Question			Marking details	Marks Available
1	*(a)*	(i)	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]	1
		(ii)	Vector: velocity, force; Scalar: distance, time, temperature, density All correct → 2 One incorrect → 1 Two or more incorrect → 0	2
	(b)	(i)	1600 cos 25° (1) = 1450 N (1)	2
		(ii)	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]	2
				[7]
2.	*(a)*		No net / resultant force [accept 'total'](1) No net / resultant moment (1) [1 mark max if 'net' or equiv missing]	2
	(b)	(i)	Downward vertical arrow indicated ± 1 cm of centre of bar [halfway between 30 N and 25 N forces], labelled 20 N	1
		(ii)	$T_A \times 3(1) = 20\times 1.5(1) + 40\times 2.35 + 30\times 1.75 + 25\times 0.85\,(1)$ [Note: LHS →(1); RHS: moment of bar (1), all other moments (1)] T_A = 65.9 N (1)	4
		(iii)	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]	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 × <u>120 sin 20°</u> (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)		<u>Use</u> of $W = Fd$ (1) [or by impl.] 28184 – 14175 (1) (e.c.f. on both) = F × <u>120</u> (1) [or by impl.] F = 117 N (1) [Accept answer based upon force components]	4 **[16]**

6	*(a)*		A surface / body that absorbs all radiation incident / falling on it.	1
	(b)		$\lambda_{\mathrm{I\,max}} = 250$ [± 10] nm (1) $T = \dfrac{W}{\lambda_{\mathrm{I\,max}}}$ (1)[<u>thus</u> or by impl.] = 11500 K (1) [e.c.f. on $\lambda_{\mathrm{I\,max}}$]	3
	(c)	(i)	$A = \dfrac{\text{power}}{\sigma T^4}$ [transposition at any stage] (1) $= \dfrac{2.53\times 10^{31}}{5.67\times 10^{-8}\times 11500^4}$ (e.c.f.) (1) = 2.55×10^{22} m^2 ((**unit**)) [e.c.f. on *T*, e.g. 10^4 K → 4.46×10^{22} m^2]	3
	(d)	(ii)	**Either** $A_{\mathrm{Sun}} = 4\pi r_{\mathrm{Sun}}^{\ 2}$ [or by impl.] (1) $= 6.1 \times 10^{18}$ m^2 « A_{Rigel} (1) e.c.f over slips in 4 or π **Or** $r_{\mathrm{Rigel}} = A_{\mathrm{Rigel}} / 4\pi$ (1) $= 4.5 \times 10^{10}$ m » r_{Sun} (1) e.c.f over slips in 4 or π	2
		(iii)	Spectral intensity higher at 400 nm than at 700 nm (1) 400 nm is at violet end of visible spectrum (1) [or converse] <u>So</u> Rigel <u>not</u> a red giant [Not a freestanding mark] [NB – "Peak closer to violet than red," unsupported by figures, loses first mark]	3 **[12]**

Question			Marking details	Marks Available
7.	*(a)*	(i)	e	1
		(ii)	zero	1
	(b)		baryon	1
	(c)		p = uud (1) u quark number for x = 4 – 3 [= 1][or equiv] (1) d quark number for x = 2 – 1 – (–1) [=2] [or equiv] (1) So x is a neutron (1) [or Δ^0]	4
	(d)		Lepton number zero before and after	1
	(e)		Any 1 × (1) of • High KE means short contact time ✓ • u and d numbers separately conserved [so not weak] ✓ • no γ involvement [suggests not e-m] ✓ So strong (1)	2
				[10]

Solids under stress

a) Take a wire of the material
Clamp at top and suspend a weight from the bottom of the wire
Draw diagram of setup
Measure diameter
Using vernier callipers
Measure length
When adding weight, measure extension
Calculate cross sectional area of wire
Calculate force applied

Use E = stress/strain

b) Start with E = stress/strain
Use energy stored = ½ Fx
Substitute for Force and extension using formulae for stress and strain
Use fact that energy stored PER unit volume means divide expression by (length times cross sectional area) which
gives desired result.