PreDP revision questions Answers for Section B of the exam

Unit 3 and 4: Forces and Pressure + Forces and Energy

(a)	**(i)**	$P = F/A$ in any form, letters, words or numbers	C1	
		1.4×10^6 Pa accept N/m^2	A1	
	(ii)	84 N OR 84.0 N	B1	
	(iii)	same force over (much) smaller area	B1	
		(much) bigger pressure	B1	
(b)	**(i)**	$P = hdg$ in any form, letters, words or numbers	C1	
		3×10^4 Pa OR 30 000 Pa OR 30 kPa accept N/m^2	A1	
	(ii)	his **(i)**	B1	[8]

(a)	5 points correctly plotted ±½ small square –1 e.e.o.o. (ignore 0,0)	B2
(b)	3 N one, however identified OR 3rd value OR 4th value	B1
(c)	good straight line through origin and candidate's remaining points	B1
(d)	straight line / constant gradient	M1
	does obey Hooke's Law	A1
	OR	
	special case: obeys Hooke's law because force $\propto$ extension or wtte	B1

(a) Mark **(i)** and **(ii)** together. Note <u>both</u> M1s required to score the A1 mark

(i)	B	M1
(ii)	idea of greater / different (NOT less) increase in length for each additional load accept load not proportional to extension or reverse argument	M1
	at 4th or 5th reading / value between 2.0 – 2.5 N / 11.6 – 12.6 cm	A1

(b) **(i)** 1.0 cm B1

(ii) 5.7 cm B1

(c) 2.5 (cm) OR 1.25 (N) OR 5.0(cm) ignore 2.5N e.c.f. from **(b)** if clear C1
8.2 cm e.c.f. from **(b)** if clear A1
e.g. 10.7/2 (= 5.35) scores 0/2 [7]

(a) all four = 40 N OR all four add up to 160 N B1
upwards B1

(b) **(i)** $W \times 0.17/0.20/0.23 = 160 \times 0.72/0.75/0.78$ C1
$W \times 0.17 = 160 \times 0.78$ **or** 600 N C1
730/734 N A1

(ii) force by P = 160 + answer to **(i)** correctly evaluated B1

all others = 0 B1

(a) **(i)** (P =) F/A in any form OR 1000/0.01 C1
100 000 Pa accept N/m^2 A1

(ii) multiplication of either force or area by 4 C1
0.08 × his **(i)** OR 0.02 × his **(i)** C1
8000 N e.c.f. from **(i)** A1
(2000 N gets C0, C1, A1)

(b) his **(ii)** – 2000 correctly evaluated C1
600 kg e.c.f. A1

(a) **(i)** 120 Ncm OR 1.2 Nm B1

(ii) 60 Ncm OR 0.6 Nm B1

(iii) idea of CW moments = ACW moments C1
60 + 20F = 120 OR 0.6 + 0.2F = 1.2 e.c.f. C1
3.0 N OR 3 N e.c.f. A1

(b) 1.2 × 20 = 2.0 × d OR 1.2 × 0.2 = 2.0 × d C1
(d =) 12 OR 0.12 C1
18 c.a.o. OR special case (30 – his 12) correctly evaluated B1 A1

(a) ρgh in symbols, words or numbers C1
700 Pa or N/m^2 A1 [2]

(b) <u>use of</u> $F = pA$ C1
14.7 N ecf from **(a)** A1 [2]

(c) (30.9 – 14.7 =)16.2 N OR evidence of calculation of resultant C1
<u>use of</u> $a = F/m$ C1
5.24 m/s^2 A1 [3]

(a)	mass = (1.5 × 10 × 12)/(30 × 10) OR = (1.5 × 12)/30 OR any correct moment equation with force or mass but not mixture = 0.6(0) kg	C1 A1	 [2]
(b)	21 N ecf from **(a)**	B1	[1]
(c)	**(i)** stays in position	B1	
	(ii) any two from: • clockwise moment = anticlockwise moment • centre of mass at pivot • no (resultant) moment/turning force acting on sculpture • balanced/in equilibrium • relative distances from pivot unchanged	 B1 B1	 [3]

(a)	(p =) F/A OR in words OR 90/4.8 OR 90 / 0.00048 = 18.75 N/cm^2 OR 1.875 × 10^5 Pa OR 187500 Pa OR 187.5 kPa OR 0.1875 MPa at least 2 s.f.	C1 A1
(b)	Area of Y bigger (than area of X so force greater)	B1
(c)	Volume of oil moved at Y = volume of oil moved at X Area of Y × distance moved by Y = Area of X × distance moved by X (so distance move by Y smaller) OR Work done by piston X = work done on piston Y Work = force × distance and F_2 is greater than F_1 so distance moved by Y smaller (than distance moved by X)	B1 B1 (B1) (B1)
(d)	Air bubbles compress when pressure applied More movement of piston X required for same movement of piston Y OR Y moves less (for same movement of X) OR Driver must push the brake pedal further / do more work OR Pressure reduced / force on Y reduced OR System is less efficient	M1 A1

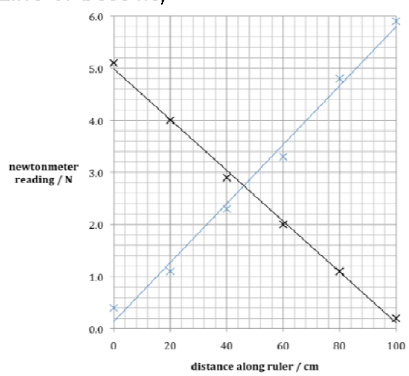
<table>
<tr><td>(a) (i)

(ii)</td><td>A – distance A

D – force D</td><td></td><td>1

1</td></tr>
<tr><td>(b) (i)

(ii)</td><td>Force (C) in N;
or
Force in newtons;

Plotting ;;
Line of best fit;


<table>
<tr><td>0</td><td>5.1</td></tr>
<tr><td>20</td><td>4.0</td></tr>
<tr><td>40</td><td>2.9</td></tr>
<tr><td>60</td><td>2.0</td></tr>
<tr><td>80</td><td>1.1</td></tr>
<tr><td>100</td><td>0.2</td></tr>
</table></td><td>Allow: Reading from newton-meter in N

To nearest ½ square, penalise errors up to two marks
Suited to candidate’s plotting (allow a smooth curve)
no double lines
judge LoBF by balance of points about the line</td><td>1

3</td></tr>
<tr><td>(iii)</td><td>Reading from graph to ± 1 cm;

e.g. 46</td><td>To nearest ½ small square</td><td>1</td></tr>
</table>

<table>
<tr><td>(c)</td><td>weight of ruler;</td><td>Accept other valid reasons
allow
force for weight
ignore
‘it’s got a force acting’
‘because of gravity’</td><td>1</td></tr>
<tr><td></td><td></td><td>Total</td><td>8</td></tr>
</table>

(a) **(i)** force is rate of change of momentum B1

(ii) force on body A is equal in magnitude to force on body B (from A) M1
forces are in opposite directions A1
forces are of the same kind A1

(b) **(i)** 1 $F_A = -F_B$ B1
2 $t_A = t_B$ B1

(ii) $\Delta p = F_A t_A = -F_B t_B$ B1

(c) graph: momentum change occurs at same times for both spheres B1
final momentum of sphere B is to the right M1
and of magnitude 5 N s A1

(a) force = rate of change of momentum (allow symbols if defined)

(b) **(i)** $\Delta p = 140 \times 10^{-3} \times (5.5 + 4.0)$
$= 1.33\ \text{kg m s}^{-1}$

(ii) force $= 1.33 / 0.04$
$= 33.3$ N

(c) **(i)** taking moments about B
$(33 \times 75) + (0.45 \times g \times 25) = F_A \times 20$
$F_A = 129$ N

(ii) $F_B = 33 + 129 + 0.45g$
$= 166$ N

(a) point at which (whole) weight (of body) (allow mass for weight)
appears / seems to act ... (for mass need ‘appears to be concentrated’)

(b) **(i)** point C shown at centre of rectangle ± 5 mm

(ii) arrow vertically downwards, from C with arrow starting from the same margin of error as in **(b)(i)**

(c) **(i)** reaction / upwards / supporting / normal reaction force
friction
force(s) at the rod

(ii) comes to rest with (line of action of) weight acting through rod
allow C vertically below the rod
so that weight does not have a moment about the pivot / rod

(a)	pressure = force / area	B1
(b)	molecules collide with object / surface and rebound	B1
	molecules have change in momentum hence force acts	B1
	fewer molecules per unit volume on top of mountain / temperature is less	
	hence lower speed of molecules	B1
	hence less pressure	A0
(c) **(i)**	$\rho = m / V$	C1
	$W = V\rho g = 0.25 \times 0.45 \times 9.81 \times 13600$	C1
	$= 15000\ (15009)\,\mathrm{N}$	A1
(ii)	$p = W / A$ (or using $p = \rho gh$) $= 15009 / 0.45$	
	$= 3.3 \times 10^4\ \mathrm{Pa}$	A1
(iii)	pressure will be greater due to the air pressure (acting on the surface of the liquid)	B1

(a) **(i)** change of shape / size / length / dimension ....
when (deforming) force is removed, returns to original shape / size

(ii) $L = ke$ ....

(b) $2e$ ....
$½k$ …(*allow e.c.f. from extension*) ....

$½e$ and $2k$ ....

$\frac{3}{2}e$ …(*allow e.c.f. from extension in part 2*) ....
$\frac{2}{3}k$ …(*allow e.c.f. from extension*) ....

(a) ability to do work B1
as a result of a change of shape of an object/stretched etc B1

(b) work = average force ×distance moved (in direction of the force) B1
either work = $½ \times F \times x$
or work is area under F/x graph which is $½Fx$ B1
$F = kx$ B1
so work / energy = $½kx^2$ A0

(c) **(i)** spring constant $= \dfrac{3.8}{2.1}$ M1
$= 1.8\ \text{N cm}^{-1}$ A0

(ii) **1** $\Delta E_P = mg\Delta h$ *or* $W\Delta h$ C1
$= 3.8 \times 1.5 \times 10^{-2}$
$= 0.057\ \text{J}$ A1
2 $\Delta E_S = ½ \times 1.8 \times 10^{-2}\ (0.036^2 - 0.021^2)$ M1
$= 0.077\ \text{J}$ A0
3 work done = $0.077 - 0.057$
$= 0.020\ \text{J}$ A1
(*allow e.c.f. if* $\Delta E_S > \Delta E_P$)

(a) *either* energy (stored)/work done represented by area under graph
or energy = <u>average</u> force × extension ……………………………………………
energy = ½ × 180 × 4.0 × 10^{-2} ……………………………………..……………………
= 3.6 J ………………………………………………………………………………

(b) (i) *either* momentum before release is zero ……………………………………….
so sum of <u>momenta</u> (of trolleys) after release is zero …………………
or force = rate of change of momentum (M1)
force on trolleys equal and opposite (A1)
or impulse = change in momentum (M1)
impulse on each equal and opposite (A1)

(ii) **1** $M_1V_1 = M_2V_2$ …………….…………………………………………..……………

2 $\underline{E} = ½ M_1V_1^2 + ½ M_2V_2^2$ ……………………………………………………………

(iii) **1** $E_K = ½mv^2$ and $p = mv$ combined to give ……………………………………
$E_K = p^2 / 2m$ ………………………………………………………………………..

2 *m* smaller, E_K is larger because *p* is the same/constant ……………………
so trolley B ….…………………………………………………………………..

(a) (i)	$\Delta E_p = mg\Delta h$	C1	
	$= 0.602 \times 9.8 \times 0.086$		
	$= 0.51$ J	A1	[2]
	(do not allow g = 10, m = 0.600 or answer 0.50 J)		
(ii)	$v^2 = (2gh =)\ 2 \times 9.8 \times 0.086$ <u>or</u> $(2 \times 0.51)/0.602$	M1	
	$v = 1.3$ (m s$^{-1)}$	A0	[1]
(b)	$2 \times V = 602 \times 1.3$ (allow 600)	C1	
	$V = 390$ m s^{-1}	A1	[2]
(c) (i)	$E_k = ½mv^2$	C1	
	$= ½ \times 0.002 \times 390^2$		
	= 152 J or 153 J or 150 J	A1	[2]
(ii)	E_k not the same/changes		
	<u>or</u> E_k before impact>E_k after/E_p after	M1	
	so must be inelastic collision	A1	[2]
	(allow 1 mark for ‘bullet embeds itself in block’ etc.)		

(a)	**(i)**	equal........	B1	
	(ii)	density of ice is less...	B1	[2]
(b)		mass of ice becomes equal mass of water (allow weight)............ melted ice fills space of water displaced by ice............................ so level does not change	M1 M1 A1	[3]

(a)	force = upthrust – weight of polystyrene in air $25 = V \times (1000 - 15) \times 9.8$ $V = 2.6 \times 10^{-3}\ m^3$	C1 C1 A1	**[3]**
(b)	boat will tend to right itself/float higher in the water if at positions B	M1 A1	**[2]**
	Total		**[5]**

(a)	force (on body) acting upwards	B1	[1]
(b)	pressure below object is different from pressure above .... ($F = pA$, so) force up > force down .... (accept gravitation as origin of pressure for 1 mark acts through CG of displaced fluid for 1 mark)	B1 B1	[2]
(c)	upthrust depends on $\Delta p = \rho g \Delta h$ OR upthrust = weight of fluid displaced .... incompressible fluid OR ρ constant .... rigid object (so volume not change) .... (first mark may be awarded for any detail anywhere)	 B1 B1 B1	 [3]

(a)	M shown near base of stem	B1	[1]
(b)(i)	density = mass/volume	C1	
	volume submerged in liquid of density 1.0 g cm^{-3} = 165 cm^3	C1	
	volume submerged in liquid of density 1.1 g cm^{-3} = 150 cm^3	C1	
	change in volume = 15 cm^3	A1	
(ii)	distance (= 15/0.75) = 20 cm	A1	[5]

(a)	centre of buoyancy is above the centre of mass	B1	
	(if displaced sideways) weight and upthrust provide couple to keep tube upright	B1	**[2]**
	(*do not allow argument in terms of metacentre*)		
(b)	*either* force on base = $L\rho g \times A$ *or* weight of liquid displaced = ρLAg	M1	
	this equals weight Mg / this equals weight Mg	A1	
	hence $L = M/A\rho$ / hence $L = M/A\rho$	A0	**[2]**
(c)	$M/A = L\rho$ = constant	C1	
	new length = 12.1 × (0.99/1.11) = 10.8 cm	C1	
	change in length = 1.3 cm	A1	**[3]**

(a) **(i)** $v^2 = u^2 + 2as$
$= (8.4)^2 + 2 \times 9.81 \times 5$
$= 12.99 \text{ m s}^{-1}$ *(allow 13 to 2 s.f. but not 12.9)*

(ii) $t = (v - u) / a$ or $s = ut + ½at^2$
$= (12.99 - 8.4) / 9.81$ or $5 = 8.4t + ½ \times 9.81t^2$
$t = 0.468 \text{ s}$

(b) reasonable shape
suitable scale
correctly plotted 1st and last points at (0,8.4) and (0.88 – 0.96,0)
with non-vertical line at 0.47 s

(c) **(i)** **1.** kinetic energy at end is zero so $\Delta KE = ½\, mv^2$ or $\Delta KE = ½\, mu^2 - ½\, mv^2$
$= ½ \times 0.05 \times (8.4)^2$
$= (-)\ 1.8 \text{ J}$

2. final maximum height $= (4.2)^2 / (2 \times 9.8) = (0.9 \text{ (m)})$
change in PE $= mgh_2 - mgh_1$
$= 0.05 \times 9.8 \times (0.9 - 5)$
$= (-)\ 2.0 \text{ J}$

(ii) change is – 3.8 (J)
energy lost to ground (on impact) / energy of deformation of the ball / thermal energy in ball

(a) **(i)** change in kinetic energy $= \frac{1}{2}mv^2$

$= 0.5 \times 25 \times (0.64)^2 = 5.1(2)\,\mathrm{J}$

(ii) zero

(iii) $(-)\,5.1(2)\,\mathrm{J}$

(b) **(i)** PE $= mgh$

$= 350 \times 0.64 \times 25$

$= 5600\,\mathrm{J}$

(If full length used allow 1/3)

(ii) $P = Fv$ or gain in PE / t, E_P / t or work done / t, W / t

$= 350 \times 0.64$ or $5600 / 25$

$= 220\ (224)\,\mathrm{W}$

(a) **(i)** $k = F / x$ **or** 1 / gradient

($k = 4.4 / (5.4 \times 10^{-2})$ =) 81 (81.48) N m^{-1}

(ii) work done = area under line **or** $\frac{1}{2}Fx$ **or** $\frac{1}{2}kx^2$

(= $0.5 \times 4.4 \times 5.4 \times 10^{-2}$ =) 0.12 (0.119) J

(b) **(i)** kinetic energy/E_k <u>of trolley/T</u> (and block) changes to EPE/strain energy/elastic energy <u>of spring</u>

EPE changes to KE <u>of trolley/T</u> and KE <u>of block</u> **or** to give <u>lower</u> KE to trolley

(ii) change in momentum = $m(v + u)$

= 0.25 (0.75 + 1.2) = 0.49 (0.488) N s