5. Work, Energy and Power

5.2 Gravitational potential energy and kinetic energy

Paper 2

Marking Scheme

Q1.

(b)(i)	$(\Delta)E_{(P)} = mg(\Delta)h$	**C1**
	$= 4.5 \times 10^{-2} \times 9.81 \times 8.0 \times 10^{-2} \sin 15°$	**C1**
	$= 9.1 \times 10^{-3}$ J	**A1**
(b)(ii)	$E_{(K)} = ½mv^2$	**C1**
	$(9.3 \times 10^{-2} - 9.1 \times 10^{-3}) = ½ \times 4.5 \times 10^{-2} \times v^2$	**C1**
	$v = (2 \times 8.4 \times 10^{-2} / 4.5 \times 10^{-2})^{0.5}$ $= 1.9\,\text{m s}^{-1}$	**A1**

Q2.

(b)(ii)	kinetic energy $= ½\,mv^2$	**C1**
	$= ½ \times 1800 \times 40^2$ $= 1.4 \times 10^6$ J	**A1**

Q3.

(b)	weight/force = mg, and g identified as acceleration of free fall	**B1**
	ΔE_P identified as work (done by lifting force/weight), and so = $mg \times \Delta h$	**B1**

Q4.

(d)(ii)	any line starting at distance = 0 and a positive non-zero value of kinetic energy	**B1**
	a straight line from distance = 0 to distance = x with positive gradient	**B1**
	a straight horizontal line at a non-zero value of kinetic energy starting at distance = x and ending at distance = x + 18 m that is continuous with the previous line	**B1**

Q5.

(c)(ii)	$E = ½mv^2$	**C1**
	$= ½ \times 4$ u $\times (150 \times 10^5)^2$ $= ½ \times 4 \times 1.66 \times 10^{-27} \times (150 \times 10^5)^2$ $= 7.5 \times 10^{-13}$ J	**A1**

Q6.

(c)(i)	$((\Delta)E) = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$= 0.30 \times 0.090$ $= 0.027$ J	**A1**
(c)(ii)	$E = ½mv^2$	**C1**
	$E = 0.044 - 0.027$ (= 0.017)	**C1**
	$v^2 = (2 \times 0.017) / (0.30 / 9.81)$ (where v = speed at A) $v = 1.1$ m s^{-1}	**A1**
	or	
	$E = ½mv^2$	**(C1)**
	$0.044 = ½ \times (0.30 / 9.81) \times v^2$ (where v = speed at B) $(v^2 = 2.88)$ $v^2 = u^2 + 2as$ (where u = speed at A) $2.88 = u^2 + 2 \times 9.81 \times 0.090$	**(C1)**
	$u = 1.1$ m s^{-1}	**(A1)**

Q7.

(c)(i)	$(\Delta)E = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$= 2.4 \times 1.8$ $= 4.3$ J	**A1**
(c)(ii)	$E = \frac{1}{2}mv^2$	**C1**
	$= \frac{1}{2} \times (2.4 / 9.81) \times 3.4^2$ $= 1.4$ J (at X)	**C1**
	kinetic energy at Y $= 4.3 + 1.4$ $= 5.7$ J	**A1**
	or	
	$\frac{1}{2}mv^2 = \frac{1}{2}mu^2 + mg(\Delta)h$	**(C1)**
	$v^2 = 3.4^2 + 2 \times 9.81 \times 1.8$ $v^2 = 46.9$ so $v = 6.85$ (m s^{-1}) KE $= \frac{1}{2} \times (2.4 / 9.81) \times 6.85^2$	**(C1)**
	$= 5.7$ J	**(A1)**

Q8.

(b)	$E_{(K)} = ½mv^2$	**C1**
	$0.048 = ½ \times 7.5 \times 10^{-3} \times v^2$ $v = 3.6$ m s^{-1}	**A1**
(c)(i)	$(\Delta)E = mg(\Delta)h$	**C1**
	$0.039 = 7.5 \times 10^{-3} \times 9.81 \times (\Delta)h$ $\Delta h = 0.53$ m	**A1**

Q9.

(c)	$(\Delta)E = mg(\Delta)h$ **or** $(\Delta)E = W(\Delta)h$	**C1**
	$(\Delta)h = (-)\ 77 / 32$	**C1**
	$(\Delta)h = (-)\ 2.4$ final height = 6.2 – 2.4 = 3.8 m	**A1**

Q10.

(b)(ii)	$(E =)\ ½mv^2$	**C1**
	$(E =)\ ½ \times 0.017 \times 4.9^2 = 0.20$ (J)	**A1**
(c)(i)	same elastic potential energy / same (initial) kinetic energy and (polystyrene ball has) smaller mass (so greater speed) **or** same (average) force and (polystyrene ball has) smaller mass, (so greater average acceleration so greater speed)	**B1**

Q11.

(a)	$E = ½mv^2$	**C1**
	$= ½ \times 0.25 \times 2.3^2$ $= 0.66$ J	**A1**

Q12.

(b)	$p = mv$ **or** $0.72 = mv$	**C1**
	$E = ½mv^2$ **or** $0.86 = ½mv^2$	**C1**
	$(m =)\ 0.72^2 / (2 \times 0.86) = 0.30$ (kg) **or** $v = 2E_K / p$ $v = (0.86 \times 2) / 0.72 = 2.4$ (to 2 s.f.) $m = 0.72 / 2.4 = 0.30$ (kg)	**A1**
(c)	$(\Delta)E = mg(\Delta)h$	**C1**
	$h = 0.86 / (0.30 \times 9.81)$ = 0.29 m	**A1**

Q13.

(a)	$(\Delta)E = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$= 330 \times (4.0 – 1.1)$ = 960 J	**A1**
(c)(i)	$E = ½mv^2$	**C1**
	$540 = ½ \times (330 / 9.81) \times v^2$ $v = 5.7$ m s^{-1}	**A1**

Q14.

(b)(i)	kinetic energy $= ½mv^2$	**C1**
	$= ½ \times 0.24 \times 2.3^2$	**C1**
	= 0.63 J	**A1**

Q15.

(b)(i)	zero / 0 J	**A1**
(c)(i)	$(\Delta)E_{(P)} = mg(\Delta)h$	**C1**
	$h = 4.8 \times 10^4 / (1700 \times 9.81)$ $= 2.9$ m	**A1**

Q16.

(c)	$E_{(K)} = \frac{1}{2}mv^2$	**C1**
	$= \frac{1}{2} \times 4 \times 1.66 \times 10^{-27} \times (1.6 \times 10^7)^2$	**C1**
	$= 8.5 \times 10^{-13}$ (J) $= 8.5 \times 10^{-13} / 1.60 \times 10^{-13}$ (MeV) $= 5.3$ MeV	**A1**

Q17.

(c)(i)	$h = 75 - 75 \sin 53° = 15$ cm	**A1**
(c)(ii)	$(\Delta)E = mg(\Delta)h$ **or** $(\Delta)E = W(\Delta)h$	**C1**
	$(\Delta)E = 2.4 \times 15 \times 10^{-2}$ $= 0.36$ J	**A1**
(c)(iii)	$E = \frac{1}{2}mv^2$	**B1**
	$0.36 = \frac{1}{2} \times (2.4 / 9.81) \times v^2$	**C1**
	$v = 1.7$ m s^{-1}	**A1**

Q18.

(b)(i)	**1.** $(\Delta)E = mg(\Delta)h$	**C1**
	$= 0.42 \times 9.81 \times 78$ $= 320$ J	**A1**
	2. $E = \frac{1}{2}mv^2$	**C1**
	$(\Delta)E = \frac{1}{2} \times 0.42 \times 23^2$ $= 110$ J	**A1**

Q19.

(c)	$(\Delta)E = mg(\Delta)h$ **or** $W(\Delta)h$	**C1**
	$(\Delta)E = 0.86 \times 2.2$ $= 1.9$ J	**A1**

Q20.

(b)(i)	$E = \frac{1}{2}mv^2$ **or** $\frac{1}{2} \times 0.062 \times 3.8^2$ **or** $\frac{1}{2} \times 0.062 \times 1.7^2$	**C1**
	loss of KE $= \frac{1}{2} \times 0.062 \times (3.8^2 - 1.7^2)$ $= 0.36$ J	**A1**

Q21.

(c)(i)	$(\Delta)E = mg(\Delta)h$	**C1**
	$h = 0.60 / (0.020 \times 9.81) = 3.1$ m	**A1**

Q22.

(a)(i)	$E = ½Fx$ **or** $E = ½kx^2$ **or** E = area under graph	**C1**
	$E = ½ \times 4.0 \times 0.32 = 0.64$ J **or** $E = ½ \times 12.5 \times (0.32)^2 = 0.64$ J	**A1**
(a)(ii)	$E = mgh$ **or** $E = Wh$ $= 2.5 \times 0.32$	**C1**
	$= 0.80$ J	**A1**
(b)(ii)	$E = ½mv^2$ $0.16 = ½ \times (2.5 / 9.81) \times v^2$	**C1**
	$v = 1.1$ m s^{-1}	**A1**

Q23.

(b)	$E = ½Fx$ **or** $E = ½kx^2$ **or** E = area under graph	**C1**
	$(\Delta)E = (½ \times 3.2 \times 0.040) – (½ \times 1.2 \times 0.015) = 0.055$ J **or** $(\Delta)E = (½ \times 80 \times 0.040^2) – (½ \times 80 \times 0.015^2) = 0.055$ J **or** $(\Delta)E = ½ \times (1.2 + 3.2) \times 0.025 = 0.055$ J	**A1**
(c)	$(\Delta)E = mg(\Delta)h$	**C1**
	$= 0.122 \times 9.81 \times (0.120 – 0.095)$ $= 0.030$ J	**A1**
	or	
	$(\Delta)E = W \times (\Delta)h$	**(C1)**
	$= 1.2 \times 0.025$ $= 0.030$ J	**(A1)**
(d)(i)	$E = 0.055 – 0.030$ $= 0.025$ J	**A1**
(d)(ii)	$E = ½mv^2$	**C1**
	$v = [(2 \times 0.025) / 0.122]^{0.5}$ $= 0.64$ m s^{-1}	**A1**

Q24.

(b)	$E = ½mv^2$	**C1**
	$E = 460 \times 1.60 \times 10^{-19}$ $(= 7.36 \times 10^{-17}$ (J))	**C1**
	$v = [(2 \times 460 \times 1.60 \times 10^{-19}) / (9.11 \times 10^{-31})]^{½}$ $= 1.3 \times 10^7$ m s^{-1}	**A1**

Q25.

(b)(ii)	$(E =) ½mv^2$	**C1**
	ratio $= (½ \times 2.0M \times 6.0^2) / (½ \times 1.5M \times 8.0^2)$ $= 0.75$	**A1**

Q26.

(b)(iv)	$E = ½mv^2$	**C1**
	ratio = $(½ \times m \times 4.6^2) / (½ \times m \times 5.5^2)$ **or** ratio = $(½ \times m \times 5.5^2 - m \times 9.81 \times 0.459) / (½ \times m \times 5.5^2)$	**C1**
	ratio = 0.70	**A1**

Q27.

(a)(ii)	energy of a mass due to its position in a gravitational field	**B1**

Q28.

(d)	$(\Delta)E = mg(\Delta)h$	**C1**
	$E = ½mv^2$	**C1**
	ratio = $(½ \times m \times 3.6^2) / (m \times 9.81 \times 1.2)$ **or** ratio = $[(½ \times m \times 6.0^2) - (m \times 9.81 \times 1.2)] / (m \times 9.81 \times 1.2)$ **or** ratio = $(½ \times m \times 3.6^2) / (½ \times m \times 4.8^2)$	**C1**
	ratio = 0.56	**A1**