Work Done & Power Past Paper Questions

Jan 2002 to Jan 2009

5(a) decreases for the first four seconds ✓
zero for the remaining six seconds ✓ (2)

(b) \[ E_k = \frac{1}{2} \times 1.4 \times 10^3 \times 16^2 \] ✓
\[ = 1.8 \times 10^5 \text{ J} \] ✓
(accept \( v = 15 \text{ m s}^{-1} \) from misleading graph and \( E_k = 1.6 \times 10^5 \text{ J} \)) (2)

(c) (use of \( P = Fv \) gives) \( 20 \times 10^3 = F \times 30 \) ✓
\[ F = 670 \text{ N} \] ✓ (2) (6)

5(a) (use of \( F = ma \) gives) \( F = 1.3 \times 10^3 \times 2.5 \) ✓
\[ = 3250 \text{ N} \) ✓ \((3.25 \times 10^3)\) (2)

(b)(i) driving force = 3250 + 410 = 3660 N ✓
(allow C.E. from (a))

(b)(ii) (use of \( P = Fv \) gives) \( P = 3660 \times 2.2 \) ✓
(allow C.E. from(i))
\[ = 8100 \text{ W} \) ✓ \((8.1 \times 10^3)\) (3)

(c) (component of) car’s weight opposes motion
[or overcomes gravity
or more work is done as car gains potential energy] ✓ (1) (6)

7(a) mark out (equal) distances along height being raised ✓
measure time taken to travel each of these distances ✓
times should be equal ✓
[or use a position sensor attached to a data logger
measure distance or speeds at regular intervals
increase in distance or speeds should be constant] max(2)

7(b) find work done by motor from gain in potential energy of metal block ✓
divide work done by time to find power ✓
measurements: mass of block, height block has risen and time taken ✓
[or power = \( Fv \)
force is weight of block
velocity is velocity of block
same measurements as above] max(2) (4)
(a)(i) (use of \( E_p = mgh \) gives) \( E_p = 70 \times 9.81 \times 150 \) ✓
\( = 1.0(3) \times 10^5 \) J ✓

(ii) (use of \( E_k = \frac{1}{2}mv^2 \) gives) \( E_k = \frac{1}{2} \times 70 \times 45^2 \) ✓
\( = 7.1 \times 10^5 \) J ✓
\( (7.09 \times 10^4 \) J) (4)

(b)(i) work done (= 1.03 \( \times 10^5 \) – 7.09 \( \times 10^4 \)) = 3.2(1) \( \times 10^4 \) J ✓
(allow C.E. for values of \( E_p \) and \( E_k \) from (a))

(ii) (use of work done = \( Fx \) gives) \( 3.21 \times 10^4 = F \times 150 \) ✓
(allow C.E. for value of work done from (i))
\( F = 210 \) N ✓
\( (213 \) N) (3)

Question 3

(a) resultant force on crate is zero ✓
forces must have equal magnitudes or size ✓
(but) act in opposite directions ✓
correct statement of 1\(^{st}\) or 2\(^{nd}\) law ✓

(b)(i) work done = \( F \times d = 640 \times 9.81 \times 8.0 \) ✓
\( = 5.0(2) \times 10^4 \) J ✓

(ii) (use of \( P = \frac{W}{t} \) gives) \( P = \frac{5.02 \times 10^4}{4.5} = 1.1(2) \times 10^4 \) W ✓
(allow C.E. for value of work done from (i)) (3)

<table>
<thead>
<tr>
<th>Question 3</th>
<th>Q3 Jan 2007</th>
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<tbody>
<tr>
<td>(a)</td>
<td></td>
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| (i)        | (use of \( F_H = F \cos \theta \) gives) \( \checkmark \checkmark \)
resultant force = \( 2 \times 6500 \cos 35 \)
resultant force = \( 11000 \) \( N \) (10649)
(1 out of 2 if only one component given) 4

(ii) (use of work = force \times distance gives) \( \checkmark \checkmark \)
work = \( 11000 \times 1.5 \times 60 \)
work = 990 000 J (958 408)
(if use 10 649 then 960 000 J) (b) there is an opposing force or mention of friction/drag \( \checkmark \checkmark \)
work is done on this force or overall resultant force is zero 2

(c) initially accelerates \( \checkmark \checkmark \checkmark \) max 3
as horizontal component increases
(so) forward force now larger than drag or resultant force no longer zero or now a resultant forward force eventually reaches new higher constant speed

Total 9
### Question 5

(i) find students weight (or mass) ✓
measure (vertical) height (of stairs) ✓
time (how long it takes student to run up stairs) ✓

(ii) using $E_p = mgh$ ✓
link measurements to quantities used to calculate $E_p$ ✓
divide gain in $E_p$ (or work) by time to get power ✓

(iii) not all work done goes to $E_p$ ✓
ignoring gain in $E_k$ ✓
or ignoring movement
or ignoring fiction
or athlete gets hot
or body not 100% efficient

Total 8

### Question 2

<table>
<thead>
<tr>
<th>(a)</th>
<th>(i)</th>
<th>vector has direction and a scalar does not ✓</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>(ii)</td>
<td>scalar examples; any two e.g. speed, mass, energy, time, power</td>
</tr>
<tr>
<td></td>
<td></td>
<td>vector examples; any two e.g. displacement, velocity, acceleration, force or weight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>✓✓✓ for 4 correct, ✓✓ for 3 correct, ✓ for 2 correct</td>
</tr>
</tbody>
</table>

| (b) | (i) | horizontal component (= 2.8 cos 35) = 2.3 (kN) (2293.6) ✓ |
| --- | --- | vertical component (= 2.8 sin 35) = 1.6 (kN) (1606.0) ✓ |
|   | (ii) | power = force × velocity or $2.3\,\text{kN} \times 8.8\,\text{m}\cdot\text{s}^{-1}$ ✓ (ecf from 2 (b)(i)) |
|   |   | $= 1.9 \times 10^4$ (19037 or 19100) ✓ ecf |
|   |   | $W$ (or $\text{J}\cdot\text{s}^{-1}$) ✓ (or 19 W (or $\text{kJ}\cdot\text{s}^{-1}$)) |

| (c) | (area of cross-section of cable =) $\pi \times (\frac{1}{2} \times 0.014)^2$ ✓ = $1.5(4) \times 10^{-4}$ (m$^2$) ✓ |
|   | stress (= $F/A$) = $rac{2800\,\text{N}}{1.54 \times 10^{-4}\,\text{m}^2}$ (allow ecf here if attempt to calculate area) ✓ |
|   |   | $= 1.8(2) \times 10^7$ ✓ ecf |
|   | $P_a$ (or N m$^{-2}$) ✓ |

Total 14