Answers prepared by Leong Yee Pak

Forces

5.1 Types of force

****1 June 02 P1 Q12** D Weight = upthrust + viscous drag

****2 June 02 P1 Q14** C Uptrhurst = resultant force due to liquid. Force on top surface downwards= p_t A. Force on bottom surface upwards = p_b A. Find resultant

***3 June 04 P1 Q12** C

***4 Nov 06 P1 Q13** B

****5 June 08 Q12** A

***6 June 08 Q15** D

***7 June 09 P2 Q11** B

5.2 Equilibrium of forces

*****1 June 02 P1Q15** D Find the resultant of the 2 perpendicular forces. Then find the resultant of the 3 forces.

*****2 Nov 02 P1 Q15** D Find the resultant of any 2 forces using parallelogram method. Compare it with the third force.

3 June 03 P1 Q14 **B Resultant force vertically = 10000 – 9000 N

****4 June 03 P1 Q15 A** Air resistance increases with velocity until it is equal to mg. Resultant force decreases until it is 0.

****5 Nov 03 P1 Q15** B From Newton's 2nd law, F = ma

*****6 Nov 03 P1 Q16** D Sketch the triangle of forces reasonably accurately and compare their length.

***7 June 04 P1 Q14** B For equilibrium, tip-to-tail rule applies. The forces must follow one after another and must closed.

***8 June 05 P1Q12** C same as in Q12

*****9 June 05 P1 Q14** D Resultant of the two perpendicular forces 3 N and 4 N = 5 N upwards and to the right. Then combined with the 4 N force.

***10 June 06 P1 Q13** D

****11 Nov 06 P1 Q15** C Find the resultant of the two 10 N upwards and then find the resultant of the 3 forces.

***12 June 07 P1 Q13** C

*****13 June 08 P1 Q13** A Force in ZX is tension, force in YZ is compressive.

****14 June 09 P2 Q12** D

Section B

June 06 P2 Q2

2 (a) (i) point at which whole weight of body may be considered to act — M1 A1 **[2]**

(ii) sum of forces in any direction is zero — B1
sum of moments about any point is zero — B1 **[2]**

(b) *either*:
T and *W* have zero moment about P — M1
so *F* must have zero moment, i.e. pass through P — A1 **[2]**

or:
if all pass through P, distance from P is zero for all forces (M1)
so sum of moments about P is zero (A1)

(c) (i) $F\cos\alpha = T\cos\beta$ — B1 **[1]**

(ii) $W = F\sin\alpha + T\sin\beta$ — B1 **[1]**

(iii) $2W = 3T\sin\beta$ — B1 **[1]**

5.3 Centre of gravity
5.4 Turning effects of forces

Section A

****1 June 02 P1 Q13**

C Perpendicular distance between forces = 0.30 x sin 50^o. Torque = magnitude of one force x perpendicular distance between forces. Or Resolve force perpendicular to rod and parallel to rod, and calculate torque.

***2 Nov 02 P1 Q13** A Couple = 2 parallel forces, opposite in direction and equal in magnitude whose lines of action do not coincide

*****3 Nov 02 P1 Q14** C Taking moment about the pivot, resultant moment = 20 x 60 - 100 x 10 = 200 g cm anticlockwise. For equilibrium, a clockwise moment of 200 g cm has to apply. Hence, 200 = 50 *x*. *x* = 4 cm. Hence mark = 40 + 4 = 44 cm

****4 June 03 P1 Q13** D

****5 Nov 03 P1 Q14** B Torque due to a couple = magnitude of one force x perpendicular distance between forces.

*****6 June 04 P1 Q13** A Uniform rod: C.G. is at the mid-point. Taking moment about the pivot, W x 1.0 = 50 x 0.5

****7 June 05 P1 Q13** B Uniform rod: C.G. is at the mid-point. Taking moment about the pivot, W x 1.25 = 300 x 2.5

***8 June 05 P1 Q14** C

****9 Nov 05 P1 Q13** A

*****10 June 06 P1 Q14** B moment = (F cos θ) *d*

*****11 June 06 P1 Q15** B Resultant moment = 200 x 0.8 – 300 x 0.4 = 40 Nm clockwise

****12 Nov 06 P1 Q14** B torque due to couple = F x (2r)

****13 June 07 P1 Q14** C moment = F x d. For F minimum, d is maximum = 0.80 m. 12 = F x 0.8

*****14 June 08 P1 Q14** A Taking moment about the top of ladder, Wa + Fh = W (2a)

***15 Nov 08 P2 Q14** A

*****16 June 09 P2 Q13** B For equilibrium, clockwise torque = anti-clockwise torque.

F x 1.20 = 900 x 0.20

Section B

June 02 P2 Q3

3 (a)	point at which (whole) weight of body	M1		
	may be considered to act	A1	[2]	
	(allow definition based on gravitational force)			
(b) (i)	380 N	B1		
(ii)	position nearer A than B	B1		
(iii)	clear indication about which point moments are taken	B1		
	e.g. $950 \times x = 380 \times 1.7$	C1		
	$x = 68$ cm	C1		
	distance = 108 cm or 1.08 m (accept 2 sig fig)	A1	[6]	

Nov 03 P2 Q3

3 (a)		force x perpendicular distance	M1	
		(of the force) from the pivot	A1	[2]
(b)		no resultant force (in any direction)	B1	
		no resultant moment (about any point)	B1	[2]
(c)	(i)	correct direction in both	B1	[1]
	(ii)1	moment = 150 x 0.3 = 45 N m (1 sig. fig. -1)	A1	
	(ii)2	torque = 45 N m i.e. same is (i)	A1	
	(ii)3	45 = 0.12 x T	C1	
		T = 375 N	A1	[4]

June 04 P2 Q5

5 (a)	(i)	distance = $2\pi nr$	B1	
	(ii)	work done = F x 2 πnr *(accept e.c.f.)*	B1	**[2]**
(b)		total work done = 2 x F x $2\pi nr$	B1	
		but torque $T = 2Fr$	B1	
		hence work done = T x $2\pi n$	A0	**[2]**

(c)	power = work done/time (= 470 x 2π x 2400)/60) = 1.2 x 10^5 W		A1	**[2]**
		Total		**[6]**

Nov 05 P2 Q2 (a) The point at which the whole weight of the body is considered to act.

(b) There is a perpendiular distance from the pivot to the C.G. Hence the weigth creates an anti-clockwise moment about the pivot, and the carboard wil move down in anticlockwise direction. A and will oscillates. After the oscillation stops, the C.G is vertically below the pivot and the perpendicular distance from the pivot to the weight = 0. Moment about pivot = 0.

Nov 08 P2 Q3

3	**(a)**	moment:	force × perpendicular distance of force from pivot / axis / point	M1 A1	
		couple:	(magnitude of) one force × perpendicular distance between the two forces	M1 A1	[4]
			(*penalise the 'perpendicular' omission once only*)		
	(b)	**(i)**	$W \times 4.8 = (12 \times 84) + (2.5 \times 72)$ $W = 250$ N (248 N)	C1 A1	[2]
		(ii)	*either* friction at the pivot *or* small movement of weights	B1	[1]

June 09 P2 Q3

3	**(a)**		product of (magnitude of one) force and distance between forces	M1	
			reference to *either* perpendicular distance between forces *or* line of action of forces and perpendicular distance	A1	[2]
	(b)	**(i)**	90°	B1	[1]
		(ii)	130 = F × 0.45 (*allow e.c.f. for angle in* ***(i)***) ..... F = 290 N ..... (*allow 1 mark only if angle stated in* ***(i)*** *is not used in* ***(ii)***)	C1 A1	[2]