OCR
RECOGNISING ACHIEVEMENT

SPECIMEN

Advanced Subsidiary GCE
PHYSICS A

G481 QP

Unit G481: Mechanics

Specimen Paper

Candidates answer on the question paper.

Time: 1 hour

Additional Materials:
  Data and formulae sheet
  Electronic calculator

Candidate Name

Centre Number

Candidate Number

INSTRUCTIONS TO CANDIDATES

- Write your name, Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Use blue or black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Do **not** write in the bar code.
- Do **not** write outside the box bordering each page.
- WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [] at the end of each question or part question.
- ✎ Where you see this icon you will be awarded marks for the quality of written communication in your answer.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.
- The total number of marks for this paper is **60**.

FOR EXAMINER'S USE

Qu.	Max.	Mark
1	12	
2	8	
3	8	
4	9	
5	12	
6	6	
7	5	
TOTAL	**60**	

This document consists of **14** printed pages and **2** blank pages.

[Turn Over

Answer **all** the questions.

1

(a) (i) Define *speed* of an object. Explain how you would determine the constant speed of a conker at the end of length of string being whirled in a horizontal circle.

....

....

....

....

....

....

....

.... **[3]**

(ii) Define *velocity* of an object.

🖉 *In your answer, you should use appropriate technical terms, spelled correctly.*

....

.... **[1]**

(iii) By reference to speed and velocity, explain the difference between a scalar quantity and a vector quantity, using as an example the terms *speed* and *velocity*.

....

....

....

.... **[2]**

(b) Fig.1.1 shows a long rope that is tied at one end to a high support. A girl swings forwards and backwards across a pool using the other end of the rope.
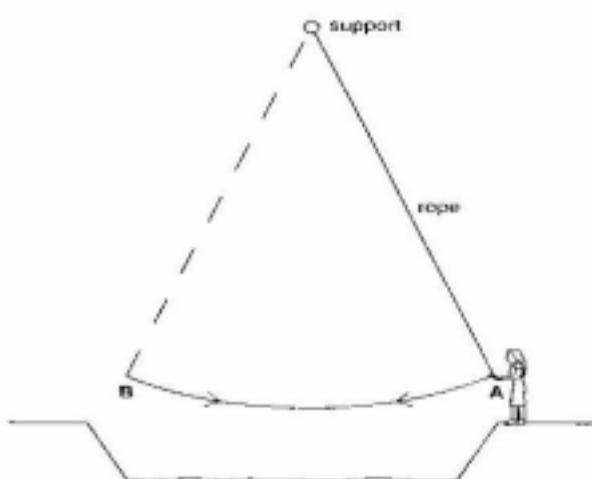
Fig.1.1

Fig.1.2 shows the variation with time *t* of the displacement *x* of the girl from **A** to **B** and back to **A**.
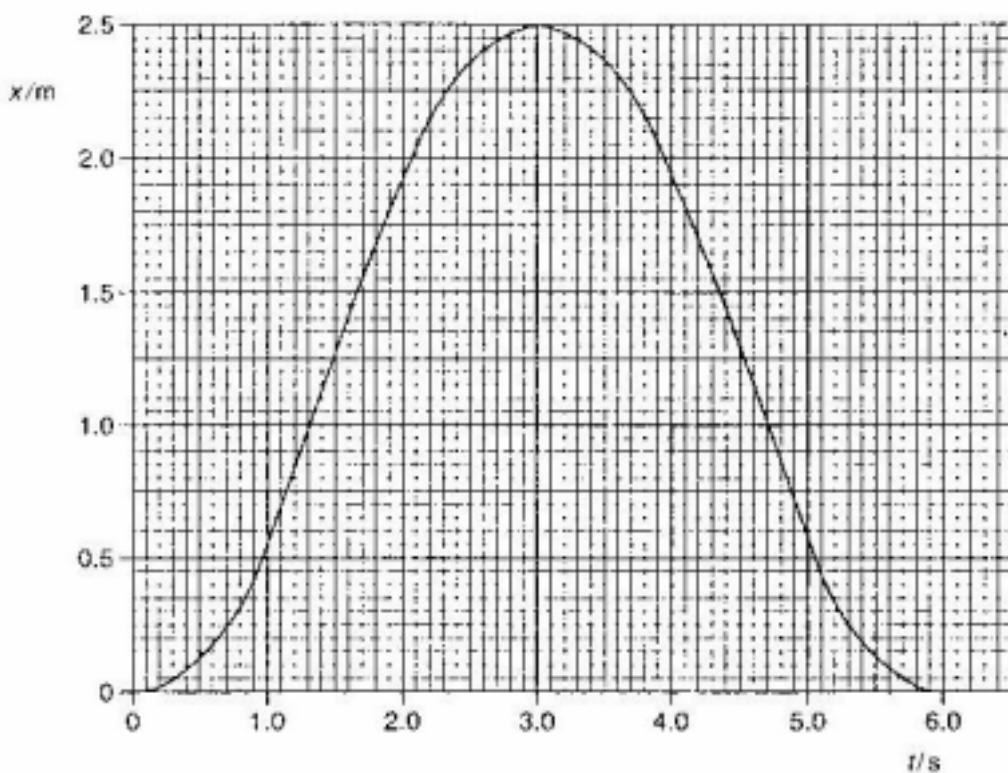
**Fig.1.2**

(i) State what the gradient of the graph represents and explain why the graph shows both positive and negative gradients.

....

....

....

.... **[2]**

(ii) Mark on Fig.1.2 with a cross a position where the speed of the girl is zero (label this **Z**).**[1]**

(iii) 1. Explain how you can determine using Figure 1.2 that the maximum speed of the girl is about 1.4ms⁻¹.

....

....

....

2. Estimate the uncertainty in the value of the maximum speed obtained in this way.

....

....

....**[2]**

[Total: 13]

2

(a) Define *acceleration*.

....

.... **[1]**

(b) An aircraft of total mass 1.5×10^5 kg accelerates, at maximum thrust from the engines, from rest along a runway for 25 s reaching the required take-off speed of 65 m s^{-1}.

Assume that the acceleration of the aircraft is constant. Calculate

(i) the net force acting on the aircraft to produce this acceleration

force = ... N **[3]**

(ii) the distance travelled by the aircraft in this time.

distance = ... m **[2]**

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(c) At a particular airport, the length of the runway for the same take-off speed is less than your answer in **(b)(iii)**. State and explain what change could be made to the aircraft to enable it to reach the required take-off speed on this shorter runway.

....

....

....

.... **[2]**

[Total: 8]

[Turn over

3

(a) Define

(i) *power*

....

.... **[1]**

(ii) a *joule.*

....

.... **[1]**

(b) A force *F* acts on an object. The object moves at an angle θ to this force. Explain why the work done *W* by the force in the direction of motion of the object is not just

$$W = Fx$$

but is equal to

$$W = Fx \cos\theta$$

✎In your answer, you should use appropriate technical terms, spelled correctly..............................

....

....**[1]**

(c) Fig.3.1 shows a part of a fairground ride with a carriage on rails.

3.9m

30°
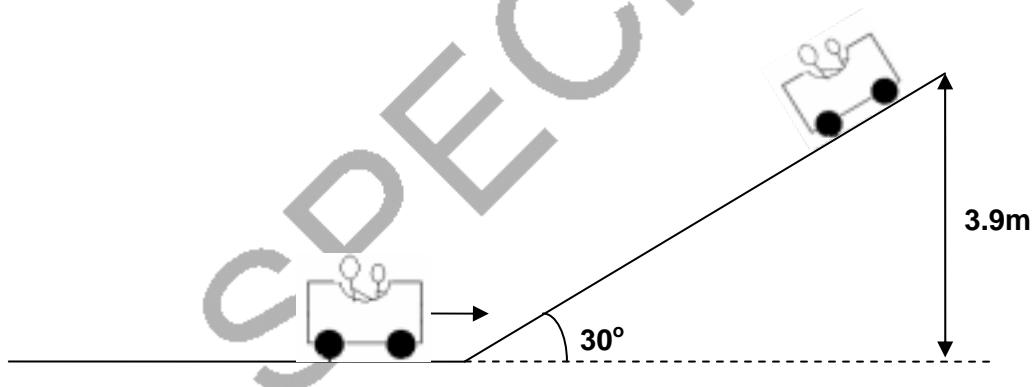
Fig. 3.1

The carriage of mass 500 kg is travelling towards a slope inclined at 30° to the horizontal. The carriage has a kinetic energy of 25 kJ at the bottom of the slope. The carriage comes to rest after travelling up the slope to a vertical height of 3.9 m.

(i) Show that the gravitational potential energy gained by the carriage is 19 kJ. **[2]**

(ii) Calculate the total work done against the resistive forces as the carriage moves up the slope.

work done = ... kJ **[1]**

(iii) Calculate the magnitude of the resistive force acting against the carriage as it moves up the slope.

resistive force = ... N **[2]**

[Total: 8]

[Turn over

4

(a) State Hooke's law.

....

.... **[2]**

(b) Fig. 4.1 shows the variation of the applied force F with the extension x for a particular spring.

force/ N

extension /
x (x10^{-3}m)
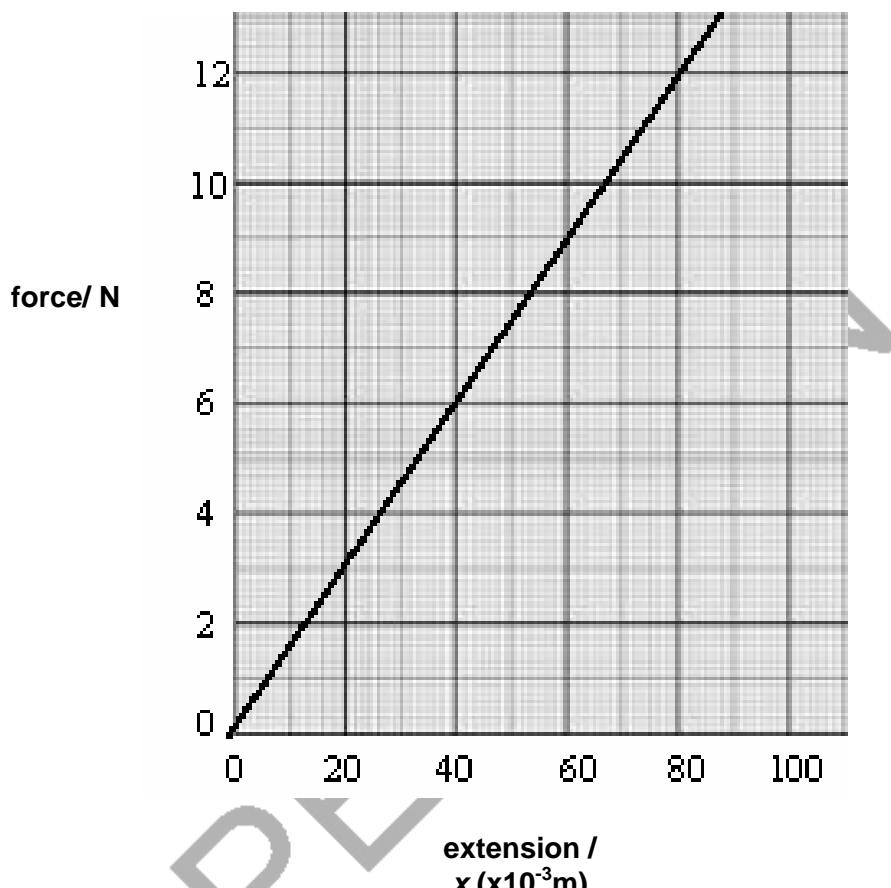
Fig. 4.1

(i) Use Fig. 4.1 to determine the force constant of the spring.

force constant = ...N m^{-1} **[2]**

(ii) Determine the elastic potential energy stored in the spring when a force of 20 N is applied.

energy stored = ... J **[2]**

(iii) State one assumption made in your calculation of the energy in **(ii)**.

....

....**[1]**

(iv) The energy stored in the spring is used to propel a metal ball of mass m horizontally. There is 100% transfer of energy from the spring to the ball. Show how the speed v of the metal ball is proportional to the extension x of the spring. Find the constant of proportionality.

....

....

....**[2]**

[Total: 9]

[Turn over

5

(a) Explain the following terms in relation to motion of a road vehicle.

  (i) *braking distance*

  ....

  .... **[1]**

  (ii) *thinking distance*

  ....

  .... **[1]**

(b) A car of mass 800 kg is travelling at a speed of 20 m s^{-1}. Calculate

  (i) the kinetic energy of the car

  kinetic energy = ... J **[2]**

  (ii) the deceleration of the car when the braking distance is 24 m.

  deceleration = ... m s^{-2} **[2]**

(c) Describe in terms of the forces acting on the driver how wearing a seat belt and having an airbag in a car can help to protect the driver from injury in a head on collision.

  ....

  ....

  ....

  ....

  ....

  ....

  ....

  .... **[4]**

(d) The wearing of seat belts became law in the UK in January 1983. Fig. 5.1 shows the annual deaths due to road accidents in Scotland since 1950.
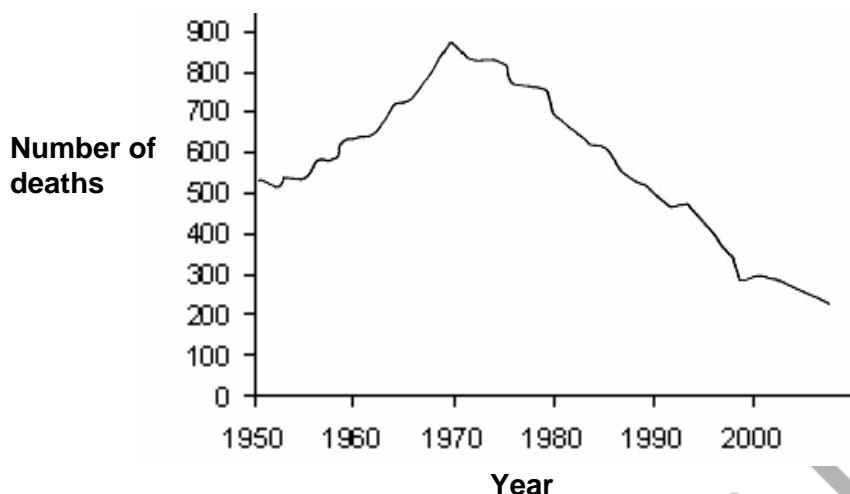
Fig. 5.1

The percentage of car drivers wearing seat belts in 1983 and at present has remained static at 93 %. On average, cars are travelling faster now than in 1983. Suggest another factor which may have been responsible for the decrease in deaths.

....

....

....

.... **[1]**

[Total: 11]

[Turn over

6

(a) State two conditions that are necessary for an object to be in equilibrium.

....

.... **[2]**

(b) Fig. 6.1 shows a computer resting on a tabletop that is hinged at point **A**.
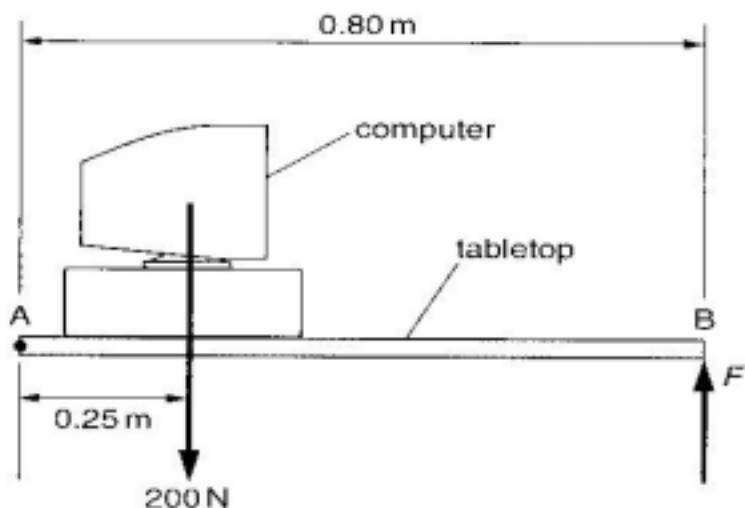
Fig. 6.1

The tabletop has a mass of 5.0 kg and its centre of gravity is 0.40 m from the axis of the hinge **A**. The computer has a weight of 200 N acting through a point 0.25 m from the hinge **A**. The tabletop is supported to maintain it in a horizontal position by a force F acting vertically at **B**. The distance AB is 0.80 m.

Calculate the force F applied at **B** that is required to maintain the tabletop in equilibrium.

force $F =$ .... N **[3]**

(c) Explain why the force F and the 200 N force shown in Fig. 6.1 cannot be a couple.

....

....**[1]**

[Total: 6]

7 (a) Define *the Young modulus* of a material.

....

.... **[1]**

(b) Explain why the quantity strain has no units.

....

.... **[1]**

(c) Explain what is meant by a brittle material.

....

.... **[1]**

(d) Define the ultimate tensile strength of a material. Suggest why an engineer designing a suspension bridge should know the value of this quantity for all his materials.

....

....**[2]**

[Total: 5]

Paper Total [60]

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Advanced Subsidiary GCE

PHYSICS A   G481

Unit G481: Mechanics

Specimen Mark Scheme

The maximum mark for this paper is **60**.

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Question Number	Answer	Max Mark
1(a)(i)	Speed is the rate of change of distance / speed = distance/time	**[B1]**
	Determine the circumference of the circle / Use $2\pi r$ to find distance	**[B1]**
	Measure the time for one revolution (using a stopwatch) (speed = circumference/time)	**[B1]**
(ii)	Velocity is the rate of change of displacement / velocity = change in displacement/time	
	The term *displacement* to be <u>included</u> and spelled correctly to score the mark.	**[B1]**
(iii)	Scalar has magnitude only, e.g: speed	**[B1]**
	Velocity has <u>both</u> magnitude and direction, e.g: velocity	**[B1]**
(b)(i)	The gradient is equal to velocity	**[B1]**
	The girl travels in two opposite directions (wtte)	**[B1]**
(ii)	**Z** at any peak or trough / **A** / **B** / 3.0 (s) / 6.0 (s)	**[B1]**
(iii)	Draw tangent at maximum gradient of graph	
	Draw two tangents and find gradients, uncertainty = ± difference in gradients/2; result, e.g. ±0.1ms^{-1}	**[4]**
2(a)	Acceleration is the rate of change of velocity / $a = (v - u)/t$ with symbols explained	**[B1]**
(b)(i)	$a = 65/25$	
	$a = 2.6$ (m s^{-2})	**[C1]**
	$F = ma$ $\quad\quad\quad\quad / F = 1.5 \times 10^5 \times 2.6$	**[C1]**
	$F = 3.9 \times 10^5$ (N) (Possible ecf)	**[A1]**
(ii)	$s = (u + v)t/2$ $\quad\quad / \quad\quad s = (0 + 65) \times 25/2$	**[C1]**
	$s = 813 \approx 810$ (m)	**[A1]**
(c)	Reduce the mass of the aircraft	**[B1]**
	Correct explanation, e.g: Smaller mass means greater acceleration (wtte).	**[B1]**
3(a)(i)	power is the rate of work done / power = energy/time	**[B1]**
(ii)	When a force of 1 N moves 1 m in the direction of the force, then the work done is equal to 1 joule	**[B1]**
(b)	The <u>component</u> of the force in the direction of the force is $F\cos\theta$.	
	The term *component* to be included and spelled correctly to gain the mark.	**[B1]**
(c)(i)	$E_p = mgh$	
	$E_p = 500 \times 9.81 \times 3.9$	**[C1]**
	$E_p = 19130 \approx 19000$ (J)	**[A1]**
(ii)	work done = (25 - 19 =) 6 (kJ)(5.870 kJ if 19130 J used)	**[B1]**
(iii)	distance up the slope = 3.9/sin30 (=7.8)	**[C1]**
(iii) cont'd	(Work = *Fx*) force = $(5870/7.8 =) 753$ (N) (769 N if 6000 J used)	**[A1]**

Question Number	Answer	Max Mark
4(a)	The extension of a spring is directly proportional to the applied force	**[M1]**
	as long as the elastic limit is not exceeded)	**[A1]**
(b)(i)	Correct pair of values read from the graph	
	force constant = 12/0.080	**[C1]**
	force constant = 150 (N m^{-1})	**[A1]**
(ii)	extension, $x = \dfrac{20}{12} \times 80 (= 133.33)$ (mm)	**[C1]**
	($E = \frac{1}{2} Fx$)	
	energy = $1/2 \times 20 \times 133.33 \times 10^{-3}$	
	energy = 1.33 (J)	**[A1]**
(iii)	The spring has not exceeded its elastic limit	**[B1]**
(iv)	(elastic potential energy = kinetic energy)	
	$\dfrac{1}{2} kx^2 = \dfrac{1}{2} mv^2$	**[M1]**
	m and k are constant, therefore $v \propto x$.	**[M1]**
5(a)(i)	Braking distance is the distance travelling by the car when the brakes are applied and the car stops	**[B1]**
(ii)	Thinking distance is the distance travelled by the car in the time taken by the driver to react	**[B1]**
(b)(i)	($E_k = 1/2 mv^2$)	
	$E_k = 1/2 \times 800 \times 20^2$	**[C1]**
	$E_k = 1.6 \times 10^5$ (J)	**[A1]**
(ii)	($v^2 = u^2 + 2as$)	
	$0 = 20^2 + (2 \times a \times 24)$	**[C1]**
	$a = (-)8.3$ (m s^{-2})	**[A1]**
(c)	**Four** from:	
	Prevents the driver from hitting the steering wheel / windscreen	
	Deflates quickly to prevent whiplash	
	Increases the time/distance to stop	
	Decreases the (impact) force on the driver	
	Much wider area of the bag reduces the pressure	**[B1× 4]**
(d)	No, because the percentage of drivers wearing seat belts is the same	
	There must be other factors like safer cars / crumble zones / side-impact bars / etc	**[B1]**
6(a)	The net force acting on the object must be zero	**[B1]**
6(a) cont'd	The net moment (about any point) must also be zero	**[B1]**
(b)	Taking moments about **A**, we have	
	Sum of clockwise moments = sum of anticlockwise moments	**[C1]**
	$(0.25 \times 200) + (5.0 \times 9.81 \times 0.4) = 0.8F$	**[C1]**

Question Number	Answer	Max Mark
	F = 87 (N)	**[A1]**
(c)	These forces are opposite but not equal in magnitude .	**[B1]**
7(a)	Young modulus = stress/strain (As long as elastic limit is not exceeded)	**[B1]**
(b)	Strain has no units because it is the ratio of two lengths.	**[B1]**
(c)	A brittle material does not have a plastic region / it breaks at its elastic limit.	**[B1]**
(d)	Ultimate tensile strength is breaking stress for a material	**[B1]**
	Materials can be chosen / tested to prevent collapse of the bridge	**[B1]**
	Paper Total	**[60]**

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Assessment Objectives Grid (includes QWC)

Question	AO1	AO2	AO3	Total
1(a)(i)	3			**3**
1(a)(ii)	1			**1**
1(a)(iii)	2			**2**
1(b)(i)	2			**2**
1(b)(ii)		1		**1**
1(b)(iii)		0	4	**4**
2(a)	1			**1**
2(b)(i)		3		**3**
2(b)(ii)		2		**2**
2(c)		2		**2**
3(a)(i)&(ii)	2			**2**
3(b)	1			**1**
3(c)(i)		2		**2**
3(c)(ii)		1		**1**
3(c)(iii)		2		**2**
4(a)	2			**2**
4(b)(i)			2	**2**
4(b)(ii)		2		**2**
4(b)(iii)	1			**1**
4(b)(iv)		2		**2**
5(a)(i)&(ii)	2			**2**
5(b)(i)		2		**2**
5(b)(ii)		2		**2**
5(c)	4			**4**
5(d)			1	**1**
6(a)	2			**2**
6(b)		3		**3**
6(c)	1			**1**
7(a)(i)	1			**1**
7(a)(ii)	1			**1**
7(a)(iii)	1			**1**
7(b)	1	1		**2**
Totals	**28**	**26**	**6**	**60**

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