Neap

Final Examination 2023

NSW Year 11 Physics

Solutions and Marking Guidelines

SECTION I

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 1 **C** $v = \frac{d}{t}$ $= \frac{100}{46.86}$ $= 2.13 \text{ m s}^{-1}$	Mod 1 Kinematics PH11–4, 11–8 Bands 2–3
Question 2 **D** $\vec{F}_{\text{net}} = m\vec{a}$ $= 51 \times 2.6$ $= 133 \text{ N}$	Mod 2 Dynamics PH11–4, 11–9 Bands 2–3
Question 3 **B** **B** is correct. The unit for velocity is m s^{-1} (metres per second) and the unit for kinetic energy is J (joules). **A** is incorrect. Although J is the unit for kinetic energy, m (metres) is the unit for distance/displacement, not velocity. **C** is incorrect. J is the unit for energy, not velocity, and m is the unit for distance/displacement, not kinetic energy. **D** is incorrect. Although m s^{-1} is the correct unit for velocity, m s^{-2} is the unit for acceleration, not kinetic energy.	Mod 1 Kinematics Mod 2 Dynamics PH11–7, 11–8, 11–9 Bands 2–3
Question 4 **D** **D** is correct. The wavelength of a wave is the distance after which the shape of the wave repeats; thus, the distance between successive crests on a sound wave is the wavelength. **A** is incorrect. The period of a wave is the time it takes to complete one cycle of a wave. **B** is incorrect. The amplitude of a wave is the maximum displacement of a particle of the medium from rest. **C** is incorrect. The frequency of a wave is the number of waves that pass a particular point in a given amount of time.	Mod 3 Waves and Thermodynamics PH11–10 Bands 2–3
Question 5 **A** **A** is correct. The direction of a magnetic field is always from north to south. **B**, **C** and **D** are incorrect. These diagrams do not show possible magnetic fields as the field does not travel from north to south.	Mod 4 Electricity and Magnetism PH11–6, 11–11 Bands 3–4

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 6 **A** **A** is correct and **D** is incorrect. Concave (diverging) lenses can only form virtual images because they cannot bring light rays to focus at a point. **B** is incorrect. Concave lenses will always produce minimised, upright images. **C** is incorrect. Concave lenses can refract light rays.	Mod 3 Waves and Thermodynamics PH11–6, 11–10 Bands 3–4
Question 7 **C** 2000 W = 2 kW 2 kW × 2.5 hours = 5 kWh Given that 1 kWh = 3.6 MJ, 5 kWh × 3.6 = 18 MJ.	Mod 4 Electricity and Magnetism PH11–4, 11–5, 11–11 Bands 3–4
Question 8 **C** $\Delta h = \frac{\Delta U}{mg}$ $= \frac{14.7}{2.0 \times 9.8}$ $= 0.75 \text{ m}$ $= 75 \text{ cm}$	Mod 2 Dynamics PH11–4, 11–9 Bands 3–4
Question 9 **A** Finding the time it takes for Sam to reach the park gives: $t = \frac{d}{v}$ $= \frac{1800}{2}$ $= 900 \text{ seconds}$ $= 15 \text{ minutes}$ Thus, Sam travels at 2 m s^{-1} for 15 minutes prior to coming to rest (0 m s^{-1}) for 5 minutes. Calculating Sam's speed during the last part of the journey gives: $v = \frac{d}{t}$ $= \frac{1800}{20 \times 60}$ $= 1.5 \text{ m s}^{-1}$ Therefore, Sam travels at a constant speed of 1.5 m s^{-1} for the final 20 minutes. Graph **A** accurately represents this information.	Mod 1 Kinematics PH11–4, 11–5, 11–8 Bands 4–5

<table>
<tr><th>Answer and explanation</th><th>Syllabus content, outcomes and targeted performance bands</th></tr>
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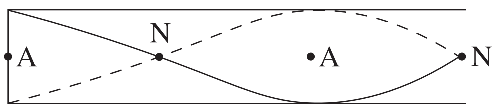
Question 10 **B**

Pipes that are closed at one end must have a pressure antinode at the closed end and a pressure node at the open end. Given that the wavelength of the first harmonic is four times the length of the pipe, a second harmonic cannot form; it would be twice the length of the pipe, which would result in a pressure antinode at the open end. The third harmonic has a wavelength that is $\frac{4}{3}$ times longer than the length of the pipe, resulting in two pressure nodes as shown in the following diagram.



closed end open end

</td><td>Mod 3 Waves and Thermodynamics
PH11–6, 11–10 Bands 4–5</td></tr>
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Question 11 **D**

Finding the change in temperature of the water gives:

$$\Delta T = 45 - 21$$
$$= 24°\text{C}$$

Substituting the change in temperature and the specific heat capacity of water into the formula gives:

$$m = \frac{Q}{c\Delta T}$$
$$= \frac{1.2 \times 10^7}{(4.18 \times 10^3) \times 24}$$
$$= 120 \text{ kg}$$

Given that the density of water is $\rho = 1.00 \times 10^3 \text{ kg m}^{-3}$, 1 kg = 1 L. Therefore, the volume of the container is 120 L.

</td><td>Mod 3 Waves and Thermodynamics
PH11–4, 11–5, 11–10 Bands 5–6</td></tr>
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Question 12 **B**

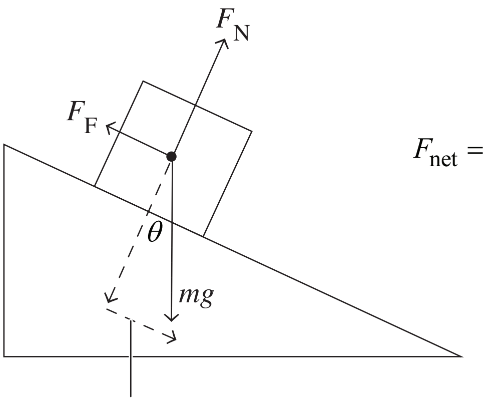
B is correct. Resistors R_2 and R_3 are in series and therefore have half the voltage drop each compared to resistor R_1.

A is incorrect. Ammeter A_1 will measure a higher current than ammeter A_2 as it is measuring the total current in the circuit, not just one of the branches.

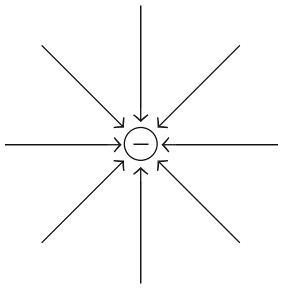
C is incorrect. The combined voltage drop of resistors R_2 and R_3 is equivalent to the voltage drop of resistor R_1.

D is incorrect. The total resistance in the circuit would decrease if resistor R_3 was removed.

</td><td>Mod 4 Electricity and Magnetism
PH11–6, 11–11 Bands 5–6</td></tr>
</table>

Answer and explanation	Syllabus content, outcomes and targeted performance bands
Question 13 **C** Using the law of conservation of momentum gives: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$ $(1200\times 30)+(910\times 18)=(1200v_1)+(910\times 25)$ $v_1 = \frac{29\,630}{1200}$ $= 25 \text{ m s}^{-1}$	Mod 2 Dynamics PH11–5, 11–9 Bands 5–6
Question 14 **C** If the box is accelerating down the inclined plane, the net force on the box must be acting down the inclined plane. Therefore, the magnitude of the net force acting on the box can be determined by calculating the component of the box's weight acting down the inclined plane, then subtracting the magnitude of the friction force, which is equivalent to half the magnitude of the normal force. This is shown in the following diagram.  $F_{net} = mg\sin\theta - \frac{1}{2}F_N$ NOT TO SCALE force down inclined plane = $mg\sin\theta$	Mod 2 Dynamics PH11–6, 11–9 Bands 5–6
Question 15 **C** $E = \frac{F}{q}$ $F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$ Therefore: $E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$ $= \frac{1}{4\pi\times 8.854\times 10^{-12}}\times\frac{1.602\times 10^{-19}}{(5.3\times 10^{-11})^2}$ $= 5.1\times 10^{11} \text{ N C}^{-1}$	Mod 4 Electricity and Magnetism PH11–4, 11–6, 11–11 Bands 5–6

SECTION II

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 16	
	Mod 4 Electricity and Magnetism PH11–7, 11–11 Bands 2–4 • Draws evenly spaced radiating lines. AND • Draws an arrowhead pointing towards the particle on each line . . . 2 • Any ONE of the above points 1
Question 17	
Latent heat is the heat absorbed or released by a material to change its physical state (for example, from solid to liquid). The term latent refers to the fact that these changes occur while the temperature of the material remains constant.	Mod 3 Waves and Thermodynamics PH11–7, 11–10 Bands 2–4 • Outlines latent heat as the heat required to change the physical state of a material without changing its temperature . . . . 2 • Provides some relevant information 1
Question 18	
To attain total internal reflection, the student would have to ensure that the angle of incidence is greater than the critical angle, which is calculated below. $\sin(\theta_c) = \frac{n_2}{n_1}$ $\theta_c = \sin^{-1}\left(\frac{1.31}{1.58}\right)$ $= 56.0°$	Mod 3 Waves and Thermodynamics PH11–4, 11–6, 11–10 Bands 3–5 • States that total internal reflection requires an angle of incidence greater than the critical angle. AND • Calculates the critical angle. . . . . . . 2 • Any ONE of the above points 1
Question 19	
$a = \frac{v - u}{t}$ $= \frac{0 - 10}{15}$ $= -0.6667 \text{ m s}^{-2}$ $\vec{F}_{\text{net}} = m\vec{a}$ $= 1.2 \times 0.6667$ $= 0.80 \text{ N}$	Mod 1 Kinematics Mod 2 Dynamics PH11–4, 11–5, 11–8, 11–9 Bands 3–5 • Calculates the magnitude of the friction force . . . . 3 • Calculates acceleration . . . . 2 • Provides some relevant working . . . 1

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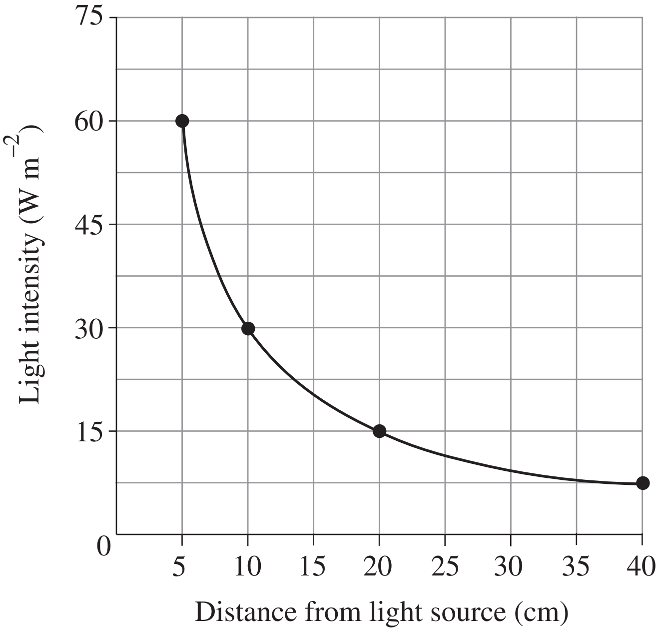
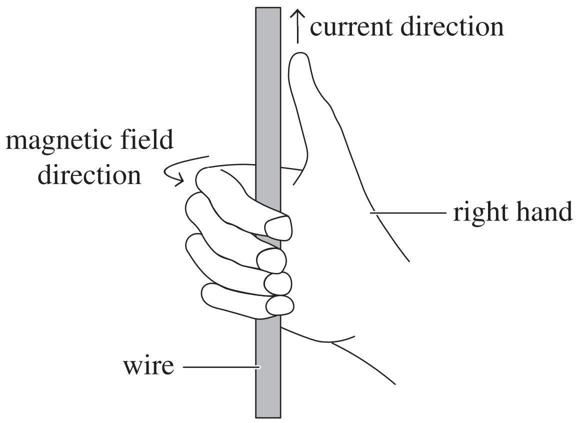
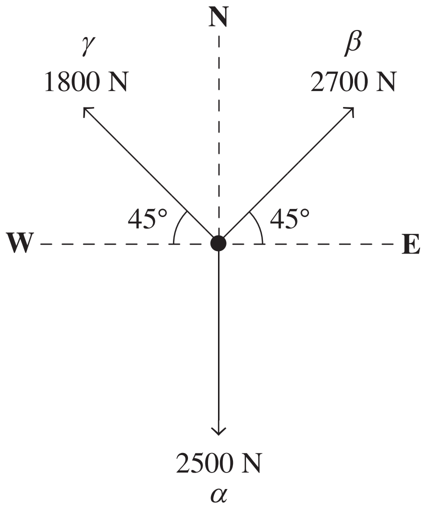
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 20	
(a) 	Mod 3 Waves and Thermodynamics PH11–4, 11–10 Bands 4–5 • Labels axes AND includes units. AND • Uses an appropriate scale. AND • Plots all data points. AND • Draws an appropriate trendline . . . . 4 • Any THREE of the above points. . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
(b) The data suggests that there is an inverse relationship between distance and light intensity. However, the mathematical model $I \propto \frac{1}{r^2}$ shows that there should be an inverse square relationship between distance and light intensity, meaning that the data is inaccurate.	Mod 3 Waves and Thermodynamics PH11–5, 11–6, 11–10 Bands 5–6 • Identifies that the data shows an inverse relationship. AND • Assesses that the data is inaccurate by referring to $I \propto \frac{1}{r^2}$ . . 3 • Assesses that the data is inaccurate by referring to $I \propto \frac{1}{r^2}$ . . 2 • Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 21	
Kirchhoff's current law states that the sum of all currents flowing into a node is equal to the sum of all currents flowing out of that node. This is in accordance with the conservation of charge as the amount of charge flowing into any point on a conductor must equal the amount of charge flowing out of that point. Kirchhoff's voltage law states that the sum of voltage drops must equal the sum of voltage rises in a closed loop of a circuit; that is, the sum of the voltages around a loop must equal zero. This is in accordance with the conservation of energy because, given that voltage is a measurement of energy per unit charge, the total energy gained per unit charge must equal the total energy lost per unit charge.	Mod 4 Electricity and Magnetism PH11–6, 11–7, 11–11 Bands 4–5 • Explains Kirchhoff's current law with reference to the conservation of charge. AND • Explains Kirchhoff's voltage law with reference to the conservation of energy. . . . . 4 • Explains Kirchhoff's current law with reference to the conservation of charge. AND • Outlines Kirchhoff's voltage law. OR • Outlines Kirchhoff's current law. AND • Explains Kirchhoff's voltage law with reference to the conservation of energy. . . . . 3 • Explains Kirchhoff's current law with reference to the conservation of charge. OR • Explains Kirchhoff's voltage law with reference to the conservation of energy. OR • Outlines Kirchhoff's current law AND voltage law . . . . 2 • Provides some relevant information 1
Question 22	
(a) 3.6 seconds	Mod 3 Waves and Thermodynamics PH11–4, 11–10 Bands 2–4 • Determines the period 1
(b) 1.0 metre	Mod 3 Waves and Thermodynamics PH11–4, 11–10 Bands 2–4 • Determines the amplitude 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
(c) $v = f\lambda$ $= \frac{1}{T}\lambda$ $= \frac{1}{3.6} \times 3.0$ $= 0.83 \text{ m s}^{-1}$ *Note: Consequential on answer to **Question 22(a)**.*	Mod 3 Waves and Thermodynamics PH11–5, 11–10 Bands 3–5 • Determines the speed . . . . 2 • Provides some relevant working . . . 1
Question 23	
The student incorrectly determines the location of the fish due to the refraction of light. The light coming from the fish bends away from the normal and towards the student as it moves from water to air, which has a lower index of refraction. The actual location of the fish would be horizontally closer and vertically deeper than the location where the student sees the fish.	Mod 3 Waves and Thermodynamics PH11–6, 11–10 Bands 4–5 • Explains refraction. AND • Determines the actual location of the fish to be horizontally closer and vertically deeper than its apparent location . . . . 3 • Explains refraction. OR • Determines the actual location of the fish to be horizontally closer and/or vertically deeper than its apparent location . . . . 2 • Provides some relevant information 1
Question 24	
To determine the direction of a magnetic field around a current-carrying wire using the right-hand grip rule, the student would grip the wire with their right hand so that their thumb points in the direction of the conventional current. The student would then curl their fingers around the wire to determine the direction of the magnetic field.  *Note: Diagrams are not required to obtain full marks, but may be used to support the response.*	Mod 4 Electricity and Magnetism PH11–7, 11–11 Bands 3–4 • Describes that the student's thumb points in the direction of the conventional current. AND • Describes that the student's other fingers indicate the direction of the magnetic field . . . . . 2 • Provides some relevant information 1

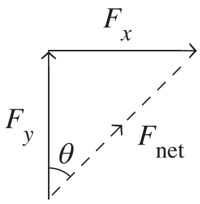
Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 25	
$v^2 = u^2 + 2as$ $v^2 = 48.0^2 + 2 \times -9.8 \times 65.0$ $v^2 = 3578$ $v = \sqrt{3578}$ $= 59.8164 \text{ m s}^{-1}$ down $K = \frac{1}{2}mv^2$ $= \frac{1}{2} \times 0.065 \times 59.8164^2$ $= 116 \text{ J}$	Mod 1 Kinematics Mod 2 Dynamics PH11–4, 11–5, 11–8, 11–9 Bands 4–5 • Calculates the kinetic energy of the arrow when it reaches the ground . . . . 4 • Calculates the kinetic energy of the arrow when it reaches the ground with ONE omission OR error . . . . 3 • Calculates the velocity of the arrow when it reaches the ground . . 2 • Provides some relevant working . . . 1
Question 26	
The student should place the ammeter in series with the circuit to measure the current flowing through the circuit and therefore through the resistor. They should place the voltmeter in parallel with the resistor to measure the voltage drop across the resistor. After switching on the power supply at a set voltage, the student should measure and record the voltage and current through the 2 Ω resistor. The student should then vary the voltage provided by the power supply, measuring and recording the voltage and current through the resistor each time the power supply is changed. The temperature of the wires would need to be kept constant, which may be achieved by switching off the power supply between each measurement. The student should then repeat these steps using the 4 Ω and 6 Ω resistors and plot their results in a voltage versus current graph. The relationship between current and voltage in ohmic resistors can then be determined by analysing the trendlines for each resistor.	Mod 4 Electricity and Magnetism PH11–2, 11–7, 11–11 Bands 4–5 • Describes how current should be measured. AND • Describes how voltage should be measured. AND • Describes how 2 Ω, 4 Ω, and 6 Ω resistors should be used. AND • Identifies how the relationship between current and voltage in ohmic resistors will be determined. AND • Identifies a relevant controlled variable . . . . 5 • Any FOUR of the above points . . . . 4 • Any THREE of the above points . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 27	



$$F_x = F_{x\alpha} + F_{x\beta} + F_{x\gamma}$$
$$= 0 + 2700\cos(45) - 1800\cos(45)$$
$$= 636.3961 \text{ N}$$

$$F_y = F_{y\alpha} + F_{y\beta} + F_{y\gamma}$$
$$= -2500 + 2700\sin(45) + 1800\sin(45)$$
$$= 681.9805 \text{ N}$$



$$F_{\text{net}} = \sqrt{F_x{}^2 + F_y{}^2}$$
$$= \sqrt{636.3961^2 + 681.9805^2}$$
$$= 933 \text{ N}$$

$$\theta = \tan^{-1}\left(\frac{F_x}{F_y}\right)$$
$$= \tan^{-1}\left(\frac{636.3961}{681.9805}\right)$$
$$= 43°$$

Therefore, the net horizontal force acting on the knot is 933 N N43°E.

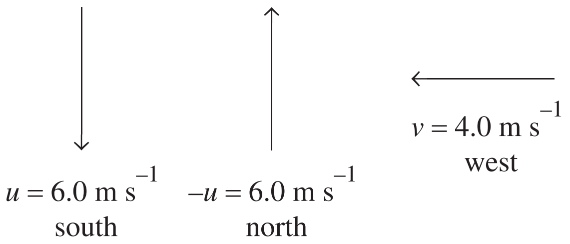
Note: Diagrams are not required to obtain full marks, but may be used to support the response.

Mod 2 Dynamics
PH11–4, 11–5, 11–9 Bands 4–6

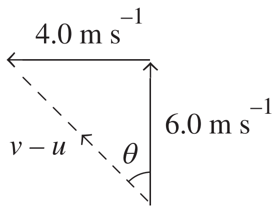
- Calculates the magnitude AND direction of the net horizontal force acting on the knot 6
- Calculates the magnitude AND direction of the net horizontal force acting on the knot with ONE omission OR error 5
- Calculates the magnitude of the net horizontal force acting on the knot 4
- Makes significant progress toward calculating the magnitude of the net horizontal force acting on the knot 3
- Makes some progress toward calculating the magnitude of the net horizontal force acting on the knot 2
- Provides some relevant working . . . 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 28	
The particles in transverse and longitudinal waves oscillate back and forth about their equilibrium positions. The particles in a transverse wave move perpendicular to the direction of energy transfer, while the particles in a longitudinal wave move in parallel with the direction of energy transfer.	Mod 3 Waves and Thermodynamics PH11–7, 11–10 Bands 4–5 • Identifies that particles in transverse and longitudinal waves oscillate. AND • Outlines particle motion in transverse waves as perpendicular to energy transfer. AND • Outlines particle motion in longitudinal waves as parallel to energy transfer . . . . 3 • Any TWO of the above points. . . . . 2 • Any ONE of the above points 1
Question 29	
$F_{\text{net}} = \frac{1}{4\pi\varepsilon_0}\frac{q_A q_B}{r^2_{AB}} + \frac{1}{4\pi\varepsilon_0}\frac{q_B q_C}{r^2_{BC}}$ $= \frac{1}{4\pi \times 8.854 \times 10^{-12}} \times \frac{1.7 \times 10^{-6} \times 1.5 \times 10^{-6}}{1.5^2}$ $+ \frac{1}{4\pi \times 8.854 \times 10^{-12}} \times \frac{1.5 \times 10^{-6} \times 3 \times 10^{-6}}{3.0^2}$ $= 1.1019 \times 10^{-2} + 4.4939 \times 10^{-3}$ $= 1.5 \times 10^{-2}$ N to the right	Mod 4 Electricity and Magnetism PH11–4, 11–6, 11–11 Bands 5–6 • Calculates the magnitude AND direction of the net force acting on point charge B due to point charges A and C. . . . . 4 • Calculates the magnitude of the net force acting on point charge B due to point charges A and C. . . . 3 • Calculates the magnitude of the force acting between any of the point charges. . . . . 2 • Provides some relevant working . . . 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 30	



$\Delta v = v - u$



Using Pythagoras' theorem gives:

$$(v - u)^2 = 4.0^2 + 6.0^2$$

$$v - u = 7.2111 \text{ m s}^{-1}$$

Using trigonometry gives:

$$\theta = \tan^{-1}\left(\frac{4.0}{6.0}\right)$$

$$= 34°$$

$$a = \frac{v - u}{t}$$

$$= \frac{7.2111}{1.9}$$

$$= 3.8$$

Therefore, the average acceleration is 3.8 m s^{-2} N34°W.

Mod 1 Kinematics
PH11–4, 11–5, 11–8 Bands 5–6

- Calculates the magnitude AND direction of the average acceleration.

AND

- Draws a vector diagram to support the answer 5

- Calculates the magnitude AND direction of the average acceleration with ONE error.

AND

- Draws a vector diagram to support the answer 4

- Calculates the magnitude OR direction of the average acceleration.

AND

- Draws a vector diagram to support the answer 3

- Makes some progress toward calculating the average acceleration.

OR

- Draws an appropriate vector diagram 2

- Provides some relevant information 1

Sample answer	Syllabus content, outcomes, targeted performance bands and marking guide
Question 31	
(a) Experiment A: $E = \dfrac{V}{d}$ $= \dfrac{9.0}{0.50}$ $= 18 \text{ V m}^{-1}$ Experiment B: $E = \dfrac{V}{d}$ $= \dfrac{6.0}{1.50}$ $= 4 \text{ V m}^{-1}$	Mod 4 Electricity and Magnetism PH11–4, 11–11 Bands 2–4 • Calculates the electric field strength in each experiment . . . . 2 • Provides some relevant working . . . 1
(b) $W \propto \Delta V$ Experiment A: $\Delta V = 4.5 \text{ V}$ Experiment B: $\Delta V = 3.0 \text{ V}$ Therefore, $W_A = 1.5W_B$.	Mod 4 Electricity and Magnetism PH11–5, 11–11 Bands 4–5 • Compares the work done in each experiment . . . . 2 • Provides some relevant information 1

