Candidate Name	Centre Number	Candidate Number

WJEC CBAC

GCE AS/A level

1321/01   **New AS**

PHYSICS
PH1: Motion Energy and Charge

P.M. THURSDAY, 21 May 2009

$1\frac{1}{4}$ 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**
1.	10	
2.	10	
3.	9	
4.	6	
5.	9	
6.	10	
7.	15	
8.	11	
Total	**80**	

2

1. *(a)* Define *acceleration*.

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[1]

(b) (i) Two horizontal forces of 12 N and 8 N are applied to a toy car of mass 2.0 kg which is on a level surface. Calculate the maximum and minimum acceleration that could be experienced by the car.

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[3]

(ii) Sketch a free-body diagram showing these forces when the car has minimum acceleration. [2]

(c) At a later time, the following condition applies to the toy car:

$$\Sigma F = 0$$

Complete the table below, indicating with a tick in one column, whether each of the statements given 'must be true', 'could be true' or 'cannot be true' when the above condition applies. [4]

Statement	Must be true	Could be true	Cannot be true
The car is accelerating.			
The car is stationary.			
The car is moving at constant speed.			
There are no forces acting on the car			

2.
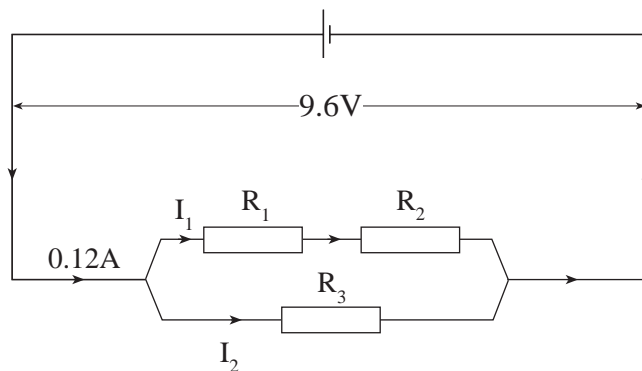
In the above circuit resistors R_1, R_2 and R_3 are identical.

(a) Explain why $I_1 = 0.04$ A and $I_2 = 0.08$ A.

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[4]

(b) State the p.d. across

   (i) R_1, ... (ii) R_3, ... [2]

(c) Calculate

   (i) the resistance of R_2;

....

....

[2]

   (ii) the total effective resistance of the combination of the three resistors.

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....

[2]

Turn over.

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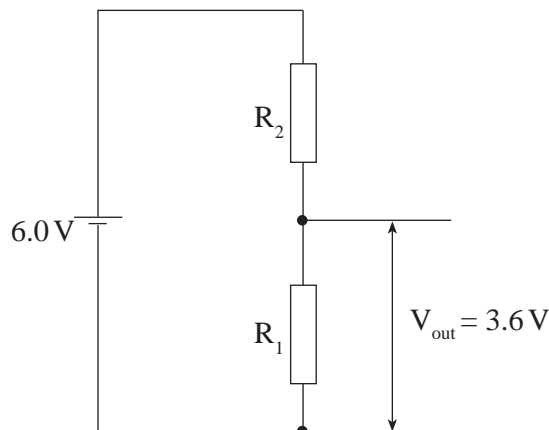**3.** A technician wishes to obtain a voltage of 3.6 V from a battery of e.m.f. 6.0 V and negligible internal resistance. He uses the following potential divider circuit where resistor R_1 has a resistance of 225 Ω.

6.0 V

R_2

R_1

$V_{out} = 3.6$ V

(a) (i) State what a voltmeter would read if it were placed across resistor R_2.

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[1]

(ii) Calculate the value of R_2.

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....
[4]

(b) In order to conserve the life of the battery, the technician replaces resistor R_1 with one which has resistance 2250 Ω.

(i) Describe one other change he should make to the potential divider circuit in order to maintain the desired output voltage.

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[1]

(ii) Show clearly the effect that these changes have on the current in the circuit.

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[3]

4. *(a)* A student writes the following:

Superconducting wires do not become hot because electrons can flow through them without there being any transfer of energy.

Explain carefully, in terms of electrons, how energy is transferred in a normal conductor and why it does not occur in superconductors.
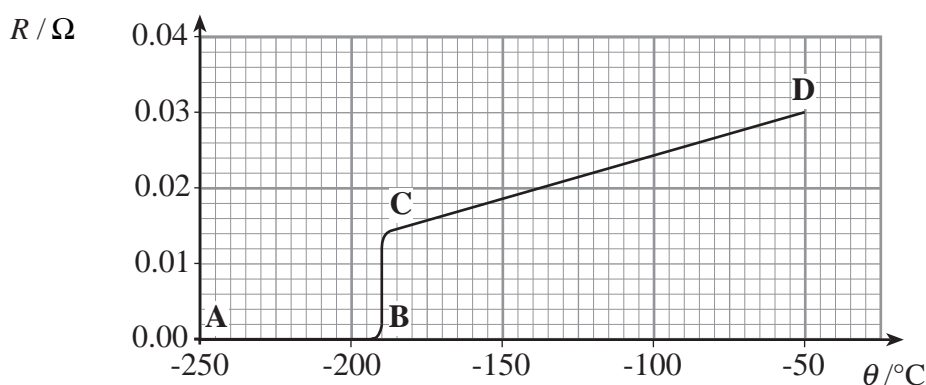
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[3]

(b) The graph shows how the resistance, R, of a compound of europium varies with temperature, θ, for very low temperatures.

(i) Determine the superconducting transition temperature of the compound of europium.

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[1]

(ii) In what region of the graph would a potential difference of 0 V be required to maintain a current?

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[1]

(c) Certain 'high temperature superconductors' have transition temperatures which are above - 196 °C. State how these materials can be kept in their superconducting state.

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[1]

Turn over.

6

5. *(a)* Explain what is meant by an electric current.

....
[1]

(b) The current, *I*, in a wire of cross-sectional area A is given by the formula.

$$I = nAve$$

(i) Derive the formula, giving a clearly labelled diagram.

....

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....
[4]

(ii) Calculate the mean drift velocity in a wire of cross-sectional area $2.0\,mm^2$ carrying a current of 3.0 A. The free electron density is $5.0 \times 10^{28}\,m^{-3}$

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[2]

(iii)
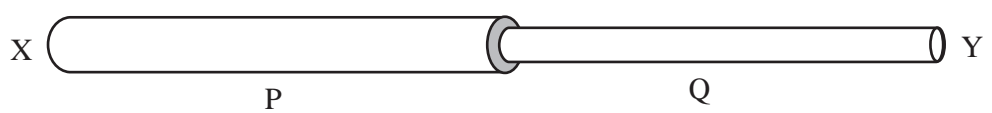
Two copper wires, P and Q, are connected in series. P has 2 times the cross-sectional area of Q. A battery is connected between the ends, X and Y, of the combination. Complete the following sentences.

(I) The current in Q is .... the current in P. [1]

(II) The electron drift velocity in P is .... the electron drift velocity in Q. [1]

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Turn over.

6. High-sided lorries are vulnerable to cross-winds when crossing motorway bridges. The force, *F*, exerted by wind on the side of a lorry can be given by

$$F = \rho A v^2$$

where ρ = density of air (kg m^{-3}), *A* = side area of the lorry and *v* = speed of the wind.

(a) (i) Show that the equation is correct in terms of units (or dimensions).

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[3]

(ii) The side of a certain lorry is (effectively) 15.0 m long and 4.2 m high. The force exerted on one side of the lorry by a cross-wind is 2.8×10^4 N. Use this information to estimate the speed of the wind. (Density of air = 1.2 kg m^{-3}).

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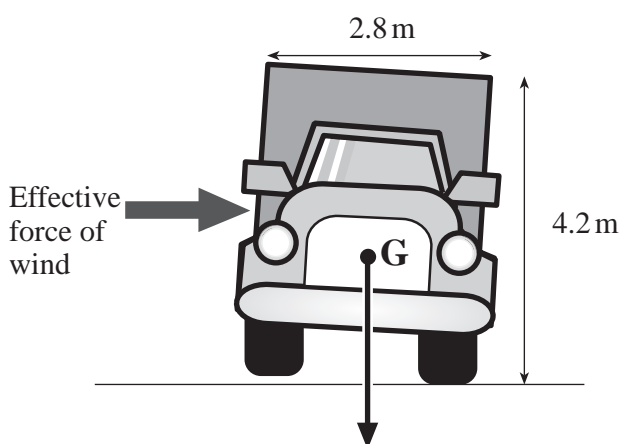[2]

(b) When crossing a bridge, the lorry experiences a different cross-wind which causes it just to tilt as shown in the diagram.

(i) 'G' represents that point where the weight of the lorry is considered to act. Name this point.

....
[1]

(ii) If the lorry stays tilted as shown, the sum of the clockwise moments about the pivot must equal the sum of the anticlockwise moments about the same pivot. Clearly label the pivot on the diagram.
[1]

(iii)   Taking the force of the wind to act at a point **midway** up the side of the lorry, calculate the force needed to maintain the tilt as shown. The weight of the lorry is 1.0×10^5 N and its width is 2.8 m.

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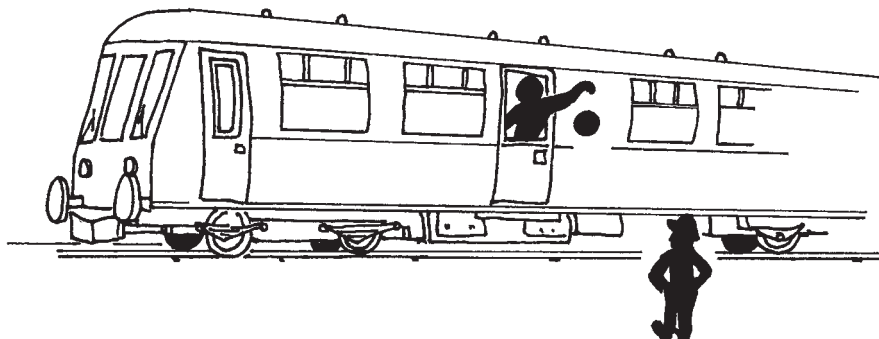
[3]

Turn over.

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7. A passenger on a train, moving at constant speed, drops a ball out of a window as shown. A stationary observer is standing near the track and directly in front of the window when the ball is dropped.

(a) (i) If air resistance is neglected, describe and explain the **horizontal** motion of the ball as seen by the passenger.

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[2]

(ii) Describe the horizontal motion of the ball as seen by the observer.

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[1]

(b) If air resistance is now taken into account, how will your answers to *(a)* (i) and (ii) have to be modified?

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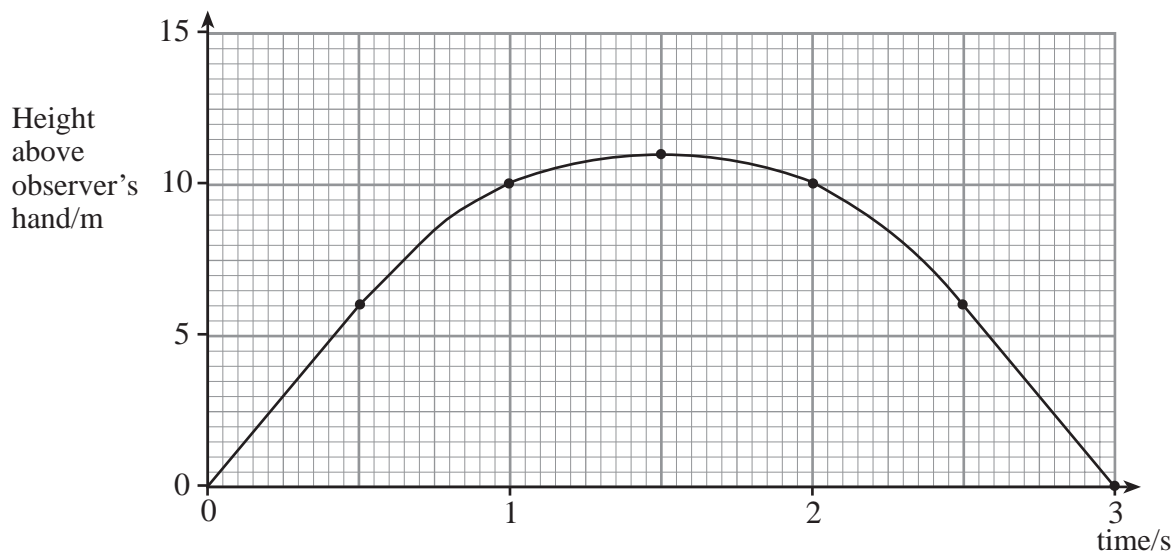..

[3]

(c) The observer retrieves the ball and throws it vertically upwards, catching it on its return. A graph of height (from the observer's hand) against time is shown.


(i) How can you tell from the graph that the air resistance now acting on the ball is negligible?

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[1]

(ii) By considering the maximum height reached, determine the initial upward velocity of the ball.

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[3]

(iii)   Use your answer to *(c)* (ii) and other data from the graph on the previous page to draw a velocity-time graph for the **whole** of the ball's flight. The time axis has been completed for you.   [5]
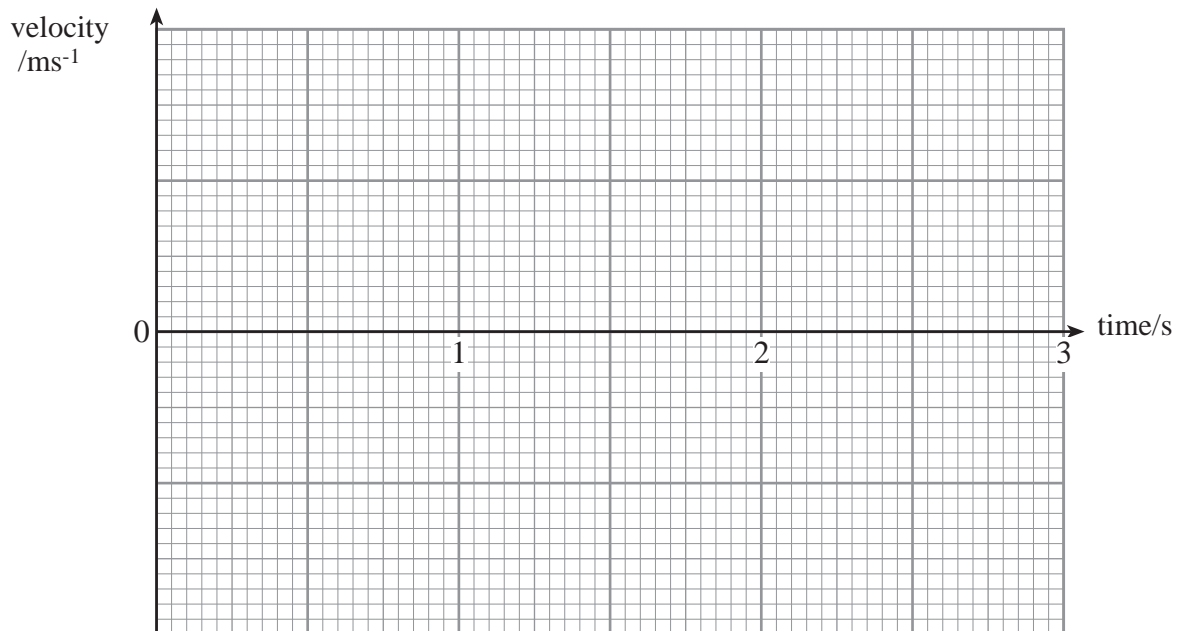
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QUESTION 8 is on page 14

Turn over.

8. *(a)* State the principle of conservation of energy.

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[2]

(b) A 'bungee jumper' standing on a high platform above the ground is attached to a bungee cord of **unstretched** length 26 m and spring constant k. When she jumps she falls a maximum distance of 96 m where she is momentarily stationary at the lowest point of her jump and about to begin moving upwards. Ignore air resistance.
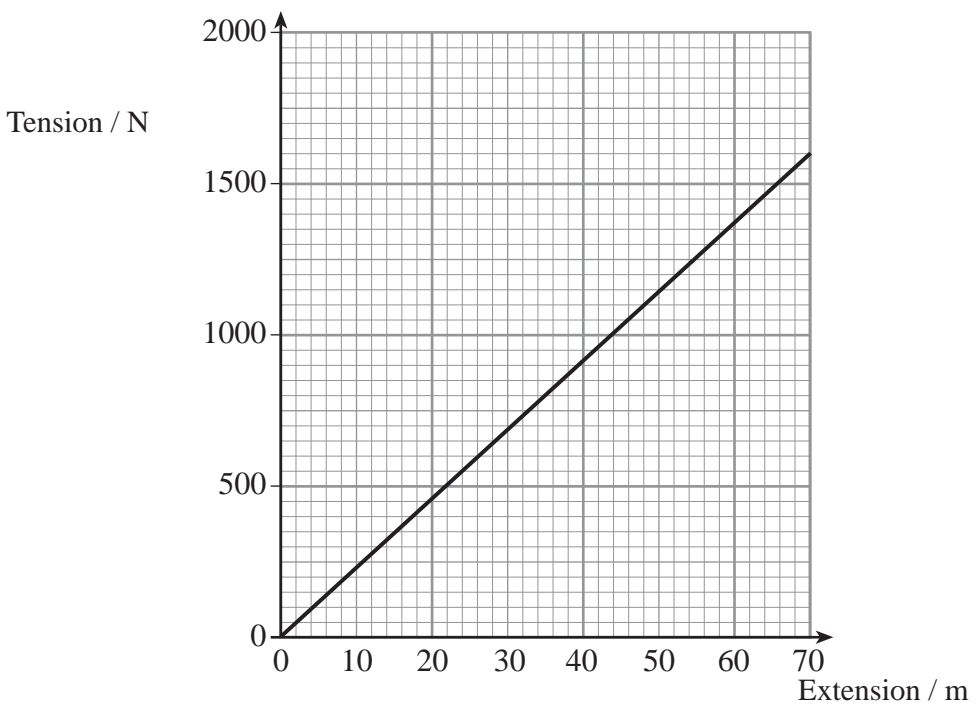
(i) The graph shows how the tension in the bungee cord varies with extension during the fall. Use the graph to calculate the elastic potential energy stored in the bungee cord when the jumper is at the lowest point.

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[3]

(ii) The initial gravitational potential energy (with respect to the ground) possessed by the jumper on the platform is 7.0×10^4 J and her mass is 60 kg. Calculate how high she is above the ground at the **bottom of her fall**.

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[3]

(iii) After 'bouncing' a few times, the bungee jumper eventually comes to rest hanging a distance, *d,* below the platform. Calculate the value of *d*.

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[3]

Turn over.