Neap:

Trial Examination 2008

VCE Physics Unit 2

Written Examination

Suggested Solutions

Copyright © 2008 Neap ABN 49 910 906 643 96–106 Pelham St Carlton VIC 3053 Tel: (03) 8341 8341 Fax: (03) 8341 8300 TEVPHYU2_SS_08.FM

SECTION A – CORE

Area of study 1 – Movement

Question 1

a. The rocket accelerates upwards at first, between 0 and 2 seconds. 1 mark

Then it starts to decelerate, while still going up, until it reaches zero velocity. 1 mark

b. The rocket now accelerates downward. 1 mark

Question 2

The gradient of the graph should be -10 m s^{-2} after 2 seconds. 1 mark

Therefore:

$$-10 = \frac{V_{max}}{6}$$ 1 mark

$$V_{max} = 60 \text{ m s}^{-1}$$ 1 mark

Question 3

Area under graph = displacement 1 mark

$(0.5 \times 2 \times 60) + (0.5 \times 6 \times 60) = s$

$s = 240$ m 1 mark

Question 4

No, the rocket will not reach the ground after 14 seconds. 1 mark

$$v_f = v_i^2 + 2as$$

$60^2 = 0 + 20s$ 1 mark

$s = 180$ m

So rocket only falls 180 m in 6 seconds. 1 mark

Question 5

The force of gravity is balanced exactly by the force of air resistance in the opposing direction, 1 mark

so the net force is zero: velocity is uniform. 1 mark

Question 6

Third 1 mark

Weight 1 mark

You pulling up the earth 1 mark

Question 7

Yes, forces other than *A* and *B* are acting on him. 1 mark

The two forces shown are not balanced, therefore Jack cannot be stationary. 1 mark

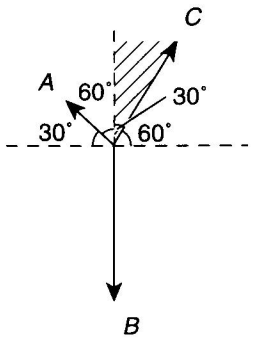
Question 8

Weight = mg

Weight = 79×10 1 mark

Weight = 790 N

Question 9



$\vec{A} + \vec{C} = -\vec{B}$ 1 mark

$\sin(30°) = \frac{A}{790}$ 1 mark

$A = 395$ N 1 mark

Question 10

$W = F \times s$ 1 mark

$W = 790 \times 5$

$W = 3950$ J 1 mark

Question 11 **C** 2 marks

During a fall, gravitational potential energy is transformed into increasing kinetic energy of the falling object as it accelerates.

Question 12

As Jack has fallen 5.2 m before stopping, the change in his potential energy is $79 \times 10 \times 5 = 3950$ J.

The work done by the mattress equals the change in Jack's potential energy:

$\therefore \frac{1}{2}kx^2 = 3950$ J 1 mark

$\therefore \frac{1}{2}k \times (0.02)^2 = 3950$

$\therefore k = 197\ 500$ N m^{-1}

$\therefore k = 2.0 \times 10^5$ N m^{-1} 1 mark

Question 13

W = energy stored in mattress

$W = F_{average} \times s$ 1 mark

$F_{average} = \dfrac{3950 \text{ J}}{0.20 \text{ m}}$ 1 mark

$F_{average} = 19750 \text{ N}$

Question 14

That the musket ball would have a falling time (ten times) greater than that of the cannon ball. 1 mark

Question 15

That both balls reached the ground (nearly) at the same time. 1 mark

Question 16

Newton would use kinematics and dynamics to explain why both accelerate at the same rate:

The cannon ball will experience a force 10 times greater than the musket ball. 1 mark

It also has a mass 10 times greater. This means that the acceleration of the cannon ball will in fact be the same as the musket ball because $a = \dfrac{F}{m}$. 1 mark

So both balls will experience the same acceleration (in the absence of air resistance), and so will have the same falling times. 1 mark

Area of study 2 – Electricity

Question 1

First find the resistance, $R_{parallel}$, of the parallel resistors:

$$\frac{1}{R_{parallel}} = \frac{1}{10} + \frac{1}{12}$$

$$= \frac{12}{120}$$

$$R_{parallel} = \frac{60}{11}$$ 1 mark

total resistance, $R_T = 10 + \left(\frac{1}{10} + \frac{1}{12}\right)^{-1}$

$= 10 + 5.5$

$= 15.5$

$= 16\ \Omega$ to two significant figures 1 mark

Question 2

$$I_T = \frac{V}{R_T}$$

$$= \frac{6.0}{15.45}$$ 1 mark

$= 0.39$ A 1 mark

Question 3

$P = VI$

$= 6.0 \times 0.39$ 1 mark

$= 2.3$ W 1 mark

Question 4

$q = It$

$= 0.39 \times 90$ 1 mark

$= 35$ C 1 mark

Question 5

$E = VIt$

$= 6.0 \times 0.39 \times 90$ 1 mark

$= 207$

$= 210$ W 1 mark

Question 6 **A** 2 marks

Since R_1 and R_2 are parallel, the voltage across R_1 is the same as across R_2. Reading from the graph, when the current through R_1 is 600 mA the voltage is 0.6 V.

Question 7 **D** 2 marks

With a potential difference across R_2 of 0.6 V, from the graph you get 800 mA.

$P = VI$

$= 0.6 \times 0.8$

$= 0.48$ W

Question 8 **C** 2 marks

Only a diode allows current to flow in one direction but not the other.

Question 9

Greg placed the resistor in series with the unknown device to limit the current through it.
He thus protected the device from overheating and being damaged. 1 mark

Question 10

First find the current through the resistor:

$I = \frac{V}{R} = \frac{9 - 0.7}{100} = 0.083$ mA 1 mark

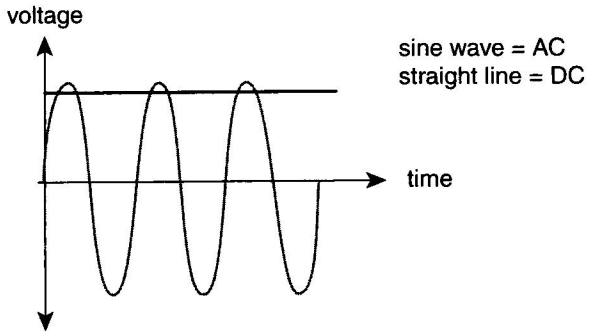
Then use $P = VI = 9 \times 0.083 = 0.75$ W 1 mark

Question 11

The setup is now wired in parallel. The diode is forward biased but has no other device in series with it so the resistance is minimal. This causes the current to be large and overheats the diode. (Effectively a short-circuit has occurred.) 1 mark

Large amounts of current flow and since there is little resistance in the circuit it damages the diode. Effectively a short-circuit has occurred. 1 mark

Question 12



2 marks

Question 13

DC 1 mark

earth 1 mark

fuse 1 mark

Question 14

Any of the following:

i. Electric shock can be affected by the skin's resistance, the lower the resistance, the greater the current for a given voltage.

ii. The current in the circuit, the greater the current the more potential damage.

iii. The time of exposure to the shock, increased time leads to increased damage.

iv. AC is more harmful than DC.

2 marks

1 mark for each explanation, up to a total of 2 marks

Question 15

$P = VI$

$= 240 \times 10$

$= 2400 \text{ W}$

$= 2.4 \text{ kW}$

$t = 7 \times \dfrac{20 \text{ min}}{60 \text{ min h}^{-1}}$

$= 2.33 \text{ h week}^{-1}$

1 mark

$E = Pt$

$= 2.4 \times 2.33$

$= 5.6 \text{ kW h}$

1 mark

SECTION B – Detailed studies

Detailed study 1 – Astrophysics

Question 1 **D**

The key difference is that the steady state theory maintains the universe has always had, and will always have, the same average density.

2 marks

Question 2 **A**

Of the four fundamental forces, gravity is the one that forms the large-scale structure of the universe.

2 marks

Question 3 **C**

Our galaxy is about 100 000 light-years in diameter. A parsec is about 3.6 light-years so 100 million parsecs is too large as a measure of galaxy diameter.

2 marks

Question 4 **D**

Most stars are found in the main sequence. (Hence the name.)

2 marks

Question 5 **D**

All three options **A**, **B** and **C** give legitimate expressions for luminosity.

2 marks

Question 6 **B**

Our Sun is a main sequence star and should therefore be found in section *B*.

2 marks

Question 7 **A and C**

Some HR diagrams are shown with a temperature scale, some with a spectral class or colour scale.

2 marks

Question 8 **C**

The expansion of the universe is only observable on intergalactic distance scales.

2 marks

Question 9 **D**

Hubble's law relates the speed of galaxies to their distance.

2 marks

Question 10 **D**

The speed of light is constant and the wavelength will decrease as the source comes towards you.

2 marks

Question 11 **A**

The Milky Way is classified as a spiral galaxy.

2 marks

Question 12 **B**

Nuclear fusion of hydrogen is what powers stars for most of their lifetime.

2 marks

Question 13 **C**

A and **B** are too short to show any measurable parallax to even the nearest stars.

D is too long: we could never achieve such a long baseline within our solar system.

2 marks

Detailed study 2 – Aerospace

Question 1 **C**

These are the correct terms for the four main forces acting on a flying aircraft.

2 marks

Question 2 **D**

This is the only combination that will cause a slowing down (**D** is bigger than **B**) and is able to account for losing altitude (**A** is smaller than **C**).

2 marks

Question 3 **A**

For a cruising aircraft all forces should be balanced.

2 marks

Question 4 **C**

If the force acts away from the centre of gravity, the aircraft is likely to start rotating

2 marks

Question 5 **B**

There will be a non-zero torque around the aircraft's centre of gravity. This will result in a rotational movement.

2 marks

Question 6 **B**

Bernoulli's theory shows that the pressure above a suitably shaped aerofoil is less than the pressure below it.

2 marks

Question 7 **C**

Conservation of momentum can be used to explain lift in aeroplanes.

2 marks

Question 8 **A**

As the wing of a real aircraft moves through the air (forward), the airflow around the wing moves backward relative to the wing.

2 marks

Question 9 **C**

The wing profile will produce lift. This force counters weight and so the force meter will read less than 20 N.

2 marks

Question 10 **B**

Skin friction and pressure drag make up total drag in flying objects.

2 marks

Question 11 **A**

Drag force is caused by the relative motion of the air. In this case: to the right.

2 marks

Question 12 **B**

$\tau = F \times r$

$= 2000 \text{ N} \times 5.0 \text{ m}$

$= 10\ 000 \text{ N m}$

2 marks

Question 13 **D**

Both engines generate equal torque, but in opposing directions. So the total torque is zero N m.

2 marks

Detailed study 3 – Alternative energy sources

Question 1 **B**

$P_{in} = 240 \times 1.5 = 360$ W, $P_{out} = 20 \times 3.25 = 65$ W

$$\text{Efficiency (\%)} = \frac{\text{energy output}}{\text{energy input}} \times 100 = \frac{65}{360} \times 100 = 18\ \%$$

2 marks

Question 2 **C**

Most of the energy is lost as heat.

2 marks

Question 3 **C**

The tilt of the axis means that more radiation is absorbed as it passes through the atmosphere.
(Also, the radiation hits the Earth's surface at a greater angle from the normal than in summer.)

2 marks

Question 4 **A**

mass = $20\ 000 \times 50 = 1 \times 10^6$ grams

= 1 tonne

2 marks

Question 5 **B**

$\frac{15\text{W}}{75\text{W}} = \frac{1}{5}$ so $\frac{20\ 000}{5}$ balloons (i.e. 4000 balloons) would be produced.

This is a reduction of 16 000 balloons from the original 20 000.

2 marks

Question 6 **B**

Coal / greenhouse effect / increase

2 marks

Question 7 **C**

The infrared radiation heats up the air which then drives a turbine and the turbine generates electricity.

2 marks

Question 8 **D**

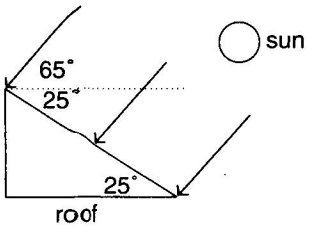
10 % of 2100 = 210 MW = 0.210 GW

Energy = power × time = 0.21 GW × 3600 s = 756 GJ

2 marks

Question 9 **C**

The maximum amount of light falls on the panel when it and the sun are the same angle from the horizontal (assuming parallel rays from the sun).



2 marks

Question 10 **C**

Firstly convert 2100 MW to kW.

$$\frac{2.1 \times 10^6}{1.37} = \frac{1.53 \times 10^6}{0.12} = 1.28 \times 10^7 \text{ m}^2$$

2 marks

Question 11 **B**

$mgh = 150.9 \times 10 \times 1\ 000 = 1\ 500\ 000 \text{ J} = 1.5 \text{ MJ}$

2 marks

Question 12 **D**

There is always some energy loss. **A** (bad design) is also acceptable as a secondary answer.

2 marks

Question 13 **A**

Nuclear power plants don't produce greenhouse gases.

2 marks