5. Work, Energy and Power

5.1 Energy conservation

Paper 2

Marking Scheme

Q1.

(b)(iii)	efficiency = useful output power / total input power = (160 / 750) × 100 = 21%	**A1**
(b)(iv)	area (of the new panel) is less	**B1**
	input power (of the new panel) is less (than the input power of the original panel) (as intensity is constant)	**B1**
	(useful power output is unchanged so) efficiency is greater (than the original panel)	**B1**

Q2.

(a)	product of force and displacement in direction of force	**B1**
(c)(i)	240 × 150 = 36 kJ	**A1**
(c)(ii)	$P = W / t$	**C1**
	= 36 000 / 60 = 600 W	**A1**
(c)(iii)	efficiency = <u>useful</u> output power / total input power	**C1**
	= 600 / 900 = 0.67	**A1**

Q3.

(d)(i)	$F = W / s$	**C1**
	= 250 / 18 = 14 N	**A1**

Q4.

(b)(vi)	% efficiency = <u>useful</u> power out / (total) power in (× 100)	**C1**
	= 1200 / (230 × 7.0) (×100) = 0.75 (× 100) = 75% or 74% (using 3 s.f. value from **(v)** gives 74%)	**A1**

Q5.

(a)(i)	work done per unit time	**B1**

Q6.

(b)(i)	resultant force (on block) is zero	**B1**
	(so) velocity is constant	**B1**
(b)(ii)	$P = Fv$ **or** $P = Fs / t$	**C1**
	$v = 2.0 / 0.80$ (= 2.5 m s^{-1})	**C1**
	distance = 2.5 × 3.0 = 7.5 m	**A1**
	or	
	$P = W / t$ **or** $P = Fs / t$	**(C1)**
	$W = 2.0 \times 3.0$ (= 6.0 J)	**(C1)**
	distance = 6.0 / 0.80 = 7.5 m	**(A1)**

Q7.

(c)(ii)	$F \times 0.53 = 0.048 - 0.039$	**C1**
	$F = 0.02$ N	**A1**

Q8.

(a)(i)	work (done) / time (taken)	**B1**
(a)(ii)	$W = Fx$ **or** $E = Fx$	**B1**
	($P =$) $Fx / t = Fv$ **or** $P = Fvt / t = Fv$	**B1**
(b)(ii)	speed = 56 / 82 = 0.68 m s^{-1}	**A1**
(b)(iii)	no change in kinetic energy (of block)	**B1**
(b)(iv)	(input power) = 56 / 0.80 (= 70 W)	**C1**
	time taken = $1.2 \times 10^3 / 70$ = 17 s	**A1**
	or	
	(useful energy) = 1200 × 80 / 100 (= 960 J)	**(C1)**
	time taken = 960 / 56 = 17 s	**(A1)**

Q9.

(a)(i)	work done per unit time	**B1**
(a)(ii)	$W = Fs$	**B1**
	$P = Fs / t$ and (so) $P = Fv$	**B1**
(b)	(F =) $130 \times 10^3 / 25 = 5200$ (N)	**A1**
(c)(ii)	F (along slope due to weight) $= 36\,000 \times 9.81 \times \sin 1.4°$ $(= 8600$ N)	**C1**
	(total) $F = 5200 + 36\,000 \times 9.81 \times \sin 1.4°$ $(= 13\,800$ N)	**C1**
	$P = 13\,800 \times 25$ $= 350 \times 10^3$ (W) $= 350$ kW	**A1**

Q10.

(a)	force × displacement in the direction of the force	**B1**

Q11.

(a)(i)	$P = Fv$	**C1**
	$= 18 \times 1.4$ $= 25$ W	**A1**
(b)(ii)	$W = 54 \times 9.5$ $= 510$ J	**A1**
(b)(iii)	curved line from the origin	**M1**
	gradient of line increases	**A1**

Q12.

(b)	(work =) 960 – 540 (= 420 J)	**C1**
	distance moved = (960 – 540) / 52 = 8.1 m	**A1**

Q13.

(a)	work (done) / time (taken)	**B1**
(b)(ii)	work done $= 440 \times 25$ $= 1.1 \times 10^4$ J	**A1**
(d)	work done = $4.8 \times 10^4 + 1.1 \times 10^4$ ($= 5.9 \times 10^4$ J)	**C1**
	time $= 5.9 \times 10^4 / 1.7 \times 10^4$ = 3.5 s	**A1**

Q14.

(b)	$P = EI$ **or** $P = VI$ **or** $P = I^2R$ **or** $P = V^2 / R$	**C1**
	$0.80^2 \times 0.40$ (= 0.256 W) **or** 0.48×0.80 (= 0.384 W)	**C1**
	efficiency = $(0.256 / 0.384) \times 100$ = 67%	**A1**

Q15.

(c)(iii)	gravitational potential energy to thermal/internal energy	**B1**

Q16.

(c)	$P = Fv$	**C1**
	$4.8 \times 10^4 = 0.24 \times 5.1 \times v^3$	**C1**
	$v = 34$ m s^{-1}	**A1**

Q17.

(a)	(work done =) force × displacement in direction of the force	**B1**
(b)(ii)	work done = 320 – 110 (= 210 N)	**C1**
	average resistive force = 210 / 78 = 2.7 N	**A1**

Q18.

(b)(i)	efficiency = $(0.72 / 0.81) \times 100$ = 89%	**A1**
(c)(ii)	$F = (0.72 – 0.60) / 3.1$	**C1**
	= 0.039 N	**A1**

Q19.

(b)(i)	kinetic energy = 0.80 – 0.64 = 0.16 J	**A1**

Q20.

(d)(i)	E = 0.055 – 0.030 = 0.025 J	**A1**

Q21.

(b)	5.6 MeV = $5.6 \times 1.60 \times 10^{-19} \times 10^{6}$ (= 8.96×10^{-13} J)	**C1**
	number = $0.15 / (5.6 \times 1.60 \times 10^{-13})$ = 1.7×10^{11}	**A1**
	or	
	0.15 W = $0.15 / (1.60 \times 10^{-19} \times 10^{6})$ (= 9.38×10^{11} MeV s^{-1})	**(C1)**
	number = $9.38 \times 10^{11} / 5.6$ = 1.7×10^{11}	**(A1)**

Q22.

(c)(ii)	$P = Fv$	**C1**
	= 360×0.020 = 7.2 W	**A1**
(d)(i)	upthrust decreases	**B1**
	tension (in wire) increases	**M1**
	power (output of motor) increases	**A1**
(d)(ii)	there is work done (on the cylinder) by the upthrust **or** GPE of oil decreases (as it fills the space left by cylinder and so total energy is conserved)	**B1**

Q23.

(a)(i)	work (done) / time (taken)	**B1**
(b)(i)	$P = Fv$	**C1**
	= $2.0 \times 10^{3} \times 45$ = 9.0×10^{4} W	**A1**
(b)(ii)	**1.** $W = (2.0 \times 10^{3}) \times (45 \times 3.0 \times 60)$ **or** $W = 9.0 \times 10^{4} \times 3.0 \times 60$	**C1**
	$W = 1.6 \times 10^{7}$ J	**A1**
	2. $(\Delta)E_P = mg(\Delta)h$	**C1**
	= $1200 \times 9.81 \times 3.3 \times 3.0 \times 60$ = 7.0×10^{6} J	**A1**
	3. $W = 1.6 \times 10^{7} - 7.0 \times 10^{6}$ = 9.0×10^{6} J	**A1**
(b)(iii)	force = $(9.0 \times 10^{6}) / (45 \times 3.0 \times 60)$ = 1.1×10^{3} N	**A1**

Q24.

(b)(iii)	$P = EI$ **or** $P = VI$ **or** $P = I^2R$ **or** $P = V^2/R$	**C1**
	efficiency = $[(0.50^2 \times 6.0) / (7.0 \times 0.50)]$ ($\times 100$) **or** efficiency = $[(0.50 \times 3.0) / (7.0 \times 0.50)]$ ($\times 100$) **or** efficiency = $[(3.0^2 / 6.0) / (7.0 \times 0.50)]$ ($\times 100$)	**C1**
	efficiency = 43%	**A1**