UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

Pre-U Certificate

MARK SCHEME for the May/June 2012 question paper

for the guidance of teachers

9792 PHYSICS

9792/02 Paper 2 (Part A Written), maximum raw mark 100

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UNIVERSITY of CAMBRIDGE
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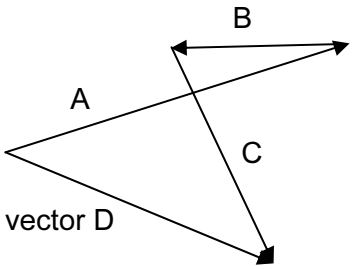
1 (a) (i) vectors have magnitude and direction but scalars have only magnitude (1) [1]

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

[Total: 7]

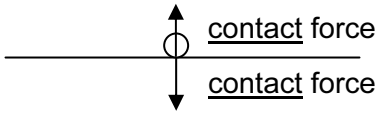
2 (a) (i)  (gravitational) pull of Earth on object

 pull of object on Earth

two forces on two objects (1)
equal, opposite and some reference to gravitation (<u>not</u> just *mg*/*W*/weight) (1) [2]

(ii) the forces in **(i)** still exist (1)

two <u>contact</u>/<u>reaction</u>/<u>electrostatic</u>/<u>normal</u> forces shown in diagram/mentioned (1) [2]



(b) (i) curve of decreasing gradient (<u>ignore</u> short, initial straight section) (1)
no deceleration <u>and</u> starts from zero (1) [2]

(ii) **two** from:
pull of Earth on object still equal to pull of object on Earth (1)
there is force on the air (molecules) downwards/due to object (1)
<u>this</u> force is increasing (1)
the force the air exerts on the object and the force the object exerts on the air remain equal and opposite (1) [2]

[Total: 8]

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

(b) **(i)** 1800 = F x 12.0; F = 1800 / 12.0 = 150 (N) (1) [1]

(ii) candidate's **(b)(i)** (expected answer = 150 (N)) (1) [1]

(c) (resultant force = mass x acceleration)
(driving force – 150 =)850 × 2.50 **or** 2125 (1)
(driving force =)2125 + candidate's **(b)(ii)** calculated (expected answer = 2275 (N)) (1) [2]

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

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

(e) P_{high} / P_{low} = 48600 / 1800 = 27; v_{high}/v_{low} = 36 / 12 = 3
(i.e. ratios of powers and speeds) (1)
27 = 3^3 therefore $P \propto v^3$ (1) [2]

[Total: 11]

4 **(a)** **(i)** (current = V/R =)240 (V) / 20 (Ω) **or** 12 (A) } **or** { V^2/R (1)
power = $V \times I$ **or** 240 × 12 } **or** { $240^2/20$ (1)
(240 x 12 =)2880 (W) (1) [3]

(ii) (E =)2880 × t = $m \times c \times \Delta T$ (1)
(t = (33 × 4200 × 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 =)10 (W) / 240 (V) **or** 1/24 (A) **or** V^2/P **or** $240^2/10$ (1)
(resistance = V/I = 240 × 24 =)5760 (Ω) (1) [2]

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

(ii) **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]

5 (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
(a diagram here must have at least three doubled headed arrows) (1) [2]

(iii) **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 = 1/500 mm = 2×10^{-6} m (1)
λ = sin 36.09 × 2.0×10^{-6} / 2 (1)
= 5.891×10^{-7} (m) (1) [3]

(ii) λ = sin 36.13 × 10^{-6} = 5.896×10^{-7} (m) (1) [1]

(iii) θ in radians **or** 0.04 × 2π / 360 (1)
(θ = 0.04° = 0.04 × 2π / 360 (rad) =)6.98×10^{-4} (rad) **or** $b = \lambda$/0.04
or $b = \lambda$/candidate's value (1)
8.4×10^{-4} (m) (1) [3]

[Total: 14]

6 (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) $^{90}_{38}\mathrm{Sr} \rightarrow {}^{90}_{39}\mathrm{Y} + {}^{0}_{-1}\beta^{(-)}$ (<u>allow</u> if candidate writes ${}_{x}\mathrm{Sr}$ and ${}_{x+1}\mathrm{Y}$)
correct yttrium numbers (1)
correct beta numbers (1) [2]

(ii) half life is 28 years so 112 years is 4 half lives (1)
number present after this time is 1/16 of original (1)
number present = $2.36 \times 10^{13} / 16 = 1.475 \times 10^{12}$ (1) [3]

[Total: 8]

7 (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)
Φ 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** $eV_s = \frac{1}{2}m v_{max}^2$ (1) [4]

(c) (i)	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)	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)	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]

Section B

8 (a) (i) use of (a =) $\Delta v/t$ **or** (101 to 103) / 150 (1)
or attempt at gradient with sensible values (1)
0.673 – 0.687 ($m\,s^{-2}$) (accept 0.68 ($m\,s^{-2}$)) (1)

(ii) 5 × 48 000 × candidate's **(a)(i) or** 48 000 × candidate's **(a)(i)** (1)
$1.61 – 1.65 \times 10^5$ (N) (1)

(iii) candidate's **(a)(ii)** ($kg\ m\ s^{-2}$) (1) [5]

(b) air resistance/drag/air friction/opposing force (ignore friction/resistance) increases (as the train accelerates/speeds up) (1)
resultant force remains constant **or** increase is cancelled by (increase) in air resistance (1) [2]

(c) evidence of counting squares (e.g. ~500 squares)
or 19 300 – 20 800 (m) (1)
19 800 – 20 300 (m) (1) [2]

(d) (i) 136 ($m\ s^{-1}$) **cao** (1)

(ii) (h =) 136 × 0.02 **or** 2.72 (m) (1)
use of (GPE =)mgh e.g. 5 × 48 000 × 9.81 × 2.72 (1)
6.40×10^6 (J) (allow J s^{-1} if candidate alters answer line)
(if factor of five already penalised in **(a)(ii)**, allow 1.28×10^6 (J)) (1)

(iii) $6.40 \times 10^6 / 9.80 \times 10^7$ (1)
6.53 (%) (1) [6]

(e) (i) (a material whose) resistance/resistivity is (very close to) zero (1)

(ii) no resistive losses/heat generated (in the coil/superconductor)/
lets a large current to flow/lets a large magnetic field be produced (1)
must be kept at a very low temperature **or** helium expensive **or** energy needed to cool coil **or** expensive to keep cold (1) [3]

(f) the answers below are in terms of the maglev system; the reverse points can be made for a conventional railway

social:
speedier journeys (1)
better for business (1)
no stopping at smaller towns/in between (1)
does not link into established network (1)
very high speeds can cause more serious collisions (1)
compete with air travel more effectively (1)
many passengers per hour (1)

environmental:

less greenhouse gas/CO_2 emitted (not carbon emissions)	(1)
more energy/fuel efficient	(1)
narrow guideways create a lesser impact	(1)
new lines built to centre of cities	(1)
less noisy **or** more noisy because speeds are higher	(1)
no overhead power lines	(1)
less wear and tear	(1)
less pollution along the track	(1)

economic:

steeper gradients (shorter track length)	(1)
more expensive to build	(1)
less expensive to run	(1)
(bank) interest on construction costs	(1)
fewer tunnels	(1)
less maintenance	(1)
cannot run on conventional track	

why few maglevs:

cost	(1)
untested system	(1)
conventional rail got established first	(1)

maximum for question = 7 (with at least **two** advantages and at least **two** disadvantages) [7]

[Total: 25]