

Answers for 2007 JC1 Promotional Examination Physics

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
B	B	B	D	D	C	D	B	C	D	A	A	D	A	C
16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
D	D	C	B	C	B	C	D	B	C	A	A	B	A	B

31 (a) (i) $pV = nRT \Rightarrow n = pV/RT = 0.0212 \text{ mol}$ [C1]

$$N = nN_A = 1.27 \times 10^{22} \quad [\text{A1}]$$

(ii) Tot KE = $1.27 \times 10^{22} \times 6.21 \times 10^{-21} = 78.9 \text{ J}$ [C1]

$$\text{PE} = 0, U = \text{tot KE} + \text{tot PE} = 78.9 \text{ J} \quad [\text{A1}]$$

(iii) $F = pA = 440 \text{ N}$ [A1]

(iv) The force is balanced by the force due to the atmosphere. [B1]

(b) (i) $WD = Fd$ (or $p \Delta V$) = $440 \times 0.020 = 8.8 \text{ J}$ [A1]

(ii) work out new temperature (using ideal gas) = 350 K [M1]

$$U \propto T \text{ so } \Delta U = \Delta T/T \times U = 50/300 \times 78.9 = 13.2 \text{ J} \quad [\text{A1}]$$

(iii) $\Delta U = q + w \Rightarrow q = \Delta U - w = 13.2 - (-8.8) = 22.0 \text{ J}$ [A1]

32 (a) Velocity is defined as the rate of change of displacement. [B1]

Acceleration is defined as the rate of change of velocity. [B1]

(b) From definition of acceleration in (a), $a = (v - u)/t$ [M1]

(i) Hence $v = u + at$

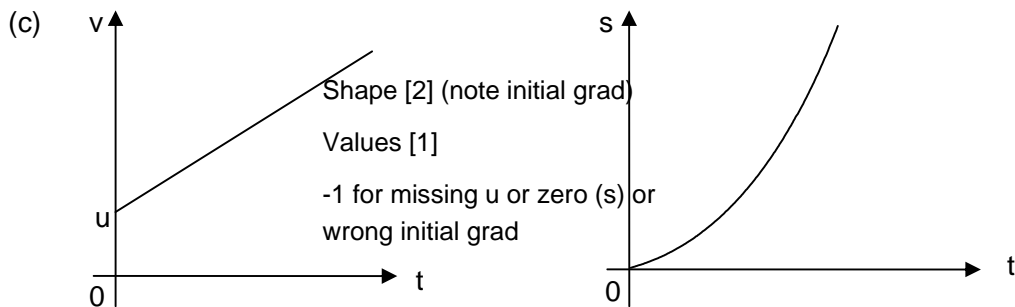
(ii) definition of velocity \Rightarrow avg. vel = change of displacement / $t \Rightarrow s = \frac{1}{2}(u + v)t$ [C1]

$$as = (u + v)t/2 \quad (v - u)/t$$

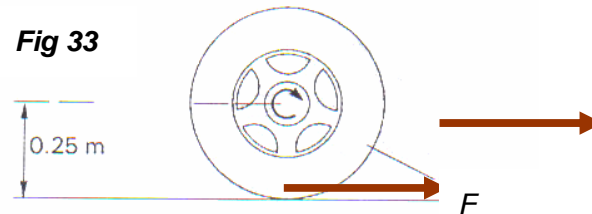
$$2as = (v + u)(v - u) \quad [\text{working A1}] \text{ Hence } v^2 = u^2 + 2as$$

For these equations to be applicable:

for uniform acceleration [B1] motion in a straight line. [B1]



- 33 Figure 33 shows the wheel of a car with a torque of 400 Nm being applied to the axle of the wheel. The car is traveling at a constant velocity of 30 ms^{-1} .



- (a) Show on **Fig. 33** the direction in which the car is traveling. [1]
- (b) Draw on **Fig 33**, an arrow representing F , the horizontal component of the force which the road exerts on the tyre. [1]
- (c) Since the car is traveling at constant velocity, what can be deduced about the resultant torque on the wheel? [1] [1]

The car is in dynamic equilibrium/turns with constant angular velocity, so the resultant torque is zero. [A1]

- (d) Find F . [2]

$$\text{Torque applied on axle}(T) - Fr = 0$$

$$T = Fr \quad \text{\{C1\}}$$

$$F = T/r = 400/0.25 = 1600 \text{ N} \quad \text{\[A1\]}$$

- (e) The wheel described above is known as a driving wheel. If the car has two such driving wheels, deduce the total forward force acting on the car.

$$\text{Total forward force} = 1600 \times 2 = 3200 \text{ N} \quad \text{\[A1\]}$$

- (f) With the value of the driving force in (d) on the wheels, the car is traveling at a constant maximum velocity of 30 m s^{-1} . Explain briefly why the car cannot accelerate anymore. [2]

The air drag on the car increases as velocity increases. [B1] When the sum of the air drag and other resistive forces is as large as the total forward force, the car travels with constant velocity [A1]

- (g) Explain why all the horizontal forces on the wheels are pointed backward during braking. [2]

During braking, the wheels tend to slide forward. [M1] The frictional force acting on the wheels will be pointing backward so as to oppose motion. [A1] trying to stop the sliding

$$34 \text{ (a) (i) } \phi = -\frac{GM_E}{r}$$

$$= -\frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{4.82 \times 10^7 + 6.37 \times 10^6} \quad [\text{C1}]$$

$$= -7.31 \times 10^6 \text{ Jkg}^{-1} \quad [\text{A1}]$$

$$\text{(ii) K.E.} = \frac{1}{2} m v^2$$

$$= \frac{1}{2} (1.7 \times 10^{19})(6.5 \times 10^3)^2$$

$$= 3.59 \times 10^{26} \text{ J} \quad [\text{A1}]$$

$$\text{(b) } \phi = -\frac{GM_E}{r}$$

$$= -\frac{6.67 \times 10^{-11} \times 5.98 \times 10^{24}}{6.37 \times 10^6}$$

$$= -6.26 \times 10^7 \text{ Jkg}^{-1} \quad [\text{A1}]$$

$$\text{(c) } \Delta U = U_f - U_i$$

$$= m(\phi_f - \phi_i)$$

$$= 1.7 \times 10^{19} \{-6.26 \times 10^7 - (-7.31 \times 10^6)\} \quad [\text{M1}]$$

$$= -9.4 \times 10^{26} \text{ J} \quad [\text{A1}]$$

$$\text{(d) Decrease in G.P.E.} = \text{Increase in K.E.} \quad [\text{C1}]$$

$$\text{K.E.} = 3.59 \times 10^{26} + 9.4 \times 10^{26}$$

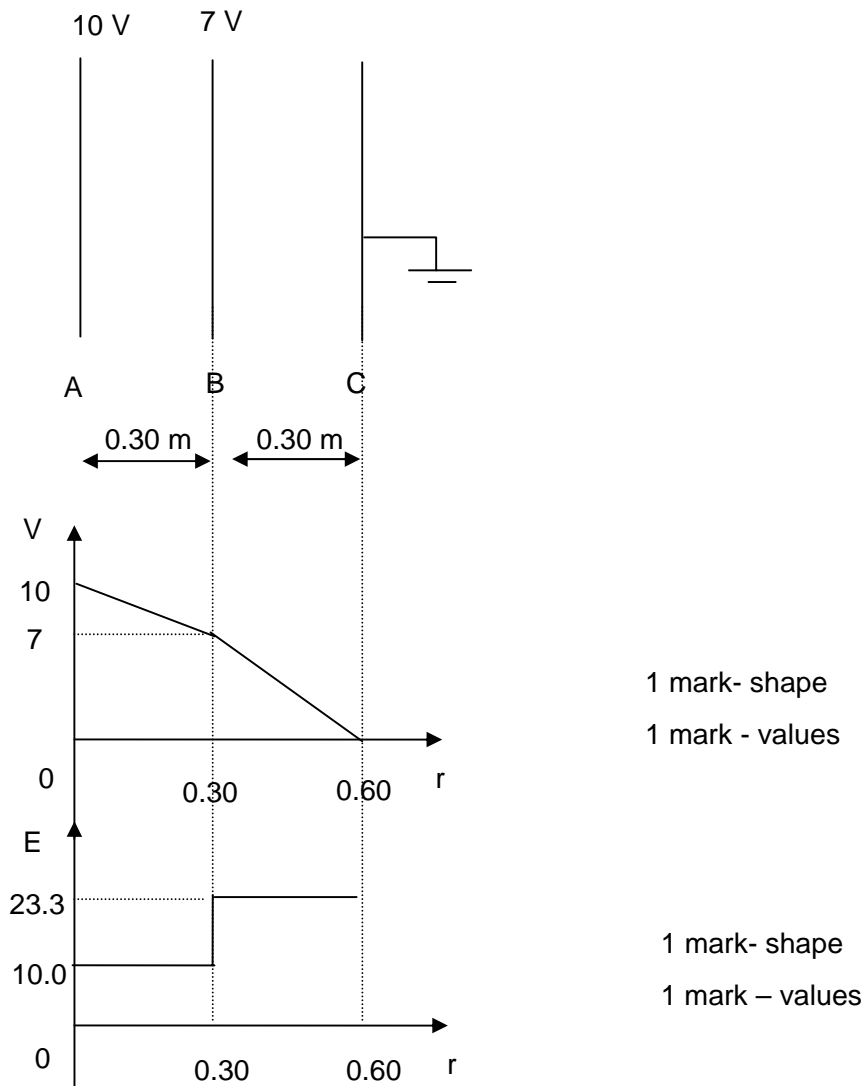
$$= 1.3 \times 10^{27} \text{ J} \quad [\text{A1}]$$

$$\text{Velocity} = \left(\frac{2 \times 1.3 \times 10^{27}}{1.7 \times 10^{19}} \right)^{1/2}$$

$$= 1.2 \times 10^4 \text{ m s}^{-1} \quad [\text{A1}]$$

assumption: [C1]

35 (a)



1 mark- shape
1 mark - values

1 mark- shape
1 mark - values

(b) (i)

$$\Delta U = \frac{Qq}{4\pi\epsilon_0 r_f} - \left(\frac{Qq}{4\pi\epsilon_0 r_i} \right) \quad [\text{C1}]$$

$$= - \frac{5.5 \times 10^{-17} \times 1.6 \times 10^{-19}}{4\pi\epsilon_0} \left(\frac{1}{0.20} - \frac{1}{2.00} \right) \quad [\text{M1}]$$

$$= -3.56 \times 10^{-25} \text{ J} \quad [\text{A1}]$$

(ii) The electron loses electric potential energy. [A1]

(iii) Using $\Delta \text{KE} = \Delta U$

$$\frac{1}{2} mv^2 = 3.56 \times 10^{-25} \quad [\text{M1}]$$

$$v = 884 \text{ m s}^{-1} \quad [\text{A1}]$$

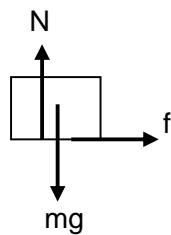
36 (a) (i) Newton's 2nd law of motion states that the rate of change of momentum of a body is directly proportional to the resultant force acting on it [B1] and the change of momentum takes place in the direction of the resultant force. [B1]

(ii) $F - f_o = (m_{\text{box}} + m_{\text{crate}}) a$ [C1]

$26 - 4.0 = (1.5 + 3.0)a$ [M1]

$a = 4.9 \text{ m s}^{-2}$ [A1]

(iii)



Total [B2]

-1 for any missing force

(when marking, ignore position)

(iv) Frictional force = $ma = 1.5 \times 4.9$ [M1]

$= 7.4 \text{ N}$ [A1]

(v) Condition is that the maximum frictional force between crate and box is less than 7.4 N. [B1]

[or any general valid statement; no friction will not be accepted]

(b) (i) the principle of conservation of momentum states that the total momentum of a system of bodies remains constant [B1] provided there is no resultant force acting on the system. [B1]

(ii) Completely inelastic collision [B1]

KE not conserved [B1]

(iii) $m_b u = (m_b + m_t)v$ [C1]

$0.030 \times 500 = (0.030 + 2.50)v$ [M1]

$v = 5.93 \text{ m s}^{-1}$ [A1]

(iv) $\frac{1}{2}(m_b + m_t)v^2 = \frac{1}{2}ke^2$ [C1]

$(0.030 + 2.50) \times 5.93^2 = 1400 \times e^2$ [M1]

$e = 0.252 \text{ m}$ [A1]

37 (a) $F = GMm/R^2$ [B1]

define all 4 terms [B2]; [-1/2 for each error or missing terms]

(b) (i) $mR\omega^2 = GMm/R^2$ [B1]

use $\omega = 2\pi/T$ [C1]

Rearrange to correct form [M1]

(ii) $r \propto T^{2/3}$

$\Rightarrow \text{ratio} = \frac{\text{radius of orbit of A}}{\text{radius of orbit of B}} = \left(\frac{\text{period of orbit of A}}{\text{period of orbit of B}} \right)^{2/3} = (1.3)^{2/3}$ [M1] = 1.2 [A1]

(iii) $m v^2 / R = GMm/R^2 \rightarrow m v^2 = GMm/R \rightarrow \text{smaller } R \rightarrow \text{larger } v$ [B1] \rightarrow B has higher orbital speed. [B1]

(c) (i) satellite appears stationary from earth or always above a fixed point. [B1]

(ii) recognize $T = 24$ hours [B1]

Subst the right values into [C1]

$$T = \sqrt{\frac{4\pi^2 r^3}{GM}} \rightarrow 24 \times 60 \times 60 = \sqrt{\frac{4\pi^2 r^3}{6.67 \times 10^{-11} (5.98 \times 10^{24})}}$$

find $R = 4.23 \times 10^7$ m [A1]

(iii) find $PE = -GMm/R = -1.132 \times 10^9$ J [B1]

find $KE = GMm/2R$ [B1] = 5.66×10^8 J [B1]

find $TE = -GMm/2R = -5.66 \times 10^8$ J [A1]

(iv) Loss energy $\rightarrow -GMm/2R$ is more negative and so R is smaller

\rightarrow K.E. = $GMm/2R$ gets larger in magnitude. [B1]

Loss energy \rightarrow more negative $\rightarrow GMm/2R = KE$ is larger [B1 for explanation] hence velocity will increase

- 38 (a) (i) Electromotive force of a source is the energy converted into electrical energy per unit charge delivered. [B1]

Volt is the potential difference between two points where one joule of electrical energy is converted to other forms of energy when one coulomb of charge flows from one point to the other. [B1]

- (ii) Resistance of a conductor is defined as the ratio of the potential difference across it to the current through it. [B1]

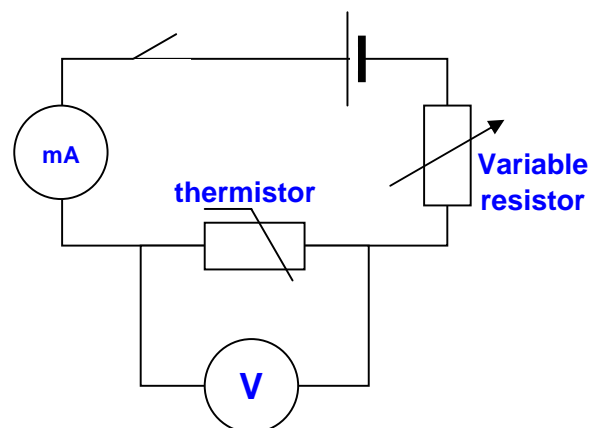
Ohm is the resistance of a conductor where a current of one ampere flows in it when the potential difference across it is one volt. [B1]

(b) (i) $R = \rho l / A$
 $= \frac{1.1 \times 10^{-6} \times 1.0}{\pi(0.050 \times 10^{-3})^2}$ [C1]
 $= 140 \Omega$ [A1]

(ii) $V = \frac{140}{140 + 150} \times 12$ [C1]
 $= 5.79 \text{ V}$ [A1]

(iii) $P = \frac{V^2}{R}$
 $= \frac{(12 - 5.79)^2}{150}$ [C1]
 $= 0.257 \text{ W}$ [A1]

(c)



[A2]

2 correct workable (vary E, vary R, vary T) (but 1 for no variable resistor)

$$\begin{aligned}
 \text{(d) (i) } I_{150\Omega} &= \frac{V}{R} \\
 &= \frac{9.0}{150} && \text{[C1]} \\
 &= 0.060 \text{ A} && \text{[A1]} \\
 I_{\text{thermistor}} &= 95 - 60 \\
 &= 35 \text{ mA} && \text{[A1]}
 \end{aligned}$$

(ii) From the graph, voltage across the thermistor = 5.6 V. [B1]

$$\begin{aligned}
 R_{\text{thermistor}} &= \frac{V}{I} \\
 &= \frac{5.6}{35 \times 10^{-3}} && \text{[C1]} \\
 &= 160 \Omega && \text{[A1]}
 \end{aligned}$$

$$\begin{aligned}
 \text{(iii) } R_{\text{resistor}} &= \frac{V}{I} \\
 &= \frac{(9.0 - 5.6)}{35 \times 10^{-3}} && \text{[C1]} \\
 &= 97.1 \Omega && \text{[A1]}
 \end{aligned}$$