Paper 1 Section A

Question No.	Key	Question No.	Key
1.	A (59)	26.	D (33)
2.	B (39)	27.	B (48)
3.	C (45)	28.	A (77)
4.	A (78)	29.	*
5.	D (18)	30.	A (33)
6.	D (57)	31.	D (53)
7.	C (80)	32.	A (77)
8.	C (48)	33.	C (66)
9.	A (25)		
10.	C (51)		
11.	A (49)		
12.	A (54)		
13.	B (45)		
14.	B (58)		
15.	B (79)		
16.	C (74)		
17.	B (48)		
18.	D (49)		
19.	D (62)		
20.	D (59)		
21.	A (45)		
22.	C (41)		
23.	C (71)		
24.	D (30)		
25.	B (75)		

* This item was deleted.

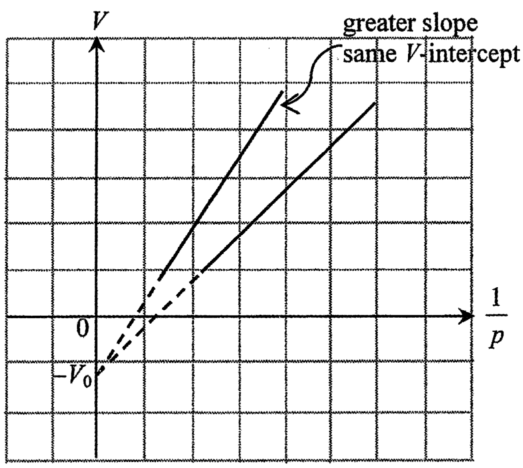
Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

General note on item deletion

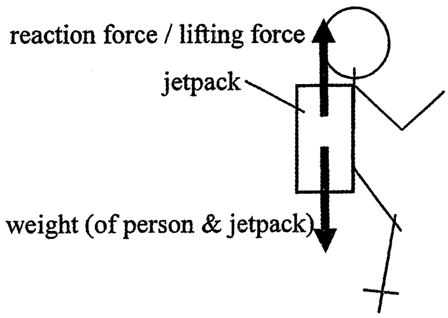
It is normal for the HKEAA to delete a small number of items from its multiple-choice question papers if they prove unsatisfactory. In practice, there are a number of reasons why this is considered necessary. By far the most common reason for deleting an item is that the item fails to discriminate between weak and able candidates – in other words, the majority of the candidates involved had to rely on guesswork in answering that question. If such an item is retained, the measurement process is rendered less effective. Where items have been deleted in the live papers, they are still included in this series of publications. They are indicated as deleted items. Such items may be discussed in the corresponding examination reports.

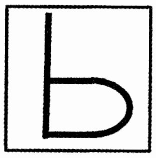
Paper 1 Section B

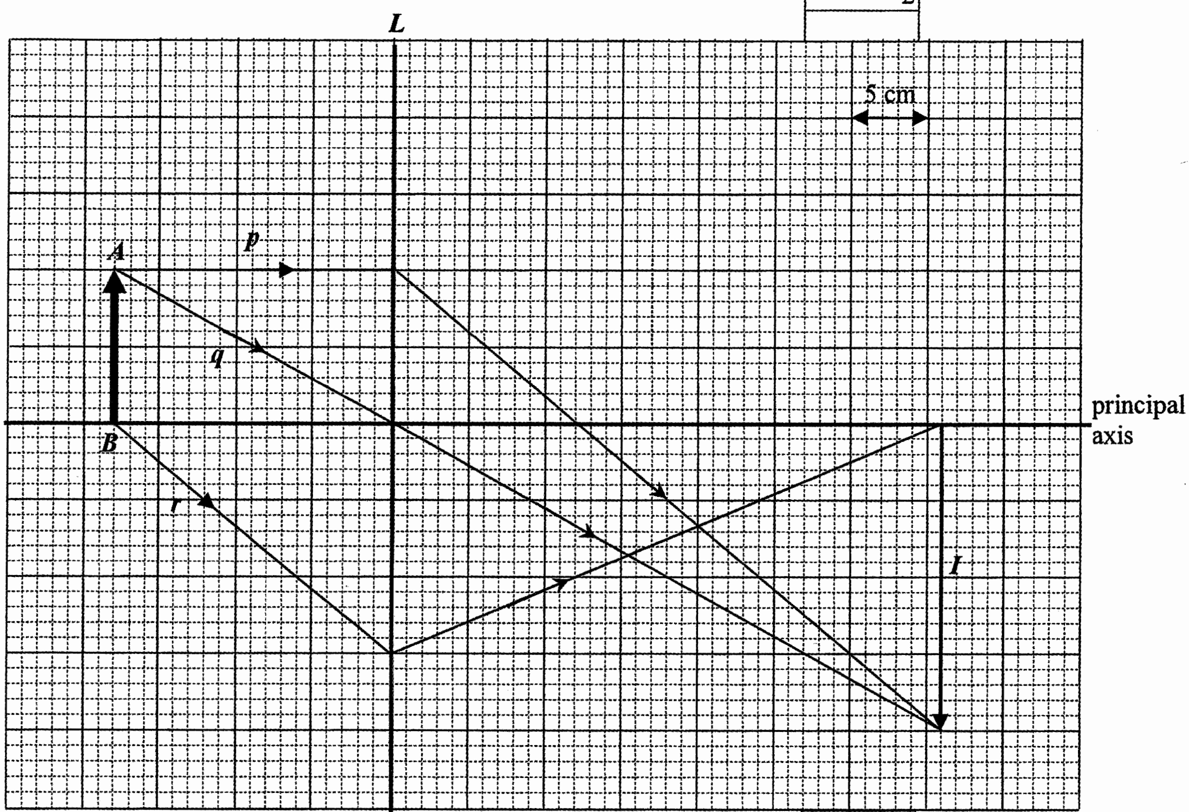
Solution			Marks	Remarks
1.	(a)	- Put the sphere into the water bath for a few minutes - Put / transfer the sphere into the polystyrene cup (of water) - Measure the final / maximum temperature T_f of the water with a thermometer	1A 1A 1A	
		$0.80 \times c_b \times (80 - T_f) = 0.50 \times 4200 \times (T_f - T_0)$ $c_b = 2625 \times \frac{T_f - T_0}{80 - T_f}$ (J kg^{-1} °C^{-1})	1A	
		Precautions: Any **TWO** - Dry the sphere with the towel quickly before putting it into the cup - Make sure the sphere is fully immersed in water - Stir the water thoroughly	1A 1A 1A	
			6	
	(b)	Thermal energy / heat is lost during the transfer / drying of the sphere	1A	
		Or Thermal energy / heat absorbed by thermometer, stirrer or cup	1A	
		Or The temperature of the sphere is higher than T_f when this final temperature is measured (i.e. T_f not reaching its maximum)	1A	
		Thus temperature rise of water in the cup is lower than it should be.	1A	
			2	

Solution	Marks	Remarks
2. (a) $pV = nRT$	1M	
$(1.0\times10^{5})(6.0\times10^{-5}) = n\ (8.31)(273+25)$	1M	
$n\ =\ 2.422891\times10^{-3}$ moles $\approx 2.42\times10^{-3}$ moles		
No. of molecules $= n\,N_A$ $= n \times 6.02\times10^{23}$ $=1.458581\times10^{21} \approx 1.46\times10^{21}$	1A	
Alternative method:		
$pV = nRT = \left(\dfrac{N}{N_A}\right)RT \Rightarrow N = \left(\dfrac{pV}{RT}\right)N_A$	1M	
$N = \dfrac{(1.0\times10^{5})(6.0\times10^{-5})}{(8.31)(273+25)}\times(6.02\times10^{23})$	1M	
$= 1.458581\times10^{21} \approx 1.46\times10^{21}$	1A	
	3	
(b) (i) Any ONE: - The piston should be pushed or pulled slowly / lightly. - Avoid taking readings immediately after moving the piston. - The syringe should not be grasped by hand too long (when the piston is pushed in or pulled out).	1A 1A 1A	
	1	
(ii) V_0 - volume of gas trapped in the rubber tubing / space connecting the pressure sensor and syringe.	1A	
	1	
(iii) 	1A 1A	**NO** mark for a curve
	2	

Solution	Marks	Remarks
3. (a) $a = \dfrac{6-0}{2-0}$	1M	
$= 3\ \text{m s}^{-2}$ (downwards)	1A	
	2	
(b) *A*: 395 N *B*: 569 N *C*: 685 N	1A	
In stage *B*, balance reading = weight (Newton's 1st law),		
$mg = m \times 9.81\ \text{m s}^{-2} = 569\ \text{N}$	1M	
$m = 58.0\ \text{kg}$	1A	For $g = 10\ \text{m s}^{-2}$, $m = 56.9$ kg
Or In stage *A*, according to Newton's 2nd law		
$(569 - 395)\ \text{N} = ma = m(3\ \text{m s}^{-2})$	1M	
$m = 58.0\ \text{kg}$	1A	
	3	
(c) (i) For stage *C*, by Newton's 2nd law,		
$F = ma$		
$(569 - 685)\ \text{N} = (58.0\ \text{kg})\ a$	1M	
$a = -2\ \text{m s}^{-2}$		For $g = 10\ \text{m s}^{-2}$, $m = 56.9$ kg, $a = -2.04\ \text{m s}^{-2}$
Thus, $a = \dfrac{0-6}{T-12} = -2\ \text{m s}^{-2}$	1M	
$T = 15\ \text{s}$		
	2	
(ii) Height $\approx$ displacement of lift = area under graph	1M	
$= \dfrac{(12-2)+15}{2} \times 6$		
$= 75\ \text{m}$	1A	
	2	

Solution	Marks	Remarks
4. (a) According to Newton's second law of motion,		
a (net) force acts on the water so as to change its momentum. (<u>Or</u> magnitude of the force equals the rate of change of momentum of water).	1A	
According to Newton's third law of motion,	1A	
a force acting downwards on the ejecting water (by the jetpack), the water exerts a reaction (equal but upward / opposite) on the jetpack / person as well.	1A	
	3	
(b) 	1A	
	1	
(c) (i) $F = \frac{\Delta p}{\Delta t} = \frac{\Delta m}{\Delta t} \times (\vec{v} - \vec{u})$	1M	
$\frac{\Delta m}{\Delta t} \times (10 - (-10))\ \text{m s}^{-1} = 1000\ \text{N}$		
$\frac{\Delta m}{\Delta t} = 50\ (\text{kg s}^{-1})$	1A	Accept using kg as the unit.
	2	
(ii) $(\frac{\Delta m}{\Delta t})gh + \frac{1}{2}(\frac{\Delta m}{\Delta t}) \times v^2$	1M	Accept using m for $(\frac{\Delta m}{\Delta t})$
$= (50\ \text{kg s}^{-1})(9.81\ \text{m s}^{-2})(7.5\ \text{m}) + \frac{1}{2}(50\ \text{kg s}^{-1}) \times (10\ \text{m s}^{-1})^2$	1M	
$= 6178.75$ W or 6.17875 kW	1A	For $g = 10\ \text{m s}^{-2}$, 3750 W + 2500 W = 6250 W
	3	
(d) The same	1A	
as the same lifting force / (water) jet speed is needed.	1A	
	2	

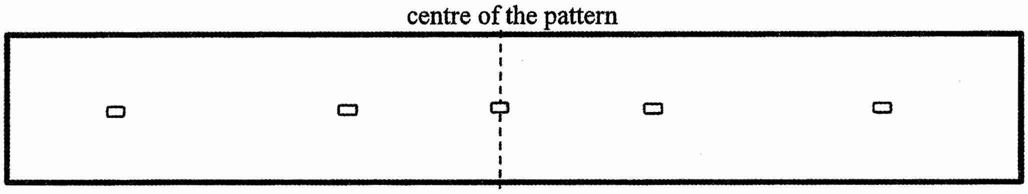
Solution	Marks	Remarks
5. (a) (i) Convex (lens)	1A	
Only convex lens forms real image (which can be captured by a screen)	1A	
Or Concave lens always forms virtual image (which cannot be captured by a screen).	1A	
Or The image is formed on the other side of the lens.	1A	
	2	
(ii)  opaque screen	1A	
	1	
(b) (i) Image distance $v = 54 - 18 = 36$ cm ($D = 54$ cm)	1A	
Magnification $= \frac{v}{u} = \frac{36}{18} = 2$	1M/1A	
	2	



Solution	Marks	Remarks
(ii) Image I of AB	1M	1M for correct position of I
Rays p and q	1M	
Ray r	1M	
	3	
(iii) Focal length = 12 ± 0.5 cm	1M/1A	
	1	
(iv) Move the lens 18 cm farther away from the object.	1M	
Or move the lens 18 cm closer to / towards the screen.	1M	
Height ratio = 1 : 4.	1A	
	2	

Solution	Marks	Remarks
6. (a) (i) $\Delta y = \frac{\lambda D}{a}$		
$\frac{(4.0-0)\times 10^{-2}}{10} = \frac{\lambda(1.8)}{0.3\times 10^{-3}}$	1M+1M	
$\lambda = 6.666667 \times 10^{-7}$ m		
$\approx 6.67 \times 10^{-7}$ m or 667 nm	1A	
	3	
(ii) To ensure that the light through the 2 slits diffracts enough to interfere / overlap.	1A 1A	Explanation in terms of formula $\lambda = \Delta y \frac{a}{D}$ is **NOT** accepted as a is the slit separation given, which is fixed.
	2	
(b) (i) $d \sin\theta = m\lambda$		
$\frac{10^{-3}}{500} \sin\theta = 6.67 \times 10^{-7}$ m	1M	
$\theta = 19.471221° \approx 19.47°$		
Separation between central and first-order bright spot		
= 1.8 tan 19.47°	1M	
= 0.636396 m ≈ 0.636 m	1A	
	3	

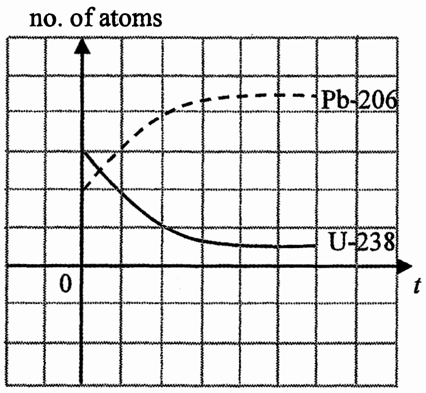
(ii)



Solution	Marks	Remarks
symmetry about the central bright spot (2^{nd} order shown)	1A	
separation between 2^{nd} and 1^{st} -order bright spots is larger	1A	
	2	

Solution	Marks	Remarks
7. (a) (i) $R = 10\ \text{k}\Omega$ (circuit I)		
$V = \dfrac{(\frac{1}{10\ \text{k}\Omega} + \frac{1}{10\ \text{k}\Omega})^{-1}}{10\ \text{k}\Omega + (\frac{1}{10\ \text{k}\Omega} + \frac{1}{10\ \text{k}\Omega})^{-1}} \times 6\ \text{V}$	1M	1M for appropriate method in calculating voltage
$= 2\ \text{V}$	1A	
$R = 100\ \Omega$ (circuit II)		
$V = \dfrac{(\frac{1}{100\Omega} + \frac{1}{10\text{k}\Omega})^{-1}}{100\Omega + (\frac{1}{100\Omega} + \frac{1}{10\text{k}\Omega})^{-1}} \times 6\ \text{V}$		Note: 100 Ω and 10 kΩ in parallel ≈ 99.0099 Ω Accept stating that V slightly < 3 V
$= 2.985\ \text{V}$	1A	
	3	
(ii) Resistance of circuit / that part of circuit would be lowered / altered significantly when introducing the voltmeter (i.e. loading effect).	1A	
Or The resistance of the voltmeter is comparable to the resistance of resistor R.	1A	
Resistance of voltmeter should be much higher than the resistance of the part of the circuit under study.	1A	
	2	
(b) (i) V_m does **NOT** give the true voltage for the resistor.	1A	
$R_m = R_A + R$	1A	
	2	
(ii) For circuit III $R_m = R + R_A = 10 + 1 = 11\ \Omega$		
percentage error $= \dfrac{1\ \Omega}{10\ \Omega} \times 100\ \%$	1M	
$= 10\%$	1A	
	2	

Solution	Marks	Remarks
8. (a) (i) - the air loses its insulating properties	1A	
Or electrons or ions can pass through the air (between clouds and Earth or between clouds and clouds)	1A	
	1	
(ii) $E = \frac{V}{d}$	1M	
$V = E\,d = (3 \times 10^5) \times 2000$		
$= 6 \times 10^8$ V	1A	
	2	
(b) (i) magnetic field into paper (due to upward lightning current)	1A	
$B = \frac{\mu_0 I}{2\pi r}$	1M	
$= \frac{4\pi \times 10^{-7} \times 30000}{2\pi \times 1500}$		
$= 4 \times 10^{-6}$ T	1A	
	3	
(ii) When the lightning current is increasing, the induced current flows in the anticlockwise direction so as	1A	
to oppose the increasing magnetic field (into paper).	1A	
After reaching maximum, the lightning current is decreasing, the induced current flows in the clockwise / opposite direction.	1A	
	3	
(iii) Electric field (in the atmosphere).	1A	
E-field increases / builds up (to threshold) before lightning happens	1A	
Or Lightning current and magnetic field only exist during lightning.	1A	
	2	

Solution	Marks	Remarks
9. (a) $(4)n_\alpha = 238 - 206 \Rightarrow n_\alpha = 8$	1A	
$(2)n_\alpha + (-1)n_\beta = 92 - 82 \Rightarrow n_\beta = 6$	1A	
	2	
(b) (i) $N = N_0 \left(\frac{1}{2}\right)^{t/T_{1/2}}$	1M	
$\frac{3}{5} = \left(\frac{1}{2}\right)^{t/4.5\times10^9\ \text{yr}}$		
Or $N = N_0\, e^{-\lambda t}$ and $\lambda = \frac{\ln 2}{T_{1/2}}$	1M	
$\therefore\ t = 3.316 \times 10^9$ years $\approx 3.3 \times 10^9$ years	1A	
	2	
(ii) Answer in (i) is an underestimate. The original number of U-238 atoms should be greater.	1A	
$\therefore$ the ratio $\frac{\text{present number of U} - 238\text{ atoms}}{\text{original number of U} - 238\text{ atoms}} = \frac{N_t}{N_0}$ is in fact smaller (than $\frac{3}{5}$), thus longer time should have been elapsed.	1A	Accept 'more U decayed'.
	2	
(iii) 	2A	
	2	

Paper 2

Section A : Astronomy and Space Science

1. B (71%)	2.C (49%)	3.A (54%)	4.C (57%)
5. D (69%)	6.B (53%)	7.A (38%)	8.D (38%)

Solution	Marks	Remarks
1. (a) *Apparent magnitude* is a measure of brightness and it depends on (star's) *luminosity* and distance from the Earth.	1A	brightness = power per unit area at the observer = luminosity / ($4\pi D^2$)
When distance D is fixed (at 10 pc), it is called *absolute magnitude* which then depends only on *luminosity*.	1A	
	2	
(b) (i) $L = 4\pi R^2 \sigma T^4$ $L_S = 4\pi R_S^2 \sigma T_S^4$	1M	
Assume that the Sun and the star are black bodies.	1A	
	2	
(ii) $\frac{R}{R_S} = \left(\frac{L}{L_S}\right)^{1/2}\left(\frac{T_S}{T}\right)^2$		
$\frac{R}{R_S} = (126000)^{1/2} \times (\frac{5840}{6100})^2$	1M	
$R = 325.350364\ R_S \approx 325\ R_S$	1A	
Star X - (super)giant	1A	
	3	
(c) (i) $\log\left(\frac{L}{L_S}\right) = 4\log T + 2\log\left(\frac{R}{R_S}\right) - 4\log T_S$ $y = \log\frac{L}{L_S}$ $x = \log T$ [Accept $x = \log(\frac{T}{T_S})$]		
It takes the form of a straight line $y = mx + c$ (with $m = 4$)	1A	
and the y-intercept c is determined by the star radius R [Note: $c = +2\log\left(\frac{R}{R_S}\right) - 4\log T_S$,R_S & T_S are constants]	1A	
	2	
(ii) B (largest)	1A	
	1	

Section B : Atomic World

1. C (34%)	2. D (50%)	3. C (57%)	4. B (56%)
5. B (46%)	6. D (52%)	7. A (49%)	8. A (32%)

Solution	Marks	Remarks
2. (a) (i) All photoelectrons emitted (from X) can reach Y.	1A	
Or Maximum number of photoelectrons emitted is limited by intensity of light.	1A	
Or Limited number of photoelectrons is produced in each second.	1A	
	1	
(ii) Maximum k.e. reaching anode $Y = (0.8 + 1.0)$ eV	1M	
$= 1.8$ (eV)	1A	
	2	
(b) (i) $3.4 = \Phi + 0.8 \Rightarrow \Phi = 2.6$ (eV)	1A	
$\frac{hc}{\lambda} = \Phi \Rightarrow \lambda = \frac{(6.63\times10^{-34})(3.0\times10^{8})}{(2.6)(1.60\times10^{-19})}$	1M	
$\lambda = 4.78125 \times 10^{-7}$ m ≈ 478 nm	1A	
	3	
(ii) No, as	1A	
$\lambda_{yellow} = 576$ nm (≈ 2.16 eV) > 478 nm (≈ 2.6 eV) or threshold.	1M	
Or $f_{yellow} = 5.20833 \times 10^{14}$ Hz $< f = 6.27451 \times 10^{14}$ Hz	1M	
Or $E_{yellow} = 3.45312 \times 10^{-19}$ J $< E = 4.16000 \times 10^{-19}$ J	1M	
	2	
(c) This light beam is more intense but with	1A	
the same frequency as the original one.	1A	
	2	

Section C : Energy and Use of Energy

1. B (59%)	2. A (26%)	3. C (76%)	4. B (48%)
5. A (41%)	6. D (53%)	7. C (61%)	8. C (46%)

Solution	Marks	Remarks
3. (a) (i) (I) Friction between contact surfaces is too large which cannot be overcome by the wind at such speed.	1A	
(II)The turbine is automatically locked and stopped, otherwise the strong wind may damage the blades.	1A	
	2	
(ii) $P = \frac{1}{2}\rho A v^3 \times \eta$	1M	
$1600 \times 10^3\ \text{W} = \frac{1}{2} \times 1.23\ \text{kg m}^{-3} \times \pi (30\ \text{m})^2 \times (15\ \text{m s}^{-1})^3 \times \eta$		
$\eta = 27.3\ \%$	1A	
	2	
(b) (i) Power required from one turbine		Note: Due to wind direction and the orientation of wind turbines, the power output of each turbine would be different in real situations.
$= \frac{40 \times 10^6}{50} = 0.8\ \text{MW}$ or $800\ \text{kW}$	1M/1A	
From the graph, wind speed needed is $10\ \text{m s}^{-1}$.	1A	
	2	
(ii) (I) $1600\ \text{kW} \times 50 = 80000\ \text{kW}$ or $80\ \text{MW}$	1M/1A	
From the graph (>80 MW), 15:00 – 21:00 (i.e. 6 hours)	1A	
	2	
(II) $(80 - 40) \times 10^6\ \text{W} \times 80\ \% = m \times 9.81\ \text{m s}^{-2} \times 120\ \text{m}$	1M	
$m = 2.7183 \times 10^4\ (\text{kg s}^{-1})$	1A	For $g = 10\ \text{m s}^{-2}$, $m = 26667\ (\text{kg s}^{-1})$
	2	

Section D : Medical Physics

1. A (48%)	2. A (46%)	3. D (55%)	4. C (66%)
5. B (49%)	6. B (45%)	7. D (49%)	8. D (53%)

Solution	Marks	Remarks
4. (a) (i) *B*	1A	
A radioactive / radiopharmaceutical substance is injected to / inhaled by the patient and	1A	
is transported in the blood stream to the rest of the body, the (radioactive) substance accumulates in particular organs.	1A	
Gamma rays emitted by the radioisotope are detected by gamma cameras.	1A	
	4	
(ii) Advantage: A hot spot (above normal uptake) or a cold spot (below normal uptake) can infer some problem with the organ, i.e. functional diagnosis.	1A	
	1	
(b) (i) $T_{phy} = 4$ days	1A	
	1	
(ii) Period of time required to reduce the amount of 'tracer' in the body / organ to one-half of its original value due to biological process (such as elimination / excretion / metabolism).	1A	
	1	
(iii) $\frac{1}{T_{eff}} = \frac{1}{T_{phy}} + \frac{1}{T_{bio}}$ $= \frac{1}{2} + \frac{1}{4}$ $T_{eff} = 1.33$ days	1M	
$N = N_0 e^{-kt}$, $k = \frac{\ln 2}{T_{eff}}$ or $\frac{N}{N_0} = (\frac{1}{2})^n$, $t = nT_{eff}$	1M	
$t = \frac{-T_{eff}}{\ln 2}\ln(\frac{10}{50})$ or $10 = 50(\frac{1}{2})^{t/T_{eff}}$ $t = \frac{-1.33}{\ln 2}\ln(\frac{10}{50})$ or $10 = 50(\frac{1}{2})^{t/1.33}$ ≈ 3.096 days	1A	Or 74.3 hours, 2.67×10^5 s
	3	