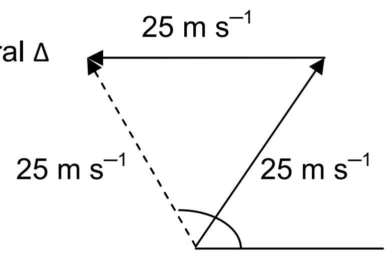
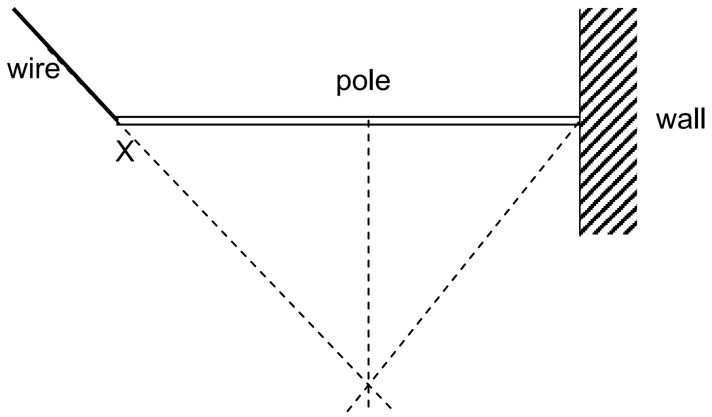
2014 H1 AJC Prelim P1 solution

1D	2C	3D	4C	5B	6C	7A	8C	9A	10A
11A	12C	13C	14C	15B	16B	17D	18D	19A	20D
21B	22C	23C	24A	25A	26D	27B	28B	29B	30D

No	Answer & Solution
1	**Ans: D** Even though work done can be negative, it is a scalar since the negative does not represent its direction. Electric current flows along the wire and therefore has no fixed direction in space.
2	**Ans: C** The absolute uncertainty of the diameter is 0.02 x 5.0 = 0.1 cm. The absolute uncertainty of the radius will be 0.1 cm / 2 = 0.05 cm The fractional uncertainty of the radius will be 0.05 cm / 2.5 cm = 0.02.
3	**Ans: D** Random error causes a scatter of points about an average which affects the precision. Systematic error causes a shift in the value away from the true value which affects the accuracy.
4	**Ans: C** A: Typical power of a toaster is around 1 kW. B: KE of a 10000 kg bus travelling at 80 km h^{-1} (22.2 m s^{-1}) = 0.5 x 10000 x 22.2^2 = 2400 kJ C: The approximate temperature of a hot oven is about 200 – 230 °C = 473 to 503 K D: The approximate volume of the swimming pool = 50 x 25 x 1.6 = 2000 m^3
5	**Ans: B** $0 = v_o^2 - 2a(\frac{1}{3}s) \Rightarrow v_o^2 = 2a(\frac{1}{3}s)$ ------------------- (1) OR using $\frac{1}{2}mv^2 = Fx$ $0 = u^2 - 2as \Rightarrow u^2 = 2as$ --------------------(2) (1)/(2) : $\frac{v_o^2}{u^2} = \frac{1}{3}$ $u = \sqrt{3}v_o$
6	**Ans: C** equilateral Δ 
7	**Ans: A** Vertical: $s = ut + \frac{1}{2}at^2$ $500 = \frac{1}{2}(10)t^2$ $t = 10$ s

	Horizontal: $s = ut = (200)(10) = 2$ km
8	**Ans: C** Applying conservation of momentum to trolley. $m_{trolley}v_{trolley} = (m_{trolley}+m_{sand})v_{trolley\&sand}$ $v_{trolley\&sand} = (2.0)(0.5)/(2.5) = 0.4\ m\ s^{-1}$ $\Delta P_{trolley} = \|(2.0)(0.4 - 0.5)\| = 0.2\ N\ s$
9	**Ans: A** System of two mass: F = 3 (a) $a = \frac{F}{3}$ System of 1 kg mass: $T = (1.0)\left(\frac{F}{3}\right)$ $= \frac{F}{3}$
10	**Ans: A** The three forces must through a common point. Hence direction of R must act along the dotted line from the wall. 
11	**Ans: A** Since object is released from rest, no viscous force would act on it at the start. Upthrust is dependent on the pressure difference acting on the object. As pressure difference remain the same as object falls, upthrust will remain unchanged.
12	**Ans: C** EPE is the area under force-extension graph. Work done by the spring during the change from L_1 to L_2 is the area of trapezium under the F-L graph.
13	**Ans: C** Based on Energy Work Theorem and isolating rice sack as system, Work done on rice sack by man + Work done on rice sack by gravity = Change in KE Work done on rice sack by man = - Work done on rice sack by gravity |Work done on rice sack by man| = |Work done on rice sack by gravity|
14	**Ans: C** $P_{out} = 0.6 \times P_{in}$ $\frac{V\rho gh}{t} = 0.6 \times P_{in}$ $P_{in} = 13.6W = 14$ W

15	**Ans: B** Based on Conservation of Energy Loss of GPE = Gain in KE + Work done against friction W = ΔKE + ΔPE -10KJ = KE_f – (5KJ) + (-40KJ) KE_f = 35 kJ
16	**Ans: B** velocity of radio wave (EM wave) = 3.0 x 10^8 m s^{-1} period = 0.011 x 10^{-6} s Using v = f λ, we have λ = v / f = v T = 3.3 m
17	**Ans: D** Amplitude of X = 2 x Amplitude of Y Period of X = 3 x Period of Y ➔ Frequency of X = 1/3 Frequency of Y Hence, I_X / I_Y = $(2)^2(1/3)^2$ I_Y = 9/4 I_X = 2.25 I_0
18	**Ans: D** At the original position, the light from Q is polarized vertically. Hence no light will pass through R as the incoming light from Q is in the plane that is perpendicular to the axis of polarisation of R. At the final position where the axes of polarisation of Q and R are aligned, the light that passes through P is polarized vertically. Hence no light will pass through Q as the incoming light from P is in the plane that is perpendicular to the axis of polarisation of Q. Therefore the intensity of light through R is zero. When Q is rotated, the light intensity will increase until it reaches a maximum at an angle of 45°, and it reduces again as the angle is increased.
19	**Ans: A** Fringe separation, x = λD/d, where λ is the wavelength of the light, D is the distance between slits and screen and d is the slit separation. Options C and D reduces the fringe separation while option A increases fringe separation (as the wavelength of orange light is larger). Option B has no effect on fringe separation.
20	**Ans: D** A: Different points on the stationary wave has different energy, hence energy is not transferred. B: Only points within the same segment (between adjacent nodes) of a stationary wave vibrate in phase. C: The wavelength of the wave is two times the distance between adjacent nodes. D: Neighbouring points on the stationary wave have different amplitudes of vibration.
21	**Ans: B** Since 6 nodes form 5 segments, Distance between adjacent nodes = (37 – 4.0) / 5 = 6.6 cm Wavelength of sound = 2 x 6.6 = 13.2 cm Speed of sound = 2500 x 0.132 = 330 m s^{-1} Be careful: 4 cm $\neq \frac{\lambda}{4}$ because there is an end correction.

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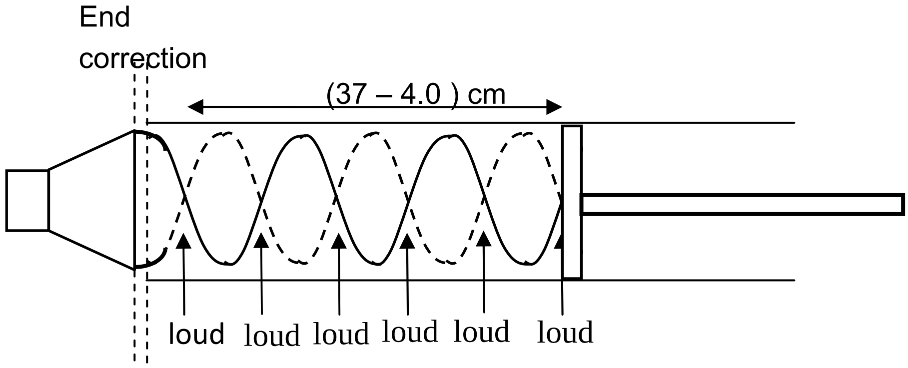
<tr><td></td><td>
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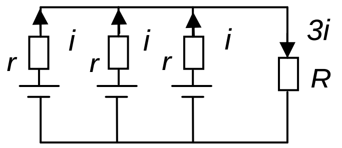
<tr><td>22</td><td>Ans: C


Fraction of total power lost
$= \dfrac{\text{Power lost by internal resistance}}{\text{Power lost by internal resistance+ Power of external resistor } R}$
$= \dfrac{i^2r + i^2r + i^2r}{i^2r + i^2r + i^2r + (3i)^2R} = \dfrac{r}{3R + r}$</td></tr>
<tr><td>23</td><td>Ans: C
Resistance is the inverse of I/V ratio.</td></tr>
<tr><td>24</td><td>Ans: A
When pd is applied across BD,
Combined resistance across BD, R_{BD} = 20/3 Ω
When pd is applied across AB,
Combined resistance in branches BD and BCD = 20/2 = 10 Ω
Add to branch AD which is in series = 10 + 10 = 20 Ω
Combined resistance across AB = $(1/10 + 1/20)^{-1}$ = 20/3 Ω

This is same as R_{BD} in the previous case. Since power to circuit, $P = V^2/R$ ➔ $P_{BD} = P_{AB}$</td></tr>
<tr><td>25</td><td>Ans: A
Original distribution of resistance across the two loops in the circuit is R/2 to R/2 i.e. 1:1. The new distribution is R to R/2 i.e. 2:1.
Due to the new distribution of resistance, the voltage across X will increase (2/3 V) and the voltage across Y and Z will decrease (1/3 V). Since current is V / R, and R is constant, the increase in voltage across X will cause an increase in current through X while the decrease in voltage across Y and Z will cause a decrease in current through Y & Z.</td></tr>
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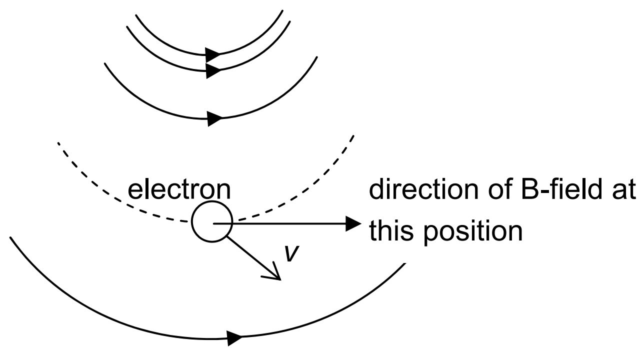
26	**Ans : D** The direction of the B-field at the electron's position is tangential to the B-field at that point (and hence is horizontal and to the right), as shown in the figure below. Resolve the B-field into 2 components: parallel and perpendicular to the motion of the electron. Using Fleming's Left Hand Rule, the direction of the force will be into the paper (direction that the thumb is pointing), taking care that the direction of the middle finger is opposite to the direction of the motion of electron. 
27	**Ans : B** F = B*Il*sin α For sides PQ and RS, α = 0° and 180°, hence F = 0 For sides SP and QR, α = 90°, F = B*Il*. Direction of the forces on SP and QR can be found by Fleming's left-hand rule. The force on QR points out of the plane of the diagram and the force on SP points into the plane of the diagram.
28	**Ans: B** From photoelectric effect equation: $\text{KE}_{\text{max}}\text{ of electrons} = hf - \phi$, using a light of higher frequency, maximum energy of ejected electrons increases. As intensity of light = $n_p \times \frac{hf}{Area}$, with a higher frequency, the rate of number of incoming photons decreases. Hence, the photoelectric current decreases.
29	**Ans: B** For absorption of a photon to take place, the energy transition is from a lower energy level to a higher energy level. For absorption of a photon with highest wavelength, the difference between the 2 energy levels is the smallest. i.e. $\Delta E = \frac{hc}{\lambda}$
30	**Ans: D** The de Broglie hypothesis is a fundamental principle exhibited by both radiation & matter. The de Broglie hypothesis can predict wavelengths for all particles.