1 Units
g is N kg-1
Vgrav is N m kg-1

2 Expanding universe
Red-shift observed for multiple galaxies
implies they are all moving away from a point (i.e. the big bang)
OR cosmic microwave background radiation is from light from the early universe and has been redshifted as the universe has expanded

3 High speed particle
$\gamma = 2.3$
$v = 2.7 \times 10^8$ ms-1

4 Momentum
a
p before = p after = 1,000,000 kgms-1
KE before = 1,000,000 J is not equal to KE after = 125,000 J
b
Energy lost as heat

5 Testing relationships
If relationship true, $T\rho$ = constant
All values about 352
Relationship is true

6 Equipotentials
B (one that looked like a figure of 8 with the two planets at the centres of the circles)

7 Radioactivity
$A = A_o e^{-\lambda t}$, so $\ln A = \ln A_o - \lambda t$
Plot a graph of lnA against t
Gradient is $-\lambda$
OR plot activity against time, find time for activity to half, use $\lambda = \ln 2/\text{halflife}$

8 Modelling
a
-0.03
-0.03
-0.0075
b
different because constant v assumed for time interval, whereas in 2nd model v is always changing

9 p verses T
C (straight line)

10 Measuring G
a
Show that
b
3.0 x 10^24
c
speed of light the same there and back
moon does not move much in time interval (?)
OR light travels the same distance to there and back
d
r = 3.75 x 10^8
G = 1.2 x 10^-10
e
Big error in mass of Earth
due to poor (under)estimate of average density (using surface rocks)

11 Pressure
a
frequent collisions with ground
particles experience change in p when they bounce off ground
ground must also experience equal and opposite change in p (to conserve momentum)
force is rate of change of momentum, so force exerted on ground
pressure is force/area, so pressure exerted on ground
b i
c = 511 ms-1
b ii
n = 1.2 x 10^27 s-1
assume all changes in momentum are 2mv
assume all collisions are elastic

12 Capacitors
a
b i
R = 2.2 kΩ
b ii
C = 2.2 x 10^-2 F
c i
I = 0.94uA
ii
ε is the energy required for electrons to flow through capacitor gap
iii
ε = 3.9 x 10^-20 J

13 Resonance
a
natural frequency = driving frequency
amplitude increases

unsafe/dangerous

OR increasing amplitude of oscillations means cable more likely to snap due to reaching breaking stress

b

Show that

c

m = 1500 + 640 = 2140 kg

fo = 1.4 Hz, which is in the range 0.2 - 2 Hz

d i

reduces efficiency of lift (increased operating cost?)

requires a more powerful lift motor (which is more expensive)

d ii

use thicker cables

fo is proportional to sqrt(A)

so thicker cables increase the natural frequency, so if enough, will be out of the 0.2-2 range.