T2-2 *[195 marks]*

1\. *[1 mark]*

Markscheme

A

Examiners report

[N/A]

2\. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

3\. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

4\. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

5\. *[1 mark]*

Markscheme

B

Examiners report

There were a few comments on the G2 forms about the use of the term “displacement”. Displacement is generally understood as the vector from a fixed point to the position of a particle. As the particle moves, the position and hence the displacement vector, changes. Thus it is perfectly correct to ask about the “change in the displacement”.

6.

[1 mark]

Markscheme

A

Examiners report

[N/A]

7.

[1 mark]

Markscheme

C

Examiners report

[N/A]

8.

[1 mark]

Markscheme

D

Examiners report

Most candidates selected the incorrect response of C. The only difference between C and D is the relative lengths of the vertical arrows and as a component of F contributes to the upward force the correct answer must be D. Candidates are urged to read all the options given as they are required to select the best option and clearly, in this case, D is better than C.

9.

[1 mark]

Markscheme

D

Examiners report

[N/A]

10.

[1 mark]

Markscheme

A

Examiners report

A few teachers commented that this question was too wordy. Yet the statistics show that most candidates understood that no work is done on a body if the force acts upon it at 90° **to its motion**, as is the case with circular motion.

11.

[1 mark]

Markscheme

B

Examiners report

The mass of the spring is negligible; hence it cannot have any kinetic energy, thus automatically eliminating C and D.

12.

[1 mark]

Markscheme

C

Examiners report

[N/A]

13.

[1 mark]

Markscheme

A

Examiners report

[N/A]

14.

[1 mark]

Markscheme

D

Examiners report

[N/A]

15a.

[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.

Examiners report

As in the previous question, candidates appeared to understand the distinction between average and instantaneous speeds but could not express a concise or (sometimes) meaningful account. Some good answers were seen that used calculus ideas but this was not required by the examiners.

15b.

[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 $v=kt^2$;

Examiners report

(i) Candidates were required to recognize that the area under an acceleration–time graph yields the speed change of a particle. They were also expected to give a realistic number of significant figures in their answer. This trapped very many.

(ii) A very large majority of candidates were able to give a good sketch of a parabola for their answer. Failing answers included a straight line through the origin and a straight line parallel to the *x*-axis.

16a. *[1 mark]*

Markscheme

mass×velocity; *(allow mv with symbols defined)*

Examiners report

Linear momentum was defined accurately. Only a handful used speed rather than velocity in the definition.

16b. *[1 mark]*

Markscheme

the rate of change of momentum of a body is equal to/directly proportional to the force acting on the body;

Accept

$F = \frac{\Delta p}{\Delta t}$ *only if all symbols are define*d.

Examiners report

Newton's second law of motion appeared to be well understood but some failed to quote it in the context of momentum and gave the simpler statement in terms of $F=ma$.

16c. *[1 mark]*

Markscheme

$\left(F = \frac{\Delta p}{\Delta t}\right)$

therefore impulse $F\Delta t = \Delta p$; *(accept t for Δt)*

Examiners report

Many were able to show that impulse is equal to the change in momentum.

16d. *[1 mark]*

Markscheme

$\left(F = \frac{\Delta p}{\Delta t}\right)$

therefore impulse $F\Delta t = \Delta p$; *(accept t for Δt)*

Examiners report

Many were able to show that impulse is equal to the change in momentum.

16e. *[12 marks]*

Markscheme

(i) (impulse=) change in momentum$=2.2\times10^3\times4.3$($=9.46\times10^3$Ns);
impulse=area under graph$=\frac{1}{2}F_{max}\Delta t$;
$\frac{1}{2}F_{max}\times0.54=9.46\times10^3$;
$F_{max}=35$k(N) ***or*** 3.5×10^4 (N);

(ii) (magnitude of) acceleration$=\left(\frac{u^2-v^2}{2s}=\frac{4.3^2-2.8^2}{30}=\right)0.355\text{ms}^{-2}$;

time$=\left(\frac{u-v}{a}=\frac{1.5}{0.355}=\right)4.2\text{s}$;

*Award **[1 max]** if an additional 0.54 s is added to answer.*

(iii) $\Delta KE=\left(\frac{1}{2}\times2.2\times10^3\left[4.3^2-2.8^2\right]=\right)1.17\times10^4\text{J}$;

rate of change of $\Delta KE=\frac{1.17\times10^4}{4.2}=2.8\text{kW}$
(mark is for division by 4.2 <u>and</u> correct calculation)

(iv) *statement of momentum conservation:*
e.g. momentum of the truck before collision=momentum of both trucks after collision;
(allow clear symbolism instead of words)

$2.2\times10^3\times2.8=5.2\times10^3V$ ***or*** $V=\frac{2.2}{5.2}\times2.8$;
to give $V=1.2\text{ms}^{-1}$

(v) the first truck loses kinetic energy that is transferred to internal energy in the links between the trucks (and as sound);
and to kinetic energy of the stationary truck;
*Award **[0]** for "lost as heat, light and sound", or "in air resistance".*

Examiners report

(i) This was another question where candidates let themselves down very badly with their quality of explanation and presentation. Although many obtained the correct answer it was often not clear that they had fully appreciated the assumptions they were making. Examiners (for full credit) were looking for explanations typically in terms of the area under the *F-t graph* – it was rare to see this – with a full consideration of the evaluation of the isosceles triangle. Many candidates will have scored only one mark for an evaluation of the momentum change (usually by inference rather than by direct candidate statement) and one mark for the answer.
(ii) This straightforward application of the kinematic equations was often well done, but some candidates failed to read the question carefully and could not identify the correct values for the speed of the truck.
(iii) A common error was to evaluate $(4.8\text{-}2.3)^2$ rather than the correct $(4.2^2\text{-}2.8^2)$ in the route towards the change in kinetic energy. However, whether evaluating the correct change in kinetic energy or not, most were able to divide a value for the change by the time calculated in (ii) to determine an average rate of energy dissipation.
(iv) Candidates were required to indicate the basis for the calculation (conservation of momentum) and to identify the algebraic or numerical method they were using. Although many gained full marks, once again candidates did not make it easy for examiners to establish the basis for the method. Clear statements of momentum conservation were rare and examiners were frequently expected to infer the method from an undefined set of symbols sometimes unrelated to this particular problem.
(v) Most candidates gained one mark from this question by outlining the transfer in kinetic energy from first to second truck. Few recognized the role of the trucks‟ coupling mechanism preferring to emphasize the relatively minor and generalized roles of heat and sound dissipation in the collision. This is a frequent response in energy transfer questions such as this; candidates should consider specific examples in the question rather than making recourse to more general issues of energy transfer.

17a. *[3 marks]*

Markscheme

distance between surfaces of blocks=0.900-0.050=0.850m;
relative speed between blocks = 0.36ms^{-1};
time = $\frac{\text{distance}}{\text{speed}} = \frac{0.850}{0.36} = 2.4\text{s}$;

or

blocks moving at same speed so meet at mid-point;
distance travelled by block=0.450-0.025=0.425m;
time = $\frac{\text{distance}}{\text{speed}} = \frac{0.425}{0.18} = 2.4\text{s}$;

*Award **[3]** for bald correct answer.*
*Award **[2 max]** if distance of 0.90 m or 0.45 m used to get 2.5 s.*

Examiners report

[N/A]

17b. *[5 marks]*

Markscheme

(i) the collision is inelastic;
because kinetic energy is not conserved (although momentum is);

(ii) initial $E_K = \frac{1}{2} \times 0.17 \times 0.18^2 = 0.002754\text{J}$;
final $E_K = 0.80 \times 0.002754 = 0.0022032\text{J}$;
final speed $= \sqrt{\frac{2 \times 0.0022032}{0.17}}$;
=0.16ms^{-1}

or

0.8×initial E_K=final E_K;
$0.8 \times \frac{1}{2} \times 0.17 \times 0.18^2 = \frac{1}{2} \times 0.17 \times v^2$;
$v = \sqrt{0.8 \times 0.18^2}$;
=0.16ms^{-1}

Examiners report

[N/A]

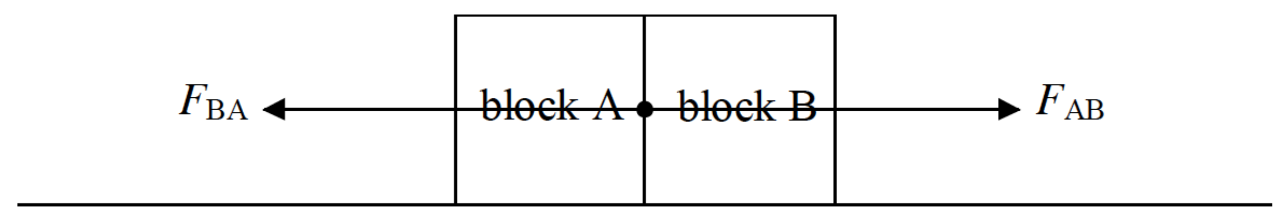
17c.

[7 marks]

Markscheme

(i) if object A exerts a force on object B, then object B (simultaneously) exerts an equal and opposite force on object A / every action has an equal and opposite reaction / *OWTTE*;

(ii) arrows of equal length; *(judge by eye)*
acting through centre of blocks;
correct labelling consistent with correct direction;



(iii) $\Delta v = 0.16 - (-0.18) = 0.34 \text{ms}^{-1}$;
$a = \frac{\Delta v}{\Delta t} = \frac{0.34}{0.070} = 4.857 \text{ms}^{-2}$;
$F = ma = 0.17 \times 4.857 = 0.83\text{N}$;

or

$\Delta v = 0.16 - (-0.18) = 0.34 \text{ms}^{-1}$;
$\text{impulse} = F\Delta t = m\Delta v \Rightarrow F = \frac{0.17 \times 0.34}{0.07}$;
F=0.83N;

Examiners report

[N/A]

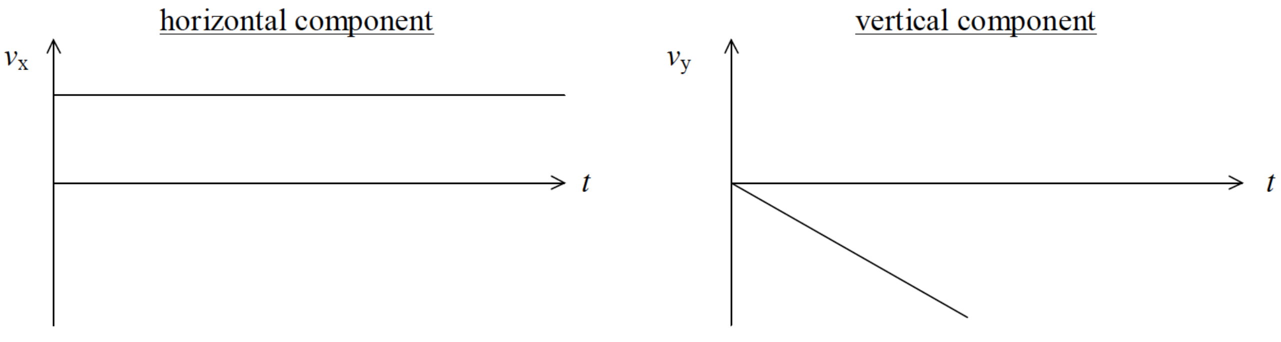
18a.

[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)*;



Examiners report

[N/A]

18b. *[4 marks]*

Markscheme

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

$t = 4.690 \approx 4.7\text{s}$;

(ii) $s_x = u_x t = 5.0 \times 4.690$;

$s_x = 23\text{m}$;

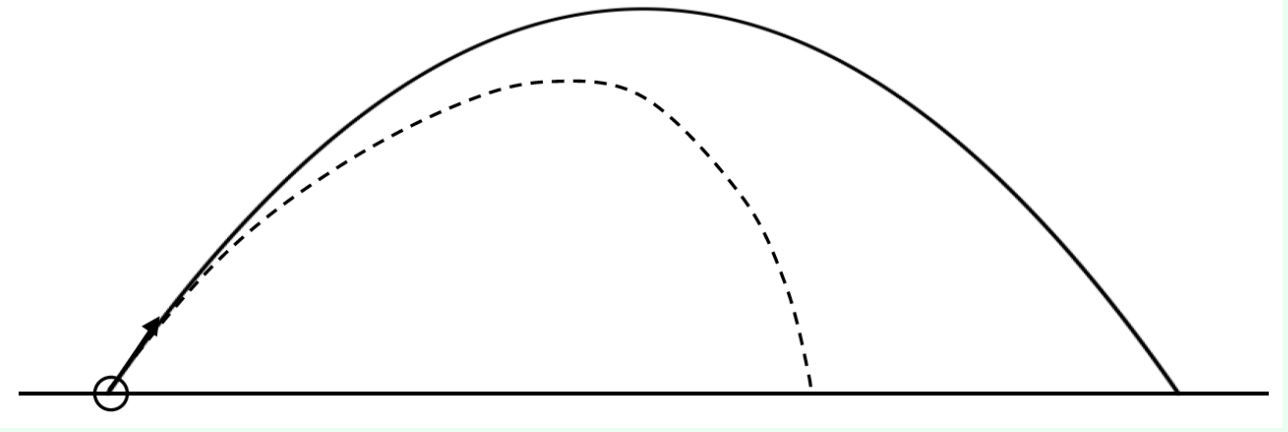
Examiners report

[N/A]

18c. *[3 marks]*

Markscheme

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



Examiners report

[N/A]

19a. *[2 marks]*

Markscheme

if no external forces act / isolated system;
momentum is constant / (total) momentum before=(total) momentum after;

Examiners report

[N/A]

19b.

[7 marks]

Markscheme

(i) use of $v = \sqrt{2gh}$;

6.11ms^{-1}; *(must show calculation to better than 1 sf)*

(ii) rate of change of vertical momentum=13×6.11;
79N; *(accept answers in the range of 78N to 80N)*

(iii) mass accrued=5.0×13=65kg;
weight of this mass (=65×9.8)=637N; *(650 from g=10ms^{-2})*
total force (637+79=)716N; } *(allow ECF from (b)(ii) and from incorrect weight)*

Examiners report

[N/A]

19c.

[4 marks]

Markscheme

(i) 14.6Js^{-1};

(ii) horizontal momentum gain per second =13×1.5(=19.5kgms^{-1});
power required=29.3W;

(iii) additional energy/power required to accelerate gravel (through friction at the surface of the belt) / the gravel has to slip to gain horizontal speed / *OWTTE*;

Examiners report

[N/A]

20a.

[7 marks]

Markscheme

(i) attempt at area under graph;
appropriate triangle 175 m;
a comment about missing area making answer a little less / *OWTTE*;

(ii) $t = \sqrt{\frac{2 \times 170}{9.81}}$ $(= 5.89\text{s})$;

u=57.8(ms^{-1}) ***or*** u^2=3340m^{2}s^{-2};

speed ($= \sqrt{\left(57.8^2 + 56^2\right)} = 80.4\text{ms}^{-1}$;

46° to horizontal;

Examiners report

[N/A]

20b.

[3 marks]

Markscheme

$\frac{GMm}{r^2} = \frac{mv^2}{r}$;

$v = \sqrt{\frac{GM}{r}}$;

7.75×10^{3}ms^{-1};

Examiners report

[N/A]

21. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

22. *[1 mark]*

Markscheme

A

Examiners report

[N/A]

23. *[1 mark]*

Markscheme

B

Examiners report

[N/A]

24. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

25. *[1 mark]*

Markscheme

B

Examiners report

[N/A]

26. *[1 mark]*

Markscheme

A

Examiners report

[N/A]

27.

[1 mark]

Markscheme

C

Examiners report

Response B was a common choice in both HL and SL. One can only assume that the candidates were taking half of the total work done from 0 cm to 6.0 cm, rather than looking at the relevant area under the graph.

28.

[1 mark]

Markscheme

A

Examiners report

29a.

[2 marks]

Markscheme

$h = \frac{v^2}{2g}$;

$= \left(\frac{225}{20} = \right) 11\text{m}$;

*Award **[1 max]** for 91m or 91.25m (candidate adds cliff height incorrectly).*

Examiners report

The kinematic solutions seen were very pleasing with clear explanations and correct answers. However some candidates added an extra 80 m to the answer having failed to appreciate that the answer should have been “from the point where it [the stone] was thrown”, i.e. the top of the cliff.

29b.

[3 marks]

Markscheme

time to reach maximum height=1.5s;
time to fall 91m=4.3s;
total time=5.8s;
Answer can be alternatively expressed as 3.0 (to return to hand) +2.8 (to fall 80m).

or

use of $s=ut+½at^2$;
$80=-15t+5t^2$ or $-80=15t-5t^2$;
$t=5.8\text{s}$;

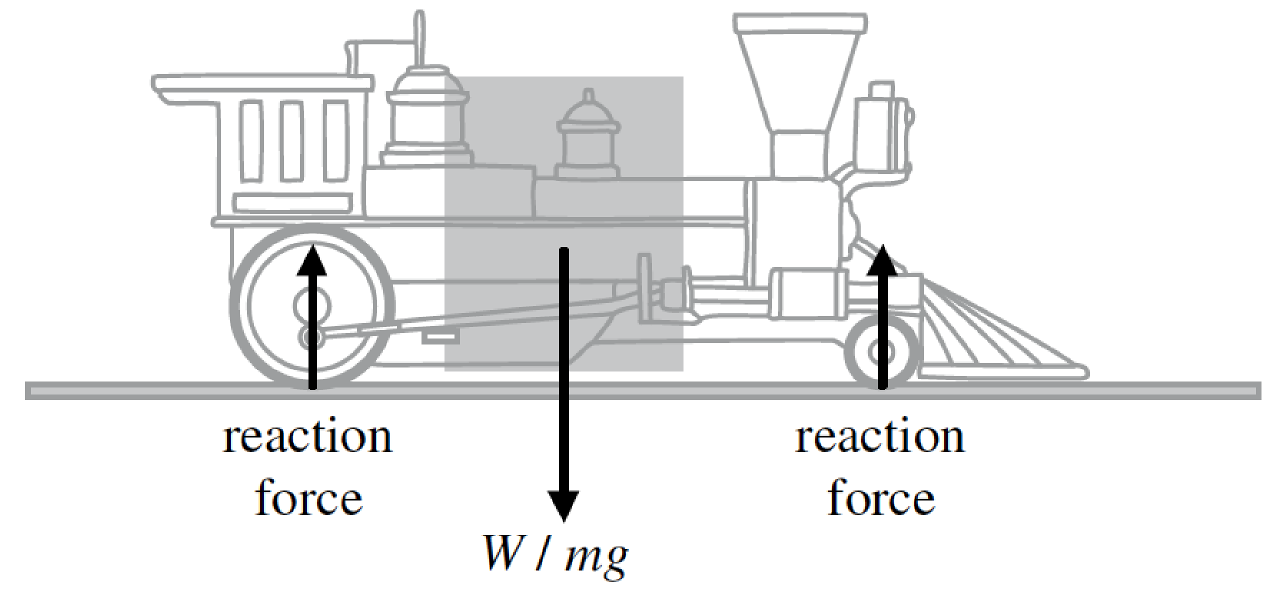
Examiners report

Two routes to the answer were seen: a straightforward approach in which both sections of the motion are considered and totalled, and a method using a single determination of a quadratic equation from $s = ut + 1⁄2at^2$. Only about half the candidates using the second route were able to arrive at the answer without error. The first approach was well done by the majority attempting this route.

30a.

[3 marks]

Markscheme



The shaded box shows the acceptable range of position for W/mg.
single downward arrow labelled *W*/weight ***or*** *mg*/gravity force; *(do not allow gravity)*
two upward arrows labelled reaction/contact forces; *(do not allow for only one arrow seen)*
arrow positions as shown in diagram;

Examiners report

[N/A]

30b.

[2 marks]

Markscheme

horizontal forces have resultant of zero; *(must describe or imply horizontal force)*
valid statement linked to theory (*e.g.* Newton 1/Newton 2/conservation of momentum)
explaining why zero force results in constant velocity/zero acceleration;

Examiners report

[N/A]

30c.

[2 marks]

Markscheme

power $=16 \times 76000$;
1.2 MW;

Examiners report

[N/A]

30d. *[2 marks]*

Markscheme

acceleration = $\frac{16^2}{2\times1100}$(= 0.116);

$m = \left(\frac{7.6\times10^4}{0.116} = \right) 6.5\times10^5\,\mathrm{kg}$;

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

or

use of *Fs*=$\frac{1}{2}mv^2$;

$m = \left(\frac{2\times7.6\times10^4\times1100}{16^2} = \right) 6.5\times10^5\,\mathrm{kg}$;

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

Examiners report

[N/A]

30e. *[5 marks]*

Markscheme

(i) 57 kN;

(ii) $F_8 = \frac{F_{16}}{2^3}$;
F_8=7.1(kN);
total force =19+7.1(kN);
=26 kN;
*Award **[4]** for a bald correct answer.*

or

$k = \left(\frac{57\times10^3}{16^3}\right) = 13.91$;

F_8=(13.91×8^3)=7.1(kN);
total force=19+7.1(kN);
=26 kN;
*Award **[4]** for a bald correct answer.*

Examiners report

[N/A]

30f. *[3 marks]*

Examiners report

[N/A]

31a. *[6 marks]*

Markscheme

(i) upward arrow labelled *T*/tension/force in cable and downward arrow labelled *W*/*mg*/weight/gravity force;{ *(both needed)*

tension arrow length >weight length;

(ii) $a = \frac{2s}{t^2}$;

$a = \left(\frac{2 \times 8.0}{6.5^2} = \right) 0.38 \left(\text{ms}^{-2}\right)$;

T=*ma*+*mg* ***or*** *T*=350(0.38+9.8);

3.6 kN;

Allow g=10 N kg^{-1} (same answer to 2 sf).

Examiners report

[N/A]

31b. *[4 marks]*

Markscheme

(i) change in gpe=350×9.81×7.0(=24kJ);

power $\left(= \frac{24 \times 10^3}{15} \right) = 1.6\text{kw}$;

Allow g=10Nkg^{-1}.

(ii) power input to motor=13.5 (kW);

efficiency=$\left(\frac{1.6}{13.5} = \right) 0.12$ ***or*** 12%;

Examiners report

[N/A]

32a. *[2 marks]*

Markscheme

(minimum) speed of object to escape gravitational field of a planet/travel to infinity;

at surface of planet;

without (further) energy input;

Examiners report

[N/A]

32b. *[5 marks]*

Markscheme

(i) $-\frac{6.67\times10^{-11}\times3.5\times10^{21}}{8.0\times10^{5}}$;

-2.9×10^5Jkg^{-1}; *(allow Nmkg^{-1})*

*Award **[1 max]** if negative sign omitted.*

(ii) $\frac{1}{2}mv^2 = mV$;

speed= $= \sqrt{2\times2.9\times10^5}$; *(allow ECF from (b)(i))*

7.6 $\times10^2$ms^{-1};

Ignore sign.

*Award **[3]** for a bald correct answer.*

Examiners report

[N/A]

32c. *[3 marks]*

Markscheme

time to hit surface $= \sqrt{\frac{2.0\times1.5}{0.37}}$ $(= 2.85\text{s})$;

distance to impact = 2.85×1.8;

5.1m;

Examiners report

[N/A]

33. *[1 mark]*

Markscheme

C

Examiners report

[N/A]

34. *[1 mark]*

Markscheme

C

Examiners report

[N/A]

35. *[1 mark]*

Markscheme

B

Examiners report

[N/A]

36. *[1 mark]*

Markscheme

A

Examiners report

[N/A]

37. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

38. *[1 mark]*

Markscheme

C

Examiners report

[N/A]

39. *[1 mark]*

Markscheme

D

Examiners report

[N/A]

40a. *[4 marks]*

Markscheme

(i) $v=\sqrt{\frac{2eV}{m}}$;

$v=\sqrt{\frac{2\times1.6\times10^{-19}\times250}{9.1\times10^{-31}}}$;

$=9.4\times10^{6}\text{ms}^{-1}$

(ii) $evB=m\frac{v^2}{r}$;

$r=\frac{9.1\times10^{-31}\times9.4\times10^{6}}{1.6\times10^{-19}\times0.12}$;

$=4.5\times10^{-4}\text{m}$

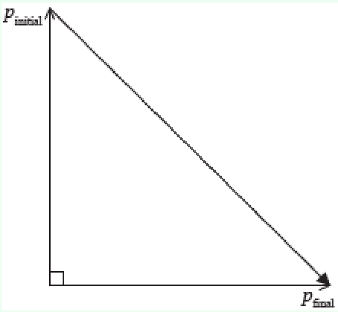
Examiners report

[N/A]

40b. *[3 marks]*

Markscheme

(i) vector as shown;



(ii) $\Delta p=\sqrt{\left[8.6\times10^{-24}\right]^2+\left[8.6\times10^{-24}\right]^2}$;

$=1.2\times10^{-23}\text{Ns}$

(iii) $F\left(=\frac{\Delta p}{\Delta t}=\frac{1.2\times10^{-23}}{7.5\times10^{-11}}\right)=1.6\times10^{-13}\text{N}$;

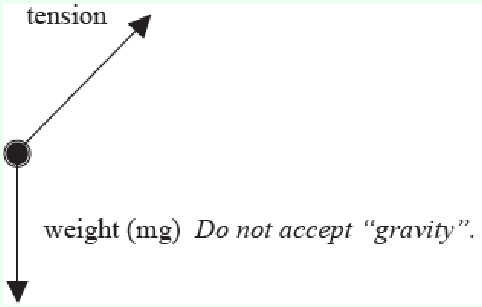
Examiners report

[N/A]

41a. *[4 marks]*

Markscheme

(i) ***[1]*** each for correct arrow <u>and</u> (any reasonable) labelling;



*Award **[1 max]** for arrows in correct direction but not starting at the ball.*

(ii) no;
because the two forces on the ball can never cancel out / there is a net force on the ball / the ball moves in a circle / the ball has acceleration/it is changing direction;
*Award **[0]** for correct answer with no or wrong argument.*

Examiners report

[N/A]

41b. *[3 marks]*

Markscheme

$T\left(=\frac{mg}{\cos 30^\circ}\right) = 2.832\text{N}$;

$\frac{mv^2}{r} = T\sin 30^\circ$;

$v = \left(\sqrt{\frac{Tr\sin 30^\circ}{m}} = \sqrt{\frac{2.832\times 0.33\times \sin 30^\circ}{0.25}}\right) = 1.4\text{ms}^{-1}$;

or

$T\cos 30^\circ = mg$;

$T\sin 30^\circ = \frac{mv^2}{r}$;

$v = \left(\sqrt{gr\tan 30^\circ} = \sqrt{9.81\times 0.33\times \tan 30^\circ}\right) = 1.4\text{ms}^{-1}$;

Examiners report

[N/A]

42a. *[1 mark]*

Markscheme

the area under the curve;

Examiners report

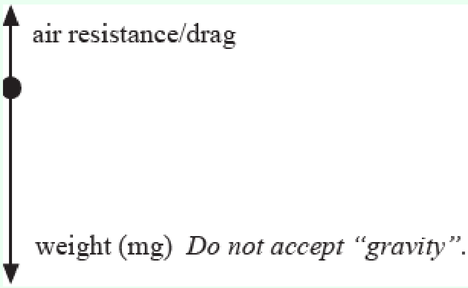
[N/A]

42b.

[7 marks]

Markscheme

(i) arrows as shown, with up arrow shorter;



(ii) drawing of tangent to curve at t = 2.0 s;
calculation of slope of tangent in range 3.6 − 4.4ms^{-2} ;
*Award **[0]** for calculations without a tangent but do not be particular about size of triangle.*

(iii) calculation of F = ma = 0.50 × 4 = 2N
R(= mg −ma = 0.50×9.81− 0.50× 4) ≈ 3N;

(iv) the acceleration is decreasing;
and so R is greater;
or
air resistance forces increase with speed;
since speed at 5.0 s is greater so is resistance force;

Examiners report

[N/A]

42c.

[6 marks]

Markscheme

(i) loss of potential energy is $mg\Delta h$=0.50×9.81×190=932J;
gain in kinetic energy is $\frac{1}{2}mv^2 = \frac{1}{2}0.50 \times 25^2 = 156\text{J}$;
loss of mechanical energy is 932–156;
≈780J

(ii) $mc\Delta\theta$=780J;
$\Delta\theta = \left(\frac{780}{0.5 \times 480}\right) \approx 3\text{K}/3^{\circ}\text{C}$;

(iii) all the lost energy went into heating just the ball / no energy transferred to surroundings / the ball was heated uniformly;

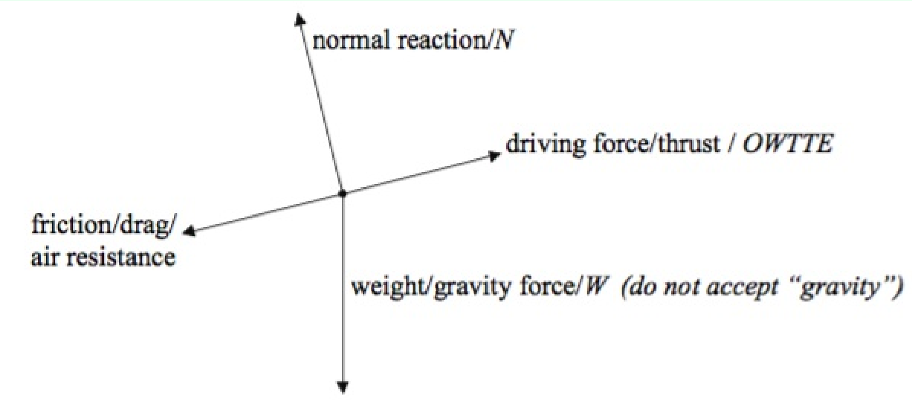
Examiners report

[N/A]

43a. *[5 marks]*

Markscheme

(i)



identification of normal reaction/*N* and weight/*W*;
identification of friction and driving force;
correct directions of all four forces;
correct relative lengths; { (*friction ≅ driving force and N ≅ W but N must not be longer than W) (judge by eye)*

(ii) zero;

Examiners report

(i) Diagrams were poorly presented and ill-thought. 4 marks were assigned to this and candidates should have given much more care to it. Marks were given for appropriate descriptions, directions and lengths of the vectors. In particular, candidates should recognize that the term "acceleration" will not do for a driving force, and that "normal" simply implies "at 90°". The essential point about the upwards force from the surface is that it is a reaction force.
(ii) About half the candidates realized that the momentum change was zero as the velocity was constant.

43b. *[3 marks]*

Markscheme

height gained in 1s=(6.2 sin 6=) 0.648(m);
rate of change of PE=$8.5\times10^{3}\times9.81\times0.648$;
=5.4×10^{4}W;

Examiners report

This question produced a mixed response varying from excellent fully-explained solutions to incoherent attempts with an incompetent inclusion of components or attempts that focussed on the change in the kinetic energy.

43c. *[3 marks]*

Markscheme

power used to overcome friction=($7\times10^{4}-5.4\times10^{4}$=)$1.6\times10^{4}$(W); {(*allow ECF from (c))*

$F = \left(\frac{p}{v} =\right)\frac{1.6\times10^{4}}{6.2}$;

=2.6kN;

Examiners report

Many recognized that the way to estimate the forces was to access the net rate of change of energy and divide this by the speed, but there were two hurdles here: a determination of the correct net power and the correct speed. Very many failed at one or both of these and thus failed to provide a correct answer.

43d.

[4 marks]

Markscheme

(i) component of weight down slope = $8.5\times10^3\times9.81 \sin 6$;
net force=$2.6\times10^3+8.5\times10^3\times9.81 \sin 6$
=11kN;
Watch for ECF from (d).

(ii) air resistance decreases as speed drops;
so net force decreases;

Examiners report

44a.

[1 mark]

Markscheme

because the force is always at right angles to the velocity / motion/orbit is an equipotential surface;
Do not accept answers based on the displacement being zero for a full revolution.

Examiners report

[N/A]

44b.

[4 marks]

Markscheme

(i) equating gravitational force $\frac{GMm}{r^2}$;
to centripetal force $\frac{mv^2}{r}$ to get result;

(ii) kinetic energy is $\frac{GMm}{2r}$;
addition to potential energy $-\frac{GMm}{r}$ to get result;

Examiners report

[N/A]

44c.

[2 marks]

Markscheme

the total energy (at the new orbit) will be greater than before/is less negative;
hence probe engines must be fired to produce force in the direction of motion / positive work must be done (on the probe);
*Award **[1]** for mention of only potential energy increasing.*

Examiners report

[N/A]

45a. *[1 mark]*

Markscheme

$t = \frac{\frac{1}{4}2\pi\times4.5\times10^{-4}}{9.4\times10^{6}}$;

$=7.5\times10^{-11}$s

Examiners report

[N/A]

45b. *[4 marks]*

Markscheme

(i) the flux in the loop is changing and so (by Faraday’s law) an emf will be induced in the loop;
(by Lenz’s law) the induced current will be (counter-clockwise) and so there will be a magnetic force opposing the motion;
requiring work to be done on the loop;

(ii) it is dissipated as thermal energy (due to the resistance) in the loop / radiation;

Examiners report

[N/A]