Name of the Student:_____
Max. Marks : 19 Marks **Time : 19 Minutes**

Mark Schemes

Q1.

(a) Attempts to set forces equal with double a component of tension.

OR

Attempts to set forces equal with single horizontal component of tension ($T \cos \theta$) ✔

(T =) 310 (N) ✔

*Expect to see $F = 2T \cos 75$ **OR** $80 = T \cos 75$*
*Condone $F = 2\ T \sin 75$ **OR** $160 = 2\ T \sin 75$*
OR $F = 2T \sin$ (their acute angle)
OR $F = 2T \cos$ (their acute angle)
OR $\frac{80}{\sin 75}$ *seen **and** 83 N on answer line.*
*Condone $F = T \cos 75$ **OR** $160 = T \cos 75$*
OR *(T=)* $\frac{160}{\cos 75}$ *with 620 N on answer line*
An answer of 83 N due to F and T being interchanged obtains zero marks.
Alternative
closed triangle (75-75-30) of forces
*An attempted use of Sine or Cosine Rule seen with correct closed triangle **MP1***

Accept answer correctly rounded to at least 2 sf.
Answer = 309 (N) to 3 sf
Calculator display= 309.0962644

2

(b) Read off for F = 208 N

OR

use of $F = ma$ ✔

Range for read-off is 208 N to 210 N

In use of F = ma:
• must see substitution for F and m
• condone either POT error in m or F outside range but not both.

(a =) 9900 (m s^{-2}) ✔

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Accepted range = 9900 to 10000
Penalise 1 x 10^4 N as a 1 sf answer.

2

(c) Area under graph calculated in J for either *s* = 0.10 m or *s*= 0.385 m ✔

s = 0.385 m is approximately 64 blocks, 1 J per block (64 J)
s = 0.10 m gives 8 blocks at 1 J per block (8 J)
Or $\frac{1}{2}$ *× 0.1 × 160 = 8 J (less than 64 J)*

s_r = 0.385 m✔

Range for s_r between 0.38 m and 0.385 m

Do not accept W=Fs for ***MP1***
Do not accept s_r = 0.4 m for ***MP2***

2

(d) (Energy transferred to arrow =) 0.82 × 64

OR

converts 190 km h^{-1} to 52.8 m s^{-1} or working seen ✔

Energy transferred to arrow = 52.48

$52.8 = 52.\dot{7} = \frac{475}{9}$ *accept any answer that rounds to 53*

Use of $E_k = \frac{1}{2} mv^2$✔

Use of is:
• A rearranged expression where m would be subject.
• Substitution: condone one error in the substitution either v ***or*** *E_k where m would be subject (condone rounding error in v)*

Do not accept their power (F v) equal to $\frac{1}{2} mv^2$

m = 0.038 (kg) ✔

Accept answer correctly rounded to at least 2 sf.
m = 2.2 x 10^{-16} kg where incorrect v of 6.84 x 10^8 is used. (Worth 2 marks) (one error in v)
m = 0.056 kg where incorrect Ek is used ($\frac{64}{0.82}$ *= 78)*
(Worth 2 marks) (one error in Ek)
Calculator display = 0.03768093075

3

[9]

Q2.

(a) idea that moments are balanced or that there is no resultant moment ✔

Answer must relate to the context e.g. reference to ***Q*** *or weight of food/spoon*
Allow 'force × distance' or 'F × d' for 'moment'.

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(because)

(overall) centre of mass is now beneath/at **Q**

OR

line of action of (overall) weight is through **Q** ✔

*'Anticlockwise moment of weight of spoon about **Q** = clockwise moment of weight of M about **Q**' gains both marks.*

2

(b) statement of balanced moments seen e.g. $mgx = Mg(16 - 4 - x)$, leading to required formula ✔ ✔

For 1 mark: condone absent g if credible evidence for '12 - x' presented e.g. mx = M(16 - 4 - x) or mx = M(28 - 16 - x)

OR

condone lack of evidence for '12 - x' if g is shown e.g. mgx = Mg(12 - x).

Need to see g and evidence for '12 - x' for both marks. Evidence for '12 - x' need not be in an expression of a moment.

Allow 9.81 or 9.8 instead of g.

2

(c) max two from: ✔ ✔

- reads off a pair of values (e.g. 115 g, 5.0 cm)
- substitutes into formula
- multiplies their *m* by *g*

answer that rounds to 1.5 or 1.6 (N) ✔

Allow correct conversion of M to kg and/or x to m for read offs or in the substitution.

Expect to see 160 g for mass of spoon.

Allow credit for an algebraic solution to get m:

e.g. when m = M, $\frac{m}{M} = \frac{(12-x)}{x} = 1$

So, 12 = 2x, x = 6.0 cm. Reads off M at 6.0 cm to get 160 g.

3

(d) (absolute) uncertainty in *M* increases as *M* increases ✔

(because) as *M* increases:

marks on the scale get closer **OR** range of values of *M* for a fixed range of *x* increases (or vice versa) ✔

the gradient (in Figure 3) increases so the scale markings are unequal owtte ✔

MP1 only awarded supported by some relevant explanation. Treat 'percentage' uncertainty as neutral.

*Allow MP2 and MP3 for quantitative evidence given using Figure 3 e.g. from 0 g to 25 g, Δx ~ 1.5 cm; from 175 g to 200 g, Δx ~ 0.4 cm **OR** calculates gradients at low and high M.*

3

[10]

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