New Specification

Rewarding Learning

ADVANCED SUBSIDIARY (AS)
General Certificate of Education
2017

Centre Number

Candidate Number

Physics

Assessment Unit AS 1
assessing
Forces, Energy and Electricity

SPH11

[SPH11]

TUESDAY 23 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 thirteen** 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 part of the question.
Your attention is drawn to the Data and Formulae Sheet which is inside this question paper.
You may use an electronic calculator.

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1 (a) An electric current of 0.54 A flows through a lamp for 15 minutes. Calculate the charge that flows through the lamp in this time.

Charge = ________________ C [2]

(b) (i) Define the **unit** of potential difference, the volt, V.

____

____

____ [2]

(ii) The potential difference across the lamp in **(a)** is 6.0 V. Calculate the amount of energy converted by the lamp in 15 minutes.

Energy = ________________ J [2]

2 A piece of conductive putty was shaped into a solid cylinder of length 5.3 cm and diameter 1.24 cm. The current through the putty was measured at three different values of potential difference and the readings were recorded in **Table 2.1**.

Table 2.1

Current/A	Potential Difference/V
0.18	3.2
0.37	6.8
0.57	10.3

(a) Calculate the electrical resistance of the putty.

Resistance = _________________ Ω [3]

(b) (i) The resistance is a property of this sample of putty while **resistivity** is a **material property** of the putty. Explain what is meant by the words in bold in the previous sentence.

Resistivity:

____

____

____ [2]

Material Property:

____

____ [1]

(ii) The volume of putty in **(a)** is now rolled into a thinner cylinder of length 6.2 cm. Calculate the new resistance of the piece of putty.

Resistance = ________________ Ω [6]

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3 **(a)** State the principle of moments.

____

____

____

____ [3]

(b) Two spheres of mass 25 g and 58 g are connected by a straight, uniform rod of mass 50 g and length 30 cm as shown in **Fig. 3.1**.

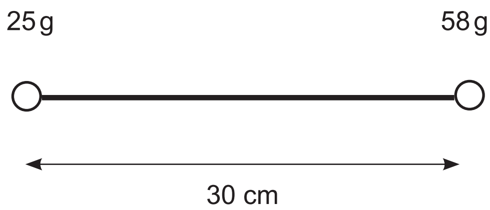

Fig. 3.1

(i) Describe simply how the centre of gravity of the system could be found physically.

____

____ [1]

(ii) By taking moments about the centre of gravity, find the distance of the centre of gravity from the sphere of mass 25 g.

Distance = _______________ cm [3]

[Turn over

4 **(a)** The speed, v, of an ultrasound wave moving through a material is given by **Equation 4.1**

$$v = \sqrt{\frac{E}{\rho}} \qquad \textbf{Equation 4.1}$$

where ρ is the density of the material.

Use **Equation 4.1** to determine the base units of the quantity E.

Base units of E = ________________ [3]

(b) A tablet of a medicinal drug contains 550 μg of a chemical.

(i) How many tablets can be produced from 1.00 kg of the chemical?

Number of tablets = ________________ [2]

(ii) In physics there is a system of units called Planck units. The Planck mass is the fundamental unit of mass in the Planck system of units.

1 Planck mass = 2.18×10^{-8} kg.

Calculate the mass of the chemical in each tablet in Planck mass units.

Mass = ________________ Planck mass units [1]

5 **(a)** An object moves with constant acceleration **a** in a straight line. After t seconds, its acceleration changes to a constant value **–a**. Describe what will happen to the **magnitude** and **direction** of the velocity and displacement of the object as a result of the change in acceleration in the time period t to 2t seconds.

Velocity:

____

____

____

Displacement:

____

____

____ [4]

(b) **Fig. 5.1** shows a velocity time graph for a parachutist from the instant the parachute is opened until the parachutist reaches the ground.

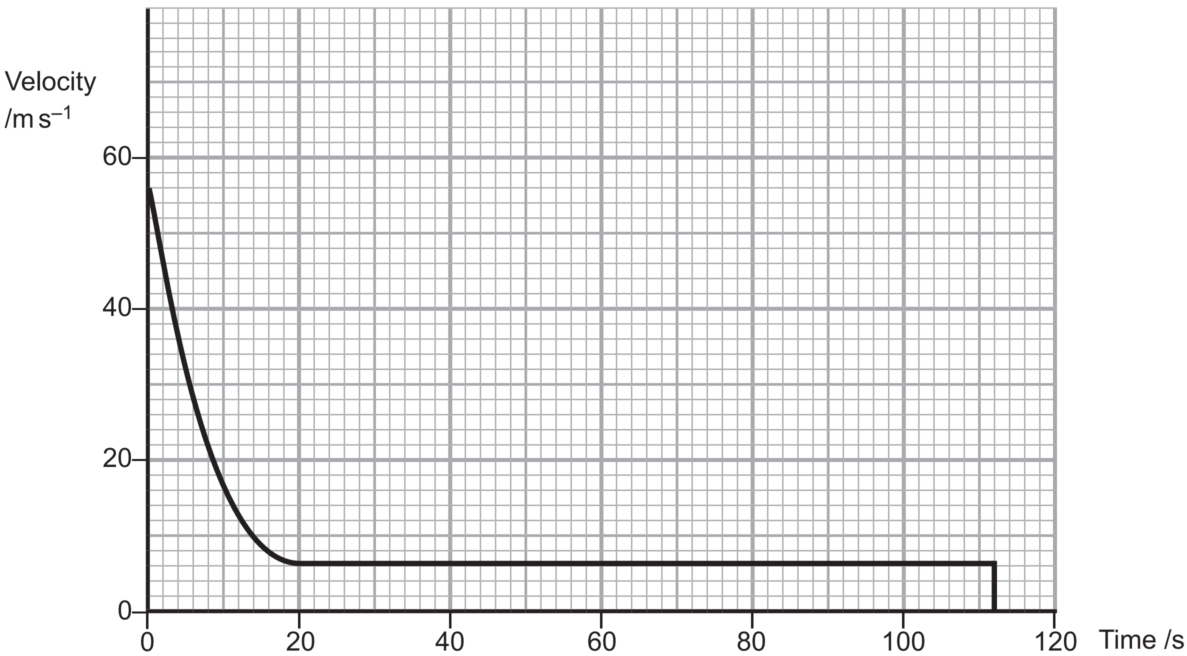

Fig. 5.1

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(i) Calculate the magnitude of the acceleration experienced by the parachutist 10 s after the parachute is opened.

Acceleration = ________________ $m\,s^{-2}$ [3]

(ii) The parachutist initially jumped from a plane flying at a height of 4100 m. Use the graph in **Fig. 5.1** to estimate the distance the parachutist fell before the parachute opened.

Distance = ________________ m [3]

[Turn over

6 An experiment to determine the acceleration of free fall, g, using one or more light gates and computer software is carried out.

(a) Describe the experiment. Include in your answer any measurements required and how these are used in the appropriate equation of motion.

[4]

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(b) Explain why the value for g obtained from an experiment such as that described in **(a)** would be expected to be lower than the actual value of $9.81\,m\,s^{-2}$.

____

____

____ [2]

7 (a) A ball of mass 0.024 kg is dropped from rest and falls to the floor. **Fig. 7.1** shows the variations in potential energy and kinetic energy with distance fallen until the ball reaches the floor.

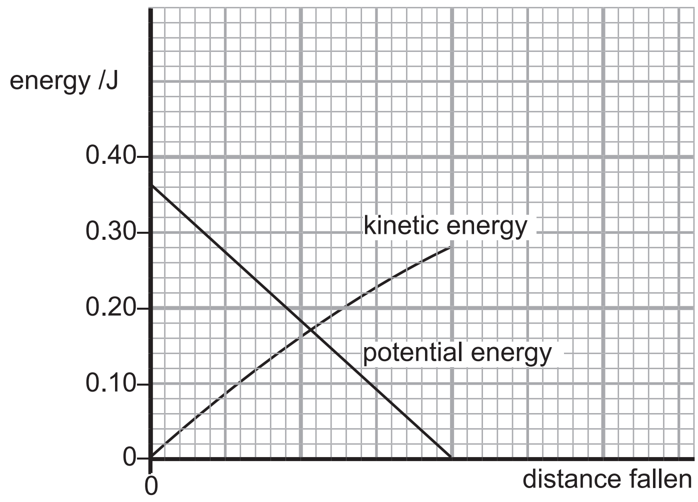

Fig. 7.1

(i) Calculate the height the ball was dropped from.

Height = ___________ m [2]

(ii) Calculate the difference between the speed reached by the ball in this case and the speed that the ball would have reached had it been dropped in a vacuum.

Difference in speed = ________________ $m\,s^{-1}$ [3]

(b) **Table 7.1** shows the efficiency and power output of a home heating boiler.

Table 7.1

	Boiler
Efficiency	94.3%
Power Output	18 kW

The boiler is required to provide 1.30×10^8 J of energy per day.

(i) Calculate the time that the boiler must be switched on to provide this energy. Give your answer in hours.

Time = ____________________ hours [3]

(ii) If one litre of oil provides 3.80×10^7 J of energy and costs £0.29, calculate the cost of using the boiler **for a week** when the energy output is 1.30×10^8 J per day.

Cost = £_______________ [5]

(iii) Apart from cost, give another reason why it is important to consider energy efficiency ratings when deciding on what household appliances to purchase.

____

____ [1]

8 **(a)** State Newton's laws of motion.

[3]

(b) A man stands on a stationary raft on still water. He then jumps off onto the shore. Explain how Newton's laws of motion apply to the movement of the raft before and after the man jumps off.

[3]

9 A fruit, such as a lemon, can be used as a small source of e.m.f. that has an internal resistance. Two pieces of metal, zinc and copper, are inserted into the fruit as shown in **Fig. 9.1**.

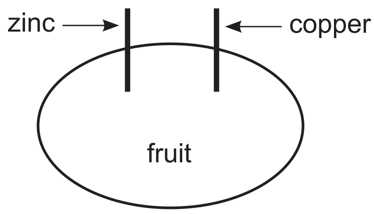

Fig. 9.1

(a) Complete **Fig. 9.1** to show a circuit that can be used to provide results that will allow the internal resistance of the lemon to be obtained graphically. [2]

(b) Describe how the circuit drawn in **Fig. 9.1** is used and state the readings that should be taken, the graph that should be drawn and how the internal resistance can be obtained from the graph.

____

____

____

____

____

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____

____

____

____

____ [5]

10 **(a)** Describe what will happen to the resistance of a negative temperature coefficient (NTC) thermistor as temperature increases. Explain why this happens.

____

____

____

____ [2]

(b) **Fig. 10.1** shows a sensor circuit to warn of icy conditions on a path.

A minimum potential difference of 5.5 V is required for the bulb to light.

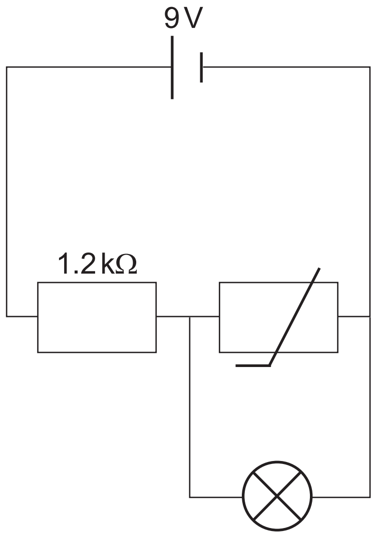

Fig. 10.1

(i) Explain why the bulb has been connected across the thermistor and not across the fixed resistor.

____

____

____ [2]

(ii) The resistance of the bulb is 2.2 kΩ. Calculate the resistance of the thermistor when the bulb first turns on.

Resistance of thermistor = ________________ kΩ [4]

11 (a) An object thrown from the Earth's surface follows a parabolic path. Describe the vertical and horizontal forces that act on it.

____

____ [2]

(b) A basketball player is standing on the floor 8.70 m from the basket, as shown in **Fig. 11.1**. He shoots the ball from a height of 1.96 m at an angle of 50° to the horizontal, with an initial speed of $9.84\,m\,s^{-1}$. The ball passes straight through the hoop without striking the backboard. What height is the hoop above the floor?

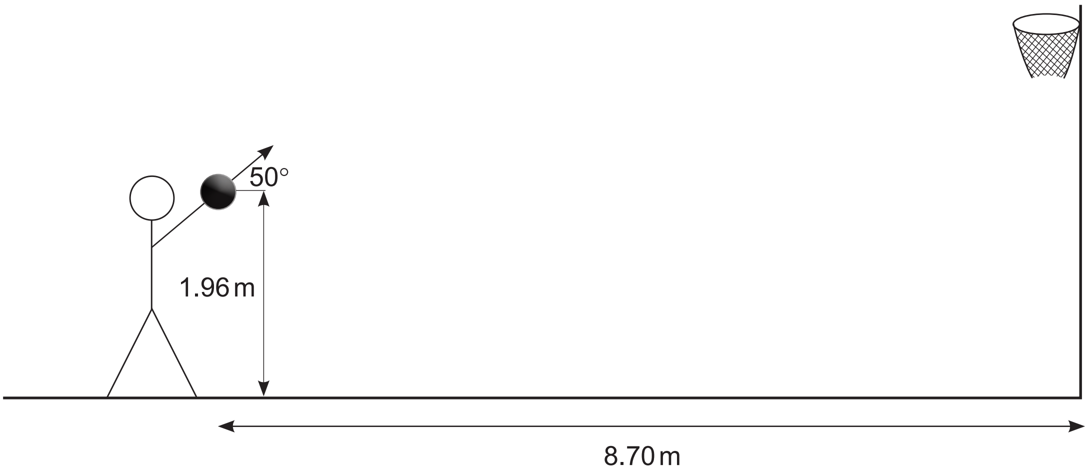

Fig. 11.1

Height of hoop = ____________ m [5]

12 Scientists at NASA's research centre have experimented with the use of airbags to soften the impact when spacecrafts land.

(a) Before the airbags are deployed the spacecraft needs to be slowed down from a speed of 96 $m\,s^{-1}$ to 8.2 $m\,s^{-1}$. This can be done by firing a jet of gas in the same direction as the spacecraft is moving. If the mass of the spacecraft, including the gas, is 6780 kg and 50 kg of gas is ejected, calculate the velocity of the ejected gas.

Velocity of gas = ___________ $km\,s^{-1}$ [3]

(b) (i) Explain how airbags help reduce the risk of damage to a spacecraft on landing.

____

____

____

____ [3]

(ii) An average force above 44 kN will damage a spacecraft on landing. What minimum stopping time is required in order to stop a 5750 kg spacecraft moving at 8.2 $m\,s^{-1}$ without causing damage?

Stopping time = ____________ s [2]

13 **Fig. 13.1** shows a uniform ladder of length 4.5 m resting against a wall. Two of the three forces acting on the ladder are shown. The weight of the ladder is W and the force acting perpendicular to the wall at the top of the ladder is 170 N. You may assume there is no friction between the top of the ladder and the wall. The ladder has a mass of 20 kg.

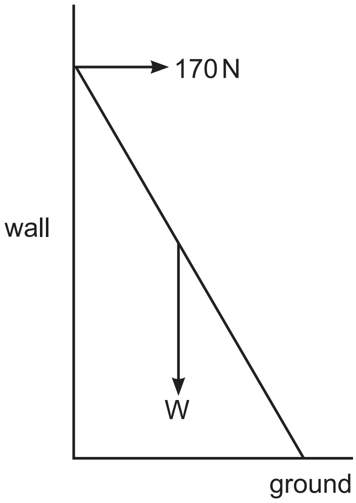

Fig. 13.1

Calculate the magnitude and direction, relative to the horizontal, of the force on the ladder due to the ground.

Force = ________________ N

Direction to the horizontal = ______________° [3]

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For Examiner's use only	
Question Number	Marks
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Examiner Number

New Specification

Rewarding Learning

ADVANCED SUBSIDIARY
General Certificate of Education

Physics

Assessment Units AS 1 and AS 2

[SPH11/SPH21]

DATA AND FORMULAE SHEET

for use from 2017 onwards

Data and Formulae Sheet for AS 1 and AS 2

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}$ m s^{-1}
elementary charge	$e = 1.60 \times 10^{-19}$ C
the Planck constant	$h = 6.63 \times 10^{-34}$ J s
mass of electron	$m_e = 9.11 \times 10^{-31}$ kg
mass of proton	$m_p = 1.67 \times 10^{-27}$ kg
acceleration of free fall on the Earth's surface	$g = 9.81$ m s^{-2}
electron volt	1 eV $= 1.60 \times 10^{-19}$ J
the Hubble constant	$H_0 \approx 2.4 \times 10^{-18}$ s^{-1}

Useful formulae

The following equations may be useful in answering some of the questions in the examination:

Mechanics

Conservation of energy $\frac{1}{2} mv^2 - \frac{1}{2} mu^2 = Fs$ for a constant force

Waves

Two-source interference $\lambda = \frac{ay}{d}$

Diffraction grating $d \sin\theta = n\lambda$

Light

Lens equation $$\frac{1}{u} + \frac{1}{v} = \frac{1}{f}$$

Electricity

Terminal potential difference $V = E - Ir$ (e.m.f., E; Internal Resistance, r)

Potential divider $$V_{out} = \frac{R_1 V_{in}}{R_1 + R_2}$$

Particles and photons

Einstein's equation $$\frac{1}{2} m v_{max}^2 = hf - hf_0$$

De Broglie equation $$\lambda = \frac{h}{p}$$

Astronomy

Red shift $$z = \frac{\Delta\lambda}{\lambda}$$

Recession speed $$z = \frac{v}{c}$$

Hubble's law $$v = H_0 d$$