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91523 Demonstrate understanding of wave systems

$d\sin \quad = n$ $\qquad n \quad = \frac{dx}{L}$ $\qquad f' = f\frac{v_w}{v_w \pm v_s}$ $\qquad v = f$ $\qquad f = \frac{1}{T}$

91524 Demonstrate understanding of mechanical systems

$F = ma$ $\qquad p = mv$ $\qquad p = F \quad t$ $\qquad E_p = mg \quad h$

$W = Fd$ $\qquad E_{K(LIN)} = \frac{1}{2}mv^2$ $\qquad x_{COM} = \frac{m_1x_1 + m_2x_2}{m_1 + m_2}$

$d = r$ $\qquad v = r$ $\qquad a = r$ $\qquad = \frac{}{t}$

$= \frac{}{t}$ $\qquad = 2 \quad f$ $\qquad f = \frac{1}{T}$ $\qquad E_{K(ROT)} = \frac{1}{2}I \quad ^2$

$_f = \quad _i + \quad t$ $\qquad = \frac{_f + \quad _i}{2}t$ $\qquad _f^2 = \quad _i^2 + 2$ $\qquad = \quad _it + \frac{1}{2} \quad t^2$

$= I$ $\qquad = Fr$ $\qquad L = mvr$ $\qquad L = I$

$F_g = \frac{GMm}{r^2}$ $\qquad F_c = \frac{mv^2}{r}$

$F = \quad ky$ $\qquad E_p = \frac{1}{2}ky^2$ $\qquad T = 2\sqrt{\frac{l}{g}}$ $\qquad T = 2\sqrt{\frac{m}{k}}$

$y = A\sin \quad t$ $\qquad v = A \quad \cos \quad t$ $\qquad a = \quad A \quad ^2\sin \quad t$ $\qquad a = \quad ^2y$

$y = A\cos \quad t$ $\qquad v = \quad A \quad \sin \quad t$ $\qquad a = \quad A \quad ^2\cos \quad t$

- attributed all aspects of the pattern formed by light shining through a diffraction grating to interference and wavelength
- explained that spectra are seen because different wavelengths of light interfere differently rather than diffract differently
- applied understanding of the relationship between wavelength and frequency to an accelerating source.

Standard-specific comments

Some candidates were familiar only with diffraction of monochromatic light and not white light, hence the question of passing white light through a diffraction grating confused many students.

Some candidates chose to describe aspects which had already been described in the question. E.g. that beats are caused by two sound waves of similar frequency; or they described the separation of colours that was evident in the photograph.

91524: Demonstrate understanding of mechanical systems

Candidates who were awarded **Achievement** commonly:

- used relevant equations in a one-step calculation, sometimes when a more complex calculation was required
- drew and identified forces acting on a car on a banked track correctly
- used correct vector diagram to calculate centripetal force or used trigonometry to calculate the correct centripetal force
- recognised that for a body on a horizontal track, the normal/reaction/support force = weight of the cart/force of gravity so there was no acceleration
- recognised that at the bottom of the loop, the force from the track was greater than the force of gravity so the car was accelerating upwards
- recognised that the energy at the top of the track = the gravitational potential energy + kinetic energy at the top of the loop
- recognised that centripetal acceleration on top of the loop was 9.81 m s^{-2}
- stated the correct energy transformation for cylinders rolling down a slope from gravitational potential energy to both rotational and linear kinetic energy
- used correct energy equation to calculate angular speed or attempted to calculate the rotational kinetic energy using the correct equation
- converted rotation to radians or attempted to calculate the period using the correct equation or calculated the final angular frequency of the rolling cylinders
- attempted to explain why a solid cylinder reached the bottom before a hollow cylinder in terms of the cylinders' rotational inertias /torque/effective radii/mass distribution
- recognised that either acceleration or restoring force are directly proportional to displacement and are always directed towards the equilibrium position
- managed one step of a two-step computation by either calculating the correct angle for t or correct value for angular frequency or by simply using the correct equation for calculating the bumble bee's acceleration

- attempted to explain the large amplitude by referring to resonance or idea of resonance
- chose the correct starting point of a cosine graph as instructed and demonstrated an understanding of damping for 3 complete cycles.

Candidates who were assessed as **Not Achieved** commonly:

- were unable to draw/identify the forces acting on the car correctly
- did not draw a correct vector diagram of forces or calculate the centripetal force acting on a car on a banked curve
- attempted to use irrelevant equations in questions requiring explanations
- discussed energy when the question was about forces
- confused gravitational potential energy with force of gravity
- were unable to differentiate between the gravity force and the force from the track on top of the hill and at the bottom of the loop
- were unable to apply the principle of conservation of energy to calculate the height H of the hill
- confused rotational kinetic energy with linear kinetic energy and did not realise that linear kinetic energy was responsible for (linear) translational motion
- used conservation of angular momentum to explain why the solid cylinder reached the bottom first, even though it is not appropriate
- stated kinetic energy to mean linear kinetic energy and gravity for gravity force.
- failed to state the two conditions for SHM
- were unable to carry out a single step in a multi-step calculation
- failed to understand resonance and instead explained constructive and destructive interference of waves
- lacked knowledge on damping and drew wrongly shaped graphs, mostly less than the three cycles expected by the question.

Candidates who were awarded **Achievement with Merit** commonly:

- drew a vector diagram correctly and calculated the centripetal force acting on the car
- identified the forces the track exerted on the car at both positions (A & B) giving correct and complete comparison using linking words in their explanation
- were able to calculate the velocity at the top of the loop or to calculate the height (using incorrect velocity)
- calculated rotational kinetic energy of the hollow cylinder using correct formula.
- used the correct equation and calculated the time required to complete the first full rotation of a rolling cylinder
- linked mass distribution to rotational inertia for solid or hollow cylinder
- used the correct equation in attempting to calculate the acceleration of a body engaged in SHM but made one error
- stated the idea of resonance and linked matching driving frequency to natural frequency and or large amplitude
- drew the correct damping graph for three complete cycles with constant period and both axes labelled or an undamped graph for 3 complete cycles with constant period, both axis labelled and a justification for no damping
- used linking words in their explanations, showing that one event causes another event.

Candidates who were awarded **Achievement with Excellence** commonly:

- used correct energy consideration (gravitational potential energy (GPE) at the top is equal to GPE + E_k at the top of the loop) to calculate the height H of the hill
- clearly understood the conservation of energy, used relevant equations and causal links to explain why the solid cylinder reached the bottom of the slope before the hollow cylinder first so the solid cylinder will reach the bottom first
- used torque, relevant equations and casual inks to explain why the solid cylinder reached the bottom of the slope before the hollow cylinder. were able to perform multi- step calculation to find acceleration of the bumble bee using the correct formulae, selecting appropriate data from the question, and gave the correct units.

Standard-specific comments

Some candidates were not able to draw the required vector diagram correctly. Care is needed when completing vector diagrams to label and show correct directions.

It is important that candidates recognise whether a question involves forces or involves energy. Some candidates lacked understanding of what types of forces act in the given situations.

Candidates are advised to support their answers with diagrams even if the question does not explicitly require them.

When explaining why the solid cylinder reaches the bottom first, some candidates stated conservation of angular momentum in their explanation while the answer required conservation of energy or torque in the discussion because angular momentum is not conserved.

Candidates who performed well were able to state the two conditions necessary for simple harmonic motion.

Some candidates were not able to identify the phenomenon as resonance and instead started explaining about interference.

Candidates need to ensure they fully address questions. For example, question 3.d asked to draw the graph starting at +20 cm for 3 complete cycles and candidates drew the sinusoidal graph or damping graph less than 3 complete cycles.

The resource booklet gave the value, g = 9.81 m s^{-2} to be used in this examination. Some candidates ignored this and used g = 9.8ms^{-2} or 10 m s^{-2}.

91526: Demonstrate understanding of electrical systems

Candidates who were awarded **Achievement** commonly:

- used simple formulae to calculate basic values
- estimated the time constant correctly from a voltage/time graph for a charging capacitor

- discussed the relationship between Q and V as a capacitor charges
- calculated the total capacitance when capacitors are added in series
- knew that an alternating current creates an alternating magnetic flux
- explained why an inductor induces an opposing emf
- converted rms voltage to peak voltage
- stated the effect of adding iron to the core of a coil on the reactance
- calculated the reactance of an inductor
- identified that an increase in current was due to a decrease in the impedance of an LCR circuit
- showed a basic understanding of the characteristics of capacitors and inductors.

Candidates who were assessed as **Not Achieved** commonly:

- did not use a graph to calculate time constant for a capacitor
- thought that protons moved onto a capacitor's plate to give it a positive charge
- described the charging of a capacitor as increasing it's internal resistance
- made calculation errors like forgetting to square values in equations
- used formulae incorrectly like square rooting entire blocks of numbers instead of just 2 when calculating peak voltage
- confused charge with capacitance and inductance with reactance
- thought that inductors create a back current to oppose a supply voltage
- did not draw phasor diagrams to show relationships for AC circuits.

Candidates who were awarded **Achievement with Merit** commonly:

- calculated the resistance of a resistor by estimating the time constant from a voltage/time graph for a charging capacitor
- showed some understanding of the stages involved when a capacitor charges
- described and explained how voltage and time constant are affected when capacitors are added in a series circuit
- explained how a voltage is induced in the secondary coil of a transformer
- explained how and why current changes when an inductor is connected to a DC supply
- calculated the energy stored in the primary coil's magnetic field given the voltage of the battery, the resistance and the inductance of the coil
- described the effect of magnetic material, when inserted inside the core of a coil, on the reactance, impedance and current through the coil
- showed an understanding of AC circuits by calculating the reactance of an inductor, the impedance and current when the frequency of the circuit was changed
- explained why the impedance changes when a capacitor is added to an L-R circuit.

Candidates who were awarded **Achievement with Excellence** commonly:

- demonstrated a good understanding of the three stages of a capacitor charging and gave reasons why the process shows an exponential growth curve for voltage
- accurately sketched a graph to show how the current changes in a circuit containing an inductor when the switch is open and closed

- explained clearly how an inductor affects the current in a circuit when the switch is closed and later opened
- drew an accurate phasor diagram and used it correctly to calculate the current in an L-R circuit.

Standard-specific comments

Candidates need to understand the characteristics of inductors and capacitors in order to achieve well.

Many candidates described the formation of an induced CURRENT to oppose the supply under varying flux conditions. They often referred to the inductor as getting charged when the current was changing. Many candidates confused voltage / current / flux and magnetic field.

Regarding the charging of capacitors, many candidates explained how positive and negative charges flowed onto opposite plates, giving the plate a charge and as a result the back emf or resistance of the capacitor increases.

Some candidates did not have a good understanding of transformers and consequently had did not know the back emf and hence the current in the secondary coil is caused by changing magnetic flux conducted by the iron core in the transformer.

Physics subject page