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VCE Mathematical Methods ¾
Differentiation II [2.2]
Test Solutions

20.5 Marks. 10 Minutes Writing.

Results:

Test Questions	_____ / 13.5
Extension Test Questions	_____ / 7

Section A: Test Questions (13.5 Marks)

Question 1 (3.5 marks)

Tick whether the following statements are **true** or **false**.

	True	False
a. If the function is undefined at $x = a$, the limit is also always undefined at $x = a$.		✓
b. A function is continuous if the limit is defined.		✓
c. For a function to be differentiable, it must be continuous and the gradient from the left and right must be the same.	✓	
d. When joined smoothly, the function is NOT differentiable.		✓
e. When the function's positive gradient is getting steeper, then it is concave down.		✓
f. Points of inflection occur when the concavity of the function changes.	✓	
g. Not all points of inflection are stationary points of inflection. However, all stationary points of inflection are points of inflection.	✓	

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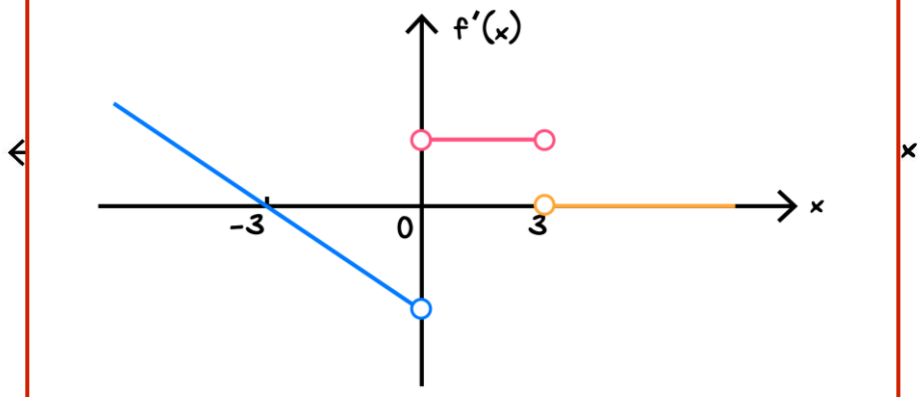
Question 2 (4 marks)

The diagram below shows the graph of a function with domain R.

Marks	0	1	2	3	Average
%	39	22	14	25	1.2



a. For the graph shown above, sketch, on the same set of axes, the graph of the derivative function. (3 marks)

b. Hence, state the domain of the derivative function. (1 mark)

Marks	0	1	Average
%	55	45	0.5

$R\backslash\{0,3\}$

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Question 3 (3 marks)

Consider the function:

$$f(x) = \begin{cases} ax^2 + 4 & -5 \leq x \leq 1 \\ \sin(x-1) + b & 1 < x \leq 3 \end{cases}$$

a. Find the value of a and b such that the graph joins smoothly at $x = 1$. (2 marks)

```
[1]:= f[x_] := a * x^2 + 4

[2]:= g[x_] := Sin[x - 1] + b
       |사인

[3]:= Solve[f[1] == g[1] && f'[1] == g'[1], {a, b}]
      |풀이 함수

t[3]= {{a → 1/2, b → 9/2}}
```

b. Hence, state the domain of the derivative function. (1 mark)

$-5 < x < 3$

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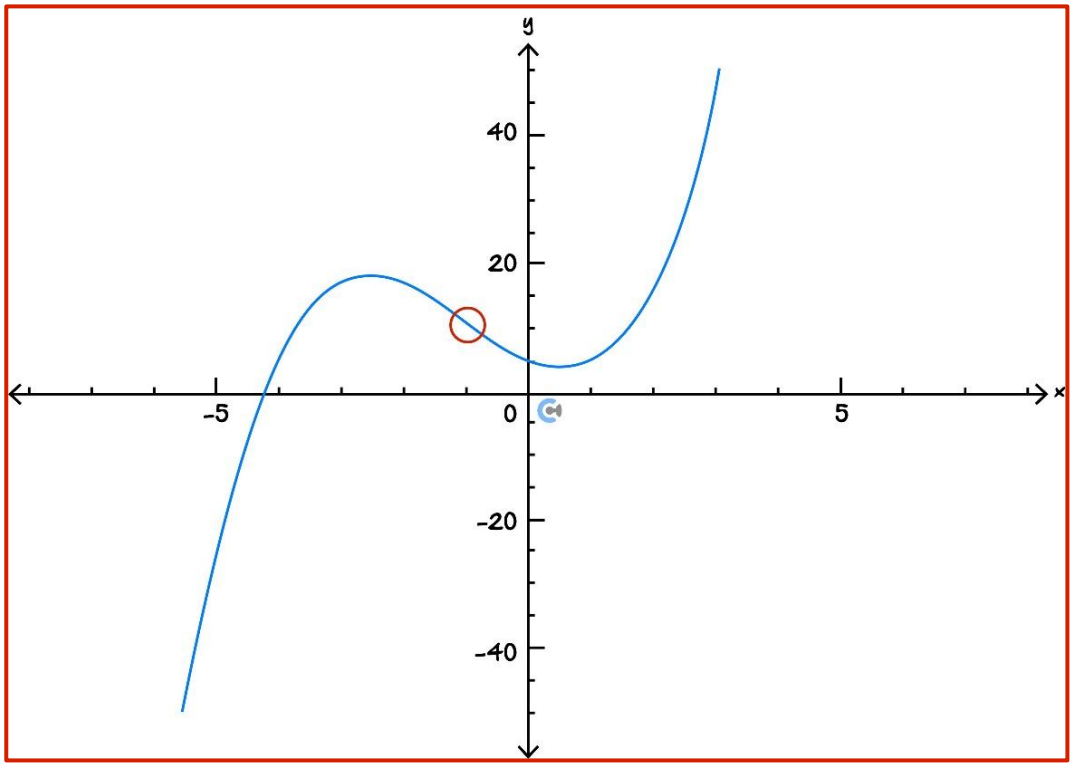
Question 4 (3 marks)

a. Circle the point of inflection on the graph below. (1 mark)



b. State whether at $x = -3$ the gradient is increasing or decreasing. Hence, state the concavity at $x = -3$. (2 marks)

Gradient is decreasing as it is concave down.

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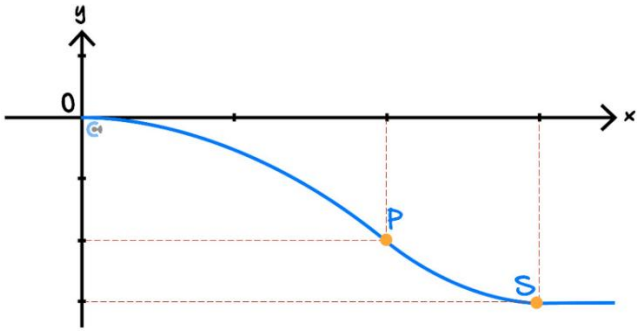
Section B: Extension Test Questions (7 Marks)

Question 5 (7 marks) **Tech-Active.**

Engineers are designing a track for a new railway station to be built underground.

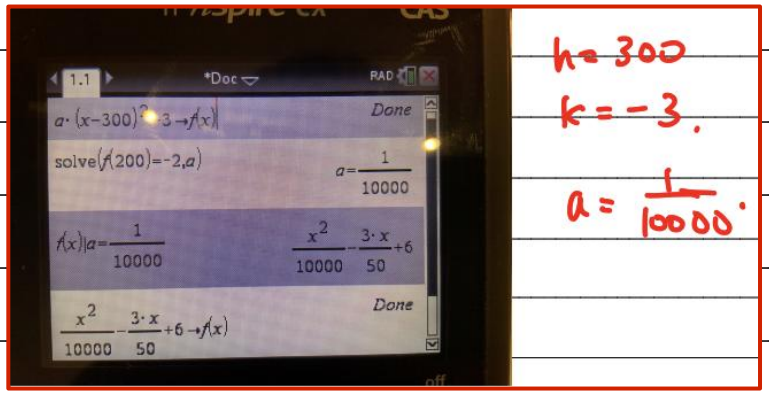


The coordinates of the station, to be positioned at S, are $(300, -3)$. The floor at S is **parallel** to the ground.

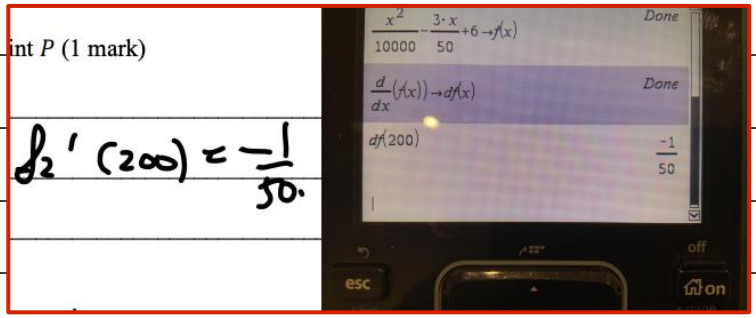
Two separate pieces of track OP and PS are to be built, that join smoothly at P: $(200, -2)$.

The rule that defines the track PS is given by $f_2(x) = a(x-h)^2 + k$, where $a, h, k \in R$.

a. Solve for the values of a, h and k. (2 marks)



b. Find the gradient of the track at point P. (1 mark)

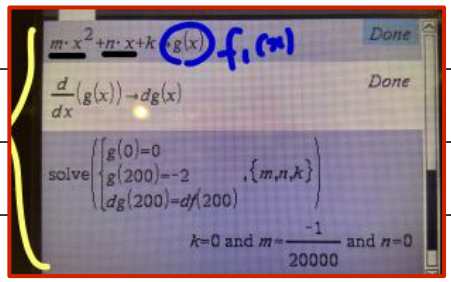


The rule defining track OP is given by $f_1(x) = mx^2 + nx + k$, where $m, n, k \in R$.

c. Construct three equations involving m, n and k. (2 marks)

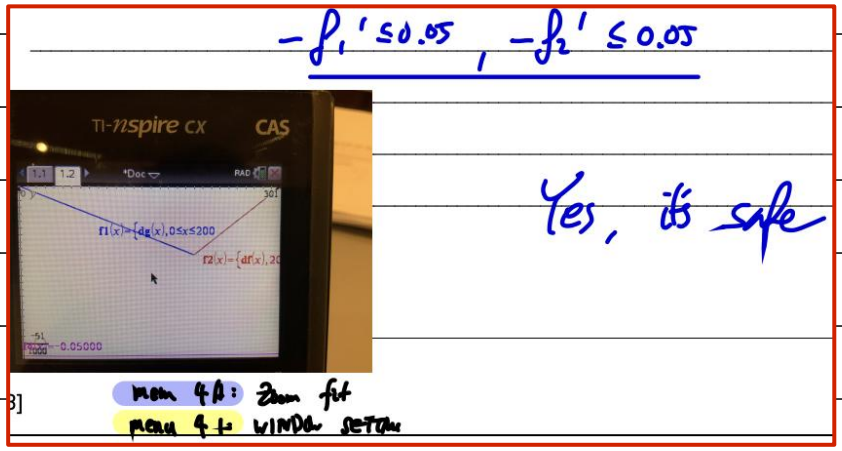
1) $f_1(0) = 0$
2) $f_1(200) = -2$
3) $f_{1'}(200) = -\frac{1}{50}$; "Join Smoothly"

d. Hence, find the values of m, n and k. (1 mark)



It is considered too dangerous if the magnitude of the gradient of the track exceeds 0.05 at any point.

e. Does the design of this track meet the safety requirements? (1 mark)



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