 201.5478N$ (B1) — Horizontal resolution

$|R| = \sqrt{(R_x)^2 + (R_y)^2} = \sqrt{(201.5478)^2 + (16.3636)^2} = 202.211N$ (M1)(A1)

$\theta = \tan^{-1}\left(\frac{16.3636}{201.5478}\right) = 4.64°$ below AB OR E 4.64°S (A1)

(B1) OR S 85.36°E

Attempt to find the angle direction of the reaction (T 2 d.p)

Correct Conclusion

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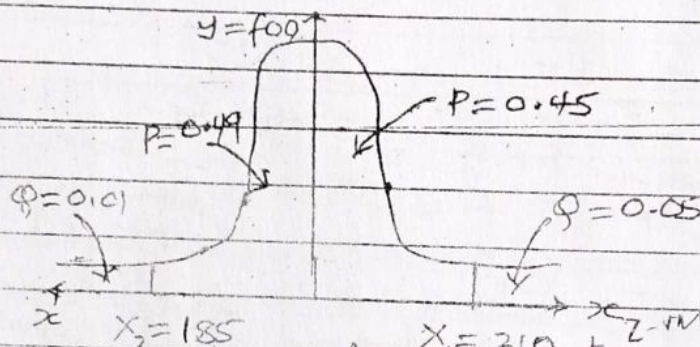
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$$x_2 = 0.5885 - \left(\frac{\sin 0.5885 - e^{-0.5885}}{\cos 0.5885 + e^{-0.5885}}\right) - 0.5885 \quad (M_1)$$

Correct substitution with $x > 4$d

$$|x_1 - x_2| = 0 \quad (B_1) \text{ - correct test of error}$$

$$\text{root } x \ 0.589 \ (3d.p.s) \quad (A_1) \text{ - correct output to}$$

(15) (a)

$y = f(x)$

$P = 0.45$

$P = 0.49$

$\varphi = 0.01$

$\varphi = 0.05$

x $X_2 = 185$ $X_1 = 210$

Correct Z-value

$$-Z_{0.49} = -2.326 \quad (B_1), \quad Z_{0.45} = 1.645 \quad (B_1)$$

$$Z = \frac{X - \mu}{\delta}$$

Correct Z-value

$$1.645 = \frac{210 - \mu}{\delta} \quad (M_1) \text{ - correct standardisation of eqn to Z-value}$$

$$1.645\delta + \mu = 210$$

$$-2.326 = \frac{185 - \mu}{\delta} \quad (M_1) \text{ equating to Z-value}$$

correct standardisation and

$$\mu - 2.326\delta = 185 \ (-) \qquad \text{can} \quad \mu = 199.6437$$

$$\mu + 1.645\delta = 210 \ (+) \qquad \delta = 6.2956$$

$$(+) - (-) \quad 3.971\delta = 25 \quad (M_1) \text{ - correct method to find}$$

$$\delta = 6.2956 \quad (A_1) \text{ - correct output to}$$

correct substitution

from (+) $\mu = 210 - 1.645 \times 6.2956 = 199.6437 \quad (M_1) (A_1)$

(b) $P(182 < X < 195)$

$$= P\left(\frac{182 - 199.6437}{6.2956} < Z < \frac{195 - 199.6437}{6.2956}\right) \quad (M_1)$$

correct standard...

$$= P(-2.8025 < Z < -0.7376) = P(Z < -0.7376) -$$

.49746
.26962
.22784

$$P(Z < -2.8025) = 0.2304 - 0.0025 = 0.2279 \quad (B_1)(M_1)$$

$$\text{OR } \Phi(-2.8025) - \Phi(-0.7376) ... \quad 0.2276$$