Marking Scheme For 2023 Sec 3E Mathematics EOY Paper 1

Item	Worked Solutions	Marks Awarded	Remarks
1	$5^3 \quad \sqrt[3]{158} \quad 4\frac{1}{6}\% \quad -7.8$	B2	1m – at least 2 consecutive correct order
2	$I=\frac{PRT}{100}$ $=\frac{(99800)(2.58)(5)}{100}$ $=\$12874.20$ Total value $=99800+12874.20$ $=\$112674.20$	M1 A1	Correct simple interest working Total value (overall minus 1m if \$112674.2 given)
3	$\frac{46\times 0.07035}{22.34-3.1\sqrt{4.45}}$ $=\frac{50\times 0.07}{20-3\sqrt{4}}$ $=\frac{3.5}{14}$ $=0.25$	M1 A1	for at least 3 number corrected to 1 sig. fig.
4a	$330\times\frac{\pi}{180}$ $=5.76\ rad$	B1	Accepts $1\frac{5}{6}\pi$ or $\frac{11}{6}\pi$
4b	$\frac{5\pi}{8}\times\frac{180}{\pi}$ $=112.5°$	B1	
5	$\sqrt{(8-3)^2+(n-6)^2}=\sqrt{34}$ $(8-3)^2+(n-6)^2=34$ $(n-6)^2=34-25$ $n=\pm 3+6$ $=3\ or\ 9$	M1 A2	Apply length of line formula correctly Both values of n found

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6	$\theta = 38.5° \text{ or } 141.5°$ (1 d.p.)	A2	Both values found
7	$7^p = \frac{1}{49} \times \sqrt{7}$ $7^p = 7^{-2} \times 7^{\frac{1}{2}}$ $7^p = 7^{-1\frac{1}{2}}$ $p = -1\frac{1}{2}$	M1 A1	Award M1 if either $7^{-2} \text{ or } 7^{\frac{1}{2}}$ seen Accepts $-\frac{3}{2}$
8	Total Amount $6850\left(1+\frac{3.13}{100}\right)^7$ $= \$8499.349649$ Interest $= \$8499.349649 - \$6850$ $= \$1649.35$	M1 M1 A1	 A1 awarded only if corrected to nearest cent
9a	$y = x^3$	B1	
9b	$y = 5^x$	B1	
9c	$y = \frac{2}{x^2}$	B1	
10	$2(-5)^2 + 9(-5) - a = 0$ $a = 5$ $2x^2 + 9x - 5 = 0$ $(x+5)(2x-1) = 0$ $x = -5$ (not applicable) *or* $x = \frac{1}{2}$	M1 M1 A1	Sub $x = -5$ M1 awarded only if a value = 5 found. Factorised form or use of general formula Award A1 only if $x = \frac{1}{2}$ seen No A1 awarded if $x = -5$ is not rejected OR Both answers written on answer line
11a	$2x - 15 \leq 19$ $2x \leq 34$ $x \leq 17$	B1	No B1 if only 17 or other form of inequalities seen

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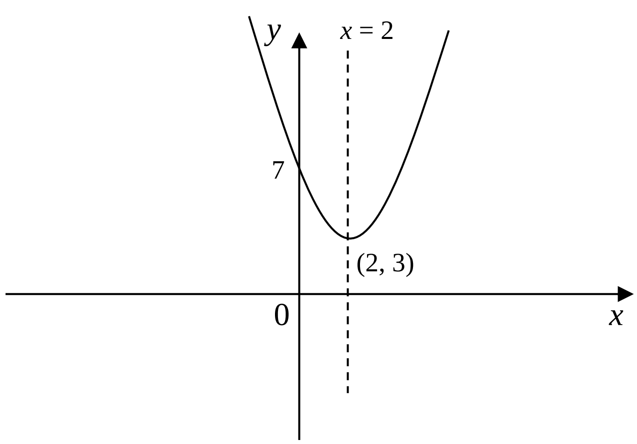
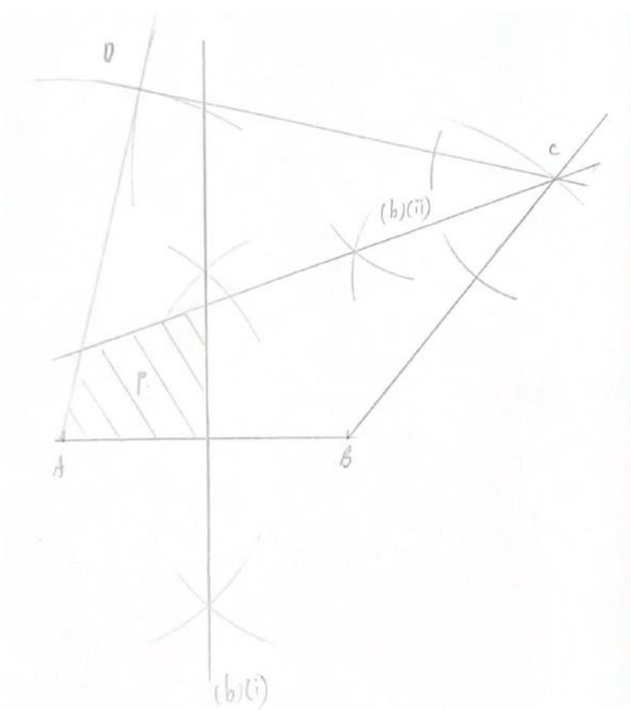
11b	No, because there are 7 prime numbers less than or equal to 17 (2, 3, 5, 7, 11, 13 and 17).	M1 A1	students must list all the 7 prime numbers.
12a	$-\frac{4}{5}$	B1	
12b	$\sin\angle ABC=\frac{16}{20}$ $\angle ABC=53.1°$	M1 A1	
13a	$6(a^2b^0)^3 \div a^{-6}$ $=6a^6 \div a^{-6}$ $=6a^{12}$	M1 A1	Award M1 if $6a^6$ is seen. No M1 if $6a^6b^0$ or any other factors multiplied to $6a^6$
13b	$\left(\frac{a^{15}}{125}\right)^{-\frac{1}{3}}$ $=\left(\frac{125}{a^{15}}\right)^{\frac{1}{3}}$ $=\left(\frac{5}{a^5}\right)$	M1 A1	Award M1 if $\frac{a^{-5}}{125^{-\frac{1}{3}}}$ seen Not accepted $5a^{-5}$ $\frac{a^{-5}}{0.2}$
14	(A) $\angle CAB=\angle SAR$(common angle) (S) $AB=12-3=9=AR$ (given) (A) $\angle ABC=\angle ARS=90°$(given) By ASA congruence test, triangle ABC is congruent to triangle ARS	M2 A1	M1 for any 2 statements Conclusion with correct test chosen. Award if '$\equiv$' sign used
15	$(3x-3y)^2$ $=9x^2-9xy-9xy+9y^2$ $=9x^2-18xy+9y^2$ $=9(x^2+y^2)-18(xy)$ $=9(23)-18(17)$ $=-99$	M1 A1	
16a	$y=-(x-5)(2x+b)$ Subs $x=0, y=10$ $10=-(0-5)(2(0)+b)$ $b=2$	B1	
16b	(5, 0)	B1	

16c	$-(x-5)(2x+b)=0$ $x=5$ *or* $x=-1$ Line of symmetry is $x=\frac{5+(-1)}{2}=2$ $y=-(2-5)(2(2)+2)=18$	M1 A1	Line of symmetry found
17a	80s to 90s	B1	
17b	Speed = Gradient Speed $=\frac{\text{Distance}}{\text{Time}}$ $=\frac{50-30}{80-35}$ $=\frac{4}{9}$ m/s or $=0.444$ m/s	M1 A1	
17c	Average Speed $=\frac{\text{Total Distance}}{\text{Total Time}}$ $=\frac{50+50}{120}$ $=\frac{5}{6}$ m/s or 0.833 m/s	M1 A1	
18a		G1 G1	Correct shape and *y*-intercept Correct turning point
18b	$(x-2)^2=-1 \rightarrow (x-2)^2+3=2$ Draw the line $y = 2$.	M1 A1	Show attempt to obtain $y = 2$ Conclusion Do not accept

	Since the line $y = 2$ does not intersect the graph of $y=(x-1)^2+2$, the equation has no real solution.		"**intercept** the graph" or "points of **interception**"
19a	$x^2-13x+9$ $=\left(x-\frac{13}{2}\right)^2-\left(-\frac{13}{2}\right)^2+9$ $=\left(x-\frac{13}{2}\right)^2-\frac{169}{4}+9$ $=\left(x-\frac{13}{2}\right)^2-\frac{133}{4}$ *or* $=\left(x-\frac{13}{2}\right)^2-33\frac{1}{4}$	M1 A1	Accept if without negative in the square $\left(\frac{13}{2}\right)^2$ Accept either answer in improper or mixed number
19b	$x^2-13x+9=0$ $\left(x-\frac{13}{2}\right)^2-\frac{133}{4}=0$ $\left(x-\frac{13}{2}\right)^2=\frac{133}{4}$ $x=\frac{13}{2}\pm\sqrt{\frac{133}{4}}$ $=12.3$ *or* 0.734 (3 s.f.)	M1 M1 A1	Bringing of the term $\frac{133}{4}$ to the right-hand side Taking square root on both sides Both answers found
20a	$141\times10^7-3.12\times10^7$ $=137.88\times10^7$ $=1.3788\times10^9$ or $=1.38\times10^9$ (3 s.f)	M1 A1	Accept answers in 5 s.f. or 3 s.f
20b	$\frac{1.41\times10^9}{3287263}$ $=428.93$ $=429$	M1 A1	
21a	$11^2+12^2=265$	B1	Accept if "**=265**" not included
21b	$n^2 + (n + 1)^2$ or $2n^2 + 2n + 1$	B1	

21c	$n = 64$ or $2n^2 + 2n + 1 = 8321$ $2n^2 + 2n - 8320 = 0$ $n^2 + n - 4160 = 0$ $(n+65)(n-64) = 0$ $n = -65 (rej)$ $n = 64$	B1	
21d	For any two consecutive numbers, one number would be even and the other one odd. Since the square of an even number is even and the square of an odd number is odd, one of the squares of the two consecutive numbers will be even, and the other will be odd. Hence, their sum will be odd.	B1	Accept if students explains: From T_n, the sum of an odd number and an even number is always odd.
22a		G1 G1	Shape of quadrilateral *ABCD* drawn with construction marks at *C* and *D*. All lengths and angle *ABC* correctly measured
22bi		G1	Perpendicular bisector constructed accurately

			with construction arcs on both sides of AB
22bii		G1	Bisector of angle constructed accurately with construction arcs
22c		G1	P region indicated
23a	When $y = 8$, $5(8)-4p-20=0$ $p=5$ (shown)	B1	p shown
23b	Gradient of l_2, $\frac{8-(-2)}{5-0}$ $=2$	M1 A1	
23c	Length of AB $\sqrt{(0-5)^2+(-2-8)^2}$ $=\sqrt{125}$ Area of triangle= $\frac{1}{2}\times 6\times 5$ $\frac{1}{2}\times d\times\sqrt{125}=\frac{1}{2}\times 6\times 5$ $d=2.68$ units	M1 M1 A1	Length of AB found Equate area of triangle
24a	$\tan 32=\frac{TP}{12}$ $TP=7.4984$ $=7.50\ m$	B1	
24b	$SQ=PR=\sqrt{9^2+12^2}=15$ Since angle of depression of R from T = angle of elevation of T from R Let θ be the angle of elevation of T from R	M1 M1 A1	Apply Pythagoras' Theorem Apply Trigo ratio

	$\tan\theta = \frac{TP}{15}$ $\tan\theta = \frac{7.4984}{15}$ $\theta = 26.560°$ $\theta = 26.6°\ (1\,d.p)$		
25a	$OP \times 2.2 = 11$ $\theta = 5$ cm	B1	
25b	Perimeter of the shaded region *PQRS* = 12+12+11+17(2.2) = 72.4 cm	M1 A1	
25c	Area of the shaded region *PQRS* = Area of sector *OQR* – Area of sector *OPS* $= \frac{1}{2}(17)^2 \times 2.2 - \frac{1}{2}(5)^2 2.2$ $= 317.9 - 27.5$ $= 290.4$ cm^2	M1 A1	Area of at least one sector found
26a	Acceleration $\frac{14-0}{24-0}$ $= \frac{7}{12}$ m/s^2 or 0.583 m/s^2	B1	
26b	Distance travelled by the van in 30 seconds = Area under graph $= \frac{1}{2}[30 + (30-24)](14)$ $= 252$ m	M1 A1	
26c	Let h be the speed of the bike at the instant when it overtakes the van $\frac{1}{2} \times (30-12) \times h = 252$ $h = 28$ m/s Disagree, since the required speed at the instant to overtake is 28 m/s, 26 m/s is lower.	M1 A1	Conclusion

	Alternative: Disagree. If the speed at this instant is 26 m/s, distance travelled by bike = $\frac{1}{2}\times(30-12)\times 26 =$ 234 m. However, this is lesser than the distance travelled by the van (252 m), so the bike would not have overtaken the van at this speed.		