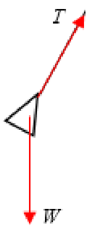
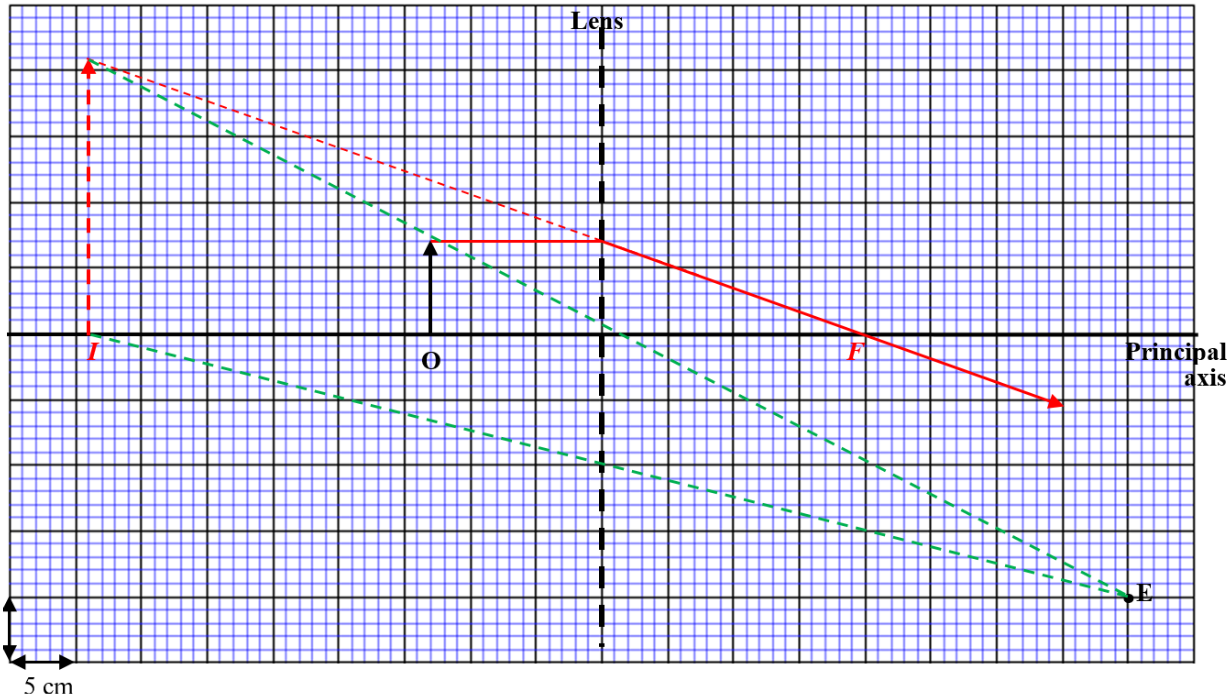
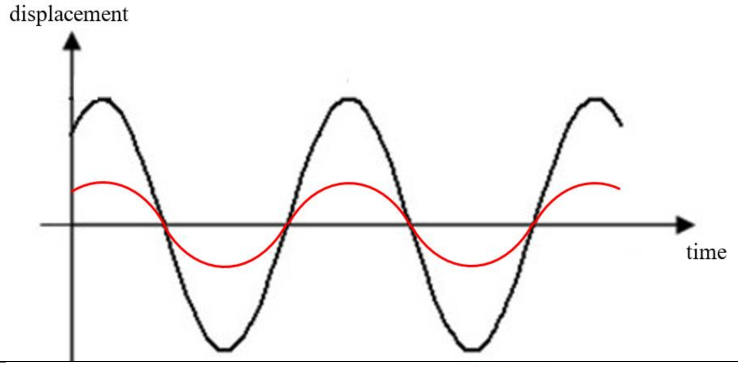
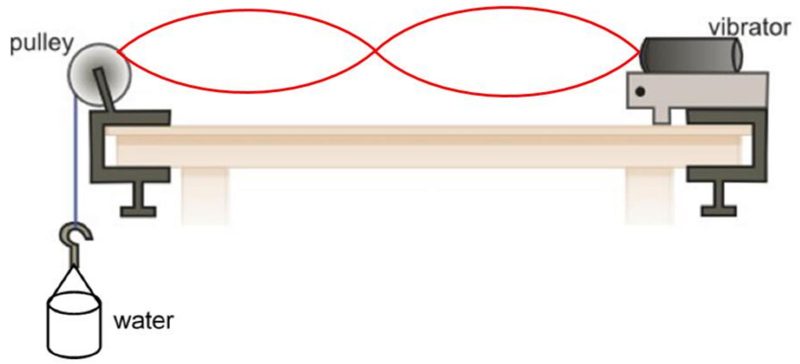
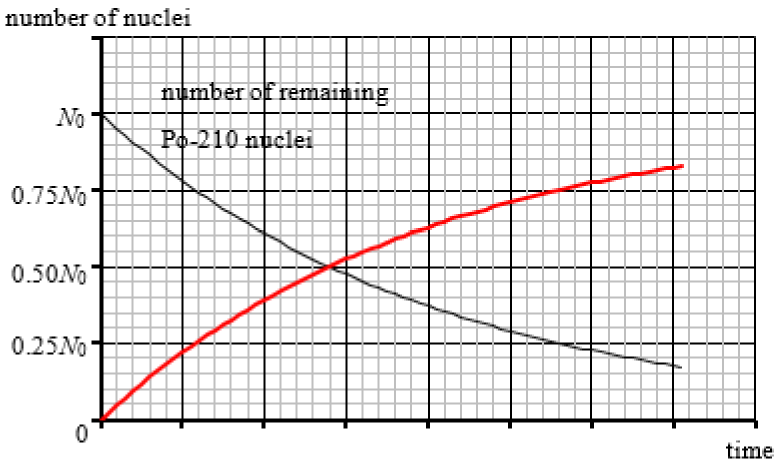
2020-2021 Physics DSE Mock Exam Marking Scheme

1. (a)	Internal energy of an object is the total energy of its component particles. It comprises both the intermolecular PE and random molecular KE. Temperature of an object is a measure of the average molecular KE of the object.	1M 1M 1M
(b)	Heat loss $E = ml = (5.4)(2.3\times10^6) = 1.242\times10^7$ J Rate of heat loss = $\frac{E}{t} = \frac{1.242\times10^7}{3.2\times3600}$ = 1078 W	1M 1A
(c)	The foil traps a layer of air around the athlete, hence reducing heat loss by convection; The shiny surface is a poor radiator of heat, hence reducing heat loss by radiation;	1M 1M
2. (a)	$pV = nRT \rightarrow (1.0\times10^5)(0.36) = n(8.31)(273+22) \rightarrow n = 14.69$ moles No. of air molecules $N = nN_A = (14.69)(6.02\times10^{23}) = 8.84\times10^{24}$	1M 1A
(b)(i)	Using the pressure law, $\frac{p}{T} = \frac{p'}{T'}$ $\frac{1.0\times10^5}{273+22} = \frac{p'}{273+5}$; p' = 94237 Pa	 1M 1A
(ii)	As temperature drops, air molecules inside the refrigerator move slower. They collide with the walls of the refrigerator less frequently and with smaller impact forces.	1M 1M
(iii)	min force needed = $A\Delta p = (0.72)(1.0\times10^5 - 94237)$; = 4149 N	1M 1A
3. (a)	The raindrop is first momentarily at rest and hence it experiences no air resistance, so it speeds up at the acceleration due to the gravity g. As it gains speed during the fall, the air resistance acting on him also increases. This reduces its acceleration. When the air resistance is large enough to balance its weight, it no longer speeds up because the net force acting on him is zero.	1M 1M 1M
(b)	The kinetic energy of the air molecules. OR Internal energy of air/raindrop	1A

4(a)(i)	10(110) = 200(v) v = 5.5 m s^{-1}	1M 1A	conservation of momentum accept -ve
(ii)	KE lost = PE gained $\frac{1}{2}mv^2$ = mgh $\frac{1}{2}m(5.5)^2$ = m(9.81)h $\Rightarrow$ h = 1.54 m d = h / sin10° = (1.5418) / sin10° = 8.88 m	1M 1A	conservation of energy
(b)	$\frac{1}{2}mv^2$ = f s $\Rightarrow$ s α v^2 s = 1 (2^2) = 4 m	1M 1A	Relation between s and v
(c)	There is a horizontal external force from the ground.	1M	Not accept conservation including the ground
5 (a)		1A	all correct
(b)(i)	$Tcos30° = mg$ $F_{net} = Tsin30°$ $= mg\ tan30°$ = (70)(9.81) $tan30°$ = 396 N	1M 1A	$F_{net} = Tsin30°$
(ii)	$F_{net} = \frac{mv^2}{r}$ $396 = \frac{(70)v^2}{(\frac{24}{2} + 20sin30°)}$ v = 11.1 m s^{-1}	1M 1A	r = 12 + 20 $sin30°$
(iii)	Energy gain = K.E. gain + P.E. gain $= \frac{1}{2}(70)(11.1)^2 + (70)(9.81)(20 - 20cos30°)$ = 6201 J	2M 1A	1M --- K.E. gain 1M --- P.E. gain
(iv)	Power = $\frac{6201.4 \times 24}{60}$ = 2481 W+	1M 1A	

6 (a)	Convex	1M	
(b)(c)			
	f = 19.5 cm ($18 \le f \le 21$) minimum size = 10.5 cm ($12< l_{min} < 9$)	1M – correct position of image and label with *I* 1M – correct light ray to locate *F* 1A 1M – st. lines joining the image and E, accept solid line 1A	
(d)	Move towards the lens	1A	
7(a)	$\tan\theta = (0.9/1) \Rightarrow \theta = 41.987°$ $a \sin\theta = m\lambda$ $a \sin 41.987° = 3(650\times10^{-9})$ $a = 2.9150\times10^{-6}$ no. of slits = $0.01/2.9150\times10^{-6} = 3430.588 \approx 3430$	1M 1M 1A	Correct angle Sub. m = 3
(b)	$a \sin\theta = m\lambda$ $(2.9150\times10^{-6}) \sin\theta = 2(650\times10^{-9})$ $\theta = 26.485°$ $y_2 = (1) \tan 26.485° = 0.49826$ $\Delta y = 0.9 – 0.49826 = 0.402$ m	1M 1A	Sub. m = 2

8(a)	$\lambda = 1.2\ (2/3) = 0.8$ m $v = f\lambda = 80\ (0.8) = 64$ m s^{-1}	1M 1A	
(b)		2M	1M – in phase 1M – smaller amplitude
(c)		1A	2 loops
(d)	Period remains unchanged Amplitude becomes larger	1A 1A	
(e)	$\frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{f\lambda_1}{f\lambda_2} = \sqrt{\frac{m_1 g}{m_2 g}}$ $\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{m_1}{m_2}} \Rightarrow \frac{0.8}{1.2} = \sqrt{\frac{0.8}{m}}$ m = 1.8 kg mass of water added = 1.8 – 0.8 = 1 kg	1M 1A	1M – new λ= 1.2 m OR $\lambda \alpha\ m$
9. (a)	(i) to the right (ii) away from the observer (from Y to X)	1A 1A	
(b)	$N\cos 30° = mg \quad N\sin 30° = BIL$ $\tan 30° = \frac{(0.2)(I)(0.1)}{(0.04)(9.81)}$ I = 11.3 A	1M 1M 1A	 Substitution
(c)	The resistance will be halved and the current will be doubled. But the magnetic force (given by BIL) is proportional to the length which is halved. Overall, the magnetic force remains unchanged.	1M 1M	
(d)(i)	Yes. Because they are connected in parallel, and have the same amount of current passing through and the same magnetic force.	1A 1M	 Same force due to same current
(ii)	By $P = VI$, the e.m.f. remains the same but the current doubles, $P = 2P_0$.	1M 1A	

10. (a)	Yes, from P to Q No	1A 1A	
(b)(i)	A vigorously shaking of the flashlight for about 30 s can provide up to 5 min of light. 1(30) = P (5×60) P = 0.1 W	 1A	
(ii)	$V = N\frac{d\phi}{dt}$ Peak induced e.m.f. = 330×0.0133 = 4.39 V r.m.s. e.m.f. = $\frac{4.39}{\sqrt{2}}$ = 3.10 V	1M 1A 1A	
(iii)	Use a stronger magnet. Increase the number of turns of the coil.	1A 1A	
(c)	EPE can be stored in the bumper during impact (KE lost during impact is reduced) Smaller impact force on the magnet.	1A 1A	Collision is more elastic
11(a)	It cannot be predicted which nucleus will decay.	1M	
(b)	${}^{210}_{84}\text{Po} \rightarrow {}^{206}_{82}\text{Pb} + {}^{4}_{2}\text{He}$	1A	
(c)(i)		1M 1M	Correct shape; sum of the values at each moment ≈ N_0
(ii)	fraction of Po that remains undecayed = $\frac{1}{1+7} = \frac{1}{8}$; $\frac{N_0}{8} = N_0 e^{-kt} \Rightarrow 0.125 = e^{-k(415.2)}$ k = 5.01×10^{-3} day^{-1} = 5.80×10^{-8} s^{-1}	1M 1M 1A	