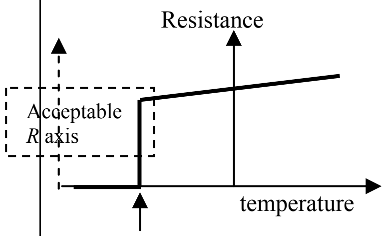
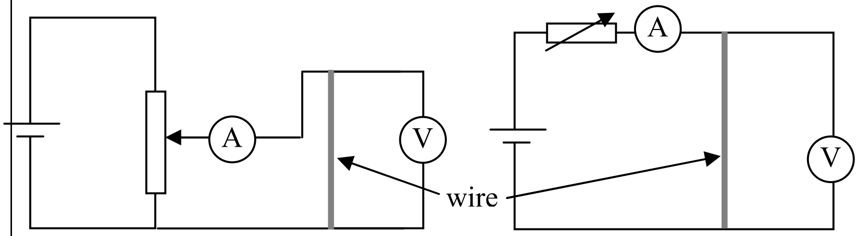
PH1

<table>
<tr><th colspan="3">Question</th><th>Marking details</th><th>Marks Available</th></tr>
<tr><td>1</td><td>(a)</td><td>(i)</td><td>Vectors have magnitude and direction; scalars have only magnitude
[Reference to vectors and scalars required for complete answer, e.g. vectors have direction and scalars do not is enough]</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td><table><tr><th>Vector</th><th>Scalar</th></tr><tr><td>velocity
force</td><td>distance
time
temperature
density</td></tr></table>All correct → 2
One incorrect → 1
Two or more incorrect → 0</td><td>2</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>1600 cos 25° (1) = 1450 N (1)</td><td>2</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Long (1) because greater component in the direction of motion (1)
[NB Decrease angle only – not enough. 2nd mark for reference to component either in direction of motion or perpendicular to it]</td><td>2

[7]</td></tr>
<tr><td>2.</td><td>(a)</td><td></td><td>No net / resultant force [accept ‘total’](1)
No net / resultant moment (1)
[1 mark max if ‘net’ or equiv missing]</td><td>2</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Downward vertical arrow indicated ± 1 cm of centre of bar [halfway between 30 N and 25 N forces], labelled 20 N</td><td>1</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>$T_A \times 3(1) = 20 \times 1.5(1) + 40 \times 2.35 + 30 \times 1.75 + 25 \times 0.85\,(1)$
[Note: LHS →(1); RHS: moment of bar (1), all other moments (1)]
T_A = 65.9 N (1)</td><td>4</td></tr>
<tr><td></td><td></td><td>(iii)</td><td>115 N (1) – 65.9 N (e.c.f.) = 49.1 N (1)
[Accept solution based on taking moments about chain A or other equiv method]</td><td>2

[9]</td></tr>
</table>

Question			Marking details	Marks Available
3	*(a)*		A material which has zero [electrical] resistance [or equiv.]	1
	(b)		 Axes (1) Line (not nec straight above T_C)(1) Temperature at which resistance [of material] drops [suddenly] to zero [or label on graph] (1)	3
	(c)		No [accept little] heat [accept energy] lost / generated (1) [Accept – large current can be produced from zero /small pd] Any application, e.g. nuclear fusion / tokamaks, particle accelerators / LHC, MRI scanners / large motors or generators (1)	2 **[6]**
4.	*(a)*		 Wire in functioning circuit with both meters correctly connected (1) Method of varying current / pd (1)	2
	(b)	(i)	Resistance values / Ω: 4.00,4.00, 4.33, 4.75, 6.00 [all correct]	1
		(ii)	Graph: Axes [scales, labels, units] (1), plots (1) line (1) [axes – no s.f. penalty; line – produced to *R* axis – accept extrapolation]	3
	(c)	(i)	0 → 0.2 A [‘at start’, ‘to begin with’] no change / constant (1) 0.2 A → 0.5 A [‘then’] increas<u>ing</u> with current (1)	2
		(ii)	0 → 0.2 A [e.c.f. from graph]	1
		(iii)	Temperature wire not constant / increases [accept changes] [with current]	1
	(d)		Current / ammeter reading would [rapidly rise from 0 then] decrease (1) and then stabilise (1)	2 **[12]**

Question			Marking details	Marks Available
5.	*(a)*		E = total energy transferred [per unit charge passed] in the source (1) V = energy [per unit charge passed] converted [accept 'lost'] in the internal resistance (1) Correct use of "per unit charge" in definitions of both E and V. (1)	3
	(b)	(i)	$Q = 0.22 \times 3600$ [= 792 C]	1
		(ii)	$E = \dfrac{4750}{792(\text{e.c.f.})}$ [= 6.0 V]	1
		(iii)	$V = \dfrac{4500}{792(\text{e.c.f.})}$ (1) [= 5.7 V] or $\left[P = \dfrac{4500}{3600} = 1.25W. V = \dfrac{1.25}{0.22} = 5.7\right]$ V	1
		(iv)	r = 0.3 V [= ans (ii) – ans (iii) e.c.f.]	1
		(v)	0.32 (e.c.f.) = 0.22 r (1) [or by impl] r = 1.45 Ω (1) [e.c.f. based upon (i) to (iv)]	2
				[9]
6	*(a)*		Accept answers in range [–] 9.6 to [–] 10.0 [m/s^2] [no unit or sign penalty] (1) Acceleration <u>due to gravity</u> (1)	2
	(b)		4.0 m s^{-1} [accept 3.9 or 4]	1
	(c)		[Constant] deceleration from 4 m s^{-1} to zero / rest in 0.4[1] s (1) [Constant] accel from rest to – 4 m s^{-1} from 0.4[1] s to 0.8[2] s (1) [Momentarily] stationary [or at its max height] at 0.4[1] s (1) [NB or equivalent wordings to the same effect]	3
	(d)	(i)	Area shaded between graph and abscissa from 0.8[2] to 3.2 s	1
		(ii)	Shaded area: ½ × 2.8 × 2.7 – ½ × 0.4 × 4 (1) = 37 m (1) [or ½ (4 + 27) × (3.2 – 0.8) (1) = 37.2 m (1) or equiv. using equations of motion, eg. $x = ut + \frac{1}{2}at^2$] [37.5 ± 1.5✓]	2
			Directly beneath (1) <u>Horizontal</u> speed constant (1) ….because .. <u>no</u> <u>horizontal</u> force[s] acting on stone (1) [NB 'no' required; horizontal only needed once]	3
				[12]

Question			Marking details	Marks Available
7.	*(a)*	(i)	Force × distance (1) moved in direction of force (1) [or equiv, eg component of force in direction of movement × distance moved, or $\underline{W = Fd}$ (1) $\underline{\cos\theta}$ (1) - explanation for 2nd mark] [Work is done when a force moves its point of application → 1 only]	2
		(ii)	kg m s^{-2} (1) × m → kg m^2 s^{-2} (1)	2
	(b)	(i)	E_P lost = 70 × 9.81 × $\underline{120 \sin 20°}$ (1) [or by impl.] = 28 000 J [28148] (1) [Use of 10 for g – 1st mark lost]	2
		(ii)	At A, E_k = ½ × 70 × 6^2 (1) [= 1260 J] At B, E_k = ½ × 70 × 21^2 (1) [=15435 J] ΔE_k = 14175 J (1) [If $(21 – 6)^2$ calculated → 1 mark only]	3
	(c)	(i)	Energy cannot be created or destroyed only changed from one form to another	1
		(ii)	Energy is converted to [accept: lost as] internal energy heat / sound / ke of air (1) Detail: Molecules of air gain E_k as skier moves / molecules of of snow / skis gain E_k / vibrational energy (1)	2
	(d)		Use of $W = Fd$ (1) [or by impl.] 28184 – 14175 (1) (e.c.f. on both) = F × $\underline{120}$ (1) [or by impl.] F = 117 N (1) [Accept answer based upon force components]	4 **[16]**

Question			Marking details	Marks Available
8	*(a)*		[A conductor is] a material through which charge / electrons [accept ions / holes] can flow / move **or** which contains free / delocalised electrons.	1
	(b)	(i)	Volume = $2.0 \times 10^{-6} \times 2.0$ (1) [or by impl] mass = $8920 \times 4.0 \times 10^{-6}$ (1) [= 0.0357 kg] ((**unit**))	2
		(ii)	$\frac{0.0357\text{(e.c.f.)}}{1.05\times10^{25}}$ (1) $\underline{\times 1.5}$ (1) [= 5.1×10^{23} electrons]	2
		(iii)	$n = \frac{5.1\times10^{23}\text{(e.c.f.)}}{4.0\times10^{-6}\text{(e.c.f.)}}$ (1) [= 1.28×10^{29} m^{-3}] $v = \frac{I}{nAe}$ [manipulation at any stage] (1) $v = \frac{1.2}{1.28\times10^{29}\times2.0\times10^{-6}\times1.6\times10^{-19}}$ (subst) (1) [e.c.f. on n] $v = 2.9 \times 10^{-5}$ m s^{-1} (1) [NB use of 5.1×10^{23} for $n \rightarrow 7.3(5)$ m s^{-1}]	4
				[9]