Work, Energy & Power

Mark Scheme 5

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Work, Energy & Power
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 5

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 **(a** power = work / time or energy / time or (force × distance) / time B1

= $kg\,m\,s^{-2} \times m\,s^{-1} = kg\,m^2\,s^{-3}$ A1 [2]

(b) power = VI [or V^2/R **and** $V = IR$ or I^2R **and** $V = IR$] B1

(units of V:) $kg\,m^2\,s^{-3}\,A^{-1}$ B1 [2]

2 **(a** **(i)** two sets of co-ordinates taken to determine a constant value (F/x) M1

F/x constant hence obeys Hooke's law A1 [2]

or
gradient calculated and one point on line used (M1)
to show no intercept hence obeys Hooke's law (A1)

(ii) gradient or one point on line used e.g. $4.5 / 1.8 \times 10^{-2}$ C1

(k =) $250\,N\,m^{-1}$ A1 [2]

(iii) work done or E_P = area under graph or ½Fx or ½kx^2 C1

= $0.5 \times 4.5 \times 1.8 \times 10^{-2}$ or $0.5 \times 250 \times (1.8 \times 10^{-2})^2$ C1

= 0.041 (0.0405) J A1 [3]

(b) KE = ½mv^2

½mv^2 = 0.0405 or KE = 0.0405 (J) C1

($v = [2 \times 0.0405 / 1.7]^{1/2}$ =) 0.22 (0.218) $m\,s^{-1}$ A1 [2]

3 (a)	(i)	straight line from $t = 0.60$ s to $t = 1.2$ s and $\lvert V_v \rvert = 5.9$ at $t = 1.2$ s	M1	
		$V_v = -5.9$ at $t = 1.2$ s i.e. line is for negative values of V_v	A1	[2]
	(ii)	$s = 0 + ½ \times 9.81 \times (0.6)^2$ *or* area of graph $= (5.9 \times 0.6) / 2$	C1	
		= 1.8 (1.77) m = 1.8 (1.77) m	A1	[2]
	(iii)	$V_h = V \cos 60°$ <u>and</u> $V_v = V \sin 60°$ *or* $V_h = 5.9 / \tan 60°$ *or* $V_h = 5.9 \tan 30°$	C1	
		$V_h = 3.4\ \text{m s}^{-1}$	A1	[2]
	(iv)	horizontal line at 3.4 from $t = 0$ to $t = 1.2$ s [to half a small square]	B1	[1]
(b)	(i)	KE $= ½mv^2$	C1	
		$= ½ \times 0.65 \times (6.81)^2$ [allow if valid method to find v]	C1	
		= 15 (15.1) J	A1	[3]
	(ii)	PE $= 0.65 \times 9.81 \times 1.77$	C1	
		= 11(11.3) J	A1	[2]

4 **(a** for a system (of interacting bodies) the <u>total</u> momentum remains constant provided there is no <u>resultant</u> force acting (on the system) M1 A1 [2]

(b) **(i)** total momentum $= m_1v_1 + m_2v_2$ C1
$= 0.4 \times 0.65 + 0.6 \times 0.45$ C1
$= 0.26 + 0.27 = 0.53$ N s A [3]

(ii) $0.53 = 0.4 \times 0.41 + 0.6 \times v$ C1

$v = 0.366 / 0.6 = 0.61$ m s^{-1} A1 [2]

(iii) KE = $\frac{1}{2}mv^2$ C1
total initial KE $= \frac{1}{2} \times 0.4 \times (0.65)^2 + \frac{1}{2} \times 0.6 \times (0.45)^2$ C1
$= 0.0845 + 0.06075 = 0.15 (0.145)$ J A [3]

(c) check relative speed of approach equals relative speed of separation
or:
total final kinetic energy equals the total initial kinetic energy B1 [

(d) the forces on the two bodies (or on X and Y) are equal and opposite B1
time same for both forces <u>and</u> force is change in momentum / time [2]

5 **(a** power = energy / time C1
= (force × distance / time) = kg m^2 s^{-2} / s C1
= kg m^2 s^{-3} A1 [3]

(b) **(i)** units of L^2: m^2 and units of ρ: kg m^{-3} and units of v^3: m^3 s^{-3} C1
($C = P / L^2 \rho v^3$) hence units of C: kg m^2 s^{-3} m^{-2} kg^{-1} m^3 m^{-3} s^3
or any correct statement of component units M1
argument /discussion / cancelling leading to C having no units A1 [3]

(ii) power available from wind = $3.5 \times 10^5 \times 100 / 55$ (= 6.36×10^5) C
$v^3 = 3.5 \times 10^5 \times 100 / (55 \times 0.931 \times (25)^2 \times 1.3)$ C1
$v = 9.4$ m s^{-1} A1 [3]

(iii) not all kinetic energy of wind converted to kinetic energy of blades B1
generator / conversion to electrical energy not 100% efficient / heat produced in generator / bearings etc B1 [2]
(there must be cause of loss and where located)

6	**(a**	**(i)**	the total momentum of a system (of interacting bodies) remains constant	M1	
			provided there are no resultant external forces / isolated system	A1	[2]
		(ii)	elastic: total kinetic energy is conserved, inelastic: loss of kinetic energy	B1	[1]
			[allow elastic: relative speed of approach equals relative speed of separation]		
	(b)	**(i)**	initial mom: 4.2 × 3.6 – 1.2 × 1.5 (= 15.12 – 1.8 = 13.3)	C1	
			final mom: 4.2 × v + 1.5 × 3	C1	
			v = (13.3 – 4.5) / 4.2 = 2.1 m s^{-1}	A1	[3]
		(ii)	initial kinetic energy = ½ $m_A(v_A)^2$ + ½ $m_B(v_B)^2$		
			= 27.21 + 1.08 = 28(.28)	M1	
			final kinetic energy = 9.26 + 6.75 = 16	M1	
			initial KE is not the same as final KE hence inelastic	A1	[3]
			provided final KE less than initial KE		
			[allow in terms of relative speeds of approach and separation]		