1 **(a** (mass flow rate =) 1030 (kg/s)
use of *mgh* C1
loss of GPE = 1030 × 10 × 3 = 30 900 J or Nm ecf from 1st line A1 [3]

(b) output power = (26 × 400 =) 10 400 (W)
efficiency = output (power)/input (power) with/without 100
OR= output/input with/without 100 OR any numbers
that clearly show relationship the correct way up is intended C1
efficiency = (100 × 10 400/30 900 =) 33.7% at least 2 s.f. A1 [3]
allow ecf from **(a)** and 1st line of **(b)**

(c) **(i)** from basin/to sea/from right/to left B1

(ii) turbine design allows rotation in both directions
OR meaningful comment on change of pitch
OR generator works when rotating in either direction B1 [2]

[Total: 8]

2 **(a)** M = V × D in any form OR $10^3 \times 10^3$ C1
1 kg A1

(b) mgh OR his **(a)** × 10 × 0.8 C1
8 J (Nm) OR 7.85 J OR 7.84 J e.c.f. from **(a)** A1

(c) P = E/t OR (his 8 × 90) / 60 e.c.f. from **(b)** C1
12 W (J/s or Nm/s) OR 11.77 W OR 11.76 W A1

(d) ρgh in any form, words, letters, numbers C1
8000 Pa (N/m^2) OR 7850 Pa OR 7840 Pa A1 [8]

3 **(a** measuring cylinder with liquid B1
immerse statue B1
volume from difference of readings from measuring cylinder B1
OR
displacement can/equivalent/beaker, filled to overflowing with liquid (B1)
immerse statue (B1)
measure volume displaced with measuring cylinder (B1)

(b) (D =) M/V OR 600/65 B1
9.23 g/cm^3 (minimum 2 s.f.) N.B. unit penalty applies B1
OR
(For gold) (M =) V × D OR 65 × 19 (B1)
1235 g (minimum 2 s.f.) N.B. unit penalty applies (B1)
OR
(For gold) (V =) M / D OR 600/19 (B1)
31.6 cm^3 (minimum 2 s.f.) N.B. unit penalty applies (B1)

'NO' ticked if justified by previous work in **(a)** or **(b)**.
e.c.f from wrong values abo B1

[6]

4 **(a)** pressure = hdg or 20 x 1000 x 10 **1**
= 2 x 10^5 Pa **1** **2**

(b) force = pressure x area or 2 x 10^5 x 0.5 e.c.f. **1**
= 1 x 10^5 N **1** **2**

(c) potential energy (at water surface) **1**
changed to kinetic energy (at pipe exit) **1** **2**
(6)

5 **(a** Example: e.g. battery: (chemical to) electrical
engine: (chemical to) kinetic / mechanical
fire: (chemical to) thermal / heat
(human) body: (chemical to) heat / kinetic B1

(b) (i) (P =) IV OR in words OR 0.27 × 17 C1
= 4.59 W at least 2 s.f. A1

(ii) (K.E. =) efficiency × input OR 0.35 × 4.59 C1
= 1.61 J or Nm at least 2 s.f. A1

(iii) **1.** $d = m/V$ OR (m =) $V \times d$ OR in words OR 0.00014 × 1000 C1
= 0.14 kg

2. P.E. gained = K.E. lost OR $mgh = ½\ mv^2$
OR 0.14 × 10 × h = 1.61 OR 1.6 C1
h = 1.15 m OR 1.14 m at least 2 s.f. A1

OR
$½\ mv^2 = 1.61$ OR
$v^2 = 2 \times 1.61 / 0.14 = 23$ OR $v^2 = 2 \times 1.6 / 0.14 = 22.86$ (C1)
(h =) $v^2/2g = 23/20 = 1.15$ m OR (h =) 22.86/20 = 1.14 m (A1)

[Total: 9]

6 **(a (i)** t = v/g or 32/10 C1
= 3.2 s A1

(ii) straight line starting at zero, inclined C1
line joining 0,0 and 3.2, 32, accept c.f. from time **(i)** A1

(iii) 2.4 kg A1 [5]

(b) (i) take volume of water before use B1
(totally) immerse stone and take new volume B1
(Not clearly measured before and after C1)

(ii) hang rock from balance and take reading B1

(iii) density = mass/volume B1

(iv) need to tie "sinker" or cork or press cork down B1
need volume with sinker then volume with sinker and cork or just completely submerge cork B1 [6]

[Total: 11]

7	**(a)**	one mark for each labelled diagram both diagrams sensible but no labels max 1	**2**	**2**	
	(b)	newtons/10 is kg or equivalent	**1**	**1**	
	(c)	volume/level/reading of water then volume etc. water + rock	**1**	**1**	
	(d)	difference in the two readings	**1**	**1**	
	(e)	density = mass/volume	**1**	**1**	
				(6)	

8	a(i)	outline, ruler pivoted (at centre), mass one side, rock other side		C1	
		quality set-up, each mass at (marked) point + labels	2	A1	
	(ii)	~~rod must be balanced before readings can be taken or record mass as 100 g~~		~~B1~~	
		distance to pivot from rock ~~and mass~~ B1 distance pivot to mass B1		B2	
		mass or 100 x distance to pivot = mass of rock x distance rock to pivot	3	B1	5
	b	put water in cylinder, read value		B1	
		insert rock until covered, read value		B1	
		difference in values is volume of rock	2	B1 M2	
	c	density = mass/volume or 88/24		C1	
		= 3.7 g/cm^3 (accept 3 3/3 g/cm^3)	2	A1	2
				QT	9