



Paper 1 – Multiple Choice Questions

1	Answer: D
	$\mu = \frac{vL\rho}{R} \Rightarrow R = \frac{vL\rho}{\mu}$ $[\text{units of } R] = [\text{units of } v][\text{units of } L][\text{units of } \rho][\text{units of } \mu]^{-1}$ $= [\text{m s}^{-1}][\text{m}][\text{kg m}^{-3}][\text{N s m}^{-2}]^{-1}$ $= [\text{kg m}^{-1} \text{ s}^{-1}][\text{kg m s}^{-2} \text{ s m}^{-2}]^{-1}$ $= [\text{kg m}^{-1} \text{ s}^{-1}][\text{kg m}^{-1} \text{ s}^{-1}]^{-1}$ $= \text{no units (dimensionless)}$

2	Answer: C
	<u>Method 1: Error Propagation</u> $a = \frac{b-c}{d^2}$ Let $K = b - c$, $\therefore K = 21 \pm 4$ $a = \frac{b-c}{d^2} = \frac{K}{d^2}$ $\frac{\Delta a}{a} = \frac{\Delta K}{K} + 2 \frac{\Delta d}{d}$ $= \frac{4}{21} + 2 \left(\frac{1}{100} \right)$ $= 0.210476 = 0.21 \text{ (2.s.f)}$ Thus, the percentage uncertainty is 21% <u>Method 2: Max – Min method</u> $a = \frac{b-c}{d^2}$ Let $K = b - c$, $\therefore K = 21 \pm 4$

	$a = \frac{25-4}{100^2}$ $a_{\max} = \frac{28-3}{(99)^2}$ $a_{\min} = \frac{22-5}{(101)^2}$ $\frac{\Delta a}{a} = \frac{\frac{1}{2}(a_{\max} - a_{\min})}{a} = \frac{\frac{28-3}{(99)^2} - \frac{22-5}{(101)^2}}{\frac{25-4}{100^2}}$ $= 0.2105373 = 0.21 \text{ (2.s.f)}$ Thus, the percentage uncertainty is 21%
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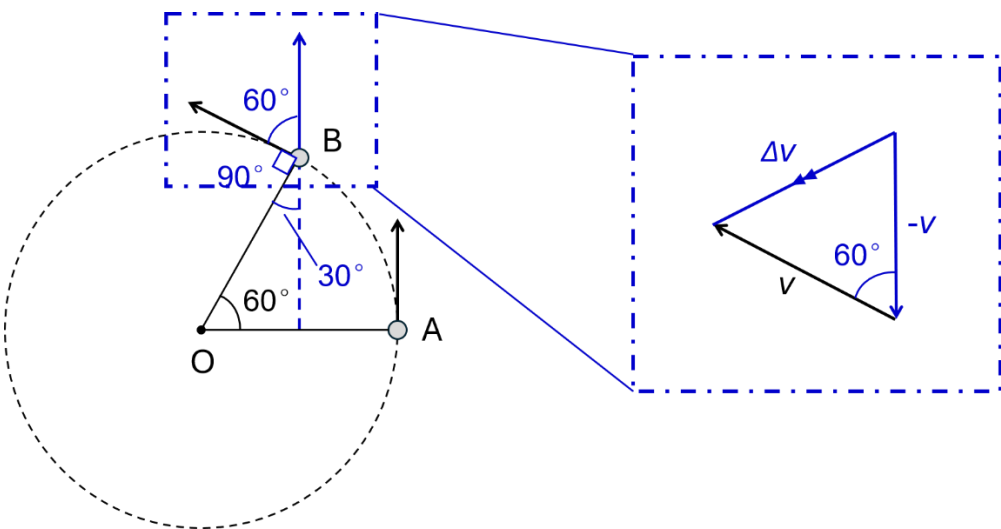
3	Answer: C
	gradient is velocity and gradient is changing so velocity is changing, hence got acceleration. The other options all show constant gradient.

4	Answer: D
	Energy stores include: gravitational potential, elastic potential, chemical potential, internal, kinetic and nuclear (also, electromagnetic store) Energy transfers include: mechanical, electrical, heating and radiation.

5	Answer: D
	Field lines should be perpendicular to metal plate surfaces. Therefore, options A and B are incorrect. At the bottom, the distance between the two metal plates is the shortest. At the top, the distance between the two metal plates is the longest. Since $E = -\frac{dV}{dr}$, field strength is strongest at the bottom and is represented by the closer field lines. Similarly, field strength is weakest at the top and is represented by the larger separation of field lines. Hence, option D is the correct option.

6	Answer: A
	Always check the axes on graph Area under force-extension graph gives elastic potential energy stored. Change in elastic potential energy when the extension changes from x_1 to x_2 is given by area P.

7	Answer: A
	Relative speed of approach = $0.100 - (-0.050c) = 0.150 c$ The only option that gives relative speed of separation = relative speed of approach is A.

8	Answer: C
	Since the radius is fixed and the mass travels at a constant angular velocity, its velocity is a constant, $v = r\omega$  The angle between the two velocity vectors is 60° and they both have the same magnitude, the “closed triangle” forms an equilateral triangle. Thus, $\Delta v = v = r\omega$

9	Answer: A
	Gravitational force, F_g provides the centripetal force F_c $\frac{GMM}{(2R)^2} = \frac{Mv^2}{R}$ $\frac{GM}{4R} = v^2$ $\therefore v = \sqrt{\frac{GM}{4R}}$

10	Answer: B
	A geostationary object must be in: - Equatorial orbit - Travelling from west to east (same direction of rotation of the Earth) - Have a period of 24 hours (and hence angular velocity) - Fixed altitude (height) from the centre of the Earth The object on Earth does not have the same radius as the geostationary object. Hence, the geostationary object cannot be orbiting with the same speed.

11	Answer: B
	Max amplitude should be higher. Note that frequency response curves should start from the same y-intercept and must not overlap with one another.

12	Answer: C
	Solution $x = -x_o \cos \omega t$ Considering equilibrium at mid-tide $2x_o = 3.0 - 1.0 = 2.0 \text{ m}$ $x_o = 1.0 \text{ m}$ $x = -1.0 \cos \omega t$ $-0.5 = -1.0 \cos \omega t$ $\frac{2\pi}{12} t = \frac{\pi}{3}$ $t = 2.0 \text{ h}$ Max duration in harbour ($x > -0.5$) = $12 - 2(2.0) = 8 \text{ h}$

13	Answer: B
	$\text{phase difference} = \frac{5.0 \sin 30^\circ}{10} \times 2\pi = 1.58 = 1.6 \text{ rad}$

14	Answer: B
	θ is the angle between two third order maxima, $n = 3$ Hence, the angle from the horizontal to the third order maxima is $\frac{\theta}{2}$ $\therefore d \sin \frac{\theta}{2} = 3\lambda \Rightarrow \theta = 2 \sin^{-1} \left(\frac{3\lambda}{d} \right)$ <u>Option A:</u> $\theta = 2 \sin^{-1} \left(\frac{3 \times 450 \times 10^{-9}}{\frac{1}{3.2 \times 10^5}} \right) = 51.189 = 51^\circ \text{ (2.s.f)}$ <u>Option B:</u> $\theta = 2 \sin^{-1} \left(\frac{3 \times 450 \times 10^{-9}}{\frac{1}{1.9 \times 10^5}} \right) = 29.724 = 30^\circ \text{ (2.s.f)}$ <u>Option C:</u> $\theta = 2 \sin^{-1} \left(\frac{3 \times 650 \times 10^{-9}}{\frac{1}{3.2 \times 10^5}} \right) = 77.217 = 77^\circ \text{ (2.s.f)}$ <u>Option D:</u> $\theta = 2 \sin^{-1} \left(\frac{3 \times 650 \times 10^{-9}}{\frac{1}{1.9 \times 10^5}} \right) = 43.492 = 43^\circ \text{ (2.s.f)}$

15	Answer: A
	The Rayleigh Criterion is: $\theta = \frac{\lambda}{b}$ Let x be the distance between the two stars and D be the distance between the stars and telescope. $\frac{\lambda}{b} = \frac{x}{D} \Rightarrow \frac{580 \times 10^{-9}}{20 \times 10^{-2}} = \frac{x}{7.3 \times 10^{17}}$ $\therefore x = 2.117 \times 10^{12} = 2.1 \times 10^{12} \text{ m (2.s.f)}$

16	Answer: C
	$\left. \begin{aligned} p_1 V_1 &= nRT_1 \\ p_2 V_2 &= nRT_2 \end{aligned} \right\} \Rightarrow \frac{p_1 V_1}{p_2 V_2} = \frac{T_1}{T_2} \Rightarrow p_1 = \frac{T_1}{T_2} \frac{V_2}{V_1} p_2 = \frac{100 + 273}{50 + 273} \frac{40}{20} \times 100 = 230 \text{ kPa}$ Wrong answers either forgot to convert degree Celsius to kelvins, or got a ratio wrong, or both.

17	Answer: C
	First law of thermodynamics: $\Delta U = W_{\text{on}} + Q_{\text{to}}$. In Scenario C, both W_{on} and Q_{to} are positive, so the internal energy must increase, hence the temperature.

18	Answer: B
	Other than temperature, internal energy also depends on the amount of matter in the object.

19	Answer: C								
	<table border="1"> <tr> <td>A</td><td>Both charges are positive. Electric potential decreases as distance increases from either charge. The electric potential at point P is minimum.</td></tr> <tr> <td>B</td><td>As both charges are positive, electric potential is positive at point P.</td></tr> <tr> <td>C</td><td>The resultant electric field between P and Y is towards X. Hence, a negative charge placed there will move towards Y (opposite direction of resultant electric field).</td></tr> <tr> <td>D</td><td>This is only true for an isolated point charge placed at position Y.</td></tr> </table>	A	Both charges are positive. Electric potential decreases as distance increases from either charge. The electric potential at point P is minimum.	B	As both charges are positive, electric potential is positive at point P.	C	The resultant electric field between P and Y is towards X. Hence, a negative charge placed there will move towards Y (opposite direction of resultant electric field).	D	This is only true for an isolated point charge placed at position Y.
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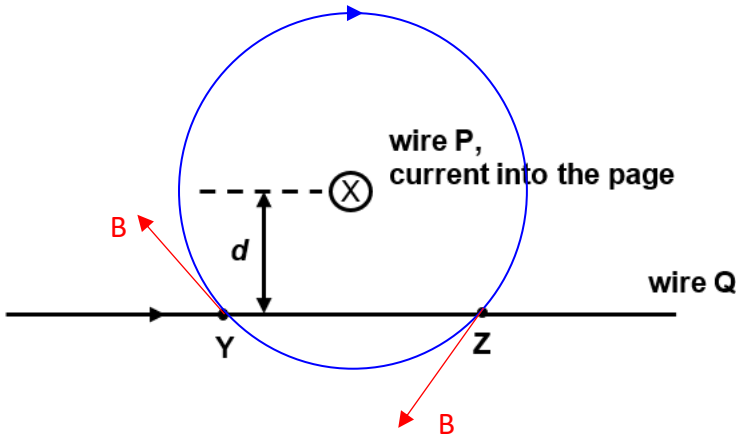
20	Answer: A
	$1/C = 1/(1+2) + 1/6 + 1/(1+1)$ $C = 1 \text{ F}$

21	Answer: D
	$I = nAvq = \text{constant (series connection)}$ n and q are also constant. Therefore, $Av = \text{constant}$ $A_X v_X = A_Y v_Y$ X has a larger cross-sectional area than Y. Therefore, $v_X < v_Y$.

22	Answer: A
	peak-to-peak voltage = 18 V peak voltage $V_0 = 9.0$ V The resistor is half-wave rectified. $V_{\text{r.m.s.}} = \frac{V_0}{2}$ $= \frac{9.0}{2}$ $= 4.5 \text{ V}$ $I_{\text{r.m.s.}} = \frac{V_{\text{r.m.s.}}}{R}$ $= \frac{4.5}{80}$ $= 0.056 \text{ A}$

23	Answer: B		
	<table border="1"> <tr> <td> $R_X = \frac{\rho L}{A}$ $R_Y = R_X$ $\frac{\rho_Y (2L)}{A_Y} = \frac{\rho L}{A}$ $\frac{\rho_Y}{A_Y} = \frac{\rho}{2A}$ </td> <td> $\frac{\rho_Y}{A_Y}$ for option A: $\frac{\rho}{A}$ $\frac{\rho_Y}{A_Y}$ for option B: $\frac{\rho}{2A}$ $\frac{\rho_Y}{A_Y}$ for option C: $\frac{2\rho}{A}$ $\frac{\rho_Y}{A_Y}$ for option D: $\frac{2\rho}{A}$ </td> </tr> </table>	$R_X = \frac{\rho L}{A}$ $R_Y = R_X$ $\frac{\rho_Y (2L)}{A_Y} = \frac{\rho L}{A}$ $\frac{\rho_Y}{A_Y} = \frac{\rho}{2A}$	$\frac{\rho_Y}{A_Y}$ for option A: $\frac{\rho}{A}$ $\frac{\rho_Y}{A_Y}$ for option B: $\frac{\rho}{2A}$ $\frac{\rho_Y}{A_Y}$ for option C: $\frac{2\rho}{A}$ $\frac{\rho_Y}{A_Y}$ for option D: $\frac{2\rho}{A}$
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24	Answer: A
	The resistor and thermistor are connected in series. Therefore, the current flowing through them are the same. The total p.d. across both components must add up to 12 V and only option A satisfies that. p.d. across resistor = 5.4 V p.d. across thermistor = 6.6 V p.d. across both resistor and thermistor = 5.4 + 6.6 = 12 V

25	Answer: A
	B field in consideration at Y is pointing upwards (only the vertical component of B field contributes to magnetic force) and B field in consideration at Z is pointing downwards (only the vertical component of B field contributes to magnetic force). Using Fleming's Left Hand Rule, force at Y is pointing out of page and force at Z is pointing into page. 

26	Answer: A
	$ \mathcal{E}_{\text{induced}} = \frac{d(N\phi)}{dt}$ $= N \left \frac{\Delta\phi}{\Delta t} \right $ $= N \left \frac{\Delta(BA \cos \theta)}{\Delta t} \right $ $= NA \cos \theta \left \frac{\Delta B}{\Delta t} \right $ $= 720(0.060)(\cos 55^\circ) \left \frac{(40 - 70) \times 10^{-3}}{5.0} \right $ $= 0.15 \text{ V}$

27	Answer: D
	$E = hf = \frac{hc}{\lambda}$, $p = \frac{h}{\lambda}$. A longer wavelength implies both a smaller energy and a smaller momentum

28	Answer: B
	Heisenberg principle: $\Delta x \Delta p \geq h \Rightarrow \Delta p \geq \frac{h}{\Delta x}$. If Δx decreases by a factor of 4, Δp increases (Δx is in the denominator) by at least a factor of 4 (signified by the $\geq$ sign).

29	Answer: C
	This is true in order for most of the alpha particles to pass through undeflected.

30	Answer: C
	Let B be the background count rate. The actual initial count rate, $C_0 = 200 - B$ After four half-lives have elapsed, the total count rate, $0.25(200) = 50$ The actual count rate, $C = 50 - B$ Using $\frac{C}{C_0} = \left(\frac{1}{2}\right)^n$ and that $n = 4$,

$$\frac{50-B}{200-B} = \left(\frac{1}{2}\right)^4 = \frac{1}{16}$$

$$\therefore 800 - 16B = 200 - B$$

$$15B = 600$$

$$B = 40 \text{ counts min}^{-1}$$