WJEC Higher AER PPQs

APR - ANNUAL PERCENTALE RATE AER - ANNUAL Equivalent RATE 1.

A building society is advertising the following savings scheme.

SUPER SAVER

Interest rate: 6% per annum
Interest is paid to you every 4 months

The building society must tell customers what the Annual Equivalent Rate (AER) is on this savings scheme.

The formula used to calculate this AER is

$$AER = \left[\left(1 + \frac{R}{100N} \right)^{N} - 1 \right] \times 100$$

Where $\quad R$ is the percentage interest rate per annum shown in the advert, and $\quad N$ is the number of interest payments you receive in one year.

Calculate the AER on this Super Saver scheme. Give your answer correct to 2 decimal places.

[3]

$$A\in \mathbb{R} = \left[\left(1 + \frac{6}{1 + \frac{6}{100}} \right)^{3} - 1 \right] \times 100 \quad M1$$

Adam is interested in opening a savings account at Morris Bank. The manager of Morris Bank explains to Adam that they have two different savings accounts. Some details of the accounts are shown below.

Account	Nominal interest rate	AER Annual Equivalent Rate, correct to 2 decimal places
Quarter Back	8.6% p.a., paid quarterly	8.88 %
Monthly Goal	5.4% p.a., paid monthly	5.54%

(a) (i) In the table above, complete the AER column in the table for the Quarter Back account using the information given below.

AER, as a decimal, is calculated using the formula $(1 + \frac{i}{n})^n - 1$, where *i* is the nominal interest rate per annum as a decimal and *n* is the number of compounding periods per annum.

c = 8.6:100 = 0.086 B1

AGR = (1+0.086) -1 = 0.0888 MIAI

ACR% = x100 = 8.884 A1

[5]

(ii) Explain why AER is used by the bank.

erables customen to make companions across different backs / accounts etc.

[1]

(D)	Will A for £41 You m	dam h 0 in 3 j ust sho	pays an ave suf years til ow all ye	ficient r me? our wor	ate of 5 noney in king and	·54% p.a. n his Mo d give a r	nthly Go	al acec	answer.		or scoote
	350	x 1.	055	4	= <i>E</i>	411. 4	+5		81	ΜI	ום
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	***************************************		***************************************	***************************************			*****************		•••••••••••		[4]



He has £5600 to invest.

In 15 years' time, he is hoping to have £7000 to spend on the retirement cruise. He has noticed an advertisement for a savings account paying 1-85% AER.

By investing his £5600 in the savings account for 15 years, will Bryn have £7000 to spend on the cruise? You must show all your working. [4]

B	
5600 × 1.0185 = £7372.31 BIMIA	
Yes he will have enough EI	

(b) Nia wants to invest £2000. Greenash Building Society has a savings account offering 2·18% per annum, with interest paid annually. Downtown Building Society has a savings account offering 2·15% per annum, with interest paid monthly.

AER % =
$$100\left(1 + \frac{r}{100n}\right)^n - 100$$

where

n is the number of times per year that interest is paid r is the gross interest rate as a percentage

By comparing AERs, advise which account will offer Nia the better interest on her investment.

You must show all your working.

[5]

CAGLUACH	010	-	0.1	50
U NEW TON	ner		05.1	0 4

Downtown AER: r= 2.15
n=12

 		***************************************	•		12					
 AER	=	100	1+	2.15	-10	00	=	2.17	6/	B4
		(1200		***********	***********	***************************************	***************************************	50 A

I. Creenash offens the better interest rate E

(a)

Account	AER Annual Equivalent Rate
Eagle Saver	5.2%

Cledwyn has been given £450.
He decides to invest £450 in the *Eagle Saver* account for 4 years.
The *Eagle Saver* account pays an AER of 5·2% p.a.
Will Cledwyn have sufficient money in his *Eagle Saver* account to be able to buy a television costing £550 in 4 years time?
You must show all your working and give a reason for your answer.

[4]

<u>, , , , , , , , , , , , , , , , , , , </u>	
450 × 1.052 = £551.16	BI MI AI
Yes he will, he has more than £550	ϵ l

(b) Cledwyn is also interested in opening a savings account. Cledwyn has some details of a *Kite Saver* account.

Account	Nominal interest rate	AER Annual Equivalent Rate, correct to 2 decimal places	
Kite Saver	6.8% p.a. paid quarterly	6.98 %	

		DECEMBER OF CONTRACTOR AND ADDRESS OF THE PROPERTY OF THE PROP
(i)	Write 6⋅8% as a decimal.	[1]
*******	0.068	
(ii)	Would you expect the AER for the <i>Kite Saver</i> account to or less than 6-8%? Tick (✓) one of the boxes below. Without doing any calculations, give an explanation for Greater than 6-8% Equal to 6-8% Less	
1	terest is compounded into the accoun	it 4 times a year
*********	In the table above, complete the AER column, correct to Kite Saver account using the following information. AER, as a decimal, is calculated using the formula (1+ where is the nominal interest rate per annum as a decimal arm is the number of compounding periods per annum.	$\left(\frac{i}{n}\right)^n - 1,$

A	$ER = \left(\frac{1+0.067}{4} \right)^{\frac{1}{2}} = 0.0697$	M) AI
07	. Aén = 6.98 %.	Al
(iv)	Explain why banks use AER. Alows customers to make four co	[1]
	was continued to make for C	reparsons.

(a)	Ffion thinks that if interest is paid monthly then the AER% rate is always higher than the Gross annual % rate.	
	Explain why Ffion is correct. [1]	
b	because the interest accumulates after account through	Λ.
(b)	Haygreen Building Society offers customers a range of savings accounts.	
	Mega Plus Gold Save & Grow	
	(i) The Gross annual interest rate on the Mega Plus savings account is 4.8%, with the interest payable monthly. Calculate the monthly interest rate payable on the Mega Plus savings account. 4.8 ÷ 12 = 0.4%	B)
	(ii) Ffion decides to open a Gold savings account on the 1 st May. The interest is paid at a rate of 0·3% per month. She invests £200 in the account. She leaves the account without withdrawing from or making payments into her account for 5 months. Calculate the balance that would be shown on Ffion's Gold savings account statement after this five-month period. [3]	
	200 × 1.003 = \$203.02 BIMI	Ai
(iii)	Haygreen Building Society has another savings account, Save & Grow. This account allows a fixed amount of money to be invested for a 12-month period. Withdrawals or further investments are not allowed. The monthly interest rate is 1.2%. A spreadsheet is used to calculate the balance on the Save & Grow savings account every month. Gareth invests £400 in a Save & Grow savings account. An example of the spreadsheet used to calculate the balance in Gareth's account	

Α	В	С	D	E	F
1	Amount invested £		Monthly interest rate %	Period of investment, x months	Balance after x months
2	400		1.2		
3				1	
4				2	
5				3	
6				4	
7				5	
8				6	
9				7	
10				8	
11				9	
12				10	
13				11	-
14				12	

Write down the formula, using cell references, which could be used to calculate the amount for each of the following cells.

F3		
	=	[2]
F14		
	=	[2

6.

(a) Morleys Building Society had an account called 'Morley's Gold Account' which paid 3-24% Gross.

At that time, the basic rate of tax was 20% and the higher rate of tax was 40%. Complete the following table giving your answers correct to 2 decimal places.

	Gross rate	Net rate for basic rate taxpayers	Net rate for higher rate taxpayers
Morley's Gold Account	3.24%	%	0

NET FOR BASIC = 80% of 3.24	
= 0.8 × 3.24 = 2.59 %	Mi
NET FOR HIGHER= 60% of 3.24	A3
50.6x 3.24 = 1.94%	
	[4]

(b) Alex has £25000 to invest in a savings account. She has picked up a leaflet in *Freads Building Society*. The information shown below is taken from the leaflet.

Freads Building Society	savings ac	count informa	ation, update	ed 04/05/13			
	Term Interest Minimum Maximum						
Oak savings account	2 years	6 monthly	£500	£100000			
Sycamore savings account	2 years	12 monthly	£1000	£50000			

The building society tells Alex that the *Oak savings account* would pay her 2·3% interest every 6 months, and the *Sycamore savings account* would pay her 4·6% per annum.

(i)	Without calculations, which of AER? You must give a reason for you look because the interpretation of the control of the contr	eranswer.	
(ii)	Alex decides to invest her £250 Calculate the difference betwee invest in the <i>Oak savings accounting</i> .	en the interest she would recei	[1] ive if she selected to vings account.
Oak:	25000 × 1.023	= £27380·57	M2 AI
Усти	or: 25000×1046	= £27352.96	MI A)
to diff	Geneve = £27.67		Al
			[6]

Marking Scheme

1.

10. Use of $R = 6$ AND $N = 3$	BI		
$\left[\left(1 + \frac{6}{100 \times 3}\right)^3 - 1\right] \times 100$	M1	Allow FT for $N = 4$ only.	
(AER =) 6.12 (%)	AI	N = 4 leads to an answer of 6.14 (%)	

2.

12.(a)(i) Use of $i = 0.086$	B1	
Use of $n = 4$	Bl	
$(1+0.086/4)^4$ -1	MI	Correct substitution in the formula given
AER 8.88(%)	A2	A1 for 0.088(813467) or incorrect rounding or truncation of the AER percentage
(ii) Explanation, based on need for fair comparison of interest rates	E1	Accept 'percentage of interest paid annually', must mention 'year' or 'annual'
(b) 5.54/100 × 350 or 0.0554× 350	B1	
$(1 + 0.0554)^3 \times 350$ (£) 411.45(21)	M1	May be embedded in further calculation Method of adding on different amounts, 3 year period, following attempts to calculate 5.54% (350+19.39=369.39 369.39+20.46(42)=389.85(42) 389.85+21.597 =)
		Accept 411.44(7)) B1 and SC1 for depreciation 294.99, but no FT
Conclusion, e.g. Yes as more than £410	E1	Accept 5.4% monthly used instead to give an answer of 411.40(15)
	10	FT from their compounded amount provided M1, and FT from simple interest for an answer of 408.17 (408.12 from monthly) being < than 410

3.

9(a) b)5600 × 1.85/100 or 5600 × 0.0185 (= 103.60)	B1	May be embedded in further calculation
$(1+0.0185)^{1.5} \times 5600$	MI	OR sight of a full cumulative method for at least 13 years
(£) 7372(.308954)	ΛΙ	Accept correct evaluation from at least 13years cumulative (e.g. 13years gives (£)7106(.8) to (£)7107) B1 and SC1 for depreciation 4231.97, but no FT
Conclusion, e.g. 'Yes (he will have more than he needs)'	E1	FT interpretation provided B1 and M1 awarded If M0 awarded and simple interest used with interest shown or implied as over (£)1400 for 14 or 15 years award SC1 or with conclusion 'Yes' award SC2. If also stated that using compound interest the amount will be greater award SC3
(b) (AER% =) $100 \left(1 + \frac{2.15}{100 \times 12}\right)^{12} - 100$ OR $100(1 + 2.15 \div (100 \times 12))^{12} - 100 = 2.17(\%)$	В4	For B4 condone missing brackets in the denominator if the answer correct. Award B3 for correct formula (including brackets in the denominator) but incorrect answer between 1 and 5 inclusive. Award B2 for correct formula and answer not between 1 and 5. Award B1 for one error in the formula e.g. missing brackets, 2000 not 100, a 12 missing, 0.0215 used.
Advise, e.g. 'Greenash as more interest (at 2.18%p.a.)'	E1	FT their appropriate interpretation provided at least B2 awarded and APR for Greenash is 2.18%.

11(a) 5.2/100 × 450 or 0.052× 450 or 23.4(0) (1 + 0.052) ⁴ × 450	BI MI	May be embedded in further calculation Method of adding on different amounts, 4 year period, following attempts to calculate 5.2% Example of working without truncation or rounding: (450-23.4(0) = 473.4(0) 473.4(0) + 24.6168 = 498.0168, 498.01 or 498.02 498.0168 + 25.8968736 = 523.9136736 523.9136736 + 27.24351 = 551.15718) Accept 551.15(7) B1 and SC1 for depreciation 363.45(099), but no FT for a conclusion Simple interest answer of 543.6(0) is awarded only the B1
(£) 551.16	Al	
Conclusion, e.g. 'Yes as more than £550'	EI	FT from their compounded amount provided M1, and FT from simple interest from an answer of 543.6(0) being < 550
(b)(i) 0.068 (ii) Greater AND a reason, e.g. 'interest is accumulated through the year (each three months)'	BI El	CAO
(iii) Use of $n = 4$ $(1 + 0.068/4)^4 - 1$ AER 6.98(%)	B1 M1 A2	Correct substitution in the formula given A1 for 0.06975373 rounded or truncated, or incorrect rounding or truncation of the AER percentage. Mark final answer (box takes priority)
(iv) Explanation, based on need for fair comparison of interest rates	E1	Allow 'percentage of interest paid annually', must mention 'year' or 'annual'

5.

10(a) Explains that 'interest is compounded'	EI	
$(b)(i)(4.8 \div 12 =) 0.4\%$	B1	
(ii) 200×1.003^5	M1	
(£)203.02 or (£)203.01	A2	A1 for (£)203.01805 or 203 from
		compound working
		Alternative method
		B1 for a correct 0.3% but not 3%
		MI For the overall method (5 stages of
		adding different 0.3%).
		Accept inappropriate rounding or truncation
		for M1 only, A0
	-	(Calculation:
		(Calculation:
		0.60
		200.60
		0.60(18)
		201.20(18)
		0.60(36054)
		201.805405
		0.60541622
		202.410821
		0.60723246
		203.018053
		Do not ignore subsequent working, penalise -
		1
		If no marks, then SC1 for Simple Interest
		(£)203.00
		A. A
		Accept / for division, * for multiplication
$(iii)(F3=) (1 + D2 \div 100) \times B2 \text{ or } B2 \times D2 \div 100 +$	B2	and ^ for index
B2		B1 for evidence of D2÷100, or D2×B2, or
or equivalent		1.012×B2, or 1.012×400 or equivalent
or equivalent		B0 for 404.8(0)
consist or est cond constants are some	B2	120 101 101.0(0)
(F14=) $(1 + D2 = 100)^{12} \times B2$ or equivalent	152	Accept cell E14 for indication of '12'.
		B1 for sight of power 12 linked to cell D2,
		or for $(1 + D2 \div 100)^{x} \times B2$,
		or (1+D2/100)^12*B2,
		or (1+D2/100)^E14*B2,
		or equivalent
	9	or for their formula for F3 with appropriate
		index provided equivalent difficulty

12(a) 3.24 × 0.8 OR 3.24 × 0.60 2.59(%) AND 1.94(%)	MI A3	Or other complete method A2 for 2.59(2) AND 1.94(4) A1 for either 2.59(2) OR 1.94(4) If no marks SC1 for sight of digits 2592 and 1944 (incorrect place value), OR for 0.65 and 1.3(0)
(b)(i) Oak AND a reason showing understand of AER	E1	Reason must say about comparing annually Accept 'Oak, because they give more interest (annually)'
(ii) Oak	M2	Or for alternative complete method
(Total amount after 2 years = £)25000 × 1.023 ⁴	1012	compounding 4 times, or M1 for 2.3% × 25000 (= £575)
(Total amount £)27380.57(37) OR (Interest £)2380.57(3696)	Al	Do not accept other rounding or truncation
Sycamore		
(Total amount after 2 years = £)25000 \times 1.046 ²	MI	Or alternative complete method
(Total amount £)27352.9(0) OR (Interest £)2352.9(0)	AI	Do not accept other rounding or truncation
(Difference in interest is £) 27.67	ВІ	FT provided M mark(s) for Oak or Sycamore
	11	awarded, with all this answer to nearest penny

3.1 AER

Specification statement (Higher tier, Mathematics - Numeracy and Mathematics)

Carrying out calculations relating to enterprise, saving and borrowing, investing, appreciation and depreciation, and understanding annual rates, e.g. AER, APR.

Notes

1. AER = annual equivalent rate.

This gives the percentage interest earned in a savings or investment account in one year. It enables **comparison** of rates between different lenders and accounts which pay interest at different frequencies e.g. each month, quarter, 6 months.

Example

A savings account is advertised as paying 4.28% interest on an investment of £100, with interest payments made once every 3 months.

The interest rate is therefore divided by 4 (the number of times it is paid per year) to give $4.28 \div 4 = 1.07\%$.

After the first 3 months, the account is worth £100 \times 1.0107 = £101.07.

*** It would be an easy mistake to assume that the additional amount paid every 3 months is always £1.07 ***

The interest is COMPOUNDED every 3 months.

After 6 months, the account is worth £101.07 \times 1.0107 OR £100 \times 1.0107² = £102.15

After 9 months, the account is worth £102.15 \times 1.0107 OR £100 \times 1.0107³ = £103.24

After 12 months, the account is worth £103.24 \times 1.0107 OR £100 \times 1.0107⁴ = £104.35

From the value of the savings afer 12 months, it appears that the AER is 4.35%.

This value could have been calculated more quickly using the formula

$$\left(1+\frac{j}{n}\right)^n-1$$

where i is 'the nominal interest rate per annum', in this case 4.28%, and n is 'the number of compunding periods per annum', in this case $12 \div 3 = 4$. Then we have

$$\left(1 + \frac{4 \cdot 28}{4} \right)^{n} - 1$$

$$= 1.043491..... - 1$$

$$= 0.043491 \quad \text{OR} \quad 4.35\% \text{ (2 d.p.)}$$

It is vital to understand that **compounding** the interest has the effect of 'increasing' the percentage interest rate

e.g. 1% compound interest per month for 1 year gives greater interest than 12% as an annual rate.

2. APR = annual percentage rate

This measures the cost of borrowing money. The calculation includes fees charged by the lender for setting up the loan.

3. EAR = equivalent annual rate

Again, this measures the cost of borrowing money, though this time in the form of an overdraft.

Examples of examination questions on AER

From the formula list given at the beginning of a Higher tier paper:

Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula $\left(1+\frac{i}{n}\right)^n-1$, where i is the nominal interest rate per annum as a decimal and n is the number of compounding periods per annum.

1. June 13 Applications of Mathematics Unit 2 Higher

(a) Morleys Building Society had an account called 'Morley's Gold Account' which paid 3-24% Gross.

At that time, the basic rate of tax was 20% and the higher rate of tax was 40%. Complete the following table giving your answers correct to 2 decimal places.

	Gross rate	Net rate for basic rate taxpayers	Net rate for higher rate taxpayers
Morley's Gold Account	3-24%	%	9

[4]

(b) Alex has £25000 to invest in a savings account. She has picked up a leaflet in Freads Building Society. The information shown below is taken from the leaflet.

Freads Building Society savings account information, updated 04/05/13					
	Term Interest paid		Minimum	Maximum	
Oak savings account	2 years	6 monthly	£500	£100000	
Sycamore savings account	2 years	12 monthly	£1000	£50000	

The building society tells Alex that the *Oak savings account* would pay her 2.3% interest every 6 months, and the *Sycamore savings account* would pay her 4.6% per annum.

(i) Without calculations, which of these savings accounts would have the greater AER?

You must give a reason for your answer.

[1]

(ii) A lex decides to invest her £25 000 for two years. Calculate the difference between the interest she would receive if she selected to invest in the Oak savings account rather than the Sycamore savings account. Show all your working.

[6]

2. June 2012 Applications of Mathematics Unit 2 Higher

Adam is interested in opening a savings account at Morris Bank.

The manager of Morris Bank explains to Adam that they have two different savings accounts. Some details of the accounts are shown below.

Account	Nominal interest rate	AER Annual Equivalent Rate, correct to 2 decimal places
Quarter Back	8-6% p.a., paid quarterly	9/6
Monthly Goal	5.4% p.a., paid monthly	5-54%

 (a) (i) In the table above, complete the AER column in the table for the Quarter Back account using the information given below.

[5]

(ii) Explain why AER is used by the bank.

[1]

3. January 14 Applications of Mathematics Unit 2 Higher

Haygreen Building Society offers customers a range of savings accounts.



 The Gross annual interest rate on the Mega Plus savings account is 4-8%, with the interest payable monthly.

Calculate the monthly interest rate payable on the Mega Plus savings account.

[1]

(ii) Ffion decides to open a Gold savings account on the 1st May.

The interest is paid at a rate of 0-3% per month.

She invests £200 in the account.

She leaves the account without withdrawing from or making payments into her account for 5 months.

Calculate the balance that would be shown on Ffion's Gold savings account statement after this five-month period. [3]

Mark schemes for examination questions on AER

1. June 13 Applications of Mathematics Unit 2 Higher

12(a) 3.24 × 0.8 OR 3.24 × 0.60 2.59(%) AND 1.94(%)	M1 A3	Or other complete method A2 for 2.59(2) AND 1.94(4)
		A1 for either 2.59(2) OR 1.94(4) If no marks SC1 for sight of digits 2592 and 1944 (incorrect place value), OR for 0.65 and 1.3(0)
(b)(i) Oak AND a reason showing understand of AER (ii) Oak	E1	Reason must say about comparing annually Accept 'Oak, because they give more interest (annually)'
(Total amount after 2 years = £)25000 \times 1.023 ⁴	M2	Or for alternative complete method compounding 4 times, or M1 for 2.3% × 25000 (= £575)
(Total amount £)27380.57(37) OR (Interest £)2380.57(3696)	A1	Do not accept other rounding or truncation
Sycamore (Total amount after 2 years = £)25000 \times 1.046 ²	M1	Or alternative complete method
(Total amount £)27352.9(0) OR (Interest £)2352.9(0)	A1	Do not accept other rounding or truncation
(Difference in interest is £) 27.67	B1	FT provided M mark(s) for Oak or Sycamore awarded, with all this answer to nearest penny

2. June 2012 Applications of Mathematics Unit 2 Higher

12.(a)(i) Use of i = 0.086	Bl	
Use of $n = 4$	Bl	
$(1 + 0.086/4)^4$ -1	M1	Correct substitution in the formula given
AER 8.88(%)	A2	A1 for 0.088(813467) or incorrect
(ii) Explanation, based on need for fair comparison of interest rates	El	rounding or truncation of the AER percentage Accept 'percentage of interest paid annually', must mention 'year' or 'annual'

3. January 14 Applications of Mathematics Unit 2 Higher

10(a) Explains that 'interest is compounded'	El	
(b)(i) (4.8 ÷ 12 =) 0.4%	Bl	
(ii) 200 × 1.003 ⁵	Ml	
(£)203.02 or (£)203.01	A2 .	A1 for (£)203.01805 or 203 from
		compound working
		Alternative method
		B1 for a correct 0.3% but not 3%
		MI For the overall method (5 stages of
		adding different 0.3%).
		Accept inappropriate rounding or truncation
		for M1 only, 40
		Calculation:
		200
		0.60
	-	200.60
		0.60(18)
	-	201.20(18)
		0.60(36054)
	-	201.805405
		0.60541622
	-	202.410821
	-	0.60723246
		203.018053)
		Oo not ignore subsequent working, penalise -
		f no marks, then SC1 for Simple Interest
	(£)203.00

Further examples of questions can be found on the WJEC website in Unit 2 Higher Applications of Mathematics papers (4362/02) from January 2011 onwards (January and June series).