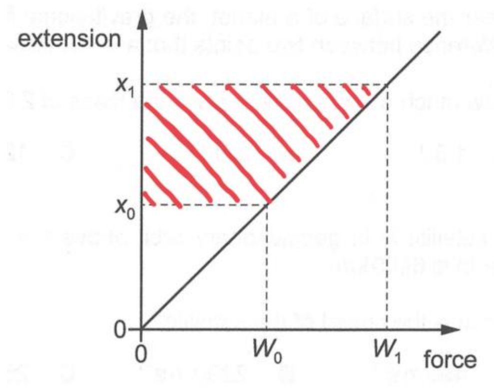
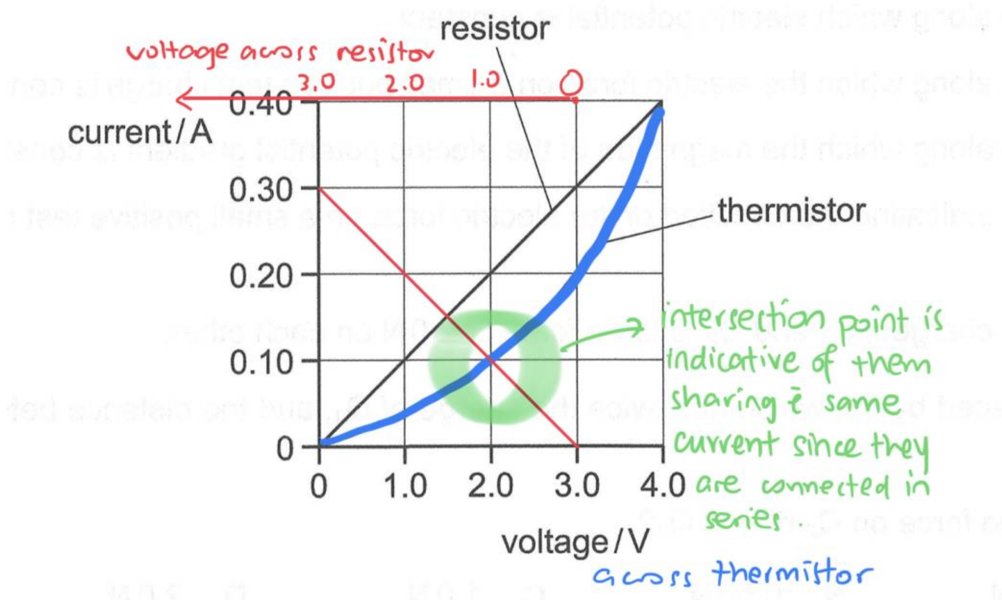
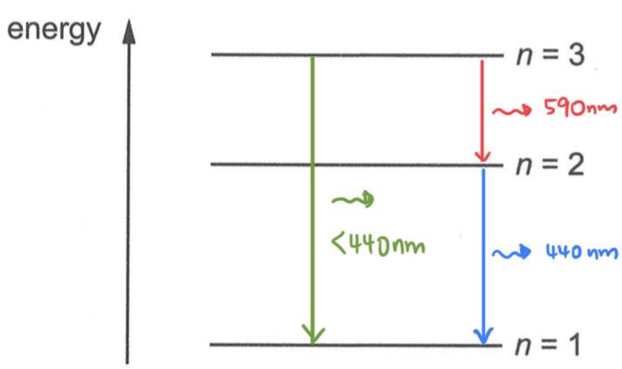
1	**C**	**11**	**D**	**21**	**B**
2	**A**	**12**	**C**	**22**	**A**
3	**B**	**13**	**D**	**23**	**C**
4	**B**	**14**	**B**	**24**	**A**
5	**A**	**15**	**C**	**25**	**D**
6	**B**	**16**	**D**	**26**	**A**
7	**D**	**17**	**B**	**27**	**B**
8	**A**	**18**	**D**	**28**	**B**
9	**A**	**19**	**D**	**29**	**D**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

Qn	**Ans**	**Explanation**
1	**C**	Smartphone is about 100 to 200 grams. mass ≈ 0.150 kg weight = mg ≈ 0.150 × 10 = 1.5 N = 150 × 10^{-2} N = 150 cN
2	**A**	Choose an equation that is mostly base quantities. For quantities that are not base quantity, replace it with a combination of base quantities that is equivalent to it. Using $F = BIL$, $[B] = \frac{[F]}{[I][L]} = \frac{[ma]}{[I][L]} = \frac{\text{kg}\left(\text{m s}^{-2}\right)}{\text{A m}} = \text{kg A}^{-1}\text{ s}^{-2}$
3	**B**	Weight is acting vertically downwards. Air resistance is present and since the ball is moving horizontally rightwards at that instant of time, the drag force due to air resistance is acting leftwards. Hence, the resultant force is both leftwards and downwards.
4	**B**	As the collision is elastic, the speed of approach of the objects before the collision should be equal to the speed of separation of the objects after the collision. $u_X - u_Y = v_Y - v_X$ $1.0v - 0 = 0.67v - v_X$ $v_X = -0.33v$
5	**A**	Weight W is the force by the Earth on the brick. Hence, by Newton's 3rd law, the force paired with W is the force by the brick on the Earth.
6	**B**	The upthrust on the ball is 0.25 of the weight of the ball. By Archimedes' principle, the upthrust is equivalent to the weight of the volume of water being displaced. $U = m_{\text{water displaced}}g = V\rho_{\text{water}}g$ $0.25m_{\text{ball}}g = V\rho_{\text{water}}g$ $0.25(100) = V(1.0)$ $V = 25\text{ cm}^3$ Hence, volume of ball will be double of that and is 50 cm^3. Common Mistake: Some students chose A because they did not realise that the hollow ball was only half submerged.
7	**D**	The stored elastic potential energy is the area under force-extension graph.

Qn	Ans	Explanation
		 stored elastic potential energy $= \frac{1}{2}(W_1 x_1 - W_0 x_0)$
8	**A**	Power required to go against resistive forces $P = Fv$ $\text{energy from fuel} = \text{time} \times \frac{\text{power required to go against resistive forces}}{\text{efficiency}}$ $m\left(48 \times 10^6\right) = \frac{1000}{20} \times \frac{400 \times 20}{0.16}$ $m = 0.0521\ \text{kg}$
9	**A**	$v = r\omega$ $r = \frac{mv}{Be} = \frac{mr\omega}{Be}$ $\omega = \frac{Be}{m}$ Angular velocity is only dependent and proportional to B Common Mistake: Some students chose B because they fail to realise that increased v results with an increased r such that period T (and ω) will be constant
10	**B**	Since the field strength is uniform, $g = \frac{\phi}{x} = \frac{\phi}{x} = \frac{6.0}{10}$ $\text{work done} = mgh = 2.0\frac{(6.0)}{10}(2.5) = 3.0\ \text{J}$
11	**D**	Period T = 24 hours (need to convert to seconds) Radius of orbit (need to convert to metres) = radius of the Earth + height of the satellite above the surface of the Earth $v = r\omega = r\left(\frac{2\pi}{T}\right) = (6400 + 36000) \times 10^3 \times \left(\frac{2\pi}{24 \times 60 \times 60}\right) = 3083\ \text{m s}^{-1}$

Qn	Ans	Explanation
12	**C**	Need to change the molar mass into kg. $\langle c\rangle^2$ used in formula is mean square speed. Need to square root $\langle c\rangle^2$ to obtain root-mean-square (r.m.s.) speed. Multiplying $pV = \frac{1}{3}Nm\langle c^2\rangle = nRT$ by a factor of $\frac{3}{2}$ gives: $\frac{1}{2}m\langle c\rangle^2 = \frac{3}{2}nRT = \frac{3}{2}pV$ $\langle c\rangle^2 = \frac{3pV}{nM_r} = \frac{3(1.0\times10^5)(10\times3\times4)}{5000\times0.029}$ $\langle c\rangle = 498\ \text{m s}^{-1}$
13	**D**	The thermal energy supplied is used to increase the water's temperature and change its state. $E = mc\Delta\theta + mL_\text{V} = 5\left(4190\times70 + 2260\times10^3\right)$ $= 1.28\times10^7\ \text{J}$
14	**B**	No heat transfer (Q = 0) or no work done on the gas (W = 0) suggests that the change in internal energy of the gas is zero. Internal energy is the sum of of a random distribution of kinetic and potential energies associated with the molecules of the system (i.e. inter-molecular kinetic and potential energies).
15	**C**	There are only conversion of energies between potential energy and kinetic energy. When the potential energy decreases, kinetic energy increases. Hence the kinetic energy line should be mirrored horizontally to the potential energy.
16	**D**	$\lambda = \frac{c}{f} = \frac{3.0\times10^8}{5.0\times10^{14}} = 0.60\times10^{-6}\ \text{m}$ $\frac{\Delta\phi}{2\pi} = \frac{\Delta x}{\lambda}$ $\Delta\phi = 2\pi\left(\frac{1.5}{0.60} - 2\right)$ $\Delta\phi = \pi$
17	**B**	At 45°, the intensity of light is the highest: $I = I_0\left[\cos^2\theta\right]\left[\cos^2(90° - \theta)\right]$ At 90°, the intensity drops to zero.
18	**D**	$\theta_\text{min} = \frac{\lambda}{b}$ $\frac{x}{5.7\times10^{16}} = \frac{620\times10^{-9}}{50\times10^{-2}}$ $x = 7.1\times10^{10}\ \text{m}$
19	**D**	

Qn	Ans	Explanation
20	C	Coulomb's law of electrostatic attraction: $F=\dfrac{Q_1Q_2}{4\pi\varepsilon_0 r^2}$ $F_{\text{new}}=\dfrac{2Q_1Q_2}{4\pi\varepsilon_0(2r)^2}=\dfrac{1}{2}F=1.0\text{N}$
21	B	Resistance of each wire: $R_1=GL$ Since the wires are parallel, $R_{\text{eff}}=\left(\dfrac{4}{GL}\right)^{-1}=\dfrac{GL}{4}$
22	A	 The reason for drawing the lines and axis coloured red: When the voltage across the thermistor is 3.0 V, the resistor should have 0 V as the emf is 3 V.
23	C	Since the lamp is connected across the thermistor, the potential difference across the thermistor needs to be higher for the lamp to glow brighter. By potential divider rule, the resistance of the thermistor should increase and the resistance of the LDR should decrease. Hence, the thermistor should be cooler in temperature and the LDR should have more light on it.
24	A	Current around the circular coil produces a magnetic field directed into the page. By Fleming's left hand rule, the magnetic force on the short wire is upwards.
25	D	$\phi=BA$ $[\phi]=[B][A]=\text{T m}^2$

Qn	Ans	Explanation
26	**A**	By Faraday's Law, $\varepsilon = \left\lvert \frac{\Delta\left(N\phi\right)}{\Delta t} \right\rvert$ $= \frac{NB\pi R^2 - 0}{\Delta t}$ $= \frac{(3000)\left(1.8\times\pi\left(0.010\right)^2\right)-0}{0.060} = 28.3\text{ V}$
27	**B**	$\frac{N_S}{N_P} = \frac{V_S}{V_P} = \frac{16}{1.88}$ $\frac{I_P}{I_S} = \frac{16}{1.88}$ $I_S = 0.32\times\frac{1.88}{16} = 0.0376\text{ A}$
28	**B**	 $E_{3\to1} = E_{3\to2} + E_{2\to1}$ $\frac{1}{\lambda_{3\to1}} = \frac{1}{\lambda_{3\to2}} + \frac{1}{\lambda_{2\to1}} \qquad \left(E_{\text{photon}} = \frac{hc}{\lambda}\right)$ $\lambda_{3\to1} = \left(\frac{1}{440} + \frac{1}{590}\right)^{-1} = 252\,\text{nm}$
29	**D**	Given that the two beams have the same frequency, the energy of each photon from each beam is the same. To increase intensity and hence total energy per unit time in a beam of light, there must be larger quantity of photons.
30	**B**	$E = \Delta m\cdot c^2 = \left(136.90709 - 136.90583 - 5.49\times10^{-4}\right)\left(1.66\times10^{-27}\right)\left(3\times10^{8}\right)^2$ $= 1.06\times10^{-13}\text{ J}$