3.9 Physics Required Practicals and Uncertainties: Test Pack

Total Marks

AQA 8464 · Calculator allowed · about 45 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Kwame uses a ripple tank to investigate water waves. A motor drives a dipper at a set frequency, and a lamp shines through the water onto a screen so the wave crests can be seen and measured. The equation linking wave speed, frequency and wavelength is: wave speed = frequency * wavelength

(a) The dipper vibrates at a frequency of 5.0 Hz. State what is meant by the frequency of a wave. **(1)**

(b) Kwame measures the distance across 5 complete wavelengths, rather than just one. Explain why this gives a more precise value for the wavelength. **(2)**

(c) The distance across 5 complete wavelengths is 20.0 cm. Calculate the wavelength of the ripples, in metres. **(2)**

(d) Calculate the speed of the ripples. **(3)**

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(e) The frequency of the dipper is increased while the depth of water in the tank stays the same. State and explain the effect this has on the wavelength of the ripples. **(2)**

(Total for Question 1 is 10 marks)

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2 Required practicals use a range of measuring equipment. For each quantity in parts (a) to (f), name one piece of equipment a student could use to measure it.

(a) The mass of a metal cube. **(1)**

(b) The potential difference across a component in a circuit. **(1)**

(c) The current flowing through a component in a circuit. **(1)**

(d) The angle between a ray of light and the normal. **(1)**

(e) The force applied to stretch a spring. **(1)**

(f) The time between a trolley passing two light gates. **(1)**

(Total for Question 2 is 6 marks)

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3 Reece investigates the reflection of light using a plane mirror, a ray box and a protractor, directing a single narrow ray of light at the mirror.

(a) State the law of reflection. **(1)**

(b) Describe how Reece draws the normal at the point of incidence and marks the paths of the incident and reflected rays, and explain why an accurate normal is essential for measuring the angles correctly. **(3)**

(c) The angle between the incident ray and the mirror surface itself (not the normal) is measured as 58 degrees. Calculate the angle of incidence, measured from the normal. **(2)**

(d) Using the law of reflection, state the angle of reflection for this ray. **(1)**

(Total for Question 3 is 7 marks)

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4 Jayden investigates the extension of a spring as increasing force is applied. The unstretched length of the spring is 10.0 cm. The equation linking force, spring constant and extension is: force = spring constant * extension

Force (N): 1.0	**2.0**	**3.0**	**4.0**	**5.0**
Length (cm): 12.0	14.0	16.0	18.0	21.0

(a) Calculate the extension of the spring when the force applied is 3.0 N. **(1)**

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(b) Show that the spring obeys Hooke's law for forces between 1.0 N and 4.0 N, by calculating the spring constant using two different pairs of results. **(4)**

(c) Identify, with a reason, the force in the table at which the spring exceeds its limit of proportionality. **(2)**

(d) Calculate the elastic potential energy stored in the spring when it is extended by 8.0 cm, within the limit of proportionality. Use the equation: elastic potential energy = 0.5 * spring constant * $(\text{extension})^2$ [Higher Tier only] **(3)**

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(Total for Question 4 is 10 marks)

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Mark scheme · 3.9 Physics Required Practicals and Uncertainties: Test Pack

Question 1

(a) the number of complete waves (oscillations) passing a point per second, measured in hertz (Hz), oe **B1**

(a) Answer: The number of complete waves passing a fixed point each second.

(b) a single wavelength is a small distance, so the fixed resolution of the ruler causes a relatively large percentage uncertainty, oe **B1**

(b) measuring across several wavelengths increases the total distance measured for the same absolute uncertainty, reducing the percentage uncertainty; dividing by the number of wavelengths then gives a more precise mean wavelength, oe **B1**

(b) Answer: A single wavelength is a small distance, so a ruler's fixed resolution gives it a large percentage uncertainty. Measuring across several wavelengths and dividing reduces this percentage uncertainty, giving a more precise value.

(c) 20.0 / 5, oe **M1**

(c) 4.0 cm = 0.040 m cao **A1**

(c) Answer: 0.040 m

(d) uses the wavelength in metres (0.040 m) from part (c), ft **M1**

(d) wave speed = 5.0 * 0.040, oe **M1**

(d) 0.20 m/s cao **A1**

(d) Answer: 0.20 m/s

(e) the wavelength decreases, oe **B1**

(e) wave speed depends on water depth, which is unchanged, so speed stays constant; since wave speed = frequency * wavelength, increasing frequency (with constant speed) means wavelength must decrease, oe **B1**

(e) Answer: The wavelength decreases. Wave speed depends on the water depth, which has not changed, so speed stays constant; since speed = frequency x wavelength, a higher frequency means a smaller wavelength.

Question 2

(a) top-pan balance, oe **B1**

(a) Answer: Top-pan balance.

(b) voltmeter, connected in parallel with the component **B1**

(b) Answer: Voltmeter (connected in parallel).

(c) ammeter, connected in series with the component **B1**

(c) Answer: Ammeter (connected in series).

(d) protractor, oe **B1**

(d) Answer: Protractor.

(e) newtonmeter (forcemeter), oe; allow slotted masses of known weight **B1**

(e) Answer: Newtonmeter (forcemeter).

(f) light gates connected to a data logger (or timer), oe **B1**

(f) Answer: Light gates connected to a data logger.

Question 3

(a) angle of incidence = angle of reflection (both measured from the normal), oe **B1**

(a) Answer: Angle of incidence = angle of reflection.

(b) draws a straight line perpendicular (at 90 degrees) to the mirror line, at the point where the ray strikes it, using a protractor or set square, oe **B1**

(b) marks the path of the incident ray and the reflected ray with crosses/pencil dots at two points on each, removes the mirror, and joins the points with a ruler, oe **B1**

(b) the angles of incidence and reflection must both be measured from the normal, not the mirror surface, so an inaccurately drawn normal would make both angle measurements wrong, oe **B1**

(b) Answer: Draw the normal at 90 degrees to the mirror at the point of incidence; mark the incident and reflected ray paths with dots, remove the mirror, and join the dots with a ruler. The normal must be accurate because both angles are measured from it, not the mirror surface.

(c) 90 - 58, oe **M1**

(c) 32 degrees cao **A1**

(c) Answer: 32 degrees

(d) 32 degrees, ft from (c) **B1**

(d) Answer: 32 degrees

Question 4

(a) 6.0 cm cao (from 16.0 - 10.0) **B1**

(a) Answer: 6.0 cm

(b) extension at 1.0 N = 2.0 cm = 0.020 m; spring constant = 1.0 / 0.020 = 50 N/m, oe **M1**

(b) extension at 4.0 N = 8.0 cm = 0.080 m; spring constant = 4.0 / 0.080 = 50 N/m, oe **M1**

(b) both values of the spring constant are equal (50 N/m) **A1**

(b) valid conclusion: since force / extension (the spring constant) is constant over this range, force is directly proportional to extension, so the spring obeys Hooke's law, oe **A1**

(b) Answer: At 1.0 N, k = 1.0 / 0.020 = 50 N/m; at 4.0 N, k = 4.0 / 0.080 = 50 N/m. Since k is the same both times, the spring obeys Hooke's law over this range.

(c) between 4.0 N and 5.0 N (at 5.0 N) **B1**

(c) because the extension at 5.0 N (11.0 cm) is greater than the 10.0 cm that proportionality (using k = 50 N/m) would predict, showing extension is no longer directly proportional to force, oe **B1**

(c) Answer: Between 4.0 N and 5.0 N; if proportional, 5.0 N should give an extension of 10.0 cm, but the actual extension is 11.0 cm, so proportionality no longer holds.

(d) converts extension to metres: 8.0 cm = 0.080 m, oe **M1**

(d) $0.5 * 50 * 0.080^2$, oe **M1**

(d) 0.16 J cao **A1**

(d) Answer: 0.16 J

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