Assessment Schedule – 2019

Scholarship Physics (93103)

Evidence Statement

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
ONE (a)	By conservation of momentum: Before: $((6+(-2.5)),(0+2.5)) = (3.5, 2.5)$ After: $(1.5+(5\times V_x), 3+(5\times V_y))$ $5V_x = (3.5-1.5) = 2.0$ $V_x = 0.40$ $5V_y = (2.5-3.0) = -0.5$ $V_y = -0.1$	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(b)	$\text{Kinetic energy before} = \left(\frac{1}{2}\times 3.0\times 2^2\right)+\left(\frac{1}{2}\times 5.0\times\left(\frac{\sqrt{2}}{2}\right)^2\right)$ $= 7.25\text{ J}$ $\text{Kinetic energy after} = \left(\frac{1}{2}\times 3.0\times\sqrt{1.25}^2\right)$ $+\left(\frac{1}{2}\times 5.0\times\left(\sqrt{0.17}\right)^2\right) = 2.30\text{ J}$ $KE_{before} \neq KE_{after}$; therefore collision is inelastic. The “missing” energy will have been converted into heat energy in the collision and into rotation KE with the discs spinning.			
(c)	The linear motions will be in straight lines as there are no external forces acting. The collision will have applied equal but opposite forces to each disc. Because angular momentum is conserved (no external torques) in the system the discs must rotate. M1 (3.0 kg – assuming it is uniform) will be rotating 1.67 times the angular velocity of M2 (5.0 kg– assuming it is uniform).			
(d)	The discs are originally neutral, so their motion through the electric field before the collision is not affected by the field. M_1 is positive after the collision, and will move in a parabola towards the right. M_2 is negative after the collision, and will slow down, reverse direction, and move towards the left, also following a parabolic path.			

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TWO (a)	When S is closed L behaves like an infinite resistor, so $I_3 = 0$ A and I_1 must equal I_2. $I_1 = \frac{\varepsilon}{R_1 + R_2} = \frac{100}{30} = 3.33\text{ A} = I_2$	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(b)	After a long time, L behaves like a wire with no resistance. The parallel branch can be considered to be the same as a 12 ohm resistor. This is now in series with a 10 ohm resistor. So the current from the cell is $\frac{V}{R} = \frac{100}{22} = 4.55\text{ A} = I_1$ $I_1 = I_2 + I_3$ – the voltage across the parallel branch will be $4.55 \times 12 = 54.55$ V so the current $I_2 = \frac{54.55}{20} = 2.73$ A			
(c)(i)	The inductor will maintain the current I_3 as it was immediately before opening the switch, therefore $I_3 = 1.82$ A $I_1 = 0$ A as no supply voltage $I_2 = 1.82$ A as it is now in series with L			
(ii)	In the end all currents will be zero, since there is no emf in the circuit. The inductor cannot maintain the back voltage for any significant length of time. One can also consider the energy stored in the field being used by the resistors.			
(d)(i)	The field is proportional to the current in the coil / magnet. As with any RLC circuit, the inductor prevents rapid change in current. The current must build up from zero (c.f. an RC circuit where the current is maximum immediately after switch closed). The capacitors store a finite amount of separated charge / energy. Eventually this dissipates, and there is no longer any capacitor voltage to drive current in the circuit. The inductor will “seek” to keep the current flowing (resists change) but eventually current and hence field must drop to zero. All energy is ultimately dissipated in the resistor, which represents the internal resistance of the coil. These systems are overdamped, so there are no oscillations.			
(ii)	It would melt. Not enough total energy in a short pulse to heat the magnet enough to melt it (although they rise to a few hundred degrees), but with DC the temperature would continue rising. Alternatively, the DC approach would require switching, which is more difficult to control.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
THREE (a)(i)	$mgL = \frac{1}{2}mv^2 \qquad v^2 = 2gL$ $T = mg + \frac{mv^2}{L} = mg + 2mg = 3mg$	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(ii)	The square of the speed reached increases as the length of the rope increases, and so the centripetal force (the tension) should also increase. But the centripetal force required is also reduced in direct proportion to the increase in radius of the motion. These factors exactly cancel each other, leading to a constant maximum tension.			
(b)(i)	$T = kx$ $T = mg + \frac{mv^2}{L+x}$ $T(L+x) - mg(L+x) = mv^2$ Energy $mg(L+x) = \frac{1}{2}mv^2 + \frac{1}{2}kx^2$ $2mg(L+x) = mv^2 + kx^2 = T(L+x) - mg(L+x) + Tx$ $3mg(L+x) = T(L+2x)$ $T = \frac{3mg(L+x)}{L+2x}$			
(ii)	The maximum velocity reached is less for the rubber than for the rope because some of the transferred GPE is taken up as elastic PE in the stretched rubber. This reduces the required centripetal force, reducing the required tension.			

Q	Evidence	1–4 Below Schol	5–6 Scholarship	7–8 Outstanding
FOUR (a)	The travelling wave generated by the vibrator meets the wave reflected from the pulley. If the wave speed and frequency are such that the two waves interfere constructively and destructively at fixed positions then a standing wave is formed.	Thorough understanding of these applications of physics. OR Partially correct mathematical solution to the given problems. AND / OR Partial understanding of these applications of physics.	(Partially) correct mathematical solution to the given problems. AND / OR Reasonably thorough understanding of these applications of physics.	Correct mathematical solution to the given problems. AND Thorough understanding of these applications of physics.
(b)(i)	$v^2 = \dfrac{T}{\mu}$ $v^2 = f^2\lambda^2$ $T = \mu f^2\lambda^2$			
(ii)	$T = ma =$ kg m s^{-2} $\mu f^2\lambda^2 =$ kg m^{-1} s^{-2} m^2 = kg m s^{-2}			
(c)	$\lambda_2 = 1.5\ \lambda_3$ $T_3 = mg = \mu f^2\lambda_3^2$ $T_{new} = \mu f^2\lambda_2^2 = \mu f^2(1.5\lambda_3)^2 = 2.25$ mg			
(d)	Diffraction illustrates the wave aspect of light. Diffraction is the spreading out of a wavefront when passing through a gap or obstacle. The wavefront acts as a series of secondary sources. A stream of particles passing through a gap would not spread out in this manner. Light striking a metal surface can lead to emission of an electron. That electron's maximum energy is directly related to the frequency of the incident light and not the intensity.			

<table>
<tr><th>Q</th><th>Evidence</th><th>1–4
Below Schol</th><th>5–6
Scholarship</th><th>7–8
Outstanding</th></tr>
<tr><td>FIVE
(a)</td><td>Conservation of momentum
$2.2 \times 8.33 = 2.2 \times V + 1.5 \times 5.55$
$V = 4.546$ (speed of model truck after collision)
Kinetic Energy lost
$\frac{1}{2} \times 2.2 \times 8.33^2 - \frac{1}{2} \times 2.2 \times 4.546^2 - \frac{1}{2} \times 1.5 \times 5.55^2$
$= 30.49$ J
This is the work done in crushing the model car:
$30.49 = Fd$
$d = \frac{30.49}{500} = 0.061$ m</td><td rowspan="5">Thorough understanding of these applications of physics.
OR
Partially correct mathematical solution to the given problems.
AND / OR
Partial understanding of these applications of physics.</td><td rowspan="5">(Partially) correct mathematical solution to the given problems.
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AND
Thorough understanding of these applications of physics.</td></tr>
<tr><td>(b)</td><td>Assumption is that all of the lost KE goes into deformation. Because a lot of KE will be lost to frictional heat between the tyres and the surface, it is therefore invalid.
Conservation of momentum is conserved only if we include all the bodies involved – that should also include the Earth due to the frictional forces involved.</td></tr>
<tr><td>(c)</td><td>Impulse = Change of momentum
$500 \times t = 1.5 \times 5.55$
$t = 0.017$ s</td></tr>
<tr><td>(d)</td><td>If two vehicles without crumple zones collide, large forces / accelerations will be produced that are dangerous to the passengers.</td></tr>
<tr><td>(e)</td><td>The seat belt prevents a person from moving within the vehicle. The person must slow down with the vehicle, which slows “gradually” because the crumple zones take appreciable time to compress. The seat belt gives the person no other option than to lose their momentum slowly along with the vehicle. Since the impulse required is fixed (by the original momentum of the moving person), any increase in the timespan of the collision will result in smaller forces having to be applied, meaning reduced accelerations and less damage to the person.
Also… the seat belt is broad so the restraining forces on the person are spread over a considerable area, resulting in lower peak pressures and therefore less damage to the person.</td></tr>
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Cut Scores

Scholarship	Outstanding Scholarship
22 – 31	32 – 40