2007 H2 Paper 1

QN.	ANS	Explanation
1	**C**	By estimating the length, breadth and height of the ruler to be 100 cm, 3 cm and 0.5 cm respectively, the volume is estimated to be 100 x 3 x 0.5 = 150 cm^3.
2	**B**	First notice that $\frac{L}{\lambda}$ is unitless, so P must have the same units as kI^2. By recalling the formula $P = I^2R$, we can conclude immediately that k has the unit ohm.
3	A	The ball is free-falling during the entire motion, both on its way up and down. Therefore, the v-t graph must be a straight line graph (gradient equals constant acceleration of g = 9.81 m s^{-2})
4	**B**	Earth pulls the ball downward. Air resistance pushes the ball leftward. The resultant of these two forces (vector summation) is towards B.
5	**A**	$(v = u + at)$ $30 = 50 + (-\frac{7000}{500})t_1 \Rightarrow t_1 = 1.4286\text{s}$ $30 = 50 + (-\frac{7000}{630})t_2 \Rightarrow t_2 = 1.8\text{s}$ $\Delta t = t_2 - t_1 = 1.8 - 1.4286 = 0.37\text{s}$
6	**A**	Notice that the initial momentum is zero. For a perfectly inelastic collision, the outcome of such a collision is that both masses would come to a complete rest. By PCOM: initial total momentum = final total momentum. So $M(2v) + 2M(-v) = 3MV$ $V = 0$
7	**C**	By PCOM: initial total momentum = final total momentum. So $mu + 0 = mv_1 + Mv_2$ ---(1) For an elastic collision: relative speed of approach = relative speed of separation $u - 0 = v_2 - v_1$ ---(2) Solve for v_2.
8	**B**	D would have been a correct statement if the word mass is replaced by the word weight.
9	**C**	First calculate the electric force acting on the charge F_E. $F_E = qE = q\frac{V}{d} = (2.0\times10^{-6})\frac{80-0}{0.10} = 1.6\times10^{-6}\text{N}$ The charge is experiencing two forces, the electric force which is rightward, and the gravitational pull which is downward. Because these two forces are equal in magnitude, the resultant force must be directed as shown by option C. Because the charge was released from rest, it will continuously accelerate and travel towards C.
10	**D**	First, calculate the propulsion force required to produce this acceleration. $(F_{net} = ma)$ $F - 160 = (1.2\times10^3)(0.20)$ $F = 400\text{N}$ Total power = Fv = 400(10) = 4000 W
11	**D**	At half-way down, the extension is at most half of the final extension at the bottom

		(assuming rope obeys Hooke's Law). So it is not possible for the elastic potential energy at the half-way point to be more than 24/4 = 6 J (one quarter the final elastic potential energy)
12	**B**	Since θ is small, the diameter of the circle of light can be approximated by the arc length subtended by the angle θ. Hence diameter = $R\theta$. (Remember $s = r\theta$) To convert R from km to m, and θ from degree to radians, we make the following adjustments, diameter = $(1000 \times R)(\frac{\theta}{180}\pi) = 17.5R\theta$
13	**C**	Since the resultant force is upward, the upward pull of tension minus the downward pull of gravity must be equal to the required centripetal force. $(F_{net} = ma)$ $T - W = m\frac{v^2}{r}$
14	**A**	***Examiner Comments*** The gravitational force was the only force acting on the satellite. As such, it is not acceptable to show both F_G and F_C in the same diagram. The gravitational force F_G provides the required centripetal force F_C.
15	**D**	$F_g = G\frac{M_1M_2}{d^2}$ $= (6.67 \times 10^{-11})\frac{(6 \times 10^{24})(1)}{0.02^2}$
16	**A**	$\omega = \frac{2\pi}{T} = \frac{2\pi}{0.063} = 99.7$ rad s^{-1} $v_{max} = \omega x_0 \Rightarrow 3.0 = 99.7x_0 \Rightarrow x_0 = 0.030\text{m}$
17	**C**	As the pendulum falls from the extreme position to the equilibrium position, GPE is converted into KE. So By PCOE, loss in GPE = gain in KE $mg\Delta h = \frac{1}{2}mv^2 - 0$ $9.81\Delta h = \frac{1}{2}0.264^2$ The rise in vertical height of the pendulum can be expressed as $R - R\cos\theta$. So $9.81(0.962)(1-\cos\theta) = \frac{1}{2}0.264^2$ After solving θ, remember to multiply by 2 in order to obtain the total angle.
18	**D**	The average KE of the gas is directly proportional to thermodynamic temperature T. Since $<KE> = \frac{1}{2}m<v^2>$, doubling T doubles $<v^2>$. Note that the root-mean-square speed of the molecules is $\sqrt{<v^2>}$.
19	**C**	$pV = nRT$ $p(0.20)^3 = \frac{20}{32}(8.31)(273.15+100)$
20	**B**	$\Delta U = Q + W_{on}$ $= Q - p(v_f - v_i)$ $= (+24) - (1.3 \times 10^5)(3.6 \times 10^{-4} - 1.3 \times 10^{-4})$ $= -5.9\text{J}$ Since the change is negative, there was a decrease in internal energy.

21	**A**	Sound waves are longitudinal. If we assume that heaps are formed at nodes, then the distance between two heaps must be half a wavelength. From the diagram, we can deduce that $4\times\frac{\lambda}{2}=20\Rightarrow\lambda=10\text{cm}$ Use $v=f\lambda$ to solve for *f*.
22	**B**	$\Delta y=\frac{L\lambda}{d}$
23	**D**	$d\sin\theta=n\lambda$ $\frac{0.010}{4.0\times10^{3}}\sin\theta=3\frac{3\times10^{8}}{6.0\times10^{14}}$ $\theta=36.87°$ $2\theta=74°$
24	**B**	We need the electric force to upward in order to balance the downward pull of gravity. C results in a downward electric force. A and D results in zero electric force.
25	**A**	The potential gradient equals the field strength. In the diagram, the spacing between equipotential lines provides an indication of the field strength. The closer the equipotential lines, the stronger the field strength.
26	**D**	The keywords are “round the complete circuit”. The correct answer is *E*, or (V_R+V_r).
27	**B**	Since $R=\rho\frac{L}{A}$, we can write $\rho_{Al}\frac{L_{Al}}{A_{Al}}=\rho_{Ag}\frac{L_{Ag}}{A_{Ag}}$ $2=\frac{A_{Al}}{A_{Ag}}$ $2=\frac{{d_{Al}}^{2}}{{d_{Ag}}^{2}}\Rightarrow d_{Ag}=\sqrt{\frac{1}{2}}d$
28	**B**	First, two 6Ω resistors in parallel present a resistance of 3Ω to the 12 V battery. Hence, the 12 V battery sees a total resistance of 6Ω. This means the battery will be supplying a current of 12/6 = 2 A. Since the current will be divided equally between the two 6Ω branches, the ammeter should read 1.0 A.
29	**D**	When the variable resistor is set to 0 Ω, the 1.0 kΩ on the left is shorted and thus completely bypassed. The voltmeter reads 12 V. When the variable resistor is set to 1.0 Ω, the total resistance of the circuit is 1.5 kΩ. Using the potential divider principle, the voltmeter reads $\frac{1.0}{1.5}(12)$ = 8 V.
30	**B**	Since the mass reading changed from 10.060 g to 10.040 g, we can conclude that the magnetic force must be $(0.020\times10^{-3})(9.81)$. $F_B=(0.020\times10^{-3})(9.81)$ $B(3.0)(0.05)=(0.020\times10^{-3})(9.81)$ $B=1.3\times10^{-3}\text{T}$
31	**A**	$<\text{emf}>=-\frac{\Delta\Phi}{\Delta t}=-\frac{0-NBA}{\Delta t}=\frac{3000(1.8)(\pi 0.010^{2})}{0.060}=28\text{V}$
32	**B**	-
33	**D**	First calculate the load current to be 80V/ 100Ω = 0.8 A.

		Then calculate the primary current using the turn ratio. $\frac{I_p}{I_s}=\frac{N_s}{N_p}\Rightarrow I_p=\frac{1000}{200}(0.8)=4.0$ A
34	**D**	Wavelength of violet light is around 400 nm. $E=hf=\frac{hc}{\lambda}=\frac{(6.63\times10^{-34})(3\times10^{8})}{400\times10^{-9}}=5\times10^{-19}\text{ J}$ To convert to eV, divide 5 x 10^{-19} J by e = 1.6 x 10^{-19}.
35	**C**	First calculate the energy of the photon $E=hf=\frac{hc}{\lambda}=\frac{(6.63\times10^{-34})(3\times10^{8})}{6.2\times10^{-7}}=3.2\times10^{-19}\text{ J}$ The energy of the photon is decided by the difference in the energy levels during the transition. Transition C (4.8 – 1.6 =3.2) fits the bill.
36	**D**	First, we note that when E is positive, we are measuring the saturation current of F. When E is negative, we measure the saturation current of E. This tells us that λ_1 causes photoelectric effect only for F but not E, whereas λ_2 causes photoelectric effect for both F and E. This tells us that 1) the energy in each photon is less in 1 than 2. So λ_1 is a longer wavelength than λ_2. 2) the work function for E must be higher.
37	**D**	A is incorrect because **free** electrons are found only in the conduction band. B is incorrect because in many metals, the conduction and valence band overlap. C is incorrect because doping improves conductivity in semiconductors.
38	**A**	-
39	**B**	First, linearise the equation so we know the gradient corresponds to $-\lambda$. $A=A_0e^{-\lambda t}$ $\ln A=-\lambda t+\ln A_0$ Next, calculate the gradient. $\text{grad}=-\frac{7.5-4.0}{800}=-4.375\times10^{-3}$ Lastly, $t_{\frac{1}{2}}=\frac{\ln 2}{\lambda}=\frac{\ln 2}{4.375\times10^{-3}}$ =160 yr
40	**C**	First calculate the mass defect $(\Delta m)c^2=E$ $(\Delta m)(3\times10^{8})^2=2.13\times10^{-13}$ $\Delta m=2.3667\times10^{-30}$ kg=0.0014257u The nucleus in the excited state must have more mass. $m=59.9308u+0.0014257u=59.9322u$