1) B
2) B
3) B
4) A
5) B
6) B
7) D
8) D
9) C
10) B
11) A
12) C
13) B
14) B
15)

| | | | |
|---|---|---|---|
| **(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] |

16)

| | | | |
|---|---|---|---|
| mass: | property of body which resists change in motion | | |
| | OR quantity/amount of matter/substance | B1 | |
| | constant OR scalar quantity | B1 | |
| weight: | effect of gravitational field on a mass/body | | |
| | OR force due to pull of gravity | B1 | |
| | variable OR vector quantity | B1 | **[4]** |
| | (if units given, allow ½ for 2nd and 4th marks) | | |

17)

| | | | |
|---|---|---|---|
| **(a)** | mass: measure of body's resistance/inertia to changes in velocity/motion ..... | B1 | |
| | weight: effect of gravitational field on mass or force of gravity ..... | B1 | |
| | any further comment e.g. mass constant, weight varies/ weight = mg/scalar and vector ..... | B1 | [3] |
| **(b)** | e.g. where gravitational field strength changes (change) in fluid surrounding body.... *1 each, max 2* ..... | B2 | [2] |

18)

| | | | |
|---|---|---|---|
| **(a)** | scalar: magnitude only | B1 | |
| | vector: magnitude and direction *(allow scalar with direction)* | B1 | **[2]** |
| | *(allow 1 mark for scalar has no direction, vector has direction)* | | |
| **(b)** | diagram has correct shape | M1 | |
| | with arrows in correct directions | A1 | |
| | resultant = 13.2 ± 0.2 N *(allow 2 sig. fig)* | A2 | **[4]** |
| | *(for 12.8 → 13.0 and 13.4 → 13.6, allow 1 mark)* | | |
| | *(calculated answer with a correct sketch, allow max 4 marks)* | | |
| | *(calculated answer with no sketch – no marks)* | | |
| | **Total** | | **[6]** |

19)

| | | | | |
|---|---|---|---|---|
| **(a)** | change in velocity/time (taken) | | B1 | **[1]** |
| **(b)** | velocity is a vector/velocity has magnitude & direction | | B1 | |
| | direction changing so must be accelerating | | B1 | **[2]** |
| **(c)** | *either* 6.1 × cos35 = 4.99 N | *or* scale shown | B1 | |
| | so no resultant vertical force | triangle of correct shape | B1 | |
| | 6.1 sin35 = 3.5 N | resultant = 3.5 ± 0.2 N | B1 | |
| | horizontally | horizontal ± 3° | B1 | **[4]** |
| | *allow answer based on centripetal force:* | | | |
| | resultant is centripetal force (which is horizontal) | | (B1) | |
| | resultant is horizontal component of tension | | (B1) | |
| | 6.1 sin35 = 3.5 N | | (B1) | |
| | horizontally | | (B1) | |

20)

| | | | | |
|---|---|---|---|---|
| **(a)** | **(i)** | use of tangent at time $t = 0$ | B1 | |
| | | acceleration = 42 ± 4 cm $s^{-2}$ | A1 | **[2]** |
| | **(ii)** | use of area of loop | B1 | |
| | | distance = 0.031 ± 0.001 m | B2 | **[3]** |
| | | allow 1 mark if 0.031 ± 0.002 m) | | |
| **(b)** | **(i)** | $F = ma$ | C1 | |
| | | = 0.93 × 0.42 {allow e.c.f. from (a)(i)} | | |
| | | = 0.39 N | A1 | **[2]** |
| | **(ii)** | force reduces to zero in first 0.3 s | B1 | |
| | | then increases again in next 0.3 s | M1 | |
| | | in the opposite direction | A1 | **[3]** |

21)

**(a)** 3.5 $T$ — B1 [1]

**(b) (i)** distance = average speed × time (however expressed) — C1
= 14 m — A1 [2]

**(ii)** distance = 5.6 × ($T$ – 5) (*or 3.5T – 14*) — A1 [1]

**(c)** 3.5$T$ = 14 + 5.6($T$ – 5) — C1
$T$ = 6.7 s — A1 [2]

**(d) (i)** acceleration = (5.6 / 5 =) 1.12 m s$^{-2}$ — C1
force = $ma$ — C1
= 75 N — A1 [3]

**(ii)** power = (force × speed =) {75 + 23} × 4.5 — C1
= 440 W — A1 [2]
(*allow 1/2 for 234 W, 0/2 for 338 W or 104 W*)

22)

**(a) (i)** $v^2 = 2as$
$1.2^2 = 2 \times a \times 1.9$ — M1
$a$ = 0.38 m s$^{-2}$ — A1 [2]

**(ii)** $F = ma$
= 42 × 0.38 — M1
= 16 N — A0 [1]

**(b)** *power* = $Fv$ — C1
= 16 × 1.2
= 19 W — A1 [2]

**(c) (i)** component = 42 × 9.8 × sin2.8 — C1
= 20.1 N — A1 [2]

**(ii)** accelerating force = 20.1 – 16 = 4.1 N — C1
acceleration of trolley = 4.1 / 42 = 0.098 m s$^{-2}$ — C1
$s = ½at^2$
$3.5 = ½ \times 0.098 \times t^2$ — C1
$t$ = 8.5 s — A1 [4]

**(d)** *either* allows plenty of time to stop runaway trolley
*or* speed of trolley increases gradually
*or* trolley will travel faster — B1 [1]
*(answer must be unambiguous when read in conjunction with question)*

23)

| | | | | |
|---|---|---|---|---|
| **(a)** | | sum of forces in any direction is zero<br>(allow vector/algebraic sum, resultant force…) | B1 | |
| | | sum of moments about any point is zero<br>(allow algebraic sum, resultant…)<br>(If no mention of direction or point, allow max ½ overall) | B1 | **[2]** |
| **(b)** | | same force $F$ in both springs | C1 | |
| | | resultant is $2F\cos 60$ OR scale drawing | M1 | |
| | | resultant is $F$, so extension is $x$<br>(maximum $\frac{1}{3}$ if uses $x$ alone, without reference to $kx$) | A1 | **[3]** |
| **(c)** | **(i)** | correct direction for W | B1 | |
| | **(ii)** | correct direction for T | B1 | |
| | **(iii)** | correct direction for R | B1 | **[3]** |