M1. B

[1]

M2. C

[1]

M3. C

[1]

M4. C

[1]

M5. D

[1]

M6. D

[1]

M7. D

[1]

M8. C

[1]

M9. B

[1]

M10. B

[1]

M11. 1 mark each correct row

B3

[3]

M12. (a) km $h^{-1} \rightarrow ms^{-1}$ (27.8 m s^{-1}) or 100000/(5.8 × 3600)

C1

acceleration equation or correctly substituted values

C1

4.79 cao

A1

3

(b) equation of motion or correctly substituted values

($s = ut + \frac{1}{2}at^2$; $s = (v + u)t/2$; $v^2 = u^2 + 2as$)

C1

80.6 m e.c.f. from (a)

A1

2

[5]

M13. (a) equilibrium statement

B1

clockwise moment = anticlockwise moment

B1

sum of anticlockwise moments = sum of clockwise

B1

(3)

(b) attempt to use moment formula
[force x distance is needed as minimum]

B1

T × 0.03 = 5.0 × 0.24 + 2.0 × 0.47

B1

= 1.20 + 0.94 = 2.14 N m; T = 71 N (71.3)

B1

(3)

[6]

M14. (a) air resistance (drag) /friction with correct arrow from or towards body

B1

weight (force of gravity/ 838 N) not *gravity* with correct arrow from somewhere on skier or ski -vertically downwards

B1

(b) clear attempt to resolve weight (not mass) or equate normal reaction with component of weight (condone sin θ)

C1

$Mg\cos\theta$ or substituted values

C1

815 (or 810 or 820) N

A1

3

(c) constant speed/velocity or zero acceleration

B1

1

[6]

M15. (a) *states* area under graph = distance **or** clear evidence of graph use

B1

½ × 30 × 25 *seen*

B1

2

(b) accel = grad of graph **or** uses a = $\Delta v/\Delta t$

M1

30/20 = 1.5 m s^{-2}

A1

2

(c) 300 + 375 = 675 m

B1

1

(d) 675/680 m (ecf) at 30m/s takes 22.5/22.7 s

C1

but actually took 90 s

C1

so loss of time = 67.5/67.3 s

A1

3

[8]

M16. (a) (i) $\frac{1}{2} mv^2 = \frac{1}{2} \times 2.8 \times 10^4 \times 71^2$

C1

$= 7.1 \times 10^7$ J

A1

2

(ii) decel = gradient of graph or $a = (v-u)/t$ or $\Delta v/\Delta t$ or evidence on graph

B1

$= (71-0)/(3.5 - 0)$

B1

$= 20.3$ [m s^{-2}]

B1

3

(iii) $[F=ma] = 2.8 \times 10^4 \times 20.3$

C1

=568 kN

A1

2

(b) $v^2 = u^2 + 2as$
$a = v^2/2s = 71^2/124$ or alt process
$= 41$ m s^{-2} [40.6]

C1 A1

2

(c) drawing correct, scale clearly stated, wind speed line>+ 2 cm **or** one

B1

correct calculation

speed 82/83/82.5 m s^{-1} [80 – 84 if drawn]

B1

course 14° [12 – 16] west of north [346°]

B1

3

[12]

M17. (a) (i) Z^0 with the weak interaction
gluons or pions with the strong nuclear force
γ photons with electromagnetic interaction
gravitons with gravity
(any exchange particle **(1)** and corresponding interaction **(1)**)

(ii) transfers energy
transfers momentum
transfers force
(sometimes) transfers charge any two **(1)(1)**

4

(b) $p\ \bar{n}\ \pi^0$ **(1)**

$V_e e^+ \mu^-$ **(1)**

$\bar{n}\ e^+$ (1)

$p e^+ \mu^-$ (1)

4

[8]

M18. proton correct (1,1) accept p or p^+

B1

electron correct (0,–1) accept e or e^- or β or β^-

B1

electron-antineutrino correct (0, 0)

B1

[3]

M19. (a) (i) hadrons

B1

1

(ii) +1e

B1

1

(b) (i) (Strangeness) 1 → 0 + 0

B1

1

(ii) (Strangeness not conserved but) decay possible because it is a weak decay

B1

1

[4]

M20. (a) (i) any two eg proton, neutron ✓✓

2

(ii) $u\bar{d}$ ✓

1

(b) (i) contains a strange quark

or longer half life than expected

or decays by weak interaction ✓

1

(ii) the second one is not possible ✓

because lepton number is not conserved ✓

2

(c) (i) weak (interaction) ✓

1

(ii) mention of charge conservation

or charge conservation demonstrated by numbers ✓

1

(iii) X must be a baryon ✓

baryon number on right hand side is +1 ✓

2

(iv) proton/p ✓

1

[11]