Work, Energy & Power

Mark Scheme 6

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Work, Energy & Power
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 6

Time Allowed: **80 minutes**

Score: **/66**

Percentage: **/100**

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

1 **(a (i)** $v^2 = u^2 + 2as$
$= (8.4)^2 + 2 \times 9.81 \times 5$ C1
$= 12.99\ \text{m s}^{-1}$ *(allow 13 to 2 s.f. but not 12.9)* A1 [2]

(ii) $t = (v - u) / a$ or $s = ut + ½at^2$
$= (12.99 - 8.4) / 9.81$ or $5 = 8.4t + ½ \times 9.81t^2$ M1
$t = 0.468$ s A0 [1]

(b) reasonable shape M1
suitable scale A1
correctly plotted 1st and last points at (0,8.4) and (0.88 – 0.96,0)
with non-vertical line at 0.47 s A1 [3]

(c) (i) 1. kinetic energy at end is zero so $\Delta KE = ½ mv^2$ or $\Delta KE = ½ mu^2 - ½ mv^2$ C1
$= ½ \times 0.05 \times (8.4)^2$
$= (-)\ 1.8$ J A1 [2]

2. final maximum height $= (4.2)^2 / (2 \times 9.8) = (0.9\ (\text{m}))$
change in PE $= mgh_2 - mgh_1$ C1
$= 0.05 \times 9.8 \times (0.9 - 5)$ C1
$= (-)\ 2.0$ J A1 [3]

(ii) change is – 3.8 (J) B1
energy lost to ground (on impact) / energy of deformation of the ball /
thermal energy in ball B1 [2]

2	**(a)**	electric field strength is the force <u>per unit positive</u> charge (acting on a stationary charge)	B1	[1]
	(b) (i)	$E = V / d$ $= 1200 / 14 \times 10^{-3}$ $= 8.57 \times 10^{4}\,\text{V m}^{-1}$	C1 A1	 [2]
	(ii)	$W = QV$ or $W = F \times d$ and therefore $W = E \times Q \times d$ $= 3.2 \times 10^{-19} \times 1200$ $= 3.84 \times 10^{-16}\,\text{J}$	C1 A1	 [2]
	(iii)	$\Delta U = mgh$ $= 6.6 \times 10^{-27} \times 9.8 \times 14 \times 10^{-3}$ $= 9.06 \times 10^{-28}\,\text{J}$	C1 A	 [2]
	(iv)	$\Delta K = 3.84 \times 10^{-16} - \Delta U$ $= 3.84 \times 10^{-16}\,\text{J}$	 A1	 [1]
	(v)	$K = ½mv^2$ $v = [(2 \times 3.8 \times 10^{-16}) / 6.6 \times 10^{-27}]^{1/2}$ $= 3.4 \times 10^{5}\,\text{m s}^{-1}$	C1 A1	 [2]
3	**(a (i)**	horizontal velocity = $15 \cos 60° = 7.5\,\text{m s}^{-1}$	A1	[1]
	(ii)	vertical velocity = $15 \sin 60° = 13\,\text{m s}^{-1}$	A1	[1]
	(b) (i)	$v^2 = u^2 + 2as$ $s = (13)^2 / (2 \times 9.81) = 8.6(1)$ m using $g = 10$ then max. 1	 A1	 [1]
	(ii)	$t = 13 / 9.81 = 1.326$ s or $t = 9.95 / 7.5 = 1.327$ s	A1	[1]
	(iii)	velocity = 6.15 / 1.33 $= 4.6\,\text{m s}^{-1}$	M1 A0	 [1]
	(c) (i)	change in momentum = 60×10^{-3} [–4.6 – 7.5] $= (-)0.73\,\text{N s}$	C1 A1	 [2]
	(ii)	final velocity / kinetic energy is less after the collision or relative speed of separation < relative speed of approach hence inelastic	M1 A0	 [1]

4	**(a**	**(i)**	power = work done per unit time / energy transferred per unit time / rate of work done	B1 [1
		(ii)	Young modulus = stress / strain	B1 [1]
	(b)	**(i)**	**1.** $E = T / (A \times \text{strain})$ *(allow strain = ε)*	C1
			$T = E \times A \times \text{strain} = 2.4 \times 10^{11} \times 1.3 \times 10^{-4} \times 0.001$	M1
			$= 3.12 \times 10^{4}$ N	A0 [2]
			2. $T - W = ma$	C1
			$[3.12 \times 10^{4} - 1800 \times 9.81] = 1800a$	C1
			$a = 7.52\ \text{m s}^{-2}$	A1 [3]
		(ii)	**1.** $T = 1800 \times 9.81 = 1.8 \times 10^{4}$ N	A1 [1]
			2. potential energy gain $= mgh$	C1
			$= 1800 \times 9.81 \times 15$	
			$= 2.7 \times 10^{5}$ J	A1 [2]
		(iii)	$P = Fv$	C1
			$= 1800 \times 9.81 \times 0.55$	C1
			input power = 9712 × (100/30) = 32.4×10^{3} W	A1 [3]

5	**(a**	*either*	energy (stored)/work done represented by area under graph	
		or	energy = <u>average</u> force × extension ……	B1
			energy = ½ × 180 × 4.0×10^{-2} ……	C1
			= 3.6 J ……	A1 [3]
	(b)	**(i)** *either*	momentum before release is zero ……	M1
			so sum of <u>momenta</u> (of trolleys) after release is zero ……	A1
		or	force = rate of change of momentum (M1)	
			force on trolleys equal and opposite (A1)	
		or	impulse = change in momentum (M1)	
			impulse on each equal and opposite (A1)	[2]
		(ii) 1	$M_1V_1 = M_2V_2$ ……	[1]
		2	$\underline{E} = ½ M_1V_1^2 + ½ M_2V_2^2$ ……	B1 [1]
		(iii)	$E_K = ½mv^2$ and $p = mv$ combined to give ……	
			$E_K = p^2 / 2m$ ……	A0 [1]
		2	m smaller, E_K is larger because p is the same/constant ……	M1
			so trolley B ……	A0 [1]

6	**(a**	evidence of use of area below the line	B1	
		distance = 39 m (*allow ±0.5 m*)	A	[3]
		(*if > ±0.5 m but ≤ 1.0 m, then allow 1 mark*)		
	(b) **(i)**	**1** $E_K = ½mv^2$	C1	
		$\Delta E_K = ½ \times 92 \times (6^2 - 3^2)$		
		= 1240 J	A1	[2]
		2 $E_P = mgh$	C1	
		$\Delta E_P = 92 \times 9.8 \times 1.3$		
		= 1170 J	A1	[2]
	(ii)	$E = Pt$	C1	
		$E = 75 \times 8$		
		= 600 J	A	[2]
	(c) **(i)**	energy = (1240 + 600) – 1170	M1	
		= 670 J	A	[1]
	(ii)	force = 670/39 = 17 N	A	[1]
	(d)	frictional forces include air resistance	B1	
		air resistance decreases with decrease of speed	B1	[2]