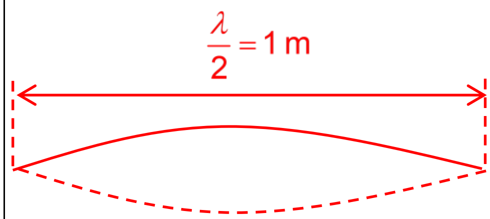
H2 Physics PU3 Preliminary Examination Paper 1 Answers

S/N	Answer	Explanation
1	D	$[E] = \frac{\lvert Q \rvert^n}{\lvert k \rvert}$ kg m^2 s^{-2} $= \frac{A^n \text{ s}^n}{A^2 \text{ s}^4 \text{ kg}^{-1} \text{ m}^{-2}}$ $n = 2$
2	C	a = b^{2}c c = $\frac{a}{b^2}$ $\frac{\Delta c}{c} = \frac{\Delta a}{a} + 2\frac{\Delta b}{b}$
3	C	At point A: object just reached the ground for the first time At point B: object just about the leave the ground after first bounce At point C: object reached the maximum height after first bounce At point D: object just reached the ground for the second time
4	C	$s = ut + \frac{1}{2}at^2$ u = o since the stone falls from rest. $2 = \frac{1}{2}at^2$ $\frac{4}{a} = t^2$ $t = \frac{2}{\sqrt{a}}$ ------------ (1) where t is the time taken for stone to fall on Earth Acceleration of free fall of moon = $\frac{a}{6}$, where a is the acceleration of free fall on Earth. Sub $\frac{a}{6}$ into equation (1) $t_{moon} = \frac{2}{\sqrt{\frac{a}{6}}} = \frac{2}{\sqrt{a}}\left(\sqrt{6}\right) = t\sqrt{6}$
5	B	Area under the force-time graph = change in momentum = impulse Total area = (5 x 0.5) + (15 x 0.5) = 10 Δp = m Δv = 10 Δv =v - 0 ➔ v = 10 / 4 = 2.5 m s^{-1} 2.5 m s^{-1} + 2.5 m s^{-1} = 5.0 m s^{-1}

6	**B**	A and D obviously wrong. Try taking moments about C, clockwise moment = (3*m*)(1.5*x*) = 4.5*mx* anti-clockwise moment = (3*m*)(1.5*x*) + (*m*)(0.5*x*) = 4.5*mx* + 0.5*mx* = 5 *mx* Therefore C is also wrong and centre of gravity is slightly to the left side of C.
7	**C**	Since the balloon is in equilibrium, upthrust on balloon = weight of balloon and helium + force by spring $\rho_{air}V_{balloon}g = \rho_{helium}V_{balloon}g + m_{balloon}g + kx$ $(1.29)(5.0)g = (0.180)(5.0)g + (\frac{3.5}{1000})g + (100)x$ x = 0.544 m
8	**C**	Force constant, $k = \frac{5.0}{0.1} = 50$ N m^{-1} Initial extension = $\frac{F}{k} = \frac{3}{50} = 0.06$ m and final extension = $\frac{F}{k} = \frac{2.5}{50} = 0.05$ m Change in E.P.E.= $\frac{1}{2}kx_f{}^2 - \frac{1}{2}kx_i{}^2 = \frac{1}{2}(50)(0.05)^2 - \frac{1}{2}(50)(0.06)^2 = -0.028$ J
9	**D**	Frictional force on the object provides the centripetal force $mr\omega^2$. Both objects have the same angular velocity and same mass, but the centripetal force required for Q is larger due to larger radius. When the centripetal force required exceeds the frictional force available, Q starts to slide.
10	**D**	Using COE: $E_i = E_f$ $GPE_i = KE_f$ $mgr = \frac{1}{2}mv^2$ $2mgr = mv^2$ ------------- (1) $T_{\text{bottom}} - mg = \frac{mv^2}{r}$ $T_{\text{bottom}} = \frac{mv^2}{r} + mg$ sub (1) into eqn $= \frac{2mgr}{r} + mg$ $= 3mg$

11	**C**	$g = \frac{GM}{r^2}$ $g \propto \frac{M}{r^2}$ Let the quantities with subscript '*J*' represent that of Jupiter while those with subscript '*E*' represent that of Earth. $\frac{g_J}{g_E} = \frac{M_J}{M_E}\left(\frac{r_E^{\ 2}}{r_J^{\ 2}}\right)$ $\frac{g_J}{g_E} = (318)\left(\frac{6370\times10^3}{7.15\times10^7}\right)^2$ Since g_E = 9.81 N kg^{-1}, $g_J = (318)\left(\frac{6370\times10^3}{7.15\times10^7}\right)^2(9.81)$ = 24.8 N kg^{-1}
12	**B**	$\Delta U = m\Delta\phi \propto \Delta\phi$ $\frac{\Delta U_{BC}}{\Delta U_{AB}} = \frac{\Delta\phi_{BC}}{\Delta\phi_{AB}} \Rightarrow \frac{-5.0}{+20} = \frac{\phi_C + 3.0}{-3.0+7.0}$ $\Rightarrow \phi_C = -4.0$ J kg^{-1}
13	**A**	When two objects A and B are placed in thermal contact, heat flows from the hotter object to the colder object B, until they reached thermal equilibrium. At thermal equilibrium, both objects A and B are at the same temperature.
14	**B**	Average K.E. $= \frac{3}{2}kT = \frac{3}{2}(1.38\times10^{-23})(27+273.15) = 6.2\times10^{-21}$ J
15	**D**	$mc\frac{\Delta\theta}{t} = \frac{m}{t}L$ $\frac{L}{c} = \frac{\Delta\theta}{t}(t)$ $= 4\times40$ $= 160$
16	**C**	Amplitude, x_o = 0.36/2 = 0.18 m $V_{max} = \omega x_o$ = $(2\pi/T)\, x_o$ = $(2\pi/0.60)(0.18)$ = 1.9 m s^{-1}
17	**B**	Damping force opposes motion.
18	**C**	Since *I* is proportional to A^2, A_R = A + (2A) = 3A Hence, 9 *I*

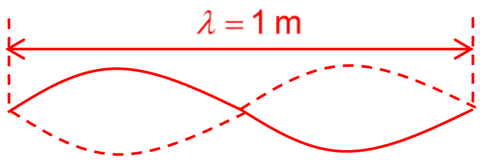
<table>
<tr><td>19</td><td>D</td><td>


At the fundamental mode,

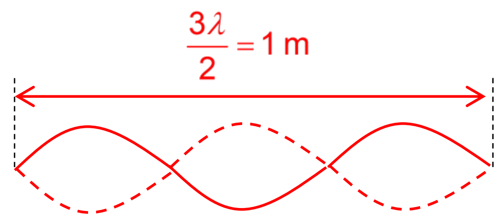
$\frac{\lambda}{2} = 1\text{ m}$, λ = 2 m → Option A is incorrect.

The mid-point of the rope is not stationary at fundamental mode. Option B is incorrect.

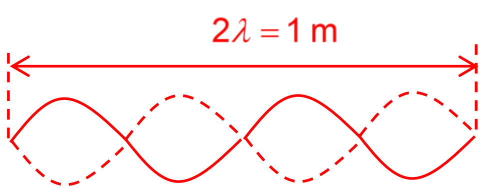
2nd Harmonic- λ = 1 m



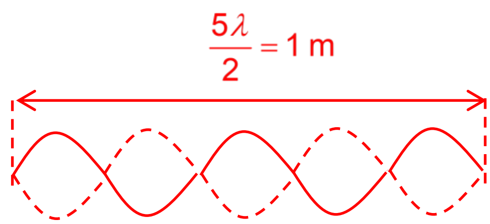
3rd Harmonic- λ = 0.667 m



4th Harmonic- λ = 0.5 m



5th Harmonic- λ = 0.4 m



When the fundamental frequency is doubled, there are 3 nodes on the rope. Option C is incorrect.

At the 5th harmonic, the wavelength is 0.4 m. Option D is correct.
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<tr><td>20</td><td>B</td><td>
Using Rayleigh's criterion for resolution: $\theta = \frac{\lambda}{b}$

For small angle, θ = sin θ = tan θ
$(700 \times 10^{-9}) / (30 \times 10^{-3}) = x / 5.0$
$x = 1.2 \times 10^{-4}$ m = 0.12 mm
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<tr><td>21</td><td>B</td><td>
$E = -\frac{dV}{dr} = 0$
where V = constant

If the electric field strength is zero at a point, it only means that the potential gradient is zero at that point. But the value of the potential at that point need not be zero.
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<tr><td>22</td><td>B</td><td>
From graph, when current is 40 mA, p.d. is approximately 1.2 V.

Therefore, p.d. across resistor = 6.0 – 1.2 = 4.8 V

R = V/I = (4.8)/(0.040) = 120 Ω
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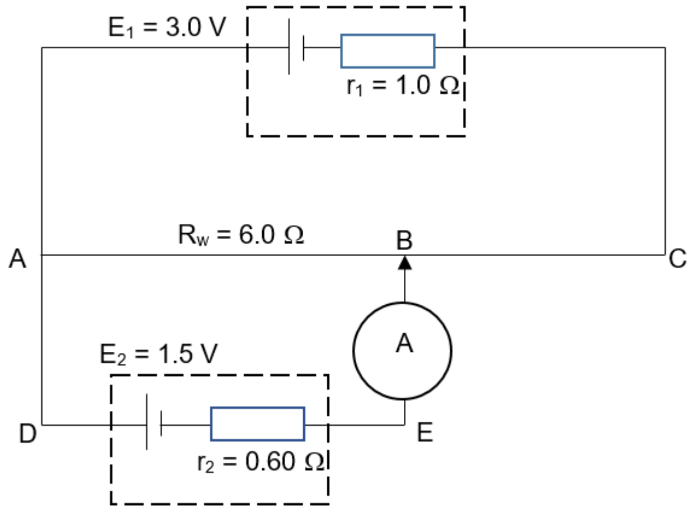
23	**D**	 At balance, $V_{AB} = V_{DE}$ Since no current flows through the bottom cell at balance, $V_{DE} = E_2$ Also, $\frac{L_{AB}}{L_{AC}} = \frac{V_{AB}}{V_{AC}} = \frac{V_{DE}}{V_{AC}} = \frac{E_2}{V_{AC}}$ Then, $V_{AC} = E_1 \frac{R_w}{R_w + r_1}$ (apply potential divider principle to the top loop) $= 3.0 \times \frac{6.0}{6.0+1.0}$ $= 2.571$ V So balance length, $L_{AB} = L_{AC} \frac{E_2}{V_{AC}}$ $= 1.0 \times \frac{1.5}{2.571}$ $= 0.58$ m
24	**A**	The electric force on a positively charged particle is directed towards SR. To pass through undeviated, the magnetic force must be directed towards PQ. When the strength of the magnetic field is increased, the magnetic force increases but the electric force remains the same. So the particles will now be deflected towards PQ.
25	**B**	$\varepsilon = -\Delta$(flux linkage) / Δt $\varepsilon = -N B \Delta A / \Delta t$ $\varepsilon = -(1)(1.2)(6 \times 10^{-3} - 0) / (3 - 0)$ $\varepsilon = -0.0024$ V

26	**A**	$\frac{V_s}{V_p} = \frac{N_s}{N_p}$ $\frac{V_s}{120} = \frac{1}{60}$ $V_s = 2.0$ V Then $I_s = V_s/R = 2.0/3.0 = 0.667$ A For ideal transformer, $V_p I_p = V_s I_s$ $120 \times I_p = 2.0 \times 0.667$ $I_p = 0.011$ A
27	**C**	The range of wavelengths for visible light is 400 nm to 700 nm. Since $E = \frac{hc}{\lambda}$, the energies of these photons range from $\frac{(6.63\times10^{-34})(3.00\times10^{8})}{(700\times10^{-9})(1.60\times10^{-19})} = 1.7759$ eV to $\frac{(6.63\times10^{-34})(3.00\times10^{8})}{(400\times10^{-9})(1.60\times10^{-19})} = 3.1078$ eV . Only 3 transitions will result in emissions of such photons: $6.12 - 4.28 = 1.84$ eV $6.81 - 4.28 = 2.53$ eV $7.02 - 4.28 = 2.74$ eV
28	**D**	For the cut-off wavelength, $eV = \frac{hc}{\lambda_{min}}$ Since the λ_{min} for graph 2 is halved of graph 1, that means that the accelerating potential for graph 2 is doubled that of graph 1. Since the characteristic wavelength remain the same for graph 1 and graph 2, this means that the target metal is the same.
29	**A**	Difference in binding energies of products and reactants = Gain in kinetic energies of products + Energy of gamma ray (39.25 + 28.48 – 64.94) = 2.31 + E E = 0.48 MeV

30	**A**	A range of (kinetic) energies indicates a range of speeds for the β particles. Since beta particles are emitted with a range of speeds, the products of a beta decay process cannot just consist of the daughter nuclide (product nuclide) and the beta particle as this would imply definite speeds for both products, in order for linear momentum to be conserved. Option B is wrong. There is no such observation. Neutrino is chargeless. The total charge of the decay products is equal to the charge of the parent nuclide. Option C is wrong. It is a true observation, but the loss in mass during β decay is due to conversion to energy released, and not the existence of the neutrino. Option D is wrong. There is no such observation. Neutrino is chargeless so has no ionising power, and therefore cannot be observed in a cloud chamber.