AS physics EOS mark scheme

1.

(a)	energy is dissipated in the internal resistance	**B1**
(b)	$E = V + Ir$	**B1**
(c)(i)	(graph shows) maximum value of potential difference is 2.8 (V) **or** (graph shows) when current/I (from battery) is zero, V is 2.8 (V) / E	**B1**
(c)(ii)	r = (–)gradient **or** $r = (E - V) / I$ **or** substituted values from the graph for E, V and I	**C1**
	$r = 1.4\,\Omega$	**A1**
(d)(i)	$R = 2.1 / 0.50$ $= 4.2\,\Omega$	**A1**
(d)(ii)	number $= 0.50 / 1.60 \times 10^{-19}$ $= 3.1 \times 10^{18}$	**A1**
(d)(iii)	energy $= EIt$ **or** $P = EI$ **and** $P = W / t$	**C1**
	$(9.2 - 1.6) \times 10^{3} = 2.8 \times 0.50 \times t$	**C1**
	$t = 5.4 \times 10^{3}$ s	**A1**

(a) there are no lost volts / energy lost in the battery
or there are no lost volts / energy lost in the internal resistance

(b) the current / I decreases (as R increases)
p.d. decreases (as R increases)

or

the parallel resistance (of X and R) increases
p.d. across parallel resistors increases, so p.d. (across Y) decreases

(c) **(i)** current = 2.4 (A)
p.d. across AB = 24 – 2.4 × 6 = 9.6 V

or

total resistance = 10 Ω (= 24 V / 2.4 A)
(parallel resistance = 4 Ω), p.d. = 24 × (4 / 10) = 9.6 V

(ii) R (AB) = 9.6 / 2.4 = 4.0 Ω
1 / 6 + 1 / X = 1 / 4 [must correctly substitute for R]
X = 12 Ω

or

I_R = 9.6 / 6.0 = 1.6 (A)
I_X = 2.4 – 1.6 = 0.8 (A)
X (= 9.6 / 0.8) = 12 Ω

(iii) power = VI *or* EI *or* V^2/R *or* E^2/R *or* I^2R
= 24 × 2.4 *or* $(24)^2/10$ *or* $(2.4)^2 \times 10$
= 57.6 W (allow 2 or more s.f.)

(d) power decreases

e.m.f. constant or power = 24 × current, and current decreases
or e.m.f. constant or power = 24^2 / resistance, and resistance increases

3.

(a)	$I_1 + I_2 = I_3$ [any subject]	**B1**
(b)	$E_1 + E_3 = I_1R_1 + I_3R_3 + I_3R_4$ [any subject]	**B1**
(c)	$E_1 - E_2 = I_1R_1 - I_2R_2$ [any subject]	**B1**

4.

(a)	E = stress / strain **or** $(F / A) / (e / l)$
	$= [\text{gradient} \times 3.5] / [\pi \times (0.19 \times 10^{-3})^2]$ e.g. $E = [\{(40 - 5) / ([11.6 - 3.2] \times 10^{-3})\} \times 3.5] / [\pi \times (0.19 \times 10^{-3})^2]$ **or** $[4170 \times 3.5] / [\pi \times (0.19 \times 10^{-3})^2]$
	E (= 1.3×10^{11}) = 0.13 TPa (*allow answers in range 0.120–0.136 TPa*)
(b)	a larger range of F required **or** range greater than 35 N

5.

(a)	$k = F / x$ **or** k = gradient	**C1**
	e.g. $k = 4.0 / 0.050$ $k = 80\ \text{N m}^{-1}$	**A1**
(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**
	$v = [(2 \times 0.025) / 0.122]^{0.5}$ $= 0.64\ \text{m s}^{-1}$	**A1**

6.

(a)(i)	$p = mv$	**C1**
	$= 0.2(00) \times 6.(00) \times \sin 60(.0)°$ **or** $0.2(00) \times 6.(00) \times \cos 30(.0)°$ $= 1.04\ \text{kg m s}^{-1}$	**A1**
(a)(ii)	$0.300 \times v_x \times \sin 60.0° = 1.04$ $v_x = 4.00\ \text{m s}^{-1}$	**A1**
(a)(iii)	$0.30 \times 4.0 \times \cos 60°$ **or** $0.20 \times 6.0 \times \cos 60°$ **or** $(0.30 + 0.20)v$ **or** $0.50v$	**C1**
	$0.30 \times 4.0 \times \cos 60° + 0.20 \times 6.0 \times \cos 60° = (0.30 + 0.20)v$ **or** $0.50v$ so $v = 2.4\ \text{m s}^{-1}$	**A1**
(b)(i)	$E = ½mv^2$	**C1**
	$½ \times 0.50 \times 2.4^2 = ½ \times 72 \times x^2$	**C1**
	$x = 0.20\ \text{m}$	**A1**
(b)(ii)	**1.** straight line from the origin sloping upwards	**B1**
	2. line drawn from a positive value of E_k at $x = 0$ to a positive value of x at $E_k = 0$	**M1**
	line has an increasing downwards slope	**A1**

7.

(a) $$\frac{V}{t} = \frac{\pi P r^4}{8 C l}$$

$C = [\pi \times 2.5 \times 10^3 \times (0.75 \times 10^{-3})^4] / (8 \times 1.2 \times 10^{-6} \times 0.25)$

$= 1.04 \times 10^{-3}\ \text{N s m}^{-2}$

(b) $4 \times \%r$

$\%C = \%P + 4 \times \%r + \%V/t + \%l$

$= 2\% + 5.3\% + 0.83\% + 0.4\%\ (= 8.6\%)$

$\Delta C = \pm 0.089 \times 10^{-3}\ \text{N s m}^{-2}$

(c) $C = (1.04 \pm 0.09) \times 10^{-3}\ \text{N s m}^{-2}$

8.

(a) resistance = potential difference / current

(b) **(i)** metal wire in series with power supply and ammeter
voltmeter in parallel with metal wire
rheostat in series with power supply or potential divider arrangement or variable power supply

(ii) **1.** intercept on graph

2. scatter of readings about the best fit line

(iii) correction for zero error explained
use of V and corrected I values from graph
resistance = V / I = 22.(2) Ω [e.g. 4.0 / 0.18]

(c) $R = 6.8 / 0.64 = 10.625$

$\%R = \%V + \%I$
$= (0.1 / 6.8) \times 100 + (0.01 / 0.64) \times 100$
$= 1.47\% + 1.56\%$
$\Delta R = 0.0303 \times 10.625 = 0.32\,\Omega$
$R = 10.6 \pm 0.3\,\Omega$

9.

(a) the point where (all) the weight (of the body) is considered / seems to act

(b) **(i)** vertical component of T (= 30 cos 40°) = 23 N

(ii) the sum of the clockwise moments about a point equals the sum of the anticlockwise moments (about the same point)

(iii) (moments about A): 23 × 1.2 (27.58)
= 8.5 × 0.60 + 1.2 × W
working to show W = 19 or answer of 18.73 (N)

(iv) ($M = W / g$ = 18.73 / 9.81 =) 1.9(09) kg

10.

(a)	$p = 1000 \times 9.81 \times 7.0 \times 10^{-2}$ **or** $1000 \times 9.81 \times 1.9 \times 10^{-2}$	**C1**
	$\Delta p = 1000 \times 9.81 \times (7.0 \times 10^{-2} - 1.9 \times 10^{-2})$ **or** $686 - 186$ $= 500$ Pa	**A1**
(b)	$F = pA$ **or** $(\Delta)F = \Delta p \times A$	**C1**
	upthrust $= 500 \times (5.1 \times 10^{-2})^2 = 1.3$ N **or** upthrust $= (686 - 186) \times (5.1 \times 10^{-2})^2 = 1.3$ N **or** upthrust $= 1000 \times 9.81 \times 5.1 \times 10^{-2} \times (5.1 \times 10^{-2})^2 = 1.3$ N	**A1**
(c)	force $= 4.0 - 1.3$ $= 2.7$ N	**A1**

(d)	extension/x/e $= 2.7/30$	**C1**
	$= 0.09$ (m) **or** 9 (cm)	**C1**
	height above surface $= 9 - 7$ $= 2$ cm	**A1**
(e)(i)	mass $= 4.0/9.81$	**C1**
	acceleration $= 2.7/(4.0/9.81)$ $= 6.6\,\text{m s}^{-2}$	**A1**
(e)(ii)	viscous force <u>increases</u> (and then becomes constant)	**M1**
	(weight and upthrust constant so) acceleration decreases (to zero)	**A1**

11.

(a)	force $\times$ <u>perpendicular</u> distance (of line of action of force) to/from a point	**B1**
(b)(i)	$2.4r$ **or** $(1.2 \times 2r)$ **or** $(1.2r + 1.2r)$	**A1**
(b)(ii)	(anticlockwise moment =) $6.0 \times r/2 \times \sin\theta$	**C1**
	$6.0 \times r/2 \times \sin\theta = 2.4r$ $\theta = 53°$	**A1**
(b)(iii)	6.0 N	**A1**

12.

(a) work done is force $\times$ distance moved in direction of force
or
no work done along PQ as no displacement/distance moved in direction of force

work done is same in vertical direction as same distance moved in direction of force

(b) **(i)** at maximum height $t = 1.5\,(\text{s})$ **or** $s = \frac{1}{2}(u + v)\,t$, $s = 11\,\text{m}$ and $t = 1.5\,\text{s}$

$V_v = 0 + 9.81 \times 1.5$ $V_v = (11 \times 2) / 1.5$

$= 15\ (14.7)\,\text{m}\,\text{s}^{-1}$

(ii) straight line from (0,0) to (3.00, 25.5)

(iii) at maximum height $V_h = 25.5/3$ (= $8.5\,\text{m}\,\text{s}^{-1}$)

ratio $= mgh / \frac{1}{2}mv^2$

$= (2 \times 9.81 \times 11.0)/(8.5)^2$

$= 3.0\ (2.99)$

(iv) deceleration is greater/resultant force (weight and friction force) is greater

time is less

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