Marking Schemes

This document was prepared for markers' reference. It should not be regarded as a set of model answers. Candidates and teachers who were not involved in the marking process are advised to interpret its contents with care.

General Marking Instructions

1. It is very important that all markers should adhere as closely as possible to the marking scheme. In many cases, however, candidates may have obtained a correct answer by an alternative method not specified in the marking scheme. In general, a correct answer merits ***the answer mark*** allocated to that part, unless a particular method has been specified in the question.

   In the marking scheme, alternative answers and marking guidelines are in $\boxed{\text{rectangles}}$.

2. In the marking scheme, answer marks or 'A' marks are awarded for a correct numerical answer with a unit. If the answer should be in km, then cm and m are considered to be wrong units.

3. In a question consisting of several parts each depending on the previous parts, method marks or 'M' marks are awarded to steps/methods or substitutions correctly deduced from previous answers.

4. In cases where a candidate answers more questions than required, the answers to all questions should be marked. However, the excess answer(s) receiving the lowest score(s) will be disregarded in the calculation of the final mark.

Paper 1 Section A

Question No.	Key	Question No.	Key
1.	*	26.	C (75)
2.	A (55)	27.	C (62)
3.	D (64)	28.	D (36)
4.	A (11)	29.	D (87)
5.	A (38)	30.	B (46)
6.	C (21)	31.	D (74)
7.	B (71)	32.	B (40)
8.	A (37)	33.	A (62)
9.	A (58)		
10.	D (58)		
11.	B (51)		
12.	A (70)		
13.	C (65)		
14.	D (72)		
15.	C (32)		
16.	B (51)		
17.	D (81)		
18.	C (73)		
19.	B (62)		
20.	D (87)		
21.	C (39)		
22.	A (55)		
23.	C (69)		
24.	B (51)		
25.	A (51)		

* This item was deleted.

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

General note on item deletion

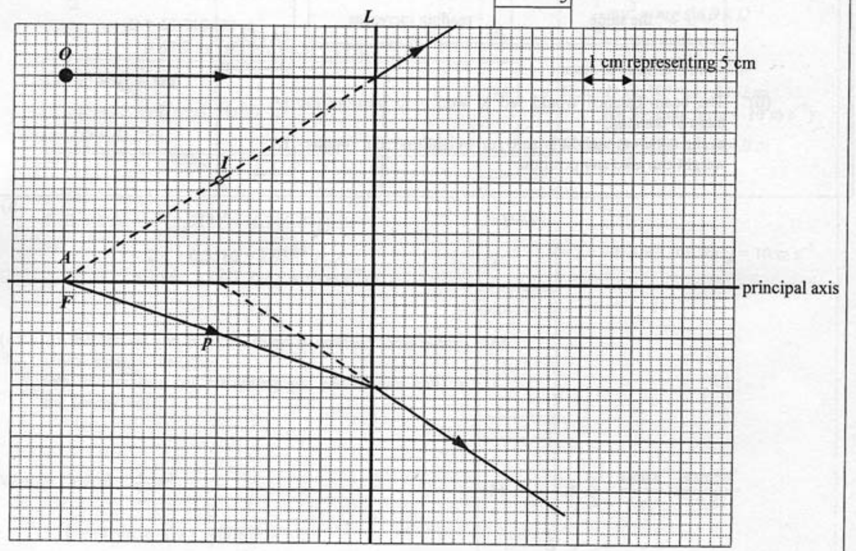
It is normal for the HKEAA to delete a small number of items from its multiple-choice question papers if they prove unsatisfactory. In practice, there are a number of reasons why this is considered necessary. By far the most common reason for deleting an item is that the item fails to discriminate between 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) Amount of energy required $E = mc\Delta T$		
$= 6 \times 4200 \times (50 - 15)$ $= 882000$ J (or 882 kJ)	1M	
Power $P = \frac{E}{t} = \frac{882000}{60}$	1M	
$= 14700$ W (or 14.7 kW)	1A	
	3	
(b) Let m kg per minute be the water flow rate $mc\Delta T = Pt$ $m(4200)(40 - 15) = 14700 \times 60$	1M	Or $\frac{m}{t} \propto \frac{1}{\Delta T}$
$m = 8.4$ (kg min^{-1} or kg)	1A	$\therefore \frac{m}{6} = \frac{50-15}{40-15}$
	2	
2. (a) $n = \frac{pV}{RT} \propto pV$ (for constant T) $\frac{n_A}{n_B} = \frac{(p)(3V)}{(2p)(2V)}$	1M	
$n_A = 0.75 \times 0.8$ mol $= 0.6$ (mol)	1A	
Or $(2p)(2V) = 0.8RT$ $pV = 0.2RT$	1M	
$p(3V) = nRT$ $n = 3 \times 0.2 = 0.6$ (mol)	1A	
	2	
(b) (i) $n = n_A + n_B$ $p'(3V + 2V) = p(3V) + (2p)(2V)$	1M	
$p' = 1.4p$	1A	
Or $p'(3V + 2V) = (0.6 + 0.8)RT$	1M	
$p'(5V) = 1.4RT$ $p' = 1.4p$	1A	
	2	
(ii) When the tap is open, number of gas molecules in vessel A increases due to the (net) flow of molecules from B to A,	1A	
the frequency of collision of gas molecules with the vessel's wall increases, pressure increases.	1A	
	2	

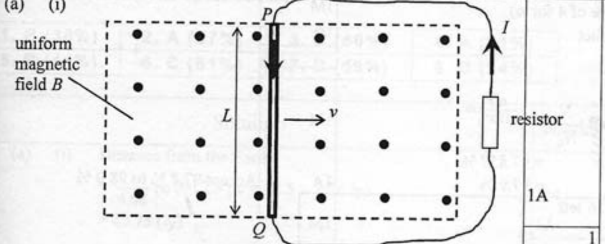
Solution	Marks	Remarks
3. (a) If the maximum load is exceeded, the braking distance will increase if the friction provided remains the same.	1A	
Vehicles would not be able to stop in time in case of emergency (thus dangerous).	1A	
Or A larger friction is required in braking the vehicle within the same distance,	1A	
accident may occur if the brakes cannot provide such frictional forces.	1A	
	2	
(b) (i) If the brakes are applied continuously, thermal energy generated will heat up the brake pads / brakes to too high a temperature that the brakes may fail.	1A	
	1	
(ii) Let D be the distance travelled along the ramp. Kinetic energy of vehicle becomes its gravitational potential energy: $\frac{1}{2}m(25)^2 = m(9.81)(D \sin 30°)$	1M	Or work done against vehicle's weight component along the ramp by its kinetic energy: $\frac{1}{2}mv^2 = mg \sin\theta \times D$
$D = 63.710499$ m ≈ 63.7 m (62.5 m for $g = 10$ m s^{-2})	1A	
Or $v^2 = u^2 + 2as$ $0^2 = 25^2 + 2(-9.81 \sin 30°)D$	1M	mass of vehicle $= m$ Note: $D \sin 30° = 31.8552$ m (or 31.25 m for $g = 10$ m s^{-2})
$D \approx 63.7$ m	1A	Accept $D = 62.0$ m to 64.0 m
	2	
4. (a) (i) K.E. + P.E. $= \frac{1}{2}(0.3)(4)^2 + (0.3)(9.81)(0.2)$	1M+1M	
$= 2.4 + 0.5586 = 2.9886$ J ≈ 2.99 J (3.0 J for $g = 10$ m s^{-2})	1A	$= 2.4 + 0.6 = 3.0$ J for $g = 10$ m s^{-2}
	3	
(ii) As the spring gun is fixed, there is external force acting on the system / the gun,	1M	
total momentum (of the spring gun and cannon ball) is not conserved.	1A	
	2	
(b) Vertical : $s = ut + \frac{1}{2}at^2$ $0 = (4 \sin 50°)\, t_f - \frac{1}{2}(9.81)\, t_f^2$	1M	Or $\frac{t_f}{2} = \frac{u\sin\theta}{g} = \frac{4\sin 50°}{9.81}$
$t_f = 0.624705$ s (0.612836 s for $g = 10$ m s^{-2}) ≈ 0.625 s (0.613 s for $g = 10$ m s^{-2})	1A	Accept $t_f = 0.61$ s to 0.63 s
Horizontal : $R = 4\cos 50° \times t_f = 4\cos 50° \times 0.625$	1M	Or $R = u\cos\theta \times \frac{2(u\sin\theta)}{g}$
$= 1.606210$ m ≈ 1.61 m (1.57 m for $g = 10$ m s^{-2})	1A	Accept $R = 1.56$ m to 1.62 m
	4	
(c) t_f increases	1A	
since the initial vertical velocity / component is greater.	1A	
	2	

<table>
<tr><th></th><th>Solution</th><th>Marks</th><th>Remarks</th></tr>
<tr><td>5. (a) (i)</td><td>m (5.0 cm) = 50 g (10.0 cm)
m = 100 g or 0.1 kg</td><td>1M
1A
2</td><td></td></tr>
<tr><td>(ii)</td><td>Counter-weight position : 10.0 cm ± 0.1 cm
Percentage error = $100\% \times (\frac{0.1}{10.0}) = 1\%$
$\therefore m$ = 101 g to 99 g
i.e. maximum error = ± 1 g</td><td>1M
1A
2</td><td></td></tr>
<tr><td>(b)</td><td>Spring balance reading = mg = (0.1 kg) (9.81 N kg^{-1})
= 0.981 N (1.0 N for g = 10 N kg^{-1})
≈ 1.0 N</td><td>1M/1A
1</td><td></td></tr>
<tr><td>(c) (i)</td><td><table><tr><td>counter-weight position on beam balance</td><td>spring balance reading</td></tr><tr><td>the same</td><td>reading increases</td></tr></table></td><td>1A+1A
2</td><td></td></tr>
<tr><td>(ii)</td><td>The beam balance would fail to work / to measure the mass of the load,
as the apparent weight is zero (or weightless), the counter-weight can take any position.</td><td>1A
1A
2</td><td></td></tr>
</table>

	Solution	Marks	Remarks
6. (a)	Place the (cylindrical) lens on the piece of paper and trace its outline, use ray tracing method e.g. - direct and trace a light ray towards the lens. - direct and trace a light ray along / parallel to the principal axis	1A	Or Using lens formula: - use ray tracing method: direct and trace a light ray (not parallel to the principal axis) towards the lens
	Direct another light ray parallel to the first one / principal axis (by shifting the ray box) and trace the path(s) of the (emerging) ray(s) on the paper.	1A	- extend (the path of) the emerging ray backward and locate the point of intersection (with the principal axis).
	Extend (the path of) the emerging rays (backward) and locate the point of intersection (on the focal plane containing F).	1A	- measure the corresponding object distance u and image distance v (on the principal axis)
	Measure the distance from the point of intersection (or F) to the centre of the lens, which gives the focal length of the lens.	1A	- sub. u and v into lens formula to find f
	Source of error: Scale uncertainty/accuracy/precision of the plastic ruler (read to nearest mm). OR Unable to mark the path correctly because of the thickness of the beam of light from the ray box OR The ray(s) is/are not parallel (to the principal axis) OR Any reasonable answer	1A 5	Accept: Using diagram(s) to supplement / simplify the description.
(b)			
(i)	L is diverging/concave. - only a diverging lens can produce a (virtual / erect / diminished) image between the object and the lens	1A 1A 2	
(ii)	Focal length = 30 cm Correct ray to find F	1A 1A 2	Accept (30 ± 1) cm
(iii)	Correct ray p	1A 1	

	Solution	Marks		Remarks
7. (a) (i)	Increase the separation between the double slit and the screen, D.	1A		
			1	
(ii)	The separation of the bright dots on the screen becomes larger, thus the percentage error in its measurement is smaller.	1A		
			1	
(iii)	The angular position of the 2nd order bright dot $\theta = \tan^{-1}\left(\frac{1.56/2}{1.40}\right) = 29.124053^{\circ}$	1M		
	Grating spacing $d = \frac{10^{-3}}{400} = 2.5 \times 10^{-6}$ m	1M		
	Applying $d \sin\theta = n\lambda$, Wavelength $\lambda = \frac{2.5\times10^{-6}\times\sin 29.12^{\circ}}{2}$ $= 6.08378\times10^{-7}$ m $\approx 6.08\times10^{-7}$ m (= 608 nm)	1A		Accept $\lambda = (6.06 \text{ to } 6.10)\times10^{-7}$ m
			3	
(b) (i)	The equation can only be applied for - $\lambda << a$ (i.e. wavelength << separation of the two sources), OR λ is much smaller than a - $a << D$ (i.e. separation of the two sources << separation of the sources and detector), OR a is much smaller than D Any ONE	1A		Note : the order of magnitude of the wavelength of sound is about 10^{-1} m
	Or Using the fringe separation equation to find the wavelength of sound is not accurate for - λ is comparable to/ NOT much smaller than a - a is NOT much smaller than D Any ONE	1A		
			1	
(ii)	For the 1st order maximum, wavelength λ = path difference $PB - PA$	1M		
	$= \sqrt{(1+0.5)^2 + 2^2} - \sqrt{(1-0.5)^2 + 2^2}$ $= 2.5 - 2.06155281 = 0.43844719 \text{ m} \approx 0.438$ m	1M		
	speed of sound: $v = f\lambda = 750 \times 0.4384$ $= 328.835$ m s^{-1} ≈ 329 m s^{-1}	1A		Accept v = 328 m s^{-1} to 330 m s^{-1}
			3	

	Solution	Marks		Remarks
8. (a) (i)	To terminals X	1A		
			1	
(ii)	$P = IV$ $800 \text{ W} = I(220 \text{ V})$	1M		
	$I = 3.636364$ A ≈ 3.64 A	1A		
			2	
(iii)	$800 = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$	1M		
	$P_{\text{keep warm}} = \frac{V^2}{4R}$	1M		
	$= 800(\frac{1}{5}) = 160$ W	1A		
	Alternative (I) $800 = \frac{V^2}{R} + \frac{V^2}{4R} = \frac{5V^2}{4R}$ $R = 75.625\ \Omega$	1M		
	$P_{\text{keep warm}} = \frac{V^2}{4R}$	1M		
	$= \frac{220^2}{4(75.625)}$ $= 160$ W	1A		
	Alternative (II) Power $\propto \frac{1}{\text{resistance}}$ $\frac{P_{\text{keep warm}}}{P_{\text{heating}}} = \frac{R_{\text{eq}}}{4R}$	1M		
	$P_{\text{keep warm}} = P_{\text{heating}}\left(\left(\frac{1}{R} + \frac{1}{4R}\right)^{-1} / 4R\right)$	1M		
	$= 160$ W	1A		
			3	
(b) (i)	Electrical energy (consumed)	1A		
			1	
(ii)	(1) only the fuse blows	1A		
	(2) only the RCCB cuts off the supply	1A		
			2	

Solution	Marks	Remarks
9. (a) (i) 	1A	
	1	
(ii) By Lenz's law, a magnetic force F_B acts on the rod such that it opposes the rod's motion,		Accept : Work done by an external force is needed to transfer mechanical energy into electrical energy.
an external force F is needed to balance F_B so as to maintain uniform motion (or constant v)	1A 1A	
$\therefore F = F_B = ILB$ (in magnitude)	1A	
Or $F{\cdot}v = I\xi$, $\therefore F = \frac{I\xi}{v}$	1A	
	3	
(iii) mechanical power input = Fv $= (ILB)\,v$	1M	
power input = power output (electrical) $ILB\,v = I\,\xi$ $\xi = BLv$	1M	
	2	
(b) (i) Horizontal (component) is perpendicular to the mast.	1A	
Or Vertical (component) is parallel to the mast.	1A	
	1	
(ii) $\xi = (B\cos30°)\,L\,v$ $= (50 \times 10^{-6}\cos30°)\,(20)\,(6)$	1M	by (a)(iii) using the horizontal component of B
$= 5.196152 \times 10^{-3}$ V ≈ 5.20 mV	1A	
more electrons at end X	1A	
	3	
(iii) No current. Both the cable and the mast cut the field lines in the same way, the e.m.f.'s produced are equal and thus oppose each other.	1A 1A	
Or No change in magnetic flux through the loop of the circuit.	1A	
	2	

Solution	Marks	Remarks
10. (a) (i) 226 – 206 = 20 (multiple of 4 for α) $\therefore {}^{206}_{82}$Pb is the end product	1M 1A	
	2	
(ii) % undecayed Ra-226 left $\frac{N}{N_0} = e^{-\frac{\ell n2}{1600}\times50}$	1M	
$= 97.857\ \%$ $\approx 97.9\ \%$	1A	Accept 97.8 % to 98.0 %
Or % undecayed Ra-226 left $= \left(\frac{1}{2}\right)^{\frac{50}{1600}}$	1M	
$\approx 97.9\ \%$	1A	
	2	
(b) (i) $\because$ random process	1A	
	1	
(ii) Some of the daughter products of Ra-226 are also radioactive and may emit β particles.	1A	
	1	
(iii) Reason: weaker ionizing power of β and γ radiations	1A	
- raise the source to a distance greater than the range of α (a few cm) will cease to have sparks. - insert a paper between the source and the gauze, sparks will cease to produce. Any ONE	1A	
	2	

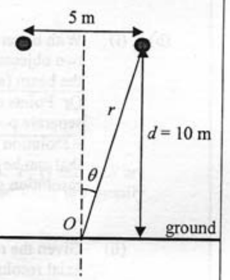
Section B : Atomic World

1. C (46%)	2. D (51%)	3. D (48%)	4. A (15%)
5. C (57%)	6. B (62%)	7. C (62%)	8. B (26%)

Solution	Marks	Remarks
2. (a) Increase / adjust the voltage just until there is no current passing through the circuit (no photoelectrons to complete the circuit),	1A	
record the voltage V_s which gives the maximum kinetic energy of the photoelectrons = eV_s	1A	
	2	
(b) (i) Ultra-violet (UV) radiation (light) (~278 nm)	1A	$\lambda = \frac{c}{f} = \frac{3\times10^8}{10.8\times10^{14}} \approx 277.8\text{nm}$
	1	
(ii) slope of the graph = $\frac{3.3-0}{(13.4-5.4)\times10^{14}}$	1M	
$= 4.125\times10^{-15}$ eV s (= 6.6×10^{-34} J s)	1A	
The slope gives the Planck constant h.	1A	
	3	
(iii) Threshold frequency $f_0 = 5.4\times10^{14}$ Hz Work function of sodium = hf_0	1M	
$= (6.6\times10^{-34})\times(5.4\times10^{14})$ $= 3.564\times10^{-19}$ J $= 2.2275$ (eV)	1A	Accept 2.20 eV to 2.40 eV
Or $hf_0 = (4.125\times10^{-15})\times(5.4\times10^{14})$	1M	
$= 2.2275\text{ (eV)} \approx 2.23\text{ (eV)}$	1A	
	2	
(c) Unchanged, i.e. the same graph.	1A	
The (maximum) kinetic energy depends on the energy of each photon, which is proportional to the frequency of radiation.	1A	
Or Maximum kinetic energy of the photoelectrons / energy of photon will not be affected.	1A	
	2	

Section C : Energy and Use of Energy

1. A (52%)	2. B (58%)	3. C (37%)	4. D (38%)
5. A (79%)	6. D (52%)	7. C (60%)	8. B (62%)

Solution	Marks	Remarks
3. (a) (i) Incandescent lamps: by heating a (tungsten) filament to a high temperature / red hot via joule heating (of a current),	1A	
most of the energy becomes thermal energy / heat or only a small portion is converted to light output.	1A	
	2	
(ii) As the eye is most sensitive to green light,	1A	
a green light source (having the same light output power) would appear brighter compared to a white one (comprises of different colours).	1A	
	2	
(b) (i) Luminous flux of each lamp: E = 10000 lumens		
$\tan\theta = \frac{2.5}{10}$ (or $\cos\theta = \frac{10}{\sqrt{10^2+2.5^2}}$)	1M	
$\theta = 14.036243° \approx 14.0°$		
$I = \frac{E\times\cos^3\theta\times2}{4\pi d^2}$ Or $\boxed{\frac{E\times\cos\theta\times2}{4\pi r^2}}$	1M	
= 14.532045 lux ≈ 14.5 lux or lx	1A	
	3	
(ii) Efficacy (A) = $\frac{11000}{150}$ = 73.333333 lm W^{-1} Efficacy (B) = $\frac{10000}{135}$ = 74.074074 lm W^{-1} Lamp B is recommended.	1A	
	1	
(iii) Advantages: ➢ Variation of illuminance smaller ➢ Effect of individual lamp failure smaller ➢ Less glare Any ONE	1A	
Disadvantages: ➢ More frequent change / replacement of lamps ➢ More expensive as installation cost increases ➢ More wiring involved ➢ More installation time Any ONE	1A	
	2	