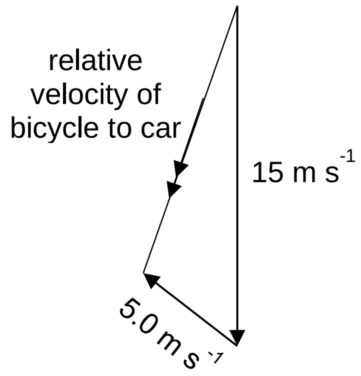
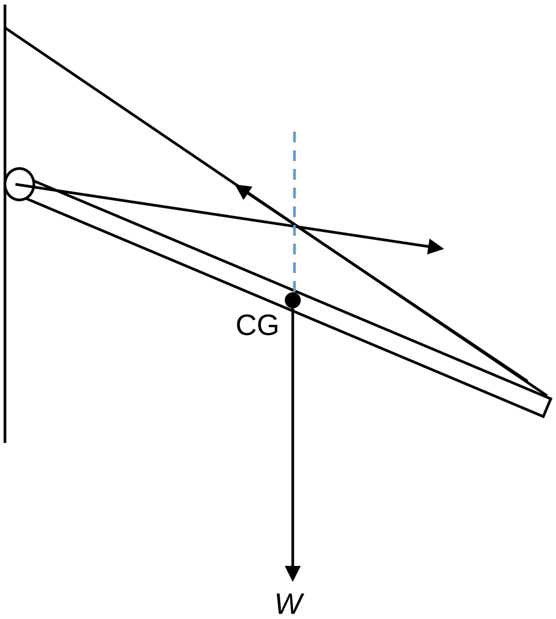
Paper 1 – Multiple Choice Questions

1	**Answer: A**
	 relative velocity of bicycle to car = velocity of bicycle – velocity of car = velocity of bicycle + (– velocity of car)

2	**Answer: A**
	Horizontally, $u\cos 30° t = 3.0 \Rightarrow t = \dfrac{3.0}{u\cos 30°}$ **Vertically**, taking upwards as positive, $u\sin 30° t - \dfrac{1}{2}gt^2 = -0.25$ Sub-in the expression for t above, $3.0\dfrac{\sin 30°}{\cos 30°} - \dfrac{1}{2}g\left(\dfrac{3.0}{u\cos 30°}\right)^2 = -0.25$ Solving, $u^2 = 29.7$, $u = 5.4$ m s^{-1} Option C: forgot to take square root Option B: took vertical displacement to be 0.25 m Option D: took vertical displacement to be 0.25 m and forgot to take square root

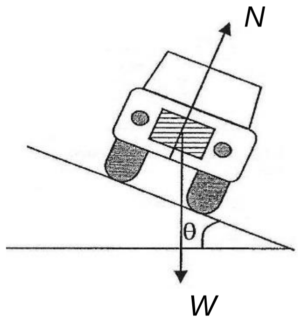
3	**Answer: B**
	<u>From FBD of block A:</u> $F_{\text{net}} = ma$ $12 + 2.0 \times 9.81 \times \sin 35° - T = 2.0a$ $23.25 - T = 2.0a$ ---> Eqn(1) **<u>From FBD of block B:</u>** $F_{\text{net}} = ma$ $T - 20 - 5.0 \times 9.81 \times \sin 20° - 20 = 5.0a$ $T - 36.78 = 5.0a$ ---> Eqn(2) From Eqn(1), 58.125-2.5T=5.0a -→ Eqn(3) (3) – (2): 94.905-3.5T=0 T=27 N

4	**Answer: B**
	Horizontally, $50v_1 \cos 60^o - 50v_2 \cos 60^o = 0$ $v_1 = v_2$ Vertically, $50v_1 \sin 60^o + 50v_2 \sin 60^o - 100(8) = 0$ $50v \sin 60^o + 50v \sin 60^o - 100(8) = 0$ $v = 9.2 \text{ m s}^{-1}$

5	**Answer: A**
	 When 3 nonparallel forces act on a object in equilibrium, the must intersect at a point.

6	**Answer: B**
	Let *d* be the initial height from ground, *h* be the height at *t*. For E_P-*s* graph, $E_P = mgh$ $= mg(d-s)$ => Sketch $y = b - cx$ (where *b, c* are constants) For E_P-*t* graph, $E_P = mgd - mgs$ $= mgd - mg(ut+1/2gt^2)$ $= mgd - ½\ mg^2t^2$ => Sketch $y = p - qx^2$ (where *p, q* are constants)

7	**Answer: C**
	$F = ma$ $F_{driving} - k(20)^2 = 1000(0.50)$ $F_{driving} = 500 + 400k$ $P = F_{driving}v$ $40 \times 10^3 = (500 + 400k)(20)$ $k = 3.75$ $P_{new} = F_{driving}v$ $P_{new} = F_{friction}v$ $P_{new} = kv^3 = (3.75)(25)^3 = 59$ kW

8	**Answer: C**
	Horizontal component of Normal contact force provides centripetal force $F_{net} = ma_c$ $N\sin\theta = \frac{mv^2}{r}$ ....(1) For vertical equilibrium: $N\cos\theta = mg$ .... (2) $\frac{(1)}{(2)}$: $\tan\theta = \frac{v^2}{rg}$ $v = \sqrt{50 \times 9.81 \times \tan 25°}$ $= 15.1 \text{ m s}^{-1}$ 

9	**Answer: D**
	Gain in GPE = Loss in KE $mgr(1+\cos\theta) = \frac{1}{2}m(v_i^2 - v_f^2)$ $gr(1+\cos\theta) = \frac{1}{2}(v_i^2 - v_f^2)$ $(9.81)(7.7)(1+\cos 30^o) = \frac{1}{2}(25^2 - v_f^2)$ V_f = 18.5 m s^{-1} Assume rod in tension $mg + F = \frac{mv^2}{r}$ $(3.5)(9.81) + F = \frac{(3.5)(18.5)^2}{7.7}$ F = 121 N (tension)

10	**Answer: B**
	$pV = nRT$ $z = nR(273.15) \quad ---(1)$ $x = nRT_3 \quad ---(2)$ $\frac{(1)}{(2)} : \frac{z}{x} = \frac{273.15}{T_3}$ $T_3 = 273.15\frac{x}{z}$

11	**Answer: C**
	$p_xV_x = n_xRT$ $p_yV_y = n_yRT$ pV = nRT assuming no gas particles escaped out of the flasks, $n = n_x + n_y$ Therefore, $pV = (n_x + n_y)RT$ $= p_xV_x + p_yV_y$

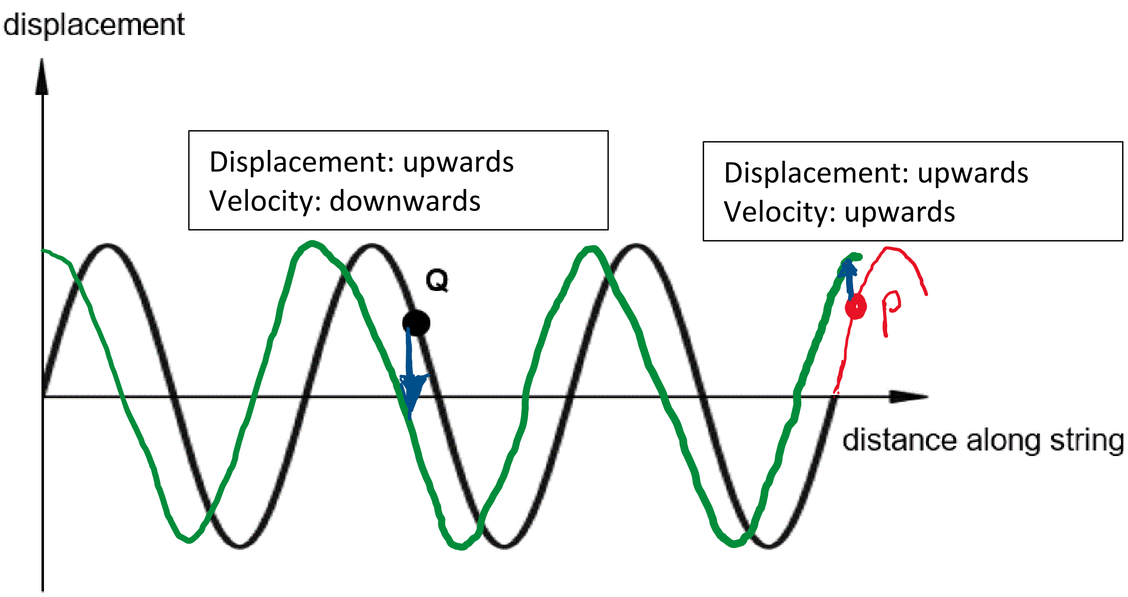
12	**Answer: D**
	$p = \frac{1}{3}\frac{Nm}{V}\langle c^2 \rangle$ $(1.00 \times 10^5) = \frac{1}{3}(1.60)\langle c^2 \rangle$ c_{rms} = 433 ms^{-1}

13	**Answer: A**
	$P_{\text{supplied}} = \frac{m}{t} l_f + h_{\text{rate of heat loss}}$ $P = \frac{m}{t} l_f + h_{\text{rate of heat loss}}$ $650 = \frac{(3.0)}{2.0 \times 60} l_f + h_{\text{rate of heat loss}}$ $1200 = \frac{(3.0)}{1.0 \times 60} l_f + h_{\text{rate of heat loss}}$ $1200 - 650 = \left[\frac{(3.0)}{1.0 \times 60} - \frac{(3.0)}{2.0 \times 60}\right] l_f$ $l_f = 22$ kJ kg^{-1}

14	**Answer: D**
	ΔU is zero as there is no change in temperature. W is zero as the volume of the refrigerator is assumed to be constant. Since, Q = ΔU – W, Q is also zero.

15	**Answer: B**
	At *t* = 0 s, the projection is at maximum amplitude. Hence displacement-time graph is cosine. Differentiating will give velocity-time and acceleration-time.

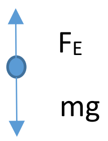
16	**Answer: C**
	The pulse undergoes 180^0 phase change upon hitting the fixed point O, options reduce to either C or D. However, the smaller amplitude portion will travel first before the larger amplitude portion as it is the portion that encounters fixed point O first. Thus, answer is C.

17	**Answer: A**
	

18	**Answer: A**
	The wavelength being 5.0 m, the path difference (147.5 – 135 = 12.5 m) corresponds to 2.5 wavelengths. Hence, the two waves meet in anti-phase. Intensity = k(amplitude)^2, k is a constant $\frac{I}{4I} = \frac{k * A_1^2}{k * A_2^2} \Rightarrow \frac{A_1}{A_2} = \frac{1}{2}$, or $A_2 = 2A_1$ When meet in anti-phase, the two vectors are in opposite direction. The resultant vector is the difference between them: $A_{tot} = A_2 - A_1 = 2A_1 - A_1 = A_1$ Hence, the resulting intensity is $I_{resultant} = kA_{tot}^2 = kA_1^2 = I$

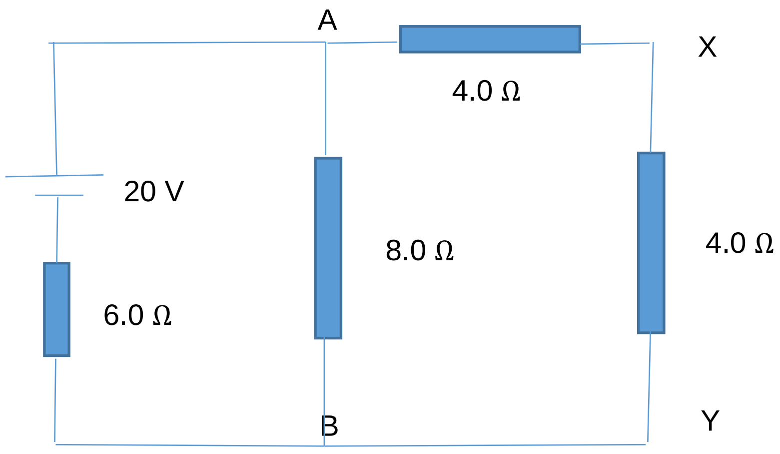
19	**Answer: B**
	$\sin\theta = \frac{\lambda}{2b} = \frac{1}{2}$ $\sin\theta \approx \frac{1}{2}\theta$ if angles are small *b* is doubled, double of the wave energy is allowed to pass through the slit. Since double of the energy is now spread over half the area, the maximum intensity is increased to 4 times.

20	**Answer: D**
	$x = \frac{\lambda D}{a}$ $y = \frac{(600 \times 10^{-9})(1.00)}{a}$ $y = \frac{(400 \times 10^{-9})D}{a}$ D = 1.50 m

21	**Answer: A**
	 At equilibrium, mg = F_E = qV/d When V increases to 2V, Resultant force, ma = q(2V)/d – mg = 2mg – mg = mg Therefore, a = g

22	**Answer: A**
	I = nAvq I, n and q are constant. Therefore, A ∝ 1/v But A is linearly related to x, Hence v = k/(x+constant)

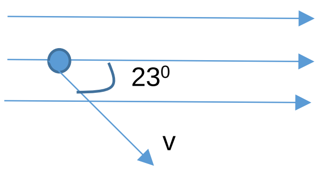
23	**Answer: A**
	Current in circuit, $I = P_{supply}/V_{supply}$ = 2400/240 = 10 A $P_{kettle} = P_{supply} – P_{loss}$ = 2400 – (10^2)(0.5+0.5) = 2300 W Potential difference across kettle = 240 – (10)(0.5+0.5) = 230 V

24	**Answer: B**
	 Effective resistance between X and Y = 4.0 Ω Effective resistance between A and B = ½ (8.0) = 4.0 Ω By potential divider rule, potential difference between A and B = 20 × 4.0 /(6.0+4.0) = 8.0 V Therefore potential difference between X and Y = ½ (8.0) = 4.0 V

25 **Answer: A**

Conventional current direction due to electron going downwards at P

From Fleming's Left Hand Rule, electromagnetic force, F on electron is into the plane



B field (0.084 T)

F will always be perpendicular to the component of velocity normal to the B field. Hence electron will move in circular motion. At the same time, the component of velocity parallel to the B field remains constant. Hence, the electron will move in a helix.

F = Bqv sin θ

$$v = \frac{7.3 \times 10^{-16}}{(0.084)(1.6 \times 10^{-19}) \sin 23^0}$$

$= 1.4 \times 10^5\ ms^{-1}$.

26 **Answer: C**

Magnetic flux, $\phi = BA$ (where A is the area exposed to perpendicular B-field)
At 4s, Q and R are entirely within the field while coil P has length of 4.0 m within.
$\phi_P = 8B$; $\phi_Q = 6B$; $\phi_R = 12B$ (largest)

Magnetic flux linkage, $\Phi = N\phi$
$\Phi_P = 8B$; $\Phi_Q = 18B$(largest); $\Phi_R = 12B$

At 4s, coils Q and R would be experiencing maximum flux linkage. Hence no change in flux linkage => no induced e.m.f. and no induced current. Only coil P has changing flux linkage, induced e.m.f. and current.

27 **Answer: A**

The brightness depends on the power delivered to the bulb. The peak power is $p = \frac{V^2}{R}$, which does not depend on the frequency f of the alternating voltage.

28	**Answer: B**
	Based on the uncertainty principle $\Delta x \Delta p \geq h$, $\Delta p = m\Delta v = 9.11\times10^{-31}\ (0.38 \times 3.0\times10^{8}) = 1\times10^{-22}$ kg m s^{-1} Min $\Delta x = 6.63\times10^{-34}/10^{-22} = 6\times10^{-12}$ m

29	**Answer: D**
	Activity $A = A_0 \exp(-\lambda t)$, where A_0 is the activity at t = 0. The decay constant is given by $\lambda = \frac{\ln 2}{t_{1/2}}$. A larger half-life yields a smaller λ. Hence, $\lambda_C > \lambda_N$. Taking natural log, $\ln A = -\lambda t + \ln A_0$. The graph of ln A vs t <u>for each nuclide</u> is a straight line with negative gradient ($-\lambda$). Initially, because of its short half-life, the activity of nuclide C dominates. So the initial part of the graph should be very close to that due to nuclide C alone, with gradient $-\lambda_C$. Later, nuclide C have mostly decayed, so nuclide N starts to dominate. The later part of the graph should be close to that due to nuclide N alone, with gradient $-\lambda_N$. Remembering that $\lambda_C > \lambda_N$, the graph should have less negative gradient (a gentler downward slope) in the later part than in the earlier part.

30	**Answer: B**
	The fact that most of the alpha particles pass straight through suggested that the atom is made up of mostly empty space with mass concentrated in the nucleus. The fact that a small proportion of alpha particles are deflected through large angles suggest that the nucleus is positively charged.