# Marking Scheme

## #1

| Question | | | Marking details | Marks available AO1 | AO2 | AO3 | Total | Maths | Prac |
|---|---|---|---|---|---|---|---|---|---|
| | | | **When ball first thrown**<br>When ball is thrown boat moves to left (backwards)<br>When released boat initially accelerates (to left)<br>[Forward] force applied to ball<br>Mention of N3 / conservation of momentum / N2<br>**Ball in mid-air**<br>When ball in mid-air boat travels with constant velocity<br>After release no forces acting<br>**When ball caught**<br>When caught boat decelerates<br>When ball caught boat comes to rest<br>When caught force in opposite direction<br>Conservation of momentum / N2 / N3<br><br>AO1 allocation – basic force analysis<br>AO2 allocation – application of forces and motion analysis<br><br>**5-6 marks**<br>Description of what happens to the boat when the ball is first thrown, in the air and caught by Ryan along with reference to at least one physics law at any stage<br>*There is a sustained line of reasoning which is coherent, relevant, substantiated and logically structured.*<br><br>**3-4 marks**<br>Description of what happens to the boat for any 2 of the following 3 stages: the ball is first thrown, in the air or when caught by Ryan along with reference to at least one physics law at any stage<br>*There is a line of reasoning which is partially coherent, largely relevant, supported by some evidence and with some structure.*<br><br>**1-2 marks**<br>Description of motion of the boat at any stage or reference to at least one physics law at any stage<br><br>*There is a basic line of reasoning which is not coherent, largely irrelevant, supported by limited evidence and with very little structure.*<br><br>**0 marks**<br>*No attempt made or no response worthy of credit.* | 2 | 4 | | 6 | | |
| | | | **Question total** | **2** | **4** | **0** | **6** | **0** | **0** |

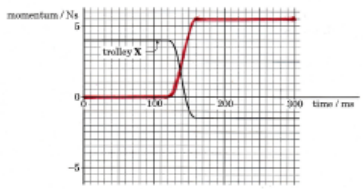
## #2

| Question | | | Marking details | Marks available AO1 | AO2 | AO3 | Total | Maths | Prac |
|---|---|---|---|---|---|---|---|---|---|
| 1 | *(a)* | | Normal force and frictional force shown by arrows in correct directions. Labelling not required nor 'correct' positions, length irrelevant | 1 | | | 1 | | |
| | *(b)* | (i) | Multiplication of $m$ by 9.81 [N kg$^{-1}$] apparent (1)<br>Multiplication by cos 70° or sin 20° apparent (1)<br>[→ 208 / 210 N] | 1 | 1 | | 2 | 1 | |
| | | (ii) | [Because no acceleration normal to surface]<br>$N = W$ cos 20° or by implication (1)<br>$N$ = 570 N or 572 N [Accept 571 N] (1) | | 2 | | 2 | 2 | |
| | *(c)* | | Correct use of $x = \frac{1}{2}at^2$ (1)<br>One of: 101 m in 9.0 s or 8.9[4] s for 100 m or 100 m in 9.0 s requires an acceleration of 2.47 m s$^{-2}$ (1)<br>Calculation predicts that he is right, but not decisive [or actually the wrong prediction] owing to [increasing] air resistance, or unevenness of snow or not enough s.f. in data or recognition that acceleration may not be uniform (1) | | | 3 | 3 | 2 | |
| | | | **Question 1 total** | 2<br>**2** | 3 | 3 | 8 | 5 | 0 |

#3

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 3 | *(a)* | | Rate of change of momentum proportional to [or equals] force(1)<br>Context or detail:<br>either *resultant* force [..... *body's* rate of change of momentum]<br>or *and takes place in the direction of the [resultant] force* (1) | 1<br><br>1 | | | 2 | | |
| | *(b)* | (i) | Tangent drawn at $t$ = 10.0 s (tolerate errors of judgement) (1)<br>Clear calculation of gradient (1)<br>Resultant force = 0.15 [±0.03] N Accept 3sf (1) | | 3 | | 3 | 2 | |
| | | (ii) | *Resultant force = weight – air resistance* (or equivalent) used (1)<br>0.34 N or 0.35 N ecf (1) | | 1<br>1 | | 2 | 1 | |
| | | (iii) | 0.49 N [accept 0.5 N or 0.50 N]<br>[accept '= weight'] | 1 | | | 1 | | |
| | | | **Question 3 total** | **4** | **4** | **0** | **8** | **3** | **0** |

#4

| Question | | | | Marking details | | Marks available | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 3 | *(a)* | | | Vector sum of momenta [or total momentum] of [a number of] bodies is constant [1]<br>provided no forces act from outside [that number] [1] | 2 | | | 2 | | |
| | *(b)* | (i) | | $\Delta p_X$ = [–] 5.5 [Ns] **or equiv or by imp** [1]<br>$\Delta p_Y$ = [+] 5.5 [Ns] **or equiv or by imp** [1] **ecf**<br>Y's velocity after collision = [+] 2.3 [m s$^{-1}$] [1] **ecf** on 5.5 [Ns] | | 3 | | 3 | 2 | |
| | | (ii) | | Up to about 120 ms, straight line along time axis [1]<br>After 120 ms upward sloping line followed by horizontal line after 160 ms [1]<br>Horizontal line after 160 ms at 5.5 [Ns] [1]<br>  <br> | | 3 | | 3 | 2 | |
| | | (iii) | | Change of momentum in a $\Delta t$ of 40 ms [**Accept** any $\Delta t$ between 30 ms and 40 ms] [1]<br>Mean force on X = (–)140 N; **ecf** on (–)5.5 Ns and 40 ms [1] | | 2 | | 2 | 2 | |
| | | | | **Question 3 total** | **2** | **8** | **0** | **10** | **6** | **0** |

#5

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 2 | *(a)* | | Energy cannot be created or destroyed only changed from one form to another | 1 | | | 1 | | |
| | *(b)* | (i) | Length from top of pendulum = $2\cos 48° = 1.34$ [m] (1)<br>Height pendulum rises = 2.00 – 1.34 = 0.66 [m] (1) | | 2 | | 2 | 2 | |
| | | (ii) | $\frac{1}{2}mv^2 = mgh$ (1)<br>$v = 3.60$ [m s$^{-1}$] (1) | | 2 | | 2 | 2 | |
| | *(c)* | (i) | The vector sum of momentum before a collision equals the vector sum of momentum after collision / Accept total for vector sum of (1)<br>provided no external forces act (1) | 2 | | | 2 | | |
| | | (ii) | $m_b v_b = 1.91 \times 3.6$ **ecf** (1)<br>$v = 687(.6)$ or 688 [m s$^{-1}$] (1) | | 2 | | 2 | 2 | |
| | *(d)* | | **Any 2 × (1) from:**<br>- Students over the age of sixteen<br>- Legitimate reason for scientific learning<br>- Needs to be transported through school play ground<br>-Possible dangers in transporting<br>- Risk assessment made | | | 2 | 2 | | |
| | | | **Question 2 total** | **3** | **6** | **2** | **11** | **6** | **0** |

#6

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| 6 | *(a)* | (i) | Constant / steady velocity no resultant / overall force acting | 1 | | | 1 | | |
| | | (ii) | Ball bearing attracted to (centre of) the earth and the earth attracted to the ball bearing/ w.t.t.e. (1)<br>Ball bearing pushing down on the oil and the oil pushing up on the ball bearing / w.t.t.e. (1) | | | 2 | 2 | | |
| | *(b)* | | Mean time i.e. 5.6 **and** 3.9 (1)<br>Velocity i.e. 0.699 or 0.70 **and** 1.2 or 1.20 (1)<br>Uncertainty i.e. 0.1 **and** 0.2 (1)<br>All s.f. consistent in all columns (accept first velocity value (i.e. 0.699 or 0.70) to 2/3 s.f.) (1) | | 4 | | 4 | 4 | 4 |
| | *(c)* | (i) | Scale suitable with at least half of the paper used (1)<br>Axis labelled with units (1)<br>All points plotted correctly with error bars for $v$ except first value (1)<br>Suitable line of best fit (1) | | 4 | | 4 | 3 | 4 |
| | | (ii) | **Any 2 × (1) from:**<br>- Straight line graph / constant positive gradient<br>- Through the origin<br>- Line of best fit through all the error bars / close to all points | | | 2 | 2 | 2 | 2 |
| | | | **Question 6 total** | **1** | **8** | **4** | **13** | **9** | **10** |

#7

| Question | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (a) | (i) | Acceleration = $\frac{0.16}{2.0}$ [=0.08] [m s$^{-2}$] or by implication (1)<br>Force = $1.2 \times [\frac{0.16}{2.0}]$ [N] (**ecf** on acc for this mark only) (1)<br>Force = 0.096 [N] (1)<br>[Deduct only 1 if wrong answer clearly due to arithmetical slip.]<br>**Alternative:**<br>**Don't award individual marks unless overall method clear**<br>$s$ =1.04 [m] (1)<br>$v^2$-$u^2$ = 0.166 [m$^2$s$^{-2}$] **or** $\Delta E_k$ = 0.0988 [J] (1)<br>Force = 0.096 [N] (1) | 1 | 1<br>1 | | 3 | 3 | |
| | | (ii) | Distance = (½)(0.60 + 0.44) × 2.0 [= 1.04 m] **or** equiv **or** by imp (1)<br>Work = 0.096 × [calculated distance] [J] **ecf on (a)(i)** (1)<br>Work = 0.10 [J] (1)<br>**Alternative solution:**<br>Final KE = (½) 1.2 × 0.44$^2$ [= 0.11616 J] **or** by imp (1)<br>Initial KE = (½) 1.2 × 0.60$^2$ [= 0.216 J] **or** by imp (1)<br>Work = 0.10 [J] (1) | 1 | 1<br>1 | | 3 | 3 | |
| | | (iii) | Momentum of system before collision = 1.2 × 0.44 [= 0.528 N s] [or by implic] (1)<br>Momentum of A after collision = –1.2 × 0.14 [= – 0.168 N s] (1)<br>1.2 × 0.44 = –1.2 × 0.14 + 3.0 $v$ **or** equivalent **or** by implic (1)<br>$v$ = 0.23 [m s$^{-1}$ to the right] (1)<br>Penalty for failure to take account of A's velocity being to the left after collision (gives $v$ = 0.12 [m s$^{-1}$]) is 2 marks if all else correct.<br>1 mark penalty for taking A's initial velocity as 0.60 [m s$^{-1}$] | 1<br>1 | 1<br>1 | | 4 | 4 | |
| | | (iv) | Initial KE = (½) 1.2 × 0.44$^2$ [= 0.116 J] **or** by imp (1)<br>Final KE = (½) 1.2 × 0.14$^2$ + (½) 3.0 × 0.232$^2$ [= 0.092 J] **ecf** (1)<br>[KE lost] so inelastic **ecf** (1)<br>**ecf** on A's initial velocity = 0.60 [m s$^{-1}$] | | | 3 | 3 | 2 | |
| | (b) | | **3 valid points made - 3rd mark can be a follow-up of one of the points**<br>Examples of 'follow-ups' are preceded by dashes (-) below.<br><br>Better traction or equivalent<br>May reduce damage to cars in collisions<br>- Metal less likely to deform [under given stress, though stress likely to be greater!]<br><br>More damage to objects hit by cars<br>May increase damage to passengers during collisions<br>- Thicker metal likely to [decrease collision time and] increase accelerations during collisions<br><br>Would increase fuel consumption<br>- More energy used to accelerate **or** more energy dissipated in tyres.<br><br>More metal used [per car] [uses up resources faster]<br>Makes manufacture more difficult<br>Makes cars harder to repair if damaged | | | 3 | 3 | | |
| | | | **Question total** | **4** | **6** | **6** | **16** | **12** | **0** |

#8

| Question | | | | Marking details | Marks available | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | AO1 | AO2 | AO3 | Total | Maths | Prac |
| | (a) | | | Essentially $F = ma$ (1)<br>$u\frac{\Delta m}{\Delta t}$ is rate of change of momentum for gases (1)<br>Hence it is (equal & opposite to force on rocket (of mass $m$) (1) | 3 | | | 3 | 1 | 3 |
| | (b) | | | Mass will be (approximately) constant (1)<br>$u$ and $\frac{\Delta m}{\Delta t}$ constant from paragraph 3 (1)<br>Mass $m$ is large and $\frac{\Delta m}{\Delta t}$ is small (1) | | 3 | | 3 | 1 | 3 |
| | (c) | (i) | | Unit is $s^2$ not s OR accept wrong unit for $t^2$ | 1 | | | 1 | | 1 |
| | | (ii) | | Subtracting 0.02 s (1)<br>Due to electromagnet delay OR systematic error in $t$ (1) | | 2 | | 2 | | 2 |
| | (d) | | | $x=ut+0.5at^2$ quoted or its use implied (1)<br>Leading to $t^2 = \frac{2xm}{F}$ OR equivalent (1)<br>But $\frac{t^2}{m}$ = gradient and $x$ = 1.4 so gradient = $\frac{2 \times 1.4}{F}$ (1) | | 3 | | 3 | 2 | 3 |
| | (e) | | | Multiplication implied and reference to equation or reference to rate of change of momentum | | 1 | | 1 | | 1 |
| | (f) | | | Gradient equated to $\frac{2.8}{F}$ (1)<br>Gives 4.41 [N] or 4.409 [N] and so correct (1)<br>**Alternative:**<br>**or** Gradient = $\frac{2.8}{4.4}$ (1)<br>= 0.64 or 0.636 so consistent (1) | | | 2 | 2 | 2 | 2 |
| | (g) | (i) | | Change in wavelength/frequency (1)<br>Due to motion (of source relative to observer) (1) | 2 | | | 2 | | |
| | | (ii) | | Point telescope/device at [Accept: observe] exhaust/gases (1)<br>Spectral analysis/prism/diffraction grating [Accept: pick out one wavelength or equivalent] (1)<br>Use Doppler equation or $\frac{\Delta\lambda}{\lambda} = \frac{v}{c}$ (1) | | | 3 | 3 | | |
| | | | | **Question total** | **6** | **9** | **5** | **20** | **6** | **15** |