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Mark Scheme Summer 2007

GCE

GCE Salters Horners Physics (6755/02)

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6755-02 Unit Test PSA5

1.

(a)

Ratio of speed of sound in steel to air:

Use of $c^2 = E/\rho$	✓	
Correct answer [5200 ms^{-1}]	✓	
So, ratio = 5200/330 = 16	✓	**3**

Example of calculation:

c^2 = 2.1×10^{11} Nm^{-2} / 7.9×10^3 kgm^{-3}

≈ 2.7×10^7 m^2s^{-2}

So c = 5200 ms^{-1}

(b)

Why sound travels faster through steel:

Atoms/molecule /particles more tightly packed in steel than in air	✓	
So vibrations/energy/wave passes more quickly/easily from atom to atom	✓	**2**

(c)

Why relationship is inappropriate:

Idea that equation only applies to vibrations that are spreading in all directions - can be from a diagram	✓	

and one point from:

• vibrations are transmitted along rail in one direction		
• energy absorbed / attenuated (as vibration passes from atom to atom)	✓	**2**

Total 7

2.

(a)

Choice of construction materials:		
Reference to porous/fibrous materials	✓	
Plastic deformation absorbs energy	✓	
Air pockets cause reduce sound transmission/reflection at air boundaries	✓	3

(b)

Meaning of resonance:		
Parts of building have about the same natural frequency as driving vibrator	✓	
so vibrate with increased/large amplitude **or** maximum/large energy transfer occurs	✓	2

(c) (i)

Why springs reduce vibration:		
Spring deforms (instead of building)	✓	
absorbing energy	✓	2

(ii) Less damage during earthquake:

vibration of building is damped / amplitude of vibration is reduced (so damage to building would be less)	✓	1
		Total 8

3.

(a) Expression for gravitational force:

$F = GMm/r^2$ ✓ **1**

(b) Expression for gravitational field strength:

g = force on 1 kg, so $g = GM/r^2$, or g = F/m so $g = GM/r^2$ ✓ **1**

(c) Radius of geostationary orbit:

Idea that a = g, and suitable expression for a quoted [can be in terms of forces] ✓

substitution for velocity in terms of T ✓

algebra to obtain required result ✓ **3**

Example of derivation:

$g = v^2/r$ **or** $g = \omega^2 r$

and $v = 2\pi r/T$ **or** $\omega = 2\pi/T$

so $(2\pi r/T)^2/r = GM/r^2$ **or** $(2\pi/T)^2 r = GM/r^2$, leading to expression given

(d) Calculation of radius:

Substitution into expression given ✓

Correct answer [4.2×10^7 m] ✓ **2**

Example of calculation:

$r^3 = 6.67\times10^{-11}\ \text{Nm}^2\text{kg}^{-2} \times 6.0\times10^{24}\ \text{kg} \times (24\times60\times60\ \text{s})^2 / 4\pi^2$

$= 7.6 \times 10^{22}\ \text{m}^3$

So $r = 4.2 \times 10^7$ m

(e) (i) Satellite with greater mass:

Yes - because, in geostationary orbit, r constant so acceleration remains the same, regardless of mass ✓

(ii) Satellite with greater speed:

No + suitable argument ✓ **2**

[e.g. for geostationary orbit, T and r are fixed, so v cannot increase ($v = 2\pi r/T$)]

(f) Why satellite must be over equator:

Idea that centre of satellite's orbit must be the centre of the Earth (can be shown on diagram) ✓

there must be a common axis of rotation for the satellite and the Earth / the satellite's orbit must be at right angles to the spin axis of the Earth ✓ **2**

Total 11

4.

(a)	Description of fusion: Two light nuclei combine to form a single (heavier) nucleus Energy is released	✓ ✓	2
(b)	Need high temperature **and** high density / pressure and one point from: • to overcome electrostatic repulsion / for a large collision rate • a reference to containment problems	✓ ✓	2
(c)	When hydrogen nuclei fuse, there is a loss of mass This is converted into energy, according to: $\Delta E = c^2 \Delta m$	✓ ✓	2
			Total 6

5.

(a) Estimate of volume of helium:

Estimate of temperature at sea level [0 ^{0}C - 30 ^{0}C] ✓

Conversion of temperatures to kelvin ✓

Correct substitution for V in expression $V = 4/3\ \pi\ r^3$ ✓

Example of calculation:
$V = 4/3\ \pi\ (105\ m)^3$
$V = 4.8 \times 10^6\ m^3$

Recall of general gas equation (pV/T = constant) ✓
Use of general gas equation ✓
Correct answer [$6 \times 10^3\ m^3 \rightarrow 7 \times 10^3\ m^3$] to 2 s.f. [since estimate] ✓ **6**

Example of calculation:
$V_1 = p_2 / p_1 \times T_1/T_2 \times V_2$
$V_1 = 1/1000 \times 293/213 \times 4.8 \times 10^6\ m^3$
$V_1 = 6.7 \times 10^3\ m^3$

(b) Labelling of graph:

Graph with lower peak labelled "sea level" ✓
At sea level, temperature is higher, so average K.E. of molecules is higher ✓ **2**

Total 8

Total for Paper = 40