Rewarding Learning

ADVANCED SUBSIDIARY
General Certificate of Education
2018

Centre Number

Candidate Number

Physics

Assessment Unit AS 1
assessing
Forces, Energy and Electricity

SPH11

[SPH11]
TUESDAY 15 MAY, MORNING

TIME

1 hour 45 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all ten** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 100.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

1 A rechargeable hand-held electric vacuum cleaner has the following specification supplied:

Voltage	9.6 V
Power	18 W
Dustbowl Capacity	610 ml
Full run time	11 min

(a) Calculate the current that would flow in the electrical circuit of the cleaner when in use.

Current = _____ A [3]

(b) Calculate the electrical energy used by the cleaner when it is used for the full run time.

Energy = _____ J [3]

(c) Calculate the total number of electrons that pass a point in the cleaner's electrical circuit over the full run time.

Number of electrons = _____ [3]

[Turn over

2 **(a)** Electrical devices which obey Ohm's law are described as ohmic. Explain what is meant by ohmic behaviour.

[2]

(b) Describe an experiment to determine the current-voltage characteristic of a tungsten filament lamp.

Your answer should include a circuit diagram, an account of the procedure, and a sketch graph of the result you would expect to obtain.

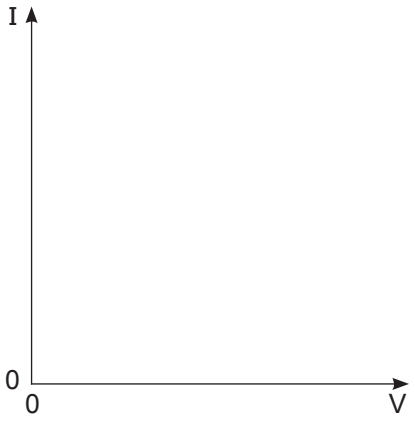
(i) Circuit diagram:

[4]

(ii) Account of the procedure:

[3]

(iii) Sketch graph:



[2]

(c) Explain why the graph you have sketched in **(b)(iii)** has this shape.

[3]

[Turn over

3 **Fig. 3.1** shows a shopping trolley of mass 25 kg. The centre of gravity of the trolley is at point G.

Image removed due to copyright

Fig. 3.1

(a) A shopper hangs a bag on the handle of the trolley causing a force F downwards as shown in **Fig. 3.1**. Calculate the value of the force F before the wheels at the opposite end of the trolley just lose contact with the ground and the trolley tips upwards.

F = _____ N [4]

(b) Another trolley is shown in **Fig. 3.2**.

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Fig. 3.2

Explain why the design of this trolley removes the potential problem of the tipping described in **(a)** when a force is exerted downwards on the handles.

_____

_____

_____

_____

_____ [2]

[Turn over

4 **(a)** A region in space has a volume of 9.4×10^{27} Tm^3 and contains a mass of 1.8×10^{13} Gg. Convert the volume and mass into the units shown below to calculate the average density of the region of space in kg m^{-3}. Give your answer to an appropriate number of significant figures.

Volume = _____ m^3

Mass = _____ kg

Density = _____ kg m^{-3} [4]

(b) Determine the base unit of B in **Equation 4.1**

$$v = BF \qquad \textbf{Equation 4.1}$$

where v is velocity and F is force.

Base unit of B = _____ [3]

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[Turn over

5 A wrecking ball is a heavy steel sphere used to demolish buildings. The wrecking ball is suspended from a crane by the lifting chain and a lateral chain pulls the wrecking ball sideways. When the lateral chain is released the wrecking ball swings like a pendulum.

Fig. 5.1 represents a particular equilibrium position where the lateral chain has pulled the wrecking ball 38° from the vertical which results in a tension in the lifting chain of 24.9 kN.

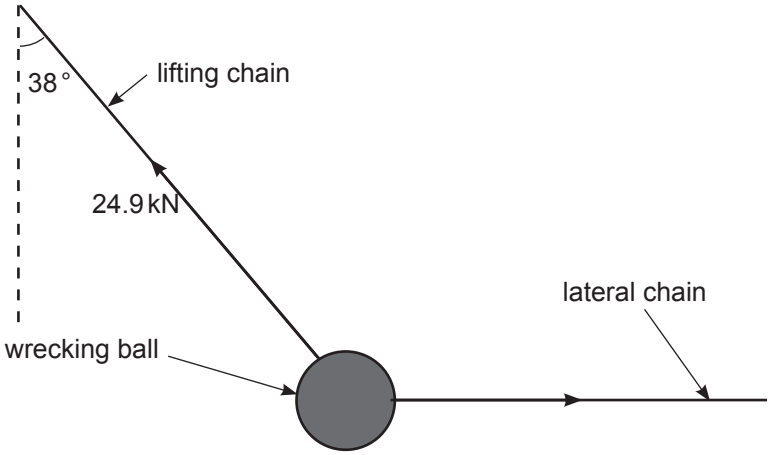

Fig. 5.1

(a) (i) Determine the mass of the wrecking ball.

Mass = _____ kg [3]

(ii) Determine the tension in the lateral chain when the wrecking ball is in the position shown in **Fig. 5.1**.

Tension = _____ kN [2]

(b) When released, the wrecking ball has both momentum and kinetic energy.
State whether each quantity is a scalar or a vector.
Explain how you can distinguish between scalar and vector quantities.

_____

_____

_____ [3]

[Turn over

6 On the 12th November 2014 the European Space Agency's spacecraft Rosetta landed the Philae probe on the surface of a comet. The Philae probe separated from Rosetta at a height of 22.5 km above the surface of the comet with a vertical downward component of velocity of 2.5 km h^{-1}. Unfortunately the thruster on board Philae did not work and the probe had to descend using only the comet's gravity, a journey that took 7 hours.

(a) Show that the mean acceleration of free fall experienced by Philae was 1.6×10^{-5} m s^{-2}.

[4]

(b) A second malfunction meant the harpoons, designed to anchor Philae to the comet, failed to fire. This caused Philae to bounce off at an angle to the surface, reaching a vertical height of 950 m. This close to the surface of the comet, the acceleration of free fall experienced by Philae was much larger, with a value of 1.2×10^{-3} m s^{-2}.

(i) Given that the horizontal velocity component at the start of the bounce was 0.49 m s^{-1}, calculate the magnitude and direction (relative to the comet surface) of the velocity with which Philae left the comet surface.

Velocity magnitude = _____ m s^{-1}

Direction = _____ °

[5]

(ii) Determine the horizontal distance travelled from the start of the bounce until Philae next hits the surface of the comet.

Distance = _____ m

[5]

[Turn over

7 **Table 7.1** provides information on an electric car.

Table 7.1

Purchase Price / £	21295
Maximum speed / m s^{-1}	25
Mass / kg	1940
Carbon dioxide emission / g km^{-1}	0
Maximum power / kW	96

(a) Calculate the kinetic energy of the car moving at its maximum speed.

Kinetic energy = _____ J [3]

(b) **(i)** When travelling at a constant speed of 8.3 m s^{-1}, the car has a range of 180 km. If the mean power output at this speed is 12% of its maximum power, calculate the useful energy output for this journey.

Useful energy output = _____ J [4]

(ii) If the efficiency of the electric car is 75%, calculate the cost to travel the 180 km. 3.6 MJ of electricity can be purchased for 16p.

Cost = £ _____ [3]

(c) Suggest why the governments of many countries offer grants to encourage the purchase of electric cars.

_____

_____

_____

_____ [2]

[Turn over

8 **(a)** State Newton's first law of motion. Use the first law to compare and contrast a car being driven along a straight road at a constant speed and a piece of rock moving in deep space at constant velocity.

[5]

(b) A 165 kg steel beam is dropped from a height of 26.4 m. Calculate the magnitude and direction of the acceleration experienced by the Earth due to the falling beam. Take the mass of the Earth to be 5.97×10^{24} kg.

Acceleration = _____ m s^{-2}

Direction = _____ [4]

[Turn over

9 A tennis ball of mass 57 g is travelling horizontally towards the player at $-18\,m\,s^{-1}$ when it is struck by a tennis racquet. The horizontal force experienced by the ball due to the tennis racquet is shown in **Fig. 9.1**.

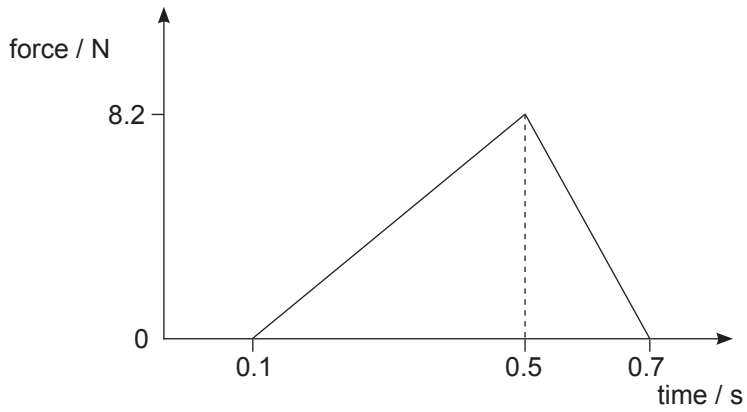

Fig. 9.1

(a) Calculate the horizontal momentum of the tennis ball before it is struck by the racquet.

Horizontal momentum = _____ kg m s^{-1} [3]

(b) Show that the impulse of the horizontal force acting on the tennis ball is +2.5 N s.

[3]

(c) Determine the horizontal speed of the tennis ball after being struck by the racquet.

Horizontal ball speed = _____ m s^{-1} [3]

[Turn over

10 (a) Standard alkaline cells can be made from manganese dioxide.
A manufacturer quotes the internal resistance of these cells to be between 150 and 300 mΩ.

(i) Explain what is meant by 'internal resistance'.

_____

_____

_____

_____ [1]

(ii) The e.m.f. of one of these alkaline cells is 1.52 V. The potential difference across its terminals is 1.38 V when a current of 636 mA flows through it.
Calculate a value for the internal resistance of the cell in mΩ.

Internal resistance = _____ mΩ [2]

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[Turn over

(b) Another cell of internal resistance 300 mΩ and e.m.f. 1.52 V is connected to the network of resistors shown in **Fig. 10.1**.

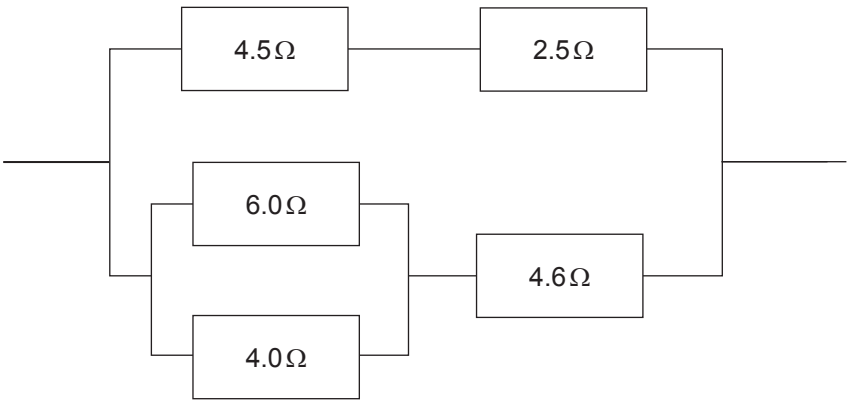

Fig. 10.1

(i) Calculate the total resistance of the network of resistors.

Total resistance = _____ Ω [5]

(ii) Calculate the current that leaves the cell when the network of resistors is connected to the cell.

Current = _____ A [2]

(iii) Calculate the current that flows through the 6.0 Ω resistor.

Current = _____ A [2]

THIS IS THE END OF THE QUESTION PAPER

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For Examiner's use only	
Question Number	Marks
1	
2	
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Total Marks	

Examiner Number