Work, Energy & Power

Mark Scheme 7

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Work, Energy & Power
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 7

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

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

1 **(a)** **(i)** speed = 4.0 m s^{-1} …(*allow 1 s.f.*) ..... A1 [1]

(ii) $v^2 = 2gh$
$= 2 \times 9.8 \times 1.96$ M1
$v = 6.2$ m s^{-1} ..... A0 [1]
(*use of g = 10 m s^{-2} loses the mark*)

(b) correct basic shape with correct directions for vectors M1
speed = (7.4 ± 0.2) m s^{-1} A1
at $(33 \pm 2)°$ to the vertical ..... A1 [3]
(*for credit to be awarded, speed and angle must be correct on the diagram – not calculated*)

(c) **(** *either* $v^2 = 2 \times 9.8 \times 0.98$ *or* $v = 6.2 / \sqrt{2}$ C1
speed = 4.4 m s^{-1} ..... A1 [2]
(*allow calculation of t = 0.447 s, then v = 4.4 m s^{-1})*

(ii) momentum = *mv* C1
change in momentum = 0.034 (6.2 + 4.4) C1
= 0.36 kg m s^{-1} ..... A1 [3]
(*use of 0.034 (6.2 - 4.4) loses last two marks*)
2 force = $\Delta p / \Delta t$ …….(however expressed) C1
$= \frac{0.36}{0.12}$
= 3.0 N ……(*allow 1 s.f.*) ..... A1 [2]

[Total: 12]

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2	**(a)**	**(i)**	*either* force = e x *(V I d)* *or* *E = V/d*	C1	
			= 1.6 x 10^{-19} x (250 / 7.6 x 10^{-3})	C1	
			= 5.3 × 10^{-15} N	A1	[3]
		(ii)	*either* 11E_K = eV *or* 11E_K = *Fd*	C1	
			= 1.6 x 10^{-19} x 250 = 5.3 x 10^{-15} x 7.6 x 1Q^3	M1	
			= 4.Q × 10^{-17} J	AO	[2]
			(allow full credit for correct working via calculation of a and v)		
		(iii)	*either* 11E_K = ½*mv*2		
			4.Q x 10^{-17} = ½ x 9.1 x 10^{-31} x v2	C1	
			v = 9.4 x 10^6 m s-1	A1	[2]
			or v2 = 2as and a = *Flm*		
			V = (2 x 5.3 x 10^{-15} x 7.6 x 10^{-3})/(9.11 x 10^{-31})	(C1)	
			v = 9.4 x 10^6 m s-1	(A1)	
	(b)		speed depends on (electric) potential difference	M2	
			(If states ΔEK does not depend on uniformity of field, then award 1 mark, treated as an M mark)		
			so speed always the same	A1	[3]

3	**(a**	**(i)**	*either* force = e × (*V* / *d*) *or* *E* = *V/d*	C1	
			= 1.6 × 10^{-19} × (250 / 7.6 × 10^{-3})	C1	
			= 5.3 × 10^{-15} N	A1	[3]
		(ii)	*either* ΔE_K = e*V* *or* ΔE_K = *Fd*	C1	
			= 1.6 × 10^{-19} × 250 = 5.3 × 10^{-15} × 7.6 × 10^{-3}	M1	
			= 4.0 × 10^{-17} J	A0	[2]
			(*allow full credit for correct working via calculation of a and v*)		
		(iii)	*either* $\Delta E_K = ½mv^2$		
			4.0 × 10^{-17} = ½ × 9.1 × 10^{-31} × v^2	C1	
			v = 9.4 × 10^6 m s^{-1}	A1	[2]
			or v^2 = 2*as* and *a* = *F/m*		
			v^2 = (2 × 5.3 × 10^{-15} × 7.6 × 10^{-3})/(9.11 × 10^{-31})	(C1)	
			v = 9.4 × 10^6 m s^{-1}	(A1)	
	(b)		speed depends on (electric) potential difference	M2	
			(*If states ΔE_K does not depend on uniformity of field, then award 1 mark, treated as an M mark*)		
			so speed always the same	A1	[3]

4	**(a)**	**(i)**	(p =) mv	B1	
		(ii)	$E_k = \frac{1}{2}mv^2$	B1	
			algebra leading to	M1	
			$E_k = p^2/2m$	A0	**[3]**
	(b)	**(i)**	Δp = 0.035 (4.5 + 3.5) OR a = (4.5 + 3.5)/0.14	C1	
			= 0.28 N s = 57.1 m s^{-2}		
			force= $\Delta p/\Delta t$ (= 0.28/0.14) OR F = ma (= 0.035 x 575.1) (allow e.c.f.)	C1	
			= 2.0 N	A1	
			Note: candidate may add mg = 0.34 N to this answer, deduct 1 mark upwards	B1	**[4]**
		(ii)	loss = $\frac{1}{2}$ x 0.035 ($4.5^2 - 3.5^2$)	C1	
			= 0.14 J	A1	**[2]**
			(No credit for $0.28^2/(2 \times 0.035) = 1.12$ J)		
	(c)		e.g. plate (and Earth) gain momentum		
			i.e. discusses a 'syste	B1	
			equal and opposite to the change for the ball		
			i.e. discusses force/moment	M1	
			so momentum is conserved		
			i.e. discusses consequence	A1	**[3]**
				Total	**[12]**

5	**(a)**	**(i)**	arrow from B towards A	B1	
		(ii)	$E = V/d$		
			= 450/(9.0 x 10^{-2})	C1	
			= 5.0 x 10^3 N C^{-1} (accept 1 sig. fig)	A1	[3]
	(b)	**(i)**	energy = qV or Eqd	C1	
			= 1.6 x 10^{-19} x 450	A1	
			= 7.2 x 10^{-17} J	A0	
		(ii)	Ek = $\frac{1}{2}mv^2$		
			7.2 x 10^{-17} = ½ x 9.1 x 10^{-31} x v^2	C1	
			v = 1.26 x 10^7 m s^{-1}	A1	[4]
	(c)		line from origin, curved in correct direction but not 'level out'	B1	[1]

6 **(a)** **(i)** distance from a (fixed) point M1
in a specified direction A1
(Allow 1 mark for 'distance in a given direction')

(ii) (displacement from start is zero if) car at its starting position ..... B1 [3]

(b) **(i)1** $v^2 = u^2 + 2as$
$28^2 = 2 \times a \times 450$ (use of component of 450 scores no marks) C1
$a = 0.87\ m\ s^{-2}$ ..... A1 [2]
(-1 for 1 sig. fig. but once only in the question)

(i) $v = u + at$ or any appropriate equation
$28 = 0.87t$ or appropriate substitution C1
$t = 32\ s$ ..... A1 [2]

(i) $E_k = ½mv^2$ C1
$= ½ \times 800 \times 28^2$
$= 3.14 \times 10^5\ J$ ..... A1 [2]

(i) $E_p = mgh$ C1
$= 800 \times 9.8 \times 450 \sin 5$ C1
$= 3.07 \times 10^5\ J$ ..... A1 [3]

(ii) power = energy/time C1
$=(6.21 \times 10^5)/32.2$ C1
$= 1.93 \times 10^4\ W$ ..... A1 [3]
(power = Fv with $F = mg \sin\theta$ scores no marks)

(iii) some <u>work also done against friction</u> forces M1
location of frictional forces identified ..... A1 [2]
(allow reasonable alternatives)

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