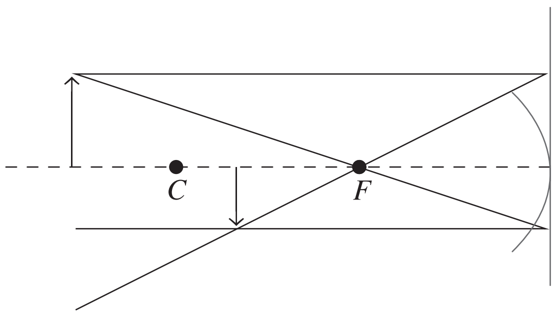
Neap

Final Examination 2021

# NSW Year 11 Physics

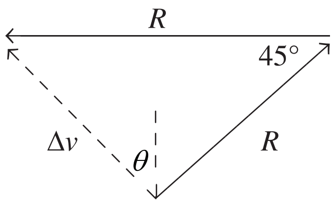
Solutions and marking guidelines

## Section I

| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 1** **C**<br>**C** is correct. Diffraction refers to the way waves bend as they move past obstacles or gaps. The wave pictured is bending as it moves past a gap. **A**, **B** and **D** are incorrect. These options give the names of other wave behaviours. | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 2–3 |
| **Question 2** **B**<br>**B** is correct. Since a battery increases potential energy, the best way to model this would be by increasing the gravitational potential energy of the marble by lifting it. Since the marbles represent electrons, they flow out of the negative terminal of the battery and into the positive, and should be lifted from the positive terminal to the negative terminal.<br>**A** is incorrect. Since the marbles represent electrons, they should not flow towards the negative terminal of the battery.<br>**C** is incorrect. Having the battery lower the marbles would imply that batteries decrease the potential energy of electrons.<br>**D** is incorrect. Having the battery lower the marbles would imply that batteries decrease the potential energy of electrons and, since they represent electrons, the marbles should not flow toward the negative terminal of the battery. | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 3–4 |
| **Question 3** **A**<br>**A** is correct.<br><br>*C* represents the centre of curvature. *F* represents the focal point. When the object is at the centre of curvature, the resulting image is inverted and of the same size as the object. As the object moves further away from the mirror, the image becomes more diminished and moves towards the focus. If the object is beyond the centre of curvature, the object will be diminished and inverted. **B**, **C** and **D** are incorrect. The image cannot be upright or magnified when placed beyond the centre of curvature of a concave mirror. | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–4 |

| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 4** **C**<br>**C** is correct. Electric field strength is represented in field diagrams by the density of field lines. Since larger charges produce stronger electric fields, a particle with greater charge would have more field lines surrounding it. **A** is incorrect. The magnitude of this charge is the same as in the original diagram, despite the polarity being different. **B** is incorrect. Changes in the magnitude of a charge are not shown by changing the size of the particle. **D** is incorrect. The length of field lines in a field diagram is irrelevant. | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 3–4 |
| **Question 5** **B**<br>$a = \frac{v - u}{\Delta t}$<br>$= \frac{(-3)-(2)}{(8)-(3)}$<br>$= -\frac{5}{5}$<br>$= -1 \text{ m s}^{-2}$ | Mod 1 Kinematics<br>PH11–8 Bands 2–3 |
| **Question 6** **C**<br>**C** is correct. The momentum of the ball changes direction when it rebounds off the edge of the table. **A** is incorrect. The speed of the ball stays the same, so $\frac{1}{2}mv^2$ will remain constant. **B** is incorrect. The mass of the billiard ball will not change. **D** is incorrect. The ball is not accelerating before the collision or afterwards, so acceleration is 0 and will not change. | Mod 2 Dynamics<br>PH11–9 Bands 3–4 |
| **Question 7** **D**<br>$E = \frac{V}{d} = \frac{F}{q}$<br>$V = \frac{Fd}{q}$<br>$= \frac{(1\times10^{-6})(1\times10^{-3})}{1.602\times10^{-19}}$<br>$= 24.96$<br>$\approx 25.0 \text{ V}$<br>*Note: The charge of an electron is drawn from the formula sheet.* | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 3–4 |

| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 8** **C**<br>$v = f\lambda = \frac{\lambda}{T}$<br>$\lambda = vT$<br>$a = v_{\text{initial}} T_{\text{intial}}$<br>$\lambda_{\text{final}} = v_{\text{final}} T_{\text{final}}$<br>$= \left(\frac{1}{2} v_{\text{initial}}\right)\left(2T_{\text{initial}}\right)$<br>$= v_{\text{initial}} T_{\text{initial}}$<br>$= a$ | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–4 |
| **Question 9** **B**<br>**B** is correct. The impulse the car experiences is equal to its momentum prior to the collision (since it has no momentum after). Its momentum prior to the collision is:<br>$p = mv$<br>$= 4000\left(\frac{72}{3.6}\right)$<br>$= 80\,000 \text{ kg m s}^{-1}$<br>The impulse of a collision can also be found by plotting a force–time graph and finding the area underneath the line. **B** is the only graph with an area of 80 000. **A**, **C** and **D** are incorrect. The area under these graphs is not 80 000. | Mod 2 Dynamics<br>PH11–9 Bands 3–4 |
| **Question 10** **A**<br>$P = \frac{\Delta E}{t}$<br>$= \frac{Fs}{t}$<br>$= \frac{(ma)s}{t}$<br>Therefore, the SI units for watts are:<br>$\text{W} = \frac{(\text{kg})\left(\text{m s}^{-2}\right)(\text{m})}{\text{s}}$<br>$= \text{kg m}^2 \text{ s}^{-3}$ | Mod 2 Dynamics<br>PH11–9 Bands 4–5 |

| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 11 B**<br>**B** is correct. Since Aaron's walking speed is less than his running speed, 0 < walking speed < running speed. If we look at the direction of the change in speed vector for each edge case (that is, walking speed = 0 and walking speed = running speed) we can find the range of possible angles.<br>When walking speed is equal to running speed, we can create the following vector diagram to calculate *v*. Running speed is represented by *R*.<br><br>Using the cosine rule or by resolving into components, you can find that $\theta = 22.5°$. The direction of the correct vector can be anywhere within the acute angle between N22.5°W and NE, with these values excluded.<br>**B** is the only value that fits into the possible range.<br>**A** is incorrect. The direction of the change in velocity vector will only be NE if the walking speed = 0, which it does not. **C** and **D** are incorrect. They are outside of the range of possible angles.<br>*Note: This amount of working is not necessary to confidently answer the question but is necessary to prove the answer is correct.* | Mod 1 Kinematics<br>PH11–8 Bands 5–6 |
| **Question 12 B**<br>**B** is correct. Gary is analysing data he collected, so it can be classified as primary data. As the data is numeric, it is quantitative. If the relationship derived between voltage and current is non-linear, the light bulb must be non-ohmic. **A** is incorrect. A non-linear relationship between voltage and current cannot imply an ohmic resistor. **C** is incorrect. The data being used was collected by Gary, so is not secondary data. **D** is incorrect. The data is not secondary, and the data describes the circuit's quantities, not its qualities, so it is not qualitative data. | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 3–4 |

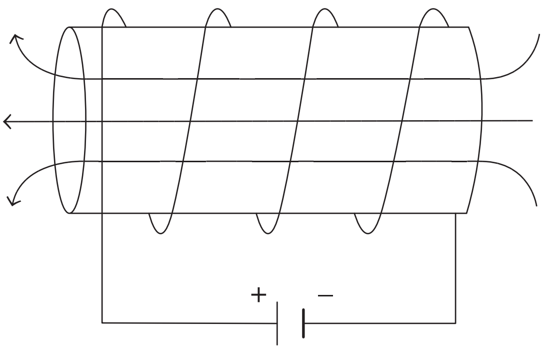
| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 13** **B**<br>Taking downwards as positive:<br>$20 = 6.32t + 4.9t^2$<br>$0 = -20 + 6.32t + 4.9t^2$<br>Thus, $a = 4.9$, $b = 6.32$ and $c = -20$.<br>Rearranging and using the quadratic formula gives:<br>$t = \frac{-6.32 \pm \sqrt{6.32^2 - 4 \times 4.9 \times -20}}{9.8}$<br>$= 1.48$ s<br>*Note: The positive solution must be taken because time cannot be negative.* | Mod 1 Kinematics<br>PH11–8 Bands 4–5 |
| **Question 14** **B**<br>**B** is correct. Newton's Third Law states that if object *A* exerts a force on object *B*, object *B* must exert an equal and opposite force on object *A*. While gravity and the normal force are equal and opposite, they are applied to the same object, so are not an action–reaction force pair. Both gravity and the normal force are associated with a separate pair.<br>**A**, **C** and **D** incorrect. These options are all examples of two objects exerting equal and opposite forces on one another, so are action–reaction force pairs. | Mod 2 Dynamics<br>PH11–9 Bands 4–5 |

| Answer and explanation | Syllabus content, outcomes and targeted performance bands |
|---|---|
| **Question 15** **C**<br>For the *n*th harmonic of a string fixed at both ends, the wavelength is $\lambda = \frac{2l}{n}$, where $l$ is the length of the string. To find the value of $l$ in the fifth harmonic, find the wavelength of the second harmonic.<br>$v = f\lambda$<br>$\lambda = \frac{v}{f}$<br>$= \frac{5}{3}$<br>$\lambda = \frac{2l}{n}$<br>$\frac{5}{3} = \frac{2l}{2}$<br>$l = \frac{5}{3}$<br>Therefore, to calculate the frequency of the fifth harmonic:<br>$\lambda = \frac{2l}{n}$<br>$= \frac{2\left(\frac{5}{3}\right)}{5}$<br>$= \frac{2}{3}$<br>$f = \frac{v}{\lambda}$<br>$= \frac{10}{\left(\frac{2}{3}\right)}$<br>$= 15 \text{ Hz}$ | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 5–6 |

## Section II

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 16** | |
| In order to balance the two forces, the opposing force must have a horizontal component of 2 N south and 1 N west. Therefore, the magnitude of the third force is given by:<br>$F = \sqrt{1^2 + 2^2}$<br>$= \sqrt{5}$<br>$\approx 2.24$ N<br>The direction of the third force is given by:<br>$\tan(\theta) = \frac{1}{2}$<br>$\tan^{-1}\left(\frac{1}{2}\right) \approx$ S26.56° W | Mod 2 Dynamics<br>PH11–9 Bands 2–3<br>• Gives the correct magnitude of the force.<br>AND<br>• Gives the correct direction of the force. . . . . . . . . . . . . . . . . . . . 2<br>• Any ONE of the above points . . . . . 1 |
| **Question 17** | |
| $\Delta v = v - u$<br>$= (-5) - 3$<br>$= -8 \text{ m s}^{-1}$<br>Therefore, the duck's change in velocity is 8 m $s^{-1}$ to the west. | Mod 1 Kinematics<br>PH11–8 Bands 2–3<br>• Gives the correct magnitude of change in velocity.<br>AND<br>• Gives the correct direction of change in velocity . . . . . . . . . . . . 2<br>• Any ONE of the above points . . . . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 18** | |
| *For example:*<br>Bella's voice could be replaced by an electronic speaker set to constant volume as an alternative source of sound. The speaker's constant level of sound output will mean the volume detected at the source will remain more constant. This variable will thus be controlled to a greater extent, leading to a more valid experiment.<br>Additionally, conducting the experiment indoors would allow Tom and Bella to have greater control over their surrounding environment, so sound from wind and other sources would affect Tom's measurements less.<br>*Note: Allow responses with other appropriate changes, including increasing the volume of the sound in some way, decreasing the length between measurements and repeating the experiment.* | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–4<br>• Identifies TWO changes that would increase validity in a significant way.<br>AND<br>• Explains how these changes would increase the validity of the experiment . . . . . . . . . . . . . . . 3<br>• Identifies TWO changes that would increase validity in a significant way.<br>AND<br>• Explains how ONE change would increase the validity of the experiment . . . . . . . . . . . . . . . 2<br>• Identifies ONE change that would increase validity in a significant way AND explains how it would affect validity of the experiment.<br>OR<br>• Identifies TWO changes that would increase validity.<br>OR<br>• Shows an understanding of valid investigations . . . . . . . . . . . 1 |
| **Question 19** | |
| (a) Newton's First Law of Motion states that an object in motion will remain in motion and an object at rest will remain at rest unless acted upon by an unbalanced force. | Mod 2 Dynamics<br>PH11–9 Bands 2–3<br>• States Newton's First Law of Motion. . . . . . . . . . . . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| (b) *For example:*<br>The football slows down due to friction and rolling resistance. These forces lead to an unbalanced net force opposite the ball's direction of motion, causing the ball to experience a change in velocity as explained by Newton's First Law of Motion. Newton's Second Law of Motion states that acceleration is proportional to the resistive force. Therefore, the ball accelerates in an opposite direction to its motion, or decelerates, until it stops. From the given data, the average acceleration experienced as a result of this force is $a = \frac{(10-0)}{5} = 2\text{ m s}^{-2}$ opposite to its direction of motion. At this point, friction stops acting on the ball, meaning it no longer experiences a net force and remains at a constant velocity of $0\text{ m s}^{-1}$.<br>*Note: Responses that include a discussion of Newton's Third Law as it applies to friction are acceptable.* | Mod 2 Dynamics<br>PH11–9 Bands 3–4<br>• Correctly applies TWO of Newton's Laws to the situation.<br>AND<br>• Mentions friction AND/OR rolling resistance and its associated force.<br>AND<br>• Explains why this force causes deceleration<br>AND<br>• Calculates acceleration .......... 3<br><br>• Attempts to apply TWO of Newton's Laws to the situation.<br>AND<br>• Mentions friction AND/OR rolling resistance and its associated force ................ 2<br><br>• Provides some relevant information ............ 1 |
| **Question 20** | |
| (a)  | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 2–3<br>• Correctly draws the magnetic field .............. 1 |

| | Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|---|
| (b) | The magnetic field strength of a solenoid is given by the equation $B = \frac{\mu_0 NI}{L}$, where $B$ is the magnetic field strength, $\mu_0$ is the magnetic permeability constant, $N$ is the number of coils, $L$ is the length of the solenoid and $I$ is the current through the wire. From this formula, we can deduce that increasing the terms of the numerator will increase the magnetic field strength. Increasing the number of coils of wire around the solenoid and increasing the current through the wires will both increase the magnetic field strength of the solenoid. Adding a ferromagnetic material such as iron to the core will also increase the magnetic field strength of the solenoid. | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 2–4<br>• Identifies THREE ways of increasing the magnetic field strength.<br>AND<br>• Explains with reference to the relevant formula. . . . . . . . . . . 2<br>• Identifies TWO ways of increasing the magnetic field strength.<br>OR<br>• Identifies ONE way of increasing magnetic field strength AND explains with reference to the relevant formula. . . . . . . . . . . 1 |
| **Question 21** | | |
| (a) | 3 m $s^{-1}$<br>*Note: The speed of the second body will be equal to that of the first body. For the two bodies to have no momentum upon collision, they must have initially had equal and opposite momentums. Since they both had the same mass, they must also have had equal (and opposite) velocities.* | Mod 2 Dynamics<br>PH11–9 Bands 3–4<br>• Gives the correct speed . . . . . . . . . . 1 |
| (b) | The collision was inelastic. After the collision, both bodies have zero velocity and, therefore, no kinetic energy. This means that whatever kinetic energy they had before the collision was not conserved. | Mod 2 Dynamics<br>PH11–9 Bands 3–4<br>• Determines that the collision was inelastic.<br>AND<br>• Gives a correct justification with reference to a change in kinetic energy . . . . . . . . . . . . . . . 2<br>• Determines that the collision was inelastic. . . . . . . . . . . . . . . . . . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| (c) Mechanical energy is conserved:<br>$E_i = E_f$<br>$E_i = U_f + K_f$<br>As gravitational potential energy ($U_f$) is zero the instant before hitting the ground:<br>$E_i = 0 + \frac{1}{2}mv^2$<br>$5 = \frac{1}{2}(0.2 + 0.2)v^2$<br>$v^2 = \frac{2 \times 5}{0.4}$<br>$v = \sqrt{25}$<br>$= 5 \text{ m s}^{-1}$ | Mod 2 Dynamics<br>PH11–9 Band 3–4<br>• Applies the law of conservation of mechanical energy.<br>AND<br>• Correctly calculates the speed . . . . . 2<br>• Applies the law of conservation of mechanical energy. . . . . . . . . . . . . 1 |
| **Question 22** | |
| $\sin\theta_c = \frac{n_2}{n_1}$<br>$n_1 = \frac{n_2}{\sin\theta_c}$<br>$= \frac{1.52}{\sin(70)}$<br>$= 1.6$<br>$n_1 = \frac{c}{v_1}$<br>$v_1 = \frac{c}{n_1}$<br>$= \frac{3 \times 10^8}{1.6}$<br>$= 1.85$<br>$\approx 1.9 \times 10^8 \text{ m s}^{-1}$ | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 4–5<br>• Calculates the correct transmission speed. . . . . . . . . . . . . . 3<br>• Calculates the refractive index of the cable ($n_1$) . . . . . . . . . . . . . . . . 2<br>• Gives some relevant information . . . . . . . . . . . . 1 |
| **Question 23** | |
| (a) $s = ut + \frac{1}{2}at^2$<br>$s = \frac{1}{2}at^2$<br>$t = \sqrt{\frac{2s}{a}}$<br>$= \sqrt{\frac{2 \times 60}{1.2}}$<br>$= 10 \text{ s}$ | Mod 1 Kinematics<br>PH11–8 Bands 3–4<br>• Calculates the correct time taken . . . . . . . . . . . . . . . . . . . . 2<br>• Gives some relevant information. . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| (b) Southern displacement:<br>$s = ut + \frac{1}{2}at^2$<br>$= ut$<br>$= 4 \times 10$<br>$= 40$<br>As the southern displacement is less than 42, Freya will not hit the rocks. | Mod 1 Kinematics<br>PH11–8 Bands 3–4<br>• Correctly calculates Freya's southern displacement.<br>AND<br>• Correctly uses the southern displacement to conclude that Freya will not hit the rocks. . . . . . . . . . . . . . . . . . . . . . 2<br>• Correctly calculates Freya's southern displacement . . . . . . . . . . . 1 |
| (c) The velocity displayed on the speedometer is wholly dependent on the boat's acceleration. Henry's instrument will detect the boat's velocity to be equal to the vector sum of the western velocity caused by the boat's acceleration and the southern velocity of the river current. Therefore, Henry's instrument will observe the boat moving with greater velocity. | Mod 1 Kinematics<br>PH11–8 Bands 4–5<br>• Identifies that Henry's instrument will observe a greater velocity.<br>AND<br>• Provides a supporting explanation with reference to how the two velocities differ . . . . 3<br>• Correctly explains how the two velocities differ . . . . . . . . . . . . . . . . 2<br>• Gives some relevant information. . . 1 |
| **Question 24** | |
| (a) *For example:*<br>Notes with low pitch correspond to sound waves that have a long wavelength. The long wavelengths of the low notes allow them to diffract around obstacles more easily than notes of higher pitch. Given that the student is a significant distance from the source of the music, it is possible that the low notes would reach them and the high notes would not.<br>*Note: Accept other accurate explanations relating to wave behaviour. Responses should make a connection between the pitch of a note and its wavelength/frequency.* | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–4<br>• Correctly explains the observation by relating the properties of notes of low pitch to their wave behaviour . . . . . 2<br>• Gives some relevant information. . . 1 |

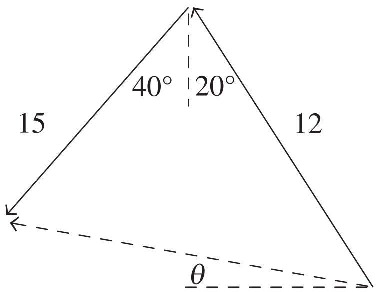
| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| (b) $v = f\lambda$<br>$f = \frac{v}{\lambda}$<br>$= \frac{340}{2}$<br>$= 170$ Hz<br>*Note: The value for v is the speed of sound as drawn from the formulae sheet.* | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 2–3<br>• Calculates the correct frequency . . . 1 |
| (c) $f' = f\frac{(v_{\text{wave}} + v_{\text{observer}})}{(v_{\text{wave}} - v_{\text{source}})}$<br>$v_{\text{observer}} = \frac{f'}{f}(v_{\text{wave}} - v_{\text{source}}) - v_{\text{wave}}$<br>$= \frac{171}{170} \times (340 - 0) - 340$<br>$= 2 \text{ m s}^{-1}$<br>The student is moving at 2 m $s^{-1}$ toward the source of the sound. | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–5<br>• Calculates the correct velocity. . . . . 2<br>• Correctly applies the relevant formula. . . . . . . . . . . . . . 1 |
| **Question 25** | |
| (a) Combining the resistors in series:<br>$R_{\text{series}} = 12 + 12$<br>$= 24\ \Omega$<br>Combining the resistors in parallel:<br>$\frac{1}{R_{\text{circuit}}} = \frac{1}{12} + \frac{1}{24} + \frac{1}{24}$<br>$= \frac{1}{6}$<br>$= 6\ \Omega$<br>As the ammeter is connected in series, its reading will be the circuit current, so we can apply Ohm's law to the resistors to obtain:<br>$I_{\text{circuit}} = \frac{V_{\text{circuit}}}{R_{\text{circuit}}}$<br>$= \frac{12}{6}$<br>$= 2$ A | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 3–6<br>• Calculates the ammeter reading. . . . 3<br>• Calculates the total equivalent resistance of the circuit . . . . . . . . . . 2<br>• Gives some relevant information. . . 1 |

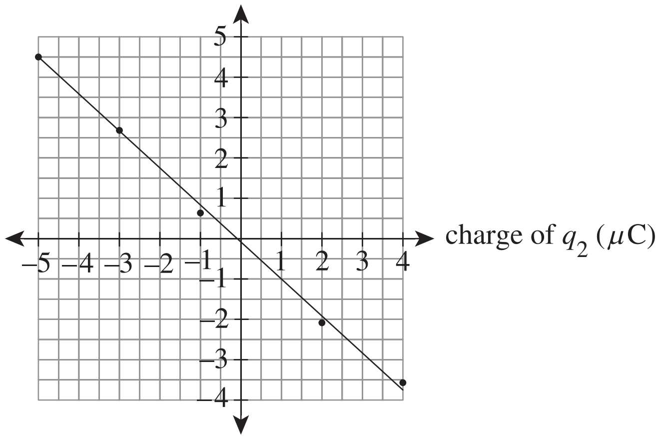
 

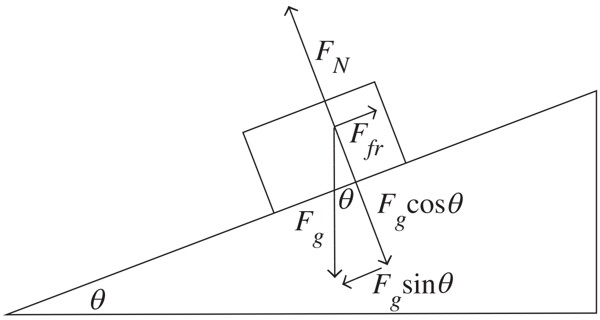
| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| (b) $P = IV$<br>$= I^2R$<br>$= 2^2 \times 6$<br>$= 24\text{ W}$<br>$P = \frac{\Delta E}{\Delta T}$<br>$\Delta E = P\Delta T$<br>$= 24 \times 60^2$<br>$= 86.4\text{ kJ}$ | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 5–6<br>• Calculates the energy consumed by the spotlight . . . . . . . . . . . . . . . . 2<br>• Calculates the power consumed by the spotlight.<br>OR<br>• Equivalent merit . . . . . . . . . . . . . . . . 1 |
| (c) *For example:*<br>As an observer moves further away from the spotlight, the light rays it produces will be dispersed further and further apart. Subsequently, a lower concentration of light energy will reach the area where the observer is, resulting in the spotlight's intensity decreasing as the observer moves away.<br>*Note: Answers could also include a suitable reference to the formula* $I_1R_1^2 = I_2R_2^2$. | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 4–5<br>• Explains how the spotlight's intensity changes as an observer moves away from it . . . . . . . . . . . . . 2<br>• Gives some relevant information. . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 26** | |
| *For example:*<br>In both systems, heat will flow from the hot object – either the metal or the polystyrene sheet – to the cold ice via conduction, causing the ice to melt. This will cause the temperature of both systems to decrease, but the total drop in temperature will be dependent on the specific heat capacities of both the metal and the sheet, so they will likely experience temperature drops of different magnitudes. Furthermore, as metal is a thermal conductor and polystyrene is a thermal insulator, the ice on the metal sheet will melt faster than the ice on the polystyrene sheet. In accordance with the zeroth law of thermodynamics, both systems will reach thermodynamic equilibrium after a large period of time passes, and the transfer of heat will then cease. However, as the metal sheet had a larger initial mass of ice to melt, and so required more energy to melt the ice, the metal sheet will have lost more energy than the polystyrene sheet. Subsequently, as metal is a good thermal conductor, the metal–ice system will likely reach a lower equilibrium temperature than the polystyrene–ice system.<br>*Note: Responses could also include a relevant reference to the latent heat required to melt the ice, a relevant reference to the equation $Q = mc\Delta T$ or a relevant diagram.* | Mod 3 Waves and Thermodynamics<br>PH11–10 Bands 3–5<br>• Explains the thermodynamic changes that occur in both systems in detail.<br>AND<br>• Compares the thermodynamic changes that occur in both systems in detail.<br>AND<br>• Presents the response in a logical, cohesive manner . . . . . 5<br><br>• Explains the thermodynamic changes that occur in both systems.<br>AND<br>• Compares the thermodynamic changes that occur in both systems.<br>AND<br>• Presents the response in a logical, cohesive manner . . . . . 4<br><br>• Explains the thermodynamic changes that occur in both systems.<br>AND<br>• Compares the thermodynamic changes that occur in both systems . . . . . . . . . . . . . . . . 3<br><br>• Explains the thermodynamic changes that occur in both systems.<br>OR<br>• Compares the thermodynamic changes that occur in both systems . . . . . . . . . . . . . . . . 2<br><br>• Gives some relevant information. . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 27** | |
| Let the final relative velocity be $v_{AB}$.<br>$v_{AB} = v_A - v_B$<br>This difference can be represented diagrammatically as follows.<br><br>$v_{AB_x} = -15\sin 40 - 12\sin 20$<br>$= -13.746055\ldots$<br>In the $y$ direction:<br>$v_{AB_y} = 12\cos 20 - 15\cos 40$<br>$= -0.21435519\ldots$<br>For magnitude:<br>$v_{AB} = \sqrt{13.746^2 + 0.214^2}$<br>$= 13.7$<br>For direction:<br>$\tan\theta = \left(-\frac{0.214}{13.746}\right)$<br>$\theta = \tan^{-1}\left(-\frac{0.214}{13.746}\right)$<br>$= -89.19°$<br>Therefore, $v_{AB}$ = 13.7 m $s^{-1}$ at bearing S89ºW. | Mod 1 Kinematics<br>PH11–8 Bands 3–5<br>• Draws a correct diagram that represents $v_{AB}$.<br>AND<br>• Correctly calculates the magnitude of the relative velocity vector.<br>AND<br>• Correctly calculates the direction of the relative velocity vector . . . . . . . . . . 4<br>• Any TWO of the above points. . . . . 3<br>• Any ONE of the above points . . . . . 2<br>• Shows some understanding of relative velocity OR vector addition. . . . . . . . . . . . . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 28** | |
| (a)   | Mod 4 Electricity and Magnetism<br>PH11–11 Bands 2–6<br>• Accurately plots data points.<br>AND<br>• Uses correct axes labels, units and scale.<br>AND<br>• Draws an accurate line of best fit.<br>AND<br>• Calculates the gradient of the line . . . . . . . . . . . . . . . . . . . . . 4<br>• Any THREE of the above points . . . 3<br>• Any TWO of the above points. . . . . 2<br>• Any ONE of the above points . . . . . 1 |
| (b) From the graph:<br>$\text{gradient} = \dfrac{4.5-(-3.6)}{(-5-4)\times 10^{-6}}$<br>$= -9\times 10^{5}$<br>Using the value of the gradient, solve for $q_1$.<br>$\text{gradient} = \dfrac{F}{q_2}$<br>$= \dfrac{q_1}{4\pi\varepsilon_0 r^2}$<br>$q_1 = \text{gradient}\times 4\pi\varepsilon_0 r^2$<br>$= -9\times 10^{5}\times 4\pi\times 8.854\times 10^{-12}\times 1^2$<br>$= -1\times 10^{-4}\ \text{C}$<br>The force on the particles is proportional to the charge on the second particle, producing a linear relationship, as seen in the graph. As $q_1$ has a negative charge, if $q_2$ also has a negative charge, the force between the charges is positive (repulsive). If $q_2$ has a positive charge, the force between the charges is negative (attractive).<br>*Note: Accept varying values for $q_1$ depending on the points on the line of best fit chosen to calculate the gradient. The gradient must be used to find an accurate value of $q_1$.* | • Uses the gradient of the line to calculate $q_1$.<br>AND<br>• Explains the changes that occur in the force between the two particles . . . . . . . . 2<br>• Any ONE of the above points . . . . . 1 |

| Sample answer | Syllabus content, outcomes, targeted performance bands and marking guide |
|---|---|
| **Question 29** | |
| <br>Equating forces perpendicular to the plane:<br>$F_N = F_g \cos\theta$<br>$N = mg\cos\theta$<br>Equating forces parallel to the plane:<br>$F_g \sin\theta = F_{fr}$<br>$mg\sin\theta = \mu N$<br>$= \mu mg\cos\theta$<br>$\mu = \dfrac{\sin\theta}{\cos\theta}$<br>$= \tan\theta$ | Mod 2 Dynamics<br>PH11–9 Bands 4–6<br>• Successfully derives $\mu = \tan\theta$.<br>AND<br>• Draws an accurate free-body diagram . . . . . . . . . . . . . . 4<br>• Obtains $mg\sin\theta = \mu mg\cos\theta$.<br>AND<br>• Draws an accurate free-body diagram . . . . . . . . . . . . . . 3<br>• Obtains $N = mg\cos\theta$.<br>AND<br>• Draws an accurate free-body diagram . . . . . . . . . . . . . . 2<br>• Draws an accurate free-body diagram.<br>OR<br>• Shows working of equivalent merit. . . . . . . . . . . . . . 1 |