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| Candidate<br>Name | Centre<br>Number | Candidate<br>Number |
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## GCE AS/A level

1321/01

### PHYSICS

### PH1: MOTION ENERGY AND CHARGE

A.M. WEDNESDAY, 13 January 2010

1½ hours

#### ADDITIONAL MATERIALS

In addition to this examination paper, you will require a calculator and a **Data Booklet**.

#### INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

#### INFORMATION FOR CANDIDATES

The total number of marks available for this paper is 80.

The number of marks is given in brackets at the end of each question or part question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

| For Examiner's use only |              |              |
|-------------------------|--------------|--------------|
| Question                | Maximum Mark | Mark Awarded |
| <b>1.</b>               | <b>8</b>     |              |
| <b>2.</b>               | <b>11</b>    |              |
| <b>3.</b>               | <b>9</b>     |              |
| <b>4.</b>               | <b>20</b>    |              |
| <b>5.</b>               | <b>18</b>    |              |
| <b>6.</b>               | <b>14</b>    |              |
| <b>Total</b>            | <b>80</b>    |              |

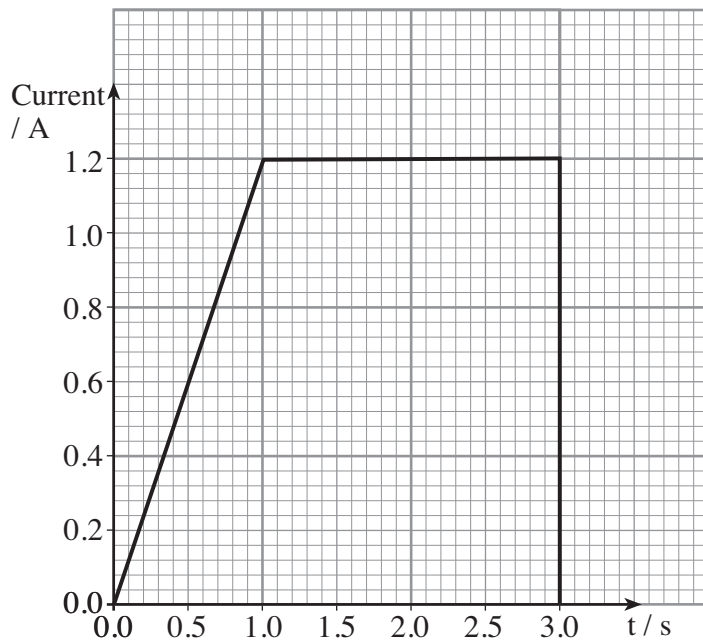
1. (a) Explain what is meant by an electric current. [1]

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- (b) The current through a conductor changes with time over a period of 3.0 s as shown.

- (i) By considering the area under the graph calculate the total charge passing through the conductor in this time. [2]



- (ii) Calculate the total number of electrons flowing past a point in the conductor in this time. [2]

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- (iii) Calculate the drift velocity of the electrons at  $t = 1.5$  s. Take the cross-sectional area of the conductor to be  $2.0 \times 10^{-6} \text{ m}^2$  and the number of free electrons per  $\text{m}^3$  to be  $1.0 \times 10^{29} \text{ m}^{-3}$ . [3]

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2. (a) Explain how electrical resistance arises in metal conductors.

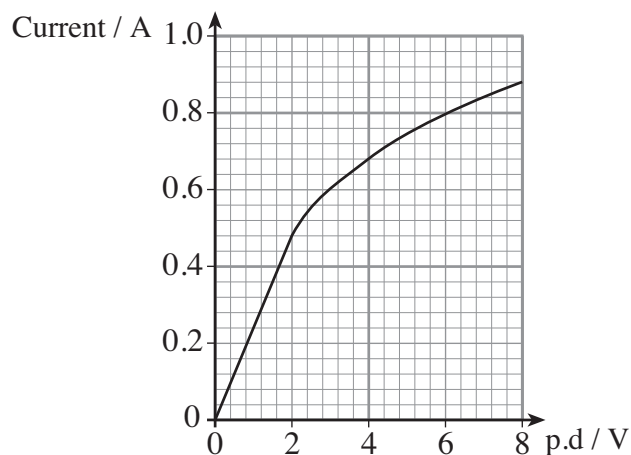
[3]

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(b) A current-voltage graph for a filament lamp is shown.



(i) Describe how the **resistance** of the lamp changes as the voltage across it increases over the range

(I) 0 V – 2 V;

[1]

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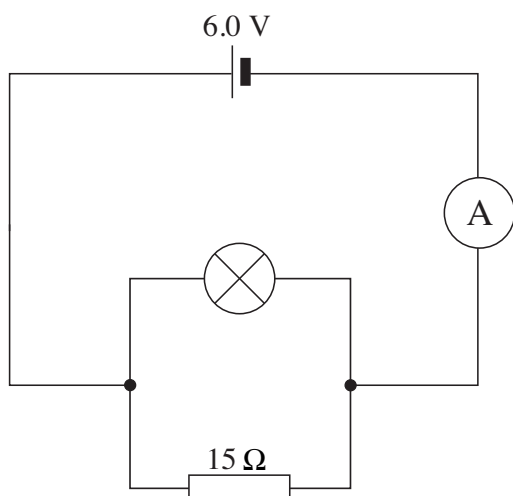
(II) 2 V – 8 V.

[1]

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(ii) The lamp is connected in parallel to a  $15\Omega$  resistor and to a 6 V supply as shown. Calculate the current through the ammeter.

[4]



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(iii) Calculate the power dissipated in the circuit.

[2]

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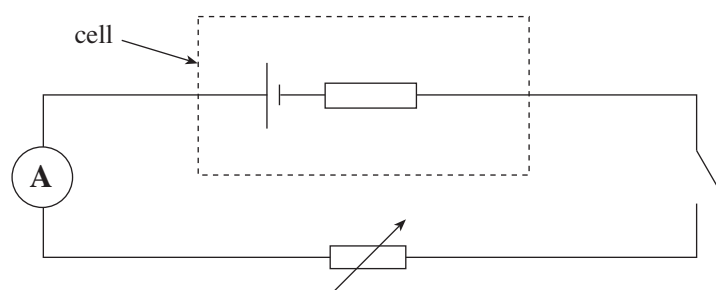
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3. (a) Define the *e.m.f.* of a cell. [2]

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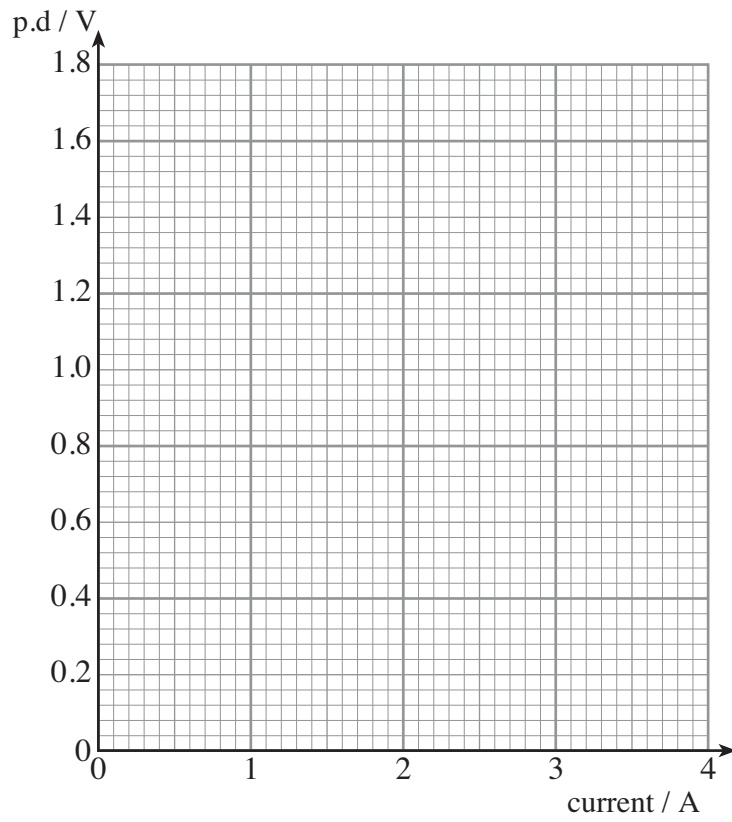
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- (b) A student sets up the following circuit to find the e.m.f. and internal resistance of a cell. Complete the circuit diagram by adding a voltmeter. [1]



- (c) With the circuit complete the student obtains the following results. Plot these results on the grid and draw a line through your points. [3]

| p.d. across cell terminals /V | Current /A |
|-------------------------------|------------|
| 1.4                           | 0.6        |
| 1.2                           | 1.2        |
| 1.0                           | 1.8        |
| 0.8                           | 2.4        |
| 0.6                           | 3.0        |



(d) Use your graph to determine

(i) the e.m.f of the cell; [1]

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(ii) the internal resistance of the cell. [2]

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4. (a) (i) Define *mean speed*. [1]

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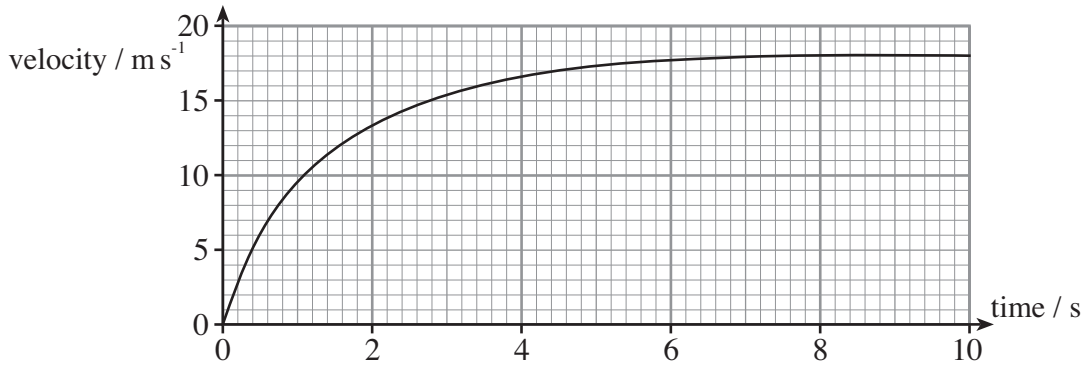
- (ii) The distance between two towns, A and B, is 240km. A motorcycle travels from A to B at a mean speed of 80km/h and then back from B to A at a mean speed of 60km/h. Calculate the mean speed for the whole journey. [3]

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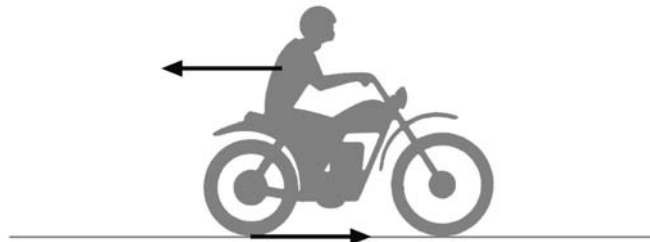
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- (b) The graph represents the motion of the motorcycle over a 10 s period.



- (i) Label the forces represented by arrows on the diagram below. [1]



- (ii) Describe, without calculation, how the **resultant force** acting on the motorcycle varies over this 10 second interval. [3]

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- (iii) By drawing a suitable tangent, determine the resultant force acting on the motorcycle at  $t = 2.0$  s. The mass of the motorcycle and rider is 350 kg. [3]

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(c) (i) Define *work done*. [2]

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(ii) A force  $F$  acts on a body moving with a velocity  $v$ .  $F$  and  $v$  are in the same direction. Starting from the definition of power, show that [2]

$$\text{Power} = Fv$$

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(iii) When the motorcycle in part (b) is travelling at the steady velocity shown in the graph, the useful power output by the engine is 40 kW. Calculate the **driving force** required to maintain this velocity. [1]

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(iv) Assuming this driving force remains constant throughout the motion, calculate the resistive force acting on the motorcycle at  $t = 2.0\text{ s}$ . [1]

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(d) At a later time the motorcycle brakes until it stops. When this happens, brake pads are forced into contact with the wheel discs.

(i) State the Principle of Conservation of Energy. [1]

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(ii) Explain what happens to the motorcycle's kinetic energy. [2]

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5. (a) (i) Draw a labelled diagram of the apparatus you could use to determine the relationship between the resistance and length of a wire. [3]

(ii) State what measurements you need to make. [2]

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(iii) What further measurement would you need to make to determine the resistivity of the metal and what apparatus would you use to make this measurement? [1]

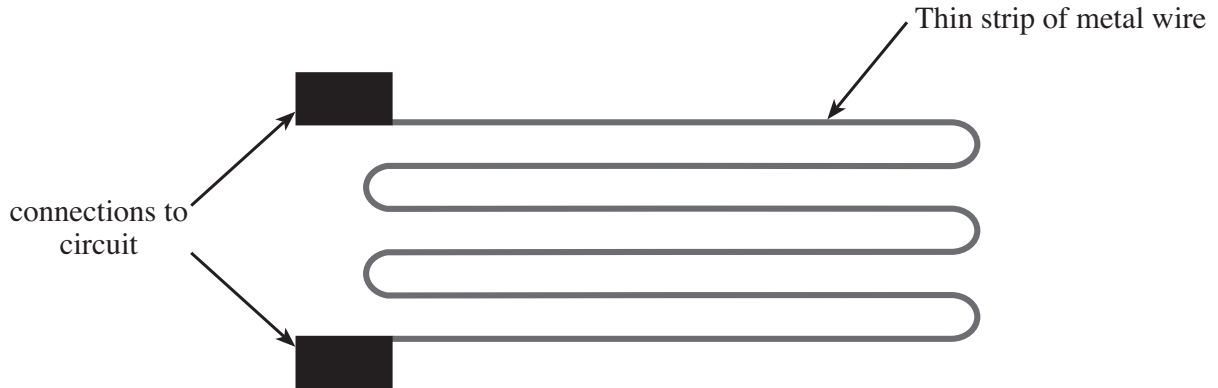
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(iv) Explain how a value of the resistivity is determined from your measurements. [3]

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(b) A strain gauge is a device used to monitor distortions in structures such as bridges and buildings. It consists of a thin strip of metal wire as shown which is then attached to the structure under test.



(i) When the structure extends, the wire in the strain gauge gets **thinner** and **longer** thus changing its resistance. Using the resistivity equation explain whether the resistance of the strain gauge increases or decreases when the structure extends. [4]

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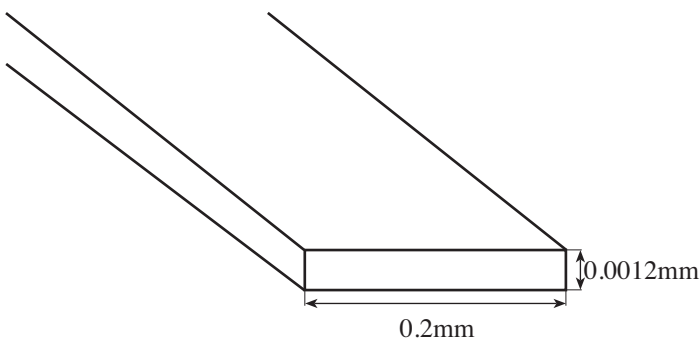
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(ii) Calculate the resistivity of the metal in a strain gauge which has a resistance of  $650 \Omega$  and a total length of 32 cm. The thin metal strip is 0.2 mm wide and 0.0012 mm thick as shown. [2]



Thin metal strip (magnified - not to scale)

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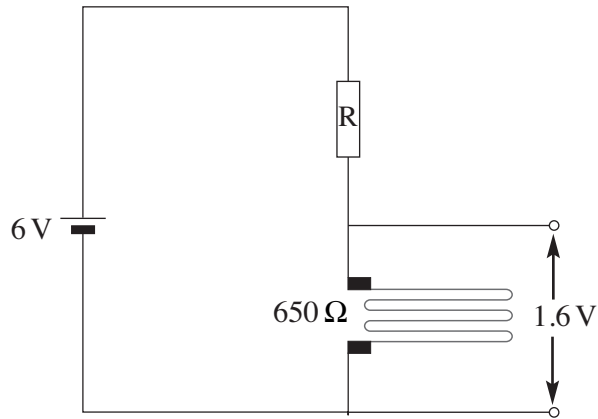
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- (iii) The changing resistance of a strain gauge is monitored using a potential divider circuit. The gauge is placed in series with a fixed resistor  $R$  as shown. Calculate the value of  $R$  which will give a p.d. of  $1.6\text{ V}$  across the strain gauge. [3]



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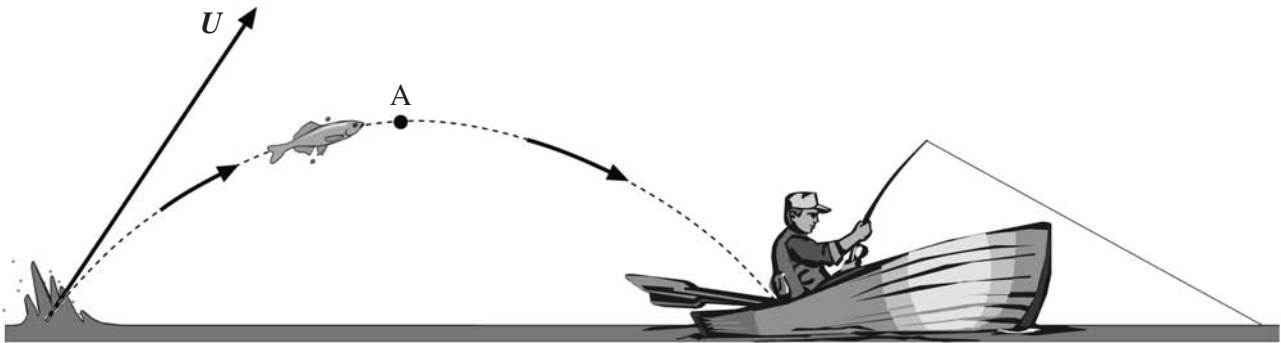
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**QUESTION 6 IS ON PAGE 12**

6. The Silver Carp is a fish which was accidentally introduced to the Mississippi river in the 1990s. It has since bred to such an extent that the river has become overpopulated with them. Many are seen to jump out of the water and they sometimes land in the boats of fishermen. **[Ignore air resistance throughout this question].**



- (a) The trajectory (flight path) of a Silver Carp is shown. Point **A** represents the highest point on the trajectory. Draw arrows at **A** to show
- (i) the direction of motion of the Carp at this instant. (Label this arrow **D**);
  - (ii) the force (or forces) acting on the Carp at this instant. (Label this/these arrow(s) **F**). [2]
- (b) A fisherman wishes to determine the velocity with which a Carp left the water (shown by the vector labelled **U**). The fisherman makes the following estimations:

Horizontal distance travelled by the Carp = 4.50 m  
 Time of flight = 1.50 s  
 Maximum height = 2.75 m

Use this information to calculate:

- (i) the horizontal component of the velocity of the Carp; [1]

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- (ii) the initial vertical velocity of the Carp; [3]

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- (iii) the magnitude of the velocity ( $U$ ) with which the Carp left the water. [2]

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- (c) Your answer to (b) (iii) can be checked by considering the energy changes that take place during the Carp's flight.

- (i) Calculate the **total** energy possessed by the Carp at point A. [Assume the Carp has mass 6.0 kg] [3]

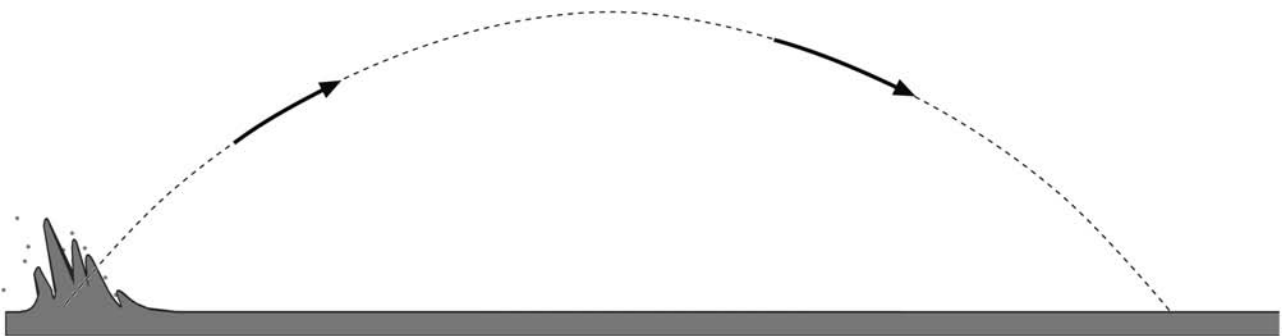
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- (ii) Below is a sketch of the Carp's trajectory but this time without the boat included. Mark on the diagram **two** points where the Carp will have its greatest kinetic energy. [Label both points with a letter **K**]. [1]



- (iii) Use your answer to (c) (i) to show that the Carp's initial velocity ( $U$ ) is the same as that calculated in (b) (iii). [2]

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