**Past Paper Revision resources Mechanics December – Mark schemes and Examiner’s comments:**

**Once you have had a go at a question, look at the mark scheme and the examiner’s comments in this document, then make corrections. Perhaps have another go at the same question a few days later.**

**If you want to do all these questions that is fine, if you want to pick out the questions on the topics you find more challenging, that is also fine.**

**Use your text book to learn anything you are unsure and come and ask for help!**

**1.** (a) (i)


n.b. B must make an appreciable angle with wall and bar

(ii) A weight of sign and bar (accept gravity) **(1)**B reaction of wall **(1)**
C tension in wire **(1)** max 5

(b) 
use of *mg* **(1)**
clockwise moments 118 × 0.375 **(1)**

 = anticlockwise moments (*T*cos40° **(1)**) × 0.750 **(1)**
*T* = 77 N **(1)** max 4

[9]

**1.** As mentioned earlier, there were many poorly drawn arrows in part (a)(i). Candidates appeared to draw arrows hurriedly in a crude manner, even though there appeared to be no evidence to support the idea that they were short of time on the paper as a whole. Most candidates were able to show the line of action of the tension in the wire and the combined weight of the sign and metal bar. However, very few candidates were able to show the line of action of the reaction force between the hinge and the bar. The most common mistake was to show an arrow directed perpendicular to the wall rather than at an acute angle upwards between the bar and the wall. Nevertheless, in part (a)(ii) many candidates correctly referred to the reaction force between the hinge and the bar. Weaker candidates referred to the mass of the sign and bar rather than their combined *weight*.

 In general, part (b) was answered poorly by all but the better candidates. Most candidates had difficulty in resolving the vertical component of the force that the wire exerts on the bar and hence in determining the counterclockwise moment. Other candidates ignored the fact that the force the wire exerts on the bar was not perpendicular to the bar.

**2.** steel
*A* = 4.91 × 10–4 (m2) *m* = 383kg **(1)**
copper
*A* = 3.32 × 10–5 (m2) *m* = 444 kg **(1)**
one cross-sectional area calculated correctly **(1)**use of *m* = *lA* **(1)**
mass of cable = 827 kg **(1)**

[Max 4]

**2.** Many candidates experienced great difficulty in calculating the masses of the hard steel core and the copper wires in part (a). Most mistakes were made in the calculation of the cross-sectional area with the conversion from mm to m being the most common source of error. Such candidates were prepared to quote enormous masses for the 100m of cable without any comment.

**3.** (a) (i) gradient =  = 3.0 ms–2 **(1)**

(ii) distance is area under graph (to *t* = 0.1 s)
or  × 0.7 × 2.1 0.3 **(1)** = 1.4(2) m **(1)** 3

(b) (i) *T* – *mg* = *ma* [or *T* = 1500(9.8+3.0)] **(1)**
= 1.9 × 104 N **(1)**

*T* = *mg* = l.5 × 104 N **(1)**

(ii) EF **(1)** 4

(c) power = *F* or l.5 × 104 × 2.5 **(1)**
= 3.7[3.8] × 104 W **(1)** 2

[9]

**3.** In this high-scoring question most of the difficulties arose in part (a), where candidates were not careful enough to distinguish between the straight part of the graph. AB, where the acceleration was uniform, and the curved part, BC. where it was not. Thus, a very common wrong answer in part (a)(i) was 2.5 ms–2 and even those candidates who recognised that they had to find the area under the graph up to C in part (a)(ii) most commonly treated that area as a triangle, giving the answer 1 .25m. Only a small proportion of the candidates calculated the area sufficiently accurately. Other mistakes included finding the area up to *t* **=** 0.7s or up to *t* **=** 4.3 s.

 Answers to part (b) were better. The main weaknesses were inadequate explanation in part (b)(i) and carelessness in part (b)(ii).

**5.** (i) *a*=  = 11 ms–2 **(1)**

*F* = *ma* =1.1 × 105 N **(1)**

(ii)  = 236 m s–1

*a* =  = 29.5 ms–2 **(1)**

(iii) *s*one =  × *t* = × 4.0 = 88m **(1)**

*s*two =  × *t* =  × 8.0 **(1)** = 1296(m) **(1)**

total distance = 1384 m **(1)**

[6]

**5.** The majority of candidates answered this question fairly well. Full marks were not uncommon. Most problems were caused by part (iii), but even this involved relatively few candidates.

**6.** (a) for equilibrium**(1)**clockwise moment = counterclockwise moment **(1)** 2

(b) (i) right hand support

*W*p = 88(N) and *W*x = 29(N) **(1)**

*F* = 44 + 29 = 73 N **(1)**

left hand support

*F*= 44N **(1)**

**6.** Candidates found this to be a very difficult question and it was only the very good candidates who got anywhere with it. Part (a) was a fairly easy starter, but a significant number of candidates simply defined the moment of a force.

 The calculation was quite unusual and, consequently, average and weak candidates found it difficult. Common mistakes were failure to convert the masses to weights, and to set up moments equations and quote the moment of the force on the supports rather than the force itself There was evidence that candidates spent quite a considerable time on this question. often with little success.

**10.** (a) (i) *T* = 2.0 × 9.8 = 19.6N **(1)**

(ii) moments about B
19.6cos30° × 1.6 **(1)** = *mg* × 0.8 **(1)**
mass =  **(1)** (= 3.46 kg) 4

(b) maximum support when wire vertical **(1)**
moments about B
2.0 × 9.8 × 1.6 = (*M* × 9.8 × 1 .2) **(1)** + 33.9 × 0.8 **(1)**
*M* *=* 0.36 kg **(1)**
[n.b. 0.33 kg if 3.5 used] 4

[8]

 **10.** For this question a pleasing number of candidates produced clear, fully explained answers which earned full marks, but many wrote down equations without indicating whether they were taking moments, or about what point, and often got into difficulties.

 Those candidates who calculated the tension wrongly in part (a)(i) often lost marks in part (ii) because they did not use their answer but adjusted the moments equation to get the correct result. Many candidates confused weight and mass, introducing g at the last moment to get the answer given, and then carrying on their mistake to part (b). Other candidates ignored the reaction at B and resolved forces, adjusting wherever necessary to get the required answer.

 Many candidates lost the first mark in part (b) by not stating that the string should be vertical for the largest mass, whilst others were unclear about which point they were taking moments. The most common error was to multiply force by distance in some terms in the equation. and mass by distance in others.

**13.** (a) (i) **region A**: uniform acceleration

 (or (free-fall) acceleration = *g*( = 9.8(i) m s–2))

force acting on parachutist is entirely his weight

 (or other forces are very small) **(1)**

(ii) **region B**: speed is still increasing

acceleration is decreasing **(2)** (any two)

because frictional (drag) forces become significant
(at higher speeds)

(iii) **region C**: uniform speed (50 m s–1)

because resultant force on parachutist is zero **(2)** (any two)

weight balanced exactly by resistive force upwards 6
 QWC

(b) deceleration is gradient of the graph (at *t* = 13s) **(1)**

(e.g. 20/1 or 40/2) = 20 m s–2 **(1)** 2

(c) distance = area under graph **(1)**suitable method used to determine area (e.g. counting squares) **(1)**with a suitable scaling factor (e.g. area of each square = 5 m2) **(1)**distance=335m (±15m) **(1)** 4

(d) (i) speed = (5.02 + 3.02) = 5.8 m s–1 **(1)**

(ii) tan ** =  gives ** = 31°**(1)** 2

[14]

 **13.** In part (a) most candidates were able to interpret the graph correctly and almost all understood why the parachutist reached constant terminal speed in region C of the graph. Although many also understood and stated that the acceleration in region A was constant, few stated that this was because the drag on the parachutist was negligible or much smaller than his weight. Answers were generally well expressed and a mark of four or five was most common. A minority of candidates, however, was quite incapable of using physics terms accurately and subsequently scored few marks.

 Many candidates understood that the acceleration in part (b) equalled the gradient of the line in region D of the graph and arrived at a correct answer (although the unit of acceleration was often given as –1). Candidates who used *a* = ( – *u*)/*t* very often chose points off the straight section of the graph and arrived at  value for a outside the acceptable range.

 In part (c) many candidates ignored the graph and attempted to use an equation of uniform acceleration to find the distance travelled. The majority, however, made some attempt to relate distance to the area under the graph and most of these answers fell within the acceptable range.

 Part (d) was most often correct, although in part (ii) many candidates inverted the tan ftmction and found the angle to the horizontal rather than the vertical.

**15.** (a) (i)



 *F*1 weight / *mg* **(1)***F*2 reaction or normal contact force **(1)***F*3 driving force **(1)***F*4 friction or air resistance **(1)**

(ii) zero acceleration **(1)**zero resultant force **(1)** max 5
 QWC

(b) (*P* = *Fv* gives) 18 × 103 = *F* × 10 **(1)** (and *F* = 1.8 × 103 N) 1

(c) (i) 1800 – 250 = 1.6 × 103 N **(1)** (1.55 × 103 N)

(ii) force = 4 × 1.55 × 103 = 6.2 × 103 N **(1)**
(allow e.c.f. from(i))

(iii) total force = 6200 + 250(N) **(1)** (= 6.45 × 103(N))
(*P* = *Fv* gives) *P* = 6.45 × 103 × 20 = 1.3 × 105 W **(1)** (1.29 × 105 W)
(allow e.c.f. for value of total force) 4

[10]

**15.** The majority of candidates were able to identify in part (a) the reaction forces, the weight and the resistive forces, but very few were able to identify the driving force correctly. Other errors which occurred were not drawing the arrows carefully enough and leaving their direction and point of origin vague. Labelling the arrows was also frequently ambiguous. Part (ii) was often not answered well. Candidates had great difficulty expressing themselves in a way that demonstrated understanding and often equated forces to velocity and incorrectly applied Newton’s third law of motion to the situation.

 Part (b) was well answered with the majority of candidates selecting and correctly rearranging the appropriate formula. Candidates found part (c)(i) more difficult and many did not realise that a simple subtraction of the forces was required. Part (ii) also caused problems for weaker candidates although a significant proportion did realise that the force was a factor of four greater than the force quoted in the question. Candidates fared better with the calculation in part (iii) and correct solutions were often seen.

**16.** (a) (i)

|  |  |
| --- | --- |
|  | two forces opposing **(1)**forces parallel **(1)***s* correct **(1)** |

(ii) N m **(1)** 4

(b) (i) anticlockwise moments = clockwise moments **(1)**

(ii) weight of beam acts at centre **(1)**this is through the pivot **(1)** 3

(c) (equating moments gives) 400 × 1.0 = 200 × 0.50 + 250 × *d* **(1)**400 – 100 = 250 × *d* and *d* = 1.2 m **(1)** 2

[9]

**16.** Part (a) was well answered and full explanations were often given although a minority defined moment rather than torque. Most candidates were familiar with the unit of the torque of a couple.

 Answers to part (b) were generally appropriate although some candidates did find it difficult to explain clearly why the weight of the beam did not need to be considered. The calculation in part (c) was done well by all but the weakest of candidates.

**47.** (a) component (parallel to ramp) = 7.2 × 103 × sin 30 **(1)** (= 3.6 × 103 N) 1

(b) mass =  = 734 (kg) **(1)***a* =  = 4.9(1) m s–2 **(1)** 2

(c) (use of *v*2 = *u*2 + 2*as* gives) 0 = 182 – (2 × 4.9 × *s*) **(1)***s* = 33(.1) m **(1)**(allow C.E. for value of *a* from (b)) 2

(d) frictional forces are acting **(1)**increasing resultant force [or opposing motion] **(1)**hence higher deceleration [or car stops quicker] **(1)**energy is lost as thermal energy/heat **(1)**  Max 2

[7]

**47.** This question provided excellent discrimination and more able candidates analysed the situation successfully. Less able candidates were confused with the distinction between mass and weight and consequently calculated the acceleration as 0.50 m s–2. Calculating the stopping distance proved more straightforward, although there was the usual confusion of signs for acceleration and whether the given velocity of 18 m s–1 was the initial or final velocity. Most candidates were able to identify friction as a reason for the stopping distance being shorter in practice, but were less confident when explaining why.

**53.** (a) resultant force zero **(1)**
resultant torque about any point zero **(1)** 2

(b) (i) force due to wire P = 5.0 - 2.0 = 3.0 N **(1)**

(ii) (moments give) 5.0 × *d =* 2.0 × 0.90 **(1)***d=* 0.36 m **(1)** 3

[5]

**53.** The January 2006 examination paper contained a question on moments that was answered very poorly. The evidence from this paper is that candidates had learned from the earlier question and consequently answered this question very well indeed. Many scored full marks with the only significant omission being a second condition for equilibrium.

**57.** accept mirror image for (a) and (b)

(a) (b) 1

 

 straight line sloping up **(1)** constant value shown **(1)**
sudden change to negative velocity **(1)**
smaller negative velocity **(1)**
same gradient as positive line **(1)**  4

(c) (i) vertically down at P **(1)**

(ii) vertically down at Q **(1)**

(iii) along tangent at P **(1)**

(iv) along tangent at Q **(1)** 4

[9]

(ii) right hand support, moments about left hand support

88 × 0.75 + 29 × 0.5 = *F* × 1.5 gives *F* = 54 N **(1)**

left hand support

*F*L *+F*R = 118 *(N)* **(1)** so FL = 64N **(1)** 6

[8]