Cambridge Pre-U

**Cambridge International Examinations**
Cambridge Pre-U Certificate

**PHYSICS (PRINCIPAL)** **9792/02**

Paper 2 Written Paper **For Examination from 2016**

SPECIMEN MARK SCHEME

**2 hours**

# MAXIMUM MARK: 100

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 3 Pre-U Certificate.

This document consists of **6** printed pages.

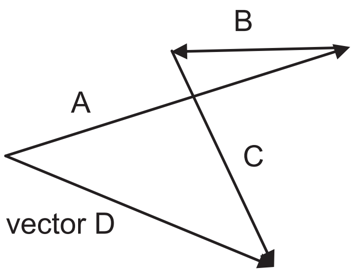
CAMBRIDGE International Examinations

## Section 1

**1** **(a)** **(i)** vectors have magnitude and direction but scalars have only magnitude (1) [1]

**(ii)** pair of correct vectors (1)
pair of correct scalars (1) [2]

**(b)** **(i)**




three vectors correctly arranged (nose-to-tail) (1)
resultant with correct arrow (1) [2]

**(ii)** (component in $x$-direction = 37cos 25° =) 33.5 (units)
(component in $y$-direction = 37sin 25° =) 15.6 (units) (2) [2]

**[Total: 7]**

**2** **(a)** power $= \frac{d(WD)}{dt}$ **or** WD $= \int P dt$ (1)
equals $\frac{d(\boldsymbol{F}.\boldsymbol{x})}{dt}$ equals $\frac{\boldsymbol{F}.d\boldsymbol{x}}{dt}$ equals $\boldsymbol{F}.\boldsymbol{v}$ (1)
**OR**
work done equals force × distance moved (in the direction of the force) so (1)
work done in unit time (second) = force × distance moved in unit time (second) (1)
(therefore power = force × velocity) accept sensible symbols [2]

**(b)** **(i)** $1800 = F \times 12.0$; $F = \frac{1800}{12.0} = 150$ (N) (1) [1]

**(ii)** 150 (N) **or** candidate's answer to **(b)(i)** (1) [1]

**(c)** **(i)** 850 × 2.5 (1)
2125 (kg ms$^{-2}$) (1) [2]

**(ii)** (driving force =) 2125 + candidate's **(b)(ii)** calculated (expected answer = 2275 (N)) (1) [1]

**(d)** **(i)** ($R \propto v^2$)
$\frac{R_{slow}}{R_{fast}} = \left(\frac{12.0}{36.0}\right)^2 = \frac{1}{9}$ **or** $k = 1.042$ (1)
(resistance at high speed = 9 × 150 =) 1350 (N) (1) [2]

**(ii)** (power output = 1350 × 36 =) 48600 (W) (1) [1]

**[Total: 10]**

**3** **(a)** **(i)** (current $= \frac{V}{R} =$) $\frac{240(\text{V})}{20}$ ($\Omega$) **or** 12 (A) (1)
power $= V \times I$ **or** $240 \times 12$ (1)
($240 \times 12 =$) 2880 (W) (1) [3]
alternatively $\frac{V^2}{R} = \frac{240^2}{20} = 2.88 \times 10^3$(W)

**(ii)** ($E =$) $2880 \times t = m \times c \times \Delta T$ (1)
($t = \frac{(33 \times 4200 \times 40)}{2880} =$) 1925 (s) (1) [2]

**(b)** **(i)** the (single) switch will cause three lights A, B and C to come on (1) [1]

**(ii)** either switch turns lamp D on (by completing circuit) (1)
either switch turns lamp D off (by breaking circuit) (1) [2]

**(iii)** (current =) $\frac{10(\text{W})}{240(\text{V})}$ **or** $\frac{1}{24}$ (A) **or** $\frac{V^2}{P}$ **or** $\frac{240^2}{10}$ (1)
(resistance $= \frac{V}{I} = 240 \times 24 =$) 5760 ($\Omega$) (1) [2]

**(c)** **(i)** one correct route from P to Q (1)
second correct route from P to Q (1) [2]

**(ii)** any **two** from:
independent switching/if one appliance fails the others work
many sockets can be attached to the ring
extra sockets can be put in with little difficulty
large currents can be supplied by two cables
less wiring needed
fault on one side will still leave circuit working (2) [2]

**[Total: 14]**

**4** **(a)** **(i)** transverse wave with oscillation/vibration at right angles to direction of travel (1)
longitudinal wave with oscillation/vibration in the direction of travel (1) [2]
accept answers in terms of a diagram

**(ii)** polarised with all the oscillation in one plane/direction/angle (1)
non-polarised with a variety of planes/directions/angles (1) [2]
a diagram here must have at least three doubled headed arrows

**(iii)** any **three** from:
standing wave as two waves (of the same type and frequency) travelling in opposite directions (1)
forming nodes and antinodes (can be from diagram) (1)
that do not change their position (can be from diagram) (1)
crests and troughs of progressive waves move forwards (can be from diagram) (1)
progressive waves transfer energy **or** standing waves do not transfer energy (1)
compares amplitudes (progressive constant; standing varies) (1)
compares phases (progressive varies; standing constant) (1) [3]

**(b)** **(i)** $(n\lambda = d\sin\theta)$

$d = \frac{1}{500}$ (mm) $= 2 \times 10^{-6}$(m) (1)

$\lambda = \frac{\sin 36.09 \times 2.0 \times 10^{-6}}{2}$ (1)

$= 5.891 \times 10^{-7}$ (m) (1) [3]

**(ii)** $\lambda = \sin 36.13 \times 10^{-6} = 5.896 \times 10^{-7}$ (m) (1) [1]

**(iii)** $\theta$ in radians **or** $\frac{0.04 \times 2\pi}{360}$ (1)

$(\theta = 0.04° = \frac{0.04 \times 2\pi}{360}$ (rad) $=$) $6.98 \times 10^{-4}$ (rad) **or** $b = \frac{\lambda}{0.04}$

**or** $b = \frac{\lambda}{\text{candidate's value}}$ (1)

$8.4 \times 10^{-4}$ (m) (1) [3]

**[Total: 14]**

**5** **(a)** **(i)** P = 236 **cao and** Q = 92 **cao** (1)
R = 143 **cao** (1) [2]

**(ii)** more neutrons are produced than are required to cause the reaction (1) [1]

**(b)** **(i)** ${}^{90}_{38}\text{Sr} \rightarrow {}^{90}_{39}\text{Y} + {}^{0}_{-1}\beta^{(-)}$ allow if candidate writes ${}_{x}\text{Sr}$ and ${}_{x+1}\text{Y}$

correct yttrium numbers (1)
correct beta numbers (1) [2]

**(ii)** 39 (1) [1]

**(iii)** half life is 28 years so 112 years is 4 half lives (1)

number present after this time is $\frac{1}{16}$ of original (1)

number present $= \frac{2.36 \times 10^{13}}{16} = 1.475 \times 10^{12}$ (1) [3]

**[Total: 9]**

**6** **(a)** when photons/em radiation/light is incident on surfaces/electrons/material/atom (1)
electrons are emitted (1)
<u>photons</u> must have sufficiently high energy/frequency (1)
$hf$ is the energy of a photon/em radiation/light/wave (1)
$\Phi$ is the work function/(minimum) energy required to liberate an electron (1)
$\frac{1}{2}mv^2$ is the (maximum) kinetic energy of a liberated electron (1) [6]

**(b)** <u>use</u> of a stopping potential (1)
arrangement with correct polarity and (sensitive) galvanometer/ammeter (1)
measure/adjust p.d. to a situation where current ceases (1)
this gives energy per unit charge so to get $v_{max}$ charge per unit mass of electron needs to be used or $eV_S = \frac{1}{2} mv^2_{max}$ (1) [4]

**(c)** **(i)** any **one** from
very low intensity still produces immediate emission
kinetic energy of electons does not depend on the intensity
emission is affected by frequency (e.g. there is a threshold frequency)

**(ii)** any **one** from
classical wave requires a wait
the more energy incident on the material, the greater will be the maximum kinetic energy
frequency does not affect emission (provided the energy is the same)

**(iii)** any **one** from
some electrons will absorb the few photons
each electron absorbs one photon (of constant energy)
energy of photon depends on frequency **or** $E = hf$

[3]

**[Total: 13]**

**7** **Limiting angle for toppling**

Calculation of angle at which this occurs (geometric method expected)

$\tan\theta = \frac{10}{15} = 0.67$ (1)

hence $\theta = 33.7°$ (1)

**Condition to slide**

component of weight down slope = $mg\sin\theta$ (1)
friction force acting up slope = $\mu_s mg\cos\theta$ (1)
leading to $\tan\theta = \mu_s = 0.60$ (1)
hence $\theta = 31.0°$ (1)

**Prediction/conclusion**

31.0°(slide) < 33.7°(topple) therefore it slides (before toppling). (2) [8]
accept conclusion based on direct comparison of values for tangents
accept conclusion based on the requirement for the coefficient of static friction to be greater than 0.600

**[Total: 8]**

## Section 2

| | | | | | |
|---|---|---|---|---|---|
| **8** | **(a)** | **(i)** | **1.** 800 (A) | (1) | |
| | | | **2.** 350 000 **or** $3.5 \times 10^5$ (V) | (1) | |
| | | **(ii)** | ($P$ =) $VI$ seen **or** implied (in **1.** or **2.**) | (1) | |
| | | | $2.8 \times 10^8$ (W) **and** 0 | (1) | |
| | | **(iii)** | up and down graph – e.g. sawtooth, triangular wave – **and** number on axis | (1) | |
| | | | decent $\sin^2$ graph with correct curvature at bottom | (1) | |
| | | | time period of bumps = 0.010 s | (1) | |
| | | **(iv)** | horizontal line | (1) | |
| | | | horizontal line at $\dfrac{2.8 \times 10^8\,\text{W}}{\text{candidate's value}}$ | (1) | |
| | | **(v)** | reference to area under the graph | (1) | |
| | | | area under the graph is greater | (1) | [11] |
| | **(b)** | **(i)** | 0.0107 (m) **or** 1.07 cm **or** 10.7 mm | (1) | |
| | | **(ii)** | $\pi({r_1}^2 - {r_2}^2)$ **or** $\pi(1.50^2 - 0.43^2)$ **or** $\pi(0.0150^2 - 0.0043^2)$ | (1) | |
| | | | $6.49 \times 10^{-4}$ (m$^2$) | (1) | |
| | | **(iii)** | $R = \dfrac{\rho l}{A}$ **or** $\dfrac{1.72 \times 10^{-8} \times 5.8 \times 10^3}{6.49 \times 10^{-4}}$ | | |
| | | | and | | |
| | | | $\dfrac{1.72 \times 10^{-8} \times 580\,000}{6.49 \times 10^{-4}}$ **or** 15.3 **or** 15.4 (Ω) | (1) | |
| | | | | (1) | |
| | | **(iv)** | ($P$ =) $I^2R$ **or** $800^2 \times 15.3$ | (1) | |
| | | | 9.79 (MW) accept 9.86 (from $R$ = 15.4 Ω) | (1) | [7] |
| | **(c)** | **(i)** | ($Q_t$) $CV_0 \sin(2\pi ft)$ **or** $CV_t$ **not** $CV$ | (1) | |
| | | **(ii)** | the charge on the plates charges and charge flows on and off the plates | (1) | |
| | | **(iii)** | **1.** the *more* quickly the charge charges <u>and</u> the *more* quickly the charge flows | (1) | |
| | | | **2.** (capacitive reactance = ) $\dfrac{1}{2\pi fC}$ <u>and</u> ohm/Ω/VA$^{-1}$ | (1) | |
| | | | **3.** ($I_0$ =) $2 \times \pi \times 50.0 \times 200 \times 7.00 \times 10^{-7} \times 350\,000$ | (1) | |
| | | | $1.54 \times 10^4$ (A) | (1) | |
| | | **(iv)** | there is an extra current (not present with d.c.) which generates greater energy losses | (1) | [7] |

**[Total: 25]**