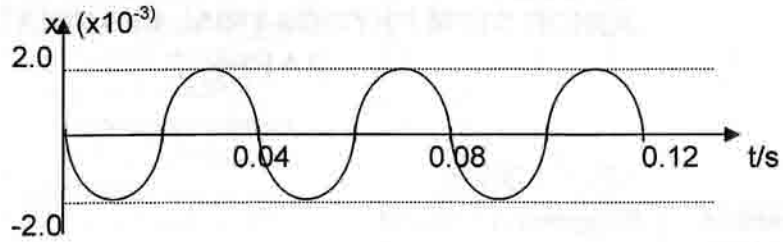
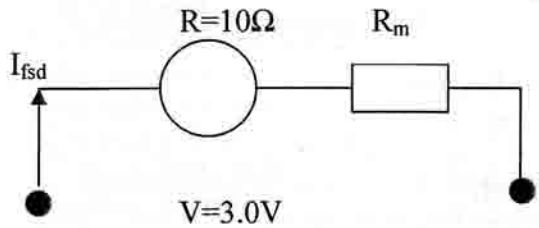
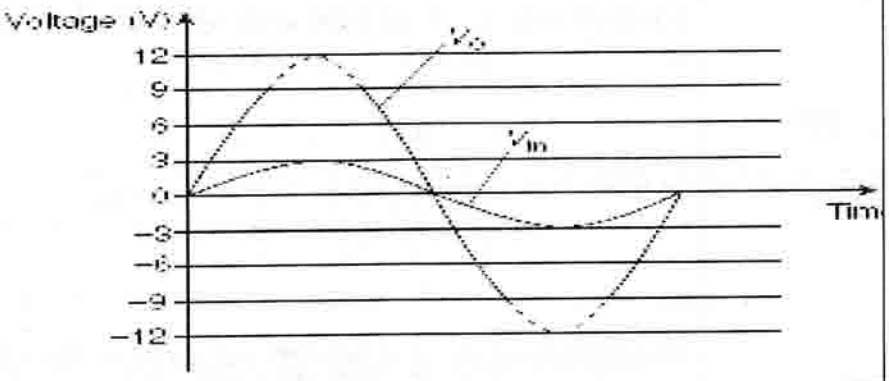
SUGGESTED ANSWERS AND MARKING SCHEME
JOHOR STPM PHYSICS TRIAL EXAMINATION 2009
PAPER 2

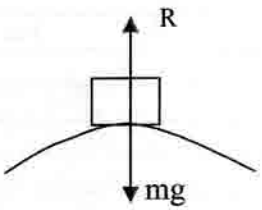
SECTION A

Question Number	Suggested Answer	Marks
1. (a)	The Principle of Conservation of Linear Momentum states that the total linear momentum of a system is constant (or conserved) if there is no external force acting on the system.	1
(b)(i)	conservation of linear momentum $2.0 \times 10^{-3} \times 500 = 1.0\ (v) + 2.0 \times 10^{-3} \times 100$	1
	$v = 0.80\ m\ s^{-1}$	1
(b)(ii)	Loss in K.E wooden block=work done against constant or average frictional force	1
	$\frac{1}{2}(1.0)(0.8)^2 = F_R(0.20)$	1
	$\Rightarrow F_R = 1.6\ N$	1
2. (a)	image is real	1
(b)	$v = 0.25(20) = 5.0$ cm	1
	$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} = \frac{1}{20} + \frac{1}{5.0}$ $f = 4.0cm$	1
	$\frac{1}{f} = (n-1)(\frac{1}{r_1} + \frac{1}{r_2})$	1
	$\frac{1}{4.0} = (1.65-1)\frac{2}{r}$	1
	$r_1 = r_2 = 5.2cm$	1
3. (a)(i)	$f = \frac{1}{T} = \frac{1}{0.04} = 25Hz$	1
(ii)	angular frequency : $\omega = 2\pi f = 157=160\ rads^{-1}$	1
	amplitude, $x_o = \frac{a_o}{\omega^2} = \frac{50}{(157)^2} = 2.0x10^{-3}m$	1

(b)		**2**
4. (a)	Brittle show no plastic deformation before it breaks	**1** **1**
(b)	$E = \frac{FL}{xA}$ $= \frac{60 \times 0.24}{3 \times 10^{-4} \times 8 \times 10^{-7}}$ $= 6.0 \times 10^{10}\ \mathrm{N\,m^{-2}}$	**1** **1** **1**
5. (a)	A multiplier is a resistor of very high resistance connected in series to a galvanometer.	**1**
(b)	The function of the multiplier is to reduce the incoming current down to the maximum current that can be carried by the galvanometer. OR The function of the multiplier is to convert the galvanometer into a voltmeter.	**1**
(c)	 $I = I_{fsd} = \frac{V}{r + R_m} = \frac{3.0}{30 + R_m} = 0.02$ $30 + R_m = \frac{3.0}{0.02} = 150 \Rightarrow R_m = 120\Omega$ The multiplier is connected in series to the galvanometer.	**2** **1**
6. (a)	to reduce the distortion of the output or to reduce the gain	**1**

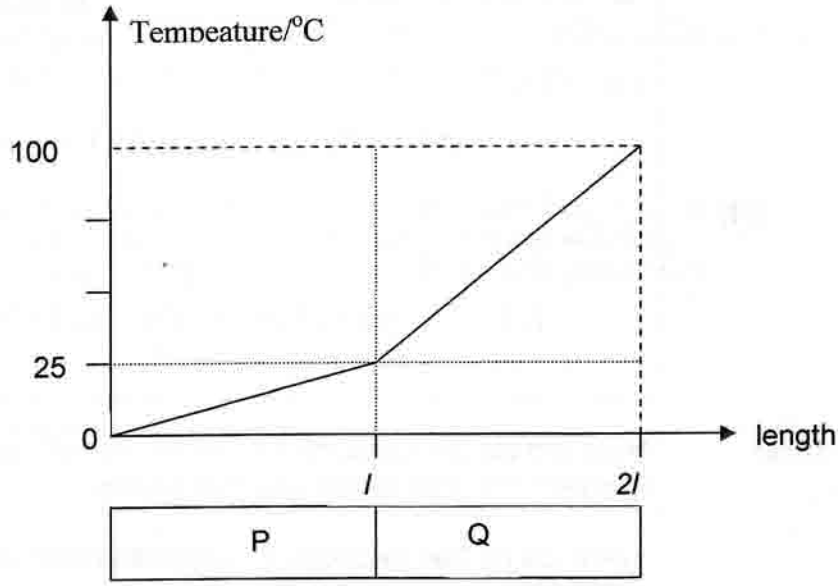
(b)(i)	Gain , $A = 1 + \frac{R_f}{R_i} = 1 + \frac{60}{20} = 1 + 3 = 4$	1
(ii)	Output, $V_o = AV_{in} = 4(3.0) = +12.0V = +9.0V\,(saturation)$	1
		2
7. (a)	There is change in magnetic flux-linkage	1
(b)	E = Bℓv = 6.0 x 10^{-5} x 20 x 10^3 x 7 x 10^3	1
	= 8.4 x 10^3 V	1
(c)	direction of generated e.m.f is from space shuttle to satellite.	1
8. (a)	Combination of 2 lighter (or smaller) nuclei at very high temperature to produce a heavier (or bigger) nucleus accompanied with the release of a lot of energy.	1
(b)(i)	${}^{13}_{6}C + {}^{1}_{1}H \rightarrow {}^{14}_{7}X$	1
	${}^{14}_{7}X$ *is* ${}^{14}_{7}N$	1
(ii)	Mass defect, $\Delta m = (13.003355 + 1.007825)u - 14.003074u$	
	$\Delta m = 8.106 \times 10^{-3} u$	1
	Energy released, $Q = 8.106 \times 10^{-3} \times 931 = 7.55\,MeV$	1

SECTION B

9. (a)	Centripetal force = force that causes a body to move in a circle, and its direction is always towards the centre of the circle.	1
(b)	The statement is false.	1
	If the two forces balance each other, the resultant force = 0. According to Newton's first law of motion, the body will move in a straight line with constant velocity. That is the body will not perform circular motion.	1
(c)		
	Resultant force towards the centreof circle = mg – R	1
	Hence mg – R = $\frac{mv^2}{r}$	1
	For maximum v, R = 0	
	v = rg = 10 x 9.81 = 98.1 m s^{-1}	1
(d)(i)	Newton's Law of gravitation states that the force between two masses is directly proportional to the product of the masses, and is inversely proportional to the square of the distance between them.	1
(ii)	The gravitational force of attraction is F= G $\frac{Mm}{r^2}$	1
(e)(i)	F = G$\frac{Mm}{r^2}$; GM = gR^2 ; r = 2R	
	F = $\frac{gR^2}{4R^2}$ x 150	1
	= $\frac{9.81x150}{4}$	
	= 368 N	1
(ii)	F = mrω^2	1
	368 = 150 x 2 x 6.38 x 10^6 ω^2	

	ω = 4.38 x 10^{-4} rad s^{-1}	1
	Period T = $\frac{2\pi}{\omega}$ = 1.435 x 10^4 s.	1
(iii)	$K.E = \frac{1}{2}mv^2 = \frac{1}{2}m(r\omega)^2$	1
	$K.E = \frac{1}{2}(150)(2\times 6.38\times 10^6)^2(4.38\times 10^{-4})^2 = 2.34\times 10^9 J$	1

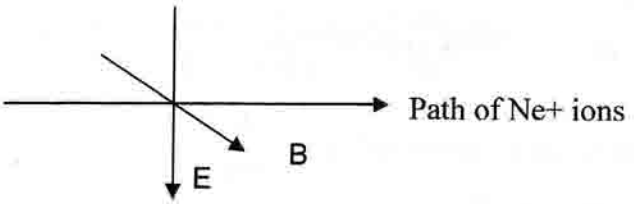
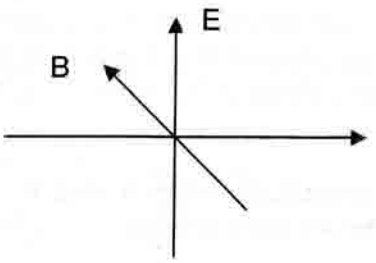
10.(a)	Heat and electric conduction in metals are both caused by the many free electrons that moves with high mobility .	1
	There are no free electrons in thermal and electric insulators.	1
	Thus thermal and electric insulators are poor conductors.	1
(b)(i)	Steady state is achieved when the temperatures at all points along the metal rod are stable and not changing.	1
(ii)	Temperature gradient is the difference in temperature per unit length along a conductor.	1
(iii)	Current, $I = \frac{Q}{t} = \frac{1}{\rho}A\frac{V}{l}$,	1
	where: I is the current in the flowing in the conductor, ρ is the resistivity of the material conductor, $\frac{V}{l}$ is the potential gradient along the conductor.	1
(c)(i)	rate of heat flow in P=rate of heat flow in Q	1
	$\Rightarrow 4kA\frac{(\theta-0)}{l} = kA\frac{(100-\theta)}{l}$	1
	$\Rightarrow 4\theta = 100 \Rightarrow \theta = \frac{100}{4} = 25^oC$	1



3

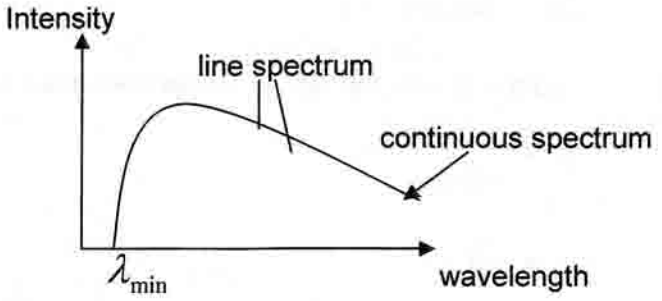
11.(a)	Supposition of 2 identical waves travelling in opposite direction.	1
	Amplitude of both waves are the same or almost the same	1
(b)(i)	Compare to stationary wave equation $y = A\sin\omega t\, kos\frac{2\pi x}{\lambda}$	
	$\omega = 2\pi f = 250$	1
	$f = \frac{250}{2\pi} = 39.8 = 40Hz$	1
(ii)	$\frac{2\pi}{\lambda} = 50$	1
	$\lambda = \frac{2\pi}{50} = 0.13m = 13.0cm$	
	distance between 2 neighbouring nodes$= \frac{\lambda}{2} = \frac{13}{2} = 6.5cm$	1
(iii)	speed of wave, $v = f\lambda = (40)(0.13) = 5.2ms^{-1}$	1
(c)(i)	Interference is the superposition of two coherent waves to produce points of maximum and minimum amplitude/intensity.	1
(ii)	Two conditions for well-defined interference are: -both waves are coherent and same or almost the same amplitude .	2
(d)(i)	Interference at G is constructive interference.	1
	Intererence at H is destructive interference.	1

(ii)	At H, is first minimum where m=1	1
	$y = \frac{(m-½)D\lambda}{d} = \frac{(1-½)(1.50)(600\times10^{-9})}{1.0\times10^{-3}}$	1
	$y = 4.5\times10^{-4}\,m = 0.45mm$	1

12.(a)	a) The stationary negative charged particle will move in the direction of the gravitational field.	1
	The stationary negative charged particle will move opposite in direction to an electric field and will not move in a magnetic field.	1
(b)	Upward electric force = downward gravitational force $eE = mg$	1
	$E = \frac{mg}{e} = \frac{(9.1\times10^{-31})(9.81)}{1.6\times10^{-19}} = 5.6\times10^{-11}\,Vm^{-1}$	1
(c) (i)	charge on Ne ion = +1.6 x 10^{-19} C	1
(ii)	mass of Ne ion, $m = \frac{M_r}{N_A} = \frac{20\times10^{-3}}{6.02\times10^{23}} = 3.3\times10^{-26}\,kg$	2
(d)(i)		
	OR	
		2

(ii)	$\frac{1}{2}mv^2 = eV$	1
	$v = \sqrt{\frac{2eV}{m}} = \sqrt{\frac{2(1.6\times10^{-19})(1400)}{9.1\times10^{-31}}} = 2.2\times10^5 ms^{-1}$	1
(iii)	electric force = magnetic force $eE = Bev$	1
	$B = \frac{E}{v} = \frac{6.2\times10^3}{2.2\times10^5} = 2.8\times10^{-2}T$	1
(e)(i)	Charge doubled, speed v increased by $\sqrt{2}$ times.	1
(ii)	Magnetic force > electric force, ions deflected from original path.	1

13.(a)(i)	The de Broglie's relationship gives the value of the wavelength λ related to a particle of linear momentum p in the equation $\lambda = \frac{h}{p}$ where h is the Planck constant	1
(ii)	The wave-particle duality refers to the wave nature of a particle under certain specific conditions and the converse is also true	1
(b)	$\frac{1}{2}mv^2 = 50\ (1.60 \times 10^{-19})$	
	$mv = \sqrt{2x50(1.60x10^{-19})m}$	1
	de Broglie wavelength $\lambda = \frac{h}{mv}$	
	$= \frac{6.63x10^{-34}}{mv} = 1.74 \times 10^{-10}$ m ; $m_e = 9.11 \times 10^{-31}$ kg	1
(c)	Continuous spectrum is produced when fast electrons from the cathode are decelerated on collision with the target. The decrease in energy of the decelerated electrons is radiated as photons in the continuous spectrum.	2
	Characteristic X-ray is produced when a vacancy in the inner shell (e.g. K-shell) of the target atom is filled by an electron from a higher shell. The difference in energy of the electron is radiated as a characteristic X-ray photon.	2

(d)		**2**
(e)	When an electron collides with a target atom, the electron will decelerate and is stopped. The loss of all the kinetic energy E of the electron in a single collision with the atom means that the X-ray emitted has maximum photon energy of $\frac{hc}{\lambda_{min}}$	**1** **1**
(f)	eV = $\frac{hc}{\lambda_{min}}$ $\lambda_{min} = \frac{hc}{20x10^3 x1.60x10^{-19}}$ = 6.22 x 10^{-11}m	**1** **1** **1**

14. (a)	Half-life : the time taken for the number of radioactive atoms in a sample to decay to half of its initial number. decay constant = - $\frac{\frac{dN}{dt}}{N}$	**1** **1**
(b)(i)	$^{226}_{88}Ra \longrightarrow {}^{222}_{86}Rn + {}^{4}_{2}He$	**1**
(ii)	Mass defect Δm = 226.025402u – (222.017570 + 4.002603)u = 0.005229 u Total K.E = 0.005229 x 931 = 4.88 MeV	**1** **1** **1**
(c)(i)	$^{4}_{2}\alpha + {}^{9}_{4}Be \longrightarrow {}^{12}_{6}C + {}^{1}_{0}X$	**2**

(ii)	alpha particle : nucleus of helium	1
	${}^{1}_{0}X$: Neutron	1
(iii)	neutron is not charged and does not cause ionization	2
(d)	$\frac{mv^2}{r}$ = Bqv	1
	m = $\frac{Bq}{v}$ r	1
	Assumption: Ions of the element and ions of C-12 have the same charge, then m $\propto$ r Hence mass number A $\propto$ r $A_x = \frac{26.2}{22.4} \times 12 = 14$	
	The element is nitrogen, N	1

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STPM TRIAL EXAMINATION 2009
ITEM SPECIFICATION TABLE
PHYSICS PAPER 2

No.	Topic	Subtopic	Skill level			No. of question	% of total question
			M	P	S		
1.	Dynamics	(a)Conservation of Linear Momentum	1			3	4.48
		(b)(i)Collision & Momentum		1			
		(ii)Work,Energy,Force			1		
2.	Refraction In Thin Lens	(a)Lens & Images	1			3	4.48
		(b)Lens Formula & Magnification		1			
		(c)Lens Maker Equation		1			
3	Simple Harmonic Motion	(a)(i)frequency and amplitude	1			4	5.97
		(ii)angular frequency	1				
		(iii)amplitude		1			
		(b)Displacement-time graph			1		
4.	Matter & Elasticity	(a)Force-extension graph Elasticity		1		2	2.99
		(b) Young's Modulus		1			
5.	D.C Circuit	(a)What is a multiplier	1			3	4.48
		(b)Function of multiplier	1				
		(c)Conversion of Galvanometer to voltmeter			1		
6.	Op-Amp	(a)Advantages of Negative Feedback of op-amp	1			4	5.97
		(b)(i) Closed loop gain	1				
		(i) Finding Output Voltage	1				
		(ii)Output-Input Graph			1		
7.	E-M Induction	(a)Process of e/m induction		1		3	4.48
		(b)Magnitude of induced emf	1				
		(c)Direction of induced emf		1			
8.	Nuclear Physics	(a)Nuclear fusion reaction	1			3	4.48
		(b)(i)Nuclear reaction equation	1				
		(ii)Energy released in nuclear reaction		1			
B							
9	Circular Motion	(a)Centripetal force	1			8	11.94
		(b)Centrifugal force		1			
		(c) Maximum speed for circular motion		1			
	Gravitation	(d)(i)Newton's Law of Gravitation	1				
		(ii) Gravitational force and centripetal force	1				
		(e)(i)Satellite in orbit		1			
		(ii)Period of satellite in orbit	1				
		(iii)Kinetic energy of satellite		1			

10	Thermal Conduction	(a)Mechanism of heat conduction-electron theory		1		6	8.95
		(b)(i)Steady state and temperature gradient	1				
		(ii)Comparison between thermal and electric conduction	1				
		(iii)Rate of heat & electric flow.		1			
		(c)(i)Calculation of steady state temperature		1			
		(ii) Distribution of temperature for well-lagged composite rod			1		
11	Stationary Mechanical Waves Interference	(a)Producing stationary waves.	1			8	11.94
		(b)Calculation involving stationary wave equation	1	2			
		(c)Definition of Interference	1				
		(ii)Conditions to produce interference pattern	1				
		(d)Young's Double slit Exp. (i) Constructive & Destructive	1				
		(ii)Bright fringe formula		1			
12	Motion of Charged Particle in electric, magnetic and gravitational fields	(a)Force on charged particles in E,B and G fields		1		7	10.45
		(b)Electric and gravitational force on charged particles.		1			
		(c)(i)Finding charge on ion.	1				
		(ii)Calculation of mass of ion	1				
		(d)(i)Balancing electric and magnetic force in E, B fields		1			
		(ii)Mutual perpendicular electric and magnetic field as speed selector			1		
		(e)Charge and electric and magnetic force			1		
13	Duality of Matter X-Rays	(a)Duality Principle	1			7	10.45
		(b)De Broglie's wavelength		1			
		(c)X-ray production			1		
		(d)X-ray spectrum		1			
		(e)Minimum wavelength		1	1		
14	Nuclear Physics	(a)Radioactivity	1			6	8.95
		(b)(i)Radioactive decay equation	1				
		(ii)K.E of decay products		1			
		(c)(i)Nuclear equation	1				
		(ii)Nuclide & particle identity	1				
		(iii)Properties of particles		1			
		(d)Mass spectrometer			1		
		Total	30	27	10	67	100
		%	44.8	40.3	14.9	100	100