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N5 National Qualifications 2019

X857/75/01

Physics
Section 1 — Answer grid and Section 2

WEDNESDAY, 15 MAY

INSTRUCTIONS TO CANDIDATES

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and Level of the subject at the top of their first answer sheet.

Total marks — 135

SECTION 1 — 25 marks
Attempt ALL questions.

SECTION 2 — 110 marks
Attempt ALL questions.

Reference may be made to the Data sheet and to the Relationships sheet.

Marks are shown in square brackets at the end of each question or part question.

Questions marked with an asterisk differ in some respects from those in the printed paper.

An OW in the margin indicates a new question.

SECTION 1 — 25 marks

The questions for Section 1 are contained in the question paper X857/75/02.

1. The answer to each question is **either** A, B, C, D or E. Decide what your answer is, then write the letter at the end of each question.

2. There is **only one correct** answer to each question.

Sample question

The energy unit measured by the electricity meter in your home is the

A ampere

B kilowatt-hour

C watt

D coulomb

E volt.

The correct answer is **B** — kilowatt-hour. You write: Question 7. B

Changing an answer

If you decide to change your answer, cancel your first answer by Brailling it out and write the answer you want.

SECTION 2 — 110 marks

Attempt ALL questions

* **1.** A quadcopter is a drone with four rotating blades.

*(a) Refer to the diagram for Question 1 (a). In a race, the quadcopter is flown along a route from point A to point E as shown in the diagram.

(i) Determine the magnitude of the resultant displacement of the quadcopter from point A to point E. **[2 marks]**

(ii) Determine the direction of the resultant displacement of the quadcopter from point A to point E. **[2 marks]**

(b) The quadcopter takes 32·5 s to complete the race.

Determine the average velocity of the quadcopter over the whole race. **[3 marks]**

(c) A second quadcopter completes the race at an average speed of $1{\cdot}25\,\mathrm{m\,s^{-1}}$.

The distance travelled by this quadcopter during the race is 37·0 m.

Determine the **difference** in the times taken by the quadcopters to complete the race. **[3 marks]**

(d) After passing point E, the quadcopter hovers at a constant height.

Describe how the overall lift force provided by the four rotating blades compares to the weight of the quadcopter. **[1 mark]**

* **2.** Refer to diagram 1 and diagram 2 for Question 2. A glider is accelerated from rest by a cable attached to a winch as shown in diagram 1.

The graph in diagram 2 shows the horizontal velocity v_h of the glider for the first 20 s of its motion.

(a) The glider is accelerated by a constant unbalanced force of 925 N.

(i) Show that the initial acceleration of the glider is $2{\cdot}5\,\mathrm{m\,s^{-2}}$. **[2 marks]**

(ii) Calculate the mass of the glider. **[3 marks]**

*(iii) Refer to the diagram for Question 2 (a) (iii). At 2·0 s the cable pulls the glider with a force of 1200 N.

(A) Determine the size of the frictional forces acting on the glider at this time. **[1 mark]**

(B) Suggest one design feature of the glider that reduces the frictional forces acting on it. **[1 mark]**

(b) At 8·0 s the glider reaches its take-off speed and leaves the ground.

Determine the distance the glider travels along the ground before take-off. **[3 marks]**

* **3.** In 1971, the astronaut Alan Shepard hit a golf ball on the surface of the Moon. He was wearing his full space suit at the time.

The ball was hit so hard that it left the ground at an angle.

Using your knowledge of physics, comment on the similarities and/or differences between this event and hitting an identical ball on the surface of the Earth. **[3 marks]**

* **4.** Refer to the diagram for Question 4. Astronomers studying a distant star analyse the light from the star that reaches Earth.

The line spectrum from the star is shown in the diagram, along with the line spectra of the elements hydrogen, helium, mercury, calcium, and sodium.

(a) Determine which of these elements are present in the star. **[1 mark]**

(b) The star is 97 light-years from Earth.

(i) State what is meant by the term *light-year*. **[1 mark]**

(ii) Calculate the distance, in metres, from the star to Earth. **[3 marks]**

(c) Astronomers use satellite-based telescopes to collect information about objects in space.

(i) Suggest an advantage of using satellite-based telescopes such as the Hubble Space Telescope. **[1 mark]**

(ii) State one **other** use of satellites. **[1 mark]**

* **5.** A student is investigating how the length of a wire affects its resistance.

The student connects different lengths of wire to a power supply of fixed voltage and measures the current in each length of wire.

(a) The measurements taken by the student are shown in the table.

Length of wire (m)	**Current (A)**
0·20	0·94
0·40	0·66
0·60	0·47
0·80	0·37
1·00	0·32

The student plots the graph shown in the diagram.

*(i) Refer to the diagram for Question 5 (a). State whether the resistance of the wire increases, decreases or stays the same, as the length of wire increases.

Justify your answer. **[2 marks]**

(ii) Use the graph to predict the current in a 0·50 m length of wire, when connected to the power supply. **[1 mark]**

(iii) Suggest one way in which the experimental procedure could be improved to give more reliable results. **[1 mark]**

*(iv) The resistance of the 1·00 m length of wire is 4·8 Ω.

Calculate the voltage across the wire. **[3 marks]**

*(b) Refer to the diagram for Question 5 (b). A length of the wire with a resistance of 5·2 Ω is then folded into a rectangular shape and the ends are joined together.

An ohmmeter is connected across the wire between point X and point Y as shown.

State whether the reading on the ohmmeter would be less than, equal to or greater than 5·2 Ω.

You must justify your answer. **[2 marks]**

* **6.** A student is investigating connecting different combinations of resistors in circuits.

*(a) Refer to the diagram for Question 6 (a). The student sets up a circuit as shown.

(i) Calculate the current in the circuit. **[4 marks]**

(ii) Calculate the power dissipated in the 120 Ω resistor. **[3 marks]**

*(b) Refer to the diagram for Question 6 (b). The student then sets up a different circuit as shown.

(i) Determine the total resistance of this circuit. **[4 marks]**

(ii) State how the power dissipated in the 120 Ω resistor in this circuit compares to the power dissipated in the 120 Ω resistor in the circuit in part (a) (ii).

Justify your answer. **[2 marks]**

* **7.** A hot water dispenser is used to heat enough water for one cup at a time.

The rating plate for the hot water dispenser is shown.

3·5 kW
230 V
50 Hz

The hot water dispenser takes 26 s to heat enough water for one cup.

(a) Show that the energy supplied to the hot water dispenser during this time is 91 000 J. **[2 marks]**

(b) The hot water dispenser heats 0·250 kg of water for each cup.

(i) Calculate the minimum energy required to heat 0·250 kg of water from an initial temperature of 20·0 °C to its boiling point. **[3 marks]**

(ii) As the water is dispensed into the cup, steam is released.

Determine the maximum mass of steam that can be produced while the water for one cup is being heated. **[4 marks]**

(iii) Explain why, in practice, the mass of steam produced is less than calculated in (b)(ii). **[1 mark]**

* **8.** Refer to the diagram for Question 8. A water rocket consists of a plastic bottle partly filled with water. Air is pumped in through the water. When the pressure is great enough, the tube detaches from the bottle. Water is forced out of the bottle, which causes the bottle to be launched upwards.

At launch, the air in the bottle is at a pressure of $1{\cdot}74 \times 10^{5}$ Pa.

(a) Clearly describe all the forces acting vertically on the bottle as it is launched.

You must name these forces **and** clearly describe their directions. **[2 marks]**

(b) The area of water in contact with the pressurised air in the bottle is $4{\cdot}50 \times 10^{-3}\,\text{m}^{2}$.

Calculate the force exerted on the water by the pressurised air at launch. **[3 marks]**

(c) At launch, the air in the bottle has a volume of $7{\cdot}5 \times 10^{-4}\,\text{m}^{3}$.

At one point in the flight, the volume of air in the bottle has **increased by** $1{\cdot}2 \times 10^{-4}\,\text{m}^{3}$.

During the flight the temperature of the air in the bottle remains constant.

(i) Calculate the pressure of the air inside the bottle at this point in the flight. **[4 marks]**

(ii) Using the kinetic model, explain what happens to the pressure of the air inside the bottle as the volume of the air increases. **[3 marks]**

* **9.** A lifeboat crew is made up of local volunteers. When there is an emergency they have to get to the lifeboat quickly.

The lifeboat crew members are alerted to an emergency using a pager.

Text messages are sent to the pager using radio waves.

(a) The radio waves have a frequency of 153 MHz.

Calculate the wavelength of the radio waves. **[3 marks]**

(b) When the pager receives a message it beeps loudly and a light on the pager flashes.

A crew member holding the pager observes the beeps and the flashes happening at the same time.

A second crew member, who is 100 m away from the pager, also observes the beeps and the flashes.

Explain why the second crew member does not observe the beeps and the flashes happening at the same time. **[2 marks]**

*****(c) The lifeboat has a mass of 25 000 kg.

Before launch it is at rest at the top of a ramp. When it is launched it slides down the ramp and enters the water.

The lifeboat loses $4{\cdot}5 \times 10^5$ J of gravitational potential energy during the launch.

(i) Calculate the maximum speed of the lifeboat as it enters the water. **[3 marks]**

(ii) Explain why, in practice, the speed of the lifeboat as it enters the water is less than calculated in (c) (i). **[1 mark]**

***10.** Infrared and gamma rays are both members of a family of waves.

(a) State the name given to this family of waves. **[1 mark]**

(b) State how the frequency of infrared compares to the frequency of gamma rays. **[1 mark]**

*(c) Some examples of sources and detectors of waves in this family are shown.

Heater
Radioactive waste
Geiger-Müller tube
Fluorescent ink
Black-bulb thermometer
LED

(i) From the examples shown, identify

(A) the detector of infrared **[1 mark]**

(B) the source of gamma rays. **[1 mark]**

(ii) Suggest one application for the waves that are detected using fluorescent ink. **[1 mark]**

11. A student carries out an experiment to investigate the effect of different shaped glass blocks on the path of a ray of light.

*(a) Refer to the diagram for Question 11 (a). The student directs a ray of red light at a triangular glass block as shown.

(i) Clearly describe the path of the ray of red light through and out of the glass block. Include any change in direction in your description. **[2 marks]**

(ii) The diagram shows a dashed line PQ.

State the name given to this line. **[1 line]**

(iii) **On the diagram**, mark an angle of incidence i. **[1 mark]**

*(b) Refer to the diagram for Question 11 (b). The student replaces the triangular glass block with a rectangular block made of the same material. The path of the ray of red light is as shown.

State whether the wavelength of the red light in this block is less than, the same as, or greater than the wavelength of the red light in the triangular glass block in (a).

Justify your answer. **[2 marks]**

***12.** A technician carries out an experiment, using the apparatus shown, to determine the half-life of a radioactive source.

Clock

Geiger-Müller tube (connected to a counter)

Radioactive source

Stop clock

(a) Describe how the apparatus can be used to determine the half-life of the radioactive source. **[3 marks]**

*(b) Refer to the diagram for Question 12 (b). The technician carries out the experiment over a period of 30 minutes, and displays the data obtained in a graph as shown.

Suggest an improvement that the technician could make to the procedure to more easily determine a value for the half-life of this source. **[1 mark]**

(c) In a second experiment, the technician absorbs $1{\cdot}2\,\mu J$ of energy throughout their body from a radioactive source.

The mass of the technician is $80{\cdot}0\,kg$.

(i) Calculate the absorbed dose received by the technician. **[3 marks]**

(ii) During the experiment, the technician receives an equivalent dose of $4{\cdot}5 \times 10^{-8}\,Sv$.

Calculate the radiation weighting factor of this source. **[3 marks]**

*(d) Refer to the diagram for Question 12 (d). The technician wears a film badge to monitor exposure to radiation.

The film badge contains a piece of photographic film behind windows of different materials.

Explain how this badge is used to determine the type of radiation the technician has been exposed to. **[2 marks]**

13. A physics teacher makes the following statement.

'Instead of nuclear fission, perhaps one day nuclear fusion will become a practical source of generating energy.'

Using your knowledge of physics, comment on the similarities and/or differences between using nuclear fission and nuclear fusion to generate energy. **[3 marks]**

[END OF QUESTION PAPER]