Review Chapter 1 and 2 *[184 marks]*

1a. *[2 marks]*

Markscheme

total momentum does not change/is constant; } *(do not allow "momentum is conserved")*
provided external force is zero / no external forces / isolated system;

1b. *[9 marks]*

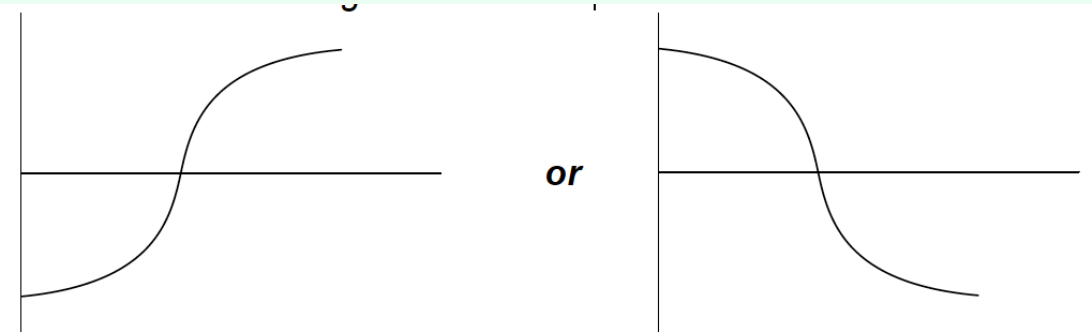
Markscheme

(i) clear attempt to calculate area under graph;
initial momentum is half change in momentum;
$\left(\frac{1}{2} \times \frac{1}{2} \times 24 \times 0.16\right) = 0.96\,(\text{kgms}^{-1})$
*Award **[2 max]** for calculation of total change (1.92kg ms^{-1})*

(ii) initial speed $= \left(\frac{0.96}{0.8} =\right) 1.2\text{ms}^{-1}$;
$a = \frac{1.2-(-1.2)}{0.16}$ ***or*** $a = \frac{-1.2-1.2}{0.16}$;
–15(ms^{-2}); *(must see negative sign or a comment that this is a deceleration)*

or
average force =12 N;
uses F=0.8×a ;
–15(ms^{-2}); *(must see negative sign or a comment that this is a deceleration)*
*Award **[3]** for a bald correct answer.*
Other solution methods involving different kinematic equations are possible.

(iii) goes through t=0.08s **and** from negative momentum to positive / positive momentum to negative;
constant sign of gradient throughout;
curve as shown;
Award marks for diagram as shown.



1c. *[4 marks]*

Markscheme

impulse is the same/similar in both cases / momentum change is same;
impulse is force × time / force is rate of change of momentum;
time to come to rest is longer for car B;
force experienced by car B is less (so less likely to be damaged);

1d. *[2 marks]*

Markscheme

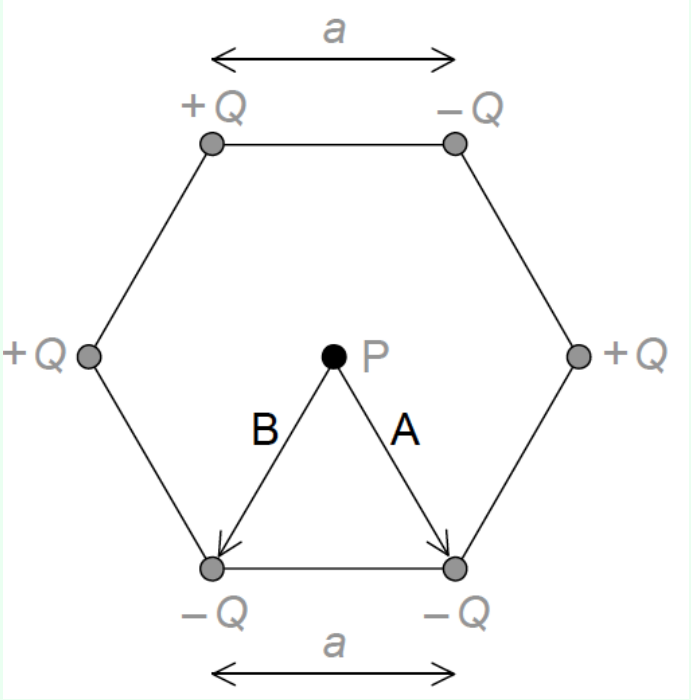
electric force per unit charge;
acting on a small/point positive (test) charge;

1e. *[8 marks]*

Markscheme

(i) states Coulomb's law as $\frac{kQq}{r^2}$ ***or*** $\frac{F}{q} = \frac{kQ}{r^2}$
states explicitly q=1;
states r=a;

(ii)



arrow labelled A pointing to lower right charge;
arrow labelled B point to lower left charge;
Arrows can be anywhere on diagram.

(iii) overall force is due to +Q top left and -Q bottom right / top right and bottom left and centre charges all cancel; } *(can be seen on diagram)*
force is therefore $\frac{2kQ}{a^2}$;

2.6×106 (N C^{-1}) ;
towards bottom right charge; *(allow clear arrow on diagram showing direction)*

2a. *[2 marks]*

Markscheme

average speed is the speed over a period of time/distance; instantaneous speed is the speed at a particular instant in time/point in space.

2b. *[3 marks]*

Markscheme

(i) speed=(area under graph =)½×7.5×3;
=10 ***or*** 11 ***or*** 11.3 (ms^{-1});

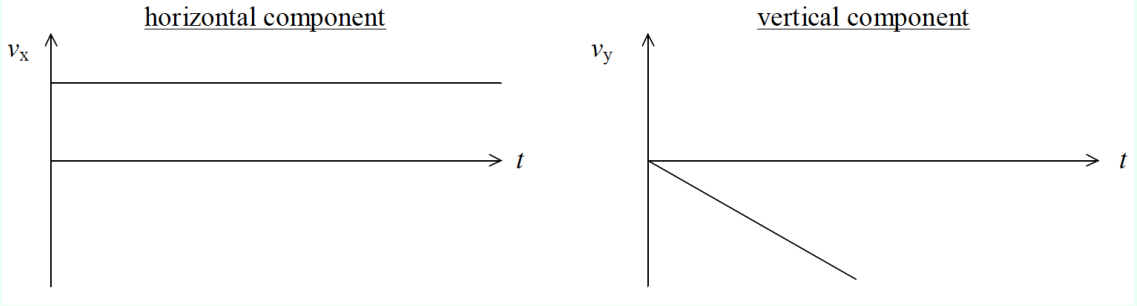
(ii) suitable curve approximating to $v=kt^2$;

3a. *[3 marks]*

Markscheme

(i) zero;

(ii) horizontal: any horizontal line not on *t*-axis *(accept lines above or below t-axis)*;
vertical: any diagonal line starting at origin *(accept positive or negative gradients)*;



3b. *[4 marks]*

Markscheme

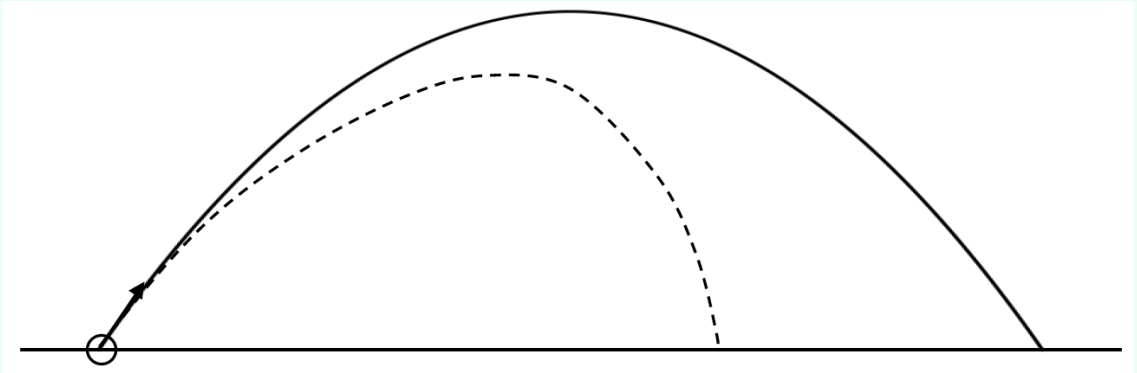
(i) $s_y = \frac{1}{2}a_y t^2 \Rightarrow 110 = \frac{1}{2} \times 10 \times t^2$;
t=4.690≈4.7s;

(ii) $s_x=u_x t$=5.0×4.690;
s_x=23m;

3c. *[3 marks]*

Markscheme

lower maximum height;
lower horizontal range;
asymmetrical with horizontal range before maximum height more than horizontal range after maximum height;



4. *[1 mark]*

Markscheme

C

5. *[1 mark]*

Markscheme

A

6. *[1 mark]*

Markscheme

B

7. *[1 mark]*

Markscheme

C

8. *[1 mark]*

Markscheme

A

9. *[1 mark]*

Markscheme

D

10. *[1 mark]*

Markscheme

C

11. *[1 mark]*

Markscheme

C

12. *[1 mark]*

Markscheme

C

13. *[1 mark]*

Markscheme

D

14. *[1 mark]*

Markscheme

B

15. *[1 mark]*

Markscheme

C

16. *[1 mark]*

Markscheme

B

17. *[1 mark]*

Markscheme

A

18. *[1 mark]*

Markscheme

D

19. *[1 mark]*

Markscheme

B

20. *[1 mark]*

Markscheme

D

21. *[1 mark]*

Markscheme

A

22. *[1 mark]*

Markscheme

C

23. *[1 mark]*

Markscheme

D

24. *[1 mark]*

Markscheme

C

25a. *[2 marks]*

Markscheme

use of conservation of energy

OR

$v^2 = u^2 + 2as$

v = «$\sqrt{2 \times 60.0 \times 9.81}$» = 34.3 «ms^{-1}»

[2 marks]

25b. *[2 marks]*

Markscheme

use of impulse $F_{ave} \times \Delta t = \Delta p$

OR

use of $F = ma$ with average acceleration

OR

$F = \frac{80.0 \times 34.3}{0.759}$

3620«N»

Allow ECF from (a).

[2 marks]

25c. *[2 marks]*

Markscheme

upwards

clearly longer than weight

For second marking point allow ECF from (b)(i) providing line is upwards.

[2 marks]

25d. *[2 marks]*

Markscheme

3620 + 80.0 × 9.81

4400 «N»

Allow ECF from (b)(i).

[2 marks]

25e. *[1 mark]*

Markscheme

(loss in) gravitational potential energy (of block) into kinetic energy (of block)

Must see names of energy (gravitational potential energy and kinetic energy) – Allow for reasonable variations of terminology (eg energy of motion for KE).

[1 mark]

25f. *[1 mark]*

Markscheme

(loss in) gravitational potential and kinetic energy of block into elastic potential energy of rope

See note for 1(c)(i) for naming convention.

Must see either the block or the rope (or both) mentioned in connection with the appropriate energies.

[1 mark]

25g. *[2 marks]*

Markscheme

k can be determined using EPE = $\frac{1}{2}kx^2$

correct statement or equation showing

GPE at A = EPE at C

OR

(GPE + KE) at B = EPE at C

Candidate must clearly indicate the energy associated with either position A or B for MP2.

[2 marks]

26a. *[2 marks]*

Markscheme

$\frac{1}{2}v^2 = 0.24\text{gh}$

$v = 11.9$ «m s^{-1}»

Award GPE lost = 65 × 9.81 × 30 = «19130 J»

Must see the 11.9 value for MP2, not simply 12.

Allow g = 9.8 ms^{-2}.

26b. *[2 marks]*

Markscheme

internal energy is the total KE «and PE» of the molecules/particles/atoms in an object

temperature is a measure of the average KE of the molecules/particles/atoms

*Award **[1 max]** if there is no mention of molecules/particles/atoms.*

26c. *[2 marks]*

Markscheme

arrow vertically downwards from dot labelled weight/W/mg/gravitational force/F_g/$F_{gravitational}$ ***AND*** arrow vertically upwards from dot labelled reaction force/R/normal contact force/N/F_N

W > R

Do not allow gravity.
Do not award MP1 if additional 'centripetal' force arrow is added.
Arrows must connect to dot.
Ignore any horizontal arrow labelled friction.
Judge by eye for MP2. Arrows do not have to be correctly labelled or connect to dot for MP2.

26d. *[3 marks]*

Markscheme

ALTERNATIVE 1

recognition that centripetal force is required / $\frac{mv^2}{r}$ seen

= 468 «N»

W/640 N (weight) is larger than the centripetal force required, so the skier does not lose contact with the ground

ALTERNATIVE 2

recognition that centripetal acceleration is required / $\frac{v^2}{r}$ seen

a = 7.2 «ms^{-2}»

g is larger than the centripetal acceleration required, so the skier does not lose contact with the ground

ALTERNATIVE 3

recognition that to lose contact with the ground centripetal force ≥ weight

calculation that v ≥ 14 «ms^{-1}»

comment that 12 «ms^{-1}» is less than 14 «ms^{-1}» so the skier does not lose contact with the ground

ALTERNATIVE 4

recognition that centripetal force is required / $\frac{mv^2}{r}$ seen

calculation that reaction force = 172 «N»

reaction force > 0 so the skier does not lose contact with the ground

Do not award a mark for the bald statement that the skier does not lose contact with the ground.

26e. *[3 marks]*

Markscheme

ALTERNATIVE 1

$0 = 8.2^2 + 2 \times a \times 24$ therefore a = «–»1.40 «m s^{-2}»

friction force = ma = 65 × 1.4 = 91 «N»

coefficient of friction = $\frac{91}{65 \times 9.81}$ = 0.14

ALTERNATIVE 2

$KE = \frac{1}{2}mv^2$ = 0.5 x 65 x 8.2^2 = 2185 «J»

friction force = KE/distance = 2185/24 = 91 «N»

coefficient of friction = $\frac{91}{65 \times 9.81}$ = 0.14

Allow ECF from MP1.

26f. *[2 marks]*

Markscheme

«76 × 9.6»= 730
Ns ***OR*** kg ms^{-1}

26g. *[2 marks]*

Markscheme

safety net extends stopping time

$F = \frac{\Delta p}{\Delta t}$ therefore F is smaller «with safety net»

OR

force is proportional to rate of change of momentum therefore F is smaller «with safety net»

Accept reverse argument.

27a. *[2 marks]*

Markscheme

correct use of kinematic equation/equations

148.5 ***or*** 149 ***or*** 150 «m»

Substitution(s) must be correct.

27b. *[3 marks]*

Markscheme

$a = \frac{2T}{11}$ ***or*** 2.45 «m s^{-2}»

$F - 160 = 492 \times 2.45$

1370 «N»

Could be seen in part (a).
*Award **[0]** for solution that uses $a = 9.81$ m s^{-2}*

27c. *[3 marks]*

Markscheme

ALTERNATIVE 1

«work done to launch glider» = 1370 x 149 «= 204 kJ»

«work done by motor» $= \frac{204 \times 100}{23}$

«power input to motor» $= \frac{204 \times 100}{23} \times \frac{1}{11} = 80$ ***or*** 80.4 ***or*** 81 k«W»

ALTERNATIVE 2

use of average speed 13.5 m s^{-1}

«useful power output» = force x average speed «= 1370 x 13.5»

power input = «$1370 \times 13.5 \times \frac{100}{23}$ =» 80 ***or*** 80.4 ***or*** 81 k«W»

ALTERNATIVE 3

work required from motor = KE + work done against friction «$= 0.5 \times 492 \times 27^2 + (160 \times 148.5)$» = 204 «kJ»

«energy input» $= \frac{\text{work required from motor} \times 100}{23}$

power input $= \frac{883000}{11} = 80.3$ k«W»

*Award **[2 max]** for an answer of 160 k«W».*

27d. *[2 marks]*

Markscheme

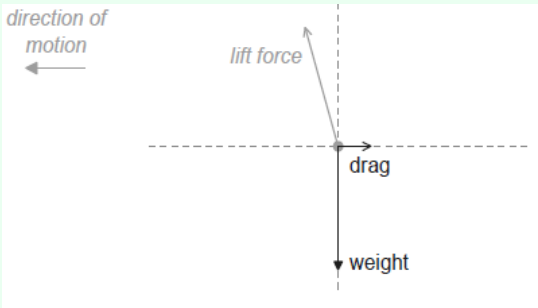
$\omega = «\frac{v}{r} =» \frac{27}{0.6} = 45$

rad s^{-1}

Do not accept Hz.
*Award **[1 max]** if unit is missing.*

27e. *[2 marks]*

Markscheme



drag correctly labelled and in correct direction

weight correctly labelled and in correct direction ***AND*** no other incorrect force shown

*Award **[1 max]** if forces do not touch the dot, but are otherwise OK.*

27f. *[2 marks]*

Markscheme

name Newton's first law

vertical/all forces are in equilibrium/balanced/add to zero
OR
vertical component of lift mentioned

as equal to weight

27g. *[3 marks]*

Markscheme

any speed and any direction quoted together as the answer

quotes their answer(s) to 3 significant figures

speed = 12.7 m s^{-1} ***or*** direction = 9.46° ***or*** 0.165 rad «below the horizontal» ***or*** gradient of $-\frac{1}{6}$

28a. *[3 marks]*

Markscheme

«light» superposes/interferes

pattern consists of «intensity» maxima and minima
OR
consisting of constructive and destructive «interference»

voltage peaks correspond to interference maxima

28b. *[1 mark]*

Markscheme

«$s = \frac{\lambda D}{d} = \frac{6.3\times10^{-7}\times5.0}{1.5\times10^{-3}}$ =» 2.1 x 10^{-3} «m»

If no unit assume m.
Correct answer only.

28c. *[2 marks]*

Markscheme

correct read-off from graph of 25 m s

v = «$\frac{x}{t} = \frac{2.1\times10^{-3}}{25\times10^{-3}}$ =» 8.4 x 10^{-2} «m s^{-1}»

Allow ECF from (b)(i)

28d. *[2 marks]*

Markscheme

ALTERNATIVE 1

«reflection at barrier» leads to two waves travelling in opposite directions

mention of formation of standing wave

maximum corresponds to antinode/maximum displacement «of air molecules»
OR
complete cancellation at node position

29a. *[1 mark]*

Markscheme

in order to keep the temperature constant

in order to allow the system to reach thermal equilibrium with the surroundings/OWTTE

Accept answers in terms of pressure or volume changes only if clearly related to reaching thermal equilibrium with the surroundings.

[1 mark]

29b. *[3 marks]*

Markscheme

recognizes *b* as gradient

calculates *b* in range 4.7×10^4 to 5.3×10^4

Pa m

*Award **[2 max]** if POT error in b.*
Allow any correct SI unit, eg kg s^{-2}.

[3 marks]

29c. *[2 marks]*

Markscheme

$V \propto H$ thus ideal gas law gives $p \propto \frac{1}{H}$

so graph **should be** «a straight line through origin,» as **observed**

[2 marks]

29d. *[2 marks]*

Markscheme

$n = \frac{bA}{RT}$ ***OR*** correct substitution of one point from the graph

$n = \frac{5 \times 10^4 \times 1.3 \times 10^{-3}}{8.31 \times 300} = 0.026 \approx 0.03$

Answer must be to 1 or 2 SF.

Allow ECF from (b).

[2 marks]

29e. *[2 marks]*

Markscheme

very large $\frac{1}{H}$ means very small volumes / very high pressures

at very small volumes the ideal gas does not apply
OR
at very small volumes some of the assumptions of the kinetic theory of gases do not hold

[2 marks]

30a. *[1 mark]*

Markscheme

it is not possible to draw a straight line through all the error bars
OR
the line of best-fit is curved/not a straight line

Treat as neutral any reference to the origin.

Allow "linear" for "straight line".

[1 mark]

30b. *[2 marks]*

Markscheme

d = 0.35 ± 0.01 ***AND*** Δd = 0.05 ± 0.01 «cm»

«$\frac{\Delta d}{d} = \frac{0.5}{0.35}$» = 0.14

OR

$\frac{1}{7}$ ***or*** 14% ***or*** 0.1

Allow final answers in the range of 0.11 to 0.18.

*Allow **[1 max]** for 0.03 to 0.04 if*
$\lambda = 5 \times 10^{6}$ m is used.

[2 marks]

30c. *[1 mark]*

Markscheme

28 to 30%

Allow ECF from (b)(i), but only accept answer as a %

[1 mark]

30d. *[2 marks]*

Markscheme

a: m^2

b: m

Allow answers in words

[2 marks]

30e. *[2 marks]*

Markscheme

ALTERNATIVE 1 – if graph on page 4 is used

$d^2 = 0.040 \times 10^{-4}$ «m^2»

$d = 0.20 \times 10^{-2}$ «m»

ALTERNATIVE 2 – if graph on page 2 is used

any evidence that *d* intercept has been determined

d = 0.20 ± 0.05 «cm»

For MP1 accept answers in range of 0.020 to 0.060 «cm^2» if they fail to use given value of "a".

For MP2 accept answers in range 0.14 to 0.25 «cm» .

[2 marks]

31a. *[4 marks]*

Markscheme

(i)

$\ll E_{el} = \gg \frac{1}{2}mv^2 + mgh$

OR

«E_{el}=» $E_P + E_K$

$\ll E_{el} = \gg \frac{1}{2} \times 55 \times 0.90^2 + 55 \times 9.8 \times 1.2$

OR

669 J

«E_{el} = 669 ≈ 670J»

*Award **[1 max]** for use of g=10Nkg^{-1}, gives 682 J.*

(ii)

$\frac{1}{2} \times 55 \times v^2 = 670\text{J}$

$v = \ll \sqrt{\frac{2 \times 670}{55}} = \gg 4.9\text{ms}^{-1}$

If 682J used, answer is 5.0ms^{-1}.

31b. *[3 marks]*

Markscheme

(i)
no force/friction on the block, hence constant motion/velocity/speed

(ii)
force acts on block ***OR*** gravity/component of weight pulls down slope

velocity/speed decreases ***OR*** it is slowing down ***OR*** it decelerates

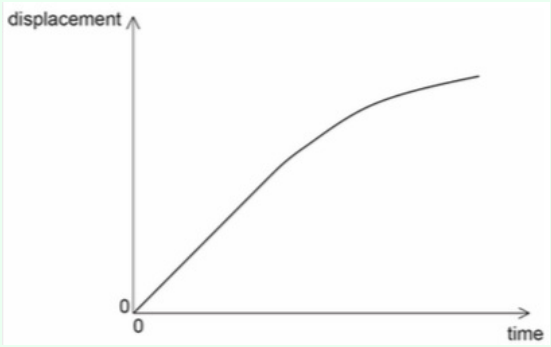
Do not allow a bald statement of "N2" or "F = ma" for MP1.
Treat references to energy as neutral.

31c. *[2 marks]*

Markscheme

straight line through origin for at least one-third of the total length of time axis **covered by candidate line**

followed by curve with decreasing positive gradient



Ignore any attempt to include motion before A.

Gradient of curve must always be less than that of straight line.

31d. *[2 marks]*

Markscheme

$F \ll= \frac{\Delta p}{\Delta t} \gg= \frac{55 \times 4.9}{0.42}$

F=642≈640N

Allow ECF from (a)(ii).

31e. *[2 marks]*

Markscheme

«energy supplied by motor =» 120 × 6.8 × 1.5 ***or*** 1224 J
OR
«power supplied by motor =» 120 × 6.8 ***or*** 816 W
e = 0.55 ***or*** 0.547 or 55% ***or*** 54.7%

Allow ECF from earlier results.

32a. *[4 marks]*

Markscheme

(i) refractive index = 1.5

*Both correct value and 2SF required for **[1]**.*

(ii) fractional uncertainty $x_3 - x_1 = \frac{0.04}{1.15} = 0.035$ ***AND*** $x_3 - x_2 = \frac{0.04}{0.76} = 0.053$

sum of fractional uncertainty = 0.088

«uncertainty = their RI × 0.088» = 0.1

Accept correct calculation using maximum and minimum values giving the same answer.

32b. *[3 marks]*

Markscheme

(i) systematic error
Accept "zero error/offset".

(ii) calculated refractive index is unchanged
because both numerator and denominator are unchanged
Accept calculation of refractive index with 0.05 subtracted to each x value.

32c. *[2 marks]*

Markscheme

numerator and denominator will be 10 times larger so refractive index is unchanged
relative/absolute uncertainty will be smaller

"Constant material" is not enough for MP1.

33. *[1 mark]*

Markscheme

D

34. *[1 mark]*

Markscheme

A

35. *[1 mark]*

Markscheme

C

36a. *[4 marks]*

Markscheme

distances itemized; *(it must be clear through use of s_I or distance I etc)*

distances equated;

$t = \frac{2v}{a}$ / cancel and re-arrange;

substitution $\left(\frac{2\times 45}{3.2}\right)$ shown / 28.1(s) seen;

or

clear written statement that the average speed of B must be the same as constant speed of I;

as B starts from rest the final speed must be 2×45;

so $t = \frac{\Delta v}{a} = \frac{90}{3.2}$;

28.1 (s) seen; *(for this alternative the method must be clearly described)*

or

attempts to compare distance travelled by I and B for 28 s;

I distance $= (45 \times 28 =)\ 1260\ (\text{m})$;

B distance $= (\frac{1}{2} \times 3.2 \times 28^2 =)\ 1255\ (\text{m})$;

deduces that overtake must occur about $\left(\frac{5}{45} =\right)\ 0.1$ s later;

36b. *[2 marks]*

Markscheme

use of appropriate equation of motion;

$(1.26 \approx)$ 1.3 (km);

*Award **[2]** for a bald correct answer.*

36c. *[3 marks]*

Markscheme

driver I moves at constant speed so no net (extra) force according to Newton 1;

driver B decelerating so (extra) force (to rear of car) (according to Newton 1) / momentum/inertia change so (extra) force must be present;

(hence) greater tension in belt B than belt I;

*Award **[0]** for stating that tension is less in the decelerating car (B).*

36d. *[2 marks]*

Markscheme

$930 \times v + 850 \times 45 = 1780 \times 52$ ***or*** statement that momentum is conserved;

$v = 58\ (\text{m s}^{-1})$;

*Allow **[2]** for a bald correct answer.*

36e. *[2 marks]*

Markscheme

use of force $\frac{\text{change of momentum}}{\text{time}}$ (or any variant, *eg*: $\frac{930 \times 6.4}{0.45}$);

$13.2 \times 10^3\ (\text{N});\}$ *(must see matched units and value ie: 13 200 without unit gains MP2, 13.2 does not)*

*Award **[2]** for a bald correct answer.*

Allow use of 58 m s^{-1} from (c)(i) to give 12 400 (N).

36f. *[2 marks]*

Markscheme

ammeter must have very low resistance/much smaller than R;

voltmeter must have very large resistance/much larger than R;

*Allow **[1 max]** for zero and infinite resistance for ammeter and voltmeter respectively.*

*Allow **[1 max]** if superlative (eg: very/much/OWTTE) is missing.*

36g. *[3 marks]*

Markscheme

power (loss in resistor)
$= 0.36\ (\text{W});\}$ *(accept answers in the range of 0.35 to 0.37 (W) – treat value outside this range as ECF (could still lead to 0.7))*

$I^2 \times 0.80 = 0.36$;

$I = 0.67\ (\text{A})$ ***or*** $\sqrt{\left(\frac{0.36}{0.8}\right)}$; *(allow answers in the range of 0.66 to 0.68 (A).*

36h. *[2 marks]*

Markscheme

resistance of the components/chemicals/materials within the cell itself;} *(not "resistance of cell")*

leading to energy/power loss in the cell;

36i. *[3 marks]*

Markscheme

power (in cell with 0.7 A) $= 0.58\ \text{W};\}$ *(allow answers in the range of 0.57 W to 0.62 W)*

$0.7^2 \times r = 0.58$;

$r = 1.2\ (\Omega)$; *(allow answers in the range of 1.18 to 1.27 (Ω))*

or

when powers are equal;

$I^2R = I^2r$;

so $r = R$ which occurs at 1.2(5) (Ω);

*Award **[1 max]** for bald 1.2(5) (Ω).*

36j. *[2 marks]*

Markscheme

$(E = I(R + r)) = 0.7(0.8 + 1.2)$;

1.4 (V);

Allow ECF from (e) or (f)(ii).

or

when $R = 0$, power loss $= 1.55$;

$E = (\sqrt{1.55 \times 1.2} =)\ 1.4\ (\text{V})$;

37. *[1 mark]*

Markscheme

B

38. *[1 mark]*

Markscheme

A