IB MATHS AI SL · UNIT 1

Number Patterns and Finance: exam practice

10 questions · 54 marks · worked solutions and markschemes

Name _____ Date _____ Score / 54

- Answer every question before you look at the solutions. They start after the last question, with the marks for each line: M for method, A for accuracy, R for reasoning.
- Online, with more practice: ibmathrevision.com/slai/number-patterns-and-finance-exam-practice

1. **3 marks · Paper 1 style · calculator allowed**

The mean distance from the Earth to the Sun is 1.496×10^8 km. Light travels at 3.00×10^5 km s^{-1}.

Find the time it takes light to travel from the Sun to the Earth, giving your answer in minutes. **[3]**

2. **3 marks · Paper 1 style · calculator allowed**

A culture starts with 2.5×10^3 bacteria. The number doubles every 20 minutes.

Find the number of bacteria after 5 hours, giving your answer in the form $a \times 10^k$. **[3]**

3. **5 marks · Paper 1 style · calculator allowed**

Use the summation tool on your Graphic Display Calculator to evaluate the following series:

$$\sum_{n=1}^{20} \left(4(1.05)^{n-1} + 3n\right)$$

Show the values you entered into your calculator or write down the exact sequence formulas used.

4. **4 marks · Paper 1 style · calculator allowed**

(a) Calculate $\dfrac{6.4 \times 10^{8}}{1.6 \times 10^{3}}$, giving your answer in the form $a \times 10^{k}$. **[2]**

(b) Calculate $3.2 \times 10^{4} + 5.1 \times 10^{3}$, giving your answer in the form $a \times 10^{k}$. **[2]**

5. **4 marks · Paper 1 style · calculator allowed**

€5000 is invested for 6 years.

(a) Find the value of the investment with 4% simple interest per year. **[2]**

(b) Find the value of the investment with 4% interest per year, compounded annually. **[2]**

6. **5 marks · Paper 1 style · calculator allowed**

Tom invests $6000\ \text{EUR}$ in an account that pays 4.2% nominal annual interest, **compounded monthly**.

1. Using your GDC, calculate the value of his investment after exactly 5 years.
2. Calculate the time, in full months, for the investment to double.

7. **4 marks · Paper 2 style · calculator allowed**

Lucia's starting salary is €$42\,000$ a year. It increases by 3% each year.

(a) Find her salary in her sixth year. **[2]**

(b) Find the total she earns in her first 10 years. **[2]**

8. **5 marks · Paper 1 style · calculator allowed**

A ping pong ball is dropped from a height of $200\ \text{cm}$. After each bounce, it reaches a height that is exactly 80% of its previous height.

1. Find the height of the 4th bounce.
2. Find the total vertical distance travelled by the ball up to the point when it strikes the ground for the 5th time.

9. **6 marks · Paper 1 style · calculator allowed**

A theatre has 25 rows of seats. There are 20 seats in the first row, and each row has 3 more seats than the row in front of it.

(a) Find the number of seats in the last row. **[2]**

(b) Find the total number of seats in the theatre. **[2]**

(c) Find which row has 74 seats. **[2]**

10. **15 marks · Paper 2 style · calculator allowed**

A family takes out a mortgage of €$350\,000$ to buy a house. The loan is for 25 years at a nominal annual interest rate of 4.5%, **compounded monthly**. Repayments are made at the end of each month.

1. Calculate the fixed monthly repayment amount.
2. Calculate the outstanding balance of the loan at the end of 10 years.
3. Calculate the total interest paid during the first 10 years.
4. If they decide to pay €2500 per month instead of the minimum repayment, find the number of **full months** it will take to pay off the loan.

Answers and worked solutions

Question 1 — 3 marks

Answer: 8.31 minutes

$\frac{1.496 \times 10^8}{3.00 \times 10^5}$ **(M1)**

$498.7\ s$ **(A1)**

8.31 minutes **A1**

Question 2 — 3 marks

Answer: 8.19×10^7

15 doublings **(A1)**

$2.5 \times 10^3 \times 2^{15}$ **(M1)**

8.19×10^7 **A1**

Question 3 — 5 marks

Answer: 762

1. Evidence of using GDC Summation tool $\sum$ OR splitting into geometric and arithmetic formulas. **(M2)**
   Geometric Part:
   $S_{20} = \frac{4(1.05^{20}-1)}{0.05} = 132.26\ldots$ **(A1)**
   Arithmetic Part:
   $S_{20} = \frac{20}{2}(3+60) = 630$. **(A1)**
   Total $= 762.26\ldots \implies 762$. **A1**

Question 4 — 4 marks

Answer: (a) 4×10^5; (b) 3.71×10^4

(a)

$\frac{6.4}{1.6} \times 10^{8-3}$ **(M1)**

4×10^5 **A1**

(b)

$32\,000 + 5100 = 37\,100$ **(M1)**

3.71×10^4 **A1**

Question 5 — 4 marks

Answer: (a) €6200; (b) €6326.60

(a)

$5000 + 5000 \times 0.04 \times 6$ **(M1)**

€6200 **A1**

(b)

5000×1.04^6 **(M1)**

€6326.60 **A1**

Question 6 — 5 marks

Answer: (a) 7399.35; (b) 199

1. GDC App:
   $N = 60,\ I\% = 4.2,\ PV = -6000,\ PMT = 0,\ P/Y = 12,\ C/Y = 12$
   (M1)(A1)
   $FV = 7399.35\ \text{EUR}$ **A1**
2. Set $FV = 12000$ (with $PV = -6000$) and solve for N **(M1)**
   $N = 198.39\ldots$ months, so round up to full months: 199 months **A1**

Question 7 — 4 marks

Answer: (a) €$48\,689.51$; (b) €$481\,482.93$

(a)

$42\,000 \times 1.03^5$ **(M1)**

€$48\,689.51$ **A1**

(b)

$S_{10} = \frac{42\,000(1.03^{10}-1)}{0.03}$ **(M1)**

€$481\,482.93$ **A1**

Question 8 — 5 marks

Answer: (a) 81.92; (b) 1144.64

1. The first bounce reaches $200 \times 0.8 = 160$ cm, so the nth bounce height is $200(0.8)^n$:
   $u_4 = 200(0.8)^4$ **(M1)**
   $u_4 = 81.92\ \text{cm}$ **A1**
2. The ball drops 200 cm, then travels up and down for bounces 1 to 4 before the 5th strike.
   Distance $= 200 + 2 \times \sum_{n=1}^{4} 200(0.8)^n$ OR $200 + 2(160 + 128 + 102.4 + 81.92)$ **(M1)(A1)**
   Total distance $= 200 + 2(472.32) = 1144.64\ \text{cm}$ ($1140\ \text{cm}$ to 3 s.f.) **A1**

Question 9 — 6 marks

Answer: (a) 92; (b) 1400; (c) row 19

(a)

$20 + 24 \times 3$ **(M1)**

92 **A1**

(b)

$\frac{25}{2}(20 + 92)$ **(M1)**

1400 **A1**

(c)

$20 + 3(n-1) = 74$ **(M1)**

row 19 **A1**

Question 10 — 15 marks

Answer: (a) 1945.41; (b) 254304.67; (c) 137754.31; (d) 199

1. GDC finance app:
   $N = 300, I\% = 4.5, PV = 350000, FV = 0, P/Y = 12, C$
   . **(M1)(A1)**
   $PMT = -1945.41\ldots \implies$ €1945.41 per month. **A1**
2. GDC finance app after 10 years:
   $N = 120, I\% = 4.5, PV = 350000, PMT = -1945.41, P$
   . **(M1)(A1)**
   $FV = -254304.67\ldots$ **(A1)**
   Outstanding balance $=$ €$254\,304.67$ (accept €$254\,305$). **A1**
3. Interest paid = total repaid − principal repaid. **(M1)**
   Total repaid $= 1945.41\cdots \times 120 =$ €$233\,449.64$. **(A1)**
   Principal repaid $= 350000 - 254304.67 =$ €$95\,695.33$. **(A1)**
   Interest $= 233449.64 - 95695.33 =$ €$137\,754.31$ (accept €$137\,754$). **A1**
4. GDC finance app:
   $I\% = 4.5, PV = 350000, PMT = -2500, FV = 0, P/Y =$
   , solve for N. **(M1)(A1)**
   $N = 198.889\ldots$ **(A1)**
   198 full payments do not clear the loan, so a 199th month is needed: 199 months. **A1**

Every solution is also on ibmathrevision.com/slai/number-patterns-and-finance-exam-practice
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